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Australian Energy Market Commission

## CONSULTATION PAPER

# NATIONAL ELECTRICITY AMENDMENT (INTEGRATING ENERGY STORAGE SYSTEMS INTO THE NEM) RULE

### PROPONENT

AEMO

20 AUGUST 2020

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# RULE

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## ABOUT THE AEMC

The AEMC reports to the Council of Australian Governments (COAG) through the COAG Energy Council. We have two functions. We make and amend the national electricity, gas and energy retail rules and conduct independent reviews for the COAG Energy Council.

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## EXECUTIVE SUMMARY

Energy storage is becoming an increasingly important part of the national electricity market (NEM) and recent forecasts point to a greater role for storage in the future. This poses the question of how the current framework should evolve to better support the market as it transitions. The Australian Energy Market Operator (AEMO) submitted a rule change request in August 2019 to amend the National Electricity Rules (NER) to support the participation of storage systems in the NEM, including by defining storage technologies in the NER.

The rule change proposal seeks to address issues AEMO has identified with how grid scale batteries, aggregations of smaller batteries, and new business models with a mix of technologies behind the connection point (hybrid facilities), register and participate in the NEM. AEMO suggests that the rule change proposal would increase clarity and transparency for all stakeholders, remove barriers to entry for storage and hybrid facilities, and support the transition to an electricity system where more storage is needed to support variable renewable energy (VRE).<sup>1</sup>

In order to assess AEMO's rule change proposal, the Australian Energy Market Commission (the Commission) needs to understand the significance of the issues identified by AEMO and whether they are likely to become worse in the future. Therefore, this consultation paper first seeks your feedback on the importance and urgency of the issues, and whether they require a regulatory solution.

To the extent these issues are significant and do require changes to the NER to address them, we are also asking for feedback on whether it would be more appropriate to integrate storage and hybrid facilities into the framework by defining them and writing specific rules for them, as proposed by AEMO, or whether a level playing field could also be achieved through more minimal amendments to the existing framework. The types of changes required to achieve a technologically neutral approach, need to be considered in light of the characteristics of storage and hybrid facilities, and the future direction of the energy market.

The issues on which we are seeking feedback include:

- the registration and classification framework
- technical issues relating to the connection and operation of storage and hybrid facilities in the NEM, including participation in central dispatch
- the application of fees and charges, including transmission and distribution use of system charges and non-energy charges levied by AEMO
- the intervention compensation framework
- the Retailer Reliability Obligation
- technology-specific language and definitions used throughout the NER.

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<sup>1</sup> AEMO, *Integrating Energy Storage Systems into the NEM - Rule Change Request*, p. 54.

## **Should storage and hybrids be defined in the NER?**

In its rule change request, AEMO recommends the NER be changed to accommodate the transition occurring in the NEM. The industry is changing from one structured around one way energy flows from large generators to customers, where storage technologies were largely uneconomic, to a future increasingly characterised by two-way energy flows where, more and more, participants are both buying and selling electricity. This transition is being driven by the expected increased role of storage technologies that both consume and send out electricity, and which will participate at all levels of the market from fixed grid scale batteries connected to the transmission network down to smaller distributed storage options that may be mobile.

AEMO is concerned that the NER do not adequately recognise storage and increasing bi-directional flows because they do not contain a specific definition for storage to use as a basis for applying storage-specific obligations.

As no forms of storage facilities are currently defined in the NER, storage assets are treated as both "load" and "generation" due to the fact that a storage asset can both 'consume' from and 'send out' to the grid significant amounts of electricity. AEMO's rule change request suggests it is problematic for the NER to treat a single energy storage asset as both generation and load. While AEMO has been able to accommodate storage to date, it notes there still remain problems for storage registering and participating in the NEM under the existing regulatory framework. AEMO also suggests that this is an issue for hybrid facilities (that have a combination of load and generation behind the connection point, which may or may not include storage) because a hybrid facility would also be defined as being both load and generation, as the facility both consumes and sends out electricity.

AEMO's rule change request proposes to define storage and hybrid facilities, so that the NER better recognise storage and connection points with bi-directional flows. This proposal can be considered as the cornerstone of AEMO's rule change request because these definitions underpin AEMO's proposed solutions for how storage would register in the NEM and participate in dispatch. It is also the mechanism for AEMO's proposal to clarify fees and charges and other obligations that apply to storage. AEMO notes in its rule change request that "defining and recognising energy storage systems (ESS) allows clarification of relevant NER requirements associated with ESS, this increases clarity and transparency for all stakeholders."<sup>2</sup>

Since AEMO submitted its rule change request, the Energy Security Board (ESB) has been tasked with developing a post-2025 design. One of the key work streams in this design is the development of a two-sided market. In seeking feedback on AEMO's proposal to define storage and hybrids in the NER, we note this may not align with the approach envisaged under the ESB's two-sided market reforms. The two-sided market design work is considering a move away from defining specific technologies and assets in the rules towards a technology-neutral approach that attaches obligations to services. This rule change request will need to be considered in the context of these broader reforms, which may require

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2 AEMO, *Integrating Energy Storage Systems into the NEM* - Rule Change Request, p. 54.

considering solutions other than one that defines storage assets and hybrid facilities in the NER. We are interested in feedback on the best way to proceed given the different approaches of the two sets of reforms.

**Is there a problem with how the registration and classification framework treats storage and hybrids? If so, how should we fix it?**

In its rule change request, AEMO outlines a number of issues that, in its view, exist with the current registration framework for storage and hybrid facilities. In AEMO's view, the current registration framework makes the registration process slower, more expensive, complex and uncertain when processing applications for storage and hybrid facilities. AEMO also suggests that, because the current framework for registration and classification does not fully consider storage and hybrid facilities, it creates issues when participants control more than one type of technology behind a connection point, and when some participants aggregate exempt storage units. AEMO suggests that these issues may create barriers to entry for participants with storage units and hybrid facilities, increase costs and regulatory risks for AEMO, and may increase costs for consumers, contrary to the NEO.

We are seeking stakeholder feedback on the extent and materiality of these issues, whether they are likely to become more prevalent in the future, and whether AEMO's proposed approach is appropriate or if alternative solutions should be pursued.

**What are the technical and operational issues facing storage and how can those issues be addressed?**

We are also exploring in this consultation paper a number of technical issues relating to the connection and operation of storage in the NEM. The key issues highlighted for stakeholder consideration are technical issues associated with participation in central dispatch, how energy limited plant like storage are reflected in short-term dispatch, and setting performance standards for storage units.

We are seeking feedback on the extent of these issues, particularly given a number of stakeholders would have experience with connecting and operating storage under the current arrangements. For example, we are interested in the cause and significance of conflicting dispatch targets being issued to scheduled storage facilities, and how this might impact the operation of these assets.

AEMO has proposed a model that would simplify how batteries participate in the NEM. Instead of being separately represented as generation and load, AEMO has proposed a model where the entire battery is treated as a single scheduled asset able to submit both load and generation tranches in the same bid. We are also interested in understanding whether AEMO's proposed changes constitute a proportionate response to the issues, and whether there may be other issues or solutions not yet considered.

**What are the issues with the application of fees and charges to storage and how can they be addressed?**

In its rule change request, AEMO identifies that the application of fees and charges, and recovery of non-energy costs is inconsistent between participant categories and raises

concern that the current arrangements could have inequitable outcomes for storage. AEMO notes, for example, that non-energy cost recovery is applied to consumed energy from a grid-scale battery but is ignored for consumed energy by Market Generators and Market Small Generator Aggregators. AEMO also indicates that it is currently unclear (as the NER do not define energy storage proponents) if and how transmission use of system (TUOS) and distribution use of system (DUOS) charges should be recovered from storage, and that this results in ambiguity as network service providers (NSPs) and proponents interpreting the rules are implementing charging arrangements individually for energy storage systems.

In order to understand the broader issue of whether the proposed rule is effective and proportionate, we are seeking feedback on AEMO's view and proposed solutions for the application of fees and charges and non-energy cost recovery. We also seek views on alternative solutions that may also result in clarity, are durable to changing market circumstances and equitable in that they apply equally across participant categories.

### **What other obligations specific to storage and hybrids should be included in the NER?**

The consultation paper also covers the question of whether storage and hybrids ought to receive special treatment under certain frameworks in the NER, and if AEMO's proposals are appropriate. Specifically, the Commission is seeking feedback on whether there should be specific obligations for storage and hybrids under the intervention compensation framework or the Retailer Reliability Obligation (RRO), and if so, what these should be.

Further, we are seeking feedback on whether storage and hybrids should be considered for membership on the Reliability Panel, and whether or not it should consider a range of other drafting issues identified by AEMO in its detailed drafting proposal for Chapters 2, 3 and 10 of the NER that accompanied its Rule change request.

### **Are some of the key terms in the NER out-of-date? If, so how should they be changed?**

AEMO has identified that the language and definitions in the NER may be out of date because they were written for a time when there were fewer bi-directional flows, lower levels of storage and less complex arrangements of assets behind connection points. This proposal, combined with the other reforms suggested by AEMO, would require significant revision of many sections of the NER. We are seeking feedback on the issue of technology specific drafting of the rules: whether existing definitions in the NER, including those relating to "load" and "generation", impede the integration of storage and hybrids to an extent that makes it appropriate to make such widespread changes.

### **What is the process for this rule change request?**

Under the National Energy Law (NEL), the Commission may only make a rule if it is satisfied that the rule will, or is likely to, contribute to the achievement of the national electricity objective (NEO).<sup>3</sup> This is the decision-making framework that the Commission must apply. To

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<sup>3</sup> Section 88 of the NEL.

ensure its final rule determination contributes to achieving the NEO, the Commission proposes to consider whether the proposed rule, or a more preferable rule:

- **Promotes competition:** Would the changes proposed remove barriers to entry and reduce operating costs?
- **Creates a level playing field:** Are the proposed obligations proportional, technology neutral and even-handed?
- **Promotes transparency:** Would the proposed clarifications to the obligations and charges in the rules reduce information asymmetry and improve decision-making of participants?
- **Appropriately allocates risks:** Would the appropriate parties be assigned responsibility for costs under the approaches proposed for cost recovery?
- **Minimises administrative and regulatory burden:** Would the proposed changes reduce the administrative burden on AEMO and participants?
- **Enhances system reliability and security:** Would the proposed obligations on storage improve reliability and security?

This rule change request will be assessed over a longer period than the standard rule change process, consisting of longer than usual consultation periods and time-frames for completing the draft determination. This is due to:

- sensitivity about the difficulties faced by stakeholders given the current COVID-19 pandemic
- its interaction with other reforms such as the ESB's post-2025 program, in particular the two-sided-market design initiative
- the extensive and detailed nature of this rule change request, which requires changes to most chapters of the NER.

Submissions to this consultation paper will be open for a period of eight weeks and will close on **15 October 2020**.

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# 1 INTRODUCTION

On 23 August 2019, the Australian Energy Market Operator (AEMO) submitted a rule change request to the Australian Energy Market Commission (Commission) seeking to amend the National Electricity Rules (NER) to support the participation of energy storage systems (ESS) in the national electricity market (NEM), including by defining storage systems in the NER.

The rule change proposal seeks to address issues AEMO has identified with how grid scale batteries, aggregations of smaller batteries, and new business models with a mix of technologies behind the connection point (hybrid facilities), register and participate in the NEM. AEMO considers that the proposed rule would be in the long-term interest of electricity consumers with respect to promoting efficient investment in and efficient operation and use of electricity services. In particular, AEMO suggests that the rule change proposal would increase clarity and transparency for all stakeholders, remove barriers to entry for storage and hybrid facilities, and support the transition to an electricity system where more storage is needed to support variable renewable energy (VRE).<sup>4</sup>

In its rule change request AEMO estimated its implementation costs associated with the proposed rule were around \$8 million, this includes:<sup>5</sup>

- system, application, procedure and guideline changes necessary to:
  - implement the proposed new participant category to accommodate storage
  - create a single dispatch model for storage
  - settle and recover non-energy services and participant fees from the new participant category and Market Small Generator Aggregators (MGSAs)
- application, procedure and guideline changes needed to undertake and incorporate the proposed rule.

AEMO has since advised the Commission that the cost estimate has been revised and is now in the range of \$8 -10 million.

In order to assess AEMO's rule change proposal, the Commission must understand how significant the issues identified by AEMO are and whether they are likely to become worse in the future. Therefore, this consultation paper seeks feedback from stakeholders on the importance and urgency of the issues, and on the merits of AEMO's proposed solution.

As there are many components to AEMO's rule change request, the Commission has set out the consultation paper as follows.

- **This chapter** sets out the approach for assessing this rule change including the process for consulting with stakeholders. This includes:
  - how you can make a submission
  - our proposed timeframes
  - who you can contact for more information

<sup>4</sup> AEMO, *Integrating Energy Storage Systems into the NEM - Rule Change Request*, p. 54

<sup>5</sup> AEMO, *Integrating Energy Storage Systems into the NEM - Rule Change Request*, p. 56-57

- how we propose to assess the rule change request.
- **Chapter two** seeks your feedback on:
  - AEMO's rationale for inserting a definition for storage technologies into the NER
  - the proposed definition and other alternatives to integrate storage into the NEM.
- **Chapter three** seeks your feedback on AEMO's view that there are registration issues for storage and hybrid facilities being caused by the NER. It also seeks views on AEMO's proposed solution and other potential options.
- **Chapter four** discusses and seeks your feedback on the various operational and technical issues identified by AEMO, such as issues in dispatch and the calculation of ramp rates for aggregated units. The chapter also seeks views on whether AEMO's proposed solution would be effective and proportionate, and other potential options.
- **Chapter five** outlines the issues AEMO has identified with how fees and charges apply and seeks your feedback on those and AEMO's proposed solution and other potential options.
- **Chapter six** outlines the remaining issues that AEMO has identified as being caused by the NER not adequately recognising storage and bi-directional flows, and seeks your views on these as well as AEMO's proposed solutions and other potential options.

Stakeholder questions can be found throughout the paper and have also been collated in a stakeholder submission template, available on the [project page](#) for this rule change request. Appendices are also attached to the consultation paper providing additional detail and context.

## 1.1 Key terms used in this consultation paper

The following terms are used in this paper:<sup>6</sup>

- **Storage:** encompasses different electricity storage technologies such as pumped hydro, batteries (grid-scale and exempt), flywheels. It is an alternative term to ESS which AEMO uses in its rule change request. The Commission is no longer using Energy Storage Systems (ESS) to refer to storage because the acronym is used by the Energy Security Board's (ESBs) post-2025 market design Initiative for Essential System Services.
- **Grid scale batteries:** batteries that are 5 MW and above and are required under AEMO's policy to register in the NEM as a Market Generator (classified as a scheduled generating unit) and as a Market Customer (classified as a scheduled load).<sup>7</sup>
- **Exempt batteries:** batteries less than 5 MW that AEMO exempts from registering in the NEM (because they are treated as a generating system and the load is treated as auxiliary supply).<sup>8</sup>
- **Hybrid facilities:** a grid-scale facility that has a group of assets that are co-located behind a single connection point that allow a registered participant to both consume and

<sup>6</sup> Additional defined terms can be found in the Abbreviations on page 111.

<sup>7</sup> AEMO's policy is set out in its 2017 paper *Interim Arrangements for Utility Scale Battery Technology*, available on its website [www.aemo.com.au](http://www.aemo.com.au).

<sup>8</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, August 2019, p. 9.

export significant amounts of electricity to the grid. This does not refer to aggregators of small customers with solar panels and batteries.

In addition, AEMO uses the following terms in its rule change request and so these will be used in this consultation paper, when directly quoting AEMO:

- **ESS:** encompasses different storage technologies such as pumped hydro, batteries and flywheels
- **Bi-directional unit:** the technology neutral term AEMO proposes is inserted into the NER in order to define a storage plant. This is discussed in detail in section 2.3.

## 1.2 Approach for this rule change request

### 1.2.1 Approach for this rule change

This rule change request will be assessed over a longer period than the standard rule change process, consisting of longer than usual consultation periods and time-frames for completing the draft determination. This is due to:

- sensitivity about the extra workload that stakeholders may be experiencing as a consequence of the current COVID-19 pandemic
- its interaction with other reforms such as the ESB's post-2025 program, in particular the two-sided market design initiative
- the extensive and detailed nature of this rule change request, which may require changes to most chapters of the NER.

### 1.2.2 Timeline for this rule change process

The extent and urgency of the problems identified by AEMO and the changes necessary to address them are not clear at the start of this process. As such, the Commission cannot confirm exact dates now.

If the Commission determines, based on stakeholder feedback, that significant changes to the NER are required, we would aim to publish a final determination in the third quarter of 2021. The Commission will provide an update on the timing of this project after it has considered stakeholder submissions on the consultation paper.

### 1.2.3 How to lodge a submission

Submissions to this consultation paper will be open for a period of eight weeks and will close on **15 October 2020**. The Commission cannot guarantee that it will be able to consider submissions provided after this date.

You must lodge written submissions to AEMO's rule change request and this consultation paper via the Commission's website.

To lodge a submission, please:

1. refer to the **submission template** on the project page at:  
<https://www.aemc.gov.au/rule-changes/integrating-energy-storage-systems-nem>

2. complete the submission template (answering the questions you want to respond to) or draft a submission using your own preferred format
3. access the 'lodge a submission' webpage at: <https://www.aemc.gov.au/contact-us/lodge-submission>
4. provide your details, noting the project name and reference number:
  - Integrating energy storage systems into the NEM
  - ERC0280
5. upload your completed submission
6. if using the submission template, also upload a signed and dated cover letter on company letterhead.

The Commission's guide for making submissions is at: <https://www.aemc.gov.au/our-work/changing-energy-rules-unique-process/making-rule-change-request/tips-making-submission>

Please note, the Commission publishes all submissions on its website, subject to confidentiality requirements. Please clearly mark any sections of your submission which you consider contain confidential material.

If you have any questions about this project, please contact either:

- Kate Degen on (02) 8296 7812 or [kate.degen@aemc.gov.au](mailto:kate.degen@aemc.gov.au)
- Kate Wild on (02) 8296 7800 or [kate.wild@aemc.gov.au](mailto:kate.wild@aemc.gov.au).

## 1.3

## Assessment framework

### 1.3.1

### Achieving the NEO

Under the National Energy Law (NEL), the Commission may only make a rule if it is satisfied that the rule will, or is likely to, contribute to the achievement of the national electricity objective (NEO).<sup>9</sup> This is the decision-making framework that the Commission must apply.

The NEO is:<sup>10</sup>

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.

### 1.3.2

### Commission assessment framework

To ensure its final rule determination contributes to achieving the NEO, the Commission proposes to consider whether the rule change request:

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<sup>9</sup> Section 88 of the NEL.

<sup>10</sup> Section 7 of the NEL.

- **Promotes competition:** Would the changes proposed remove barriers to entry and reduce operating costs?
- **Creates a level playing field:** Are the proposed obligations proportional, technology neutral and even-handed?
- **Promotes transparency:** Would the proposed clarifications to the obligations and charges in the rules reduce information asymmetry and improve the decision-making of participants?
- **Appropriately allocates risks:** Would the appropriate parties be assigned responsibility for costs under the approaches proposed for cost recovery?
- **Minimises administrative and regulatory burden:** Would the proposed changes reduce the administrative burden on AEMO and participants?
- **Enhances system reliability and security:** Would the proposed obligations on storage improve reliability and security?

#### QUESTION 1: PROPOSED ASSESSMENT FRAMEWORK

Do you agree with the proposed assessment framework or are there any additional assessment criteria the Commission should use when assessing identified issues and possible solutions?

### 1.3.3 Making a more preferable rule

Under s. 91A of the NEL, the Commission may make a rule that is different (including materially different) to a proposed rule (a more preferable rule) if it is satisfied that, having regard to the issue or issues raised in the rule change request, the more preferable rule will or is likely to better contribute to the achievement of the NEO.

### 1.3.4 Northern Territory rule-making requirements

Under the Northern Territory legislation adopting the NEL, the Commission must regard the reference in the NEO to the “national electricity system” as a reference to whichever of the following the Commission considers appropriate in the circumstances having regard to the nature, scope or operation of the proposed rule:<sup>11</sup>

- (a) the national electricity system
- (b) one or more, or all, of the local electricity systems<sup>12</sup>
- (c) all of the electricity systems referred to above.

<sup>11</sup> Clause 14A of Schedule 1 to the *National Electricity (Northern Territory) (National Uniform Legislation) Act 2015* (referred to here as the NT Act), inserting section 88(2a) into the NEL as it applies in the Northern Territory.

<sup>12</sup> These are specified Northern Territory systems, listed in schedule 2 of the NT Act.

For the purposes of the proposed electricity rule, the Commission proposes to regard the reference to the “national electricity system” in the NEO to be a reference to item (c) from the list above.

The NER, as amended from time to time, apply in the Northern Territory, subject to derogations set out in regulations made under the Northern Territory legislation adopting the NEL.<sup>13</sup> Under those regulations, only certain parts of the NER have been adopted in the Northern Territory.<sup>14</sup>

As the proposed rule, in part, relates to the parts of the NER that apply in the Northern Territory, the Commission is required to assess whether to make a uniform or differential rule (defined below) under Northern Territory legislation.

Under the NT Act, the Commission may make a differential rule if, having regard to any relevant MCE statement of policy principles, a different rule will, or is likely to, better contribute to the achievement of the NEO than a uniform rule.<sup>15</sup>

A differential rule is a rule that:

- varies in its term as between:
  - the national electricity system, and
  - one or more, or all, of the local electricity systems, or
- does not have effect with respect to one or more of those systems

but is not a jurisdictional derogation, participant derogation or rule that has effect with respect to an adoptive jurisdiction for the purpose of s. 91(8) of the NEL.

A uniform rule is a rule that does not vary in its terms between the national electricity system and one or more, or all, of the local electricity systems, and has effect with respect to all of those systems.<sup>16</sup>

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13 The regulations under the NT Act are the National Electricity (Northern Territory) (National Uniform Legislation) (Modifications) Regulations 2016.

14 For the version of the NER that applies in the Northern Territory, refer to: [www.aemc.gov.au/regulation/energy-rules/northern-territory-electricity-market-rules/current](http://www.aemc.gov.au/regulation/energy-rules/northern-territory-electricity-market-rules/current).

15 Section 14B of Schedule 1 to the NT Act, inserting section 88AA into the NEL as it applies in the Northern Territory.

16 Section 14 of Schedule 1 to the NT Act, inserting the definitions of “differential Rule” and “uniform Rule” into section 87 of the NEL as it applies in the Northern Territory.

## 2 THE THRESHOLD QUESTION: SHOULD STORAGE BE DEFINED IN THE NER?

### 2.1 Introduction

In its rule change request, AEMO recommends the NER be changed to accommodate the transition occurring in the NEM. This consists of changing from an industry structured around one way energy flows from large generators to customers, where storage technologies were largely uneconomic, to a future increasingly characterised by two-way energy flows where participants are increasingly both buying and selling electricity. This is due to the expected increased role of storage technologies that both consume and send out electricity, which will increasingly participate at all levels of the market from fixed grid scale batteries connected to the transmission network down to smaller distributed storage options that may be mobile. AEMO is concerned that the NER do not adequately recognise storage and bi-directional flows because they do not contain a specific definition for storage to use as a basis for applying storage-specific obligations.

As no forms of storage facilities are currently defined in the NER, storage assets are treated as both “load” and “generation” due to the fact that a storage asset can ‘consume’ significant volumes of electricity from the grid and can also send significant volumes of electricity out to the grid. AEMO’s rule change request suggests it is problematic for the NER to treat a single energy storage asset as both generation and load. While AEMO has been able to accommodate storage to date, it notes there still remain problems for storage registering and participating in the NEM under the existing regulatory framework. AEMO also suggests that this is an issue for hybrid facilities (that have a combination of load and generation behind the connection point, which may or may not include storage) because a hybrid facility would also be defined as being both load and generation, as the facility both consumes and sends out electricity.

AEMO’s rule change request proposes to define storage and hybrid facilities, so that the rules better recognise storage and connection points with bi-directional flows. This proposal can be considered as the cornerstone of AEMO’s rule change request because these definitions underpin AEMO’s proposed solutions for how storage registers in the NEM and participates in dispatch. It is also the mechanism for AEMO’s proposal to clarify fees and charges and other obligations that apply to storage. This is explained by AEMO, who notes in its rule change request that “defining and recognising energy storage systems (ESS) allows clarification of relevant NER requirements associated with ESS, this increases clarity and transparency for all stakeholders.”<sup>17</sup>

Therefore, the Commission requests feedback on AEMO’s proposal to define storage and hybrids in the NER. While the following chapters of this consultation paper seek feedback on the registration and participation issues in detail, this chapter seeks your feedback on the threshold question about whether storage and hybrid facilities should be defined in the NER. The questions that this chapter focuses on are as follows:

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<sup>17</sup> AEMO, *Integrating Energy Storage Systems into the NEM - Rule Change Request*, p. 54.



- Do you agree with AEMO's view that the NER do not appropriately accommodate storage technologies and hybrids?
- If so, is AEMO's proposed solution involving a definition of storage assets in the NER appropriate or are there alternative solutions that should be considered?

## 2.2 Do the NER appropriately recognise storage and hybrids?

The Commission is seeking stakeholder views in response to AEMO's proposition that there is a problem with the way the NER treat storage and hybrid facilities as both generation and load. AEMO has articulated the following key reasons to support its proposal for defining storage and hybrid facilities in the rules:

- The rules are based on binary concepts of load and generation that no longer reflect the current market.
- There is evidence that this treatment by the NER is causing issues for how storage and hybrids register and participate in the NEM.
- These issues will be greater in the future because storage and bi-directional flows are going to be a more important feature of the future market.
- The Commission has previously recognised that there is an issue with how the NER treats storage.
- Stakeholders have told AEMO that they consider the NER's current treatment of storage is problematic.

Each of these key points are discussed below and the Commission has included questions on these points for stakeholders to consider and respond to.

### 2.2.1 Are the binary concepts of load and generation in the NER out-of-date?

In its rule change request, AEMO states that the rules were written for the market of the past reflecting the power system before NEM commencement, where assets connected to the grid consisted primarily of large thermal generators, large hydroelectric generators, industrial loads, and smaller customer loads. AEMO adds that [at NEM commencement], almost all demand was met by large grid-scale generation, and the two key types of traders in the NEM were Market Generators and Market Customers, each were assumed to be overwhelmingly only producers or consumers of electricity respectively".<sup>18</sup>

According to AEMO, the NER were "designed around binary concepts of 'generation' and 'load'" and did not consider a future where there would be business models that combined load and generation behind a connection point.<sup>19</sup> The NER were designed for participants that were either:

- **loads:** that is, large industrial energy users and retailers without any generating units
- **generators:** that is, generating facilities comprising uniform generating units with only minor auxiliary loads.

<sup>18</sup> AEMO, *Integrating energy storage systems into the NEM* - rule change request, pp. 4-5.

<sup>19</sup> AEMO, *Integrating energy storage systems into the NEM* - rule change request, p. 2.

AEMO notes this is no longer appropriate as there are currently greater numbers of participants, including storage systems, that are load and generators as they both draw in electricity from the grid and send electricity out to the grid.

#### **Current market now features more storage and bi-directional flows - AEMO's observations**

In its rule change request, AEMO explains that the market now consists of greater numbers of participants who are both purchasing and selling electricity rather than predominately just doing one of these activities. AEMO notes that proponents are now more frequently including storage (mainly batteries) in their facilities and portfolios and it "expects the role of inverter-converter ESS in the power system, which provide energy and system support service, will continue to grow."<sup>20</sup>

In addition, AEMO is observing:<sup>21</sup>

- growing grid scale battery storage connections
- increasing numbers of applications and interest in registering storage systems and hybrid facilities
- significant growth in battery storage and bi-directional flows at the distribution level.

AEMO says that the recent increases in connecting storage systems in the NEM, at both the transmission and distribution level, are due to the:<sup>22</sup>

- support energy storage systems can provide to variable renewable energy (VRE)
- ability for energy storage systems to provide important grid support services
- opportunities for energy storage systems to leverage energy arbitrage.

