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RESOURCE ADEQUACY MECHANISMS IN THE NATIONAL ELECTRICITY MARKET

A REPORT FOR THE ENERGY SECURITY BOARD (ESB)

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Executive summary

Power systems provide an essential service to consumers by producing, transporting and delivering electricity. These systems require supply and demand to be balanced at all times for **consumers to have a reliable source of electricity**. A critical factor in delivering a reliable supply of electricity is ensuring that investments in energy resources can be made at the appropriate time and location to match demand. Sufficient provision of such resources is often referred to as **resource adequacy**.

Achieving resource adequacy at an **efficient cost** is a fundamental objective for the long-term interests of **consumers**. Insufficient resources or network capability leads to load shedding, which can impose a (potentially significant) economic cost on consumers. At the same time, reliability should be delivered at **value for money**, whilst accommodating policy objectives, expected changes to the market, and technological advancements.

In common with most electricity markets around the world, the Australian National Electricity Market ("**NEM**") is experiencing many changes to the market as part of the energy transition. **The share of generation from renewable intermittent sources, notably solar and wind generation, is increasing rapidly**. At the same time, the demand for electricity is also evolving, driven by factors such as decentralised energy resources, digitalisation and deployment of electric vehicles.

This transition is affecting the need for resource adequacy, as well as how it is delivered and experienced. Achieving resource adequacy often relies on resources that are dispatchable (i.e. that can respond to changes in market conditions or notices from the Australian Energy Market Operator ("**AEMO**") at short notice). As variable renewable energy ("**VRE**") generation increases, the variability of net load increases (i.e. the variability of the difference between load and the energy supplied by VRE generation). This will increase the importance of having sufficient dispatchable resources to respond at short notice to maintain the balance of supply and demand.

Given these complexities, significant attention is required from regulators and policymakers to ensure that the appropriate wholesale market and other mechanisms are in place to deliver resource adequacy for consumers at value for money.

Resource adequacy measures complement the functioning of electricity markets to support resource adequacy

Ideally, an electricity market delivers resource adequacy by allowing market participants to respond to efficient real-time price signals that incentivise efficient short-run and long-run outcomes. Such a market design, with the appropriate regulatory oversight, would deliver resource adequacy at lowest cost in the long-term interest of consumers.

However, for a variety of reasons, electricity markets are often not “ideal”, and an important implication of this is that the signals from real-time prices may not be sufficiently efficient to drive the investments required to meet the socially-optimal levels of reliability. Separately, it may also be desirable to seek to ensure an even greater level of reliability than would theoretically be produced through the reliability settings.

Resource adequacy mechanisms (“**RAMs**”) are mechanisms that **complement** electricity markets to improve the delivery of resource adequacy. RAMs support resource adequacy by providing resources with additional revenues and/or risk mitigating opportunities to increase the propensity to invest and be available when required.

The purpose of this report is to highlight, in a systematic way, the key aspects of a range of potential RAM options that ESB may be mindful of as it considers if and how to further support resource adequacy in the NEM.

The RAM options covered in this report are as follows:

- **Changes to the “reliability settings” of the NEM** (and in particular the Market Price Cap) which have implications for resource adequacy.
- The Reliability and Emergency Reserve Trader mechanism (“**RERT**”) used by AEMO to contract directly for additional capacity in advance of a projected shortfall. In principle, this is to ensure resources are available whenever (and wherever) needed, whilst seeking to minimise market distortions.
- The Retailer Reliability Obligation (**“RRO”**), a recently introduced mechanism designed to support resource adequacy in the NEM. The RRO requires that AEMO identifies any potential shortage of dispatchable resources over certain timescales. If a shortage is identified, retailers can be required to enter into contracts to cover their share of demand if the market does not respond to the forecast shortage.

- **Scarcity pricing mechanisms**, which are mechanisms for explicitly increasing the real-time energy price during periods of scarcity, to reflect requirements for responsive capacity (capacity that can respond at very short notice to variations in supply and demand, such as operating reserves). The simplest form is a **scarcity price adder,** which adds a margin to the price that increases to the extent that responsive capacity decreases the probability of an outage. Another form of scarcity pricing approach is an **operating reserves mechanism**, where the scarcity pricing effect occurs within the execution of the market dispatch. The market design for the operating reserves mechanism includes separate markets to schedule one or more types of operating reserves (and also possibly other so-called Essential System Services ("**ESS**")).
- **Capacity markets**, which seek to guarantee a certain volume of capacity is installed, through the use of forward-looking obligations (typically 1 to 5 years ahead obligations, but can be up to 15 years) and associated penalty regimes. This report focuses on two broad types of capacity markets – **centralised capacity markets** (where a central body such as the System Operator ("**SO**") procures capacity through a central auction) and **decentralised capacity markets** (where the SO places obligations on retailers to procure physically-backed capacity).

Our report describes each of the RAM options identified above and considers the merits of each. We have not scored or ranked each RAM option, but rather set out some advantages and disadvantages of each, given the context of the NEM. Our overall reflections are summarised below.

Some existing features of the NEM could in principle be adjusted to support resource adequacy, but policymakers should be circumspect about relying on them

The NEM has two long-standing design features which are relevant in supporting resource adequacy – the RERT, and the reliability settings. Notwithstanding the question of whether there is a need for *any* changes to the NEM to meet future resource adequacy needs, it seems reasonable to consider what adjustments could first be made to these features of the NEM design if policymakers wished to further support resource adequacy.

The RERT is a critical "backstop" but its usage should not be expanded to attempt to address resource adequacy in a broad sense

The RERT is a form of "backstop" in the electricity market to support reliability in extreme circumstances. A key feature is that it is an "out-of-market" measure in which the SO directly intervenes to ensure the ongoing reliability of the system. Most liberalised electricity markets have some form of backstop, but they are not intended to be a substitute for the resource adequacy formed through a well-functioning electricity market. Indeed, such backstops are rarely used as the only mechanism in a market to support resource adequacy.

It is outside the scope of this report to provide a view on exactly why the RERT has been used more in recent years – it could be related to several overlapping factors including, but not limited to, a lack of resource adequacy, potentially stemming from market design issues. Policymakers in some markets have sought to use backstop measures, like the RERT, to manage extreme events to secure reliability beyond what might be expected under the reliability standard. Additionally, a backstop mechanism could theoretically be relied on more heavily as an interim measure to assist with bringing new resources online as a new market design is implemented. However, anything other than minimal use of the RERT risks embedding reliance on it, which, because it is an "out-of-market" measure, has the potential to undermine the operation of the wholesale market. This could risk imposing significant costs for consumers.

An (upward) adjustment to the reliability settings improves the theoretical efficiency of market signals, but there may be limited benefits to doing so

In the NEM, the reliability settings are developed through a robust process. One of the key reliability settings, which we focus on in this report, is the Market Price Cap ("**MPC**") which can provide a degree of consumer protection against very high prices. Fundamentally, a price cap set around the value that consumers (on average) place on lost load will balance the cost of delivering resource adequacy with the cost and risk of shed load.

If the MPC is significantly below the theoretical value that consumers place on shed load, then increasing the cap could in theory increase resource adequacy due to stronger investment signals. However, there is a significant risk that such a change will not result in new efficient investments, due to (i) the presence of other market imperfections; and (ii) market perceptions (whether founded or not) that policymakers will not retain a higher price cap in the long term. Given this, a change in the reliability settings alone could potentially lead to an undesirable consumer outcome of higher short-term prices without associated investments to further support resource adequacy.

For additional RAMs, if so desired, a key choice is whether to use a more centralised governance system to manage resource adequacy, or whether to continue relying predominately on wholesale market price signals

A key feature of any additional mechanisms to support resource adequacy is the relationship between **reliability and cost**. Whilst the ultimate "value for money" for the consumer, provided in terms of reliability and cost, is extremely sensitive to the design choices in the RAM (and therefore difficult to examine for the broad options presented in this report), a key question is whether policymakers wish to select for a given level of reliability – i.e. whether they seek to provide a guarantee that a specified level of capacity will be available over a specified time horizon.

The NEM has arguably taken a step in this direction, with the RRO mechanism. The RRO is a new approach, which, in principle, combines the benefits of: (i) centralised resource adequacy procurement (i.e. AEMO monitors for future shortfalls and **obliges market participants to procure certain types of products**); with (ii) the benefits of using market forces to assess and value risk (i.e. risk is placed on retailers, who should be well-placed to manage it). This should support resource adequacy by encouraging more long-term financial contracts, reducing the risk exposure to resources and increasing resource investment signals.

A key consideration for the RRO to maximise its efficiency may be to develop a methodology, to trigger the RRO, that is uniformly based on a **clear, well-defined set of criteria *ex-ante* to set clear long-term expectations to market participants**.

The above is based on the premise that the RRO is not intended to be used widely as a centralised planning process for resource capacity. An RRO mechanism that becomes "embedded" in market expectations and is frequently triggered would arguably move it closer to a capacity market approach, since it would effectively have similar obligations (for this reason, the RRO mechanism would likely not co-exist effectively with a capacity market).

Capacity markets seek to guarantee a certain volume of capacity is installed, and do this through the use of forward-looking obligations and associated penalty regimes. For eligible resources, the higher certainty in future cash flows can lower their cost of capital, incentivising **more investment in advance of delivery at a lower cost**. Policymakers have significant discretion to choose the desired reliability standard, but there is a **risk of over-procurement, leading to unnecessarily high costs to consumers**.

Additionally, there is no guarantee that the capacity procured through a capacity market would be “**deliverable” to meet load in real-time**, as required. Finally, the implementation of a capacity market is a particularly significant administrative undertaking relative to other RAMs, and whilst (in theory) temporary, they are in practice difficult to reverse in practice.

Scarcity pricing mechanisms augment market signals to explicitly reflect the value of responsiveness which is why they are becoming prevalent in many liberalised electricity markets

Scarcity pricing supports resource adequacy by augmenting price signals to reflect the value to load of incremental capacity that can respond quickly. This rewards flexibility and raises the prices for all market participants operating at times of scarcity.

In the NEM, resources are already free to offer bids above variable cost up to the MPC, and are incentivised to do so when it is profitable during periods of scarcity. Therefore, scarcity pricing exists in the NEM “implicitly”; market participants are incentivised to invest and make their capacity available when there is a financial opportunity.

If this implicit scarcity pricing effect is insufficient in the NEM, a scarcity price mechanism could explicitly augment price signals to reflect the value to load of incremental capacity that can respond quickly, and do so in a **more transparent and predictable manner** than is currently the case. This could potentially support greater investments in **responsive capacity** as and when needed in the NEM.

An explicit scarcity pricing mechanism could be implemented in two main ways, a scarcity price adder or an operating reserves mechanism:

- An operating reserves mechanism is more complex to implement but would provide **co-optimisation of energy and reserves, with reserves acting as an ESS**. This would be an evolutionary change to the NEM, but can potentially lead to **material cost savings in the dispatch of energy and reserves**.
- A scarcity price adder could be a “stepping stone” towards an operating reserves mechanism, leaving open the possibility of implementing the more simple form first before developing the more advanced form for implementation.

RAMs could have different broad implications for the NEM's rapid transition away from coal-powered generation

In many jurisdictions, the share of generation from renewable intermittent sources, notably solar and wind generation, is increasing rapidly, in tandem with the exit of coal-powered generation.

This transition, however, is expected to occur relatively rapidly in the NEM, in part because significant coal-fired generation capacity is expected to retire over a short period of time.[1] This may lead to or exacerbate reliability concerns in the system, especially if there is accelerated or unexpected early exit of large units.

Given this, any consideration of RAMs in the context of the NEM should give due regard to the impact on coal generation capacity, and the implications on the transition away from this.

The impact of any RAMs on coal generating capacity would ultimately depend on the detailed design of the RAM – which means it is not possible to be definitive about the impact in broad terms. However, there are two main factors which are particularly relevant:

- First, how successful the RAM is at providing investment signals (which would benefit all types of generation).
- Second, the extent to which the investment signal is targeted at capacity that can respond quickly to changes in supply and demand conditions (which may put coal generators at a *relative* disadvantage as they are generally less responsive than other technologies such as gas-fired generators and battery storage units).

Based on these two factors, we highlight a number of key points for each RAM:

- A change in the **reliability settings** means that coal generation (along with all other types of resources) could benefit from higher or longer price spikes. However, other resources that are more responsive could have a relatively higher benefit compared to coal generators.
- Increased reliance on the **RRO** mechanism provides stronger signals (via obligations for retailers to procure financial contracts) for dispatchable resources (which includes coal generation).

1 For example, the Central ISP scenario forecasts that approximately 15GW out of 23GW of coal will retire in the NEM by 2040.

- Increased **reliance on the RERT** depends on how and when the RERT is procured. The impact on coal generation in general would likely be minimal (as intervention pricing seeks to mitigate pricing impacts of RERT).
- **Scarcity pricing mechanisms** would lead to all resources (including coal generation) receiving higher settlement prices, particularly during periods of scarcity. However, other resources that are more responsive could have a relatively higher benefit compared to coal generators.
- For **capacity markets**, there is a very wide range of design choices which means they provide options for policymakers to target specific types of resources (or not). Coal generation would benefit if eligible to participate. In principle, a capacity market could be designed to either advantage coal generators (e.g. if the capacity market favours assets approaching retirement) or to disadvantage coal generators (e.g. if the capacity market favours more responsive capacity or if emissions requirements are introduced).

Conclusions

The increasing use of the RERT is arguably concerning, but does not in and of itself point to an immediate lack of resource adequacy. With this in mind, it seems reasonable to consider, in the first instance, approaches which aim to "fix" the missing elements of electricity markets that could potentially lead to sub-optimal resource adequacy in the first place. This would provide an **incremental improvement** to the functioning of the market.

Scarcity price mechanisms go some way towards this goal, explicitly *augmenting* existing price signals to reflect the value to load of incremental capacity that can respond quickly. They offer a market-driven solution, and are aided by (but do not *require*) some of the other NEM developments currently under consideration by ESB.

It therefore seems reasonable to suggest that ESB considers, in further detail, an explicit scarcity pricing mechanism for the NEM. An operating reserves mechanism could be implemented as a standalone ESS development or as part of a wider suite of ESS services. As noted above, this could potentially lead to material cost savings in the dispatch of energy and reserves. A simpler form of scarcity pricing mechanism (the scarcity price adder) could be used as a stepping-stone towards this. Further detailed assessments are required, particularly on the incremental benefits of such a mechanism in the context of the NEM where scarcity pricing effects already exist implicitly through resource offers.

As well as scarcity pricing mechanisms, we have also considered some forms of capacity markets in this report. As explained above, they fundamentally seek to "guarantee" resource adequacy, by providing resources with additional, forward-looking and de-risked cashflows. There are many advantages to this approach, in terms of the level of comfort they could provide around installed capacity and the potential for significant reductions in the cost of capital. However, the approach ultimately transfers risk to consumers and relies on a willingness for policymakers to move away from the use of wholesale market prices alone to signal efficient investment. This is to some extent a matter of socio-economic preference, but our sense is there is not a broad consensus in Australia that intervention on this scale is justified. Additionally, implementing a capacity market may reduce the implicit scarcity pricing effect that currently exists in the NEM. This will require an explicit scarcity pricing mechanism to reintroduce the scarcity price signals.

Finally, capacity markets would not be complementary to the RRO, which is a relatively new mechanism which seeks to provide (in a limited and contingent way) the resource adequacy "guarantee" that a (decentralised) capacity market would seek.

1. Background and introduction to this report

Background and purpose of the report

1.1 In common with most electricity markets in the world, the Australian National Electricity Market[2] ("**NEM**") has entered a period of transition as the share of generation from renewable intermittent sources, notably solar and wind generation, is increasing rapidly. At the same time, the demand for electricity is also evolving, driven by factors such as decentralised energy resources, digitalisation and deployment of electric vehicles.

1.2 This energy transition is affecting the way resource adequacy is delivered and experienced. Intermittent generation is expected to continue increasing rapidly, changing the generation mix, dynamics of the spot market and the longer-term requirements of the energy system. Additionally, emerging technologies such as demand side response, battery storage and distributed generators provide new opportunities to deliver resource adequacy.

1.3 Historically, competitive electricity wholesale markets have been able to deliver the required investments, mostly large-scale thermal generation, by allowing market prices to adjust freely. However, amidst this energy transition, there are concerns being expressed that the market, left to itself, may not provide sufficient signals to encourage timely investment in reliable sources of generation.

1.4 In response to these concerns, policymakers in many liberalised electricity markets have developed additional mechanisms to support resource adequacy (which we refer to in this report as resource adequacy mechanisms or "**RAMs**"). For example, in the NEM, recent policies such as the Retailer Reliability Obligation ("**RRO**") and enhancements to the Reliability and Emergency Reserve Trader ("**RERT**") have been developed.

1.5 Looking ahead to the second half of the decade, there is an ongoing debate in Australia on whether resource adequacy in the NEM will be sufficient and, if not, what further adjustments, enhancements or additions could, or should, be made to support resource adequacy in the long term.

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2 The NEM covers five regions: Queensland, New South Wales, Victoria, South Australia and Tasmania.

1.6 The Council of Australian Governments ("**COAG**") Energy Council has initiated a wide-ranging review programme to consider potential options for a long-term market framework design, to meet the National Electricity Objective. As part of this programme, the Energy Security Board ("**ESB**") has been requested to develop advice on the long-term, fit-for-purpose market framework to support reliability from the mid-2020s. This consists of several market design initiatives, including potential resource adequacy mechanisms.[3]

Purpose and objectives of this report

1.7 ESB, in collaboration with the Australian Energy Market Operator ("**AEMO**"), the Australian Energy Market Commission ("**AEMC**") and the Australian Energy Regulator ("**AER**"), has been requested to advise on a long-term, fit-for-purpose market framework to support reliability, modifying the NEM as necessary, to meet the needs of future diverse sources of non-dispatchable generation and flexible resources, including demand side response, storage and distributed energy resource participation.

1.8 The purpose of this report is to support ESB on one specific strand of the post-2025 market design, relating to RAMs. In this strand, ESB is currently looking to understand the key features of potential RAM options and the circumstances in which each may be useful. Specifically, in this report, we:

- describe the **background and challenges to resource adequacy** in electricity markets and the NEM specifically;
- articulate a **range of RAM options**, exploring the definition, the key underlying premises of each option, and interactions with other mechanisms and market design features that might be required; and
- **assess the options**, considering for each RAM: (i) how it might meet the theoretical principles of good market design; and (ii) the potential stakeholder impact.

[3] COAG, Post 2025 Market Design - Scope and Forward Work Plan, 22 March 2019 (link). Other market design initiatives include ageing thermal generation exit strategy, essential system services, ahead markets, two-sided markets, Distributed Energy Resources markets and Coordination of Generation and Transmission.

Restrictions

1.9 This report has been prepared solely for the benefit of ESB and AEMC[4] for the purpose described in this introduction.

1.10 FTI Consulting accepts no liability or duty of care to any person other than AEMC for the content of the report and disclaims all responsibility for the consequences of any person other than ESB or AEMC acting or refraining to act in reliance on the report or for any decisions made or not made which are based upon the report.

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1.13 This report contains information obtained or derived from a variety of sources. FTI Consulting has not sought to establish the reliability of those sources or verified the information provided.

1.14 No representation or warranty of any kind (whether expressed or implied) is given by FTI Consulting to any person (except to AEMC under the relevant terms of our engagement) as to the accuracy or completeness of this report.

1.15 This report is based on information available to FTI Consulting at the time of writing of the report and does not take into account any new information which becomes known to us after the date of the report. We accept no responsibility for updating the report or informing any recipient of the report of any such new information.

[4] Under the terms of the Engagement for services between AEMC and FTI Consulting, dated 23 April 2020.

Structure of this report

1.16 This report has the following sections:

- Section 2 presents a **background to resource adequacy in electricity markets**, including a summary discussion of the features of electricity markets that means RAMs are sometimes necessary.
- Section 3 summarises the **key features of the NEM** that are relevant to resource adequacy, and the potential future changes that may drive the need for changes to resource adequacy in the market.
- Section 4 introduces a range of **potential RAM development options**, characterised in a systematic framework which includes a discussion of the key premises underlying each RAM option.
- Section 5 provides a **high-level qualitative assessment** of the options introduced in Section 4, considering for each: (i) how it might meet the theoretical principles of good market design; and (ii) the potential stakeholder impact.
- Section 6 provides some **overall reflections on the different options available to the NEM**, based on the discussions in Section 4 and 5.

1.17 A glossary of key terms used in this report is attached at the end of this report.

2. Background to resource adequacy in electricity markets

2.1 Power systems provide an essential service to consumers by producing, transporting and delivering electricity. These systems require supply and demand to be balanced at all times for consumers to have a reliable source of electricity. A critical factor in delivering a reliable supply of electricity is ensuring that investments in energy resources that can be made available at the appropriate time and location to match demand. Sufficient provision of such resources is often referred to as resource adequacy.

2.2 Historically, competitive wholesale electricity markets were developed based on the premise that competition would be more successful than monopoly providers in identifying sources of generation at lowest cost. In these markets, the investment in and delivery of resources is driven by market-based price signals, incentivising market participants to make optimal operational and investment decisions. However, several impediments can exist in electricity markets which may hinder the efficient delivery of resource adequacy.

2.3 This section provides a background to resource adequacy in electricity markets, and the potential role for RAMs, by:

- first, explaining the concept of resource adequacy in electricity markets;
- second, introducing the principles of a well-functioning electricity market;
- third, explaining why missing elements may exist in these electricity markets and how emerging trends are exacerbating these issues; and
- finally, explaining the potential role of RAMs to support the delivery of resources.

A. Resource adequacy in electricity markets

2.4 Resource adequacy is a term referring to a power system that has a "*sufficient overall portfolio of energy resources to continuously achieve the real-time balancing of supply and demand*".[5] This covers two requirements:

- The direct provision of resources to match supply and demand. These resources include both electricity produced by generators as well as demand reduction.
- The capability to respond to large, continual changes in the requirements of the system, especially when they affect the balance between supply and demand (e.g. increase in peak demand due to high temperatures or supply shortfalls due to a generator outage).

2.5 To deliver resource adequacy, the provision of resources needs to balance supply and demand both temporally and locationally. To achieve this, resource adequacy has traditionally been split into capacity adequacy and energy adequacy, each of which must be sufficient:

- Capacity adequacy refers to a power system that has sufficient resources to achieve the balancing of supply and demand at a <u>specific point in time</u>. This includes both:
  - during peak demand periods (i.e. under maximum demand conditions); and
  - during other variations in generation or transmission (e.g. when there is unusually high electricity demand caused by extreme temperatures).
- Energy adequacy refers to a power system that has sufficient fuel resources to achieve the balancing of supply and demand over a <u>period of time</u>, for example over hours, days, seasons or years. Energy adequacy must also cover changes to energy requirements that last for longer periods of time (e.g. during droughts or unplanned gas supply outages).

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5 AEMO, Power System Requirements, March 2018 (link), page 10.

2.6 Whilst energy adequacy can be met by a wide range of technologies (both supply-side and demand side), achieving capacity adequacy often relies on resources that are dispatchable (i.e. that can respond to changes in market conditions or notices from AEMO at short notice). These resources are crucial in delivering capacity adequacy, and in turn, resource adequacy. As variable renewable energy ("**VRE**") generation increases, the variability of net load increases, i.e. the variability of the difference between load and the energy supplied by VRE. This will increase the importance of having sufficient dispatchable resources to respond at short notice to maintain the balance of supply and demand.

2.7 To balance supply and demand locationally, the power system must have sufficient network transport capacity and the capability to connect resources to demand. As network investment can be costly, delivering resource adequacy efficiently requires an efficient coordination of generation and network investments. This could include, for example, managing the potential trade-off between locating generation at more efficient sites, further from demand (where more network investment is required) and locating generation close to demand (where less network investment is required).

2.8 The extent to which a power system has sufficient resources (generating capacity and fuel) and network capability to withstand variations in supply and demand is referred to in the NEM as **reliability**.[6]

2.9 Separate to the reliability requirements of the power system, the system must also operate within defined technical limits at all times, such as voltage and frequency limits. Unexpected contingency events, such as an unplanned outage, may cause a power system to deviate away from these limits. The extent to which a power system operates within these limits, and can withstand contingency events, is referred to in the NEM as **security**. To address security issues, specific system services are required, rather than having sufficient resource adequacy per se. While this report focusses primarily on the delivery of resource adequacy to meet the reliability requirements of the system, there may be notable overlaps as some resources are able to provide both reliability and security.

2.10 Achieving reliability at an efficient cost is a fundamental objective for the long-term interests of consumers. Insufficient resources or network capability leads to load shedding, which can impose a (potentially significant) economic cost on consumers. At the same time, reliability should be delivered at value for money, whilst accommodating policy objectives, expected changes to the market, and technological advancements.

6 AEMO, System operations website (link).

2.11 Given these complexities, significant attention is required from regulators and policymakers to ensure that the appropriate wholesale market and other mechanisms are in place to deliver resource adequacy.

B. Principles of a well-functioning electricity market

2.12 One of the key tenets of competitive wholesale electricity markets, since their introduction around the world in the 1980s, is the belief that competition is better than monopoly providers in meeting the long-term interests of consumers. This is based on the premise that such competition would incentivise greater innovation and efficient investment in the lowest cost resources able to deliver resource adequacy.

2.13 A well-functioning competitive electricity market is typically designed adhering to five key principles. These are:

- Efficient dispatch to drive efficient price signals.
- Efficient price signals to drive efficient investments.
- No undue discrimination, in the interests of maximising competition (noting there may be good reasons for "due" discrimination, e.g. targeting certain resource characteristics such as responsive capacity).
- Minimum regulatory intervention.
- Cost recovery and risks are allocated appropriately.

2.14 We explain each of these below.

Efficient dispatch to drive efficient price signals

2.15 Efficient dispatch and efficient price signals are central to an ideal competitive wholesale electricity market. As physical electricity is difficult to store, electricity must generally be supplied to meet load in real-time, observing any technical constraints. A competitive wholesale electricity market facilitates and delivers this physical requirement through a security-constrained real-time dispatch based on voluntary bids and offers from market participants. The real-time market clearing prices arise from the same bids and offers used for the real-time dispatch. These real-time prices, if formed correctly, are essential market-based signals to incentivise market participants to make optimal operational and investment decisions.