#### **Current levels of grid-scale storage in the NEM**

Storage systems, including batteries and pumped hydro units, are not new technologies in the NEM. Storage systems have been connected to the Australian electricity grid since 1973, when the 1,500 MW Tumut 3 pumped hydro unit was first built as part of the Snowy Hydro complex. Over the past two decades, a number of small battery systems have also connected to the grid in a range of demonstration projects and trials, but these systems were too small to require registration.

In December 2017, the Hornsdale Power Reserve became the first utility-scale battery in the NEM when it connected to the grid. Since then, four more lithium-iron batteries have connected across the network. Of these five projects, two connected adjacent to wind and solar power plants, one behind the same connection point, and two were deployed at network substations. These projects have storage capacities that range from 15 minutes to 2 hours. An appendix listing these projects is in appendix a.

The proportion of sent out electricity and demand that is attributable to hydro facilities and grid-scale batteries is increasing, as demonstrated by the figure below. However, compared

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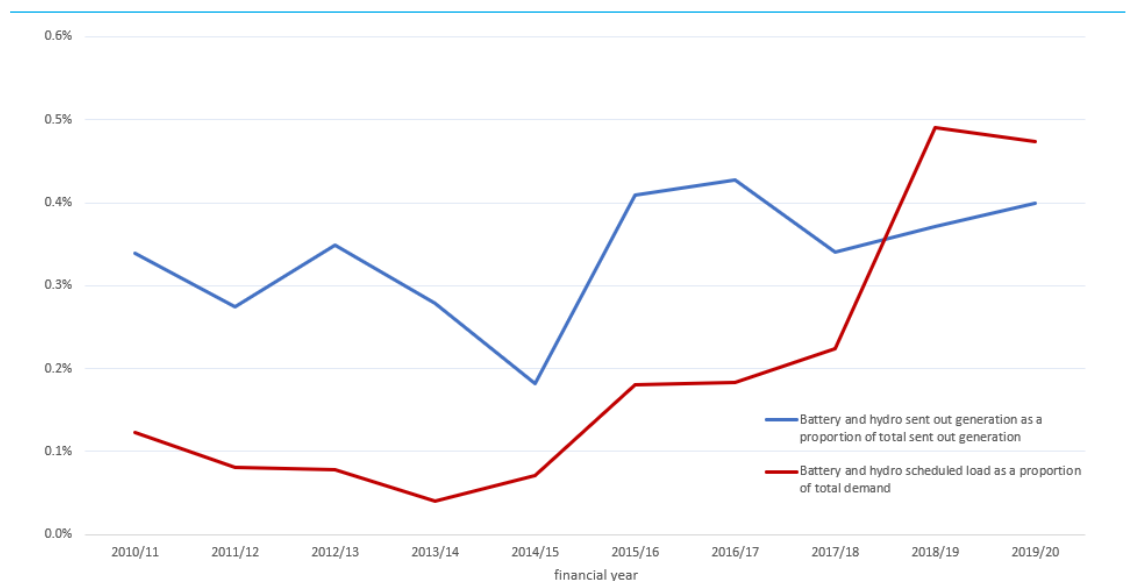
20 AEMO, *Integrating energy storage systems into the NEM* - rule change request, p. 4.

21 AEMO, *Integrating energy storage systems into the NEM* - rule change request, p. 4.

22 AEMO, *Integrating energy storage systems into the NEM* - rule change request, p. 2.

to total sent out generation and demand, storage still only represents a very small part of market activity.

**Figure 2.1: Battery and hydro activity as a proportion of total sent out generation and total demand (TWh)**



Source: AEMC analysis of AEMO’s Market Management System (MMS) database.

### Current interest in connecting large hybrid facilities

Hybrid facilities have, in some ways, always been part of the NEM. All power plants have auxiliary loads, and many of these could consume electricity from the grid. However, these auxiliary loads generally consume a far smaller amount of electricity than the electricity exported. For most of the NEM’s operation, there were only a few facilities that had significant exports and imports of electricity behind a single connection point, and few assets that could both import and export electricity.

While the Commission understands that there are currently no grid-scale hybrid facilities in operation, in its rule change request, AEMO notes that it is continuing to receive registration and connection enquiries in relation to storage systems as part of a hybrid facility (i.e storage system coupled with a generating system and/or industrial loads).<sup>23</sup>

### Current levels of storage and bi-directional flows in distribution networks

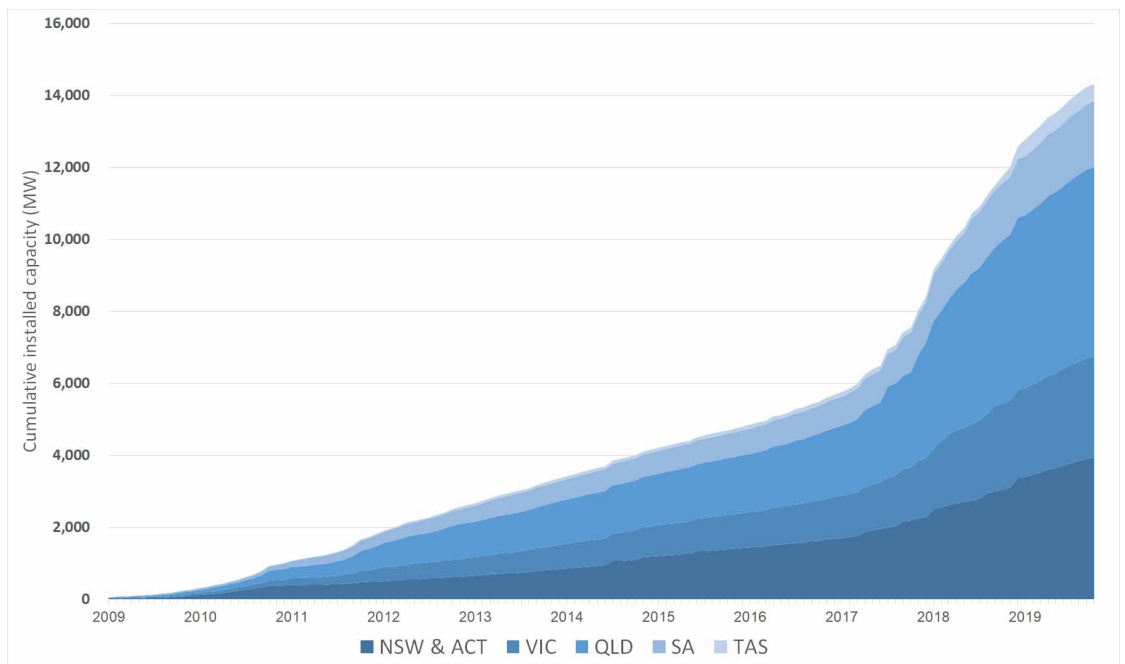
AEMO notes in its rule change request that the current market includes greater numbers of connection points with two-way electricity flows including, at the distribution level, “residential customers with installed devices, e.g. rooftop photovoltaic (PV) and batteries”.<sup>24</sup> The figures below demonstrate these trends in distribution networks by illustrating the

<sup>23</sup> AEMO, *Integrating energy storage systems into the NEM* - rule change request, p.4.

<sup>24</sup> AEMO, *Integrating energy storage systems into the NEM* - rule change request, p.2

cumulative rooftop PV capacity in the NEM and the number of rooftop PV and battery system installations each year in the NEM respectively.

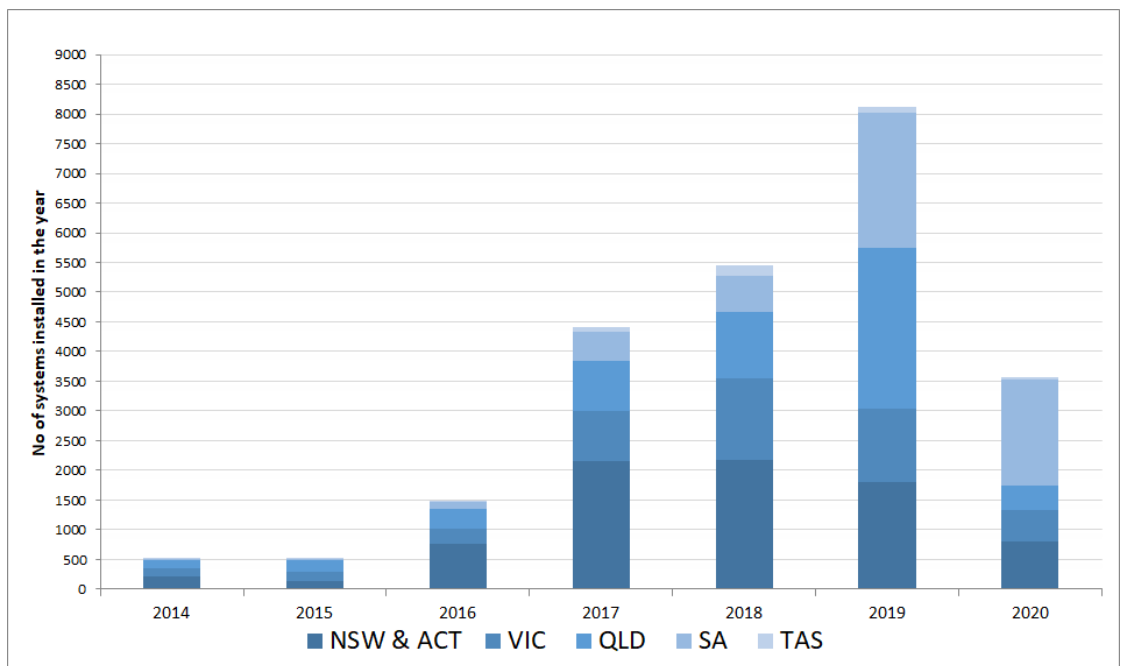
**Figure 2.2: Cumulative installed small-scale solar PV capacity in the NEM (30 June 2020)**



Source: Clean Energy Regulator postcode data for small-scale installations: [available here](#)

Note: The data includes new installations, upgrades to existing systems and stand-alone (off-grid) systems. A 12 month creation period for registered persons to create small-scale technology certificates applies under the *Renewable Energy (Electricity) Act 2000*. Therefore the 2018 and 2019 figures will continue to rise due to the 12 month creation period.

**Figure 2.3:** Combined residential battery storage and PV system installations in the NEM (30 June 2020)



Source: Clean Energy Regulator postcode data for small-scale installations: [available here](#)

Note: The data includes new installations, upgrades to existing systems and stand-alone (off-grid) systems. A 12 month creation period for registered persons to create small-scale technology certificates applies under the *Renewable Energy (Electricity) Act 2000*. Therefore the 2018 and 2019 figures will continue to rise due to the 12 month creation period. Also note that this data is based on the calendar year and not the financial year and so the data above represents only half a year.

## 2.2.2

### Is the lack of a definition for storage currently causing issues?

AEMO explains in its rule change request, that even though a storage unit is a single piece of equipment, it is treated as if it was two separate load and generating units.<sup>25</sup> While AEMO can accommodate the registration and participation of grid-scale storage and hybrid facilities in the NEM, it suggests that changes to the NEM, including definitions of these facilities, are needed to address various issues for storage and hybrid facilities registering and participating in the NEM.<sup>26</sup>

<sup>25</sup> AEMO, *Integrating Energy Storage Systems into the NEM* - rule change request, p. 9.

<sup>26</sup> AEMO, *Integrating energy storage systems into the NEM* - rule change request, p. 4.

### **AEMO is currently accommodating storage and hybrids and has made changes to address issues**

While storage units are currently able to participate in Frequency Control Ancillary Services (FCAS) and wholesale energy markets, the process of registering storage and hybrid facilities is not explicitly set out in the rules.

To deal with this, AEMO has developed *Interim Arrangements for Utility Scale Battery Technology* guidelines (Interim arrangements guidelines) which set out how utility scale battery projects should register and participate in the NEM.<sup>27</sup> AEMO's guideline explains that a person who owns, operates or controls a grid-scale storage system must typically register as both a Market Generator (scheduled generating unit) and Market Customer (scheduled load).<sup>28</sup> Proponents are then assigned the various rights and obligations that apply to these two registered participant categories, which were originally intended for large industrial loads and thermal generating units.

The following chapters of this consultation paper will seek your feedback on how well these arrangements are working to support storage to register and participate in the NEM.

### **Despite the changes made to processes, AEMO says that issues remain because the problem is created by the NER**

In its rule change request, AEMO notes that categorising storage systems and hybrid facilities as both load and generation is having unintended consequences. The consequent impacts will be discussed in greater detail in subsequent chapters. However, AEMO summarises its concerns with the current rules as causing:<sup>29</sup>

- a lack of clarity in the NER for proponents regarding how to register and participate in the NEM
- increased operational complexity and inefficiency involved in treating a single asset as two components because the unit is treated as load and generation (in particular the need for storage to participate in dispatch with separate and simultaneous bids)
- possible issues where the technical requirements applicable at the grid connection point are not symmetrical for the same asset (for example ramp rates differ for the generation category compared to the load category)
- complicated IT arrangements for registered participants and AEMO
- difficulty for AEMO and other parties understanding and analysing market data, because it is necessary to reference two dispatchable unit identifiers (DUID) (one DUID for generation category and one DUID for the load category) to understand the operation of the single storage asset

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27 AEMO, 2017, *Interim arrangements for utility scale battery technology*. Accessed at: [https://www.aemo.com.au/-/media/Files/Electricity/NEM/Participant\\_Information/New-Participants/Interim-arrangements-for-utility-scale-battery-technology.docx](https://www.aemo.com.au/-/media/Files/Electricity/NEM/Participant_Information/New-Participants/Interim-arrangements-for-utility-scale-battery-technology.docx)

28 *Interim Arrangements for Utility Scale Battery Technology*, p. 1. Where an ESS proponent does not wish to purchase electricity from the NEM, it is not required to register as a Market Customer.

29 AEMO, *Integrating Energy Storage Systems into the NEM* - rule change request, p. 17.

- uncertainty regarding the application of fees and TUOS and DUOS charges, and non-energy cost recovery due to the consumed electricity for storage being treated as a market load
- insufficient information provided on the limited energy capacity reserves of a storage system.

AEMO argues these issues increase its administrative costs and impact on its oversight as market operator, and as a result it may underestimate or overestimate available reserves.<sup>30</sup> AEMO believes that these issues may also increase costs for some participant types, creating barriers to entry.

AEMO's rule change request identifies many issues that arise, in its view, from the fact that the NER do not adequately recognise storage and hybrid facilities. However, there may be other issues that AEMO has not explicitly identified in its rule change request that are caused by the NER not containing a storage definition. The Commission seeks stakeholder input on whether AEMO's rule change request identifies all relevant issues that arise from the core problem that AEMO has outlined.

#### **QUESTION 2: CURRENT ISSUES CAUSED BY THE TREATMENT OF STORAGE (AND HYBRIDS) UNDER THE NER**

1. Do you agree with AEMO that there are currently significant issues for storage units and hybrid facilities being caused by the rules not including a storage definition? Why, or why not?
2. Has AEMO identified all the current issues for storage and hybrid facilities that arise from its primary issue that the NER does not recognise and adequately define storage? If not, what are the other issues?

### **2.2.3**

#### **Is a definition for storage needed to ensure the rules adapt to the future market?**

In its rule change request, AEMO explains that, in addition to the current issues noted above, there is a need to address the issues it has identified for storage and hybrids now given the expected strong uptake of battery storage and increasingly complex arrangements of assets behind connection points.<sup>31</sup>

The following section summarises:

- drivers for increased investment in storage technologies in the future
- upcoming projects
- AEMO's recent reports that show an increasingly important role for storage in the future.

<sup>30</sup> Ibid, p.17.

<sup>31</sup> AEMO, *Integrating energy storage systems into the NEM* - rule change request, pp. 2, 3, 26, 28, 54. See also AEMO's rule change request cover letter.

## Drivers for increased investment in storage technologies in the future

The drivers for increased uptake include:

- technology costs reducing
- government programs that subsidises investment in batteries
- reforms to the market design that will provide stronger signals for investing in storage technologies.

### **Technology costs reducing**

The cost of utility-scale storage technologies has significantly decreased over the past decade. For example, Bloomberg New Energy Finance (BNEF) identifies that between 2010 and 2019, the cost of lithium ion batteries fell by 87%.<sup>32</sup>

More information is provided in appendix a about the likely costs of battery technologies in the future.

### **Government programs**

A range of government programs are driving uptake of both small and grid-scale storage, whether as stand-alone units, combined with PV behind-the-meter, or aggregated into virtual power plants (VPPs).

- The NSW Government has introduced a \$75 million Emerging Energy Program that provides grants for pre-investment studies and capital investment for dispatchable generation technologies. It has so far awarded grants to 10 projects and shortlisted 21 projects for capital funding. These projects include pumped hydro, battery, VPPs, and solar thermal storage technologies.<sup>33</sup>
- The Queensland Government's Renewables 400 reverse auction program is providing financial support to renewable energy and energy storage projects. In July 2019, it shortlisted 10 projects for potential support: eight of these were combined VRE and battery projects, and one was a stand alone battery project. The Queensland Energy Security Taskforce is also tasked with developing options to increase pumped storage generation capacity in the state.<sup>34</sup>
- As well as providing grant funding for the Gannawarra and Ballarat storage systems, the Victorian Government has also committed to provide 10,000 rebates for Victorian households with existing solar PV systems to install batteries.<sup>35</sup> It is currently running a pilot program that will provide 1,000 rebates of up to \$4,838 each. The battery program is designed to target postcodes with high PV penetration and population growth.<sup>36</sup>

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32 (BNEF, *Battery Pack Prices Fall As Market Ramps Up With Market Average at \$156/kWh In 2019*, 3 December 2019. Accessed [here](#).

33 Department of Planning, Infrastructure and Energy, *Emerging Energy Program*, webpage, NSW Government. Accessed [here](#).

34 Department of Natural Resources, Mines and Energy, *Powering Queensland Plan: an integrated energy strategy for the state*, webpage, Queensland Government, 23 October 2019. Accessed at: <http://dnrme.qld.gov.au/energy/initiatives/powering-queensland>

35 The Hon Daniel Andrews MP, 2018, *Cheaper Electricity with Solar Batteries for 10,000 homes*, media release, Victorian Government, 11 September 2018. Accessed [here](#).

36 Solar Victoria, *Solar battery rebate*, webpage, Victorian Government. Accessed [here](#).



- The South Australian Government has committed \$100 million to the Home Battery Scheme, which will provide 40,000 households subsidies to install battery storage systems. Households can access low finance through the program to cover the balance of the subsidised battery system, as well as purchase new or additional solar panels, if required.<sup>37</sup> The South Australian Government has also committed to support Tesla to install up to 50,000 Powerwall batteries and operate it as a VPP with a capacity of 250MW/650MWh.<sup>38</sup>
- The ACT Government started the Next Generation Energy Storage Program, one of the world's largest roll out of household batteries, in early 2016. The program is supporting the roll out of 36MW of battery storage to ACT homes and businesses.<sup>39</sup>

***Current reforms that will provide stronger incentives for storage to enter the NEM***

There are a number of market reforms underway or being considered that, once implemented, are expected to provide stronger incentives for storage to enter the NEM. For example, the five-minute settlement reforms, commencing in 2021, will increase the opportunity for price arbitrage in the NEM's energy and FCAS markets. Increasing the granularity of the settlement period should also lead to an increase in profitability for batteries as they'll become better compensated for their ability to quickly charge and discharge their full capacity in just a few trading intervals.

The Commission's transmission access reforms will reinforce these incentives by introducing locational marginal pricing. The Commission has suggested that the timing of this reform will be coordinated with the implementation of other reforms being developed through the 2025 work, and will take account of changes that will be required to systems and adjustment of contracts. This will likely take about four years to be implemented following the finalisation of the rules.

When congestion arises on the transmission network, the underlying value to consumers and impact on emission reductions of an additional unit of electricity differs from location to location. Without building more transmission capacity, which takes time and costs money, the amount of electricity flowing out of the congested area cannot increase due the limit being reached on the element or network section. Therefore, the value of electricity in congested parts of the network is typically relatively low: any additional generation can only offset the most expensive generator which is also in the congested area.

In some congested areas and at some times, all the generators that are operating may be variable renewable generators, so the incremental value and emission reduction of additional variable renewable generation is close to zero: the next renewable generator simply reduces the output of the existing renewable generators. In contrast, additional renewable generation in an uncongested area will offset the most expensive generator anywhere and so be of higher value. It will likely also have a greater impact on emission reductions.

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37 Government of South Australia, *South Australia's Home Battery Scheme*, webpage. Accessed [here](#).

38 Government of South Australia, *South Australia's Virtual Power Plant*, webpage. Accessed [here](#).

39 ACT Government, *Next Generation Energy Storage (Next Gen) Program*, webpage. Accessed [here](#).

Despite the difference in the marginal *value* of electricity by location, under the current arrangements, all market participants – including storage devices - pay and receive the regional spot *price* for electricity (subject to loss factors).

Under locational marginal pricing, the spot price received (and paid) by scheduled and semi-scheduled generators and storage devices varies based on the marginal value of electricity at that location.

For storage devices, this means that they will be able to better arbitrage price differences that arise over time at their location – reflecting the different value of electricity at their location over time. For example, consider a part of the network which is congested at the sunniest parts of the day, because of the large amounts of solar generation in the area. At those times of the day, a storage device could charge up at relatively low prices. As the sun sets, and the congestion is alleviated, the local price will increase approximately back to parity with prices elsewhere on the network. The storage device can now discharge, enjoying relatively high prices compared to those at which it charged earlier in the day.

This will incentivise storage devices to locate in parts of the network where it can store electricity which is abundant but cannot get to load as a consequence of congestion. The current arrangements do not promote these outcomes because the price received and paid by storage is a regional price, and so does not reflect the different value of electricity across the network.

### **Upcoming projects**

AEMO has identified a number of upcoming storage projects. In its *July 2020 NEM Generation Information* dataset, AEMO identifies around 13GW of publicly announced, maturing and committed future storage projects for the NEM, as shown in the table below.<sup>40</sup>

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<sup>40</sup> AEMO, *April 2020 Generation information* dataset. Accessed [here](#).

**Table 2.1: Total MW capacity of announced, committed and maturing storage projects in the NEM as at July 2020**

	<b>PUBLICLY AN- NOUNCED</b>	<b>COMMITTED</b>	<b>MATURING</b>	<b>TOTALS (BY TECHNOLO- GY)</b>
<b>Batteries</b>	6090	27	20	<b>6137</b>
<b>Pumped hydro</b>	44620	2040	0	<b>6660</b>
<b>VPP</b>	5	6	0	<b>11</b>
<b>TOTAL (by status)</b>	10715	2073	20	12808

Source: AEMO, *July 2020 NEM Generation Information* dataset. Accessed [here](#).

Note: Publicly announced projects are those that "have been announced publicly, but do not yet have any finance arrangements in place. Costs and capabilities of these projects are developed using recently-completed projects and projections of cost components such as raw material supply and labour." In this table, Committed projects are those where construction and has commenced; project finance is in place; the projects have either completed contracts for major equipment components (or are at an advanced stage); and planning and registrations are completed or are at an advanced stage. Maturing projects "have progressed with site, planning applications, and finance arrangements, but not to the point that they can be classified as advanced. Maturing projects may be explicitly included in scenario analysis to assess future reliability or market impacts and are tested for economic efficiency in capacity outlook modelling."

This data indicates that storage projects are already starting to incorporate larger storage capacities: around 4 hours for battery projects and several days for the larger pumped hydro projects.<sup>41</sup> Projects are also now being developed without direct support from government grants and subsidies. For example, Nexif's 10/10MWh Lincoln Gap battery was deployed using only low-cost finance from the Clean Energy Finance Corporation (CEFC).<sup>42</sup>

Another notable upcoming project is the Kennedy Energy Park. This facility is seeking to co-locate 15MW of solar resources, 43.2MW of wind resources and a 2MW/4MWh battery storage facility in the one facility.<sup>43</sup> This project has reportedly experienced difficulties connecting to the NEM<sup>44</sup> and would be the first hybrid facility in operation in Australia.

#### **AEMO's recent reports about the role of storage in the future**

AEMO states in its rule change request that it expects the number of battery units and hybrid facilities in the NEM to significantly increase, and this expected growth is one of the reasons why it has submitted its rule change request.<sup>45</sup> AEMO has separately articulated possible future roles for storage in its *Renewable Integration Study* and forecast expected growth in storage in its *Integrated System Plan*. These are detailed below. Other storage forecasts are discussed in appendix a.

41 Ibid.

42 "Nexif's Port Augusta battery at Lincoln Gap ready to turn on and pay its way commercially", *Adelaide Now*, 21 June 2019. Accessed at: <https://www.adelaidenow.com.au/business/sa-business-journal/marketbased-big-battery-at-port-augusta-ready-to-switch-on-and-pay-its-way-commercially/news-story/f5842818169aa47b8e4f4d08cf5d5fd4>

43 ARENA, Kennedy Energy Park. Project site available [here](#).

44 "After more than a year, Kennedy renewable energy farm still not fully connected to grid", *ABC*, 4 March 2020. Accessed [here](#).

45 AEMO, *Integrating energy storage systems into the NEM* rule change request p. 2, 4, 56.

### **Renewable Integration Study**

AEMO's 2020 *Renewable Integration Study* considers potential roles for storage in the future grid. AEMO identifies that the system will need to operate more flexibly to accommodate increased variability and uncertainty.<sup>46</sup> It identifies storage, particularly batteries and pumped hydro, as a possible source of flexibility.<sup>47</sup>

Storage can participate by increasing demand (load) or increasing supply (generation). It can decrease production or increase its load during periods of surplus generation, such as in high VRE periods. It can then increase production in periods where VRE is lower. Having a diverse range of technical characteristics across the storage fleet allows management of variability over different timescales, for example pumped hydro and battery storage.

- Pumped hydro has the capability to quickly produce or demand large amounts of energy over a longer duration, although there are limitations to how quickly it can switch between these modes. New variable speed drive pumped hydro projects, such as three of Snowy 2's six units, are able to provide this flexibility almost instantaneously.
- Batteries have fast response times and can cycle from charge to discharge much quicker than pumped hydro, however, the units currently installed in the NEM have a much shorter duration for which they can run. This is important, as having a diverse range of technical characteristics across the storage fleet allows management of variability over different timescales. Battery storage is also a scalable technology that can be readily co-located with VRE resources in a hybrid facility to firm VRE output or as a stand-alone installation.

### **2020 Integrated System Plan**

AEMO's Integrated System Plan (ISP) models the optimal development path for the NEM.<sup>48</sup>

The 2020 ISP, released on 30 July 2020, identifies that storage, combined with strategically placed interconnectors and renewable energy zones, "will be the most cost-effective way to add capacity and balance variable resources across the whole NEM".<sup>49</sup> The ISP identifies that, to support an expected 26 to 50GW of new grid-scale renewable generation, the grid requires 6 to 19GW of new dispatchable resources by 2040. Dispatchable resources include flexible gas generators, demand-side participation, hydrogen generation, and storage technologies like pumped hydro, grid-scale battery storage, and distributed batteries participating as VPPs.<sup>50</sup>

The 2020 ISP forecasts that most initial investment in dispatchable generation will be in "utility-scale pumped hydro (such as Snowy 2.0, already committed) or battery storage

46 AEMO, *Renewable Integration Study Stage 1 Appendix C: Managing variability and uncertainty*, April 2020, p. 45. Accessed [here](#).

47 Ibid, p. 46.

48 AEMO, *2020 Integrated System Plan*, webpage. Accessed [here](#).

49 AEMO, *2020 Integrated System Plan: for the National Energy Market*, 30 July 2020, p. 13. Accessed [here](#).

50 Ibid, p. 50.

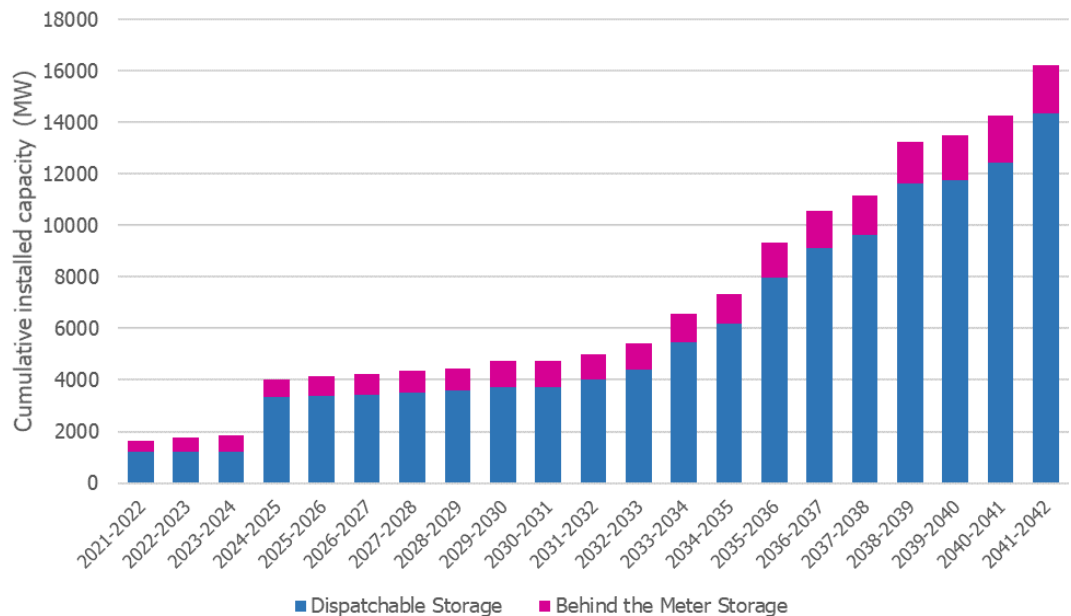
(assuming technology costs continue to fall, and the market arrangements sufficiently incentivise this development).<sup>51</sup>

The ISP identifies that:

- Utility-scale energy storage can shift the timing of renewable energy production, reduce the magnitude of new intra-regional transmission required, and provide firming support during peak loads or when renewable production is low.<sup>52</sup>
- The growth in storage is expected to be broadly aligned with timing of coal-fired generation retirements.<sup>53</sup>
- The type and depth of storage required will depend on the mix and location of renewable generation, and the ability of existing generators to smooth out short-term and seasonal renewable variability.<sup>54</sup>

As shown in the figure below, AEMO’s 2020 ISP central scenario forecasts over 16,000MW of storage installed in the NEM by 2042.

**Figure 2.4:** Cumulative installed storage capacity (MW) by year (ISP central scenario)



AEMO, *2020 ISP NEM Generation Outlook*, dataset extracted from online visualisation, central scenario, filtered for storage technologies. Note that dispatchable storage includes all sizes of dispatchable storage, including grid-scale batteries, pumped hydro and virtual power

51 Ibid, p. 50.  
52 Ibid.  
53 Ibid p. 51.  
54 Ibid

plants. Behind the meter storage includes all storage that is not dispatchable, such as residential batteries that are not part of a virtual power plant. Chart completed in Excel using AEMC formatting. Accessed [here](#).

AEMO notes that its 2020 ISP analysis “assumes optimal operation of the installed storage with perfect foresight. However, even minor inefficiencies in real world operations lead to the need for more storage or other forms of dispatchable generation, to ensure reliable supply for consumers.”<sup>55</sup>

### QUESTION 3: IMPLICATIONS OF STORAGE FORECASTS

Do you agree that storage and hybrid facilities are likely to play a significant role in the future market? If so, do you agree that this indicates that the issues AEMO has identified in its rule change request, arising from the current treatment of storage under the NER, are likely to become worse over time? Why, or why not?

#### 2.2.4

#### The Commission’s previous projects in relation to storage

In its rule change request, AEMO notes that the Commission has previously considered how to best integrate storage into the NEM and has previously made changes to the NER to clarify that the generation participant category could accommodate storage. AEMO also notes the Commission’s recommendation arising from the 2018 Coordination of Generation and Transmission Investment (COGATI) review, that consideration be given to introducing into the NER a specific participant category for storage.<sup>56</sup>

While the Commission’s recommendation in the 2018 COGATI report is consistent with AEMO’s rule change request, it is important to note that this recommendation predates the current work of the ESB post-2025 market design two-sided market reforms. The two-sided market design work is considering a move away from defining specific technologies and assets in the rules towards a technology-neutral approach that attaches obligations to services and activities. This rule change request will need to be considered in the context of these broader reforms, which may require considering solutions other than one that defines storage assets and hybrid facilities in the NER. The relationship between this rule change proposal and the two-sided market reforms is discussed below in section 2.3, which discusses alternative options to defining storage assets in the NER.

This section provides a brief overview of the Commission’s earlier consideration of the integration of storage into the NEM, in order to provide useful background to assist stakeholders in responding to this consultation paper. This section will cover:

- previous amendments to the NER to better integrate storage

<sup>55</sup> Ibid p. 50.

<sup>56</sup> AEMO, *Integrating Energy Storage Systems into the NEM* - rule change request, p. 5.

- the Commission’s recommendation for further rule changes that would involve defining storage assets in the NER.

#### **Previous reviews and rule changes regarding the integration of storage**

In 2015, the Commission recognised the increasing interest in, and application of, storage in the NEM and began a review titled *Integration of Storage: Regulatory Implications*. This review considered possible issues with the regulatory framework that may be acting as a barrier to the integration of storage.<sup>57</sup> Following consultation with stakeholders, the Commission found that the regulatory framework in the NEM was largely robust to this technology change and could accommodate the installation of storage across the electricity sector.<sup>58</sup> In particular, the Commission found that it was not necessary to create a new registered participant category for storage in the NEM:

The AEMC is of the view that a new category of registered participant does not need to be introduced for persons seeking to participate in the NEM using a storage device. This is because the existing categories are sufficiently flexible to incorporate the use of storage. Further, there are no specific rights or obligations that are particular to storage which would necessitate the creation of a new participant category.<sup>59</sup>

The Commission’s review discussed whether the definition of a generating unit captured all storage systems. The Commission recommended that an interested party submit a rule change request to ensure the definitions of ‘Generator’ and ‘generating unit’ included storage. Subsequently, AEMO submitted this rule change request and in 2016, the Commission made this Rule. The final determination clarified that “a person seeking to participate in the NEM using a storage device should be registered according to the activities that the person intends to perform in the NEM using that device” and that “AEMO can register the owners and operators of battery storage as Generators.”<sup>60</sup>

#### **Commission’s recommendation for future NER amendments to integrate storage**

The Commission again considered the issue of whether NER changes were required to better recognise and facilitate storage’s participation in the NEM in its 2018 COGATI review. The final 2018 report made some recommendations relating to storage, including that:<sup>61</sup>

- The appropriate NEM registration category that should apply to storage systems, and consequently how they should be treated within the regulatory framework, are issues that require long-term solutions.
- Greater clarity should be provided for storage system proponents and to remove operational inefficiencies for registered participants and AEMO.
- AEMO should submit a rule change request to create a new NEM registration category to accommodate storage systems.

<sup>57</sup> AEMC, *Integration of Storage: regulatory implications*, final report, 3 December 2015. Available [here](#).

<sup>58</sup> *Ibid*, p. iii.

<sup>59</sup> *Ibid*, p. 21.

<sup>60</sup> AEMC, *Registration of proponents of new types of generation*, final determination, 26 May 2016, p. 6.

<sup>61</sup> AEMC, *COGATI review final report*, 21 December 2018 p. 105.

- The rule change regarding a new participant category should also consider whether or not it is appropriate for storage systems to pay TUOS. The Commission's preliminary position on the applicability of TUOS in 2018 aligns with that of AEMO's in this rule change request.
- Apart from TUOS, the rule change request should consider what other regulatory obligations should be placed on participants registered under the new category for energy storage systems.

At the time, the Commission's rationale for recommending a new participant category for storage was as follows:<sup>62</sup>

- "Currently, energy storage systems have to be registered as both a generator and a market customer, which imposes a double set of obligations on them. In this sense, creating a new registration category will reduce barriers to entry for these technology types, allowing them to be considered on equal footing as generators, and preserving the underlying NEM principle of technology neutrality."
- "Implementation of a long-term solution for how energy storage systems are treated in the NER will reduce confusion about the appropriate registration categories for these technologies, and provide regulatory certainty for proponents of these systems."
- "It will support more efficient integration of energy storage systems into the NEM and reduce the operational burden for AEMO and current registered participants with regard to the participation of these systems in the market."
- Creating a new category for energy storage systems may be necessary for implementing recommendations in the COGATI final report for access settlement: "In order for energy storage systems to be able to be treated differently to load under these arrangements in terms of the price they pay to import electricity (the dynamic regional price rather than the existing regional reference price), they require a separate registration category that details these specific conditions and associated obligations."

AEMO subsequently responded to the Commission's recommendation that it submit a rule change request to create a new NEM registration category and submitted this rule change request, which is the subject of this consultation paper.

In making its recommendation, the Commission also noted in the final report that it was cognisant of the extensive changes that would be required throughout the whole NER to incorporate storage. It stated that "[t]he many and varied NER obligations (e.g. technical performance standards) are tied to the existing registration categories. A new approach to registering storage participants would need to map regulatory obligations to the appropriate parties throughout the NER framework."<sup>64</sup>

It is also important to note that, while the Commission considered that there was a pressing need to create clarity for storage proponents, in its earlier options paper, the Commission expressed the view that a more holistic look at the registration categories in the NEM may be needed in order to:

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64 Ibid, p. 113.



- make sure that the existing participant categories in the NER sufficiently accommodate and support the participation of existing and emerging technologies and business models into the future
- reduce operational complexity and administrative burden for AEMO and participants.<sup>65</sup>

The Commission also set out some alternative ways to assign rights and obligations to registered participant categories. These alternatives are discussed in more detail in section 2.3 below.<sup>66</sup>

### 2.2.5

#### **Stakeholders have previously considered there is a problem with the way the NER treats storage**

AEMO's rule change request was informed by its Emerging Generation and Energy Storage (EGES) initiative. As part of this initiative AEMO discussed the challenges and issues for storage and hybrids registering and participating in the NEM. This consultation process included stakeholder workshops in both December 2017 and March 2018 and a stakeholder paper published in November 2018.<sup>67</sup>

This engagement process asked stakeholders their views on AEMO's proposed solution including a definition for storage. The majority of stakeholder feedback supported AEMO's proposed model which included a proposal to define storage in the NER. Stakeholder feedback summarised in AEMO's rule change request also shows there was support for including a definition for storage in the NER. Reasons provided by stakeholders included that such a definition would:<sup>68</sup>

- enable streamlining of the registration process
- reduce complexity for participation in the NEM
- reflect the changing technologies being connected to the grid.

## 2.3

### **How should the NER recognise storage and hybrid facilities?**

AEMO proposes a detailed solution for improving the integration of storage and hybrid facilities, which incorporates extensive changes throughout the NER. Its rule change request is based on introducing a definition for storage and hybrid facilities in the NER as an alternative to these technologies and business models being treated as load and generation. An overview of AEMO's proposed solution is provided in appendix b of this consultation paper. The following chapters of this paper will seek stakeholder feedback on the details of AEMO's rule change request. This section seeks views on whether:

- AEMO's proposed solution to define storage and hybrids in the NER, including its proposed wording for the definitions, are appropriate
- there could be other solutions that the Commission should consider in more detail through this rule change process.

<sup>65</sup> Ibid p. 109.

<sup>66</sup> Ibid, p. 109.

<sup>67</sup> These materials are available on AEMO's website [here](#).

<sup>68</sup> AEMO, *Integrating Energy Storage Systems into the NEM* - rule change request, p 58.

### 2.3.1

#### What are your views on AEMO's proposed solution to define storage and hybrid facilities in the NER?

AEMO proposes to address the issues it has identified in its rule change request by defining and explicitly recognising bi-directional units (single or aggregated storage units), and bi-directional facilities (hybrid systems where flow can be in either direction at the connection point). AEMO considers that "this approach will resolve the regulatory and operational uncertainty associated with the current arrangements".<sup>69</sup> The Commission seeks your feedback on the questions below regarding AEMO's proposal for storage and hybrid facilities to be defined in the rules as a mechanism for clarifying how they register and participate in the NEM.

#### QUESTION 4: AEMO'S RATIONALE FOR DEFINING STORAGE AND HYBRIDS IN THE NER

1. Do you agree with AEMO that there is a strong rationale for defining storage and hybrid facilities in the NER (as different to load and generation)? Why or why not?
2. Bearing in mind that the two-sided market reforms (as discussed in section 2.2.4) propose to move towards service-based requirements (rather than technology-based requirements), are there differences in the nature of the services provided by or to storage facilities that require these services to be distinguished from generation and load?

AEMO explains that its "proposed bi-directional unit definition is technology neutral to allow for different storage technologies, e.g pumped hydro, batteries, flywheels, to be covered by the definition".

AEMO's proposed definition for a hybrid facility allows for facilities consisting of:

- bi-directional units (either by themselves or co-located with generation and/or load); or
- generation units and market loads.<sup>70</sup>

The proposed definitions for storage and hybrids, which are set out below, provide a basis for AEMO's proposed new registration participant category, which is discussed in chapter 3. These definitions would also facilitate the participation of storage assets in dispatch with a single bid (chapter 4 seeks feedback on the proposed dispatch model). This would also provide the mechanism for AEMO's proposal to clarify how fees and charges, which is discussed in chapter 5 and other obligations apply to storage and hybrids, which is discussed in chapter 6.

<sup>69</sup> AEMO *Integrating energy storage systems into the NEM* - rule change request, p. 26.

<sup>70</sup> *Ibid*, pp. 30, 49, 63.

### **BOX 1: PROPOSED WORDING FOR THE DEFINITIONS FOR STORAGE AND HYBRID FACILITIES**

#### **Definition for storage = bi-directional unit**

Plant that has the capability to both:

- a) consume electricity to convert into stored energy; and
- b) convert stored energy to produce electricity, together with all related equipment essential to its functioning as a single entity.

#### **Definition for a hybrid facility = bi-directional facility**

- a) A facility incorporating one or more bi-directional units.
- b) A facility incorporating an interconnected combination of one or more:
  - i) bi-directional units with generating units and/or loads; or
  - ii) generating units with loads, where that combination of interconnected plant:
    - iii) is connected to a transmission or distribution system at a common connection point; and
    - iv) can be operated such that, at any time, there may be an amount of sent out electricity or an amount of consumed electricity at the connection point.

Source: AEMO, Integrating energy storage systems into the NEM - rule change request, pp. 48-49.

AEMO previously consulted with stakeholders about a definition through its EGES stakeholder paper. In its rule change request, AEMO made three points in response to the stakeholder feedback on its proposed definition for storage and hybrids. It suggests that the definitions:<sup>71</sup>

- Allow electricity to be consumed from the grid or another source at the site. For a bi-directional facility (which functions as a single entity) electricity flows from an on-site generating unit or to a market load would be allowed. The electricity flow measured at the connection point is used for settlement, prudentials and calculation of marginal loss factors (MLFs).
- Do not prevent the storage unit from providing ancillary services.<sup>72</sup>
- Do not include capacitor banks, reactors, static var compensators and synchronous condensers, which are all reactive power devices. These are separately defined in the NER and specifically used to relate to distribution or transmission lines and generating units.

The Commission requests your feedback on the wording of AEMO's proposed definitions for storage and hybrid facilities.

<sup>71</sup> AEMO, *Integrating Energy Storage Systems in the NEM - rule change request*, p. 7.

<sup>72</sup> To provide ancillary services the bi-directional resource provider will need to classify its bi-directional unit as an 'ancillary services generating unit'.

**QUESTION 5: AEMO'S PROPOSED WORDING FOR DEFINING STORAGE AND HYBRID FACILITIES IN THE NER**

Do you have any comments on AEMO's wording for its proposed definitions of storage and hybrid facilities?

**2.3.2**

**Alternative options to defining storage and hybrids in the rules**

As noted in section 2.2.4 above, AEMO's proposed solution for accommodating storage will need to be considered in the context of the ESB's 2025 market design initiative for a two-sided market. The reason for this is that, while the problems that AEMO is seeking to address are also issues that need to be addressed as part of moving to a two-sided market, AEMO's proposed solution may not align well with the direction of the ESB's market design. For example, the two-sided market reforms propose to combine most types of market participants (including generators and retailers) into a single registration category, and impose obligations based on services rather than asset types.<sup>73</sup> The Commission is interested in feedback on the best way to proceed given the different approaches of the two sets of reforms.

The following sections set out the possible:

- alignments and inconsistencies between the two reform proposals
- alternative options for addressing the integration issues AEMO has identified in its rule change request.

**2.3.3**

**Relationship between AEMO's proposed solution and the two-sided market reforms**

On 6 December 2019, the then COAG Energy Council tasked the ESB with investigating interim measures to preserve reliability and system security in the NEM as it transitions to the 2025 market design.<sup>74</sup> As part of this task, the COAG Energy Council requested that the ESB provide advice on arrangements to give visibility of available resources and options to ensure their sufficiency, and that be coordinated with, amongst other things, the longer-term market design for a two-sided market.

A two-sided market is a market model that promotes direct interaction between end-users in the electricity system, whether they be predominantly suppliers or customers (or both). Most traditional markets are two-sided, such as commodity and agricultural markets. A two-sided market can deliver benefits of improved efficiency and innovation, and customer benefits including better prices and more choice. A two-sided market design allows innovations in technical standards and services, without rigid market designs linking services back to physical types of generators, loads or storage devices. Technical capabilities and the set of services offered could then evolve without requiring major rule change processes.

<sup>73</sup> ESB, Moving to a two-sided market, April 2020, chapter 3. Accessed [here](#).

<sup>74</sup> Tasking letter can be found [here](#).

### **Relationship between AEMO’s proposed solution and the two-sided market reforms**

There are many issues that need to be addressed on the path to a two-sided market. One of the key challenges is removing barriers to entry for more active participation on both sides of the market. This happens to be an issue that AEMO’s rule change request is seeking to address. As discussed in this chapter, AEMO has identified that storage and hybrid facilities face difficulties due to the current arrangements that require them to register and participate as both a scheduled generator and a scheduled load. AEMO suggests these obligations are not clear enough and that this is inefficient, presenting a barrier to entry. As storage participates on both sides of the market, removing barriers for storage would assist in removing barriers to the participation in the market more generally. This could therefore be considered as an important milestone on the path to a two-sided market.

While both this rule change request and the two-sided market project are seeking to address similar problems, there are also inconsistencies in the approaches.

While AEMO’s rule change request seeks to define storage assets in the NER in order to establish a new participant category to accommodate storage, the proposed design for a two-sided market proposes obligations be attached to services provided (or functions and activities) instead of assets. The two-sided market design also involves streamlining the existing registered participant framework, and collapsing the participant categories into a trader and services model, which is a different approach to AEMO’s proposed rule change that involves adding a new participant category. The different approaches to participant categories is discussed further in chapter 3.

#### **2.3.4**

#### **Are there alternative ways to address the integration issues that AEMO has identified?**

In assessing the rule change request, the Commission will consider whether the different approach being proposed under a two-sided market can address the integration issues that AEMO has identified in its rule change request, and if so whether this approach might be the more preferable solution.

As noted above in 2.2.4, the Commission considered in its 2018 COGATI review final report the alternative option to defining storage and creating new categories in the NEM for storage:<sup>75</sup>

In the report, the Commission discussed the option of amending the framework to:

“define each service individually, and participants could choose which service they wish to buy/sell and not be constrained by the requirements of a particular registration category. Under this approach, participants could choose whether they only provide one service, or provide all. The rules would then apply to the specific service that participant is providing, not what registration category they are in. Such an approach

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<sup>75</sup> AEMC, *COGATI review final report*, 21 December 2018 p. 109.

<sup>76</sup> *Ibid.*

would likely support a more efficient means of registering hybrid facilities, as the framework would focus more on the services that are being provided at the connection point rather than the assets that are used to provide them. Any significant change to the registration framework in the NER would need to be reflected throughout the rest of the NER framework.”<sup>76</sup>

This more comprehensive reform to the participant categories was not recommended by the Commission in 2018 as the Commission considered there was a pressing need to address the issues facing proponents of storage and that adding a new participant category would be quicker.

The Commission is therefore interested to see if stakeholders have views on both the timing for when issues facing storage should be addressed as well as your proposed approach to addressing the issues.

#### **QUESTION 6: ALTERNATIVES TO AEMO’S PROPOSED SOLUTION TO INTEGRATION ISSUES FOR STORAGE**

In light of the alignment issues between AEMO’s rule change request and the direction the ESB’s two-sided market reforms are taking, which of the following approaches do you support and why?

1. Waiting for the implementation of the two-sided market reforms to address the integration issues facing storage and hybrid facilities
2. Introducing AEMO’s rule change proposal as an interim step prior to the implementation of the two-sided market reforms
3. Implementing certain aspects of the two-sided market reforms through this rule change project, such as combining the different types of market participants and imposing obligations based on services rather than assets
4. Taking an alternative approach (please specify)

## 3 REGISTRATION ISSUES FOR STORAGE UNITS AND HYBRID FACILITIES

In its rule change request, AEMO outlined a number of issues that, in its view, exist with the current registration framework. This chapter:

- details the issues AEMO has identified
- describes AEMO's proposed solution and how it proposes to address these issues
- discusses possible alternative solutions.

From this, the Commission is seeking your feedback on:

- the extent of these issues and whether these issues are likely to become more prevalent in the future
- whether AEMO's proposed approach is appropriate and possible alternative solutions.

### 3.1 Registration framework issues for storage and hybrids

In identifying potential issues with the current registration framework, AEMO is of the view that the current rules on participant registration and unit classification may:

- create problems during the registration process, including barriers to entry for storage and hybrids and regulatory risks for AEMO
- create confusion in the registration process for hybrid facilities because the current regulatory framework assumes participants only control one type of technology behind a connection point
- not clearly indicate whether Small Generation Aggregators (SGAs) can include storage units of less than 5MW in its portfolios (alongside exempt generating units).

#### 3.1.1 Overview of the current registration approach for storage and hybrids

This section outlines the current approach to registration for operators of storage units and hybrid facilities. It also describes the current arrangements for SGAs. These relate to the issues that AEMO has identified in its rule change request.

##### The current framework for registration in the NEM

Broadly, the NEL and NER require all legal entities that intend to buy or sell electricity from the spot market to register with AEMO.<sup>77</sup> Chapter 2 of the NER sets out the categories under which entities can register to become participants in the market. Some of these categories include classifications that each entity must apply to its units depending on the technical characteristics of that unit and how the entity chooses to participate in the market. Each category also sets out eligibility requirements that entities must meet to register in that category. The relationship between registered participant categories and classifications is explained in Box 2 below.

<sup>77</sup> *National Electricity Law (South Australia) Act 1996*, sections 11 and 12; National Electricity Rules Chapter 2.

Once registered, an entity becomes bound by the obligations in the NER that are specific to that category and classification. In general, the NER assign rights and obligations to participants at their connection point.

#### BOX 2: THE RELATIONSHIP BETWEEN REGISTRATION AND CLASSIFICATION IN THE NEM

To participate in the NEM, people must become registered participants unless eligible for an exemption. The generating equipment or load that is owned, operated or controlled by registered participants, and used to provide services in the NEM, must then be classified based on its size, technical capacity and the services it provides.

Any person engaged in the activity of owning, controlling or operating a generating system in the NEM must be **registered** as a *Generator*. Similarly, any person involved with purchasing electricity through a wholesale market must be **registered** as a *Customer*. This is the case unless the person is eligible for an exemption.

Additionally, *Market Generators* are also required to **register** as *Market Customers* where the electricity consumed by this system is not auxiliary load. AEMO considers this the case for batteries as the energy they consume to charge with is considered a primary input for their operations, and is treated as a market load.

Before officially becoming a registered participant in the NEM, a *Generator* must also **classify** each of its *generating units*. There are three primary types of generator **classifications**:

- scheduled – the *generating unit* participates in *central dispatch*
- non-scheduled – the *generating unit* does not participate in *central dispatch*
- semi-scheduled – the *generating unit* will participate in *central dispatch* in specific circumstances.

Generally, the **classification** of a *generating unit* is determined by its size and technical capacity. All **classifications** are subject to AEMO's approval, which is in turn subject to the satisfaction of various technical and operational requirements.

A *Generator* will also be **classified** as either a *Market* or *Non-Market Generator* depending on whether the electricity it produces will be sold through the *spot market* or used in other commercial processes respectively.

Although any *Market Customer* may request to have any of its *market loads* **classified** as a *scheduled load*, AEMO requires that any battery storage facility **registered** by a *Market Customer* must also be **classified** as a *scheduled load* and thus participate in central dispatch.

Source: AEMO, *Guide to generator exemptions and classifications of generating units*, Available [here](#). Section 11(1)(a) of the NEL. Clauses 2.2.1(c), 2.2.2, 2.2.3, 2.2.7 and 2.3.4(d) of the NER.



### Current registration approach for storage units and hybrid facilities

As discussed in chapter 2, the NER does not define storage technologies and as a consequence there are no specific registration categories and classifications for storage units and hybrid facilities. To clarify how storage units register and participate in the NEM, AEMO has developed the Interim arrangements guidelines.<sup>78</sup>

Based on the requirements of the NER and AEMO's guidelines:

- A participant with a grid-scale storage unit would typically register as both a Market Generator and a Market Customer.<sup>79</sup>
- Participants with hybrid facilities would typically:
  - register as both a Market Generator and Market Customer<sup>80</sup>
  - classify their units according to their technical capabilities.<sup>81</sup>
- All batteries 5MW or above are required to be registered (no batteries over 5MW can apply for an exemption from registration; unlike generating units between 5MW and 30MW which do have the option to apply for an exemption from registration)<sup>82</sup>
- AEMO encourages all batteries above 5MW to apply to have the load and generation components classified as "scheduled".
- Owners / operators of battery systems less than 5MW are automatically exempt from registration in the NEM as these batteries are currently treated as though they are generating units<sup>83</sup> and the load component of these small battery systems are treated as auxiliary load<sup>84</sup>
- As small batteries are considered to be 'small generating units,' the NER does not prevent these from being included in the portfolios of SGAs or other participants registered in a single category (for example a Market Customer), and does not limit the number of these units that may be aggregated or limit the aggregated MW response that can be provided.<sup>85</sup>

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78 AEMO, 2018, *Interim arrangements for utility scale battery technology*. Accessed at: [https://www.aemo.com.au/-/media/Files/Electricity/NEM/Participant\\_Information/New-Participants/Interim-arrangements-for-utility-scale-battery-technology.docx](https://www.aemo.com.au/-/media/Files/Electricity/NEM/Participant_Information/New-Participants/Interim-arrangements-for-utility-scale-battery-technology.docx)

79 AEMO notes on page 9 of its rule change request that in some cases pumped hydro operators have only been registered as a Generator, although consumption by the pumps operates as a scheduled load in dispatch and is historically treated as auxiliary supply.

80 Ibid, pp. 11-12.

81 Ibid, p. 12.

82 AEMO explains on page 9 of its rule change request that a person who owns, operates, or controls a pumped hydro system, which would typically have a nameplate rating of 30MW or more, registers and classifies its generating units as scheduled generating units.

83 AEMO, *Guide to Generator Exemptions and Classification of Generating Units*, January 2020, pp. 7-8. Note that AEMO specifically refers to battery storage facilities in this guide; it does not cover other types of storage technologies.

84 AEMO, *Integrating energy storage systems into the NEM* — rule change request, p. 13.

85 AEMO, *Guide to Generator Exemptions and Classification of Generating Units*, January 2020, pp. 7-8. AEMO, *Integrating energy storage systems into the NEM* - rule change request, p. 13.