2.16 The key requirements that must be met to deliver efficient dispatch are as follows:

- Technical constraints of the power system, and of the physical operation of supply (e.g. ramping constraints) must be observed to maintain real-time reliability. This means that real-time dispatch as well as the real-time prices should ideally consider marginal losses and congestion.
- Material externalities should be accounted for in the dispatch model and prices. This includes environmental externalities.
- Prices should be able to adjust freely in real-time to reflect real-time conditions (e.g. during scarcity periods).
- Market participants should be subject to settlement at the real-time market clearing prices.

Efficient price signals to drive efficient investments

2.17 Market clearing prices formed in real-time, if reflective of the above requirements, should be sufficient to provide incentives for efficient and timely resource investments.[7] The investments may differ in technical characteristics to meet different needs of the power system, such as ramping speed, start-up time and location. Prices should incorporate the requirements to cover these technical characteristics.

2.18 Price signals should also be sufficiently transparent and predictable to facilitate efficient financial markets that underpin these investments. Market participants are reliant on independent and efficient financial markets to manage their risk exposure to real-time energy prices. Price signals that enable the hedging of these risks across a longer time period provide investors with more certainty (which is particularly important given that such investments are often large and capital-intensive, with long lead-times and asset lives).

2.19 Therefore, the design of the real-time market dispatch and the associated real-time prices are critical to deliver efficient investments. If these are inconsistent with real-time offers or reliability constraints, problems will arise when market participants intend to secure physical delivery on their forward market transactions (which are based on expectations of real-time prices), but physical delivery is not possible (because of real-time physical constraints).

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7 Resource investment decisions also depend on expectations about changes in transmission grid capacity and configuration.

2.20 This means that there are uncertainties about whether a physical asset under a forward commitment can deliver in real-time to meet load when required, because of physical limitations to reliable transmission system operation. Central coordination of real-time dispatch is necessary to balance supply and demand and determine real-time clearing prices to settle the difference between forward commitments and real-time physical quantities. Without settlement of these differences at efficient real-time market prices, financial markets and forward commitments would unlikely be able to deliver efficient investments.

No undue discrimination

2.21 In running a competitive wholesale electricity market, no undue discrimination must be made for or against any participant. Some forms of "discrimination" might be desired by policymakers; for example, when developing a renewable subsidy to offset an externality, or occasional procurement of emergency strategic reserves due to an unexpected and temporary market failure. However, these must be designed in view of fostering a competitive electricity wholesale market with minimal distortions.

2.22 Discrimination will affect market participants' behaviour. Market participants that expect to be discriminated against may ultimately choose not to invest over the longer-term. The overall principle of no undue discrimination is becoming increasingly important, particularly when designing renewables policy, supporting ageing thermal generation or accelerating innovation in emerging technologies.

2.23 For this report, this principle considers the risk of unintentionally creating discrimination in the design of a RAM. Policymakers may have to make decisions on how technology-neutral a RAM should be, or whether it should target specific resource characteristics. For example, some specific technical characteristics required by the electricity system related to resource adequacy might be:

- Peaking capacity, which is capacity that can be dispatched during peak periods;

- Responsive capacity, which is a subset of peak capacity for capacity that can respond quickly to changes in demand and supply conditions.[8] As intermittent renewable generation increases, more responsive capacity is required to respond to any shortfall or surplus in energy at short notice.

Minimum regulatory intervention

2.24 To allow the competitive market to produce optimal outcomes (e.g. resource adequacy at lowest cost to consumers), a well-functioning electricity market should aim to have minimum regulatory intervention. This means that markets are predominantly relied on to deliver efficient outcomes with minimal government and/or regulatory interventions.

2.25 The reliance on markets, rather than on regulatory interventions, may need to be supported by credible and transparent central bodies such as a regulator, rule maker and a centralised SO. These bodies provide oversight on the functioning of the markets and also coordinate the dispatch and maintain energy security. These are ultimately required to ensure that competition in the electricity market is complemented with **consumer protections** to serve the interests of consumers.

Cost recovery and risks allocated appropriately

2.26 A well-functioning electricity market would also ensure that cost recovery and risks are allocated appropriately. This consists of two principles:

- First, participants who impose costs should be exposed to those costs (also known as the "polluters pay" principle). This principle is often linked with the first principle discussed above, as any externality should be "priced in" to the dispatch model.

- Second, risks should be borne by participants best able to manage them at the lowest cost.

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[8] This report considers that responsive capacity is also dispatchable (i.e. resources that can respond to instructions to change output or usage) and flexible (i.e. resources that can respond to changes in demand and supply in a timely manner). Capacity that are more responsive also have a higher ramp rate capability, which is defined as the "*rate of change of active power (expressed as MW/minute) required for dispatch*". AEMC, Reliability Frameworks Review, 26 July 2018 (link).

Conclusion

2.27 Taking these five principles together, a well-functioning electricity market delivers resource adequacy by allowing market participants to respond to real-time price incentives, leading to efficient short-run and long-run outcomes. Such a market design, with the appropriate regulatory oversight, would deliver resource adequacy at lowest cost in the long-term interest of consumers.

C. "Missing elements" of electricity markets

2.28 Historically, competitive wholesale electricity markets have been designed with the intent to adhere to the principles above. Energy-only markets are a type of electricity market relying only on price signals for electricity produced and consumed by competitive market participants. We describe energy-only markets further in Box 2-1 below.

Box 2-1: Energy-only markets

Energy-only markets is a term covering a range of electricity market designs. Fundamentally, energy-only markets are markets where resources rely on price signals for electricity produced and consumed, receiving no remuneration from a capacity market or capacity contracts from the SO.

The core premise is that market participants are able to respond to clear real-time incentives, enabling an efficient real-time dispatch supported by efficient prices. Prices can vary freely and can rise sufficiently high to enable marginal plant to fully recover its long-run costs. Market participants' actions, including the ability to contract and hedge in anticipation of these prices, underpin long-term investment decisions.

In concept, policy and regulatory intervention are kept at a minimum. The clearing prices formed in the real-time market reflects not only the short-run marginal cost of energy, but also the marginal cost of all actions required to manage technical constraints and meet reliability objectives.[9] This negates the need for interventions which can affect the behaviour of market participants and market prices.

9 In practice, all energy markets entail contracts for system services that are not compensated via energy prices (e.g. system restart ancillary services).

> This describes the basic form of an energy-only market, which can be implemented in different ways (such as a centralised dispatch and self-dispatch models). Over time, new features have been introduced in energy-only markets to encompass additional technical details of the dispatch, such as accounting for congestion and marginal losses, or introducing the need to schedule operating reserves.

2.29 There are many variations in the market design for a competitive wholesale energy-only market, with different approaches to balancing real-time load and supply, as well as managing technical constraints. Over time, numerous refinements and adjustments have been introduced to improve these markets around the world. Changes also occur because underlying structural changes (such as decreasing costs for intermittent generation) reveal new technical constraints.

2.30 Structural changes, such as those occurring in the NEM, prompt examination of whether further improvements may be required in electricity market designs in order to meet the principles set out above.

2.31 Importantly, interactions between the structural changes and certain "missing elements" of wholesale electricity markets increase the potential for the basic energy-only market design to fall short of the principles set out above.

2.32 The "missing elements" are elements of a market which have not been developed technically, or for which there has not been sufficient regulatory and/or industry commitment to implement.

2.33 There are four such elements which may impede the ability of electricity markets to function effectively. These are:

- lack of dispatchable demand;
- incomplete markets;
- unpriced products / services; and
- unpriced externalities.

2.34 We discuss each in turn below.

Lack of dispatchable demand

2.35 Dispatchable demand refers to demand that can be responsive within each dispatch period. Dispatchable demand could support efficient dispatch by modifying consumption in response to real-time prices.

2.36 However, electricity demand has traditionally been unresponsive to changes in electricity prices in real-time. While every consumer would likely be able to attach a value to interruptions (i.e. how high must the energy price be for consumers to be willing to reduce load), consumers have typically been unable to receive the level of reliability they choose. This means that consumers cannot easily vary the reliability of their supply (an example of this might be those with lower tolerance for interruptions paying higher prices than those with higher tolerance).[10]

2.37 Dispatchable demand has not generally been prevalent in material quantities in electricity markets. This may be due to three reasons.

- First, electricity market designs and implementations typically only allow consumers with very high demand the option to be invoiced at real-time prices, most often due to the complications of implementing systems for metering and settlements.
- Second, even high demand consumers that might have suitable meters might prefer, given the choice, not to be exposed to real-time price signals, instead paying a price that is averaged over a period of time and across a broad region.
- Third, lower demand consumers that have the choice of real-time pricing might be prevented from responding, because they lack the technical capability to do so, such as the lack of smart metering or home devices that can automatically respond to a price signal.

2.38 In the absence of sufficient dispatchable demand, the emphasis in electricity markets is on generating capacity to deliver resource adequacy in all periods.

Incomplete markets

2.39 In this context, incomplete markets refer to where prices are either unable to adjust freely, or where there are other practical impediments to prices incentivising the appropriate short-term and long-term response from providers of supply and demand.

10 We discuss the proposed introduction of two-sided markets in the NEM in Section 3 below, which may be a step towards facilitating dispatchable demand.

2.40 Incomplete markets may exist, hindering the required investments to meet reliability objectives. For example, even if energy prices can rise sufficiently high, the periods of high prices may be very infrequent, meaning that investing in additional plants is highly risky. Ideally, financial markets would provide investors the ability to hedge, reducing their exposure to these high prices, but allowing them to gain sufficient certainty to invest in resources. However, there may be practical impediments to the formation of financial markets that allow for an optimal level of such hedging activity.

Unpriced products / services

2.41 In order to maintain a secure and reliable power system, the SO must ensure that a sufficient amount of a number of ESS are provided alongside the dispatch of energy. Examples of ESS include frequency response, inertia and voltage control. Investors in energy supply may also be able to earn returns from providing these services in addition or instead of energy supply, but only if there is a market or opportunity to contract with other parties to provide those services.

2.42 However, this is a complex undertaking, as a range of interrelationships exist among ESS, as well as between ESS and the energy dispatch. Several issues can arise when the pricing of the service is inconsistent with energy prices. For example, some products and/or services provided by resources might not be priced accurately to reflect the marginal value of the contributing resource. Additionally, explicit markets do not exist for all ESS, meaning that providers may not be appropriately remunerated for services supplied.

Unpriced externalities

2.43 Many externalities that exist in electricity markets may not be priced correctly (or at all). For example, carbon emissions will not be reflected in price signals without an integrated decarbonisation policy such as a cap-and-trade mechanism or a carbon price. In the absence of such policy, other interventions to achieve decarbonisation objectives could disrupt the price signals needed to achieve reliability objectives.

2.44 Another notable example of unpriced externalities is costs imposed on the network. For example, intermittent generation at a specific location may impose a cost on the network, as it may displace synchronous generation, which could reduce inertia in the system and also may trigger incremental network investments to manage the intermittency. Ideally, investment signals will take locational issues into account. The lack of locational signals is recognised as an issue affecting many electricity markets.

Box 2-2: Lack of locational signals

Depending on the design of the electricity market, one key missing element may be a lack of locational signals, in particular on the treatment of transmission congestion at different locations.

Transmission congestion arises due to transmission limits that cause out-of-merit dispatch. When this occurs, the marginal value of electricity may differ at locations across the transmission network, because of the different impacts of incremental injections at each location on flows over transmission constraints.

To support efficient dispatch, locational pricing that reflects transmission congestion and reliability constraints is required. This is known commonly as locational marginal pricing ("**LMPs**"). Ideally, this would be set at each node, which would then convey a more accurate marginal cost in each time period, leading to more efficient price signals. With financial transmission rights, LMPs guide investments by incentivising more efficient siting decisions, which would improve the delivery of resource adequacy where it is needed.

Interaction with structural changes

2.45 Interactions between the structural changes and the "missing elements" of wholesale electricity markets increase the potential for electricity market designs to fall short of the objectives outlined in Subsection 2B.

2.46 Such structural changes, related to ongoing pressures in the sector, are typically caused or exacerbated by policy interventions and uncertainty. This may lead to changes in the functioning of the market, as well as the generation mix.

2.47 Policy interventions are becoming more prevalent in liberalised electricity markets worldwide, and in particular:

- In some jurisdictions, such policy interventions result in setting market price caps too low, to a point where it could deter investments in resources that would contribute towards meeting the socially optimal level of reliability.
- Direct subsidies to specific generators are becoming increasingly common. This may lead to changes in the way dispatch is undertaken, which in turn may trigger further intervention in dispatch such as must-run contracts and operator commitments.

- Decarbonisation policies can accentuate issues caused by missing elements in electricity markets. Policies that are not integrated well with the electricity wholesale market, or are not coordinated across neighbouring regions, disrupt price signals. For example, very high levels of subsidised intermittent renewables capacity (with zero marginal cost of generation) could deter investments in other generation types (particularly as generation types that have high marginal costs may run less frequently).

2.48 In addition to direct policy interventions, discussions and "threats" of intervention may also deter investors. It can create "self-fulfilling prophecies", whereby even discussing these policies could create the expectation of such interventions, and in turn, cause the actual need for them.

D. The role of resource adequacy mechanisms

2.49 RAMs are mechanisms that complement electricity markets in order to improve the delivery of resource adequacy. The need for RAMs is based on the premise that, because of the missing elements described above, real-time prices alone are insufficient to drive the investments required to meet socially optimal levels of reliability.

2.50 Hence, RAMs might be needed to support the existing market design of an electricity market to deliver the resources required. RAMs cannot completely "solve" any underlying market issues, but support resource adequacy by incentivising resources via additional revenues and/or risk mitigating opportunities to increase the propensity to invest and be available when required.

2.51 Different RAMs have fundamentally different approaches. Some examples include:

- Directly affecting how the real-time price is formed; either by removing any impediments or by enhancing price signals to reflect the demand for more resources.
- Creating obligations on market participants to procure, deliver and activate a forecasted level and/or type of resources required in advance of the relevant delivery period.
- Using the SO to centrally procure a forecasted level of resources required in advance of the relevant delivery period.

2.52 The latter two approaches depart from an energy-only market, by remunerating resources based on pre-defined contributions to resource adequacy. As a result, application of these approaches requires particular consideration of the challenges of “deliverability” discussed above – that is, the challenge of how the capacity procured in advance can deliver electricity to meet load efficiently in real-time, when required.

2.53 All electricity markets around the world have implemented one or more types of RAMs. The choice of RAMs in each jurisdiction is often based on many factors. Some examples of the key factors are:

- the level of comfort policymakers might have that the real-time energy market is sufficient to deliver resource adequacy;
- the level of discretion policymakers would like to have in delivering resource adequacy;
- the level of certainty or “insurance” policymakers desire in advance of real-time; and
- expected significant events in the future – for example, large generator closures creating a risk of an unmet gap between the reduction in capacity and new investments of the appropriate type.

3. Resource adequacy in the NEM

3.1 As described in Section 2 above, resource adequacy reflects the "*sufficient overall portfolio of energy resources to continuously achieve the real-time balancing of supply and demand*".[11] However, resource adequacy cannot be guaranteed to be met in all locations and at all times. In part, this is due to the inherent uncertainty in forecasting the exact levels of demand and supply, and subsequently balancing them under all conditions over a period of time.

3.2 In the NEM, the reliability standard is set as a measure of unserved energy ("**USE**"). This measures the "*maximum expected amount of energy that is at risk of not being served in a region in a given financial year*".[12] The current standard is set at 0.002%, which means it is expected that, at most, 0.002% of demand might not be met in a specific region in the current financial year. Conversely, this means that at least 99.998% of all demand is met.

3.3 The NEM's reliability standard is set by the Reliability Panel, made up of a range of participants to represent policymakers (AEMC as the rule maker and AEMO as the SO), industry groups and consumer groups.[13] The standard has not changed since it was established in 1998. This sets the context on how resource adequacy is planned for and managed in the NEM.

3.4 Having described challenges to resource adequacy in general terms in Section 2, this section focuses on the NEM:

- First, we summarise the current tools in the NEM for planning and managing resource adequacy to meet the reliability standard described above.

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11 AEMO, Power system requirements, March 2018 (link), page 10.

12 AEMC, Review of reliability standard and settings guidelines, 1 December 2016 (link), page 5.

13 The Reliability Panel is guided by the National Electricity Objective (under the National Electricity Law) to "*promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to: (a) price, quality, safety, reliability and security of supply of electricity; and (b) the reliability, safety and security of the national electricity system".*

- Second, we summarise some overarching recent trends and potential future changes in the NEM that are relevant to resource adequacy.
- Third, we summarise aspects of recent policy developments, and potential future changes in the NEM market design that are relevant to resource adequacy.

A. Current tools in the NEM for resource adequacy

3.5 The NEM facilitates the physical generation and consumption of electricity through a financial electricity wholesale market. This takes the form of a real-time spot market based on a "mandatory gross pool" design. This means that generators must sell, and retailers must buy, all metered electricity output through the market. Demand is currently estimated by AEMO for each five-minute period (based on the forecast of expected regional demand).[14]

3.6 In the real-time spot market, a clearing price is set every five-minutes for particular pre-determined nodes, known as the regional reference point in each of the five zones.[15] This clearing price is set based on a dispatch algorithm as the highest generator bid required to meet the forecast demand in that five-minute period, at the relevant regional reference point on the system.

3.7 The real-time spot market is supported by three other sets of markets or mechanisms to function effectively:

- first, **ancillary services,** (e.g. FCAS, and others), which are run by AEMO to manage real-time balancing on a second-by-second basis;[16]
- second, a **settlement regime**, to facilitate the efficient transfer of money between retailers, generators and network operators for both electricity generated and the provision of ancillary services; and

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14 There are currently discussions and plans to move towards two-sided markets, which would obviate the need for AEMO to estimate demand at this level of granularity. See, for example, COAG's consultation on two-sided markets. COAG Energy Council, ESB moving to a two-sided market, April 2020 (link).

15 The five regions or price zones are Queensland, New South Wales (including the Australian Capital Territory), Victoria, South Australia and Tasmania.

16 AEMO runs a range of ancillary services, also known as ESS, such as Frequency Control Ancillary Services ("**FCAS**"), Network Support & Control Ancillary Services ("**NSCAS**"), and System Restart Ancillary Services ("**SRAS**").

- third, a parallel **financial contracts market**, that provides an opportunity for market participants (retailers, generators and third parties) to hedge the risk exposure to the spot market significantly ahead of, and up to, real-time.

3.8 These markets and mechanisms are intended to drive resource adequacy. The spot price in the energy market sets the real-time financial exposure of all market participants.[17] As these clearing prices can be volatile, market participants often hedge their exposure (i.e. managing their risk and cashflows) through financial contracts. In turn, the long-term expectations of spot prices support resource adequacy, either by managing the provision of supply resources, or by managing load (i.e. demand).

3.9 In common with other electricity markets, the SO also has various informational tools to signal to the market where forecasts gaps in resource adequacy may be expected. These include:

- The Electricity Statement of Opportunities ("**ESOO**"), which provides the market a ten-year projection to assist with long-term planning. This is published annually.
- The Energy Adequacy Assessment Projection ("**EAAP**"), which provides the market information on the impact of potential energy constraints over a two-year projection. This is published annually.
- The Medium-term Projected Assessment of System Adequacy ("**MT PASA**"), which provides the market with a two-year projection of unserved energy. This is published weekly.
- The Short-term Projected Assessment of System Adequacy ("**ST PASA**"), which provides the market with a six-day projection of capacity reserves. This is published every two hours.

3.10 There are four features of the NEM, further to those summarised above, that are particularly relevant to resource adequacy. These are:

- reliability settings;
- the Retailer Reliability Obligation;
- the Reliability and Emergency Reserve Trader regime; and
- Directions and Instructions from AEMO.

3.11 We discuss each in turn below.

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[17] This is also true of any ancillary services associated with real-time spot prices.

Reliability settings

3.12 The reliability settings are a feature of the electricity wholesale market in the NEM, designed to limit market participants' exposure to wholesale prices while delivering community accepted levels of resource adequacy. The settings are reviewed by the Reliability Panel every four years.

3.13 There are four reliability settings:

- The **Market Price Cap** ("**MPC**") is the maximum market price that can be reached in any interval. This is measured in $/MWh. The MPC is intended to enable the market to deliver efficient price signals, whilst limiting market participants' exposure. It is set at $14,700/MWh for the 2019/20 financial year and is indexed to inflation.
- The **Cumulative Price Threshold** ("**CPT**") is the maximum cumulative market price over 336 trading intervals, before an administered price cap is introduced. This is measured in Australian dollars. The CPT is intended to limit market participants' exposure over a longer, sustained period. It is set at $221,110 for the 2019/20 financial year and is indexed to inflation.
- The **Administered Price Cap** ("**APC**") is the maximum market price paid to participants when the CPT is met. This is measured in $/MWh. Together with the CPT, this is intended to limit market participants' exposure over a longer, sustained period. It is set at $300/MWh and is not indexed to inflation.
- The **Market Floor Price** ("**MFP**") is the minimum market price that can be reached in any interval. This is measured in $/MWh. The MFP is intended to limit market participants' exposure during low demand / high supply conditions. Negative prices arise when multiple generators have to compete to dispatch, for example, if the cost of dispatch outweighs the cost of curtailing generation and subsequently increasing output again. Hence, the market price sets which generators should be curtailed. It is set at -$1,000/MWh and is not indexed to inflation.

3.14 Whilst the reliability settings are not a RAM, changing the settings would likely have an effect on resource adequacy, as they affect the risk exposure of market participants, particularly during conditions of system stress.

3.15 For example, increasing or reducing the MPC would affect different risks faced by consumers, either by increasing the risk of higher prices (and hence higher consumer bills), or increasing the risk of interruptions (which has an implicit cost to consumers).

Retailer Reliability Obligation

3.16 The Retailer Reliability Obligation ("**RRO**") is a relatively new mechanism[18] that was introduced in July 2019 in response to concerns of resource adequacy, as intermittent renewables generation is expected to increase.[19]

3.17 The RRO was designed to support resource adequacy by incentivising retailers and some large energy users to contract or invest in dispatchable resources to cover their share of expected peak demand. This is based on the premise that an increase in hedging contracts[20] would create further price signals for investment in new generating capacity that could meet peak demand. The peak demand is measured based on AEMO's "one-in-two year" peak demand forecast for a pre-defined period.

3.18 The RRO is triggered by the AER when AEMO identifies a shortfall three years ahead in the annual ESOO. The South Australian State Government also has the ability to trigger the RRO.

3.19 Once the RRO is triggered, the AER may then issue two reliability instruments.[21] These are:

- At three years ahead ("**T-3**"), the AER may place retailers and large energy users on notice to enter into "qualifying contracts", which are financial contracts to cover peak demand.[22]

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18 The RRO was initially developed to meet the "reliability requirement" of the National Energy Guarantee. The proposed plans to meet the other requirement, the "emissions reduction requirement" have not progressed.

19 In March 2020, following advice from the ESB, COAG Energy Council agreed to implement interim measures to deliver further reliability by amending the triggering arrangements for the RRO. COAG Energy Council, Meeting communique, 20 March 2020 (link), p. 1.

20 Typically, retailers and generators hedge most of their positions using financial derivatives to reduce their exposure to the volatile spot market, providing both with more stable cash flows.

21 This information is based on the interim guidelines and are subject to change following publication of the final guidelines. AER, Retailer Reliability Obligation (link).

22 Qualifying contracts are defined in the National Electricity Law as contracts that are: (i) directly related to the purchase or sale, or price for the purchase or sale, of electricity from the wholesale exchange during the stated period; and (ii) entered into voluntarily by the liable entity to manage its exposure in relation to the volatility of the spot price. Examples of qualifying contracts include swap and cap contracts, interregional contracts and option contracts, among others.

- At one year ahead ("**T-1**"), the AER may require retailers and large energy users to disclose their net contract positions to AER. The contract positions will be adjusted for "firmness", to reflect the extent to which each contract is expected to contribute to meeting the entities obligation (based on factors such as how dispatchable the resource is considered to be).

3.20 Smaller market participants may have difficulty accessing these financial derivatives required to meet their obligations. Therefore, a separate Market Liquidity Obligation ("**MLO**") has been developed and will be placed on generators to offer qualifying contracts on an exchange to provide easier access to smaller market participants.

3.21 Retailers and large energy users that do not procure sufficient contracts to meet their obligations may face financial penalties. These penalties will be based on the consequential cost of any emergency reserves procured, if needed to cover the unmet shortfall. Penalties are capped at $100m.

3.22 The RRO, by obligating retailers and large energy users to cover their share of expected peak demand, is intended to improve resource adequacy by decreasing the risk exposure to generators through more long-term contracting, and by providing greater price signals for potential new sources of generating capacity.[23]

Reliability and Emergency Reserve Trader

3.23 The Reliability and Emergency Reserve Trader ("**RERT**") is a mechanism used by AEMO to contract for additional resources in advance of a projected shortfall. While the use of the RERT has historically been very infrequent, the RERT is now effectively operating as a "strategic reserve"; that is, reserves that are procured out-of-market and used in conditions that might not have otherwise been met by the market. These resources can be both on the electricity supply and demand side. In effect, the RERT operates as a "measure of last resort".[24]

3.24 AEMO procures the RERT based on its projected shortfalls and the length of time in advance of the relevant period. To initiate procurement and activation, projected shortfalls must be declared as a Lack of Reserve ("**LOR**") condition, where the market is considered to be unlikely to deliver sufficient electricity to balance the system. RERT can also be activated to meet specific security events, in addition to any reliability issues.

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23 The RRO has been triggered for the first and only time to date in January 2020 by the South Australia Minister for Energy and Mining. A T-3 reliability instrument has not yet been issued.

24 With the RRO now in place, the RERT would also be used to address shortages if the RRO is insufficient in delivering the required resources.

3.25 To expedite the procurement process, AEMO may form a RERT panel, which is comprised of entities that have pre-qualified.