### 3.1.2 Registration process issues for storage and hybrid facilities

The Commission seeks your feedback on issues raised by AEMO with the current registration process for storage and hybrid facilities, including the extent of the issues and whether they might become worse in the future.

In AEMO's view the current arrangements for registering storage units and hybrid facilities, may:

- increase administrative costs for AEMO
- increase registration costs (fees and time spent registering) for intending participants with storage units and hybrid facilities
- make the registration process slower, more expensive, complex and uncertain.<sup>86</sup>

In turn, these outcomes may:

- reduce the integrity of the NER
- create barriers to entry
- reduce competition
- create inefficiencies.

If material, all of these issues may increase costs for consumers, contrary to the NEO.<sup>87</sup>

#### Possible issues with registering storage and hybrid facilities

In its rule change request, AEMO argues that it must spend additional time and resources to:

- interpret how the NER should apply to storage units and hybrid facilities
- guide participants and determine how they should register and participate in the market
- adapt its registration process to accommodate these arrangements.<sup>88</sup>

AEMO states that new participants with storage units and hybrid facilities must spend additional time and resources to work with AEMO to understand how the NER might apply to their facilities.<sup>89</sup>

AEMO also indicates it may be more complex and expensive for participants with standalone storage units to register in the NEM than for participants registering a standalone generating unit or load.

Currently, participants with grid-scale storage units (5 MW or larger) must:

- pay for two separate registrations, paying higher fees and charges compared to participants registering a unit in a single category (see Box 3)<sup>90</sup>

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86 AEMO, *Integrating energy storage systems into the NEM* rule change request, pp. 17, 18.

87 Ibid, pp. 17, 54.

88 AEMO, *Integrating energy storage systems into the NEM*, rule change request, pp. 17, 18, 55, 56.

89 Ibid, pp. 17, 19, 20.

90 Ibid, p. 17.

- complete two separate registrations (one for a Market Customer, one for a Market Generator), including providing different power system models and data for the generation and load components of their units.<sup>91</sup>

### BOX 3: COMPARING REGISTRATION FEES

Intending participants with storage units larger than 5 MW typically register as a Market Customer and Market Generator under the current framework. This means they must also pay fees for two separate registrations (one as a *Generator* and one as a *Customer*). This may make the registration fees more expensive for participants with a standalone storage unit than for a participant registering a load or standalone storage unit.

For example, under AEMO's 2019-20 registration fees, it would cost:

1. \$23,000 to register a power plant as a *Market Generator* with a *scheduled generating unit*
2. \$11,000 to register a factory as a *Market Customer* with a *scheduled load*
3. \$34,000 to register a standalone storage unit (in both of these categories and classifications).

Source: AEMO, *Electricity market revenue requirement and fees: 2019-20*, 21 February 2020, Table 2: "AEMO Schedule of Registration Fees 2019-20", p. 2. Accessed [here](#).

AEMO notes that the guidelines it has prepared to assist participants to register their facilities are an interim measure until changes to the NER can be made.<sup>92</sup>

AEMO argues that these guides do not resolve the fundamental issues with the registration process and the challenges AEMO is having interpreting the NER.<sup>93</sup>

Further, AEMO states that it must still work extensively with applicants "almost on a case-by-case basis" to determine how the NER should apply to hybrid facilities:<sup>94</sup>

While AEMO and proponents have generally been able to resolve application issues to date, the increasing number and diversity of 'hybrid' facilities means it is desirable to improve the clarity of the NER, and the associated procedures and systems, to explicitly recognise 'hybrid' facilities.<sup>95</sup>

#### **Particular difficulties for registering hybrid facilities**

Participants must seek AEMO's approval to aggregate units for dispatch when they apply for registration under Chapter 2 of the NER, or, alternatively, under Chapter 3 of the NER if seeking to aggregate units after they have been registered.<sup>96</sup>

91 See AEMO, *Application Guide for Registration as a Customer in the NEM*, 2020, version 1; and AEMO, *NEM Generator Registration Guide*, 3 June 2019, version 1.1.

92 AEMO, 2018, *Interim arrangements for utility scale battery technology*, p. 1.

93 AEMO, *Integrating energy storage systems into the NEM*, rule change request, p. 17.

94 AEMO, *Integrating energy storage systems into the NEM* rule change request, p. 18.

95 *Ibid*, p. 18.

96 Aggregation issues are further discussed in chapter 4 of this consultation paper.

In discussions with the Commission, AEMO has noted that the NER do not clearly indicate how participants can aggregate different types of units for dispatch.<sup>97</sup> AEMO considers that the NER allow units of the same classification to aggregate, but would not allow participants to aggregate units that are classified differently, stating:

NER clause 3.8.3 does not allow a registered participant to aggregate generating units, scheduled loads and scheduled network services with each other, e.g. a scheduled generating unit and scheduled load cannot be aggregated.<sup>98</sup>

AEMO explicitly prohibits participants from aggregating different technology types through its guidelines and procedures.<sup>99</sup> This means that, under the current framework, participants can aggregate:

- generating units with identical or very similar technological profiles (such as a group of identical or nearly identical wind turbines)
- scheduled loads with other scheduled loads.

However, they cannot aggregate:

- generating units with scheduled loads
- dissimilar generating units (such as wind turbines with gas turbines).

In order to assess the rule change request, the Commission is interested to understand why participants are interested in aggregating different technologies within a hybrid facility.

#### QUESTION 7: UNDERSTANDING THE INTEREST IN REGISTERING HYBRID FACILITIES AND THE CHALLENGES THAT EXIST

1. Why would you consider aggregating different technologies together in a hybrid facility? Which technologies do new participants propose to combine in hybrid facilities?
2. Are you considering using storage to minimise causer-pays liabilities by balancing the output of your units across multiple connection points under the current NER? What are the challenges of this approach?
3. Would you prefer to balance output and consumption across multiple connection points or combine technologies behind an individual connection point?
4. Are you considering aggregating renewable plant and batteries together as a scheduled generating unit under the current rules? What regulatory challenges do you see with this approach?
5. Do you consider that the lack of clarity in the NER on whether different technologies can be aggregated is a significant issue for registering hybrid facilities? If so, why?

<sup>97</sup> Discussions between AEMO and the Commission after submission of the rule change request.

<sup>98</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 10.

<sup>99</sup> See: AEMO, *Power system model guidelines*, final, version 1.0, 29 June 2018, section 4.7, p. 27. Accessed [here](#).

### Interpretation issues and regulatory risks for AEMO in the registration process

As discussed above, because the NER do not fully consider storage and hybrids, AEMO claims it is interpreting and applying the NER for technologies and situations they were never intended for. AEMO argues that:

- to apply the rules to storage, it must create artificial arrangements that do not clearly represent the physical characteristics of these assets and how they connect to the system
- interpreting how rules apply to arrangements they were never intended for exposes AEMO to a higher level of regulatory risk.

AEMO identifies that this situation may create regulatory risks because AEMO, rather than the NER, must determine how rights and obligations apply to certain technology types.<sup>100</sup>

### Current extent of issues and future impacts

As discussed in chapter 2, AEMO expects the number of battery units and hybrid facilities in the NEM to significantly increase, and is concerned that the current registration issues could also worsen.<sup>101</sup>

The Commission seeks your feedback on issues with the registration process for storage and hybrid facilities, including the current extent of these issues, their possible impacts in the future, and whether AEMO has identified all relevant issues.

#### QUESTION 8: REGISTRATION PROCESS ISSUES

1. What are your experiences with the current registration categories for storage projects and hybrid facilities?
2. Do you agree the existing approach imposes high administrative and financial costs for participants registering storage units and hybrid facilities or create barriers to entry?
3. Do you consider that the NER should set out how participants with storage units and hybrid facilities should register and participate in the market, rather than AEMO guides? Or have AEMO's guides and fact sheets now solved the identified registration issues for storage and hybrid facilities?
4. Do you consider the registration issues AEMO has raised in its rule change request will become worse in the future if the current NER are retained?
5. Are there other registration issues for intending participants with storage and hybrid facilities that arise from the fact that the NER do not fully consider these technologies, which are not detailed in AEMO's rule change?

<sup>100</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, pp. 5, 18, 56.

<sup>101</sup> *Ibid* pp. 2, 4, 56.

### 3.1.3 Issues with exempt storage units

AEMO's rule change request suggests that greater clarity is needed in the NER in relation to whether SGAs can include exempt batteries in their portfolios.

#### What is an SGA?

Chapter 2 of the NER allows entities to register as SGAs.<sup>102</sup> An SGA is a registered participant category that can classify small generating units as market generating units and use them to generate and sell electricity directly to the market. An SGA receives the spot price for all sent out electricity at each of its connection points and must purchase all electricity supplied to those connection points.<sup>103</sup>

The SGA framework in the NER allows the owners of small generating units the option to sell their electricity through an SGA instead of a Market Customer (i.e. a retailer). By doing this, the SGA framework is intended to reduce barriers to entry for small generating units and encourage them to participate in the market.<sup>104</sup>

AEMO has fielded numerous enquiries, as part of its ongoing virtual power plant (VPP) demonstration trial, from organisations seeking to register VPP projects utilising the SGA framework. AEMO considers a VPP to broadly refer to an aggregation of resources, such as decentralised storage, generation and controllable loads, coordinated to deliver services for power system operations and electricity markets.<sup>105</sup>

#### What are the issues AEMO raises in relation to classifications of exempt batteries by SGAs?

As discussed in section 3.1.1, under the current framework owners/operators of battery storage units that are less than 5 MW nameplate capacity are exempt from the requirement to register with AEMO, and these small storage units are considered to be 'small generating units.' AEMO's rule change request states that the NER do not prohibit small storage units from being classified by SGAs, which allows for them to be included in SGA portfolios. However, in its rule change request, AEMO have provided for it to be clarified in the NER that this is allowed. This is discussed below in section 3.2.4.

AEMO also notes in its rule change request that it has no oversight of these small storage units<sup>106</sup> and they would effectively act as 'non-scheduled' generators.<sup>107</sup> Similarly, the current NER may also allow a participant registered in a single category (as either a Market Customer or a Market Generator) to include small storage units within its portfolio, which could involve a very large set of storage units that AEMO would not have oversight of in dispatch and scheduling<sup>108</sup>

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102 NER clause 2.3A.1.

103 NER clause 2.3A.1(h).

104 For more information on the design of the SGA framework see [here](#).

105 For more information on AEMO's ongoing VPP trials see [here](#).

106 However, SGAs are required to classify these small units as market generating units under clause 2.3A.1.

107 AEMO, *Integrating energy storage systems into the NEM* - rule change request, p. 13.

108 This is because the SGA is not required to be scheduled.

The Commission notes that AEMO may lack oversight of how small generating units participate in the market, not just small storage units. However, AEMO does have more oversight of batteries compared to other generating units between 5MW and 30MW. This is because, while the default classification for generating units in this range is non-scheduled, AEMO's guidelines encourage batteries of this size to apply to be scheduled. The issue of AEMO's oversight of small generating units is currently being explored in other policy processes, including the *Generator registration thresholds* rule change request, and the ESB's post-2025 market design work on moving to a two-sided market.

AEMO also discusses the implications of the SGA and other market participants including exempt storage units in their portfolios in relation to the recovery of non-energy costs. The issue of non-energy cost recovery is considered in chapter 5 of this consultation paper.

#### QUESTION 9: ISSUES WITH SMALL STORAGE UNITS

1. Do you agree that there is not sufficient clarity regarding whether SGAs and other market participants, can include small storage units in their portfolios?

## 3.2 AEMO's proposed solution

The Commission seeks your feedback on AEMO's proposed solution to the issues it has identified in the registration process, which consists of creating a new registered participant category and classification and assigning these rights and obligations throughout the NER.

AEMO states that its proposed rule would:

Improve regulatory certainty, operational efficiency and reduce the associated costs by:

- Clarifying how an ESS and 'hybrid' facilities are to register and participate in the NEM.
- Clarifying the regulatory arrangements and obligations relevant to an ESS and 'hybrid' facilities. This would facilitate streamlining the NEM registration, dispatch and operational processes for ESS and 'hybrid' arrangements (combinations of ESS, generating systems and load).<sup>109</sup>

This section:

- summarises the changes that AEMO's proposed rule would make to the existing registration and classification framework
- outlines how owners/ operators of storage units, hybrid facilities and pumped hydroelectric facilities would typically register and classify their units under the proposed rule
- seeks your feedback on the proposed solutions.

<sup>109</sup> Ibid, p. 56.

### 3.2.1

#### AEMO’s proposed solution for storage units and hybrid facilities

AEMO proposes to amend the NER to create a new registered participant category (a bi-directional resource provider) and unit classification (a bi-directional unit).

AEMO’s proposed rule would also amend the NER to clarify:

- that SGAs can aggregate small storage units within their portfolio, and
- the aggregation rules that would apply to participants seeking to register hybrid facilities.

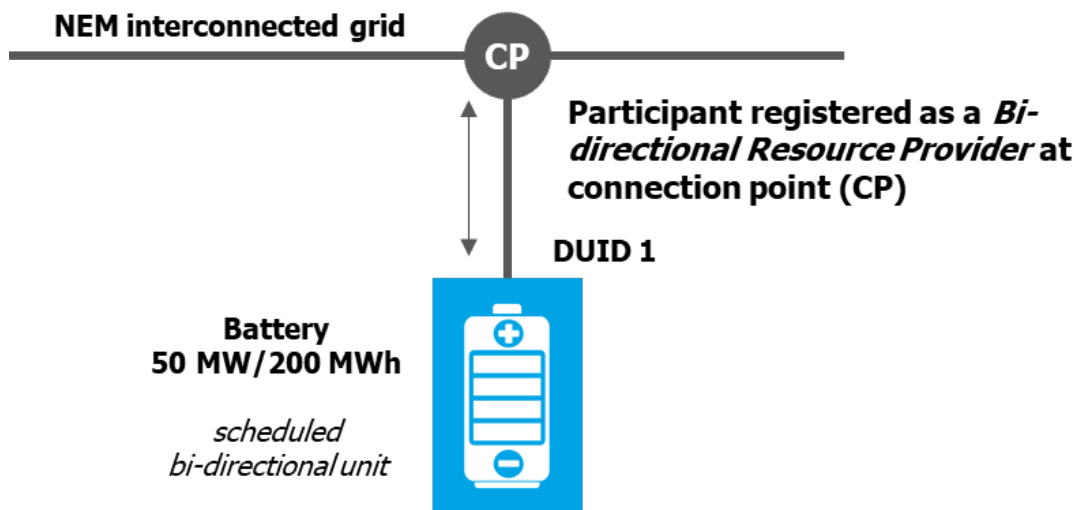
**How standalone storage units would typically register and classify under the proposed rule**

Under AEMO’s proposed rule, a proponent of a standalone storage unit would seek to:

- register as a scheduled bi-directional resource provider, a type of market participant
- have each storage unit classified as a scheduled bi-directional unit.<sup>110</sup>

This is shown in Figure 3.1.

**Figure 3.1:** How owners/ operators of standalone storage units larger than 5 MW would typically register under the proposed rule



Source: AEMC diagram based on AEMO, *Integrating energy storage systems into the NEM - rule change request*, pp. 26-28, 63.

**How hybrid facilities would typically register and classify under the proposed rule**

AEMO’s proposed rule would create a participant category specifically for situations where a participant controls multiple technologies behind a single connection point in a hybrid facility. Generally, AEMO’s proposed rule would set obligations for bi-directional resource providers by asset, as if there was a connection point at the level of each unit in a hybrid facility. This

<sup>110</sup> AEMO, *Integrating energy storage systems into the NEM rule change request*, pp. 26-28, 63.



approach would effectively change where the NER apply obligations for participants if they control multiple technologies behind a single connection point.

Under AEMO's proposed rule, a participant intending to connect a combination of storage units, scheduled generating units, semi-scheduled generating units and/or loads would register as a Scheduled bi-directional resource provider, a type of market participant, and classify:

- each storage unit as a scheduled bi-directional unit.
- each generating unit that meets the criteria to be scheduled as a scheduled generating unit
- each generating unit that meets the criteria to be semi-scheduled as a semi-scheduled generating unit
- any loads that it wishes to be scheduled as a scheduled load.<sup>111</sup>

A bi-directional resource provider would separately dispatch each scheduled bi-directional unit, scheduled generating unit, semi-scheduled generating unit and scheduled load.<sup>112</sup>

AEMO's proposed rule drafting shows how it would set these obligations:

#### 2.2A.2 Scheduled bi-directional resource provider

- (f) *A bi-directional resource provider is taken to be:*
- (1) *a Scheduled bi-directional resource provider only in so far as its activities relate to a scheduled bi-directional unit or a scheduled load that is part of a bi-directional facility;*
  - (2) *a Scheduled Generator only in respect of a scheduled generating unit that is part of a bi-directional facility; and*
  - (3) *a Semi-Scheduled Generator only in respect of a semi-scheduled generating unit that is part of a bi-directional facility.*<sup>113</sup>

The summary of AEMO's proposed rule in appendix b of this consultation paper provides additional information about the proposed participant category including the possible asset combinations that the bi-directional facility could accommodate.

Figure 3.2 illustrates how a hypothetical hybrid facility would register under AEMO's proposed rule. In this example, a participant has combined a grid-scale battery with a wind farm, gas power plant and a large factory behind a single connection point. Under AEMO's proposed rule, the participant would register as a bi-directional resource provider. It would classify the battery as a scheduled bi-directional unit, as it is a storage unit larger than 5 MW nameplate capacity that can ramp linearly between charge and discharge. In this example, it has aggregated a set of wind turbines together into a single *semi-scheduled generating unit* with

<sup>111</sup> Ibid, pp. 30, 49, 63.

<sup>112</sup> Ibid, p. 63.

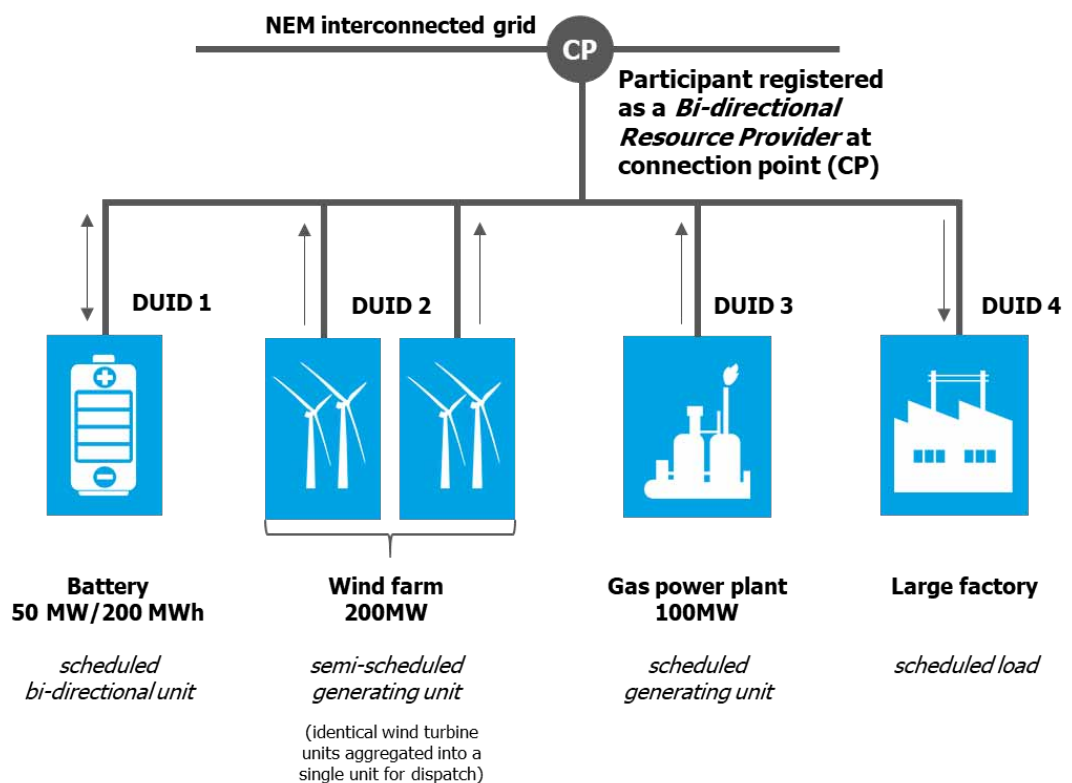
<sup>113</sup> AEMO, *Integrating energy storage systems into the NEM*, marked-up proposed rule, clause 2.2A.2. Note that AEMO's proposed markup for 2.2A.2 contains two clauses marked 'f'. If implemented, the above rule would become

a 200MW nameplate capacity. It would classify the gas power plant as a *scheduled generating unit*. In this example, the participant has also chosen to classify its load as a *scheduled load*.

As shown in Figure 3.2, for each dispatch interval, the participant would provide:

- one dispatch bid for its battery (DUID 1)
- one dispatch bid for its wind farm (DUID 2)
- one dispatch bid for its gas power plant (DUID 3)
- one dispatch bid for its large factory (DUID 4).

**Figure 3.2:** Example of how a hybrid facility would typically register and classify under AEMO’s proposed rule



Source: AEMC diagram based on AEMO, *Integrating energy storage systems into the NEM - rule change request*, pp. 26-28, 63

AEMO’s solution for clarifying the aggregation rules that would apply to hybrid facilities.

AEMO proposes to amend clause 3.8.3(b) of the NER to clarify that participants can aggregate generating units if they:

- have the same classification

- have the same technology type and similar energy conversion models.<sup>114</sup>

In its rule change request, AEMO explains that existing NER clause 3.8.3(c) would still allow AEMO to approve an application for aggregation if these conditions are not met (e.g. allowing aggregation of different technology types), provided such an aggregation would not materially distort central dispatch.<sup>115</sup>

AEMO says improving certainty in the NER regarding permitted forms of aggregation would help improve the regulatory process, improving certainty, operational efficiency and reducing associated registration costs.<sup>116</sup>

The Commission is interested in stakeholder views on whether it is necessary to amend the NER to allow participants to aggregate different technologies for dispatch to address the issues that AEMO has identified.

The Commission also notes that, under NER clause 3.8.3, participants may currently be able to aggregate different technologies so long as they have the same classification.<sup>117</sup> For example, a participant with a renewable power plant and a co-located battery could potentially combine both units together as a single unit for dispatch if it registers as a Market Generator (and Market Customer) and classifies both units as *scheduled generating units*. Participants would need to demonstrate that these units would not materially affect power system security and that their control systems satisfy the rules.<sup>118</sup> However, the NER do not currently allow participants to combine generating units with loads.

If the primary reason proponents are looking to aggregate different technologies behind the connection point is to minimise causer pay liabilities, the Commission notes that this may be possible without aggregation. This is because the *Regulation FCAS Contribution Factors Procedure* states that causer pays factors are aggregated across a registered participant's portfolio.<sup>119</sup> This suggests that it may be possible for participants to use storage to balance the output of nearby generating units under the current framework across multiple connection points. If this is possible, it may not be necessary to amend the NER to enable some benefits from combining different technologies that stakeholders have identified.

In this context it is also noted, that while participants could potentially minimise causer-pays liabilities by balancing their output across all their connection points, it is not clear whether this is feasible, viable or would cause unintended consequences for the system. For example, to balance and 'firm' the output of a solar farm, an adjacent battery would need to deviate from its dispatch target, and deviating from a dispatch target is generally not a desired outcome under the current framework.

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114 Ibid, p. 34; p. 102 of AEMO's markup of the NER showing its proposed rule.

115 Ibid, pp. 23, 34.

116 Ibid, p. 56.

117 NER clause 3.8.3.

118 NER clauses 3.8.3(b)(3) and (4).

119 *Regulation FCAS Contribution Factor Procedure: determination of contribution factors for regulation FCAS cost recovery*, version 6.0, 2 December 2018, pp. 19-20. Accessed [here](#).

While we note there may be interest in aggregating different technologies together, AEMO's approach for considering such requests on a case by case basis is likely to be appropriate, given that it may be necessary to clarify in each case whether the proposed aggregation:

- is technically possible and feasible
- poses risks to security and reliability, and whether these risks can be appropriately managed
- provides benefits to participants or the system, and could reduce costs in the long-term interests of consumer.

**QUESTION 10: PROPOSED APPROACH TO REGISTRATION CATEGORIES AND CLASSIFICATIONS**

1. Do you consider that AEMO's proposed solution will make the registration process simpler and less expensive for intending participants seeking to classify storage units and hybrid facilities?
2. In relation to the registration of hybrid facilities, do you agree that the NER should provide that participants cannot aggregate units with different classifications or different technology types (unless AEMO approves it on a case-by-case basis)?

### 3.2.2

#### How pumped hydro facilities would register

Some storage units like certain types of pumped hydroelectric facilities may classify differently to other storage facilities under AEMO's proposed rule. AEMO proposes its bi-directional unit definition to be 'technology neutral' so it can encompass different storage technologies, including "pumped hydro, batteries, flywheels."<sup>120</sup>

However, AEMO also states that a storage unit "without the ability to transition linearly from production to consumption, meaning it cannot submit a single dispatch bid" would classify as both a load and generating unit under its proposed rule (as under the current rules).<sup>121</sup> Storage units that cannot transition linearly from production to consumption could include some types of pumped hydro units, particularly those that use a combined pump and turbine. These units need to pause and allow water pressure to drop before they can transition between generation and consumption.

For example, under the proposed rule, a participant with a pumped hydro plant would register as a bi-directional resource provider and either classify:

- its pumped hydro plant as a bi-directional unit (if the unit can transition linearly between production and consumption)
- the plant as a scheduled load and scheduled generating unit (if the plant cannot transition linearly between production and consumption).<sup>122</sup>

<sup>120</sup> Ibid, pp. 26, 63.

<sup>121</sup> Ibid, p. 26.

<sup>122</sup> Ibid, pp. 26, 30, 63.

#### QUESTION 11: REGISTERING PUMPED HYDRO FACILITIES

1. Do you support AEMO's proposed approach to registration and classification for pumped hydro facilities?
2. Is a storage unit's ability to ramp linearly from production to consumption the best way to determine whether it should classify as a bi-directional unit, or classify as a scheduled generating unit and scheduled load?

### 3.2.3

#### Transitional arrangements

AEMO's proposed solution would not require existing storage operators to re-register their facilities under the proposed category.<sup>123</sup> A key consideration then is whether the proposed rule would still address AEMO's identified issues and make market operations simpler if participants who are currently connected to the grid continue under the current arrangements.

In responses to AEMO's 2018 Emerging Generation and Energy Storage (EGES) stakeholder paper, stakeholders including Origin Energy, Edify Energy and Tesla indicated support for flexibility in how AEMO's proposed rule would apply to existing participants.<sup>124</sup>

#### QUESTION 12: PROPOSED APPROACH FOR TRANSITIONAL ARRANGEMENTS

1. Would participants with storage that are currently registered as a Market Generator and Market Customer want to transition to AEMO's new category and classification? If so, what advantages would it offer?
2. Should owners/operators of existing standalone storage units be grandfathered, i.e. permitted to remain on their current registration and classification arrangements?

### 3.2.4

#### How AEMO proposes to clarify what small units SGAs can aggregate

In its rule change request, AEMO states that it would provide exemptions from registration for owners/operators of bi-directional units in the same way as for generating systems under the current NER.<sup>125</sup> Under AEMO's proposed rule, if a bi-directional unit is owned, controlled or operated by a person that has been exempted from the requirement to register as a bi-directional resource provider it can be treated as a 'small bi-directional unit'.<sup>126</sup> The proposed rule would amend clause 2.3A.1 of the NER to establish that an SGA would be allowed to classify a 'small bi-directional unit' as a 'market bi-directional unit'. The proposed rule would

<sup>123</sup> Ibid, p. 57.

<sup>124</sup> Submissions to AEMO's *Emerging Generation and Energy Storage in the NEM November 2018 Stakeholder Paper*, Origin Energy, p.1; Edify Energy, p. 4; Tesla, p. 4.

<sup>125</sup> AEMO, Integrating energy storage systems into the NEM - rule change request, p. 26.

<sup>126</sup> AEMO, *Integrating energy storage systems into the NEM* - proposed rule, definition of "small bi-directional unit", NER chapter 10.

also amend the NER to clarify that an SGA's activities in the market include selling sent out electricity or purchasing consumed electricity.<sup>127</sup>

Essentially, AEMO's proposed rule would amend the NER to:

- allow AEMO to exempt owners/operators of bi-directional units from registration (as they can under the current NER in relation to generation)
- clarify that an SGA can classify these small storage units to provide energy services (which AEMO considers SGAs can already do under the current NER).

**QUESTION 13: AEMO'S SOLUTION TO CLARIFY WHAT SMALL UNITS SGAS CAN AGGREGATE**

1. Do you agree with AEMO's proposal to clarify how an SGA can include storage units in its portfolio?
2. Does AEMO's solution provide flexibility for an SGA to include DER, other than storage, that may have bi-directional energy flows?

## 3.3 Alternative solutions

The Commission also seeks feedback on possible alternatives to AEMO's proposal to create a new participant category to accommodate storage.

### 3.3.1 Changing registered participant categories

#### Adding more registered participant categories

The Commission seeks feedback about whether the number of registered participant categories is making the NER unclear and becoming an issue for participants, and whether stakeholders consider that AEMO's proposed rule would contribute to this issue.

Previous rule changes have amended the NER to accommodate new technologies and services by adding new registered participant categories. For example:

- The National Electricity Amendment (Central Dispatch and Integration of Wind and Other Intermittent Generation) Rule 2008 added the *semi-scheduled generator* classification to accommodate variable renewable generators that cannot participate in dispatch.<sup>128</sup>
- Several rule changes introduced new registered participant categories for metering activities, including:

<sup>127</sup> AEMO, Integrating energy storage systems into the NEM - rule change request, p. 32.

<sup>128</sup> AEMC, *Central Dispatch and Integration of Wind and Other Intermittent Generation*, final determination, 1 May 2008. Available [here](#).

- The National Electricity Amendment (Provision of Metering Data Services and Clarification of Existing Metrology Requirements) Rule 2010 introduced the Metering Data Provider category, replacing the existing Metering Data Agents category.<sup>129</sup>
- The National Electricity Amendment (Expanding competition in metering and related services) Rule 2015 No. 12 introduced a new category of market participant called the Metering Coordinator, responsible for the day-to-day operations (i.e. provision, installation and maintenance of a metering installation) and coordination and engagement of the Metering Provider and Metering Data Provider.<sup>130</sup>
- The National Electricity Amendment (Wholesale demand response mechanism) Rule 2020 introduces a new market participant category, a demand response service provider, and unit classification, a wholesale demand response unit, to allow loads to participate in the new wholesale demand response mechanism.<sup>131</sup> This category takes over an existing (but still relatively new) category, the market ancillary service provider (MASP), which was introduced through the National Electricity Amendment (Demand Response Mechanism and Ancillary Services Unbundling) Rule 2016.<sup>132</sup>

Other new rule change requests also propose changes to the registered participant framework to accommodate new technologies and services. For example, two of the six 'system services' rule change requests currently under consideration propose new classifications and categories:

- Hydro Tasmania's *Synchronous Services Markets (including inertia)* proposed rule would create a new participant category, a 'synchronous service generator', to distinguish units that provide inertia as part of their operations.<sup>133</sup>
- Delta Electricity's *Capacity commitment mechanism for system security and reliability services* proposed rule would introduce a new unit classification for generators, a 'Capacity Commitment Generating Unit', for generating units that provide inertia system strength and other system services.<sup>134</sup>

While adding new registered participant categories to accommodate new technologies has worked in the past, this approach may not be sustainable as system complexity and regulatory complexity increase with each new category added. This is being considered by the ESB in its post-2025 market design work on moving to a two-sided market (discussed further below).

<sup>129</sup> AEMC, *Provision of Metering Data Services and Clarification of Existing Metrology Requirements*, final determination, 25 November 2010. Available [here](#).

<sup>130</sup> AEMC, *Expanding competition in metering and related services*, final determination, 26 November 2015. Available [here](#).

<sup>131</sup> AEMC, *Wholesale demand response mechanism*, final determination, 11 June 2020. Available [here](#).

<sup>132</sup> AEMC, *Demand Response Mechanism and Ancillary Services Unbundling*, final determination, 24 November 2016. Available [here](#).

<sup>133</sup> Hydro Tasmania, *Synchronous Services Markets (including inertia)*, rule change request, 17 September 2019. Available [here](#).

<sup>134</sup> Delta Electricity, *Capacity Commitment Mechanism for Operational Reserve and Other System Security Services*, rule change request, 4 June 2020. Available [here](#).

#### **QUESTION 14: ADDING FURTHER REGISTERED PARTICIPANT CATEGORIES**

Is there a strong case to add a participant category for storage or are there other alternative solutions that could help to reduce complexity?

#### **Streamlining the NER and setting obligations by service**

Given the ESB is exploring a two-sided market as part of the post-2025 package of reforms, it may be necessary to consider if AEMO's rule change request is a worthwhile interim step before the broader changes for a two-sided market are implemented, and when these reforms might occur.

As discussed in chapter 2, the ESB's two-sided market design is exploring streamlining the existing registered participant framework, and collapsing the participant categories into a trader and services model. Under this model, the NER would set obligations based on the services that a participant provides at the connection point. This could eliminate the need to define technology types in the NER.

If the reforms are not on the path to a 2SM, then in order to be justified, the case would need to be made that the reforms are needed in the short term and the benefits outweigh the costs of an interim solution.

We are interested in stakeholder feedback on what the benefits of a short term solution would be. Benefits of implementing an interim solution could include:

- a quicker implementation timeframe
- a faster way to address major issues for storage and hybrid facilities.

The costs of implementing an interim solution may include:

- more effort overall for both regulators and participants
- greater costs for AEMO and participants, who may need to adapt their systems and processes to accommodate two major changes rather than just one.

#### **Other options for addressing the issues that do not involve a new participant category**

It may be possible to address the issues for storage and hybrid facilities without a new participant category. AEMO considered in its EGES initiative an option that would involve amending the existing participant categories rather than creating a new one. This is set out in Box 4 below.



#### BOX 4: OPTIONS OUTLINED IN AEMO'S 2018 EGES STAKEHOLDER PAPER

AEMO considered three different options to integrate storage units and hybrid facilities into the NER in its 2018 *EGES* stakeholder paper.

- **Option 1:** create a new registered participant category only for storage units
- **Option 2a:** create a new bi-directional resource provider category that allows a person to register a hybrid system, including grid-scale storage, generation, or load
- **Option 2b:** amend the existing Generator or Customer category to include a classification for energy storage.

Source: AEMO, *Emerging Generation and Energy Storage in the NEM stakeholder paper*, 5 November 2018, pp. 20-25.

Note: Further details are in AEMO's EGES paper, available [here](#).

We understand that the stakeholder feedback that AEMO received in response to those options, indicated that option 2a was preferred because it would allow participants to combine storage with other assets and operate all units as a single aggregated system.<sup>135</sup> Conversely, stakeholder responses did not support option 2b because it would prevent participants from doing this.<sup>136</sup> Interestingly, while AEMO's proposed rule change does provide AEMO discretion to allow the aggregation of different technologies within a hybrid facility it is not clear whether this would be feasible. AEMO states that its systems "do not currently support aggregation of different resource types".<sup>137</sup> It is noted that there would be costs involved in making the system upgrades and the benefits to the market and consumers would need to outweigh any increased costs.

Therefore, given that a single dispatch model for hybrids is currently not available, the Commission is interested in whether stakeholders would still be in favour of creating a new participant category for storage, or whether those stakeholders would prefer to amend the existing participant categories instead.

#### QUESTION 15: ALTERNATIVE SOLUTIONS FOR REGISTERED PARTICIPANT CATEGORIES

1. Is AEMO's proposed rule the most efficient and effective way to address the identified issues relating to participant registration and unit classification? Are there alternatives or ways to potentially improve it?

<sup>135</sup> Submissions to AEMO's *Emerging Generation and Energy Storage in the NEM November 2018 Stakeholder Paper*, GE Grid Solutions, p.4; Tesla, p. 4.

<sup>136</sup> Ibid.

<sup>137</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 12.

## 4 TECHNICAL AND OPERATIONAL CHALLENGES RELATING TO UTILITY SCALE STORAGE AND HYBRID FACILITIES

This chapter seeks feedback on the technical and operational issues relating to storage and hybrid facilities highlighted by AEMO in its rule change request, and feedback on AEMO's proposed solution to these issues. It also asks whether there are any other technical and operational issues arising from the integration of storage, and for other potential solutions to these issues.

In its rule change request, AEMO identifies issues relating to:

- dispatch participation issues for scheduled storage facilities, including calculating ramp rates for aggregated units and scheduled storage facilities
- operational forecasting for new technologies like storage and hybrids, including assessing energy availability in storage units
- determining performance standards.

This chapter explores these issues and sets out questions for stakeholders.

### 4.1 Participation in central dispatch

#### 4.1.1 How storage and hybrids currently participate in central dispatch

Under the current arrangements, scheduled participants are required to participate in the central dispatch process operated by AEMO. These participants include:

- Market Generators with scheduled and semi-scheduled generating units
- Market Customers with scheduled loads
- scheduled network service providers
- providers of FCAS.

Each scheduled participant has a unique DUID.

Generators submit 'offers' and scheduled loads submit 'bids' to AEMO. These offers and bids specify the quantities at which each participant is willing to supply or consume electricity at nominated prices.

AEMO runs central dispatch through the NEM Dispatch Engine (NEMDE). NEMDE optimises the bids and offers provided by market participants to determine a 'least-cost' dispatch for energy and ancillary services accounting for technical constraints.<sup>138</sup> AEMO dispatches participants every five minutes to balance the supply and demand of the electricity market in real-time. The participants that receive dispatch targets are required to comply with these targets.<sup>139</sup>

<sup>138</sup> Clause 3.8.1 of the NER.

<sup>139</sup> For semi-scheduled generators, compliance with dispatch targets constitutes generating at any level up to a binding maximum level of generation in instances where AEMO also issues a dispatch cap.

### Storage units

As discussed in section 3.1.1, a participant with a stand-alone scheduled storage facility would need to register as both:

- a Market Generator, and classify the export component of the storage as a scheduled generator
- a Market Customer, and classify the import component of the storage as a scheduled load.

The operator of the storage facility would then participate in central dispatch by providing both an offer to generate electricity (from the export component of the storage) and a bid to consume electricity (from the import component).

In comparison, standalone scheduled generators only need to bid generation (even if they have auxiliary load) and standalone scheduled loads only need to bid load (even if they also have generation).

Scheduled storage facilities participating in central dispatch must provide two separate energy and FCAS offers, one for generation and one for load. For each offer, it would set out 10 price-quantity pairs. This means the operator of a scheduled battery, for example, is able to bid its quantity into 10 price bands to consume energy and 10 price bands to generate energy.

### Hybrid facilities

As discussed in chapter 3, participants with hybrid facilities would need to register similarly to stand-alone scheduled storage facilities (that is, as both a Market Generator and Market Customer) as well as classifying the other assets bundled into the hybrid facility. For example, if the hybrid facility comprised storage and utility-scale solar PV, the solar PV would be classified as a semi-scheduled generating unit.

When a hybrid facility is participating in central dispatch, it would need to submit separate offers for each of its generating units (e.g. one offer for a wind farm unit, another for the generation component of a scheduled storage unit, etc.) and submit separate bids for each of its scheduled loads (e.g. one bid for the load component of a scheduled storage unit, etc.).

### Ramp rates

Ramp rate limits maintain the dispatch targets issued to generators within their technical limits so the operation of the power system stays within its secure operating limits. Generators are limited in how quickly they can change the level of output. These limitations need to be reflected in the security constrained optimisation run by NEMDE to make sure generators are not set dispatch targets beyond their technical capability.

The NER also set out minimum ramp rate requirements.<sup>140</sup> Minimum ramp rates seek to reduce the risk of scheduled participants changing their ramp rates to take advantage of

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<sup>140</sup> Clause 3.8.3A of the NER.

market conditions. For example, minimum ramp rates prevent a generator using ramp rates to not reduce output under high priced market conditions.

Minimum ramp rates are for scheduled:

- generating units, the lower of three per cent of maximum capacity or 3 MW per minute
- generating units that are aggregated, the lower of three per cent of maximum capacity or 3 MW per minute applied to individual physical units, then summed
- network services and scheduled loads, 3 MW per minute
- network services and scheduled loads that are aggregated, 3MW per minute applied to individual network services and individual loads, then summed.

#### 4.1.2

#### **AEMO proposes changes to address the issues it has identified**

In its rule change request, AEMO notes it considers the current approach to accommodating scheduled storage facilities in dispatch is problematic.

It considers there is increased operational complexity and inefficiency involved in treating a single asset as two components. In particular, AEMO considers it is problematic to require a Registered Participant with a scheduled storage facility (which has two DUIDs, one for load and one for generation) to submit separate.<sup>141</sup>

- energy bids and offers for the scheduled load and scheduled generating unit, which could result in simultaneous dispatch of the load and generation.
- FCAS offers for the ancillary service load and ancillary service generating unit (the combined offers need to reflect the overall capacity to move from load to generation and vice versa).

AEMO argues that this makes participation more complex, expensive, and risky for scheduled storage units (compared to other asset types), which could create barriers to entry and impact on efficient investment and operation.<sup>142</sup>

In its rule change request, AEMO highlights some issues relating to minimum ramp rates. AEMO notes that different aggregation methods can result in different minimum ramp rates calculated for semi-scheduled generating units and bi-directional units.<sup>143</sup>

AEMO's rule change request proposes the introduction of a bi-directional resource provider and indicates how that new participant would participate in central dispatch. Under the proposal, scheduled storage assets would participate in central dispatch as a single asset with one DUID.<sup>144</sup>

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141 AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 17.

142 Ibid, pp. 17, 18, 27.

143 AEMO provides an example of how the aggregation methods could lead to different minimum ramp rates under the current arrangements on p. 22 of its rule change request. AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 22.

144 However, AEMO notes that if a scheduled storage asset is unable to participate as a single DUID due to technical constraints, it would instead need to participate as a scheduled load and scheduled generating unit, i.e. the approach under the current arrangements. AEMO notes that this might be the case for pumped hydro with operating dead bands.

AEMO considers there should be one aggregation approach for semi-scheduled generating units and storage systems, reflecting the process in clause 3.8.3 of the NER. This clause also requires AEMO to approve aggregation of generating units if certain conditions are met. AEMO notes that the NER were not drafted with a view to 'hybrid' configurations, including for different technology types (e.g. a solar farm and wind farm). As such, participation in dispatch as an aggregated generating unit (i.e. with one DUID) may not always be possible depending on the technology type. AEMO considers it is appropriate for the NER to allow AEMO the discretion to consider whether different technology types can be aggregated.<sup>145</sup>

In its view, AEMO's proposal would be to give greater flexibility for it to consider different technology types and classifications to be aggregated within a 'hybrid' facility, which it could do if there is no adverse impact on central dispatch.

In its rule change request, AEMO considers that a single dispatch model and bidding for scheduled storage would reduce the set-up and ongoing operational costs of participating in central dispatch. Scheduled storage operators would set up and operate a less complicated bidding and dispatch system when compared to managing two dispatch bids, two dispatch instructions and incurring costs associated with managing any conflicts.

The proposal would also set out ramp rate requirements that are applicable to a scheduled bi-directional unit, including requiring the ramp rate for each unit be the lower of 3MW/minute or 3 per cent of the maximum produced electricity or consumed electricity (for a bi-directional unit).

AEMO considers there is no longer a rationale to apply a 6 MW maximum threshold to the aggregation of semi-scheduled generating units which exists in Chapter 2 of the NER. AEMO considers there should be one aggregation approach for semi-scheduled generating units and storage systems, reflecting NER clause 3.8.3. It proposes to remove the aggregation provisions in Chapter 2 of the NER. AEMO also considers it is appropriate for the NER to allow AEMO the discretion to consider whether different technology types can be aggregated under Chapter 3 of the NER.

#### 4.1.3

#### **We are seeking feedback on the issues and the proposed solutions**

Potential challenges associated with the current arrangements for bidding a scheduled storage facility in the NEM include the:

- risk and impact of being issued conflicting dispatch instructions
- interaction with FCAS bids and provision when simultaneously bidding as a generator and a load
- determination of ramp rates.

These issues and potential solutions are explored in more detail below.

#### **Bidding for scheduled storage units**

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<sup>145</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 23.

In its rule change request, AEMO raises the complexity of bidding in scheduled storage units under the current arrangements.

The Commission notes that establishing a bidding platform and bidding arrangements for a new entrant is already a complex and potentially costly process. Scheduled storage units are likely to use a high degree of automation in organising and optimising bids over the course of a day.

Further, the Commission notes that there is now a greater degree of experience for scheduled storage units participating in central dispatch under two DUIDs. This may mean that the challenges and complexities that were encountered initially have been resolved or mitigated. It may also mean that changing now to a single DUID would require software developers to develop different systems for bidding in scheduled storage units.

If requiring scheduled storage facilities to bid as both scheduled loads and scheduled generators limits their ability to participate efficiently in energy and FCAS markets, solutions can be explored through changes to the NER.

In AEMO's rule change request, it proposes introducing a new participant category that would bid differently from other participants. This scheduled bi-directional resource participant would have 10 price bands to bid for both export and consumption. This would be less than the 20 price bands currently accessible to scheduled storage.<sup>146</sup>

Moving to a smaller number of price bands may reduce the flexibility of scheduled storage facilities in dispatch. It may be that the current arrangements (where the quantities in each price band can be rebid, but the bid prices themselves are fixed over the course of the day) could be adjusted to improve the bidding flexibility of all participants. For example, examining whether changes could be made so that participants could elect to change the prices of bid bands during the day, which would provide them with more flexibility.

The Commission also understands that some changes to the dispatch engine would be required to accommodate the new bids under AEMO's proposal. The associated costs of making these changes would need to be assessed against the benefits of introducing the new participant category and bidding structure.

The Commission also notes that any changes made to the arrangements for bidding in the market should account for how the market is developing over a longer timeframe. For example, digitalisation should enable greater participation in the wholesale market by improving communications equipment, metering and DER such that it is accessible to a wider array of consumers. The approach for participation in central dispatch, including how participants submit bids and offers, should be developed in a way that, where possible, accounts for these trends.

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<sup>146</sup> AEMO notes in its rule change request that current participants do not appear to use all of these bands.

### QUESTION 16: BIDDING IN SCHEDULED STORAGE FACILITIES

1. How complex are the current arrangements for bidding for a scheduled storage facility compared to bidding for a scheduled generator or load?
2. If available and if you had storage facilities, would you opt to change from the existing arrangements to a single DUID model, with 10 price bands rather than 20?

### Conflicting dispatch instructions

Because a scheduled storage unit participates in dispatch as if it were two separate machines, this arrangement increases the risk of dispatch conflicts. That is, a participant could receive dispatch instructions to simultaneously generate and consume energy for the same dispatch interval even though it cannot physically do so.

The Commission understands this can arise under a number of circumstances where:

- bids have not been properly devised so the battery was scheduled to charge and discharge in the same interval
- the co-optimisation with FCAS offers results in a dispatch conflict.

AEMO highlights that currently Market Participants need to properly manage energy and FCAS bids such that they do not receive dispatch instructions for a scheduled storage unit to simultaneously consume and produce electricity.<sup>147</sup>

There are provisions in the NER to manage participants not conforming with dispatch instructions. If a participant fails to conform to a dispatch instruction (for an energy bid, energy offer, or an FCAS offer), it could be declared and identified as non-conforming.<sup>148</sup> The unit would remain non-conforming until it satisfactorily responds to AEMO and AEMO is satisfied that the unit will respond to future dispatch instructions.<sup>149</sup> Further, clause 4.9.8(a) of the NER requires all Registered Participants to comply with dispatch instructions given by AEMO unless doing so would be a hazard to public safety or materially risk damaging equipment.

There are also financial incentives for scheduled participants to comply with dispatch instructions linearly. Contribution factors are determined based on the extent to which a scheduled participant's deviations from a linear ramp between dispatch targets impacts upon system frequency.<sup>150</sup>

The Commission notes that while some dispatch conflicts may arise due to poorly devised bids, there are also instances where scheduled storage units can receive conflicting dispatch instructions due to complex optimisation outcomes involving the provision of FCAS. These

<sup>147</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, pp. 10, 17, 26.

<sup>148</sup> That is, if it fails to respond to a dispatch instruction within a tolerable time and accuracy (as determined in AEMO's reasonable opinion), as per clause 3.8.23(a) of the NER.

<sup>149</sup> Clause 3.8.23(d) of the NER.

<sup>150</sup> Clause 3.15.6A(j) of the NER.

conflicts may be more difficult to anticipate and manage from a participant's perspective and consequences could include a potential risk under-provision of FCAS.

Market participants can, for example, deploy software that devises and submits offers and bids to AEMO. The Commission understands that these software packages can include built-in features that can provide automatic warnings for conflicting offers, reducing the risk of conflicting offers, or automate bids and offers in line with dispatch requirements.

#### **QUESTION 17: DISPATCH CONFLICTS**

To the extent that the current arrangements for scheduled storage units results in conflicting dispatch instructions, we would like to understand:

1. How often these conflicts occur in relation to energy and FCAS, and how material are they for the operators of scheduled storage units and other market participants?
2. To what extent can these conflicts be, or to what extent have they already been, remediated through experience and through improved bidding systems?
3. Would moving to a single DUID model be an appropriate and proportionate response?

#### **Ramp rates**

AEMO's rule change request raises issues relating to ramp rates including:

- an inconsistent approach to determining minimum ramp rates for aggregated units participating in dispatch
- an inconsistent treatment of generation and load
- different treatment of units aggregated under Chapter 2 of the NER compared to Chapter 3.

When a scheduled participant makes a bid or an offer for one of its assets, it is required to also submit its maximum and minimum ramp rate. This lets AEMO know the technical limitations of that asset to increase or decrease output. A relevant participant may provide a ramp rate less than the minimum if it is affected by an event or other occurrence that physically prevents it from attaining the minimum ramp rate or makes it unsafe to operate at that ramp rate. If a relevant participant provides a ramp rate that is less than the minimum, it must simultaneously provide AEMO with a brief, verifiable and specific reason for that ramp rate being below the minimum ramp rate.<sup>151</sup>

Minimum ramp rate requirements exist to manage scheduled participants gaming market conditions. Without minimum ramp rates, participants could rebid their ramp rates to limit the rate at which their dispatch targets could be reduced, for example, when there are binding network constraints, and to therefore maximise output under commercially favourable conditions, or vice versa.

<sup>151</sup> Clause 3.8.3A of the NER.



The Commission made the *Generator ramp rates and dispatch inflexibility in bidding* final rule in 2015. This rule extended the minimum ramp rate requirements to individual physical units that make up aggregated facilities. The final rule treated aggregated and non-aggregated facilities on the same basis.

However, as highlighted in AEMO's rule change request, it considers the current arrangements to be inconsistent regarding the determination of minimum ramp rates for aggregated units. Further, there are inconsistencies between the minimum ramp rates for generation and load. This presents a challenge where a facility is able to transition quickly from generation to load.

Under the current arrangements, the minimum ramp rate for scheduled generating units that are aggregated is the lower of 3 per cent of the maximum capacity *or* 3 MW per minute applied to individual units, then summed.<sup>152</sup> A key cause of inconsistencies is a requirement for ramp rates for each individual unit in an aggregation to be at least 1MW/minute.<sup>153</sup> This means, as AEMO points out, that an aggregation of small units would have a very large minimum ramp rate. For example, an aggregation of 40, 1MW turbines would have a minimum ramp rate of 40MW per minute because:

- the ramp rate would be determined for each unit, which is  $3\% * 1\text{MW} = 0.03\text{MW/minute}$ , but this is rounded to 1MW/minute for each unit
- for the 40 units, this is summed together, giving the aggregation a minimum ramp rate of 40MW/minute.

However, AEMO also notes that semi-scheduled generating units can be aggregated in Chapter 2 of the NER and treated as single units for the purposes of dispatch. In the above example, this would mean an aggregation of 40, 1MW turbines *aggregated under the provisions in Chapter 2 of the NER* would have a minimum ramp rate of 1MW per minute because:

- the units are treated together so the minimum ramp rate is  $3\% * 40\text{MW} = 1.2\text{MW/minute}$ , rounded down to 1MW/minute for the aggregation.

This situation is further complicated because the ability to aggregate under Chapter 2 of the NER is only available to semi-scheduled units that have similar energy conversion models, and the individual units are below 6 MW.<sup>154</sup>

From the perspective of scheduled storage facilities, different minimum ramp rates can arise for the load and generation components of these facilities. This is because the minimum ramp rate for:

- load is 3MW per minute
- generation is the lesser of 3 per cent of capacity per minute **or** 3MW per minute.

<sup>152</sup> Clause 3.8.3A(b)(1)(iv) of the NER.

<sup>153</sup> Definition of "generating unit minimum ramp rate requirement" in Chapter 10 of the NER.

<sup>154</sup> In its rule change request, AEMO suggests that this 6 MW restriction may not be necessary any more. Discussion of potential changes to this threshold is set out in chapter 3 of this consultation paper.

Therefore, inconsistencies appear to arise in the determination of minimum ramp rates because under the current arrangements there are options for aggregating units under Chapter 2 and Chapter 3 of the NER, which result in different minimum ramp rates, and the NER has a different process for determining minimum ramp rates for load and generation.

These inconsistencies are likely to add unnecessary complication to the operation of aggregations of semi-scheduled units and scheduled storage facilities.

#### **QUESTION 18: AGGREGATION AND RAMP RATES**

1. What problems arise under the current arrangements in relation to the application of minimum ramp rates?
2. Do you agree with AEMO's proposal to rely on the aggregation approach set out in Chapter 3 of the NER (rather than the one set out in Chapter 2 of the NER)?

## 4.2

### Forecasting and energy availability

#### 4.2.1

#### **An overview of AEMO's forecasting responsibilities**

AEMO has multiple forecasting responsibilities as market operator, including managing the:

- projected assessment of system adequacy (PASA) processes, which collect information on, analyse and disclose medium term and short term power system security and reliability of supply prospects up to two years in advance<sup>155</sup>
- Energy Adequacy Assessment Projection (EAAP), which analyses and quantifies the impact of energy constraints on energy availability under a range of scenarios over a two year period<sup>156</sup>
- pre-dispatch process, which is a daily forecast of electricity demand for scheduled and semi-scheduled generation, scheduled load and projected demand.<sup>157</sup>

AEMO is responsible for collecting the necessary information from participants and determining and publishing the results. The NER require this information to be submitted by market participants on behalf of scheduled generators, scheduled loads, ancillary service generating units and ancillary service loads. This includes the export and import sides to utility scale scheduled storage.

The information that needs to be provided includes:

- dispatch bids, dispatch offers, and market ancillary service offers<sup>158</sup>
- intention to self-commit and synchronise scheduled generating units (via PASA and pre-dispatch)<sup>159</sup>

<sup>155</sup> Clause 3.7.1 of the NER.

<sup>156</sup> Rule 3.7C of the NER.

<sup>157</sup> Clause 3.8.20 of the NER.

<sup>158</sup> Clauses 3.8.2(a), (c), (c1) and (e); 3.8.6; 3.8.7; 3.8.7A of the NER.

<sup>159</sup> Clauses 3.8.17(e) and (f) of the NER; applies to scheduled generating units 30MW and above.

- self-decommitment and de-synchronisation (via PASA and pre-dispatch).<sup>160</sup>

Ahead of real time, market participants must also provide AEMO their daily energy availability for any energy constrained scheduled generating units or scheduled loads.<sup>161</sup>

An energy constraint is “a limitation on the ability of a generating unit or group of generating units to generate active power due to the restrictions in the availability of fuel or other necessary expendable resources such as, but not limited to, gas, coal, or water for operating turbines or for cooling.”<sup>162</sup>

A scheduled generating unit is considered energy constrained if it can’t generate at full output for a trading day. A scheduled load may be considered constrained if it cannot consume the normal amount of energy it would consume over the full 24 hours of a given trading day.<sup>163</sup>

Under the current arrangements, a scheduled storage facility would be obligated to provide AEMO its daily energy availability if it was constrained. Given the rules were originally written for thermal generators and industrial loads, it is unclear how they should apply to batteries.