3.26 There are currently three different procurement approaches. These are:

- The **long-notice RERT**, where the RERT is procured between 12 months and ten weeks from the projected shortfall period. These contracts are procured through separate invitation-to-tender processes.[25]
- The **medium-notice RERT**, where the RERT is procured between ten weeks and seven days from the projected shortfall period. These contracts can be procured from the RERT panel, with prices negotiated separately each time.
- The **short-notice RERT**, where the RERT is procured between seven days and three hours from the projected shortfall period. These contracts can be procured from the RERT panel, using pre-agreed prices.

3.27 These resources may also be procured based on specific requirements, such as the availability over a particular period or location, the capacity, and the length of time the resource can sustain generation.

25 In addition to amending the triggering arrangements for the RRO, the COAG Energy Council has also agreed to establish an interim out-of-market capacity reserve. The measure, which the ESB is currently developing, would allow AEMO to procure reserves for contract terms of up to three years, replacing the long notice RERT. Together with the amendments with the RRO, this intends to keep unserved energy to no more than 0.0006% in any region in any year. COAG Energy Council, Meeting communique, 20 March 2020 (link), p. 1.

3.28 As the RERT is procured and activated out-of-market, RERT providers cannot participate in the market.[26] This may lead to the RERT potentially competing with the market for resources. For example, a generator that could earn higher revenues through the RERT could choose not to participate in the wholesale market for the 12 months prior to signing a RERT contract, thereby reducing available in-market resources, and in turn, increasing the size of a forecast shortfall and the RERT needed.[27] To mitigate this issue, an intervention pricing mechanism restores the real-time price to the level it would have been without the dispatch of RERT resources.

Directions and Instructions from AEMO

3.29 If the procured and activated RERT is insufficient, AEMO may also resort to "Directions". Directions are notices to generators to run at a specified output level, in cases where they would otherwise generate at a lower output level or be offline. These generators are paid the 90th percentile spot price based on their directed quantities (if this price is insufficient, generators can claim for additional remuneration).

3.30 Directions are likely to lead to lower energy market prices during the dispatch period they are applied, as additional generating capacity is required to participate, increasing the supply stack. As a result, several other parties involved in the dispatch would be affected. To minimise the effects caused by the change in dispatch outcomes, an intervention pricing mechanism is used (as with the RERT). This works by running a counterfactual dispatch to calculate the "what-if" prices and quantities. These outcomes are then used to change the price received by the affected participants.

3.31 Subsequently, if directions are insufficient, AEMO may resort to providing "Instructions". Instructions include all final resort notices that are not Directions, such as instructions to Transmission Network Service Providers ("**TNSPs**"), to undertake involuntary load-shedding.

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26 Under the current rules, scheduled providers (i.e. providers that are 30MW or larger) cannot participate in the RERT if they have participated in the wholesale market in the 12 months prior to signing a RERT contract. Scheduled providers also cannot participate in the wholesale market for the entire duration of the RERT contract. Unscheduled providers (i.e. providers that are smaller than 30MW) cannot participate in both the wholesale market and in the RERT for the specific trading intervals specified in their RERT contracts.

27 Another example is a large electricity consumer, who can sign a RERT contract to be paid to reduce its load when it might have done so even without a RERT contract.

3.32 Directions and Instructions are not generally considered primary tools to support resource adequacy. Therefore, we do not discuss Directions and Instructions further in this report. However, for completeness, we note that any mechanism that affects the settlement to resources will indirectly affect resource investment decisions over the longer term.

B. Recent trends and potential future changes

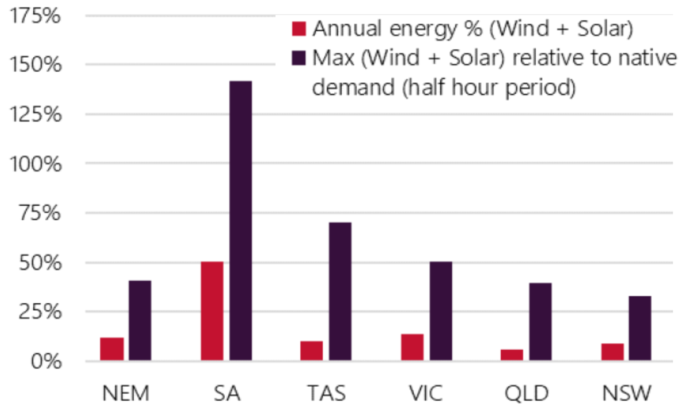
3.33 In common with many other parts of the world, the NEM has entered a period of rapid transition away from traditional sources of generating electricity (such as coal-fired generation) and towards newer technologies such as solar and wind. Additionally, ongoing technological progress has opened up emerging opportunities for more decentralised technologies such as demand side response and battery storage.

3.34 This subsection surveys these trends and potential future changes, as well as the implications they may have for resource adequacy.

Increase in intermittent generation

3.35 In recent years, the NEM has experienced significant growth in generation from intermittent renewables, such as wind and solar generation, and now has some of the highest penetration levels of such technologies in the world. In South Australia, where penetration is highest, wind and solar generation can now exceed total demand, as illustrated in Figure 3-1 below.

Figure 3-1: Proportion of energy demand served by wind and solar in 2018



Source: AEMO, Maintaining Power System Security with High Penetrations of Wind and Solar Generation, October 2019 (link), page 9.

Note: The first column shows the proportion of annual energy provided by wind and solar in each region. The second shows the maximum proportion of wind and solar generation relative to system demand (regional or "native" demand). Numbers greater than 100% occur when generation is larger than native demand and the excess is exported.

3.36 In addition to the transmission-connected renewables resources, distributed behind-the-meter solar generation has also increased significantly, with installed capacity rising from 4.2 GW in 2015, to 9.0 GW in 2019.[28]

3.37 This trend of growing intermittent renewables, both utility-scale and behind-the-meter,[29] is expected to continue, in line with the forecasted increase in renewable capacity in all scenarios in AEMO's Integrated System Plan ("**ISP**").[30]

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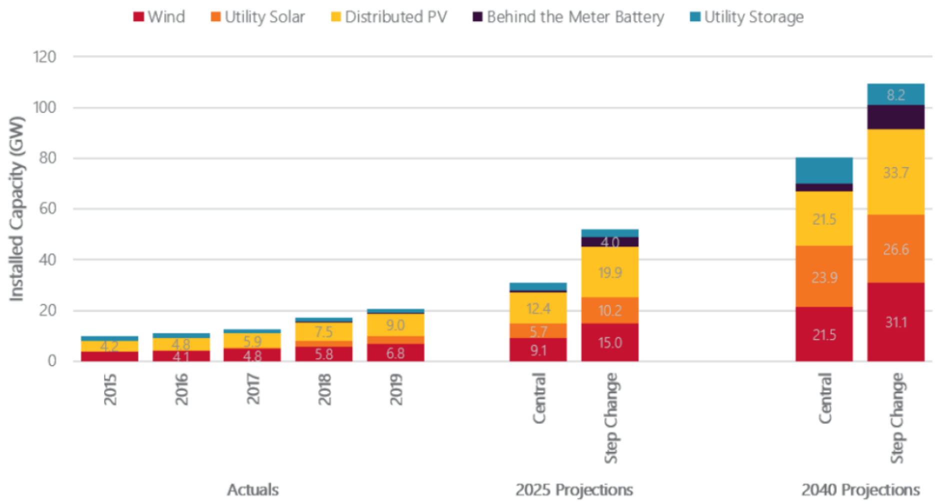
28 AEMO, Draft 2020 Integrated System Plan, 12 December 2019 (link), page 18.

29 "Behind-the-meter" resources refer to resources that are sited on the same premise as the consumer (i.e. on the consumer's side of the meter) as opposed to a direct connection to the transmission or distribution grid. These resources are often difficult to monitor and measure as they might be observed as "negative demand" on the consumer's meter.

30 The ISP is a system-wide plan that sets out a blueprint on generation and transmission investments required in the NEM. This is intended to support the coordination of such investments. The first ISP was published in 2018, and a new version will be updated every two years. AEMO, Draft 2020 Integrated System Plan, 12 December 2019 (link), page 37 & page 41.

3.38 As shown in Figure 3-2 below, AEMO forecasts that by 2040, utility wind and solar would reach 45.4 GW in the Central scenario,[31] and up to 57.7 GW in the Step Change scenario.[32] Similarly, the behind-meter solar capacity is estimated to reach up to 21.5 GW by 2040 in the Central scenario, or a 140% increase from 2019.

Figure 3-2: Current and forecasted wind and solar capacity



Source: AEMO, Renewable Integration Study: Stage 1 report, April 2020 (link), page 18.

3.39 This level of renewables is very high compared to the total forecast demand for electricity. In the Central scenario, the maximum penetration of wind and solar is expected to exceed 75% of underlying demand[33] by 2025, up from under 50% in 2019. In the ISP Step Change scenario, the maximum penetration is expected to be even higher, up to 100%. This is illustrated in Figure 3-3 below.

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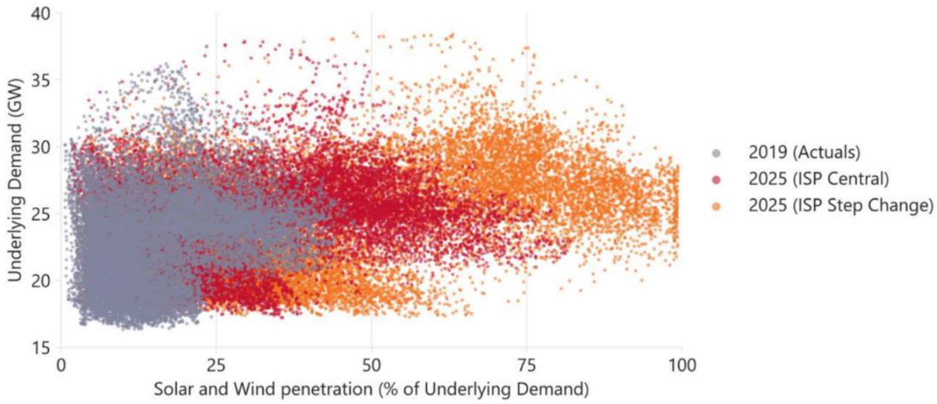
31 In addition to the Central scenario, four other scenarios are considered in the ISP: Slow Change scenario, High DER scenario, Fast Change scenario, and Step Change scenario.

32 In the Step Change scenario, consumer-led and technology-led transitions occur "*in the midst of aggressive global decarbonisation and strong infrastructure commitments*". Source: AEMO, Draft 2020 Integrated System Plan, 12 December 2019 (link), page 28.

33 "*Underlying demand […] includes demand response, energy storage, and coupled sectors such as gas and the electrification of transport",* Source: AEMO, Renewable Integration Study: Stage 1 Report, 30 April 2020 (link), page 6.

Figure 3-3: Penetration of wind and solar generation



Source: AEMO, Renewable Integration Study: Stage 1 report, April 2020 (link), page 19.

3.40 Significant growth in renewable generation may impact resource adequacy in several ways. Some key implications might include:

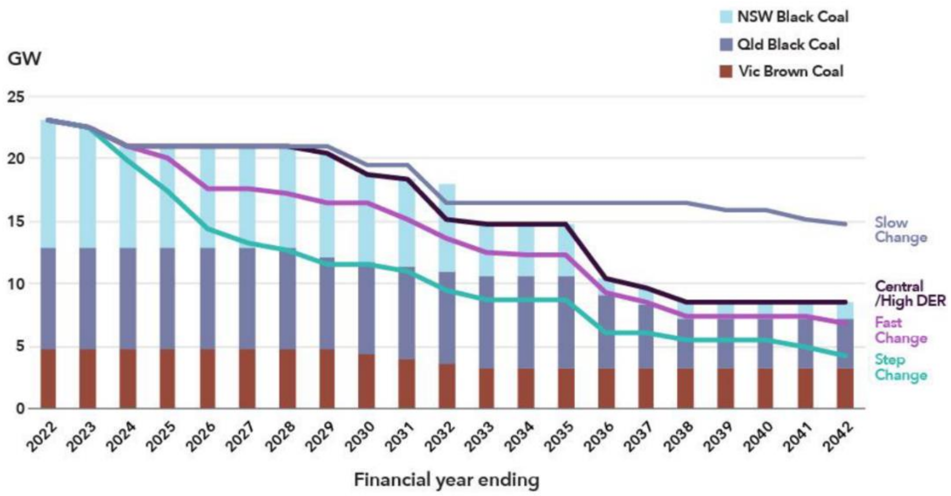
- Renewable capacity is becoming a large contributor to resource adequacy. It will be increasingly challenging and important to plan how renewable generation can match demand at different time periods and locations.
- The value of dispatchable resources that can respond at short notice to unexpected variations may increase in line with the increase in renewable capacity. RAMs would need to take this into account.

Reduction in large-scale thermal generation

3.41 The steady increase in renewable generation has been accompanied by a decrease in large-scale thermal generation, mostly black and brown coal power plants. This has been driven by the increasing competitiveness of renewable resources and policy ambition to reduce carbon emissions.

3.42 This trend is expected to continue, with thermal generation forecasted to progressively decline as a share of the total generation, with coal-fired generation in particular falling as ageing plants are retired. By 2040, the Central ISP scenario forecasts that approximately 13 GW of black coal plants and 2 GW of brown coal plants will retire across the NEM, reducing total coal capacity to 9 GW, down from 23 GW as expected in 2022. In the Step Change scenario, this trend is even sharper, with total capacity falling to 4 GW. This is illustrated in Figure 3-4 below.

Figure 3-4: Forecasted coal generation capacity



Source: AEMO, Draft 2020 Integrated System Plan, December 2019 (link), page 42.

3.43 The expected reduction in large-scale thermal generation capacity creates a risk of a shortfall in supply in the system. This is because there is a greater risk of mismatch between the size, timings and location of the entry of new resources with the exit of relatively large thermal plants.

3.44 Additionally, as ageing thermal plants approach the end of their useful asset lives, there may be a greater risk of unplanned outages affecting how resource adequacy is delivered.

Emergence of new flexible technologies

3.45 Historically, resource adequacy has been delivered predominantly by generation. With demand being inflexible and inelastic, and electricity being extremely difficult to store, resource adequacy had to be maintained by reliable generating capacity, often large-scale units, at all times.

3.46 However, several advancements in technology are emerging rapidly, changing the way resource adequacy is delivered. Three particular technologies, known collectively as Distributed Energy Resources (“**DER**”),[34] are:

- demand side response (“**DR**”);
- battery storage; and

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34 These are not exclusive, as battery storage is increasingly being used in transmission applications. DER also includes smart technology (appliances and meters), and hot water systems and air conditioners. AEMO, Distributed Energy Resources Program website (link).

- distributed generation.

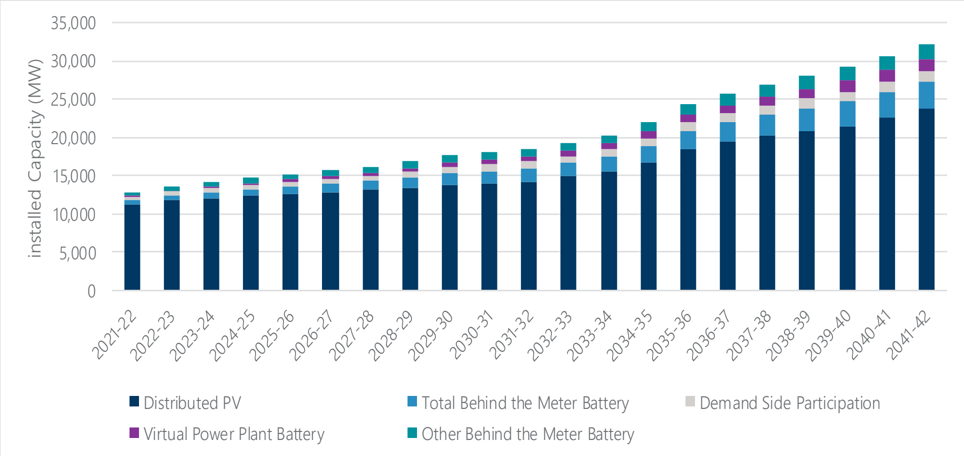
3.47 DR is the ability of consumers to participate in energy markets by changing their consumption profile (either by increasing, decreasing or shifting load). Historically, DR is mostly provided by large industrial and commercial consumers, however emerging technologies (particularly metering and aggregators) are improving rapidly. In response, several wholesale market design changes are being considered such as a two-sided market (see Subsection 3C below) and other trials.

3.48 As electricity has been historically difficult to store, large hydroelectric facilities have been the predominant way to effectively store electricity. These facilities tend to be limited, geographically. However, smaller, battery storage technologies have been emerging with a trend of decreasing cost, and can be used across many applications in the provision of energy and essential services. Battery storage capacity is also useful in complementing VRE generation (such as the Hornsdale Power Reserve in South Australia). It is expected that the significance of battery storage will continue increasing as the cost efficiency of the technology increases.

3.49 Smaller distributed generation has also seen a recent and significant rise in capacity. This includes both VRE generation capacity (e.g. solar and wind units), but also smaller-scale thermal generation (e.g. gas and diesel reciprocating engines). While not as efficient as larger transmission-connected thermal generators, distributed thermal generators have the advantage in that they may have lower capacity costs and are more dispatchable with faster ramp rates. These generators could therefore respond to higher prices more flexibly during scarcity periods.

3.50 Taken together, DER is increasingly becoming a significant contributor to resource adequacy. This has prompted AEMO to develop a DER register to provide more transparency to the market. Virtual Power Plants are also being trialled to aggregate these resources to support the delivery of resource adequacy. The expected growth in DER capacity is shown in Figure 3-5 below.

Figure 3-5: Installed DER capacity by year



Source: AEMO, ISP, Appendix 3 dataset, Central scenario, December 2019 (link).

Note: This chart excludes forecasted small peaking gas generators that may be connected to the distribution network.

Resource adequacy in the NEM

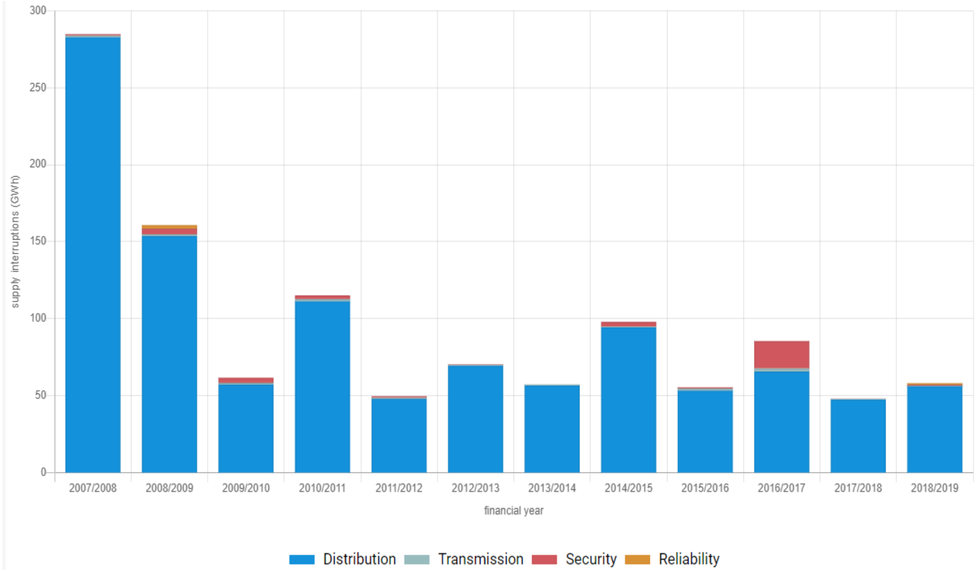
3.51 The NEM has historically delivered resource adequacy.

3.52 Between 2007/08 and 2018/19, there were 3.4 GWh of interrupted supply due to insufficient resource adequacy (either by insufficient generation, demand response and/or interconnection).[35] This represents approximately 0.29% of total supply interruptions across the period, where the vast majority is caused by network interruptions, followed by security-related interruptions (e.g. frequency and voltage issues).[36]

35 AEMC, Figure 2.21: Sources of supply interruptions in the NEM (2008/09-2018/19), attached CSV, March 2020 (link).

36 AEMC, Reliability Frameworks Review, 26 July 2018 (link).

Figure 3-6: Sources of supply interruptions in the NEM



Source: AEMC 2019 Annual Market Performance review, March 2020 (link).

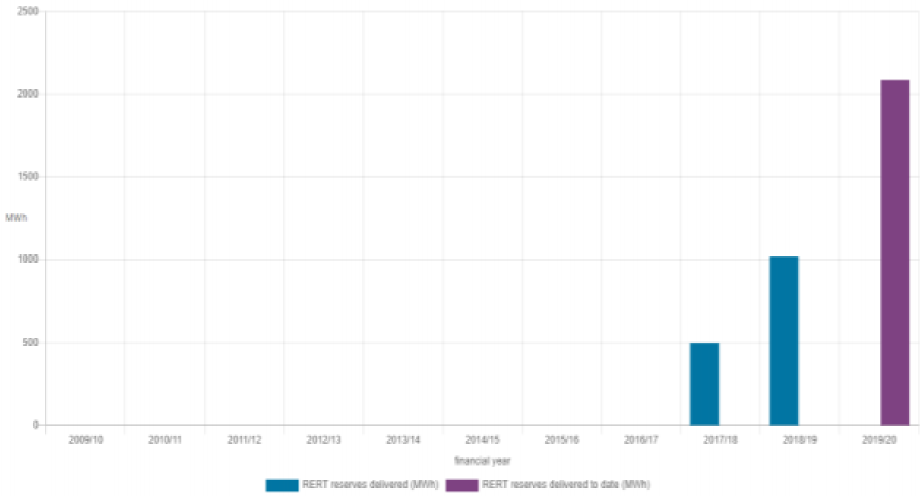
3.53 Apart from 2008/09, the reliability standard was met in all years and all regions, i.e. unserved energy did not exceed 0.002% of demand. The three instances of reliability interruptions were:[37]

- In 2008/09 in both Victoria and South Australia. This was driven by high temperatures, as well as the reduced availability in the Basslink interconnector and generators in Victoria. This contributed to 0.004% and 0.0032% of unserved energy in each state respectively, exceeding the reliability standard.
- In 2016/17 in South Australia, with unserved energy of only 0.00036%. The major blackout incident that occurred in this year was concluded to be a security-related interruption, and hence is not a factor here.
- In 2018/19 in Victoria and South Australia, with 0.0017% and 0.0004% of unserved energy respectively.

3.54 While the reliability standard has been met in recent years, the increasing use of RERT may be indicative of potential underlying resource adequacy issues. This is shown in both Figures 3-7 and 3-8 below.

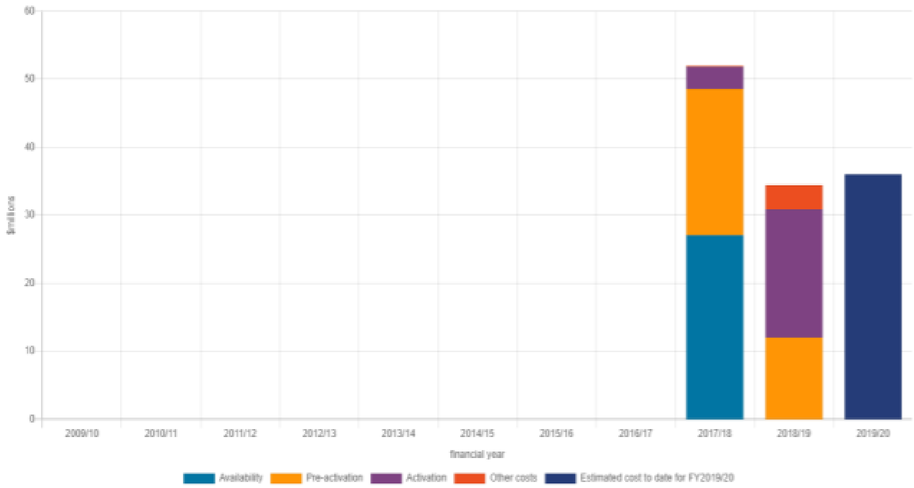
[37] AEMC, The Reliability Standard: Current Considerations, 12 March 2020 (link).

Figure 3-7: Use of the RERT



Source: AEMC, The Reliability Standard: Current Considerations, 12 March 2020 (link), page 18.

Figure 3-8: Cost of the RERT



Source: AEMC, The Reliability Standard: Current Considerations, 12 March 2020 (link), page 19.

3.55 As shown in Figures 3-7 and 3-8 above, the volume of RERT being activated has been increasing in each year. Furthermore, the cost of RERT contracts, which are procured and utilised out-of-market, may potentially be more costly than market-based mechanisms.[38] For example, in Q1 2020, the cost of exercising the RERT was $18,317.77/MWh, in excess of the MPC, and with a total cost of $34.37m.[39]

3.56 More recently in 2019/20, this coincided with peak demand periods during very hot weather (whilst some generation and network assets have been disconnected due to the bushfire events). Should this trend persist in the future, this may be indicative of potential resource adequacy concerns.

3.57 Additionally, several areas of risk over the next decade have been raised in AEMO's ESOO 2019 report.[40] In particular, the areas of risk that would be substantially affected by major new investments and closures are:

- 5GW of committed new generators or upgrades are expected by March 2025 (before Snowy 2.0 is due to start commissioning). However, a significant proportion are VRE generators, which may not be able to generate at full capacity during peak periods;
- the gradual closure of Torrens Island A Power Station by 2021/22 in South Australia;
- the gradual closure of Liddell Power Station by 2023/24 in New South Wales;
- uncertainties on new interconnectors between states; and
- increasing "tail risk" in the NEM due to the trend of increasing maximum temperatures leading to higher demand and lower supply (due to the derating of generation and transmission).

3.58 In parallel with these concerns, energy prices have increased in recent years amidst testing economic conditions, making affordability a key issue for consumers. This creates a greater challenge when addressing resource adequacy, as any mechanism which leads to further investments are likely to increase consumers' energy bills for delivering a higher level of reliability.