For example, a scheduled storage unit may be considered to be energy constrained if cannot generate at its maximum capacity for 24 hours, in which case all utility scale batteries in the NEM would be energy constrained. Similarly, a storage unit may be considered to be an energy constrained scheduled load if the amount of electricity it can take in a trading day is constrained (that is, there is a limitation on the capability of the unit such that it is unacceptable to consume the level of electrical power that would occur if the limitation was removed).<sup>164</sup>

#### 4.2.2

#### **AEMO proposes changes to increase information provided to it for forecasting**

AEMO considers that, under the current arrangements, insufficient information is provided on the energy limited capacity reserves of scheduled storage. AEMO also notes that it considers battery systems to be of particular concern because they can charge and discharge quickly and cycle a number of times a day and typically rebid regularly. Currently, AEMO considers these resources are not optimised in pre-dispatch and PASA because the NER do not recognise or specify any requirements for these assets.

AEMO considers this lack of information might result in less informed decision-making for:<sup>165</sup>

- registered participants, as pre-dispatch information is less accurate
- AEMO when managing power system security and reliability. For example, if scheduled storage capacity is not known in a certain timeframe, it cannot be relied on when assessing system reserves and may result in AEMO underestimating available reserves

<sup>160</sup> Clauses 3.8.18(c) and (d) of the NER; applies to scheduled generating units 30MW and above.

<sup>161</sup> Clauses 3.8.4(c)(3) and (d)(2) of the NER.

<sup>162</sup> Definition of “energy constraint” in Chapter 10 of the NER.

<sup>163</sup> There are definitions of “energy constrained scheduled generating unit” and “energy constrained scheduled load” in Chapter 10 of the NER.

<sup>164</sup> Definitions of “energy constrained scheduled load” and “constraint” in Chapter 10 of the NER.

<sup>165</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 17.

and, for example, inefficiently intervening. Alternatively, relying on scheduled storage capacity when energy limits are not accurate could lead to AEMO overestimating available reserves and not taking action early enough.

AEMO's proposed rule would require registered participants with a scheduled storage facility to submit a dispatch bid that reflects their available capacity for each trading interval. This would need to reflect the 'energy limits' of a scheduled storage unit, effectively the remaining stored energy capacity. AEMO considers an accurate availability profile is needed for pre-dispatch and is an input to other forecasting tools.<sup>166</sup>

Currently, a dispatch bid for an energy constrained scheduled generating unit or scheduled load may (or must) specify a daily energy limit.<sup>167</sup> While the proposed rule does not seek to change this approach for scheduled generation and load, AEMO is currently reviewing whether the PASA tools and processes are fit for purpose and this may result in subsequent rule changes.<sup>168</sup>

#### 4.2.3

#### **We are seeking feedback on the issues and the proposed solution**

AEMO's rule change request highlighted potential issues arising in the timeframes leading up to dispatch. This relates to how energy-limited participants are reflected in short-term forecasts. For example, a battery might have 100MW of rated output and this full output could be reflected as generating over the entire timeframes of short-term PASA (ST-PASA) and pre-dispatch. However, what isn't reflected is that because the battery is energy limited (i.e., it needs to recharge), the battery would not be able to maintain the full 100MW level of generation.

AEMO's rule change request highlights that the ability of batteries to charge and recharge is not currently reflected in pre-dispatch and PASA.

This issue may apply more broadly to energy market participants who have limited energy availability and/or a high degree of flexibility. For example, providers of demand response who are unlikely to be able to provide consistent, prolonged demand response.

The Commission has previously considered the issues of energy storage system availability as part of the 2018 *Generator Technical Performance Standards* rule change process.<sup>169</sup> For this rule change, AEMO proposed a rule that would have required scheduled storage facilities to have remote monitoring capabilities so that AEMO could access real-time information on their available energy. AEMO advised this was also intended to support the accuracy and effectiveness of the pre-dispatch and dispatch process.

In its final determination, the Commission decided that AEMO's proposal to require generators to have remote monitoring capability for energy storage facilities was not

<sup>166</sup> Ibid, p. 27.

<sup>167</sup> Scheduled generating units *must* specify a daily energy limit and scheduled loads *may* specify a daily energy limit. Clauses 3.8.4(c)(3), 3.8.6(b) and 3.8.7(m) of the NER.

<sup>168</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 27.

<sup>169</sup> AEMC, 2018, *National electricity amendment (generator technical performance standards) rule 2018*, final rule determination, September 2018. Available [here](#).

necessary from the perspective of supporting efficient pre-dispatch and dispatch processes and could impose unnecessary costs on generators.<sup>170</sup>

#### **QUESTION 19: FORECASTING AND ENERGY AVAILABILITY**

1. Are there problems arising from energy-limited plant not being reflected in forecasts?
2. Could this problem be addressed by requiring storage facilities to provide additional information on energy limits in their bids, as proposed by AEMO?

## 4.3

### Performance standards

#### 4.3.1

#### **A brief overview of performance standards for generators and loads in the NEM**

Equipment that connects to the power system needs to be able to perform in a manner that enables the power system to operate securely and reliably. For connecting generating systems, this means:

- having certain technical capabilities available while in normal operating conditions
- the need to be able to withstand certain disturbances (including those caused by faults and generation tripping) and provide support to the power system throughout the disturbances, and
- the ability to quickly recover after disturbances to help bring the power system back to normal operating conditions.

Loads generally have less onerous performance standards applied when connecting. When scheduled storage facilities connect to the NEM, they are required to meet a single set of performance standards agreed at the connection point for either a stand-alone battery system or a hybrid facility.

#### 4.3.2

#### **AEMO identifies issues with how the performance standards are currently applied to storage and hybrids**

AEMO raises additional technical issues relating to the connection and operation of scheduled storage and hybrid facilities relating to technical performance standards and ramp rates.

In its rule change request, AEMO notes that technical requirements are not currently symmetrical for two sides of the same asset, i.e. there are different technical requirements on the export and consumption sides of a scheduled storage facility.<sup>171</sup>

In its rule change request, AEMO notes that currently, for both scheduled storage and hybrid facilities, there would be a single performance standard agreed for the connection point.

AEMO argues that it is necessary to have greater visibility of all assets in a hybrid facility so that AEMO can understand the impact these facilities are likely to have on the power system. AEMO considers that it is no longer appropriate to base performance standards on the

<sup>170</sup> Ibid, pp. 80-81.

<sup>171</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 17.

registered participant category as greater numbers of storage and hybrid facilities connect to the NEM. Instead, AEMO considers that a registered participant's performance standard should be based on its physical assets.<sup>172</sup>

#### 4.3.3 We are seeking feedback on these issues

The current rules set different performance standards for market generators and customers. This reflects a historical difference in the nature of generators and loads connecting to the NEM.

Schedule 5.2 of the NER sets out the performance standards for generators and schedule 5.3 sets out the performance standards for customers. The obligations for generating units are more onerous and extensive than those for loads. For example, the performance standards for connecting loads do not require management of fault current and frequency or respond to disturbances to the same degree as generators.

The reasoning for the different treatment of large loads and generators may not hold in the case of utility-scale scheduled storage. Generally, the load component of scheduled storage facilities actively participates in the market and provides energy and FCAS.

AEMO's rule change request does not go into detail regarding the problems that arise with the load component of a scheduled storage having a lesser set of obligations and performance standards as its generating component. It says that "[i]t is necessary for AEMO to have greater visibility of all assets in a 'hybrid' facility to ensure AEMO understand the impact these facilities have on the power system".<sup>173</sup> This may refer to the fact that generators need to meet monitoring and communications requirements and customers do not. Consequently, AEMO may not have the level of oversight and engagement it considers necessary to perform its functions as Market Operator.

Setting two different performance standards on a single asset may also make it more complex to agree a set of performance standards and receive a connection agreement. This could have the effect of delaying the connection and operation of scheduled storage facilities. It may also make the operation of the power system more difficult to anticipate if the response of a scheduled storage facility is dependent on whether the facility is exporting or consuming at that point in time.

The complications arising from determining performance standards may be exacerbated with hybrid facilities. AEMO identifies this issue in its rule change request.<sup>174</sup>

The Commission is considering how these frameworks can remain fit-for-purpose in light of greater decentralisation of the power system. For example, making sure frameworks relating to how participants engage with the market, such as the determination of performance standards, account for new entrants such as aggregations of DER.

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172 Ibid, p. 18.

173 Ibid, p. 18.

174 Ibid, p. 18.

In its two-sided market workstream, the ESB is exploring whether it would be appropriate to move from asset-based obligations to service-based obligations. That is, instead of focusing obligations on the type of asset, the obligations are instead applied to the service being provided. A consequence of this may be reducing the emphasis on visibility behind the connection point. The Commission would be interested to understand from stakeholders whether they consider increasing visibility behind the meter is the best way for AEMO to maintain the security of the power system as the sources of supply and price-responsive demand become increasingly decentralised.

#### **QUESTION 20: PERFORMANCE STANDARDS**

1. Are the current rules unclear on how performance standards should apply in facilities with a mix of asset types? Do the current rules create barriers for storage hybrid facilities? To maintain power system security, should AEMO have greater visibility of the assets behind a connection point?
2. Could these challenges be mitigated by having a single set of performance standards for each asset, as proposed by AEMO?

## 5 ISSUES WITH FEES AND CHARGES

Market participants face a number of costs associated with being part of the NEM. These costs include:

- NEM participant fees and charges
- non-energy costs associated with maintaining a safe and secure power system
- network charges i.e. TUOS and DUOS charges associated with use of the transmission and distribution networks, respectively.

In its rule change request, AEMO identifies that the calculation of fees and charges, and non-energy costs are inconsistent between grid-scale batteries and other Market Participants, including exempt batteries which can be registered with MSGAs. In particular, AEMO raises a concern about the possibility that the current arrangements could be inequitable. It notes, for example, that consumed energy is used to calculate the non-energy cost recovery from a grid-scale battery but is ignored for non-energy cost recovery from Market Generators and MSGAs.<sup>175</sup> AEMO also indicates that it is currently unclear (as the NER do not define energy storage proponents) if and how TUOS and DUOS charges should be recovered from battery systems, and that this results in ambiguity as network service providers (NSPs) and proponents interpreting the rules are setting charging arrangements individually for energy storage systems.<sup>176</sup>

In order to understand the broader issue of whether the proposed rule is effective and proportionate, the Commission seeks your feedback on AEMO's view and proposed solutions for the application of fees and charges to battery systems (including hybrid facilities). The Commission also seeks views on alternative solutions that involve looking at these issues more broadly across all Market Participant categories. This chapter therefore seeks feedback on:

- AEMO's characterisation of the current issues relating to fees and charges
- how significant the current issues relating to fees and charges are and whether they are likely to become worse in the future
- whether the proposed solution(s) would address the issues AEMO has raised
- whether there are any alternatives or additional solutions that would better address the issues identified by AEMO.

### 5.1 Participant fees and charges, and non-energy costs

#### 5.1.1 Issues relating to participant fees and charges and the recovery of non-energy costs

In its rule change request, AEMO has identified an inconsistency in the way participants fees and charges and non-energy cost recovery apply across market participant categories. The key issue AEMO raises is that a different method for levying these charges and costs applies to grid-scale batteries compared to other technologies in the NEM, including exempt

<sup>175</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, pp. 19-20.

<sup>176</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 20.



batteries. As a consequence of being treated as both load and generation under the NER, grid-scale battery charges are based on two separate datastreams. This is quite different to other technologies which have charges based on net meter data (a single datastream). AEMO notes this is an example of how the requirement under AEMO's Interim arrangements guidelines for grid-scale batteries to register and participate under two different categories is resulting in an uneven playing field and is not achieving a technology-neutral approach.

The Commission is seeking feedback on this issue in order to understand whether the NER create an uneven playing field in this respect, and how important or urgent it is to resolve this issue.

### What are participant fees and charges?

AEMO charges registered participants fees to recover its budgeted revenue requirements. The NER state that the components of participant fees charged to each registered participant should be reflective of the extent to which the budgeted revenue requirements for AEMO involve that registered participant.<sup>177</sup> As such, the fees differ between categories of registered participant. Additionally, the NER states that participant fees should not unreasonably discriminate against a category or categories of registered participants.<sup>178</sup>

Table 5.1 below sets out the participant fees for specific functions AEMO has under the NER. In addition, AEMO recovers the cost of new registrations through fees determined for each registration category.<sup>179</sup>

**Table 5.1: Recovery of Participant fees and charges**

<b>FEES AND CHARGES</b>	<b>COST RECOVERY FROM</b>
NEM fees (funds AEMO's core NEM functions):	
General (unallocated)	Market Customers
Allocated direct costs	Market Customers (54%)
	Market Generators, MSGAs, Market Network Service Providers (46%)
Other fees and charges:	
Energy Consumers Australia	Market Customers
Full Retail Competition	Market Customers (with a retail licence)
National Transmission Planner	Market Customers, MSGA's
Registration fees	Proponents registering
Participant Compensation Fund	Market Generators (Scheduled and Semi Scheduled)

Source: AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 15.

<sup>177</sup> Clause 2.11.1 of the NER.

<sup>178</sup> Ibid.

<sup>179</sup> AEMO, Final Report - Structure of Participant Fees in AEMO's Electricity Markets 2016.

### What are non energy costs and how are they recovered?

AEMO has a responsibility to operate the power system in a safe, secure and reliable manner. AEMO fulfils this by controlling technical characteristics of the system through various market and non market ancillary services and regulatory mechanisms.

AEMO generally recovers the cost of these services and mechanisms from participants in proportion to the energy consumed or sent out in relevant trading intervals (currently 30 minutes). The costs of some services are recovered based on a causer pays principle. The objective of this principle is to create an incentive for market participants to minimise the overall requirements for that service.

Table 5.2 below identifies all NEM non-energy cost recoveries and which registered participants AEMO recovers these costs from.

**Table 5.2: Current NEM non-energy cost recovery**

	<b>COST RECOVERY FROM</b>	<b>NER REFERENCE</b>
Market ancillary services:		
FCAS – contingency raise	Market Generators, MSGAs	3.15.6A(f)(3)
FCAS – contingency lower	Market Customers	3.15.6A(g)(3)
FCAS – regulation	Market Generators, MSGAs and Market Customers on causer pays basis	3.15.6A(i)
Non-market ancillary services:		
Network support control ancillary services (NSCAS)	Market Customers	3.15.6A(c2)(1)
System restart ancillary services (SRAS)	Market Customers, Market Generators, MSGAs	3.15.6A(c2)(2)
Interventions:		
Direction – energy	Market Customers	3.15.8(b)
Direction – FCAS	Market Customers, Market Generators and MSGAs on a causer pays basis	3.15.8(f)
Direction – other	Market Customers, Market Generators, MSGAs	3.15.8(g)
Mandatory restrictions	Market Customers	3.12A.7(e)
Reliability and emergency reserve trader (RERT)	Market Customers	3.15.9(f)
Affected Participant Compensation	Scheduled Generator, Scheduled Network Service Provider, Market Customer	3.12.2
Market suspension	Scheduled Generators, Ancillary Service Providers	3.14.5A
Other events:		

	<b>COST RECOVERY FROM</b>	<b>NER REFERENCE</b>
Market shortfall and surplus	Market Generators, MSGAs	3.15.22, 3.15.23
Administered price cap or administered floor price compensation Payments	Market Customers	3.15.10(a)

Source: AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 14.

### **The issue with using net meter data for participants other than grid-scale batteries**

Grid-scale batteries have participant fees and charges, and non-energy costs recovered based on two separate meter datastreams for each interval, while other registered participants can use a net meter datastream (netting imports and exports within an interval). According to AEMO, this can result in registered participants with technologies other than grid-scale batteries being able to minimise the costs and charges that apply to them.

#### ***What is net meter data?***

AEMO receives net meter data for each trading interval and financially responsible Market Participant. This net meter data provides an energy value for market settlement, fees and non energy cost recovery calculations. This arrangement has been in place since NEM start and is reflected in the NER settlement formula as adjusted gross energy (AGE).<sup>180</sup> The energy value used is either a positive or negative amount for each trading interval, adjusted for a distribution loss factor.

#### ***Use of net meter data for calculation of participant fees***

For grid-scale battery participants, AEMO's fees and charges are currently recovered based on:

- Market Customer liability in respect of the battery's consumption (referred to as load or customer energy in the NER).
- Market Generator liability in respect of the battery's sent out generation.

AEMO notes that for Market Customers and Market Generators that are not grid-scale battery operators, it bases the calculation of participant fees on the absolute net energy amount. For example, participant fees for AEMO's core NEM functions are mostly charged on a \$ per MWh amount for Market Customers and for Market Generators on a \$ per day rate based on capacity and energy produced.<sup>181</sup> AEMO considers this creates a perverse outcome in that if a significant portion of a Market Customer's market load connection points have exempt generating units (behind the connection point), the calculation of participant fees will be reduced. If generation behind the meter is equivalent to load, then no fees are paid.<sup>182</sup>

<sup>180</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 15.

<sup>181</sup> AEMO, Final Report - Structure of Participant Fees in AEMO's Electricity Markets 2016, p. 16.

<sup>182</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 15.

### ***Use of net meter data for calculation of non-energy cost recovery***

AEMO notes that the use of net meter data for non-energy cost recoveries can lead to a perverse outcome for registered participants registered in a single category with significant counter flows. For example, if a Market Customer has a significant amount of generation behind its market load connection points it:

- reduces the amount being recovered compared to the outcome if consumed and sent out energy occurred at separate connection points
- can lead to payment being made to the Market Customer rather than recovered from the Market Customer if sent out energy exceeds energy consumed.

For Market Generators and MSGAs, AEMO notes that any consumed energy is considered auxiliary supply and is ignored for recovery of non energy costs.<sup>183</sup>

### ***How does this impact grid-scale batteries?***

A grid-scale battery participant, either standalone or in a hybrid facility, currently registers as a Market Customer for consumption and Market Generator for generation. This leads to the fees and non energy cost recovery for grid-scale battery being calculated based on the meter data of the consumed and sent out energy separately. To illustrate this AEMO provides the example of a 30-minute trading interval where FCAS regulation services are used, in this example if a grid-scale battery:

- is only consuming electricity, recovery would be based on consumption only (the 'E' datastream)
- consumes and produces electricity over that period, recovery would be based on the consumption and generation separately (the 'E' and 'B' datastreams).<sup>184</sup>

AEMO considers that this approach is consistent with causer or beneficiary pays principles since it ensures that a registered participant who contributes to the need for a service also contributes to the cost associated with delivering that service. AEMO notes that this approach best reflects and places a value on a registered participant's contribution when non-energy services are needed.<sup>185</sup>

In contrast, for a Market Customer, Market Generator or MSGA with both consumed and sent out energy at a single connection point during a trading interval, the energy value for settlement is netted out. Subsequently, the fees and charges for these participants are based on the net amount of consumed and sent out energy.<sup>186</sup> Additionally, this applies for some existing pumped hydro facilities that AEMO notes have only been registered as a Generator with pumping load treated as auxiliary supply.<sup>187</sup>

Given the expected growth in battery systems registering in the NEM, the Commission is interested to understand stakeholders' views on the apparent inconsistency in approach to

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183 AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 19.

184 Ibid.

185 Ibid, p. 19.

186 Ibid, p. 19.

187 Ibid, p. 5.

fees and charges and recovery of non-energy costs from grid-scale batteries and other Market Participants.

### ***Inconsistency between grid-scale (big) vs exempt (small) batteries***

AEMO has also identified there are inconsistencies between the way that exempt batteries (less than 5MW in size) are having non-energy costs recovered, compared to grid-scale batteries. This is because exempt batteries are treated as generating units when included in a MSGAs portfolio. While the NER does not expressly provide for MSGAs to include exempt batteries in their portfolios it is not prohibited either.<sup>188</sup>

The Commission originally considered, in the 2012 *Small generator aggregator framework Final Determination*, that the rationale for the introduction of the MSGA framework was to provide exempt generators with better access to the market. The most relevant category to compare to MSGAs are therefore Market Generators. There was no expectation that an MSGA might consume energy from the grid in some periods as would be the case in the operation of an exempt battery by an MSGA. Consequently, at the time the Commission concluded that the arrangements for the payments of ancillary service fees by MSGAs should match those for Market Generators as closely as possible.<sup>189</sup>

Given this, the NER does not contemplate recovery from an MSGA based on its consumed energy. AEMO states that this is a NER gap and should be addressed if the NER is clarified to continue to allow MSGAs to include exempt batteries in their generation portfolio.<sup>190</sup>

### **Metering and hybrid facilities**

AEMO also notes that, since the NER currently requires a single metering installation at each connection point, it is challenging to determine the energy flows occurring between individual assets in 'hybrid' facilities to calculate fees, charges or non-energy cost recoveries for separate energy flows into and out of an individual asset.<sup>191</sup>

This is considered further in the next section where AEMO's solutions are discussed.

### **What is the impact of these issues?**

Given grid scale storage systems are currently registering as a Market Customer and a Market Generator it seems this would likely result in higher costs from participant fees and non-energy costs recovered from them compared to if they registered in only one participant category. This is in contrast to other technologies that can register under a single category and as a consequence, can have fees and charges based on net meter data, resulting in lower costs and potentially providing an advantage to these Market Participants.

Given the predicted uptake in small scale DER, as included in the AEMO 2019 Electricity Statement of Opportunities (ESOO) and noted in chapter 2, the amount of bi-directional

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188 Ibid.

189 Australian Energy Market Commission, 2012, *Small Generation Aggregator Framework, Rule determination*, 29 November 2012, Sydney.

190 Ibid.

191 AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 18.

energy flows occurring will increase. The Commission is interested in understanding whether stakeholders consider the burden of costs will be exacerbated as exempt generating units or batteries increase behind the meter.

**QUESTION 21: ISSUES WITH HOW FEES AND CHARGES, AND NON-ENERGY COSTS ARE RECOVERED.**

1. Do you agree that there is an inconsistency with how fees and charges and non-energy costs are recovered from Market Participants?
2. What is the impact of this issue? Does it create an uneven playing field and does it create (or has it the potential to create) perverse behaviours and outcomes?
3. Do you consider the burden of costs will be exacerbated as exempt generating units increase behind the meter?
4. Are there any other issues that the Commission should consider with respect to fees and charges, and non-energy cost recovery?

### 5.1.2

#### **AEMO's proposed solution for issues with Participant fees and charges, and non-energy cost recovery**

AEMO seeks to address the issues with the way participant fees and non-energy cost recovery is calculated by changing the methodology of their calculation for the proposed bi-directional resource provider and the existing MSGA category. This applies the current approach to the new participant category for all storage and hybrid schemes which is to calculate these fees and costs based on these participant categories consumed and sent out energy separately, rather than the netted energy amount. AEMO considers that this will level the playing field between the proposed new bi-directional resource provider and the MSGA participant categories.

Additionally, AEMO notes that the Commission should consider more broadly whether the Market Customer and Market Generator categories should also have their fees and costs calculated in the same manner. Such an approach involves implementing a technologically neutral approach across all participant categories and is covered in the next section, section 5.1.3.

#### **What is AEMO's solution?**

AEMO's solution proposes that the proposed bi-directional resource provider and the existing MSGA participant categories should pay non-energy cost recovery and NEM Participant fees based on consumed and sent out energy to the grid for relevant trading intervals as measured at the connection point. Under AEMO's solution a battery or pumped hydro proponent would register under the bi-directional resource provider or MSGA participant category.

For a registered participant with a grid scale battery that is currently registered as both a Market Customer and a Market Generator, AEMO's solution is consistent with the existing

NEM arrangements for non-energy cost recovery and Participant fees. For pumped hydro proponents AEMO's solution means facilities which historically have had load considered as auxiliary would now have it acknowledged for fee and cost recovery purposes.

***How would this work in practice?***

In order to calculate charges and non-energy cost recovery based off consumed and sent out energy AEMO's proposal includes the addition of two new definitions in the NER - adjusted consumed energy (ACE) and adjusted sent out energy (ASOE). These new definitions represent the metered energy (ME) recorded at the market connection point flowing away from ACE and towards ASOE the transmission network connection point, for each trading interval. The sum of ACE and ASOE represent the previously utilised netted AGE amount.

***How does this affect MSGA's?***

For an MSGA, this means non-energy cost recovery would be based on their consumed and sent out energy instead of the netted export energy amount at the connection point.

AEMO recognises that, for an MSGA without an exempt battery in its portfolio, this would mean that the consumed energy that is currently considered 'auxiliary' supply and ignored for fees and charges, and non-energy cost calculations would be acknowledged for these purposes.<sup>192</sup>

For an MSGA with an exempt battery in its portfolio, AEMO's proposal would mean that fees and charges, and non-energy cost calculations would be done in the same manner as is currently done for grid-scale batteries. It would also be in the same manner for batteries registered through the proposed bi-directional resource provider category as part of AEMO's solution.

***What does AEMO say are the benefits of this solution?***

AEMO considers that this approach is consistent with causer or beneficiary pays principles, since it ensures these registered participants would pay for services based on their contribution to the need to provide the service. AEMO notes that the change is needed otherwise registered participant's with exempt storage (or generating units) will be able to continue to reduce paying appropriately for these services, which may create a competitive advantage for those registration categories.<sup>193</sup>

AEMO states that recovering non-energy costs from bi-directional resource providers and MSGAs based on their consumed or produced energy ensures they pay their share of costs for the non-energy services they contributed towards the need for. AEMO states that this improves allocative efficiency because a bi-directional resource provider and an MSGA would produce or consume electricity at a price that better reflects the costs associated with its production.<sup>194</sup>

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192 AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 20

193 Ibid, p.19.

194 Ibid.

## What else does AEMO say about its solution?

### **Hybrid facilities**

AEMO notes that further consideration of the appropriate metering arrangements for 'hybrid' facilities is needed to prevent any perverse incentives for the co-location of assets (particularly loads in 'hybrid' facilities with storage units) or Registered Participants switching between categories to avoid obligations. AEMO poses the following questions to be considered:

- Are further requirements needed, for example should each asset in a 'hybrid' facility be required to have a revenue meter or is supervisory control and data acquisition (SCADA) data appropriate?
- Can the policy option be implemented and is this consistent across the calculation of fees, charges or non-energy cost recoveries?<sup>195</sup>

### **Implementation**

AEMO notes that, if the proposed rule is made, it will also need to consider appropriate registration fees for the bi-directional resource provider registered participant category.<sup>196</sup>

In relation to implementation of its proposed solution, AEMO has based the rules drafting on the Global Settlement & Market Reconciliation Rule that comes into effect on 6 February 2022. AEMO notes that if the effective date of the proposed rule occurs before this date, AEMO would need to continue to recover non-energy costs based on the existing NER provisions until the effective date of the Global Settlement & Market Reconciliation Rule.<sup>197</sup>

#### **QUESTION 22: SOLUTIONS FOR ISSUES WITH FEES AND CHARGES AND NON-ENERGY COSTS RECOVERY**

1. Do stakeholders agree with AEMO's proposed solution that MSGA and the proposed bi-directional resource provider participant categories should pay non-energy cost recovery and NEM Participant fees and charges based on consumed and sent out energy separately (as is the current practice for a grid-scale battery registered as both a Market Generator and Market Customer)?
2. Will AEMO's proposed solution level the 'playing field' between existing grid-scale batteries, MSGAs and participants under the proposed new category bi-directional resource provider? That is, will AEMO proposed solution more efficiently allocate fees and charges and non-energy costs between these Market Participants categories?
3. For hybrid facilities are further requirements needed, for example, should each asset in a hybrid facility be required to have a revenue meter or is supervisory control and data acquisition (SCADA) data appropriate?

<sup>195</sup> Ibid, p. 18.

<sup>196</sup> Ibid.

<sup>197</sup> Ibid.



4. Are there practical or implementation issues associated with charging MSGAs non-energy costs and NEM Participant fees based on consumed and sent out energy?

### 5.1.3

#### **Alternative solutions for issues with Participant fees and charges and non-energy cost recovery**

AEMO's solution only proposes to change how fees and non-energy costs are recovered for the proposed bi-directional resource provider and existing MSGA categories. AEMO notes that this solution would make the regulatory landscape more consistent for participants looking to register grid-scale or exempt batteries though it does not deal with inconsistencies across all participant categories. This section:

- expands on the AEMO's proposed solution and asks stakeholders to consider the issues raised more broadly across all market participant categories
- asks stakeholders to consider if a new participant category (bi-directional resource provider) is required or could amendments be made to existing participant categories and non-energy cost recovery calculations to achieve the same outcome.

#### **Levelling the playing field across all participant categories**

##### ***Should the same approach be applied to Market Generators and Market Customers?***

AEMO does not specifically identify how the issues it raises impact on Market Generators and Market Customers, but it does note it would be appropriate to consider all registered participant categories in a broader review of participants fees and charges and how non-energy costs are recovered.<sup>198</sup> AEMO states that, if non-energy costs recovery is not based on consumed and sent out energy flows in the same way for all registered participant categories, this may:

- Provide incentives to register in certain registered participant categories to avoid the financial cost of non-energy services, and potentially other services like DUOS.
- Result in the burden of non-energy services being borne by customers that cannot afford to own and connect 'exempt' generating units or storage behind their connection point. This impost would be made worse if the base of registered participants to recover costs from diminishes further.<sup>199</sup>

Given this issue has been raised in AEMO's rule change request, the Commission would like your views on whether it is also appropriate to recover non-energy costs from Market Customers and Market Generators consistent with what AEMO has proposed for the bi-directional resource provider and MSGA participant categories. Both Market Generators and Market Customers can also have bi-directional energy flows at the connection points where they are financially responsible. Noting that the metering installation is at the grid connection

<sup>198</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 20.

<sup>199</sup> *Ibid*, p. 20.

point and therefore energy flows behind that point are used for consumption or storage. This would mean that the auxiliary load of Market Generators and the export of behind-the-meter generation for Market Customers, which is currently ignored for the purpose of calculating fees and charges and non-energy cost recovery, would be acknowledged for these purposes.

From a technical perspective, AEMO has advised the Commission that they will be able to implement this solution for Market Generators and Market Customers because after global settlements is implemented they will have access to the data streams that will allow them to recover non-energy costs from the sent out and consumed energy flows separately.

#### **Make the changes without a new participant category**

Given the intention of the ESB's two-sided market work program to potentially consolidate the participant categories, it will be important to consider whether changes could be made without the creation of a new participant category. If changes are made so that the calculation of fees and charges for Market Customers and Market Generators, in addition to MSGAs, were based off consumed and sent out energy separately, rather than net energy it would level the playing field across relevant market participants. This may negate the need for a new participant category, the proposed bi-directional resource provider, in the context of participant fees and non-energy cost recovery.

#### **QUESTION 23: ALTERNATIVE SOLUTIONS FOR ISSUES WITH FEES AND CHARGES AND NON-ENERGY COSTS RECOVERY**

1. Do you consider it appropriate to recover non-energy costs from Market Customers and Market Generators in the same way AEMO recovers costs from grid-scale batteries? That is, should participant fees, charges and non-energy costs for Market Generators and Market Customers be calculated on energy consumed and energy sent out separately, not on netted energy as is the current practice?
2. If changes are made to how participants' fees, charges and non-energy costs are recovered, do you consider creating a new participation category, bi-directional resource provider, is the best way to do this? Or could it be appropriate to make changes to existing market participant categories to achieve the same outcome?
3. Do you consider that there are other changes that could be made to Participant fees and non-energy cost recovery that would create a more consistent and level the playing field across Participant categories?

## **5.2**

### **TUOS and DUOS**

#### **5.2.1**

#### **Issues relating to TUOS and DUOS**

AEMO has identified that there is a lack of clarity in the way that TUOS and DUOS charges apply to grid-scale batteries and hybrid schemes. AEMO suggests that this lack of clarity results in uncertainty for proponents of battery and hybrid facilities, possible barriers to entry and ad hoc arrangements across the NEM. The Commission seeks feedback from

stakeholders on how significant these issues are and whether they are likely to become even more significant in the future.

### **What are TUOS and DUOS charges?**

NSPs are subject to economic regulation and receive a regulated rate of return for the network assets that provide standard shared network services to those connected to the NSP's network, including for the costs associated with augmentation, replacement, operating and maintenance costs. Currently TUOS and DUOS charging arrangements are covered by a combination of instruments, including the NER and AER's regulatory determinations. These instruments identify who pays for NSP shared network services, and how much.<sup>200</sup>

The AER-approved revenue requirements of Transmission Network Service Providers (TNSPs) and Distribution Network Service Providers (DNSPs) are recovered from users through a range of charges including:

- TUOS from Transmission Network Users for the provision of prescribed transmission services and prescribed common transmission services as defined in the NER, subject to an individual NSP pricing methodology approved by the AER
- DUOS from Transmission Customers (Customers, Non-registered Customers and DNSPs) and Network Users for the provision of direct control services.<sup>201</sup>

### **What do generators pay?**

Currently, transmission and distribution networks in the NEM operate under an open access regime for the connection of generation. This means generators, whether they are grid-scale renewable generators or small customers with roof-top solar systems, do not pay for their use of distribution or transmission networks in exporting energy.<sup>202</sup>

For distribution networks, the connection charge varies with the type of connection service.<sup>203</sup> The connection charge also depends on the size of the connection and its proximity to shared network assets.

Under the NER, network service providers are obliged to allow new generating units to connect to their networks.<sup>204</sup> While generators are not required to pay use of system charges when they export energy, they in turn do not receive firm (or guaranteed) access to the network—any individual generator can be dispatched down or off if the network is constrained.<sup>205</sup> This would include any grid-scale battery classified as a scheduled generator.

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200 AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 16.

201 *Ibid*, p. 16.

202 On 2 July 2020 the AEMC initiated a rule change request that proposes to remove barriers for DNSPs to recover the costs associated with supporting the export of electricity from small customers who export energy. Project page access [here](#).

203 NER, Chapter 5A, Part B.

204 NER, clause 5A.B.1.

205 The principle of open access applies to all generators, however scheduled and semi-scheduled generators are constrained in different ways.

### **What issues does AEMO identify?**

In its rule change request, AEMO identifies that each NSP interprets how the rules apply to battery storage units differently, meaning there is no clear agreement between the AER and NSPs on how TUOS and DUOS should apply to battery storage units and hybrids. This creates regulatory risk for NSPs, and ambiguity and uncertainty for battery storage market participants.

Additionally, AEMO notes that it is difficult and even impossible in some circumstances to properly meter hybrid facilities which impacts the calculation of appropriate charges. This issue also applies to calculation of appropriate fees and non-energy cost recovery as covered in section 5.1.

These issues are discussed below.

### ***Regulatory risk and increased development costs from differing interpretations***

Because the rules do not clearly consider battery systems, AEMO indicates that NSPs may interpret the rules differently and, as such, apply TUOS and DUOS to battery systems differently in each jurisdiction.<sup>206</sup> AEMO identifies two consequent impacts of increased:

- regulatory risk for NSPs, where they may breach their obligations if they interpret the rules differently to the AER
- development costs, where developers need to work out how TUOS and DUOS costs are applied in each network of the NEM.

AEMO writes:

Since Market Customers are typically charged TUOS and DUOS for their consumed electricity, each NSP needs to consider whether it must recover TUOS and DUOS charges from ESS proponents in a manner that is consistent with the relevant NER provisions in Chapter 6 or 6A.

The NER should clarify whether TUOS and DUOS is to be charged for ESS. The current ambiguity results in NSPs and proponents interpreting the rules and implementing charging arrangements individually for ESS in their network. If this is not clarified different arrangements may be implemented across the NEM, potentially creating perverse incentives for locating ESS in some regions or to configure facilities for the purpose of defeating any charging requirements rather than in a way that reflects efficient outcomes. Proponents need certainty in this area to understand the ongoing costs of their business models.<sup>207</sup>

### ***Hybrid facilities issue***

As noted in section 5.1 in relation to participant fees and charges, and recovery of non energy costs, the challenges with measuring separate energy flows for each individual asset within a hybrid facility also make it difficult to apply TUOS charges, particularly if it is decided

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<sup>206</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 20.

<sup>207</sup> *Ibid*, p. 20.

to exempt battery systems from TUOS charges. This is considered further in the next section where AEMO's solutions are discussed.

#### **QUESTION 24: ISSUES WITH TUOS AND DUOS CHARGING ARRANGEMENTS**

1. Do you agree that there is ambiguity and uncertainty around how transmission and distribution network businesses calculate and charge TUOS and DUOS for battery systems?
2. Does this ambiguity and uncertainty create a material issue for investment in battery storage projects now, or in the future as the number of energy storage projects increase across the NEM?
3. What are the pros and cons to allowing each NSP discretion in developing and applying TUOS and DUOS charges? On balance, should the approach and method to applying TUOS and DUOS charges be harmonised among NSPs?
4. Is there a regulatory risk when NSPs interpret how to apply the current rules to battery systems?

### **5.2.2**

#### **AEMO's proposal for clarifying the application of TUOS and DUOS charges**

AEMO's solution is to provide clarity to battery proponents by establishing that:

- TUOS would not apply
- DUOS would not apply to sent out electricity
- DUOS charges would apply for consumed or imported energy.<sup>208</sup>

AEMO states that clarifying these arrangements would improve investor certainty and operational efficiency. The Commission seeks feedback from stakeholders on whether this solution will address the issues identified in section 5.2.1.

#### **What is AEMO's solution?**

AEMO proposes changes to:

- relevant terms and definitions in Chapter 6 of the NER to incorporate the proposed pi-directional resource provider category
- NER clause 6.1.4 to ensure DUOS charges are not charged for sent out electricity from a bi-directional unit connected to a distribution network
- NER Chapters 6A and 10 to ensure that TUOS does not apply to battery systems (both as stand-alone units or within a hybrid facility).<sup>209</sup>

<sup>208</sup> AEMO, 2018, *Integrating Energy Storage Systems into the NEM*, p. 3.

<sup>209</sup> AEMO, 2018, *Integrating Energy Storage Systems into the NEM*, pp. 45-46.

### ***What is AEMO's rationale for not charging TUOS to battery systems?***

AEMO notes that, in relation to grid-scale batteries, it should not be required to pay TUOS charges, given a scheduled resource can be constrained off. AEMO's rationale is:

- NSPs would not increase the capacity of the shared network to provide unrestricted access to batteries. In effect, a scheduled grid-scale battery acts as a part of the supply chain. Not charging TUOS for a grid-scale battery will not increase charges to others.
- Irrespective of whether it is a stand-alone battery or part of a 'hybrid' system connected to the grid, a battery is treated as a connecting asset subject to negotiated connection charges, in this way it is being treated in a similar way to a generating unit or system.

### **Will this solution fix the problem identified?**

AEMO states that clarifying TUOS and DUOS charging arrangements will benefit battery (stand-alone or in hybrid facilities) participants, as it improves:

- Investor certainty because a battery system proponent could assess with certainty whether these costs need to be accounted for when assessing their potential business investments. This also eliminates any perverse incentives for locating batteries systems in some regions where charges may be unclear or to configure facilities for the purpose of defeating any charging requirements rather than in a way that reflects efficient outcomes.
- Operational efficiency as certainty reduces the inefficiency and debate associated with contesting whether a battery system should be charged TUOS or DUOS.

### **What issues are there with this solution?**

#### ***Is there a metering challenge to implement AEMO's solution for hybrid facilities?***

AEMO is aware the calculation of TUOS and DUOS for 'hybrid' assets will be challenging for NSPs since it will be difficult to determine the 'market load's' consumption from the grid. AEMO notes that as the NER do not define and easily allow for 'hybrid' facilities, it has to interpret the rules to accommodate these facilities in the regulatory framework and systems. It sometimes needs to work with proponents almost on a case-by-case basis as unique differences emerge.<sup>210</sup>

AEMO provides the example that if a grid-scale battery is to be exempt from TUOS charges and the 'hybrid' facility includes a load, battery and generating unit, the load's consumption from the NEM is impossible to determine on the basis of the metering data from a single metering installation at the connection point.

Further AEMO suggests that consideration of the appropriate metering arrangements for 'hybrid' facilities is needed to prevent any perverse incentives for the co-location of assets (particularly loads in 'hybrid' facilities with battery systems) or registered participants switching between categories to avoid obligations. AEMO poses the following questions to be considered:

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<sup>210</sup> AEMO, 2018, *Integrating Energy Storage Systems into the NEM*, p. 18.

- Are further requirements needed, for example should each asset in a 'hybrid' facility be required to have revenue meters or is supervisory control and data acquisition (SCADA) data appropriate?
- Can the policy option be implemented and is this consistent across the calculation of fees, charges or non-energy cost recoveries?

***Is there an inconsistency with AEMO's proposed solution for TUOS and DUOS charging?***

AEMO's solution is that battery systems should not be charged for TUOS but should be charged for DUOS for consumed energy.<sup>211</sup> The Commission notes that an overarching theme of AEMO's proposed solution for the inconsistencies in fees, and non-energy cost recovery for storage proponents was to be more fairly distributed among Market Participants, being more aligned with the causer or beneficiary pays principles.<sup>212</sup> The Commission is interested in your views on whether the approach to TUOS and DUOS charging should be consistent. That is, if it was decided to exempt TUOS charges for energy storage participants, should an exemption also apply for DUOS charges? Alternatively, if it was decided to not exempt TUOS charges for energy storage participants, should DUOS charges apply too?

**Prior stakeholder feedback**

***Emerging Generation and Energy Storage project***

In its rule change request, AEMO provides a summary of stakeholder submissions to its EGES Stakeholder Paper.<sup>213</sup>

Stakeholder views were mixed on whether energy storage systems should be charged for TUOS. Stakeholders who said energy storage systems should be charged TUOS noted:

- Application of a blanket TUOS exemption on all storage would effectively be a subsidy on storage, creating a market distortion and unfair technological advantage.
- Any proposed rules should attempt to treat storage consistent with the underlying economic principles that led to the current approach to charging customers rather than generators. This may result in zero TUOS charges for some storage business models, but in other cases TUOS charges equivalent to conventional transmission customers would be appropriate.<sup>214</sup>

Stakeholders who thought storage should not be charged for TUOS noted that charging storage TUOS would:

- create double charging of TUOS as this cost would be past onto end users who are already paying TUOS for their usage.
- be inefficient, likely distort investment signals and would not align with the need for significantly more storage investment across the NEM.<sup>215</sup>

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211 AEMO, 2018, *Integrating Energy Storage Systems into the NEM*, pp. 2-3.

212 AEMO, 2018, *Integrating Energy Storage Systems into the NEM*, p. 19.

213 AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 62.

214 *Ibid*, p. 62.

215 *Ibid*, p. 62.

### **COGATI**

Of those stakeholders who commented on energy storage systems and TUOS in their submissions to the COGATI options paper, the view was widely held that storage should not pay TUOS. A point made by the majority of stakeholders that commented on storage and TUOS was that TUOS would be double-charged if storage is required to pay for use of the transmission system — once when the electricity is imported by the energy storage system and again by the final end-user as the consumer of the electricity. The argument for this being a problem was that it would result in higher costs for consumers and be contrary to the NEO.<sup>216</sup>

Further, a majority of stakeholders expressed the view that in cases where transmission connected energy storage is used for energy arbitrage and grid support (i.e. not driving grid augmentation), such energy storage should be treated only as a generator under the existing transmission charging regime.

A number of stakeholders identified circumstances in which, or reasons why, energy storage systems should pay TUOS charges:

- Electricity “retained” by electricity storage may attract TUOS, as it is properly consumed. It may also be deemed to be auxiliary load, as this loss is necessary to operate the electricity storage device.
- A battery should pay for the costs associated with its acquisition of the energy it will later release as electricity. For example, to be consistent, a battery should pay for its electricity network costs as an importer of electricity, just as a gas turbine pays pipeline network charges for importing its gas.
- Where storage acts as a load on the system it should pay a suitable TUOS charge reflective of the loading it places on the system. A cost reflective approach makes sense as most storage facilities will act as a load during low demand/high generation times which should translate into low cost TUOS charges.
- TUOS charges may be applicable to storage facilities that do not export electricity into the grid.<sup>217</sup>

#### **QUESTION 25: SOLUTIONS FOR CLARIFYING THE APPLICATION OF TUOS AND DUOS CHARGING**

1. Do you agree with AEMO’s proposal to exempt all energy storage systems from TUOS charges? If you agree with an exemption, should the exemption of TUOS charges also apply to energy used on site (auxiliary load) i.e. energy that is not stored and sent out into the network?
2. If battery systems are exempt from TUOS charges does this:

<sup>216</sup> Refer to the 2018 COGATI Final Report [here](#) for more information.

<sup>217</sup> Refer to the 2018 COGATI Final Report [here](#) for more information.



- a. create a subsidy for battery technology and therefore an advantage over other generation technologies?
  - b. remove the ability to provide an efficient location and/or price signal to potential battery system proponents, and therefore impact on the efficient entry and location of new battery system participants?
3. If battery systems are not exempt from TUOS charges does this:
- a. create double charging of TUOS /DUOS for end use customers?
  - b. distort investment signals and not align with the need for significantly more storage investment across the NEM?
4. How should TUOS and DUOS charges apply to hybrid facilities? Should TUOS and DUOS charges be based on metered data at the network connection point, or another option? Are there technical or implementation issues with this?
5. Do you agree that battery systems should pay DUOS charges for consumed energy? Please explain why or why not.

### 5.2.3

#### **Alternative solutions for issues with TUOS and DUOS charging**

AEMO's proposed solution provides clarity for stakeholders on whether TUOS and DUOS charges apply to battery systems through the introduction of a definition for storage technologies and hybrid facilities and a new Market Participant category to accommodate them and hybrids. However, this approach:

- may not align with the ESB's two-sided market reforms currently underway, or efficiently allocate the costs associated with the use of the transmission system when TUOS charging is considered across all market participants.
- needs to be considered alongside the COGATI work, which is considering local price signals to coordinate generation and transmission investment. A requirement for battery systems to pay TUOS could disrupt these otherwise efficient price signals.

This section describes these issues and asks stakeholders to consider AEMO's proposed solution in this broader context. This section also seeks feedback on the issue of varying approaches to calculating network charges across the NSPs and if harmonising these approaches would be beneficial to Market Participants.

#### **AEMO's proposed solution and two-sided market reforms**

As noted in chapter 2, the ESB's two-sided market reforms is exploring moving away from defining specific technologies and assets in the rules and towards a technology-neutral approach that attaches obligations to services. It is proposed that within a two-sided market most participant categories would be combined into one, and the NER would impose obligations based on services provided to, or purchased from, the market, rather than on asset type. This could mean that changes made to how network charges are calculated and

which market participants they apply to could be dependent on the services provided by participants rather than the market participant category they currently belong to.

***Apportioning network costs based on services received (energy consumed)***

In the 2018 COGATI final report, the Commission identified that the fundamental principles that underpin the existing transmission framework are that the purpose of the network is to supply electricity to consumers, and that consumers of electricity pay for the costs incurred by the TNSP in providing the shared transmission services from which they benefit.<sup>218</sup> In a broader review of TUOS charging, careful consideration would need to be given to how consumption is defined. In the context of two-sided markets, it may be more appropriate to consider apportioning network charges with respect to the services provided or received by market participants (or consumption), rather than the asset type or existing categories participants belong to. This would mean that all Market Participants would pay TUOS and DUOS charges for the energy that is consumed at their network connection point. This would include auxiliary loads used to power energy generation sites and charge batteries.

AEMO's proposed solution is predicated on the NER including a definition for storage technologies. However, under the two-sided market reforms, the NER would not contain technology-specific definitions, meaning under such reforms it would not be possible to provide an exemption from TUOS for storage technologies. However, an alternative mechanism that would be consistent with the services based approach envisaged for the two-sided market would be to provide an exemption for scheduled load. Noting that scheduled load currently mainly consists of grid scale battery and pumped hydro.

The Commission would therefore like to know stakeholder views on whether there is a strong enough rationale for grid-scale batteries to be exempt from paying TUOS that would warrant storage being defined in the NER, noting this would be contrary to the reform direction under a two-sided market. Alternatively, we welcome feedback on whether stakeholders support an approach that would be more consistent with a two-sided market which would involve clarifying the application of TUOS for scheduled loads.

**COGATI - Transmission Access Reforms**

The appropriateness of TUOS for storage may be impacted by the introduction of locational marginal pricing (LMP) and financial transmission rights (FTRs) being contemplated by the Commission and the ESB.<sup>219</sup>

Under these reforms, scheduled and semi-scheduled market participants (including scheduled storage) would face the LMP at their location. LMPs reflect the short run cost of a congestion at that location, as revealed by the bidding behaviour of market participants. When a scheduled or semi-scheduled market participant exacerbates congestion by being dispatched, the LMP it receives/pays will be less favourable for the market participant (ie, receiving a lower LMP for generation, or receiving a higher LMP for load - these would not occur at the

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<sup>218</sup> Refer to the 2018 COGATI Final Report [here](#) for more information.

<sup>219</sup> Refer to the 2018 Final Report [here](#) for more information.

same time). Conversely, when a scheduled or semi-scheduled market participant alleviates congestion by being dispatched, the LMP will be more favourable for the market participant.

As such, the wholesale market price faced by scheduled storage (when acting as both load and generation) would send efficient price signals reflective of the short run cost of transmission shortages (ie, congestion). Any additional TUOS charge on scheduled storage may disrupt these otherwise efficient price signals, leading to inefficient investment and/or operational behaviour.

Furthermore, FTRs can be purchased by these market participants which provide a hedge against the cost/benefit of exacerbating/alleviating congestion, reflected in LMPs. The revenue from the sale of these FTRs will primarily be used to offset TUOS charges. Again, additional TUOS charges on those market participants may disrupt these otherwise efficient price signals sent by LMPs and FTRs.

#### **Approach for TUOS and DUOS charging**

AEMO notes that there is a broader issue with network pricing arrangements for distribution and transmission networks that needs to be reviewed.<sup>220</sup> The Commission understands that NSPs use different approaches for charging their customers, and seeks to understand stakeholder views on this. The Commission asks stakeholders to consider:

- if a more consistent approach to network charging was implemented would this create clearer investment signals for the uptake of energy storage systems?
- if a more variable network pricing framework (linked to the level of congestion) was implemented would this reduce network costs and reward energy storage proponents for storing energy in times of low demand?

#### **QUESTION 26: ALTERNATIVE SOLUTIONS FOR ISSUES WITH TUOS AND DUOS CHARGING**

1. How would charging all Market Participants TUOS and DUOS, based on the services received by participants (energy consumed) rather than based on the asset type, impact participants' behaviour and market outcomes? This would mean that all Market Participants would be liable for TUOS and DUOS charges for the energy that is consumed at their network connection point.
2. If all Market Participants were charged TUOS and DUOS, would this have any impact on existing external arrangements?
3. Is a definition for storage technologies needed to clarify TUOS and DUOS charging, or could AEMO's proposed solution or an alternate solution be implemented using the existing Market Participant categories, such as a scheduled load?
4. Are there technical issues or complications with implementing AEMO's proposed solution or an alternative solution?

<sup>220</sup> AEMO, 2018, *Integrating Energy Storage Systems into the NEM*, p. 29.

5. Do stakeholders consider there is an inconsistency in the approach NSPs use to calculate network prices? If yes, would a more harmonised approach to network pricing provide clearer investment signals across the NEM and reduce costs for battery system proponents?
6. Does the introduction of LMP and FTRs as contemplated through transmission access reform impact whether storage should face TUOS?
7. Are there any other approaches that could be considered to address the issues raised by AEMO?

## 6 STORAGE AND HYBRID INTEGRATION DRAFTING AND OTHER ISSUES

In this chapter, the Commission is seeking feedback on the other integration issues identified by AEMO in its rule change request and its proposed solutions for addressing them. These issues are contained in section 3.5 of AEMO's rule change request.<sup>221</sup> and are as follows:<sup>222</sup>

- technology specific drafting in the rules
- mandatory restrictions and intervention compensation
- the Retailer Reliability Obligation (RRO)
- network losses and marginal loss factors
- other integration issues.

### 6.1 Technology specific drafting in the rules

AEMO has identified that the NER currently contain technology specific language which does not recognise technologies or connection points that have bi-directional flows. AEMO suggests that this is because the NER were established at a time when there were low levels of bi-directional flows at connection points. While this issue was discussed in chapter 2 in relation to AEMO's proposal to insert a definition for storage into the NER, this section of the paper focuses on existing terms and definitions in the NER that AEMO proposes changing to make them more consistent with the way the market is evolving. The Commission is therefore seeking your feedback on the drafting AEMO has identified and whether the new definitions and terms proposed by AEMO are appropriate. We also seek your feedback on whether there are alternative terms and definitions that should be considered and if there are any other drafting issues that AEMO has not identified.

#### 6.1.1 **Is the technology specific drafting AEMO has identified problematic?**

According to AEMO<sup>223</sup>, the terms used in the current rules are technology-specific as they tend to refer to both a type of asset and a direction of electricity flow. It says this makes it difficult to fully integrate assets which make significant use of bi-directional flows.

Technological-neutral drafting in the NER is important for achieving the NEO to prevent undue restriction of otherwise efficient sources of generation and other electricity services.

#### **Previous consultation with stakeholders about issues relating to technology specific drafting in the NER**

Consultation conducted by the Commission and AEMO has demonstrated that stakeholders have previously been concerned that the NER are not sufficiently technologically neutral.

<sup>221</sup> AEMO, *Integrating energy storage system into the NEM - rule change request*, pp. 20-26.

<sup>222</sup> In section 3.5 of AEMO's rule change request the issue of ramp rates and aggregation is also discussed. This is addressed in chapter 3.

<sup>223</sup> *Ibid*, pp. 20-21.

This includes the Commission's *Integration of storage review*<sup>224</sup>, the Commission's *Registration of proponents of new types of generation rule change*<sup>225</sup> and AEMO's EGES paper.<sup>226</sup>

The *Integration of storage review* recognised the concern of some stakeholders that the definition of generation in the NER was ambiguous, making it difficult to register storage assets to participate in the NEM at the time.<sup>227</sup> Of the 24 stakeholder submissions made to this review, three of them explicitly stated the need to improve how a generator is defined in the NER in accordance with technology neutral principles.<sup>228</sup> AEMO's submission on the matter noted that the definition of generation in the NER at that time created legal uncertainty due to the lack of technology and process neutrality.<sup>229</sup>

The *Registration of proponents of new types of energy rule change* also sought feedback on whether the NER were technology neutral in relation to the terms 'Generator' and 'generating unit.' Of the seven stakeholder submissions received, all were supportive of AEMO's proposed amendments to the rules on the basis of their support for technology neutral drafting in the rules.<sup>230</sup>

The *COGATI* review in 2018<sup>231</sup> sought feedback on the registration of energy storage and hybrid systems in the NEM. Of the 31 submissions received only two directly addressed the issue of ensuring this process for registration is technologically neutral.<sup>232</sup> The Public Interest Advocacy Centre stated that any new participant category which seeks to incorporate storage and hybrids should be technologically neutral.<sup>233</sup> AEMO's submissions made the same claim but also included a discussion of different options for integration which are largely replicated in its EGES stakeholder paper<sup>234</sup>

As noted in chapter 2, AEMO's EGES stakeholder paper, though mainly concerned with seeking stakeholder feedback on its proposed options for better integrating storage and hybrids into the NER, did also seek stakeholder feedback on how to approach defining storage and hybrids in the NER. Of the 20 stakeholder submissions received, the vast majority were supportive of AEMO's efforts to provide a technologically neutral definition of storage and hybrids in the NER.