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38 AEMO, Reliability and Emergency Reserve Trader (RERT) Quarterly Report Q1 2020, May 2020 (link).

39 This excludes the additional cost of contracting resources to be available which was $0.56m in Q4.

40 AEMO, 2019 Electricity Statement of Opportunities, August 2019 (link).

3.59 Although this report does not consider the likelihood of future resource adequacy issues in the NEM, we consider this backdrop in our assessment of RAM options, in particular the implications of each RAM on consumer outcomes.

C. Recent policy developments and future potential NEM reforms

3.60 The concerns summarised above form the context that led to recent policy developments and discussions on future NEM reforms. In this subsection, we summarise four key recent developments and discuss some potential reforms that are being considered by ESB as part of its post-2025 market design work.

National Energy Guarantee and the RRO

3.61 ESB began development of the **National Energy Guarantee** (“**NEG**”) in 2017, following COAG’s decision to implement recommendations from the Independent Review into the Future Security of the National Electricity Market (“**Finkel Review**”). The proposed NEG had two limbs:[41]

- a mechanism to deliver the “reliability requirement” to support investments in dispatchable resources to meet reliability objectives; and
- a mechanism to deliver the “emissions reduction requirement” to meet Australia’s emissions reduction objectives.

3.62 The mechanism to deliver the reliability requirement eventually became known as the RRO mechanism described above. The emissions reduction mechanism, however, has not been progressed due to decisions by the Government.[42]

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41 ESB, National Energy Guarantee, Final Detailed Design, 1 August 2018 (link).

42 Norton Rose Fulbright, What’s next for the NEG, 21 August 2018 (link).

Changes to the procurement of the RERT

3.63 Between 2018 and 2019, several amendments were made to how **RERT is procured**.[43] First, long-notice RERT was reinstated, meaning that RERT contracts could be procured up to nine months ahead of a projected shortfall. Second, enhancements were made, linking the procurement approach to the reliability standard, providing AEMO more flexibility in procuring the RERT, and increasing the lead-time from nine to twelve months. The RERT is now considered to be a permanent backstop feature in the NEM.

Changes to the lack of reserve framework

3.64 AEMO has the responsibility to notify the market on any forecast or actual LOR conditions. This is intended to elicit a response from the market to alleviate these conditions. In 2017, several changes were made to the way AEMO determines the reserve declaration. These changes were mostly intended to make these notices more transparent and flexible, with the objective of increasing short-term reliability.

Wholesale Demand Response Mechanism

3.65 Recently, the AEMC and AEMO have developed the Wholesale Demand Response Mechanism ("**WDRM**"), which is intended to facilitate greater DR participation in the electricity wholesale market. The WDRM allows single or aggregated DR to participate in the dispatch process as an eligible resource in a similar way as a generating resource would.

3.66 This mechanism would support resource adequacy by enabling greater participation from a new group of resource, that is DR, to balance supply and demand at lower cost. This would likely be a step forward in addressing the "dispatchable demand" missing element described above in Section 2.

ESB work programme

3.67 As noted in Section 1, ESB is considering several other potential reforms as part of its post-2025 market design work.

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43 As mentioned earlier, ESB has recently consulted on introducing changes to the RERT including the ability to procure multi-year contracts. This temporarily replaces the long-notice RERT until 2025 and is intended to keep unserved energy to no more than 0.0006%. COAG Energy Council, Consultation on the Draft national Electricity Amendment (Interim Reliability Measure) Rule 2020, 12 May 2020 (link).

3.68 Notably, this includes investigating the benefits of a **two-sided market**. This involves reforming the wholesale market to receive bids and offers from both producers and consumers of electricity, where it can clear the market and dispatch based on this information. A two-sided market intends to facilitate greater active participation on the demand side, with the objective of creating a more dynamic market that can respond to a volatile market in scarce conditions more effectively. This market would take advantage of the emerging advancements in technologies – DER and greater digitisation would potentially offer the opportunity for consumers to participate more easily, either directly or through aggregators.

3.69 A two-sided market may improve reliability either by fostering more efficient real-time price signals or by allowing greater DR resources to participate. One of the design options of a two-sided market, the "full participation" option, involves the participation of all end-users in the market, either directly or through a trader.[44] This option is closest to introducing a form of "dispatchable demand" as discussed in Section 2, as the consumers would in principle be able to select their own level of reliability.

3.70 While they might not affect reliability directly, there are two further specific areas which may affect how resource adequacy is delivered. These are:

- **Coordination of Generation and Transmission Investment** ("**COGATI**") – to improve the way generators access and use the transmission networks, and the accompanying charging arrangements. This significantly impacts the investment decision and timings of generators, which in turn, affect resource adequacy.
- **System services and ahead markets** – to improve how resources can meet security requirements of the NEM. This has several material overlaps with resource adequacy, as resources that provide security services may also provide energy and reserves. This requires coordinated investment and operational decisions. A more efficient design and use of system services may also address some of the missing elements identified above (in particular "unpriced products / services").

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44 COAG Energy Council, Moving to a Two-Sided Market, April 2020 (link).

3.71 Finally, we also note the future implementation of a **five minute settlement period**. In 2017, AEMC made a final rule to reduce the settlement period for the electricity spot price from 30 minutes to five minutes.[45] Five minute settlement is currently planned to be implemented in 2022, which will align the financial settlement period with the dispatch period. This is intended to provide sharper price signals, as market participants will now have a greater incentive to respond to the five minute dispatch price instead of the 30 minute settlement price. This would mean that market participants' incentives and actions would be more aligned to real-time conditions, thereby improving operational and investment decisions to meet the short-term requirements of the electricity system more effectively.

3.72 Overall, a move to five minute settlement is likely to improve the delivery of resource adequacy. For example, retailers would be incentivised to avoid negative prices and manage any load that is price-responsive more effectively. These price signals would also increase the incentives to invest in dispatchable resources that can respond more quickly, such as battery storage, DR and peaking generators.

45 AEMC, Rule Changes – Five Minute Settlement, November 2017 (link).

4. Options for RAM development

4.1 The NEM operates as a gross pool, energy-only market, where investment signals for capacity are intended to be provided directly through wholesale energy prices. There are several features of the NEM that are intended to monitor, support and address resource adequacy (such as the specific oversight role of the ESB itself, and the tools discussed in Section 3).

4.2 The purpose of this report is to assess different options potentially available to the NEM to further support resource adequacy. We have defined seven options for RAM development, grouped into three types:

- adjustments to the existing NEM;
- enhancements of the existing NEM; and
- capacity markets.

4.3 These three types are explained in the subsections below.

4.4 Before discussing each RAM development option, we first provide a framework for describing the key features of the options, such that they can be characterised in a broadly consistent manner.

A. RAM description framework

4.5 This has three elements:

- definition of the RAM;
- key underlying premises; and
- interactions with other RAMs and market design features that are required.

4.6 We discuss each in turn below.

Definition of the RAM

4.7 First, for each RAM, we describe it by reference to five dimensions. These are as follows:

- **Product description**. This focuses on the "product" or tool being adjusted or introduced, and how it may be defined. This includes, for example, whether the RAM allows for any particular "type" of capacity to be targeted (e.g. responsive capacity).
- **Obligation**. This focuses on where the obligation to procure the "product" falls (e.g. retailers, generators, and/or a central body), and who determines the nature and the level of the obligation.
- **Procurement approach**. This focuses on where, how, and over what time dimensions the product is procured and/or traded. This includes whether the "product" is traded bilaterally or in a central market.
- **Enforcement**. This focuses on how non-compliance with any obligation is monitored and/or penalised. Penalties form a key component of the incentive regime for many RAMs.
- **Pricing**. This focuses on how the product itself is priced, and the relationship of that price with real-time energy prices, system service revenues and/or capacity revenues (as appropriate).

Key underlying premises of the RAM

4.8 Second, for each RAM, we set out the key **underlying premises** that might motivate its use. This is focused on the **policy premises,** which includes, for example, the extent to which policymakers are willing (or not) to seek to guarantee or mandate a minimum level of capacity reserves at all times. Where relevant, we also set out what incentives, signals and methodologies need to be functioning well in order for the RAM to be effective.

Interactions with other RAMs and other market design features that are required

4.9 Where relevant, we explain which RAMs could be considered as potential "transition steps" to others or, alternatively, where RAMs preclude the use of other RAMs. For clarity, we recap the interactions between RAMs in Section 5.

4.10 Further, some RAMs rely on, or are amplified by, other market design elements, which may not currently exist in the NEM. We therefore explain what critical changes might need to be made to the NEM for each RAM to be effective.

B. Adjustments to existing NEM

4.11 As set out in Section 3, the three features of the existing NEM design most directly relevant to resource adequacy are the reliability settings, RRO obligation, and RERT.

4.12 When considering how a particular market design could potentially be developed to support resource adequacy, a natural starting point is to review existing features of the market and how they could be adjusted.

4.13 Therefore, under **adjustments to the existing NEM**, we examine potential broad and directional adjustments to the parameters of the reliability settings, RRO obligation, and RERT.[46]

i. Reliability settings adjustments

4.14 One potential change to the NEM, which could affect resource adequacy, is a *change* to one or more of the key parameters of the reliability settings (the MPC, CPT or APC).

4.15 Broadly speaking, an upward adjustment to any of these parameters would allow real-time price signals (and hence revenue potential to resources during (infrequent) scarcity periods) to increase, **providing stronger incentives for resource provision,** which supports higher resource adequacy.

Reliability settings adjustments: description

4.16 The **"product"** in this case is the value of unserved energy, and the adjustment would seek to enhance the definition of this value. For example, if the MPC is below the VOLL, an increase would enhance the definition of the value of unserved energy towards the VOLL.

4.17 Intrinsically, supporting resource adequacy by adjusting the reliability settings favours **responsive capacity,** as participants are exposed to higher and sharper price spikes.

4.18 The relevant **obligations** for this option are: (i) the existing electricity market incentives that market participants face when balancing their positions in real-time or risk being exposed to changes in prices; and (ii) the obligations to determine the reliability settings, which are then applied in the NEM.

[46] While the reliability settings, RRO obligation, and RERT have been described in Section 3 above, we also include them in this section so they can be described in a manner consistent with the other RAM options introduced.

4.19 In respect of the latter, the reliability settings themselves are reviewed by the Reliability Panel every four years. The key **decision points** are:

- the level of the various caps (MPC, CPT and APC), and the parameters for their operation (for example, over what period the CPT is measured); and
- governance, procedures and signalling related to the frequency and method of future adjustments to the reliability settings, which are relevant to market expectations about how the settings will evolve over time.

4.20 The direct impact on **pricing,** if the MPC were to be adjusted upwards, is sharper and more volatile prices during periods of scarcity. Similarly, if the CPT was adjusted upwards, the period of sharper and more volatile prices may be allowed to continue for longer. Any change in reliability settings would also affect the prices of FCAS and other ESS that are co-optimised with energy.

Reliability settings adjustments: key underlying premises

4.21 The fundamental policy choice (if applying this option in isolation) is the reliance on the (price-cap constrained) spot price to deliver (over time) the desired level of reliability. The mechanism by which this would, in principle, be delivered is market participants acting in response to clear price signals to deliver the level of reliability desired by consumers, from settings approved by a representative body acting on their behalf.

4.22 Alongside this, another important policy choice is the willingness and ability of consumers to tolerate periods of high prices and low reserves as the market response develops without intervention. This is because, when relying on this in isolation, strong expectations would need to be formed that prices would be allowed to reach very high levels persistently, to induce operational and investment responses.

4.23 The effective operation of this RAM relies on the following:

- Setting the cap to a higher level is sufficient to induce investment that is consistent with socio-economic expectations about levels of reliability and prices. Prices would be allowed to reach very high levels persistently, to provide sufficient investment signals.

- Other market imperfections will not be an impediment. In principle, absent any such imperfections, an MPC set at the estimated VOLL for retail customers should deliver a socially optimal level of reliability (although VOLL is challenging to estimate as it can vary for each consumer).[47]
- There would be efficient "price propagation" through different timeframes and markets (e.g. from real-time prices to investment signals). In principle, if real-time prices are formed correctly, there would be no intrinsic barriers to investment signals, but there can in practice be impediments to this.
- Policymakers are able to set credible long-term expectations (for example, that the government will not intervene to undermine the price cap), since a price cap that is not credible will not induce private capital to bring forward sufficient resources.
- Retailers face full liability for unhedged risks. If any retailers have limited liability (for example, through their corporate legal structure), they may not be fully exposed to very high prices at times of scarcity. This means that it may not be rational for them to plan or hedge appropriately for such high prices.

Reliability settings adjustments: interactions with other RAMs and other market design features that are required

4.24 As noted above, if this option is relied on in isolation to incentivise resource investment, there needs to be very strong market expectations that the reliability settings will not be inappropriately adjusted downwards (in response to, say, political pressure, or public investment).[48] To cement these expectations, it may be helpful to instigate regulatory or legal mechanisms to reduce the risk of changing the methodology considerably over a pre-determined period.

4.25 An adjustment to the current reliability settings may be considered alongside any of the other RAM options discussed in this report.

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47 This challenge is evident in AER's extensive consultation in 2019 in developing the Values of Customer Reliability ("**VCR**"), which is the NEM-specific term for VOLL. AER notes the large range in VCR values across different consumer groups ranging from $16.96/kWh to $117.99/kWh. AER, Values of Customer Reliability, December 2019 (link). The Reliability Panel must consider the VCR when deciding on the reliability standard and/or the reliability settings.

48 In the NEM, the MPC and CPT have not decreased in nominal terms since they have been introduced in 1998 and 2002 respectively (and have, in fact, risen). Additionally, they have not decreased in real terms since 2012, since they were subject to indexation. Reliability Panel, Reliability standard and settings review 2018, Table 7, April 2018 (link).

ii. Modified RRO

4.26 As explained in Section 3, the RRO is a recently introduced mechanism designed to support resource adequacy in the NEM. The RRO requires that AEMO identifies any potential shortage of **dispatchable and on-demand resources** over certain timescales – if a shortage is identified, retailers can be required to enter into contracts to cover their share of demand if the market does not respond to the forecast shortage.

4.27 As explained above, this report does not provide a view on the performance of existing RAMs in delivering resource adequacy. However, it could in principle be modified (in the same way that the reliability settings could be adjusted as described above) to increase the level to which retailers are required to contract with resources, or to **further strengthen retailers' incentives** to contract with resources.

4.28 The **key decisions points** on this RAM, which could in principle be modified, are:

- changing the definition and tightening the measurement of firmness;
- introducing closer monitoring and stricter enforcement before the proposed T-1 reliability instrument; and
- increasing the level of penalties.

4.29 Such adjustments would in principle support resource adequacy by encouraging more long-term financial contracts, reducing the risk exposure of resources, and thereby increasing resource investment and operational signals.

Modified RRO: description

4.30 Currently, the RRO has one main "**product**" type which are "qualifying contracts"; that is, financial contracts to cover peak demand. The definition of "qualifying contracts" is broad with different levels of "firmness" or how effective they might be.

4.31 Intrinsically, this approach favours peak MW through hedging contracts for the appropriate time periods. Responsive MW capacity is not necessarily incentivised, as the obligation set by the RRO would cover specific time periods ex-ante.

4.32 The specific definitions of the product might change with any modifications, for example with a different definition or measurement of firmness.

4.33 The main **obligations** for this option are:

- An obligation on AEMO to determine, for each region, the potential future shortages and their duration.

- A financial obligation on retailers (and large energy users) to enter into the qualifying contracts to meet the "one-in-two year" peak demand, or face having to pay back AEMO for any action taken if a shortfall persists in the shortage period identified by AEMO.

4.34 The **procurement approach** involves AEMO identifying the shortfalls and triggering the RRO. AEMO then submits a request to the AER to issue the relevant reliability instrument (either the requirement to enter qualifying contracts or to disclose net contract positions). The RRO is applied to each State separately. The South Australian State Government is also able to trigger the RRO, irrespective of any expected shortfall in resource adequacy as determined by AEMO.

4.35 **Enforcement** of the RRO is conducted by the AER. There are penalties for non-compliance (e.g. retailers or large energy users not procuring sufficient qualifying contracts), which are based on a share of the cost of the RERT required to cover the shortfall not met by the liable party.

4.36 The **pricing** impact in the longer term (if the RRO is successful in increasing capacity) is likely to be a reduction in market price and volatility (albeit potentially in a small number of periods), as the additional capacity is dispatched. This price impact reduces the spot market revenue of existing resources.

Modified RRO: key underlying premises

4.37 The fundamental policy choice for this option is a willingness to "centrally" assess and monitor potential future shortfalls in resource adequacy, and address those shortfalls **indirectly with a financial market mechanism**. The implication is that policymakers accept the risk that contractual obligations *may not* always lead to the required physical capacity being available and operating when it is needed.

4.38 The effective operation of this RAM relies on the following:

- AEMO (and other parties, if applicable) can correctly identify when to trigger the RRO and set an appropriate penalty ex-ante.[49]
- The method of calculating "firmness" reflects the expected effectiveness of the contracts in reducing the exposure to the spot price volatility.

49 Typically, a penalty would be considered appropriate if it is cost-reflective – that is, that non-compliant parties should be exposed to *at least* the cost they impose on the market as a result of their non-compliance (either directly on consumers, or through additional actions the SO has to take).

- Retailers have sufficient ability to meet obligations (e.g. with a liquid market and no market failures) and sufficient incentives to hedge forward appropriately (e.g. they face sufficiently strong penalties).
- Increasing the amount of longer-term financial hedging contracts is sufficient to bring forward **adequate** physical resources of the right type and in the right timescales.

Modified RRO: interactions with other RAMs and other market design features that are required

4.39 As per the comments above, a key market design feature required for the RRO to work effectively is well-functioning and efficient financial markets that can produce investment in physical resources, if required.

4.40 Aside from this, if greater reliance were to be placed on the RRO mechanism in future, there may need to be less discretion in when it is triggered (including potentially removing any State Government discretion completely). This is because of the **risk** that such discretion can be unduly influenced by short-term political judgments, leading to:

- mixed signals to investors and, consequently, inconsistent expectations, which may lead to inefficient investment decisions; and/or
- a prevalence of resources that are increasingly reliant on RRO-supported retailer contracts. This could affect market-based investments that are less reliant on the increased contracting from the RRO.

4.41 The current RRO mechanism, and any related adjustments, could be implemented alongside any of the other RAM options, but **may not be effective alongside capacity markets**. This is because capacity markets and RRO would effectively have competing obligations for capacity contracts (either through a new capacity market or through qualifying contracts). Indeed, an RRO that becomes "embedded" in market expectations, is frequently triggered, and requires contracts that have physical backing, would be very similar to a decentralised capacity market.

iii. RERT adjustments

4.42 As described in Section 3, the RERT is a backstop mechanism used by AEMO to contract directly for additional out-of-market capacity in advance of a projected shortfall. In principle, this is to ensure resources are available whenever (and wherever) needed, whilst seeking to minimise market distortions.

4.43 As with the RRO mechanism described above, a potential change to the NEM, with implications for resource adequacy, is an adjustment to how the RERT is procured and utilised. While the RERT has been reviewed and amended in recent times (see Section 3), a range of further adjustments could be considered, for example:

- the conditions for activating the reserves;
- the level of discretion AEMO has on procuring and utilising the RERT;
- the applicability to existing resources and/or new build; and
- the applicability to only plants that are at risk of closure.

4.44 Policymakers in some markets have sought to use backstop measures, like the RERT, to manage extreme events to secure reliability beyond what might be expected under the reliability standard. Additionally, a backstop mechanism could theoretically be relied on more heavily as an interim measure to assist with bringing new resources online as a new market design is implemented. For example, the recently enhanced RERT has assisted in bringing more demand response resources to the market. Any such interim measure should still seek to minimise the impacts on market-led investment and minimise competition between market resources and the backstop.

4.45 The conditions under which the RERT is utilised influence the degree to which the RERT can be considered a "last resort" measure. This is, in effect, the **key decision point** for this RAM. Relaxing the conditions under which the RERT is used, or widening the use of the RERT, moves the RERT away from a last resort measure and towards a "business-as-usual" mechanism.

RERT adjustments: description

4.46 The current RERT "**products**" are reserve contracts for MW of generation or demand reduction that can be sustained for at least 30 minutes. There is a spectrum of contracts used (e.g. with different response times and run-times of resources). These contracts provide AEMO with the option to dispatch scheduled resources or activate unscheduled resources when required.

4.47 As the RERT is used to procure capacity out-of-market, any type of capacity can be procured, whether peak or responsive capacity, depending on what is deemed necessary by AEMO.

4.48 Under the RERT, the **obligation** is on AEMO to enter into contracts, and for those contracted resources to provide energy when called upon by AEMO, under the specifications in the contract. The reserves contracted must not otherwise be available in the market.

4.49 AEMO **procures** reserves using the RERT based on the projected shortfalls and the length of time in advance of the period. Currently, there are three broad forms of RERT contract (long-notice, medium-notice, and short-notice, as described in Section 3 above).

4.50 AEMO decides: (i) whether to enter into reserve contracts, as well as the volume, duration and method of procurement; and then (ii) how and whether to dispatch scheduled resources or activate unscheduled resources.

4.51 Resources may face **penalties** for failure to meet obligations.

4.52 The **pricing** arrangements, as set out above, depend on the type of RERT contract. RERT can potentially be activated at prices significantly higher than the MPC.[50]

4.53 The RERT, on its own, distorts the wholesale market as procuring and utilising resources require out-of-market actions (therefore, to some degree, crowding out market-based investments or distorting the merit order). However, intervention pricing is applied in the NEM, which seeks to mitigate the RERT's distortionary effects.

RERT adjustments: key underlying premises

4.54 The fundamental policy choice underlying the RERT is that there should be a "backstop" available to AEMO to ensure reliability (and security once resources have been procured) in extreme circumstances.

4.55 A key premise of the RERT is that reliance on it can be minimised, as to ensure its proper functioning as a last resort measure and to avoid undesired distortionary effects on the market. In particular, the amount of capacity procured by the RERT should be kept to a minimum, as these resources would not be able to participate in the market.[51] Additionally, there should be political credibility that the RERT will not be used unless reliability is at risk and cannot be addressed by market means (thereby setting appropriate expectations in the market).

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50 For example, in Q1 2020, the cost per MWh on exercising the RERT was $18,317.77, with a total cost of $34.37m. Source: AEMO, Reliability and Emergency Reserve Trader (RERT) Quarterly Report Q1 2020 (link), page 32.

51 One common approach to minimise distortions of similar mechanisms is to only procure capacity from existing resources that would otherwise exit the market.

RERT adjustments: interactions with other RAMs and other market design features that are required

4.56 Adjustments to the RERT mechanism could be made alongside any of the other RAM options discussed in this report. In principle, the RERT interacts minimally with other market features if it is credibly fulfilling its role as a last resort mechanism. Indeed, should policymakers decide to increase resource adequacy through existing or new RAMs, this may mean that less RERT contracts would be required to be procured and activated.

4.57 While backstop measures like the RERT are an important feature of many electricity markets, if the role of the RERT were to significantly expand, or to be perceived to be at risk of doing so, there would be a risk of a ”slippery slope” (i.e. a reduced role for market-driven investments and, possibly, decreased reliance on market forces for energy and ESS). In extremis, this creates a strong incentive for market-driven capacity to be physically withdrawn from the market, especially if RERT resources are paid significantly more than the market price cap.

C. Enhancements to the existing NEM

4.58 As discussed in Section 2, in a perfectly functioning market, the resources required to meet a socially optimal reliability standard would, in principle, recover almost all their costs through revenues from the energy and ESS markets. Often, markets are not perfectly-functioning because of certain “missing elements”.

4.59 In the US, **scarcity pricing mechanisms** have been developed, motivated by a lack of dispatchable demand (a missing element preventing electricity markets from clearing based on bids from demand). In a scarcity pricing mechanism, there is an explicit increase in the energy price in periods of scarcity, even if generators bid at variable cost, or their unfettered bids are mitigated due to concerns about potential market power.[52]

4.60 In theory, with dispatchable demand, prices could rise during periods of supply scarcity until a point where demand would voluntarily reduce to clear the market. These prices would be materially higher than the variable cost of the marginal plant, and supply and demand would be in balance at a lower level of energy. However, for a variety of reasons, US markets lack dispatchable demand and have other rules that can prevent prices from rising to clear the market during supply scarcity. If prices remain low rather than rising, additional capacity might be needed to increase supply to meet demand, thereby maintaining reliability.

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52 In the US, supplier offers may be mitigated when, based on pre-set rules, it is determined that the number and size of supply-side competitors may lead to inefficient market outcomes, inconsistent with those in a competitive market. The degree of mitigation of suppliers' offers depends on how severely competition is restricted; in competitive regions there is no mitigation. This is in contrast to the NEM, where unfettered supplier offers are acceptable in all circumstances. This is referred to as "transient pricing power", which is the ability to increase supply offers and clearing prices for short periods of time. Unlike the US, this is generally regarded as acceptable in the NEM because it is considered to reflect supply and demand conditions in particular periods. Market power is considered to be an issue in the NEM if it relates to a competition concern (e.g. where a party might dominate or game the market leading to adverse competitive effects). This is referred to as "substantial market power". AEMC, Final Rule Determination – Potential Generator Market Power in the NEM, April 2013 (link).

4.61 A market without dispatchable demand or scarcity pricing can experience shortages and price spikes where real-time prices “jump” significantly to hit the price cap. This forms the rationale for a scarcity pricing mechanism that augments energy demand with a demand curve for reserves. The reserve demand curve represents the willingness to pay increasingly high prices for reserve capacity (to avoid outages) as scarcity increases.[53] Explicit valuation of different levels of reserves enables prices to rise to be more consistent with the actual cost of scarcity and signals to the market to supply additional energy and reserves, and consume less energy. Creation of a **more stable and gradual trajectory of prices towards the price cap enables more frequent and moderate price increases,** thereby supporting capacity investments.

4.62 In the NEM, some **scarcity pricing effects already exist**. Resource bid offers above variable cost do not constitute market power in the NEM. As such, even without dispatchable demand, resources can freely offer bids above variable cost up to the MPC. Therefore, scarcity pricing exists in the NEM “implicitly”; market participants are incentivised to invest and make available their capacity when there is financial opportunity.

4.63 A formal scarcity pricing mechanism in the NEM could shift this implicit scarcity pricing effect to an **explicit mechanism** with a more transparent demand curve for reserves. This could potentially support greater investments as and when needed in the NEM.

4.64 The two enhancement options are as follows:

- A **scarcity price adder**, which is a mechanism for increasing the real-time energy price during periods of scarcity to reflect requirements for responsive capacity, such as operating reserves.
- A (co-optimised) **operating reserve market,** which is a system service-based resource adequacy mechanism.

i. Scarcity price adder

4.65 A scarcity price adder supports resource adequacy by augmenting price signals to reflect the value to load of *incremental capacity that can respond quickly* (i.e. responsive capacity). The scarcity price adder adds a margin to the price that increases with the extent to which **responsive capacity** decreases the probability of an outage.

53 If dispatchable demand were included in the energy demand curve, energy demand would fall as prices rise. The parallel treatment in the reserve demand curve is an increase in price as reserves fall below a desired level.

4.66 The intention of the scarcity price adder mechanism is to increase revenue potential to all scheduled resources (i.e. those dispatched to generate electricity or deliver co-optimised ancillary services) during scarcity periods, thereby increasing resource investment signals to support resource adequacy. Importantly, the real-time scarcity price signal also provides incentives for the development and continued operation of responsive capacity that is needed to manage the variations in intermittent resource output.

4.67 The simplest form of scarcity pricing, as currently used by ERCOT, [54] is manually applying a scarcity price adder to the real-time energy price.[55] We describe this further in Box 4-1 below.

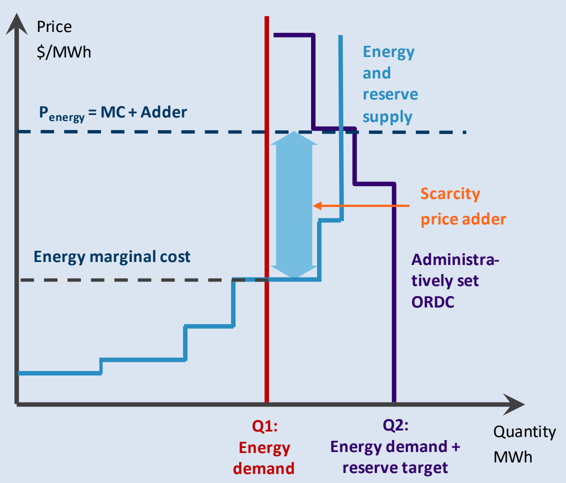
Box 4-1: Application of the scarcity price adder mechanism in ERCOT

In practice, different approaches have been used to determine scarcity price adders to the energy price. In the implementation in ERCOT, the scarcity price adder is calculated from a price-sensitive demand curve for incremental responsive reserves. This type of curve, called an Operating Reserve Demand Curve ("**ORDC**"), is determined by a central body. The scarcity price adder computed with the ORDC impacts the energy price through a "manual" addition to the energy price.[56] This is illustrated in the figure below.

54 ERCOT, the Electric Reliability Council of Texas, is the SO covering Texas.

55 In most US ISOs, the reserve scarcity price is integrated into the energy price by the energy and reserves co-optimisation. The lack of real-time co-optimisation in the ERCOT market design has been shown to be costly. ERCOT is currently engaged in a stakeholder process to implement scarcity pricing through real-time co-optimisation, so as to prospectively preserve the high scarcity prices possible under their current ORDC when there are reserve shortages.

56 ERCOT also has a second price adder mechanism to account for market price suppression that occurs as the result of out-of-market commitments made by ERCOT. While this has not been significant in size, it may be more important in markets where there are a lot of out-of-market commitments.



In ERCOT, the height and shape of the ORDC, which drives the level of scarcity pricing, is calculated periodically from principled rules and engineering-economic data.

Scarcity price adder: description

4.68 The "**product**" in this context is the provision of incremental **responsive capacity,** incentivised by a price adder to real-time market prices (noting that all capacity types that are dispatched are paid the same augmented energy spot price). As described above, the price adder is compensation for the value of **responsive capacity** and rises as lower levels of responsive capacity are scheduled.

4.69 The relevant **obligation** for this option is the existing energy market incentives that market participants face when balancing their positions in real-time or risk being exposed to changes in prices. The mechanism is intended to incentivise additional voluntary investment in capacity as a hedge for price increases when capacity scarcity arises, and in expectation of increased revenues to resources that are utilised.

4.70 In terms of **procurement**, a central body (typically the regulator) must determine the principles and methodology on how the scarcity price adder is set. This will be used by the SO to periodically determine an ORDC (which, as explained above, is used to calculate the adder to prices corresponding to different levels of responsive capacity).

4.71 ORDCs are used for scarcity pricing under both the scarcity price adder and operating reserve mechanisms. In US ISOs, they are more commonly used for operating reserve mechanisms (explained in the next subsection) and it is only in ERCOT where they are used for scarcity price adders.

4.72 To avoid repetition, in Box 4-2 below we summarise the key principles of ORDC design, which can largely apply across both the scarcity price adder and operating reserve mechanisms. The formation of the ORDC, and the related decision of whether to use different curves in different NEM regions, are the **key decision points** for scarcity pricing mechanisms.

Box 4-2: ORDC design choices

ORDCs are used for scarcity pricing under both the scarcity price adder and operating reserve mechanisms. The curves express a relationship between the marginal value of reserves (or, more generally, capacity), and the quantity of physically available reserves or capacity scheduled in the dispatch. Some ORDCs are based on estimates of the costs and the reserve quantities associated with progressively more interventionist actions that the SO could take as reserve shortages develop.

ERCOT developed a simplified way to calculate ORDCs from estimates of three parameters: (i) the VOLL; (ii) the probability of loss of load; and (iii) a minimum level of required reserves to avoid cascading outages, "**X**" (30-minute reserves, in this case).

In principle, if the level of operating reserves starts to fall close to **X**, the system operator would curtail load in order to preserve necessary reserves. For this reason, when reserves fall to **X**, the ORDC sets the marginal value of having more at the VOLL.[57]

An important characteristic of this ORDC is that the value of reserves does not fall to zero as soon as the minimum value, **X**, is scheduled. Instead, reserves above the level of **X** have value due to the probability of uncertain events occurring between the time of the real-time dispatch, when the reserves are scheduled, and the time when the reserves are needed (30 minutes in the future, for the purposes of discussion).

System operators typically employ multiple ORDCs for scarcity pricing. The different ORDCs enable scarcity prices to vary according to factors such as: (i) the response time of physically responsive reserves (e.g. 30 or 60 minutes); (ii) the location of the reserves; (iii) the time of day; and (iv) other operational factors.

57 PJM has approval to implement ORDCs designed on these same principles.

4.73 There is no specific **enforcement** regime for this RAM, although resources may be exposed to greater risk. For example, resources bear the performance risk of not being paid a high price when a shortage occurs if they are not dispatched. Conversely, resources that are under a forward contract may face a penalty (under the terms of the contract) if they were obligated to be available but fail to do so. Additionally, retailers that are unhedged would face greater risk exposure to the higher prices produced by the scarcity pricing effect.

4.74 In terms of **pricing**, a scarcity price adder can have a significant impact on market prices:

- Prices increase with decreases in the quantity of dispatchable capacity available (more so than in the absence of the scarcity price adder) and may reach very high levels (of course, subject to implementation of any price caps).[58]
- The degree of price impact depends on the value of the scarcity price adder at different levels of availability of dispatchable capacity. If the demand curve is set based on VOLL estimates and outage probabilities, this will likely promote small price impacts much more frequently than large price impacts.[59]
- Higher prices, as determined by the scarcity adder design, compensate all resources that are dispatched to provide energy. In principle, this should include other ESS products that are procured on a market-basis and require the real-time availability of capacity, such as operating reserves and frequency response (if the energy market is co-optimised with ESS).
- Unhedged loads pay higher real-time prices during periods of scarcity, and resources with forward contracts may pay a higher price for failure to be available.

Scarcity price adder: key underlying premises

4.75 The fundamental **policy choice** is a reliance on the spot price (as augmented by the price adder) to deliver (over time) the desired level of reliability. In parallel with this, there needs to be the ability to tolerate periods of high prices and low reserves as the market response to scarcity develops.

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58 Depending on the shape of the demand curve, prices may begin to increase incrementally as the available capacity in the system decreases, even before scarcity conditions. However, the adder will be much more prominent during scarcity conditions.

59 In the first few years of the scarcity price adder in ERCOT, there was sufficient available capacity that the impact from the adder was minimal.

4.76 The effective operation of this RAM relies on the following:

- the resultant increase in spot prices would be strong enough to induce sufficient investment, consistent with expectations about levels of reliability and prices;
- there would be efficient "price propagation" through different timeframes and markets (e.g. from augmented real-time prices to investment signals); and
- the ability to set credible long-term expectations (i.e. that government will not intervene by contracting out-of-market for capacity or, in the context of the US LMP framework, by building transmission).

Scarcity price adder: interactions with other RAMs and other market design features that are required

4.77 Introducing a scarcity price adder could help to prevent capacity shortfalls, reducing the likelihood of the RRO being triggered and reducing the use of RERT.

4.78 A scarcity price adder (or an operating reserves mechanism) may be needed if capacity markets are introduced. This is because capacity markets may reduce the implicit scarcity pricing effect that exists in the NEM (i.e. resources with capacity contracts could offer bids closer to variable cost as a significant portion of their fixed costs would be recovered from capacity payments). A scarcity price adder would support capacity markets by re-introducing this scarcity pricing effect through a formal ORDC.

ii. Operating reserves mechanism

4.79 An alternative RAM to support scarcity pricing is an operating reserves mechanism, which is used in many US ISOs. Similar to the scarcity price adder, the operating reserves mechanism:

- supports resource adequacy by augmenting real-time price signals to reflect the scarcity value of available incremental capacity;
- uses a price-sensitive demand curve for incremental responsive reserves, often based on an ORDC (as described above). This increases the revenue potential to all scheduled resources during scarcity periods, thereby increasing resource investment signals to support resource adequacy; and
- provides incentives for the development and continued operation of responsive capacity that is needed to manage the variations in intermittent resource output.

4.80 However, unlike the scarcity price adder, the operating reserves mechanism applies an ORDC to produce the scarcity pricing effect *within the execution of the market dispatch*, rather than through an ex-post price adder. The market design for the operating reserves mechanism includes separate markets to schedule one or more types of operating reserves (and also possibly other ESS).

4.81 As resources submit bids and offers for operating reserves concurrently with bids and offers for energy, the SO can add operating reserves to its co-optimised dispatch of energy and FCAS.[60] We describe the co-optimisation of energy and reserves process at a high-level in the Box 4-3 below.

Box 4-3: Co-optimisation of energy and reserves

Co-optimised dispatch is a market design feature that economically positions resources of all types, including dispatchable loads, to provide energy and **one or more ESS products**. Resources submit bids and offers for ESS, such as frequency response and operating reserves, concurrently with bids and offers for energy. SOs review the bids and offers at the same time, while also taking into account all operational constraints (such as ramping constraints, transmission system contingencies, etc.), and then issue simultaneous real-time dispatch instructions for energy and schedules for the ESS products.

As intermittent production increases, co-optimised dispatch of energy and ESS (such as operating reserves) can enable efficient adjustment of the output of resources, that can increase or decrease production at least cost to balance load. The co-optimisation dispatches and/or schedules capacity for its highest-value use (whether reserves or energy, in particular) with the objective of maximising social welfare. Suppliers are paid the market clearing price for energy and their ESS schedules, not their offer or bid price, thus supporting the least-cost dispatch.

For the case of reserve scarcity pricing, co-optimisation produces consistent prices for energy and reserves – the demand for reserves (represented by the ORDC) provides a market-clearing scarcity price for reserves that also enters the clearing-price for energy. This means the energy price reflects the marginal value of energy considering the incremental value of operating reserves at each point in time.

60 If this RAM mechanism were applied in an ahead market, the co-optimised dispatch would be preceded by a co-optimised unit commitment.

4.82 Using an ORDC in the co-optimised dispatch results in increasing operating reserve market clearing prices as the level of scheduled reserves falls. Energy prices also rise, because scarcity of operating reserves occurs due to the need to schedule available capacity to provide energy rather than reserves. Co-optimising energy, FCAS and operating reserve schedules, with an ORDC, would enable these prices to rise with capacity scarcity, thereby increasing resource investment signals.

4.83 This type of mechanism would be a permanent change to the design of real-time markets and would affect real-time settlement prices.

Operating reserves mechanism: description

4.84 The **products** in this context are the operating reserve products that are defined in the system design. This can be one or more products, with different **activation lead times, duration and other factors**. Target quantities of the products could be specified to support reliability goals and could vary by location and/or based on other measures of system operational status.

4.85 Typically, the requirements for OR product(s) would be specified as ORDCs, with prices rising towards estimated VOLL as quantities of scheduled reserves fall. These products monetise the real-time value of **incremental responsive capacity**.

4.86 The **obligation** on market participants depends on the specified OR market design. Resource offers for operating reserves could be voluntary or mandatory. If voluntary, retailers would be incentivised to contract forward with resources in order to economically manage their expected scarcity costs.

4.87 In terms of **procurement**, a central body (ideally a body representing consumer interests and accountable for their outcomes) would determine the principles to be used by the SO to periodically determine the ORDCs. The SO would typically be responsible for specifying target quantities to be procured and would run the market to procure ORs itself in real-time (and ahead markets, if relevant). The ORDC design issues are similar to those described above for the scarcity price adder RAM.

4.88 As with a scarcity price adder, there is no specific **enforcement** regime for this RAM, although resources may be exposed to greater risk if they are unhedged. Conversely, resources that are under a forward contract may face financial penalties (under the terms of the contract) if they fail to be available when required to do so.

4.89 In terms of **pricing**, OR mechanisms have a significant impact on market prices:

- Co-optimised prices for energy are typically used for real-time settlements of injections and withdrawals, and co-optimised real-time operating reserve prices are paid to resources scheduled for operating reserves. (This is a key contrast to scarcity price adders, where only resources dispatched for energy pay the (augmented) energy spot price).
- Total compensation paid to suppliers of operating reserve and costs to consumers could be impacted by hedging contracts between resources and retailers, such as options contracts for the availability of reserves that could be called on by retailers during periods of scarcity (depending on design choices).
- Both energy and reserve prices increase during scarcity periods. Reserve prices might increase independently of energy prices during low load conditions (if the system is "long" on energy but "short" on dispatchable capacity). The price impact depends on the design of the ORDCs, as described above for the scarcity price adder.
- Prices provide compensation exceeding variable cost to all resources that are scheduled to provide energy or operating reserves when incremental operating reserve capacity has value, according to the ORDC.
- Unhedged loads pay significantly higher prices during periods of scarcity, and resources with forward contracts with retailers to provide energy or reserves may pay a higher price for failure to be available.

Operating reserves mechanism: key underlying premises

4.90 The **fundamental policy choice** is a reliance on the co-optimised prices of energy and reserves to deliver (over time) the desired level of reliability by providing incentives for market participants to invest in capacity. In parallel with this is the willingness and ability to tolerate periods of high prices and low reserves as the market response develops.

4.91 The effective operation of this RAM relies on the following:

- the resultant increase in spot prices would be strong enough to induce investment consistent with socio-economic expectations about levels of reliability and prices;
- there would be efficient "price propagation" through different timeframes and markets (e.g. from augmented real-time prices to investment signals); and

- the ability to set credible long-term expectations (i.e. that government will not perceive the need to intervene by building transmission or contracting out-of-market for capacity).

Operating reserves mechanism: interactions with other RAMs and other market design features that are required

4.92 For the same reasons as explained above for the scarcity price adder, the operating reserves mechanism can be implemented independently, without conflicting with other RAMs. This may reduce the use of RERT and may reduce the likelihood of the RRO being triggered through the reductions of forecast shortfalls.

4.93 An operating reserves mechanism (or a scarcity price adder) may be needed if capacity markets are introduced. This is because capacity markets may reduce the implicit scarcity pricing effect that exists in the NEM (i.e. resources with capacity contracts could offer bids closer to variable cost as a significant portion of their fixed costs would be recovered from capacity payments). An operating reserves mechanism would support capacity markets by re-introducing this scarcity pricing effect through a formal ORDC.

4.94 Critically, and as explained above, an operating reserves mechanism requires co-optimisation of energy and reserves. This would require the handling of new dispatch bids, constraint equations and other software changes within AEMO (and in turn, within the suite of tools that market participants use to form market strategies over short and long-term horizons).

4.95 The use of the operating reserves mechanism in the NEM would be premised on co-optimising energy and reserve prices in each of the NEM regions.

4.96 To date, the operating reserves mechanism has only been applied in markets with LMPs. Further consideration is required on potential challenges that might arise from the need for more locational granularity, to engender prices that will result in the desired dispatch.[61]

4.97 The operating reserves mechanism would also function as an ESS, and in turn, should be considered with the rest of the ESS design.

61 For example, if greater operating reserves capacity is required in a specific area within a price zone.

D. Capacity markets

4.98 In some jurisdictions, forms of capacity mechanisms such as capacity markets have been introduced by policymakers. The underlying reasons vary but are typically linked to one or more of:

- trends in subsidised intermittent renewable generation (which affects energy price dynamics) and/or an increased tendency for political and regulatory intervention in electricity markets (particularly in response to higher prices) have in some jurisdictions reduced investor appetite in conventional, dispatchable generation. In turn, this has led policymakers to be concerned that the reduction in such generation puts resource adequacy at risk;
- a view that capacity markets are the best way to mitigate the effects of the market imperfections explained in Section 2; and/or
- the political desire to have a reliability standard that is significantly higher than the theoretical socially optimal level of reliability that would be produced by market forces.

4.99 The fundamental feature of capacity markets is that they seek to **explicitly guarantee** a certain volume of capacity is installed, through the use of forward-looking obligations (typically 1 to 5 years ahead obligations, but can be up to 15 years) and associated penalty regimes.

4.100 The advanced procurement is effectively an insurance mechanism which provides certainty for all market participants. For resources, a capacity market provides an additional revenue stream that is de-risked (from their perspective) which supports investment at a lower cost of capital.

Box 4-4: Capacity mechanisms in Europe

There is growing belief across Europe that the current markets cannot guarantee reliability of supply in every situation in the long-term, for various reasons including: (i) price caps and barriers to scarcity pricing (the so-called "missing money" issue); (ii) aversion to risk associated with investing on the basis of uncertain revenues; and (iii) the difficulty related to hedging or transferring risk on a long-term basis.[62] This issue is exacerbated by the development of variable renewables which amplifies price volatility and creates greater uncertainty for annual sales by peaking units.[63]

Capacity markets aim to address these issues by providing a separate revenue stream to some or all capacity resources, and have been implemented, or are in the process of being implemented, in various forms across many European countries.

In 2015, the European Commission ("**EC**") launched a state aid Sector Inquiry into capacity mechanisms, and found that they may fall within the category of measures that can be subject to the European Union's rules on state aid. [64] The EC Sector Inquiry defines capacity mechanism categories in terms of:

- the scope of capacity mechanism application (i.e. *targeted* mechanisms that only benefit specified capacity providers, or *market-wide* mechanisms, which are in principle open to participation from all categories of capacity providers); and
- the main instrument of inducing capacity (i.e. *volume-based* mechanisms, where the capacity requirement is defined, and a capacity price will emerge through market dynamics, and *price-based* mechanisms, where policymakers set the capacity price and the level of capacity emerges through market dynamics).

4.101 This report focuses on two broad types of capacity markets – *centralised* and *decentralised*. We describe these in in the two subsections below.

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62 Joskow, 2008; Roques, 2008; Roques and Finon, 2008, Roques Cramton, Ockenfel, Stoft, 2013.

63 Cramton, Ockenfel, Stoft, 2013.

64 European Commission, Final Report of the Sector Inquiry on Capacity Mechanisms, 30 November 2016 (link).

i. Centralised capacity market

4.102 Centralised mechanisms are typically applied to the whole market (i.e. not just for a specific type of resource), and **are procured and run by a central body through an auction mechanism.** As noted above, by remunerating the provision of capacity rather than energy, a centralised mechanism provides an additional revenue stream and greater certainty for resources.

Centralised capacity market: description

4.103 The "**product**" in this context is a capacity product, procured through a market where capacity contracts are auctioned to resources in advance. Most commonly, this requires a certain (administratively-set) volume of capacity to be procured.

4.104 Capacity products are typically defined by features such as:

- **Period** of obligation: the period during the delivery year when the capacity providers should fulfil their obligations.
- **Type** of the obligation: the form of the agreement according to which the capacity providers receive payments.
- Contract **duration**: the time period during which the providers will receive the capacity payments based on the result of the auction (e.g. in the GB market, contracts can be entered into for periods between one and fifteen years).
- **Penalties** enforcing the obligation: the penalties that will apply if the obligation is not fulfilled.

4.105 The specific details of the product definition could incentivise investment into different types of capacity. For example, if the period of obligation is only known to participants nearer to the delivery date, and there are high penalties, this may incentivise greater investment in responsive capacity.

4.106 For a centralised capacity market, there is no **obligation** to participate. However, resources that are successful in bidding for a capacity market revenue stream need to be available during defined periods, depending on the nature and the level of the centrally-set obligations.[65]

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65 Existing resources that are unsuccessful will have to continue relying on the spot-market to recover their fixed costs, facing a disadvantage relative to their competitors with a capacity contract.

4.107 The **procurement** approach is typically that the SO procures the capacity directly. This type of capacity market is often operated as a single buyer market in a **competitive** manner, such as via an auction, where supply and demand are matched. This establishes a market-clearing price for the provision of capacity (ahead of the capacity being required). Different auctions can be applied to different price zones, to procure the required capacity in each zone.

4.108 The design of a capacity market is a complex undertaking, requiring significant analytical work, technical expertise, and ongoing monitoring, review and consultation. Aside from the volume of capacity to procure (and related demand curve) and whether this is done at a market-wide or regional level, other key decision points that need to be considered are:

- **Which technologies are eligible**. Centralised *market-wide* mechanisms[66] are generally open to all types of capacity, including DR, capacity imported from other regions, and renewables. However, it is possible to introduce criteria which lead to the (implicit or explicit) exclusion of certain types of resources. As an example, participation could be conditional on: (i) environmental criteria (such as CO_2 emission rates); (ii) flexibility criteria (such as ramping speed); or (iii) economic criteria (such as non-receipt of subsidies). Policymakers in the EU are contemplating making eligibility subject to specific criteria (such as flexibility) as part of the ongoing reforms of these schemes.

- The **timings of procuring the capacity ahead of delivery**. As noted above, the SO procures capacity in advance of the capacity being required, typically between 1 and 5 years ahead. The decision about how far ahead to advance (which includes the duration of contracts) is a trade-off between the revenue certainty delivered to investors (important, given the required lead times for new build) and the forecasting risk (in particular, the risk and cost of over estimating capacity requirements in future years) transferred to consumers.

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66 As noted above, some capacity markets in Europe are targeted towards specific resources. Increasingly, these are being challenged.

- The **de-rating factor** used to reflect the proportion of time that a particular resource is expected to be able to contribute to meeting demand (which in turns drives the remuneration of the resource).[67] The capacity considered available for the purpose of the capacity market, for which resources will receive capacity payment, is generally less than the installed "nameplate" capacity, reflecting the actual *expected* contribution of the capacity. Such "de-rating" of the installed capacity takes into account maintenance needs, physical constraints or other factors. De-rating is particularly relevant for renewables because of their intermittence. De-rating factors can be applied based on technology type, or can be bespoke for individual resources. They can be determined based on historical data (e.g. calculated average availability during previous peak periods[68]) or based on the expected marginal contribution estimated with stochastic modelling.[69]
- The **overall volume of capacity to procure and the auction mechanism used**. This includes decisions on the shape of the demand curve (typically reflecting estimates of the capacity required, the cost of new entry, and the VOLL) and how that demand curve interacts with estimated energy and system services revenues.

4.109 In terms of **enforcement**, resources are subject to penalties for non-delivery (referring to both being available to be scheduled and responding to instructions to activate). The penalties may involve capacity providers returning previously received capacity payments or even paying a penalty, in addition.

4.110 A capacity market requires an appropriately designed and carefully calibrated penalty regime that balances the trade-off between encouraging participation and incentivising commitment: penalties may have to be very high to incentivise commitment.[70]

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67 De-rating factors are not strictly required – in principle, a penalty regime could be designed which obviates this feature, but has not been done in any capacity market in practice.

68 This is used for thermal resources in GB, Poland and Italy.

69 This is used for interconnectors in Ireland, France and GB.

70 As explained above, penalty prices should be cost-reflective, that is *at least* the cost the non-compliant party imposes on consumers as a result of their non-compliance. Penalty prices may be set higher than this amount due to other factors such as the impact on competition.

4.111 The **pricing** of capacity in a centralised capacity market is complex. The value of capacity contracts is not necessarily linked to expected real-time prices, and typically the clearing price of auctions affect all successful bidders.

Centralised capacity market: key underlying premises

4.112 The **fundamental policy choice** underlying a centralised capacity market is the desire for a system that seeks to guarantee a minimum reliability standard at all times, rather than relying on a combination of market forces and the procurement by the SO of reserves when shortfalls are identified from time to time.

4.113 The underlying rationale for such a guarantee is summarised above – for example, if it is considered that market price signals are not considered strong enough to induce investment sufficient to achieve a socially-optimal level of reliability, or that policymakers desire a reliability standard that is significantly higher than a theoretically socially optimal reliability standard.

4.114 The effective operation of this RAM relies on the following:

- The willingness of policymakers to allow the reliance on long-term capacity market revenues to become embedded in the system. This is because the introduction of a capacity market would diminish the reliance on spot market signals, as project finance becomes more reliant on long-term capacity market revenues. This may lead to a scenario where it may be challenging to reverse the policy.
- Contrasting with the decentralised capacity market described below, policymakers need to be willing and able to develop and operate a highly-centralised system, with a cogent set of rules relating to products, procurement, and enforcement that has the confidence of market participants.

Centralised capacity market: interactions with other RAMs and other market design features that are required

4.115 A key point with capacity markets is that they are not intended to be a substitute for a well-functioning set of energy (and ESS) markets. As noted above, their fundamental purpose is to provide a level of "insurance" where this is desired by policymakers.

4.116 Indeed, within the European Union, capacity market implementation is *conditional* on member states demonstrating a plan for addressing market failures affecting energy (and ESS) markets, and capacity markets are (in principle) bound to a duration of less than 10 years. However, in practice, capacity markets appear difficult to "roll back" once implemented, and in many jurisdictions the market expectation is that they will be perpetual.

4.117 Hence, a centralised capacity market, if introduced, can co-exist with most other RAMs that could be developed in a market, as a means to procure more capacity in advance of delivery to provide greater insurance. A notable exception is the RRO, because capacity markets and RRO would effectively have competing obligations for capacity contracts (either through a new capacity market or through qualifying contracts).

4.118 We would also note that:

- In practice, the presence of a capacity market would usually imply reduced offer prices, because a high portion of fixed costs are funded through a capacity payment, so the spot price is not required to cover full investment costs, just the variable costs of plant. This would reduce the implicit scarcity pricing effect that exists in the NEM, meaning there may be more incremental benefit to an (explicit) scarcity pricing mechanism to augment the real-time price signals.
- A centralised capacity market actually has some similarities to the RERT, in that it is a specific procurement of an administratively determined volume. However, the RERT is designed to be procured and used in limited circumstances, meaning the SO has considerable discretion in which resources it contracts with and how it schedules, dispatches, and pays them. By contrast, a capacity market is a fundamental re-shaping of the market.

Box 4-5: Reliability options as an alternative to fixed capacity payments

One variant of a capacity market that is becoming increasingly popular in Europe is based on reliability options. Most recently, this has been adopted in Ireland in 2017, and in Italy in 2019. Similar variants exist in ISO New England and Colombia. The description of the variant in this box is based on the capacity market design in Ireland (known as the Capacity Remuneration Mechanism).[71]

[71] Ireland's wholesale electricity market is known as the Integrated Single Electricity Market ("**I-SEM**"). This covers both the Republic of Ireland and Northern Ireland.

In this design, the SO, as a central buyer, runs an auction to purchase reliability options from providers of capacity to cover the volume of capacity it deems necessary to ensure reliability. A reliability option is a financial contract that entitles the SO (as the buyer) to receive the difference in payments between the electricity wholesale market price and the pre-defined strike price of the contract from the resource (as the seller). Reliability options function akin to call options that must be physically backed with capacity.

Following the auction, the SO pays an annual amount to resources based on the auction outcomes as a capacity payment. In turn, during the delivery year, resources pay the total difference between the market price and the strike price multiplied by the volume of capacity sold, across all periods. Retailers, who fund the capacity market through the SO, are effectively the holders of these options which enables them to be hedged against these high prices.

This design has three advantages over a traditional centralised capacity market:

1. First, generators could receive more stable cash flows (in addition to hedging in the usual way), by forgoing a level of profits for an earlier capacity payment.
2. Second, resources would have the incentive to be available during periods where the market price exceeds the strike price, otherwise they would be penalised as they would have to pay the SO the difference regardless.
3. Third, retailers, as holders of the options through the SO, are hedged against prices higher than the strike price. Indeed, if all the capacity in the market is sold as reliability options, the strike price would become the price cap in the market.

These advantages would be most prominent in energy markets that do not have liquid financial contracts markets. This means that the reliability options variant may not be a significantly beneficial option for the NEM, as it is in Ireland. As such, this report does not examine this variant further; any further consideration of this variant would need to be assessed in more detail.

ii. Decentralised capacity market

4.119 As noted in Section 4H above, there are a wide variety of types of capacity markets, and this report focuses on two broad types (centralised and decentralised). The underlying rationale for each is the same, and in this subsection, we focus on the key areas where the decentralised capacity market departs from the centralised capacity market.

4.120 Decentralised capacity markets share the same fundamental feature with capacity markets – that is, seeking to **explicitly guarantee** a certain volume of capacity is installed. Similarly, they are also **forward-looking,** acting as "insurance" which provides certainty for all market participants (and in particular for resources, providing an additional de-risked revenue stream which supports investment).[72]

4.121 However, rather than a central body (e.g. the SO) procuring the capacity in advance, the SO places obligations on *retailers* to procure physically-backed capacity (rather than allowing them to act purely based on market signals).

Decentralised capacity market: description

4.122 The "**product**" is a volume-driven capacity product, where tradeable units (or capacity certificates) of resources are bought and sold.

4.123 The tradeable units (or capacity certificates) are typically defined by features such as the period, type and duration, together with associated penalties for non-performance.

4.124 Similar to a centralised capacity market, the specific details of the product definition could incentivise investment into different types of capacity. While capacity markets are often used to increase investments in peaking capacity, greater investment in responsive capacity can be incentivised (for example, by narrowing the period of obligation to specific periods nearer to the delivery date and setting harsher penalties).

4.125 A decentralised capacity market puts a primary **obligation on retailers** to procure products to meet a demand level that is administratively determined (typically, this might be their expected demand, augmented by a specified margin).

4.126 It is important to note there is a wide spectrum of possible definitions for the obligations: for example, the obligations may or may not be binding at all times (in the latter case, and as explained further below, the mechanism becomes somewhat similar in principle to the current RRO scheme).

4.127 Whilst the fundamental feature of capacity markets is to provide insurance, in a decentralised approach, retailers decide how to meet the obligation (e.g. with their own contracting / hedging approach). As we note below, this reliance on the market mechanism can in principle be more efficient than a centralised approach where the SO typically makes such a decision.

72 One key example where a decentralised capacity market has been introduced with relative success is the French capacity market. For more detail, see FTI-CL Energy, Assessment of the impact of the French capacity mechanism on electricity markets, June 2016 (link).

4.128 As with centralised capacity markets, there is no obligation on resources to participate, but those that do have the obligation to deliver resources during scarcity commensurate with capacity units sold.

4.129 Whilst retailers **procure** the capacity, a central body (e.g. the SO) needs to define and quantify the products that retailers are obligated to procure. There are various ways that the volume can be defined, but two popular options are a specified MW amount for each retailer, or an amount representing each retailers' peak demand plus a margin.

4.130 As with centralised capacity markets, decentralised capacity markets require detailed consideration of key factors like eligibility, whether responsive capacity is specifically targeted, timings of procurement, and de-rating factors for different resources. Different procurement arrangements can be applied to different price zones to reflect the varying requirements of each zone.

4.131 In terms of **enforcement**, resources face penalties for non-delivery (referring to both being available to be scheduled and responding to instructions to activate), as well as penalties for retailers that do not have sufficient units to cover their obligations. This requires an appropriately designed and carefully calibrated penalty regime that balances the trade-off between encouraging participation and incentivising commitment. Again, as with centralised capacity markets, a robust penalty regime is critical to incentivise the performance of resources.

4.132 The **pricing** of capacity in a decentralised capacity market can be complex. The value of capacity contracts is not necessarily linked to expected real-time prices, and typically the clearing price of auctions affect all successful bidders.

Decentralised capacity market: key underlying premises

4.133 The underlying premise of this RAM is the same as with centralised capacity markets – i.e. the fundamental policy choice is the desire for a system that seeks to guarantee a minimum reliability standard at all times.

4.134 The effective operation of this RAM relies on the following:

- The willingness of policymakers to allow the reliance on long-term capacity market revenues to become embedded in the system. This is because the introduction of a capacity market would diminish the reliance on spot market signals, as project finance becomes more reliant on long-term capacity market revenues. This may lead to a scenario where it may be challenging to reverse the policy.
- In the case of a decentralised capacity market, another central premise is that market participants (i.e. retailers) could efficiently assess, value and manage the risks better than the SO.

Decentralised capacity market: interactions with other RAMs and other market design features that are required

4.135 Decentralised capacity markets have the same interactions as centralised capacity markets – in summary, a mechanism which is not fundamentally suited to *addressing* energy market imperfections but is instead working as an additional mechanism in addition to other RAMs, if needed.

4.136 Hence, a decentralised capacity market, if introduced, can co-exist with most other RAMs that could be developed in a market. One exception is the RRO. This is because capacity markets and RRO would effectively have competing obligations for capacity contracts (either through a new capacity market or through qualifying contracts). Additionally, as mentioned above, an RRO that becomes "embedded" in market expectations, is frequently triggered, and requires contracts that have physical backing would be very similar to a decentralised capacity market.

4.137 Similar to a centralised capacity market, the presence of a decentralised capacity market may reduce the implicit scarcity pricing effect that exists in the NEM due to the incentives of resources to maximise their availability during peak periods. This could increase the incremental benefit of an (explicit) scarcity pricing mechanism to augment the real-time price signals.

5. Assessment of RAM development options

5.1 Section 4 above discussed seven options for RAM development, with different underlying premises that are relevant to considering which of the options (if any) may be appropriate for the NEM.

5.2 As noted in Section 1, this report does not provide a recommendation on a particular course of action, or a view on whether or not the current NEM provides sufficient resource adequacy as it stands.

5.3 However, it may be of assistance to the ESB to assess each RAM in a comparative way using a consistent framework. Hence, in this section, we set out such a framework before then applying it to each RAM option.

5.4 For clarity, at the end of this section, we also summarise the interaction between the potential RAMs, given there are important interlinkages that need to be considered in any assessment.

A. Assessment framework for each RAM

5.5 The assessment framework is not designed to provide a "score" or "ranking" for each RAM. Rather, it is designed to provide a high-level and qualitative assessment along three different dimensions:

- first, a review of the main features of the RAM against the theoretical principles of good electricity market design; and
- second, the potential stakeholder impacts of each RAM.

5.6 These are each explained further below.

i. Review of the RAM against the principles of good market design

5.7 This assessment is important in the context of a liberalised (rather than centrally planned) electricity market which has generally driven good outcomes for consumers in the NEM. For the purpose of this report, we comment on the implications of each RAM against each principle.

5.8 The five principles (which are introduced and explained in Section 2) are as follows:

- Principle 1. Efficient dispatch to drive efficient price signals

- Principle 2. Efficient price signals to drive efficient investments
- Principle 3. No undue discrimination
- Principle 4. Cost recovery / risks allocated appropriately
- Principle 5. Regulatory intervention minimised

Principle 1. Efficient dispatch to drive efficient price signals

5.9 Real-time prices, if formed correctly, are essential market-based signals to incentivise market participants to make optimal operational and investment decisions. The features of a RAM most relevant to this principle include:

- how the RAM affects real-time price signals (to both resources and loads – in a two-sided market, loads are more responsive to such signals); and
- whether the RAM accommodates co-optimisation between energy and appropriate ESS in the dispatch model, and/or includes the costs of targeted environmental externalities if desired.

Principle 2. Efficient price signals to drive efficient investments

5.10 Market clearing prices formed in real-time, if supportive of the least-cost real-time dispatch consistent with observing the technical requirements of the system, should provide incentives for efficient and timely resource investments. The investments may differ in technical characteristics to meet different needs of the power system, such as ramping speed, start-up time and location. Real-time price signals should ideally reflect the requirements for these technical characteristics and should also be sufficiently transparent and predictable in order to facilitate efficient financial markets that underpin these investments.

5.11 If real-time price signals are inefficient, market participants that intend to secure physical delivery on their forward market transactions (which are based on expectations of real-time prices) may encounter a "deliverability" issue when physical delivery is not possible (because of real-time physical constraints). These issues will be resolved by the SO, at a cost to consumers. This means that RAMs that secure physical forward commitments may lead to this deliverability issue, which will ultimately have to be solved by the SO for the real-time dispatch, at a cost to consumers.

Principle 3. No undue discrimination

5.12 In running a competitive electricity wholesale market, no undue discrimination must be made for or against any participant. However, policymakers may have to (or may wish to) make decisions on how RAMs treat different types of resource characteristics (or even different types of technology).

5.13 For the purposes of this report, the feature of a RAM most relevant to this principle is the extent to which the RAM allows for appropriate discrimination between different resource characteristics (if that is a policy objective).

Principle 4. Cost recovery / risks allocated appropriately

5.14 Costs and risks should be identified and allocated efficiently among relevant stakeholders. For costs, this generally means that, as far as is practicable, individual users should bear the costs they impose on the system (at the margin)[73]. For risks, this generally means that risks should be allocated to parties best able to manage them.

Principle 5. Regulatory intervention minimised

5.15 A premise of a liberalised electricity market is that the market should be primarily used to deliver efficient outcomes rather than through government and regulatory interventions. This does not preclude the need for a centralised SO to coordinate dispatch and maintain energy security.

5.16 The intrinsic risks of regulatory intervention (such as the risks of unintended consequences, or uncertainty over future policy decisions) have been documented widely, and we will not repeat them here. For the purpose of this report, we assess the differing potential that RAMs have to require intervention and to foster market concerns about the potential for intervention. Where relevant, we also comment on RAMs that may require particular regulatory intervention regarding the exercise of market power.

ii. What is the potential stakeholder impact of each RAM in the NEM?

5.17 Our assessment is driven by our view of the key potential impacts for each type of stakeholder. It is not fully exhaustive but intended to draw out the critical points for consideration.

5.18 A key aspect of this is the potential **impact on consumers**. For this report, we focus on three main areas.

- First, the extent to which each option delivers a given level of reliability for consumers – clearly, this is driven by the ultimate market response to a RAM, but RAMs differ in the extent to which they *seek to guarantee* reliability.

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73 The implications of different RAMs for the detailed design of network charges are not in the scope of this report. We would note, however, that the emergence of much more intermittent generation and the consequent reduction in thermal plant generation means that network charge formulation will need to be considered very carefully in the future.

- Second, the types of costs that consumers are exposed to through all charges for electricity consumption over a period of time, and whether these are driven through higher spot prices, higher volatility in spot prices or other routes, such as changes in charges for ESS. It is important to consider the impact of a RAM on the total customer bill, since different RAMs may impact different parts of the bill in different directions and to different extents. Since the efficient level of cost is unknown in advance, this includes consideration of the balance of risks that consumers face (for example, stranding risks if consumers ultimately pay for resources that are not eventually required, or risks of outages if capacity is not adequate).
- Third, where relevant, we also consider future developments such as the ability of consumers to participate in any of the markets and receive benefits via this participation (instead of only passively receiving lower prices).

5.19 Other impacts we consider are as follows:

- **Impact on resource investment**. In general, this refers to the investment signals and incentives the RAM provides for investors or potential investors in resources. Where there are potentially significant differentials on the impact by generation technology, we highlight them. However, we note that most of the RAMs can discriminate by technology, if desired, but may differ materially in the degree to which this discrimination has detrimental impacts on competitive markets.
- **Impact on retailers**. The primary factors in the assessment are the changes in the risks and obligations that retailers would be taking on.[74]
- **Impact on policymakers**. This focuses on the level of confidence in resource adequacy the RAM could provide to policymakers, and the risks (if any) of potentially inappropriate government intervention. Where relevant, we also note the level of administrative complexity that that some RAMs may introduce.

5.20 As noted in Section 4, for each of the RAM options that we assess, there is significant scope for variation within RAM options. While our assessment sets out the potential stakeholder impact at a high-level, the impact would be very sensitive to the detailed design of the RAM.

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74 Note that wholesale energy costs, network costs and RAM costs are considered in the "impact on consumer" category as these are generally passed through to consumers.

B. Reliability setting adjustments

5.21 Reliability settings are features of the electricity wholesale market in the NEM that limit market participants' exposure to wholesale prices. They are reviewed by the Reliability Panel every four years. Broadly, an increase in the reliability settings relies strongly on market participants responding rationally to the economic incentives, by managing the risks that they are more fully exposed to as a result of (for example) a higher MPC.

Reliability setting adjustments: review against the principles of good market design

5.22 The table below sets out the assessment of how this RAM meets the principles of good market design.

Reliability setting adjustments: assessment against market design principles

Principle	Assessment
Efficient dispatch to drive efficient price signals	▪ Reliability settings reflective of the VOLL would enable prices to rise in line with the potential value of energy-not-supplied.[75] ▪ At this level, market participants would be able to respond to these accordingly – there are clear signals to all participants (both supply side and demand side). ▪ However, the application of the APC (when the CPT is triggered) could potentially affect efficient dispatch.[76]
Efficient price signals to drive efficient investments	▪ If successful, provides a greater incentive for dispatchable resources that can deliver at times of very high prices. ▪ However, there is a risk that change in reliability settings alone may not result in new efficient investments, as there may be other deficiencies in the market. One such potential deficiency is where prices do not reflect demand for reserve capacity, which leads to a lack of price signals when there is insufficient operating reserve capacity but plenty of available energy). Other deficiencies have been explained in Section 2 but particularly notable is the extent to which there is political will to allow high prices to occur.

75 As noted above, AER has estimated a wider range in VCR values from $16.96/kWh to $117.99/kWh. Notably, the lowest of the range, $16.96/kWh, is higher than the MPC, $14.70/kWh.

76 There is some evidence that when the CPT was triggered in January 2019, demand response providers withdrew from the market due to the $300/MWh cap from the APC. AEMC, Investigation into intervention mechanisms in the NEM, 15 August 2019 (link), page 124.

Principle	Assessment
No undue discrimination	▪ No specific impact on undue discrimination, but intrinsically the approach favours dispatchable resources that can take advantage of conditions that cause price spikes.
Cost recovery / risks allocated appropriately	▪ If set appropriately, allocation of risks still remains with market participants, and participants are exposed to prices reflective of market conditions. ▪ Investment risk remains with the owners of resources, who forecast market conditions and have incentives to make their supply available when prices are high. ▪ Retailers have incentive to minimise costs by contracting forward with resources and setting contract terms to encourage availability of supply when conditions are tight, and prices are high. ▪ Central body determining settings is accountable for understanding and accounting for the reliability level demanded by the public (a price cap set around VOLL balances cost of delivering resource adequacy with cost and risk of load-shedding).
Minimum regulatory intervention	▪ Central body decides the levels of the setting, the frequency of changes, and the application (e.g. by price zones, or how the CPT is calculated and applied) ▪ Once set, no further interventions should be required.

5.23 Adjusting the reliability settings generally provides an improvement in meeting the *theoretical* principles of good market design. The key downside, however, is that these adjustments do not (and are not intended to) resolve the missing elements explained in Section 2. This means that such adjustments in isolation may not sustain the intended levels of reliability should a reliability issue exist.

Reliability setting adjustments: potential stakeholder impact

5.24 The table below sets out the potential stakeholder impact of this RAM. As noted above, this is a high-level assessment and the actual impact may be very sensitive to the detailed design of the RAM.

Reliability setting adjustments: summary of stakeholder impacts

Stakeholder	Assessment
Consumers/ affordability	▪ Does not seek to guarantee resource adequacy – risk that other features of market mean that a socially optimal level of reliability is not achieved. ▪ Higher settings (e.g. higher price caps) exposes consumers to more energy price volatility. Retailers would hedge this increase in volatility (on behalf of consumers) in forward markets, but end-consumers may be implicitly charged for a higher risk premium by retailers for doing so. ▪ Could incentivise more agility and responsiveness, especially when two-sided markets are developed.
Resource investment	▪ Price signals apply across the whole market – as all resources that are dispatched receive the clearing price. Higher settings would therefore increase the revenue potential to resources. ▪ Reliability settings are especially important for dispatchable resources where the investment case is based on periods of high prices. These settings automatically adjust the compensation and incentives for investment to reflect differences in characteristics such as intermittency and risk of unplanned outages among resources. Therefore, they can provide more incentive for investment in responsive resources that can deliver to meet those price spikes (assuming no concerns about credibility of high prices).[77] ▪ This includes thermal generation, as well as DR, DER and storage, which have stronger incentives.
Retailers	▪ Retailers are more exposed to peaking prices. ▪ Under certain conditions, there is a possibility that retailers that estimate risks accurately may get “crowded out” by retailers that underestimate risks. This may undermine the objective of the policy itself, as retailers that underestimate risks may not contract enough.

77 In some instances, a greater risk exposure to generators may deter certain types of investments, especially if the plant has a greater risk of not being able to back the obligations of the financial contracts. This risk is likely higher for non-responsive capacity relative to responsive capacity.

Stakeholder	Assessment
Policymakers	▪ Does not seek to provide any specific guarantee of resource adequacy, as the approach is reliant on market response. ▪ Need to estimate settings (MPC, CPT, APC, etc.) and have confidence in VOLL measure if decision is taken to set MPC at the estimated VOLL. However, it is relatively easy to implement new reliability settings and can be done rapidly. ▪ A higher MPC means higher price spikes are possible. Even if infrequent, can still result in political risk. As a result, market price caps can be prone to political pressure from Governments to adjust them downwards. This means it can be difficult to set credible long-term expectations. ▪ Policymakers may also face the temptation to reduce higher price spikes through alternative means such as investing more in transmission, subsidising local generating capacity or procuring more RERT capacity. These alternatives are likely to be more expensive than market-based solutions

5.25 Broadly, an increase in the reliability settings increases investment incentives for all dispatchable resources but responsive capacity in particular (including, in the future, individual consumers in a two-sided market). However, reliance on the reliability settings for resource adequacy may introduce risks to policymakers because it allows higher price spikes and the change to resource adequacy is uncertain ex-ante.

C. Modified RRO

5.26 The RRO is a relatively new mechanism that was introduced in July 2019 in response to concerns of resource adequacy as intermittent renewables generation is expected to increase. By obligating retailers and large energy users to cover their share of expected peak demand, it is intended to meet resource adequacy by decreasing the risk exposure to generators through longer-term contracting.

Modified RRO: review against the principles of good market design

5.27 The table below sets out the assessment of how this RAM meets the principles of good market design.

Modified RRO: assessment against market design principles

Principle	Assessment
Efficient dispatch to drive efficient price signals	▪ Obligation to cover peak demand with "qualifying contracts" – long-term financial contracts could create a more competitive bidding environment regardless of new generation capacity. ▪ Not expected to adversely impact short-run dispatch efficiency.
Efficient price signals to drive efficient investments	▪ RRO is a new mechanism, which means effect of signals in the market is not clear yet. ▪ There is a potential risk that the number of financial contracts sold without physical backing may lead to inefficient speculative behaviour, without guarantee of additional physical capacity. However, the potential downside of speculative behaviour (e.g. exposure to high spot prices or penalties greater than the MPC) is high. ▪ The more frequently RRO is triggered, the more resources may be increasingly reliant on RRO-supported retailer contracts. This could affect market-based investments that are less reliant on the increased contracting from the RRO.
No undue discrimination	▪ There is a risk of the firmness methodology artificially or unduly biasing against particular technologies.
Cost recovery / risks allocated appropriately	▪ Arguably a risk transfer from generators to retailers. ▪ Typically, retailers are expected to be able to manage risk better. Consumers are potentially exposed to higher risk, if retailers pass on risk to consumers.
Minimum regulatory intervention	▪ Regulatory intervention required in setting the obligation, triggering the obligation and enforcing the obligation.

5.28 The key market design principles the RRO fails to meet are:

- Efficient price signals to drive efficient investments. In the case of the RRO, investment is not triggered by price signals but by centrally-determined obligations.
- Minimum regulatory intervention. As explained in Section 4, if there is uncertainty on how the RRO is triggered, this may not lead to reliable long-term investment signals for either RRO capacity or non-RRO capacity.

5.29 Furthermore, the RRO does not (and is not intended to) resolve the missing elements explained in Section 2.

Modified RRO: potential stakeholder impact

5.30 The table below sets out the potential stakeholder impact of this RAM. As noted above, this is a high-level assessment and the actual impact may be very sensitive to the detailed design of the RAM.

Modified RRO: summary of stakeholder impacts

Stakeholder	Assessment
Consumers/ affordability	▪ The RRO relies on active central monitoring of potential shortfalls with a mechanism to address shortfalls, reducing the risks to consumer of insufficient resource adequacy. ▪ Consumers may face a lower cost through the spot market in the long-term if the RRO brings forward new generation capacity. However, consumers would also bear the cost of the RRO contracts (which may be higher as these contracts are driven by regulatory decisions rather than markets). ▪ Could increase consumer costs overall if RRO results in inefficient expenditures on hedging contracts or inefficient investments in physical capacity (e.g. insufficient flexible capacity). ▪ If the RRO is only triggered when it is actually needed, and if the RRO is successful in procuring the resources required, this may save consumer costs relative to capacity markets, where capacity may be procured that might not be needed in the end. ▪ On consumer participation, consumers could, in principle, participate effectively in the RRO (e.g. through financial contracts based on aggregated DR).

Resource investment	▪ Price signals have a direct effect on participants involved in the obligation when the RRO is triggered.
	▪ However, price signals may also have an indirect effect depending on the expectations set on participants. For example, if the RRO is increasingly relied on, participants' behaviour may change when the RRO is not triggered.
	▪ Impact on resource investment is unclear:
	    ▪ Generators may have access to lower risk exposure through greater demand for financial contracts, and this may potentially increase the incentives for more investment (e.g. through lower financing costs).
	    ▪ More flexible resources (DR and DER) may have an advantage as they can provide availability during the relevant periods more easily.
	    ▪ Intermittent generation cannot easily participate in these contracts without further action (e.g. hybrid portfolios with battery storage).

Stakeholder	Assessment
Retailers	▪ Retailer incentives to cover their positions would depend on the expected cost (in the current scenario, this would depend on the likelihood of RRO resources being required, and the cost of it). ▪ Retailers take on more risk but may pass the cost of this risk to consumers. Vertically integrated retailers would be able to manage this risk more easily (subject to the MLO requirements).

Policymakers	▪ Some elements of the RRO are reliant on the discretion of policymakers (e.g. firmness methodology), so the RRO is potentially prone to political influence. Where a State Government itself has discretion to trigger the RRO, this can introduce a political incentive for the RRO to be triggered even when not needed.
	▪ On triggering the RRO, need to decide:
	  ▪ the "who" (e.g. who can trigger the RRO);
	  ▪ the "how" (e.g. the approach to forecasting and requesting reliability instruments); and
	  ▪ the "when" (e.g. T-3, T-1 or a different time period).
	▪ On the obligation design, need to decide the type of contracts and firmness methodology.
	▪ On enforcement, need to decide the level of penalties, which will in turn affect retailer incentives.

5.31 As a new mechanism, the impact of the RRO is unclear at the present time. Shifting risk from capacity resources to retailers could lower financing costs, leading to greater resource investment. However, the detailed design and running of the RRO needs to be very carefully managed so as to avoid adverse consequences (e.g. a market-driven investment that is not supported by an RRO might not occur because of the potential that its business case would be undermined by a subsequent RRO).

D. RERT adjustments

5.32 RERT is a mechanism used by AEMO to contract for additional resources in advance of a projected shortfall. The procurement of RERT has evolved over the years so that it now functions effectively as a "strategic reserve", that is, reserve that is procured out-of-market and used in conditions that might not have otherwise been met by the market. Strategic reserve in different forms is a common feature of electricity markets worldwide.

RERT adjustments: review against the principles of good market design

5.33 The table below sets out the assessment of how this RAM meets the principles of good market design.

RERT adjustments: assessment against market design principles

Principle	Assessment
Efficient dispatch to drive efficient price signals	▪ Procuring and utilising out-of-market resources are likely to affect dispatch efficiency negatively. ▪ It is unclear how effective and sufficient intervention pricing is (but it is "second-best" to a market approach).
Efficient price signals to drive efficient investments	▪ RERT is likely to reduce long-term investment signals if generators are increasingly remunerated by out-of-market revenues (i.e. the "slippery slope problem"). ▪ However, this effect can be mitigated if the scope and use of RERT are reduced in a politically credible way (e.g. only applying to generation that would otherwise face closure).
No undue discrimination	▪ The SO procures RERT to meet specific needs, such as shortfalls in very specific locations, but intervention pricing is applied to seek to mitigate adverse consequences.
Cost recovery / risks allocated appropriately	▪ Poor allocation of risk (as out-of-market) – transfer of risk from resources procured under RERT contracts to consumers. ▪ Also risk of dulling signals to market, which could lead to market participants being exposed to risks that they cause (but depends on cost recovery mechanisms). However, this is mitigated by intervention pricing.
Minimum regulatory intervention	▪ Significant regulatory intervention is required in addition to the risk and threat of further intervention (i.e. the "slippery slope problem"). ▪ The existence of RERT means that there is always the temptation for policymakers to procure more, and this is difficult to reduce over-time. ▪ Ad hoc and difficult to regulate / police quantum that is needed.

5.34 Generally, the RERT fails to meet key market design principles. In particular, the RERT may exacerbate issues with inefficient dispatch, although we note intervention prices are applied to mitigate distortion. Additionally, as an out-of-market approach, any investment or exit decisions are not driven by market price signals.

5.35 Broadly, the RERT is appropriate as a "backstop" (indeed, all SOs have similar instruments), but anything other than minimal use of the RERT also means the principle of minimum regulatory intervention is compromised – particularly due to the fact that decisions on RERT can be ad hoc.

5.36 Furthermore, the RERT does not (and is not intended to) resolve the missing elements explained in Section 2.

RERT adjustments: potential stakeholder impact

5.37 The table below sets out the potential stakeholder impact of this RAM. As noted above, this is a high-level assessment and the actual impact may be very sensitive to the detailed design of the RAM.

RERT adjustments: summary of stakeholder impacts

Stakeholder	Assessment
Consumers/ affordability	▪ The RERT is likely to have a high impact on resource adequacy, as AEMO can procure the specific amounts required and use them to cover reliability issues in specific times, locations and conditions (that may be unaddressed by other RAMs). ▪ Consumers, however, would face a very high increase in cost.[78] This would largely be incurred directly "out-of-market" and not in energy spot prices (where the cost of RERT could at times exceed the MPC). However, also potential for indirect costs, through out-of-merit dispatch and distortionary behaviour if not appropriately mitigated. ▪ Direct transfer of risk from generators to consumers (unless the cost of RERT is applied as a penalty for failure to meet obligations in other RAMs) ▪ A RERT may be a lower-cost way to resolve an issue with system security than a transmission expansion, especially if the issue might be temporary. In particular, without LMP, a RERT might be the low-cost alternative when the energy price signal might not be strong enough to support efficient investment in a location to resolve congestion. ▪ On consumer participation, large consumers (i.e. industrial and commercial load) and aggregators could participate effectively in RERT, and would have a strong incentive to, given that the prices in RERT contracts could exceed the MPC.

78 Additionally, because it is uncertain when RERT contracts are exercised, the high cost of the RERT could lead to a shock in energy bills, especially to higher energy users such as commercial and industrial customers.

Stakeholder	Assessment
Resource investment	▪ Providers of RERT will receive payments directly when procured and/or activated. ▪ RERT will have an indirect effect on other resources through its impact on the spot market, although intervention pricing is intended to mitigate this. ▪ Increased reliance on RERT may reduce resource investment via the "slippery slope" impact – as real-time prices fall, generation capacity exits (or does not enter) the market, increasing the demand for RERT and so forth. ▪ To avoid the above, the use of RERT as a last resort needs to be credible. ▪ Intermittent generation cannot easily participate in the RERT as they are non-dispatchable.
Retailers	▪ Unless the reason for using the RERT can be directed at a particular retailer (e.g. failure to meet the RRO obligation), the cost of RERT is shared based on market size of the retailers. This cost is unrelated to retailers' actions such as hedging of risk and will be passed to consumers.
Policymakers	▪ Policymakers are potentially incentivised to over-procure RERT, which could lead to useful resources being attracted out of the market. ▪ On procuring RERT, need to decide how far in advance to procure RERT, and in which quantities (greater quantities could have a greater distortionary impact, but provides more insurance); and which resources to procure from (procuring RERT from existing resources that would otherwise exit the market would be the least distortive option, as they would move to out-of-market resources). Competitive procurement rules could also be tightened to increase the benefits from competition. ▪ On activating the RERT, need to decide the rules, discretion and transparency on how AEMO would utilise them, as well as the method of intervention pricing.

5.38 Similar to many similar instruments in other jurisdictions, the impact of RERT is to increase costs significantly to retailers (and, in turn, consumers), to support resource adequacy at specific times, locations and conditions unaddressed by other RAMs. RERT is not intended to be economically efficient, which means its use should be minimised.

E. Scarcity price adder

5.39 A scarcity price adder supports resource adequacy by augmenting price signals to reflect the value to load of incremental capacity that can respond quickly. The scarcity price adder adds a margin to the price that increases with the extent to which responsive capacity decreases the probability of an outage. The intention of the scarcity price adder mechanism is to increase revenue potential to all dispatched resources during scarcity periods, thereby increasing resource investment signals to support resource adequacy.

5.40 Moving the scarcity pricing effect from “implicit”, as within the current NEM, to an explicit design, centrally-administered by the SO, may create more transparent and consistent signals to support market-based investment in resource adequacy. This also produces an incremental benefit if the current mechanisms for providing reserves are not reliable, or are insufficient to meet the requirements of the power system (e.g. if the market is unable to deliver sufficient responsive capacity with “implicit” scarcity pricing).

Scarcity price adder: review against the principles of good market design

5.41 The table below sets out the assessment of how this RAM meets the principles of good market design.

Scarcity price adder: assessment against market design principles

Principle	Assessment
Efficient dispatch to drive efficient price signals	▪ Improvements to dispatch as a result of response of loads to scarcity pricing, (e.g. batteries), and binary decisions by non-dispatchable loads (e.g. cutting a plant shift). ▪ Improvements to dispatch because scarcity pricing supports incentive for supply offers close to variable costs; reduces incentive to increase offer to profit when capacity is scarce. ▪ Improvements to dispatch through increased availability of responsive supply. ▪ Concerns around resources pricing above variable cost are reduced because dispatch offer prices do not need to be increased to achieve an appropriate scarcity value of capacity. ▪ Unlike an OR mechanism, the price adder is calculated ex-post – this forgoes possible material cost saving from co-optimization of the dispatch of energy and reserves. ▪ Supports efficient dispatch because the charge for being “short” of capacity is equal to the real-time cost of the shortage, per ORDC.

Principle	Assessment
Efficient price signals to drive efficient investments	▪ The higher resulting clearing prices during scarcity periods should increase investments in resources over time. If no new investments are delivered as a result, this may be indicative of other impediments in the market design, or high regulatory risk affecting investment decisions. ▪ There is a greater incentive to invest in dispatchable resources to increase ramping capability, and to decrease start-up times (to the extent that the price adder reflects the scarcity of those requirements). The approach could also provide increased incentives to invest in resources in regions experiencing more frequent or larger capacity shortages. ▪ In principle, provides incentives for the socio-economic optimal level of capacity investment, although this will be a moving target. This requires the ORDC to be calculated from appropriate estimates of VOLL and outage probabilities, and be adjusted over time.
No undue discrimination	▪ Provides same scarcity payment to all resources that are available and scheduled. ▪ As with other RAMs, objective may be improved as less RERT may be needed.
Cost recovery / risks allocated appropriately	▪ Market participants determine the extent and duration of forward financial commitments based on scarcity price expectations and risk preferences. Quantity and duration of forward hedging are not centrally determined. ▪ Risks remain with any participants that are exposed to paying higher real-time prices. ▪ The risk allocation is generally appropriate assuming ORDC is set correctly (e.g. risk of “over-procurement” if ORDC is set too high, or of “under-procurement” if ORDC is set too low).
Minimum regulatory intervention	▪ The market encourages participants to react accordingly to energy and operating reserve price signals, and hence regulatory intervention is kept to a minimum. ▪ Methodology to set ORDC should be robust and transparent to promote the credibility of the regime and its enduring nature. Mechanism may be adversely affected if there is uncertainty about the possibility of increased RERTs or other interventions.

5.42 A scarcity price adder generally contributes towards meeting good principles of an electricity market design. In particular, assuming the methodology to form the demand curve is appropriately set, the RAM should achieve an efficient allocation of risk.

5.43 Furthermore, the scarcity pricing effect, which can be supported by a price adder, directly addresses a missing element by providing an incentive to compensate for the lack of dispatchable demand. Additionally, this effect, which enables a higher real-time price signal particularly during scarcity periods, would provide an incentive to engender growth in dispatchable demand.

Scarcity price adder: potential stakeholder impact

5.44 The table below sets out the potential stakeholder impact of this RAM. As noted above, this is a high-level assessment and the actual impact may be very sensitive to the detailed design of the RAM.

Scarcity price adder: summary of stakeholder impacts

Stakeholder	Assessment
Consumers/ affordability	▪ Scarcity price adder should support efficient market investment to meet demand, thereby lowering risks of insufficient resource adequacy. Approach does not guarantee a certain quantity of resources in the future, but ORDC can be adjusted to change real-time prices if needed to achieve future reliability objectives. ▪ Overall consumer impact (relative to status quo) is the sum of retailer charges for unhedged scarcity costs and retailer charges for forward contracts to hedge scarcity. ▪ Consumers face risks related to setting of ORDC, with potential for costs exceeding their willingness to pay for reliability if ORDC is set too high; and potential for outage risk that is higher than acceptable (and that they would be willing to pay to reduce) if ORDC is set too low. ▪ On consumer participation, consumers could participate effectively and relatively easily as the scarcity pricing mechanism works through the real-time spot market. Two-sided markets would enhance the ability for consumers to participate.

Resource investment	▪ Resources that participate in the spot market will receive a higher settlement price, particularly during periods of scarcity. This directly contributes to higher revenues to these resources (and particularly those that operate only at times of scarcity).
	▪ The scarcity pricing mechanism is expected to increase resource investment as it sets a transparent and pre-determined ORDC to signal to the market the incremental value of capacity.
	    ▪ Resources that are flexible would benefit more from the mechanism as it can be made available (and with short ramping times) during scarce conditions. This includes DR and DER.
	    ▪ Intermittent generation would benefit indirectly – even though they have less control on dispatchability. Those that generate during scarce periods would receive higher prices.

Stakeholder	Assessment
Retailers	▪ Retailers may face a higher cost with the scarcity pricing mechanism, especially if they are unhedged. ▪ Retailers take risk and may profit if scarcity less than expected or take losses from insufficiently hedging their loads. ▪ Provides incentive for retailers to efficiently hedge/contract forward to reduce the scarcity price they pay to serve their customers. ▪ This may create a greater incentive for retailers to increase their hedge, particularly during anticipated scarcity periods – which in turn, increases investment signals.
Policymakers	▪ Application of an ORDC could provide policymakers more comfort over the longer-term that greater investments in responsive capacity would be incentivised to respond to contingencies. ▪ The key intervention risk is that governments can favour certain types of technology – best practice is for government itself to have a minimal role in setting the ORDC. Policymakers need to determine the shape of ORDC and whether it may vary by location, time or conditions. This includes the potential for ORDC to vary by state. ▪ The methodology in setting ORDC should be transparent and should not be changed frequently to set long-term expectations and maintain robustness to political pressure.

5.45 Broadly, a scarcity price adder is expected to increase resource investment as it sets a transparent, pre-determined ORDC to signal to the market the incremental value of reserves. If well designed, this would increase resource adequacy in a broad-based manner, although particularly rewards resources which only operate at times of scarcity. However, it does not guarantee a pre-set quantity of resources, and there may be higher prices in the short-term whilst market response develops.

F. Operating reserves mechanism

5.46 The market design for the operating reserves mechanism includes separate markets to schedule one or more types of operating reserves (and also possibly other ESS). This mechanism produces the scarcity pricing effect within the execution of the market dispatch (i.e. in a co-optimised way) rather than through an ex-post scarcity adder.

5.47 Moving the scarcity pricing effect from “implicit”, as within the current NEM, to an explicitly design, centrally-administered by the SO, may create more transparent and consistent signals to support market-based investment in resource adequacy. This also produces an incremental benefit if the current mechanisms for providing reserves are not reliable or are insufficient to meet the requirements of the power system (e.g. if the market is unable to deliver sufficient responsive capacity with “implicit” scarcity pricing). Under the operational reserves mechanism, dispatch co-optimises both the energy and reserve markets which could increase the efficiency of price signals.

Operating reserves mechanism: review against the principles of good market design

5.48 The table below sets out the assessment of how this RAM meets the principles of good market design.

Operating reserves mechanism: assessment against market design principles

Principle	Assessment
Efficient dispatch to drive efficient price signals	▪ Significant improvements in the dispatch mechanism as OR requirements are included and co-optimised with energy (and reflected in the price, thereby increasing the efficiency of price signals). ▪ Concerns around resources pricing above variable cost are reduced because dispatch offer prices do not need to be increased to appropriate scarcity value of capacity. ▪ Supports efficient dispatch because the charge for being “short” of capacity is equal to the real-time cost of the shortage, per the ORDC.

Principle	Assessment
Efficient price signals to drive efficient investments	▪ The higher resulting clearing prices during scarcity periods should increase investments in resources over time. If no new investments are delivered as a result, this may be indicative of other impediments in the market design, or high regulatory risk affecting investment decisions. ▪ There is a greater incentive to invest in dispatchable resources to increase ramping capability and decrease start-up times (as the higher scarcity price might only apply to a few dispatch period intervals). The approach could also provide increased incentives to invest in resources in regions experiencing more frequent or larger capacity shortages.[79] ▪ In principle, provides incentives for the socio-economic optimal level of capacity investment, but requires the ORDC to be calculated from appropriate estimates of VOLL and outage probabilities, and adjusted over time.
No undue discrimination	▪ Provides same scarcity payment to all resources that are available and scheduled. ▪ Does not need advance procurement, hence there is no risk of undue discrimination in determining de-ratings or for other reasons.
Cost recovery / risks allocated appropriately	▪ Market participants determine the extent and duration of forward financial commitments based on scarcity price expectations and risk preferences. Quantity and duration of forward hedging are not centrally determined. ▪ Risks remain with any participants that are exposed to paying higher real-time prices. ▪ Risks to suppliers from not being available when prices are high. ▪ Risk of "over-procurement" of resources could occur if ORDC is set too high, or of "under-procurement" if ORDC is set too low.
Minimum regulatory intervention	▪ The market encourages participants to react accordingly to energy and operating reserve price signals, and hence regulatory intervention is kept to a minimum. ▪ Methodology to set ORDC should be robust and transparent to avoid undue discretion from policymakers. ▪ Mechanism will not work well if policymakers create uncertainty about the possibility of increased RERTs or other interventions.

79 Different ORDCs can be applied to different regions. However, for this to work effectively, the mechanism must take into account interconnection constraints and the quantity of reserves in one region that are available for use in other regions during contingencies.

5.49 An operating reserves mechanism generally contributes towards meeting good principles of electricity market design. In particular, assuming the methodology to form the demand curve is appropriately set, the RAM should achieve an efficient allocation of risk.

5.50 Alongside this, co-optimisation of energy and reserves drives a significant improvement in dispatch efficiency. Assuming the methodology to form the demand curve is robust and transparent, undue discrimination should be minimised.

5.51 Furthermore, the scarcity pricing effect, which can be supported by the operating reserves mechanism, directly addresses a missing element by providing an incentive to compensate for the lack of dispatchable demand. Additionally, this effect, which enables a higher real-time price signal particularly during scarcity periods, would provide an incentive to engender growth in responsive demand.

Operating reserves mechanism: potential stakeholder impact

5.52 The table below sets out the potential stakeholder impact of this RAM. As noted above, this is a high-level assessment and the actual impact may be very sensitive to the detailed design of the RAM.

Operating reserves mechanism: potential stakeholder impacts

Stakeholder	Assessment
Consumers/ affordability	▪ OR mechanism should support efficient market investment to meet demand, thereby lowering risks of insufficient resource adequacy. Approach does not guarantee a certain quantity of resources in the future, but ORDC can be adjusted to change real-time prices, if needed, to achieve future reliability objectives. ▪ Relies on higher market spot prices, rising faster at times of scarcity. Material costs savings for consumers from co-optimisation if OR needed as an ESS. ▪ Implementation costs are high (relative to scarcity price adder) and implementation timelines means it would not address any near-term capacity shortfalls. ▪ Overall consumer impact (relative to status quo) is the sum of retailer charges for unhedged scarcity costs and retailer charges for forward contracts to hedge scarcity. ▪ Consumers face risks related to setting of ORDC, with potential for costs exceeding their willingness to pay for reliability if ORDC is set too high; and potential for outage risk that is higher than acceptable (and that they would be willing to pay to reduce) if ORDC is set too low. ▪ On consumer participation, consumers could participate effectively and relatively easily as the mechanism works through the real-time spot market. Two-sided markets would enhance the ability for consumers to participate.

Resource investment	▪ Resources that provide operating reserves in the reserves market will receive higher revenues directly, particularly during periods of scarcity.
	▪ Resources that provide energy in the spot market would also receive higher revenues directly during these periods, as the energy market would be co-optimised with the reserves market to set a consistent price signal.
	▪ The operating reserves mechanism is expected to increase resource investment as it sets a transparent and pre-determined ORDC to signal to the market the incremental value of capacity.
	    ▪ Resources that are flexible would benefit more from the mechanism as they can be made available during scarce conditions. This includes DR and DER.
	    ▪ Intermittent generation would benefit indirectly – even though they have less control on dispatchability. Those that generate during scarce periods would receive higher prices.
	    ▪ The mechanism should increase the impact of DR as price definition is enhanced, especially during scarcity periods (if they can classify as an eligible OR).
	    ▪ The mechanism should increase the impact of DER that are flexible and able to ramp quickly to meet higher prices.

Stakeholder	Assessment
Retailers	▪ Retailers face a higher cost with the scarcity pricing mechanism, especially if they are unhedged. ▪ Retailers take risk and may profit if scarcity less than expected, or take losses from insufficiently hedging their loads. ▪ Provides incentive for retailers to efficiently hedge/contract forward to reduce energy price (which includes scarcity) to serve their customers. ▪ This would create a greater incentive for retailers to increase their hedge, particularly during anticipated scarcity periods
Policymakers	▪ Application of an ORDC could provide policymakers more comfort over the longer-term that greater investments in responsive capacity would be incentivised to respond to contingencies. ▪ The key intervention risk is that governments can favour certain types of technology – best practice is for government itself to have a minimal role in setting the ORDC. Policymakers need to determine the shape of ORDC and whether it may vary by location, time or conditions. This includes the potential for ORDC to vary by state. ▪ The methodology in setting ORDC should be transparent and should not be changed frequently to set long-term expectations and maintain robustness to political pressure.

5.53 Broadly, an operating reserves mechanism is expected to increase resource investment as it sets a transparent and pre-determined ORDC to signal to the market the incremental value of reserves. It increases resource adequacy in a broad-based manner which in principle is across a relatively wide range of resource technologies. However, it does not seek to guarantee a pre-set quantity of resources for a specific target year, and there may be higher prices in the short term whilst market response develops.

G. Centralised capacity market

5.54 Centralised capacity markets are typically applied to the whole market and are procured and run by a central body through an auction mechanism. By remunerating the provision of capacity rather than energy, a centralised mechanism provides greater certainty for resources through an additional forward-looking and de-risked revenue stream. This lowers the cost of capital for resources and incentivises investment.

Centralised capacity market: review against the principles of good market design

5.55 The table below sets out the assessment of how this RAM meets the principles of good market design.

Centralised capacity market: assessment against market design principles

Principle	Assessment
Efficient dispatch to drive efficient price signals	▪ Dispatch efficiency generally unaffected. ▪ However, may reduce the "implicit" scarcity pricing that exists in the NEM to signal capacity during scarcity periods. This is because a capacity market would usually imply reduced offer prices, because a high portion of fixed costs are funded through the capacity payment
Efficient price signals to drive efficient investments	▪ Typically is successful in delivering new investments, as the auction clearing price would settle at the level required to meet objectives. ▪ However, the greater the capacity required, the costlier to consumers (i.e. effectively a risk transfer from generators to consumers). ▪ Additionally, there is no guarantee that the capacity procured will be able to deliver energy when required in real-time (i.e. the "deliverability" challenge referred to in Section 2). ▪ Relevance of the spot market to drive investments will diminish (as project finance will be more reliant on long-term capacity market revenues).
No undue discrimination	▪ Auctions can be designed to be technology-neutral, but there is a significant risk of errors, and scope for disagreements in how this is delivered (e.g. on determining de-rating factors).
Cost recovery / risks allocated appropriately	▪ Risks transferred from generators to consumers (which may not be best placed to manage them). However, the cost of financing should reduce, benefitting consumers. ▪ Consumers face risks of both of over-procurement and under-procurement.
Minimum regulatory intervention	▪ Requires significant regulatory intervention, including discretion required on the volume to procure as well as approach to managing any over or under-procurement closer to real-time.

5.56 Broadly, a centralised capacity market is an effective mechanism that is very likely to support investment, and provide an insurance to achieve the desired level of resource adequacy. However, this is a significant intervention and may compromise on some market design principles. The key market design principles a centralised capacity market fails to meet are:

- Efficient price signals to drive efficient investments (but scarcity pricing would mitigate this). Additionally, there is no guarantee that capacity procured will be "deliverable" to meet the real-time requirements of the power system.
- Minimum regulatory intervention. It is a very significant intervention, with wide-reaching implications in terms of the administrative and consultative effort required to implement and monitor.

5.57 Capacity markets do not directly resolve any of the missing elements explained in Section 2. However, the procurement of capacity ahead indirectly compensates for a range of market issues (such as "incomplete markets") by providing an additional multi-year revenue stream.

Centralised capacity market: potential stakeholder impact

5.58 The table below sets out the potential stakeholder impact of this RAM. As noted above, this is a high-level assessment and the actual impact may be very sensitive to the detailed design of the RAM.

Centralised capacity market: potential stakeholder impacts

Stakeholder	Potential impact
Consumers/ affordability	▪ The key aspect is a significantly reduced risk of insufficient resource adequacy – but consumer pays through a separate (and more stable) charge. The overall effect is akin to consumers paying for insurance. ▪ Level and volatility of energy market spot prices reduced relative to status quo. ▪ Capacity markets are typically successful in delivering new investments as the capacity (or certificate) price will rise to meet capacity required. ▪ This approach risks higher costs to consumers, stemming from either (i) a politically-driven reliability standard higher than the socially optimal level; or (ii) forecast risk (where a central body administering the capacity market may have an incentive to over- rather than under- procure capacity). ▪ Costs are also locked-in years ahead, so there is a stranding risk (e.g. if future demand is lower than expected). However, a mitigating factor is that the cost of capital for new investment is likely lower due to the financeability of the revenue streams. ▪ Longer auction lead times create more uncertainty in terms of reaching the adequacy target, but also make it easier for new capacity to develop between the auction and the delivery year. In this way, a capacity market can contribute towards better planning for entry and exit decisions.

Stakeholder	Potential impact
Resource investment	▪ General: Provides a forward-looking revenue stream which is known in advance, de-risked, and can be long in duration (contract length typically linked to capex). The main impact is a significant increase in financeability of eligible projects, thereby incentivising timely investment. ▪ Thermal: Assuming the capacity market is not “targeted” towards assets approaching retirement, then design can support all thermal investment. ▪ Renewables: Depends on eligibility criteria, but in principle, renewables can be included in the capacity market. Assuming firmness is properly quantified (which is a very large assumption, given the debate around this in some jurisdictions), renewables could participate efficiently. However, capacity markets may require: (i) "hybrids" that include storage, e.g. battery-wind portfolios rather than pure; and (ii) non-participation of renewables in receipt of subsidies. ▪ DR: Depends on eligibility criteria, but in principle, DR can be included in the capacity market (and would generally be incentivised to do so given the additional revenue stream). Aggregated DER could also participate as a capacity provider. ▪ For all resources, there is a risk that eligibility criteria may preclude some resource types and the risk of errors/biases in technical neutrality.
Retailers	▪ Retailers take risk away from capacity sources.
Policymakers	▪ Provides certainty around reliability standards (including option of “gold plating” if within policy objectives). ▪ Requires detailed ongoing technical work and industry consultation to set parameters (including procurement design and volume requirements, penalty regime, firmness assessment, eligibility etc.). ▪ Policymakers have the option of changing eligibility standards to meet other policy goals (e.g. on environmental attributes). ▪ Difficult to roll-back once implemented. ▪ Policy choices required on who is eligible to participate, length of contract, a factor to reflect expected availability, and number of years ahead of delivery. ▪ Ideally, products and volume in market should be designed to meet resource adequacy requirements. The key intervention risk is that governments can favour certain types of technology – best practice is for government itself to have a minimal role in setting the products required.

5.59 Broadly, a centralised capacity market is likely to significantly increase resource investment incentives – although the impact by technology type will depend on eligibility criteria. Policymakers have significant discretion to choose the desired reliability standard, but there is a tendency to over-procure resources which can lead to unnecessarily high costs for consumers.

5.60 Determining the volume to procure is crucial in managing the trade-off on the risk of over-procuring and under-procuring. This is also affected by how far in advance of delivery to procure – the further ahead, the more certainty to investors (leading to lower costs of capital),[80] but the more uncertainty in the volume of capacity required.

H. Decentralised capacity market

5.61 Decentralised capacity markets share the same fundamental feature with capacity markets – that is, seeking to provide an explicit guarantee that a certain volume of capacity will be installed. Similarly, they are also forward-looking, acting as “insurance” which provides certainty for all market participants (and in particular for resources, providing an additional de-risked revenue streams which supports investment).

5.62 However, rather than a central body (e.g. the SO) procuring the capacity in advance, the SO places obligations on retailers to procure physically-backed capacity, rather than allowing them to act purely based on market signals.

Decentralised capacity market: review against the principles of good market design

5.63 The table below sets out the assessment of how this RAM meets the principles of good market design.

Decentralised capacity market: assessment against market design principles

Principle	Assessment
Efficient dispatch to drive efficient price signals	▪ Dispatch efficiency generally unaffected. ▪ However, may reduce the “implicit” scarcity pricing that exists in the NEM to signal capacity during scarcity periods. This is because a capacity market would usually imply reduced offer prices, because a high portion of fixed costs are funded through the capacity payment

80 In Europe, two to five-year contracts are typically awarded to plants with moderate level of new CAPEX (mainly refurbished plants). New plants with high capital expenditure are often eligible to seven to 15-year capacity agreements.

Principle	Assessment
Efficient price signals to drive efficient investments	▪ Typically is successful in delivering new investments as the auction clearing price would settle at the level required to meet objectives. ▪ However, the greater the capacity required, the costlier to consumers (i.e. effectively a risk transfer from generators to consumers). ▪ Additionally, there is no guarantee that the capacity procured will be able to deliver energy when required in real-time (i.e. the "deliverability" challenge referred to in Section 2). ▪ Relevance of the spot market to drive investments will diminish (as project finance will be more reliant on long-term capacity market revenues). ▪ In principle, if retailers are in aggregate better at assessing and managing risk, devolving the procurement to retailers rather than the SO improves efficiency.[81]
No undue discrimination	▪ Obligations can be designed to be technology-neutral, but there is a significant risk of errors and scope for disagreements (e.g. on the specific product definition and obligation, which may drive different types of capacity).
Cost recovery / risks allocated appropriately	▪ Risks transferred from generators to retailers (which may in turn be passed on to consumers). However, the cost of financing should reduce, benefitting consumers. ▪ Consumers face both risk of over-procurement and under-procurement.
Minimum regulatory intervention	▪ The range of regulatory intervention required varies depending on the specific design of the capacity market. A variant that maximises decentralisation might require less oversight, with retailers incentivised to meet their obligations, managing their risk themselves and without affecting the bidding behaviour of participants.

81 Broadly, retailers will have more information than the SO in anticipating load more accurately for their consumers, which can be a source of efficiency gains. Retailers will also have greater incentives to innovate, for example through different procurement or hedging approaches. However, the SO will have more information on the system needs in aggregate.

5.64 Broadly, this an effective mechanism that is very likely to support investment and provide a level of insurance to achieve the desired level of resource adequacy. However, this is a significant intervention and may compromise on some market design principles. The key market design principles a decentralised capacity market fails to meet are:

- Efficient price signals to drive efficient investments (but scarcity pricing would mitigate this). Additionally, there is no guarantee that capacity procured will be "deliverable" to meet the real-time requirements of the power system.
- Minimum regulatory intervention. It is a very significant intervention, with wide-reaching implications in terms of the administrative and consultative effort required to implement and monitor.

5.65 Capacity markets do not directly resolve any of the missing elements explained in Section 2. However, the procurement of capacity ahead indirectly compensates for a range of market issues (such as "incomplete markets") by providing an additional multi-year revenue stream.

Decentralised capacity market: potential stakeholder impact

5.66 The table below sets out the potential stakeholder impact of this RAM. As noted above, this is a high-level assessment and the actual impact may be very sensitive to the detailed design of the RAM.

Decentralised capacity market: potential stakeholder impacts

Stakeholder	Potential impact
Consumers/ affordability	▪ As with centralised capacity markets, the overall effect is akin to consumers paying for insurance. ▪ Level and volatility of energy market spot prices reduced relative to status quo. ▪ Capacity markets are typically successful in delivering new investments as the capacity (or certificate) price will rise to meet capacity required. ▪ This approach risks higher costs to consumers, stemming from either (i) a politically-driven reliability standard higher than the socially optimal level; or (ii) forecast risk (where a central body administering the capacity market may have an incentive to over- rather than under- procure capacity). ▪ Costs are also locked-in years ahead, so there is a stranding risk (e.g. if future demand is lower than expected). ▪ Decentralised obligation means market forces drive procurement – potential for significant savings through greater efficiency and innovation leading to lower consumer costs.

Stakeholder	Potential impact
Resource investment	▪ General: Provides a forward-looking revenue stream which is known in advance, de-risked, and can be long in duration (contract length typically linked to capex). The main impact is a significant increase in financeability of eligible projects, thereby incentivising timely investment. ▪ Thermal: Assuming the capacity market is not “targeted” towards assets approaching retirement, then design can support all thermal investment. ▪ Renewables: Depends on eligibility criteria, but in principle, renewables can be included in the capacity market. Assuming firmness is properly quantified (which is challenging), renewables could participate efficiently. However, capacity markets may require: (i) "hybrids" that include storage, e.g. battery-wind portfolios rather than pure; and (ii) non-participation of renewables in receipt of subsidies. ▪ DR: Depends on eligibility criteria, but in principle, DR can be included in the capacity market. ▪ For all resources, there is a risk that eligibility criteria may preclude some resource types, and the risk of errors/biases in technical neutrality.
Retailers	▪ Retailers take risk away from capacity sources, lowering financing costs for capacity. ▪ Retailers have obligation to procure capacity.
Policymakers	▪ Requires detailed ongoing technical work and industry consultation to set parameters (including procurement volume requirements, penalty regime, firmness assessment, eligibility etc.). Although, significantly less onerous than a centralised capacity market. ▪ Regulators, in application of policy objectives, have the option of changing eligibility standards to meet other policy goals (e.g. on environmental attributes). ▪ Difficult to roll-back once implemented. ▪ Relative to centralised capacity market, less burden on regulators to design and set a number of key market design parameters centrally. ▪ Ideally, products and volume in market should be designed to meet resource adequacy requirements. The key intervention risk is that governments can favour certain types of technology – best practice is for government itself to have a minimal role in setting the products required.

5.67 Broadly, a decentralised capacity market is likely to significantly increase resource investment incentives – although the impact by technology type will depend on eligibility criteria. As with a centralised capacity market, policymakers need to determine the products and volume to procure – but allow individual retailers to develop their own contracting and risk mitigation approaches, potentially increasing efficiency and innovation.

5.68 Determining the volume to procure is crucial in managing the trade-off on the risk of over-procuring and under-procuring. This is also affected by how far in advance of delivery to procure – the further ahead, the more certainty to investors (leading to lower costs of capital)[82], but the more uncertainty in the volume of capacity required.

I. Recap on the interactions between RAMs

5.69 Each RAM is designed to address resource adequacy in different ways and across different time periods. While each RAM could lead to different outcomes if implemented in isolation, the interactions between the RAMs, if implemented together, may have important implications.

5.70 We consider there are five key interactions between RAMs, which are summarised below.

i. Interactions between reliability settings and the other RAMs

5.71 First, as described above, reliability settings are the parameters that limit the extent to which prices can rise and fall, and in turn, limits the risk exposure to market participants. These settings are not RAMs per se, but instead could influence the extent to which market participants can respond to price signals, in order to deliver the investments required to meet the reliability standard.

5.72 Assuming the reliability settings are set sufficiently high (i.e. a reasonable estimate of VOLL that reflects the value of reliability to consumers), the implementation of other RAMs should <u>not</u> affect the reliability settings. This is so that the functioning of the other RAMs and any impact on the market price would not be impeded by the settings. Therefore, reliability settings could, and should, be set independently to other RAMs.

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82 In Europe, two to five-year contracts are typically awarded to plants with moderate level of new capital expenditure (mainly refurbished plants). New plants with high capital expenditure are often eligible to seven to 15-year capacity agreements.

ii. Interactions between the RRO and capacity markets

5.73 Second, implementing both RRO and capacity markets are likely to be unnecessary. This is because capacity markets and RRO would effectively have competing obligations for capacity contracts (either through a new capacity market or through qualifying contracts). Indeed, with certain modifications such as the frequency of trigger and introducing physical backing, the RRO could function very similarly to a decentralised capacity market.

iii. Interactions between the two scarcity pricing mechanisms

5.74 Third, both the scarcity price adder and operating reserves mechanism are designed to augment the price signals for energy and reserves requirements. As these RAMs apply the same ORDC (but using different approaches), there is no need to implement both of these RAMs simultaneously.

5.75 The scarcity price adder, which does not require incorporating a scarcity pricing within the execution of the market dispatch, is often preferred because of its simplicity and because it can be implemented relatively easily in comparison to other RAMs. As such, a scarcity price adder might also be more effective in when an energy market is undergoing a significant "transition period", and a RAM is required at short notice.

5.76 Implementing a scarcity price adder first could also be used to "buy time" for policymakers to diagnose and fix other market design issues. For example, a scarcity price adder may lead to new investments whilst policymakers design and develop a more robust operating reserves mechanism that can co-optimise energy and ESS. Conversely, if a scarcity price adder *does not* lead to new investments, this may be indicative of another significant market design issue that should be addressed.

iv. Interactions between the scarcity pricing mechanisms, capacity markets and the RRO

5.77 Fourth, scarcity pricing mechanisms may be needed if capacity markets are introduced. This is because a capacity market would usually imply reduced offer prices as a high portion of fixed costs are funded through capacity payments. As the spot price is not required to cover full investment costs, this would reduce the implicit scarcity pricing effect that exists in the NEM, meaning there may be more incremental benefit to an explicit scarcity pricing mechanism to augment the real-time price signals.

5.78 Additionally, both capacity markets and the RRO by themselves may not be able to bring forward sufficient investments in responsive reserve capacity, if required in the power system. Scarcity pricing mechanisms could then support capacity markets and the RRO by introducing a scarcity price signal into the real-time price to reflect additional reserve requirements. Conversely, if a scarcity pricing mechanism is in place, a supplementary capacity market could be implemented to procure additional capacity, in order to guarantee the greater level of “insurance” desired by policymakers.

5.79 Implementing a scarcity pricing mechanism in a market with either a capacity market or an RRO could reduce the cost of each. Any extra capacity procured through the capacity market would lead to lower clearing prices in the real-time spot market, whilst opportunities for further revenues in the real-time market would lead to lower capacity prices.

v. Interactions between the RERT and other RAMs

5.80 Fifth, the RERT as a last-resort measure, would typically be used as a backstop option when all other RAMs are insufficient to meet reliability requirements. Therefore, the introduction of additional RAMs (or adjustments to existing ones) that would improve the delivery of resource adequacy, if successful, would likely reduce the volume of capacity required to be procured by the RERT.

5.81 The introduction of different RAMs may also lead to the reduction of different types of RERT contracts. For example, with a capacity market, less long-notice RERT may be needed, due to certainty from the additional capacity procured in advanced through the capacity market.

6. Overall reflections

6.1 As explained in Section 1, the purpose of this report is to articulate and assess a range of RAM options potentially available to the NEM.

6.2 In common with many jurisdictions, there is active debate and uncertainty about the need for new RAM options in the NEM, both now, and in the coming years. This reflects different policy preferences, stakeholder interests, and views on the evolution of the energy market. Overlaying this debate is a wide-ranging review considering potential for future NEM reforms in the context of long-term market framework design.

6.3 In light of this uncertainty, the assessment in Section 5 above summarised how each of the RAM options might meet the theoretical principles of good market design, and the potential stakeholder impact of each. The purpose of that assessment was not to provide a single RAM option recommendation to ESB, but instead highlight (in a systematic way) the key aspects of each RAM that ESB should be mindful of as it considers the different options in a wider context.

6.4 This section of the report seeks to further assist ESB by drawing on the points made in this report to provide some overall reflections. This includes specific commentary on the transition away from coal-powered generation, which is particularly important given that significant coal-fired generation capacity is expected to retire over a short period of time, and a considerable proportion of new capacity is likely to be VRE capacity. Additionally, any accelerated or unexpected early exit of large units could lead to or exacerbate reliability concerns.

Some existing features of the NEM could in principle be adjusted to support resource adequacy, but policymakers should be circumspect about relying on them

6.5 As described in Section 3, the NEM currently has at least four key features which are relevant in supporting resource adequacy. Notwithstanding the question of whether there is a need for *any* changes to the NEM to meet future resource adequacy needs, it seems reasonable to first consider what adjustments could be made to the current NEM design if policymakers wished to further support resource adequacy.

The RERT is a critical "backstop" but its usage should not be expanded to attempt to address resource adequacy in a broad sense

6.6 The fundamental policy choice underlying the RERT is that there should be some form of "backstop" in the electricity market to support reliability in extreme circumstances. Most liberalised electricity markets have some form of backstop, but they are not intended to be a substitute for the resource adequacy formed through a well-functioning electricity market. Indeed, such backstops are rarely used as the only mechanism in a market to support resource adequacy.

6.7 The increasing use of the RERT in the NEM could be related to several different factors: that resource adequacy is otherwise insufficient; that public expectations about reliability have risen; there has been a change in the preferences of the parties that have discretion to use the RERT; and/or that there are other market design issues that need to be resolved. However, anything other than minimal use of the RERT risks embedding reliance on it, which seems likely to lead to long-term inefficiency.

6.8 With this in mind, it would generally be against the principles of good market design to relax the conditions under which the RERT is used, or to otherwise widen its use. However, the RERT mechanism does allow policymakers the option of directly targeting existing resources that would create the least distortions in the market, in which case its use as a "last resort" mechanism can be exercised to bridge temporary resource gaps. An intervention pricing mechanism is also applied to mitigate distortions to market prices caused by the RERT.

An (upward) adjustment to the reliability settings improves the theoretical efficiency of market signals, but there may be limited benefits to doing so

6.9 In the NEM, reliability settings are developed through a robust process by the Reliability Panel. This is reviewed every four years, together with the reliability standard.

6.10 For the purposes of this report, we have generally interpreted a change in reliability settings as increasing the MPC. All else equal, if the MPC is significantly below the VOLL, then increasing the cap towards VOLL will increase the likelihood of resource adequacy reaching socially optimal level. This is because a level less than the VOLL is, fundamentally, a market distortion which suppresses real-time price signals (albeit put in place for good reason, chiefly as a consumer protection measure).

6.11 There is also a significant risk that change in reliability settings alone will not result in new efficient investments. This can potentially lead to an undesirable consumer outcome of higher short-term price spikes, without associated investments to further support resource adequacy.

6.12 There are two main reasons why a change in MPC alone may not result in new investments. Firstly, the presence of other market imperfections, for example, the lack of price signals for reserve capacity which may lead to situations when there is insufficient operating reserve capacity but plenty of available energy. Secondly, there may be market perceptions (whether founded or not) that policymakers will not tolerate a higher price cap in the long term.

The RRO is a new approach which may provide a level of resource adequacy, but there are risks to expanding its use significantly

6.13 The RRO is a new approach which, in principle, combines the benefits of centralised resource adequacy monitoring (i.e. AEMO monitors for future shortfalls) with the benefits of using market forces to assess and value risk (i.e. risk is placed on retailers, which are well-placed to manage it). It is linked to the reliability standard – increasing the reliability standard in turn increases the level of retailer obligations. This supports resource adequacy by encouraging more long-term financial contracts, reducing the risk exposure to resources and increasing resource investment signals.

6.14 In our view, a key consideration for the RRO, in order to maximise its efficiency, would be to develop a methodology to trigger the RRO that is uniformly based on a well-defined set of criteria ex-ante, to set clear long-term expectations to market participants.

6.15 Wide discretion in triggering the RRO may, in extremis, lead to the forestalling of any investments that are not required to meet an RRO (and would, therefore, need to be profitable based on energy market revenues alone). In this scenario, capacity investment effectively defaults to being determined through a centralised planning process for RROs.

The decision on whether to implement a capacity market is mainly driven by socio-economic preferences

6.16 One of the dimensions with which we have assessed the RAM options is the key policy implications of each one, in terms of the relationship between reliability and cost.

6.17 In our view, a key question for developing RAM options is whether policymakers wish to select for a given level of reliability, seeking to provide an **explicit guarantee** that a specified level of capacity will be available over a specified time horizon.

6.18 This is the fundamental feature of **capacity markets**, which in turn provides certainty for all market participants. For eligible resources, the higher certainty in future cash flows can lower their cost of capital, incentivising more investment in advance of delivery at a lower cost. Policymakers have significant discretion to choose the desired reliability standard, but there is a risk of over-procurement, leading to unnecessarily high costs to consumers. As also described above, the implementation of a capacity market is a lengthy and costly process (and particularly so for a centralised capacity market).

6.19 Perhaps more importantly, capacity markets do not seek to solve the energy market imperfections which may exist that lead to sub-optimal levels of resource adequacy. Indeed, in many jurisdictions where capacity markets have been introduced, there are specific policies in place to: (i) limit their longevity (although this appears to be difficult in practice); and (ii) ensure that other market reforms are developed alongside capacity markets (such as scarcity pricing).

6.20 Finally, we would note that a capacity market could not co-exist with the RRO, as they would effectively have competing obligations (indeed, an RRO that becomes "embedded" in market expectations and is frequently triggered would be very similar to a decentralised capacity market). This means that any decision around the implementation of a capacity market is directly linked to policymakers' views on how the new RRO mechanism develops.

A form of scarcity pricing already exists in the NEM, but there are opportunities to make scarcity pricing function more transparently

6.21 The intention of an explicit scarcity pricing mechanism is to increase revenue potential to all scheduled resources (i.e. those dispatched to generate electricity or deliver co-optimised ancillary services) during scarcity periods, thereby increasing resource investment signals to support resource adequacy. Importantly, the real-time scarcity price signal also provides incentives for the development and continued operation of responsive capacity that is needed to manage the variations in intermittent resource output.

6.22 As explained in Section 4, some scarcity pricing effects already exist in the NEM. Resource bid offers above variable cost do not constitute market power in the NEM (unlike in many jurisdictions such as the US). As such, even without dispatchable demand, resources can freely offer bids above variable cost up to the MPC. Therefore, scarcity pricing exists in the NEM "implicitly"; market participants are incentivised to invest and make available their capacity when there is financial opportunity.

6.23 A formal scarcity pricing mechanism in the NEM could shift this implicit scarcity pricing effect to an explicit mechanism, with a more transparent demand curve for reserves. This could potentially support greater investments as and when needed in the NEM.

6.24 Overall, scarcity pricing mechanisms offer a transparent market-driven solution to an issue affecting many electricity markets – rewarding flexibility but raising prices for all market participants operating at times of scarcity.

For a scarcity pricing mechanism, the implementation approach depends on whether policymakers desire a less complex mechanism that can be implemented quickly, or a more complex mechanism with additional co-optimisation benefits

6.25 Scarcity pricing can be implemented in two main ways: a scarcity price adder or an operating reserves mechanism. Importantly, the former could be used as a "stepping-stone" towards the latter.

6.26 Aside from implementation complexity, the key difference between the two is that the latter requires specification of another ESS (operating reserves), which would enable **co-optimisation of energy, FCAS and operating reserves**. This would be an evolutionary change to the NEM, but can potentially lead to material cost savings in the dispatch of energy and reserves.

6.27 Across US ISOs that have implemented scarcity pricing, the majority have implemented an operational reserves mechanism rather than a scarcity price adder (i.e. taking the view that the benefits outweigh the additional complexity).

The NEM's transition away from coal-powered generation

6.28 Whilst this report does not explicitly consider the transition path for RAM development options, we have been asked to comment on the impact of RAMs on coal-powered generation, given the exit of such generation is a key current feature of the NEM with significant implications for resource adequacy. We discuss this below in Box 6-1.

Box 6-1: Impact of RAMs on coal-fired generation

In common with many other parts of the world, the NEM has entered a period of rapid transition away from traditional sources of generating electricity (such as coal-fired generation) and towards newer (intermittent renewable) technologies such as solar and wind. Additionally, ongoing technological progress has opened up emerging opportunities for more decentralised technologies such as demand side response and battery storage.

This transition, however, is expected to occur relatively more rapidly in the NEM, in part because significant coal-fired generation capacity is expected to retire over a short period of time. For example, the Central ISP scenario forecasts that approximately 15GW out of 23GW of coal will retire in the NEM by 2040.

Therefore, any consideration of RAMs in the context of the NEM should give due regard to the impact on coal generation capacity, and the implications on the transition away from this.

The impact of any RAMs on coal generating capacity would ultimately depend on the detailed design of the RAM – which means it is not possible to be definitive about the impact in broad terms. However, there are two main factors which are particularly relevant:

- First, how successful the RAM is at providing investment signals (which would benefit all types of generation).
- Second, the extent to which the investment signal is targeted at responsive capacity (which would put coal at a relative disadvantage).

Based on these two factors, we highlight a few key points for each RAM.

- A change in the reliability settings means that coal generation (along with all other types of resources) would benefit from higher or longer price spikes. However, other resources that are more responsive could have a relatively higher benefit compared to coal generators.
- Increased reliance on the RRO mechanism provides stronger signals (via obligations for retailers to procure financial contracts) for dispatchable resources (such as coal).
- Increased reliance on the RERT depends on how and when RERT is procured. The impact on coal generation in general would likely be minimal (as intervention pricing seeks to mitigate pricing impacts of RERT).

- Scarcity pricing mechanisms would lead to all resources (including coal generation) receiving higher settlement prices, particularly during periods of scarcity. However, other resources that are more responsive could have a relatively higher benefit compared to coal generators.
- For capacity markets, there are a very wide range of design choices, which means they provide options for policymakers to target specific types of resources (or not). Coal generation would benefit if eligible to participate. In principle, a capacity market could be designed to either advantage coal (e.g. if capacity market favours assets approaching retirement) or to disadvantage coal (e.g. if capacity market favours more responsive capacity or introduces emissions requirements).

Conclusions

6.29 As explained in this report, the increasing use of the RERT is arguably concerning, but does not, in and of itself, point to an immediate lack of resource adequacy. With this in mind, it seems reasonable to consider, in the first instance, approaches which aim to "fix" the missing elements of electricity markets that could potentially lead to sub-optimal resource adequacy in the first place. This would provide an incremental improvement to the functioning of the market.

6.30 Scarcity price mechanisms go some way towards this goal, seeking to resolve some missing elements of electricity markets, such as the lack of dispatchable demand and services that are not priced. Scarcity pricing mechanisms *augment* existing price signals to reflect the value to load of incremental capacity that can respond quickly. They offer a market-driven solution, and are aided by (but do not *require*) some of the other NEM developments currently under consideration by the ESB.

6.31 It therefore seems reasonable to suggest that the ESB considers, in further detail, whether an operating reserves mechanism could be suitable for the NEM, either as a standalone ESS development or as part of a wider suite of ESS services. Further detailed assessments are required, particularly on the incremental benefits of such a mechanism in the context of the NEM, where scarcity pricing effects already exist implicitly through resource offers. This is because such "implicit" scarcity pricing is not a feature of many jurisdictions where operating reserves mechanisms have been introduced.

6.32 As well as scarcity pricing mechanisms, we have also considered some forms of capacity markets in this report. As explained above, they fundamentally seek to "guarantee" resource adequacy, by providing resources with additional, forward-looking de-risked cashflows. There are many advantages to this approach, but it relies on a willingness for policymakers to move the energy market away from energy prices as the sole signal for efficient investment.

6.33 As we have argued in this report, this is to some extent a matter of socio-economic preference, but our sense is that there is not a broad consensus that intervention on this scale is justified (not least because the RRO is already a "contingent" form of decentralised capacity market). Additionally, implementing a capacity market may reduce the implicit scarcity pricing effect that currently exists in the NEM. This will require a scarcity pricing mechanism to reintroduce scarcity price signals.

6.34 Finally, we would note that whilst the *option* of developing some form of capacity market remains, even if it is not taken now, experience in some other jurisdiction is that it can be difficult to remove capacity markets once implemented.

Glossary

Term	Definition
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
APC	Administered Price Cap
COAG	Council of Australian Governments
COGATI	Coordination of Generation and Transmission
CPT	Cumulative Price Threshold
DER	Distributed energy resources
DR	Demand side response
EC	European Commission
ESB	Energy Security Board
ESOO	Electricity Statement of Opportunities
ESS	Essential System Services
Finkel Review	Independent Review into the Future Security of the National Electricity Market
ISP	Integrated System Plan
LMP	Locational marginal pricing
LOR	Lack of Reserve
MLO	Market Liquidity Obligation
MPC	Market Price Cap
NEG	National Energy Guarantee
NEM	National Electricity Market
ORDC	Operating Reserve Demand Curve
RAM	Resource Adequacy Mechanism
RERT	Reliability and Emergency Reserve Trader
RRO	Retailer Reliability Obligation
SO	System Operator
T-1	One year ahead
T-3	Three years ahead
TNSP	Transmission Network System Provider
USE	Unserved energy
VOLL	Value of lost load
VRE	Variable renewable energy