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224 Project page available [here](#).

225 Project page available [here](#).

226 Project page available [here](#).

227 AEMC, *Integration of storage review*, Final Report, December 2015, p. 22.

228 Ibid.

229 Ibid.

230 AEMC, *Registration of proponents of new types of generation*, Final Determination, pp. 5-6.

231 Project page available [here](#).

232 AEMC, *Coordination of generation and transmission investment*, Final Report, pp. 108-112.

233 Ibid, p. 110.

234 Ibid, p. 112.

### Issues with the definitions of load and generation

In its rule change request, AEMO states that the NEM is currently undergoing a fundamental change and that the NER must adapt accordingly. Currently, AEMO views the NER as being:<sup>235</sup>

designed around binary concepts of 'generation' and 'load' and the assumption of a one-to-one relationship between a given type of registered participant and an asset at a connection point that must (typically) be classified as either generation or load.

AEMO views this as an issue because it believes the existing binary definitions of 'generation' and 'load' make it difficult for the regulatory framework to accommodate the situation where:<sup>236</sup>

- There are increasing numbers of, and interest in connecting, energy storage systems (ESS) in the national electricity market (NEM) to support variable renewable energy (VRE), provide grid support services and leverage energy arbitrage opportunities. This is already occurring in both distribution and transmission systems.
- The number of connection points with two-way electricity flows continues to grow, including:
  - Residential customers with installed devices, e.g. rooftop photovoltaic (PV) and batteries.
  - 'Hybrid' facilities connecting to the grid with a mix of technology types at a single connection point.

### Existing definitions of load and generation in the NER

Under Chapter 10 of the NER, 'load' is defined as "the amount of electrical power delivered at a defined instant at a connection point or aggregated over a defined set of connection points." Under Chapter 10 of the NER, there are several relevant terms which relate to the definition of 'generation':

#### generated

In relation to a generating unit, the amount of electricity produced by the generating unit as measured at its terminals.

#### generating plant

In relation to a connection point, includes all equipment involved in generating electrical energy.

#### generating system

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<sup>235</sup> AEMO, *Integration of energy storage systems in the NEM - rule change request*, p. 2.

<sup>236</sup> Ibid.

(a) Subject to paragraph (b), for the purposes of the Rules, a system comprising one or more generating units.

(b) For the purposes of clause 2.2.1(e)(3), clause 4.9.2, Chapter 5 and a jurisdictional derogation from Chapter 5, a system comprising one or more generating units and includes auxiliary or reactive plant that is located on the Generator's side of the connection point and is necessary for the generating system to meet its performance standards.

#### generating unit

The plant used in the production of electricity and all related equipment essential to its functioning as a single entity.

#### generation

The production of electrical power by converting another form of energy in a generating unit.

#### Generator

A person who engages in the activity of owning, controlling or operating a generating system that is connected to, or who otherwise supplies electricity to, a transmission or distribution system and who is registered by AEMO as a Generator under Chapter 2. For the purposes of Chapter 5, the term includes a person who is required or intends to register in that capacity or is a non-registered embedded generator (as defined in clause 5A.A.1) who has made an election under clause 5A.A.2(c).

#### Sent out generation

In relation to a generating unit, the amount of electricity supplied to the transmission or distribution network at its connection point.

This set of definitions allows the NER to specify obligations by entity, facility, or unit. There is also a separate definition to refer to the quantity of power produced from generating units.

The associated terms for 'generation' in the NER were the subject of a rule change request which sought to clarify the rules for generator registration as technology neutral to unambiguously permit storage assets as eligible for registration in the NER.<sup>237</sup> This rule change was recommended by the Commission in its *Integration of storage review* in 2015, which acknowledged that the terms 'Generator' and 'generating unit' were ambiguous as they

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<sup>237</sup> Project page available [here](#).



related to storage assets.<sup>238</sup> This rule was subsequently made in 2016.<sup>239</sup> Specifically, this rule change amended the definition of 'generating unit' in Chapter 10 of the NER:<sup>240</sup>

*'The actual generator of plant used in the production of electricity and all the related equipment essential to its functioning as a single entity.'*

This rule change also deleted clause 2.2.1(b) of the NER, which stated that:

*'A person who otherwise supplies electricity to a transmission or distribution system may, on application for registration by that person in accordance with rule 2.9, be registered by AEMO as a Generator.'*

This rule change reduced ambiguity in the NER to the extent that AEMO was able to register storage assets for participation in the NEM. Subsequently, AEMO interpreted the NER such that these assets are required to register as both a Market Customer and Market Generator to effectively participate within AEMO's system and therefore the market.<sup>241</sup>

#### QUESTION 27: TECHNOLOGY SPECIFIC DRAFTING IN THE NER - ISSUES

1. Are you concerned that the terms relating to load and generation, or other terms in the NER, are not sufficiently technologically neutral? If so why?
2. Do you consider key terms in the NER such as 'generation' and 'load' are ambiguous when applied to storage and hybrids? If so, why?

### 6.1.2

#### Do you agree with AEMO's proposed updates to the drafting to make the NER more technology neutral?

##### Proposed new terms covering electricity flows

In its rule change request, AEMO proposes that the NER include new terms which recognise that registered participants can consume and produce electricity at their connection points. AEMO suggests its proposed changes will facilitate a better recognition of the two-way flows storage and hybrid facilities produce, which are central to their operation and business models.<sup>242</sup> AEMO therefore recommends that the rules should replace:<sup>243</sup>

- the second part of the definition of 'load' with the new term 'consumed electricity', which is to refer to "a quantity of electricity flowing *from* the network at a connection point"
- 'sent out generation' with the term 'sent out electricity', which is to refer to "a quantity of electricity flowing *to* the network at a connection point"

238 AEMC, *Integration of storage review*, Final Report, p. 22.

239 AEMC, National Electricity Amendment (Registration of proponents of new types of generation) Rule 2016 No. 4.

240 AEMC, *Registration of proponents of new types of generation*, Rule Determination, pp. 1-2.

241 AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 5.

242 AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 3.

243 *Ibid*, p. 21.

- 'generation' with 'produced electricity', which is to refer to "a quantity of electricity produced by a generating unit or bidirectional unit as measured at its terminals".

Any decision to change terms to make them more technology-neutral will need to consider whether the current terms are unclear and, if so, whether the proposed terms are clearer. AEMO suggests that the current terms 'generate' and 'load' are not technology neutral. However, these words could potentially describe (and are currently interpreted as describing) the operation of storage and hybrids as well as generating units and loads.

#### **Other proposed changes to the language in the NER**

AEMO also proposes to replace references to groups of registered participant categories (e.g. 'Scheduled Generators, Semi-Scheduled Generators and Market Participants') with a generic reference to 'Registered Participant' or 'Market Participant' wherever possible.<sup>244</sup>

Another key proposed change for the language in the rules is to replace 'dispatch offer' with 'dispatch bid', which would be redefined to refer to dispatch in relation to any scheduled plant (not just scheduled generation). AEMO explains its proposal as follows:<sup>245</sup>

In considering the need to accommodate market submissions for bidirectional facilities relating to either the sale or purchase of electricity, AEMO reflected on the definitions of dispatch bid and offer, and related terms. Where a distinction is made between the terms 'bid' and 'offer', it is generally understood that a person 'bids' to buy a commodity or service, and 'offers' to sell it, even though that is not how the terms are defined in the NER (they are asset-specific). In the NEM, however, it could be said that the dispatch of energy and ancillary services is a process where all participants effectively bid in order to be scheduled, whether buying or selling. It is noted that the single term 'rebid' applies to both bids and offers. Other markets offer limited comparison. The declared wholesale gas market uses 'bids' to apply to both scheduled injections (selling) and withdrawals (buying) from the market, while the gas short term trading market rules use both bids and offers, defined so as to specifically refer to withdrawal or supply respectively.

The Commission is interested in hearing stakeholder feedback on the implications of removing the term 'bid' from the rules for participants in all NEM markets.

AEMO has included a list of proposed definitions in Table 6 of its rule change request. This includes new definitions for bi-directional unit, bi-directional facility, and the new bi-directional resource provider category.

#### **Extent of the proposed language changes**

Due to the scale of amendments required to properly address what AEMO perceives as technology specific drafting in the NER, only a portion of what these changes would entail have been provided in the form of a drafting proposal. As part of its rule change request, AEMO has provided a detailed drafting proposal for Chapters 2, 3 and 10 of the NER to

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<sup>244</sup> Ibid, p. 34.

<sup>245</sup> Ibid, pp. 32-33.

demonstrate what it believes is a “workable and reasonably simple approach to integrating bi-directional resource providers into the rules.”<sup>246</sup>

By analysing the frequency of new key terms which AEMO is proposing to insert into the NER, it is possible to assess the scale of changes AEMO is proposing for just a portion of the NER. AEMO has provided a table of all the new, amended and deleted terms it has included in its detailed drafting proposal for Chapters 2, 3 and 10 of the NER.<sup>247</sup> Table 6.1 demonstrates the scale of AEMO’s proposed changes to the NER by showing how many times new terms have been inserted into Chapters 2, 3 and 10 of the NER throughout the drafting proposal provided. It shows that new terms would need to be inserted into those chapters 978 times to accommodate the usage of the new terms proposed by AEMO. Importantly, this figure only indicates a portion of the changes required to integrate storage and hybrids into Chapters 2, 3 and 10 of the NER under AEMO’s proposed changes. The table below only counts the frequency of new terms inserted into this drafting proposal and does not account for the number of other amendments and deletions required.

**Table 6.1: The frequency of new terms inserted into Chapters 2, 3 and 10 of the NER in AEMO’s detailed drafting proposal.**

<b>TERM</b>	<b>NUMBER OF APPEARANCES IN DRAFTING PROPOSAL</b>
adjusted consumed energy	23
adjusted sent out energy	17
bi-directional facility	35
Bi-directional Resource Provider	215
Bi-directional Resource Provider transmission use of system, Bi-directional Resource Provider transmission use of system service	1
bi-directional unit	283
consumed electricity	43
dispatched bi-directional unit	1
dispatched electricity	2
embedded bi-directional unit	3
Market Bi-directional Resource Provider	117
produced electricity	15
Scheduled Bi-directional Resource Provider	42
scheduled bi-directional unit	145
Sent out electricity (replaces ‘sent out generation’)	18
small bi-directional unit	18

<sup>246</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 21.

<sup>247</sup> *Ibid*, pp. 48-52.

<b>TERM</b>	<b>NUMBER OF APPEARANCES IN DRAFTING PROPOSAL</b>
<b>Total</b>	<b>978</b>

Source: AEMO, 2018, *Integrating energy storage systems into the NEM - rule change request*, p. 48.

#### **QUESTION 28: TECHNOLOGY SPECIFIC DRAFTING IN THE NER - PROPOSED SOLUTION**

1. Would AEMO's proposed changes to these key terms in the NER assist with the effective integration of storage and hybrids in the NER? Are there other terms or definitions that are more appropriate than those suggested by AEMO?
2. Do you think the benefits of this proposed drafting solution would likely outweigh the costs, given the scale of the changes?
3. Would changes to these fundamental terms in the NER affect related external documents such as contracts, procedures and guidelines (other than AEMO's), and if so would the changes cause you to incur costs or other difficulties? What implementation period would be needed to address these issues?

### **6.1.3**

#### **What other options should we consider?**

It is important to note that AEMO acknowledges there are other potential drafting options available, and that the detailed drafting provided is merely one option for making the NER more technologically neutral.<sup>248</sup>

#### **QUESTION 29: TECHNOLOGY SPECIFIC DRAFTING IN THE NER - OTHER OPTIONS**

1. Are there other terms and definitions in the NER that are not sufficiently technology neutral?
2. What are some other drafting approaches which could be used to make the NER more technology neutral?

## **6.2**

### **Intervention compensation frameworks**

As part of considering how all the various obligations should apply to storage and hybrid facilities, in its rule change request, AEMO has questioned how the intervention compensation frameworks should apply to storage and hybrid facilities. In particular, AEMO has queried how the frameworks would apply to AEMO's proposed new bi-directional resource provider participant category. AEMO did not set out a particular approach for

<sup>248</sup> Ibid, p. 21.

applying these frameworks to storage and hybrids because the frameworks were subject to rule change requests that were yet to be submitted at the time.

Through this rule change request, the Commission will need to determine whether:

- a separate compensation framework should apply to storage and hybrid facilities: or
- the framework that currently applies to scheduled generator and scheduled loads other participants should continue to apply to storage and hybrids (subject to any changes to the compensation framework that are currently under consideration).

Exactly how the Commission determines the framework will apply to storage and hybrids will depend on whether the Commission decides to make a rule that includes AEMO's proposed new participant category for storage and hybrid facilities; the bi-directional resource provider.

Your feedback is sought on whether you consider there are issues with the way the compensation frameworks currently apply to storage and hybrid facilities (in addition to those issues already being considered by other rule change processes) and whether there is a need for a separate approach to apply to them.

### 6.2.1

#### **AEMO has questioned how the intervention compensation frameworks apply to storage and hybrids**

The increasing use of interventions in the NEM has prompted both the Commission and AEMO to undertake reviews of intervention mechanisms, intervention pricing and related compensation frameworks in the NEM. Since 2017, more than 515 directions have been issued by AEMO.<sup>249</sup> Figure 6.1 illustrates how significant this rise in the use of directions has been in recent years. This growing use of directions in the NEM is what led the Commission to launch the *Investigation into intervention mechanisms in the NEM*.<sup>250</sup>

Following anomalous intervention pricing outcomes, AEMO established the Intervention Pricing Working Group to consider whether changes were needed to the intervention pricing methodology, and to consider other issues related to the interventions frameworks.<sup>251</sup> These pieces of work carried out by the market bodies, as well as other market events, have led AEMO to lodge several rule change requests related to these frameworks. These are at differing stages of the rule change process.

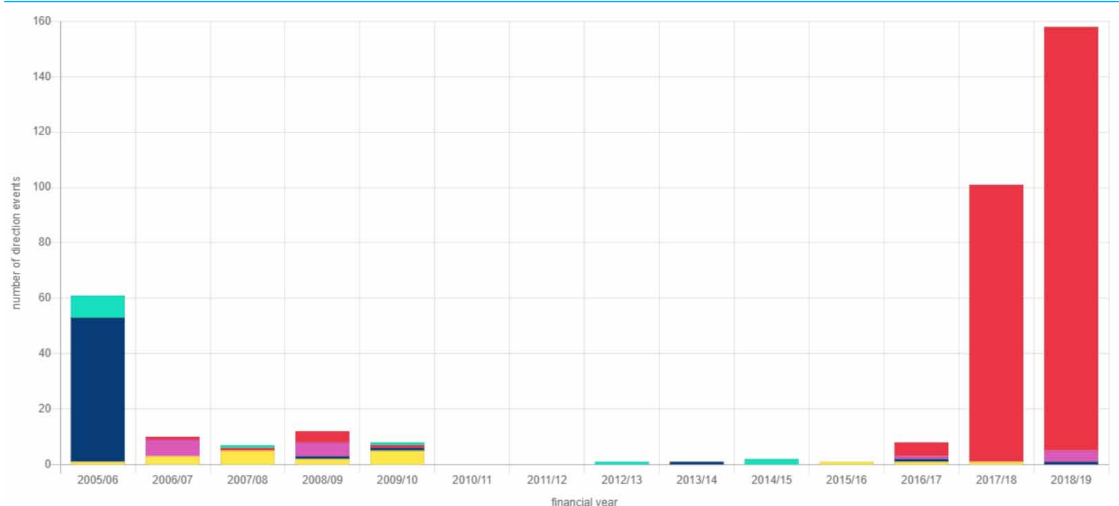
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<sup>249</sup> AEMC, *Compensation for market participants affected by intervention events*, consultation paper, p. 5.

<sup>250</sup> Project page available [here](#).

<sup>251</sup> Details available on AEMO's website [here](#).

Figure 6.1: Directions issued by AEMO in the last decade



Source: Reliability Panel, 2019 Annual Market Performance Review, Final report, 12 March 2020, p. 147.

When AEMO lodged its *Integrating energy storage systems into the NEM* rule change request, it did not propose any specific changes to the mandatory restrictions or affected participant compensation frameworks to accommodate storage and hybrids. This was because these frameworks were to be the subject of other rule change requests which had not yet been submitted.<sup>252</sup> However, AEMO did provide the following comment on how it considered the mandatory restrictions frameworks should apply to storage assets in this rule change request:<sup>253</sup>

AEMO considers that a bi-directional resource provider should be eligible for intervention compensation because it could be impacted by an AEMO intervention event, however further consideration is needed to determine the appropriate calculation and recovery method for this proposed new category. In particular, it will be necessary to consider different 'what-if' scenarios and (if relevant) transparent compensation measures depending on the composition of a bi-directional facility. Given the need to consider rule changes for intervention compensation, AEMO has not proposed drafting amendments to incorporate Bidirectional Resource Providers into NER rule 3.12 at this stage.

AEMO's rule change request (quoted above) articulates its view that bi-directional resource providers should be eligible for affected participant compensation under rule 3.12. As noted,

<sup>252</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 23.

<sup>253</sup> Ibid.

however, further consideration may be required as to how such compensation is calculated and recovered.<sup>254</sup>

The mandatory restrictions and intervention compensation frameworks, as well as other relevant compensation frameworks in the NER, are discussed in appendix c. Please note that this consultation paper will not deal with the issue of applying the mandatory restrictions framework to storage and hybrids. This is because in its rule change request, AEMO did not propose any drafting amendments to incorporate bi-directional resource providers into the mandatory restrictions framework given the Commission's recommendation to remove that framework.<sup>255</sup>

### Other compensation frameworks in the NER

Two other compensation frameworks need to be considered to determine whether any changes should be made to better integrate storage and hybrids into the rules. These are the market suspension and administered price period compensation frameworks.

The **market suspension framework** applies if, during a market suspension, prices are set by the market suspension pricing schedule rather than by the normal dispatch and pricing process.<sup>256</sup> Given that the objective of this framework is to remove the incentive for generators to withdraw and await direction where market suspension pricing schedule prices are low, the compensation framework focuses on scheduled generators (which could include grid-scale storage units under the current framework) as these are the parties who would typically be directed by AEMO in the event that they did not provide services voluntarily.

The framework was established in the wake of the black system event and market suspension in South Australia in 2016 and has not been used since its inclusion in the NER.

Compensation is payable to scheduled generators and ancillary service providers in the suspended region if prices in the market suspension pricing schedule are not sufficient to cover their estimated short run marginal costs.<sup>257</sup>

If a participant suffers a loss as a result of an administered price period, the **administered price period compensation framework** enable a participant to make a claim for direct costs and opportunity costs. Administered price periods occur when the cumulative price threshold is triggered following a prolonged period of high prices.<sup>258</sup>

254 The reference to "what if" scenarios relates to AEMO's use of intervention pricing, or "what if", pricing data to calculate affected participant compensation. To implement intervention pricing, AEMO runs the NEM dispatch engine twice. The "dispatch run" sets the dispatch targets for all units in the market, including those which are operating under direction. While this run dispatches the physical market, it does not set the price at which the market clears. That is the role of the intervention pricing or "what if" run: this run excludes the directed units in order to estimate what the price would have been if the intervention had not occurred. Affected participant compensation is calculated based on the difference in the dispatch targets in these two runs.

255 AEMC, *Investigation into intervention mechanisms in the NEM*, Final Report, p. 135.

256 Clause 3.14.5A of the NER.

257 The Commission noted that this framework is consistent with the cost-based approach to compensation it would like to see applied to the directed participant compensation framework: AEMC, *Investigation into intervention mechanisms in the NEM*, Final report, p. 67.

258 When the cumulative sum of spot prices in a region across a rolling seven day period exceeds the cumulative price thresholds (currently set at \$224,600), an administered price cap of \$300/MWh is imposed, together with an administered floor price of -\$300/MWh. This administered price period continues until the rolling seven day cumulative price drops back below the level of the cumulative price thresholds.

The objective of this framework is to maintain the incentive for generators and network service providers to supply energy, ancillary service providers to supply ancillary services and market participants with scheduled load to consume energy during an administered price period. By providing a compensation framework, the NER reduce the probability that market participants with high marginal costs will await a direction from AEMO rather than dispatch voluntarily during such periods.<sup>259</sup> Only one claim has been lodged under this framework (by Synergen in 2009).

### 6.2.2 **Reforms to the intervention compensation frameworks are the subject of two rule change processes**

Certain changes to the intervention compensation framework are the subject of the *Compensation for market participants affected by intervention events*<sup>260</sup> and *Compensation following directions for services other than energy and market ancillary services*<sup>261</sup> rule changes.

The *Compensation for market participants affected by intervention events* rule change is considering reconciling a symmetry of obligations for scheduled generators and scheduled loads within the affected participant compensation framework by considering the inclusion of FCAS costs, amongst other issues, which currently exist in them. Conversely, the *Compensation following direction for services other than energy and market ancillary services* rule change is clarifying intervention compensation obligations for participants as they relate to 'other services' such as a direction for a battery to maintain a specific state of charge in order to maintain system security. Appendix c provides a more in-depth discussion of the context for these rule changes, the issues they are considering and stakeholder engagement with them thus far.

### 6.2.3 **How should the compensation frameworks apply to storage and hybrids?**

Even if changes are made to the way storage and hybrid assets register in the NEM via the incorporation of AEMO's proposed bi-directional resource provider registered participant category, there will remain a need for a compensation framework for scheduled generators and scheduled loads which are not registered as bi-directional resource provider. As such, the existing compensation frameworks for scheduled generators and scheduled loads could continue to apply (with any appropriate amendments) to storage and hybrids, as an alternative to creating a new compensation calculation and cost recovery methodology specifically for bi-directional resource provider.

An example of the kinds of appropriate changes that might be considered for the existing framework due to their potential interaction with storage and hybrids can be found in clause 3.15.7B of the NER. The Commission notes that the wording of clause 3.15.7B does not refer

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<sup>259</sup> For a more detailed discussion of the different compensation mechanisms refer to: AEMC, *Compensation for market participants affected by intervention events*, Consultation Paper, pp. 24-27.

<sup>260</sup> Project page available [here](#).

<sup>261</sup> Project page available [here](#).



to all parties which may be the subject of a direction. For example, clause 3.15.7B(a)(1) enables a directed participant <sup>262</sup>to claim additional compensation with respect to loss of revenue and net direct costs incurred in respect of a “scheduled generating unit, semi-scheduled generating unit or scheduled network services, as the case may be, as a result of the provision of the service under direction”. Of relevance to bi-directional resource providers, this provision does not refer to scheduled loads, even though AEMO can – and has – issued directions to utility scale batteries (which are registered as market customers with scheduled loads).

Similarly, clause 3.15.7B(a3) refers to direct costs incurred by a generating unit or network service in the course of complying with a direction. Again, no reference is made to scheduled loads, presumably reflecting the fact that – when such provisions were drafted – it was not envisaged that AEMO would issue directions to scheduled loads. As part of changes to better accommodate bi-directional resource providers, the Commission seeks feedback on whether changed should be made to clause 3.15.7B to create consistency with the existing definition of directed participant and address the omission of scheduled loads.

Furthermore, as AEMO has also proposed changes to the market suspension framework and administered price period compensation framework to integrate bi-directional resource providers into them<sup>263</sup>, the Commission is also requesting stakeholder feedback on these the current arrangements for these frameworks and AEMO’s proposed changes to them.

#### **Should a separate framework for storage and hybrids apply?**

If a specific compensation framework was to be developed for these assets, it would need to maintain sufficient consistency with the existing compensation frameworks for generators and loads to avoid the potential for market distortion. In view of this, we welcome stakeholder feedback on whether there is a need to change existing arrangements and what the benefits would be of developing a compensation framework specifically for storage and hybrids.

The compensation framework that currently applies to scheduled generators and loads following directions for other services will remain in the NER, even if new registration categories are introduced for storage and hybrid facilities. Therefore, this existing framework could continue to apply to these emerging assets Alternatively, a separate framework could be developed for these assets if it was considered necessary and efficient to do so.

As the Commission will need to determine if there are issues with how the compensation framework applies to storage and hybrid facilities and if this warrants the development of a separate framework, or amendments to the existing framework that go beyond the specific issues considered in the rule change projects described above, we request stakeholder feedback on the following questions.

<sup>262</sup> Defined as “a Scheduled Generator, Semi-Scheduled Generator, Market Generator, Market Ancillary Service Provider, Scheduled Network Service Provider or Market Customer the subject of a direction”.

<sup>263</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, pp. 38, 43, 44.

### QUESTION 30: INTERVENTION COMPENSATION - ISSUES

1. What other specific issues relating to storage and hybrid assets need to be considered in formulating appropriate intervention compensation arrangements?
2. Are the current arrangements for applying the market suspension framework and administered price period compensation framework to storage and hybrid appropriate in light of the increasing numbers of these facilities in the NEM? If not, what changes do you consider are required?
3. Should changes be made to clause 3.15.7B to create consistency with the existing definition of direct participant and address the omission of scheduled loads?

### QUESTION 31: INTERVENTION COMPENSATION - SOLUTIONS

1. Do you consider that a separate compensation framework should be developed for storage and hybrid assets, or should they continue to be compensated in line with existing intervention compensation frameworks in order to minimise market distortions, subject to the amendments currently under consideration?
2. If you consider a separate compensation framework should be developed, how should it differ from the existing frameworks?
3. If you consider that the current frameworks should continue to apply to storage and hybrid assets, are any additional amendments required?

## 6.3 Retailer Reliability Obligation

In its rule change request, AEMO also raises the matter of how the RRO should apply to storage and hybrid facilities. In particular, AEMO raises the issue of whether storage and hybrids should be liable entities under the RRO in respect of their loads. This section of the consultation paper explores this issue and seeks feedback on whether the application of the RRO needs to be clarified for storage and hybrids, and if so, what this obligation should be.

### 6.3.1 Brief overview of the RRO and how it relates to storage and hybrids

The RRO is designed to encourage Market Customers (retailers) to contract and invest in dispatchable capacity and demand response to support the reliability of the power system.<sup>264</sup> A Market Customer is considered a liable entity under the RRO if it's aggregate annual load is over 10GWh in a particular NEM region.<sup>265</sup>

Consultation documents and provisions in the NER indicate that contracts with operators of storage assets were intended to reduce a liable entity's obligation under the RRO, in the

<sup>264</sup> COAG Energy Council Energy Security Board, *Retailer Reliability Obligation Final Rules Package*. Available [here](#).

<sup>265</sup> See Part D in Chapter 4A of the NER.

same way as contracts with providers of generation or demand response. For example, the second sentence of the *Retailer Reliability Obligation Regulation Impact Statement* states that the RRO “requires retailers to contract with generation, storage or demand response to incentivise dispatchable generation to be available to meet consumer and system needs”.<sup>266</sup>

### 6.3.2 How should the RRO apply to storage and hybrids?

#### **AEMO considers storage should be exempt from the RRO unless co-located in a hybrid facility with separate load**

In its rule change request, AEMO identifies that storage and hybrid facilities will be RRO liable entities (subject to the energy use threshold) if they are registered as Market Customers for the load component of their facility, even though these units help improve system reliability.<sup>267</sup> A Market Participant with a storage unit is a liable entity if it has an aggregate annual load above 10GWh.<sup>268</sup> This obligation applies to retailers with storage and hybrids, as well as Market Customers that only control storage and hybrids, if they are large enough.

The electricity consumed by these assets may also count towards a Market Customer’s liability under the RRO, and AEMO suggests in its rule change request that this may not be appropriate given the function they would likely play in the market:

because an ESS is likely to consume and store electricity when demand is low, and to produce electricity in periods of high demand, an ESS should be regarded as improving system reliability.<sup>269</sup>

Therefore, AEMO proposes that storage assets, and therefore bi-directional resource provider, should not be a liable entity under the RRO on the condition that they are not co-located in a facility that includes a separate load:

a bi-directional resource provider should not be a liable entity under the RRO unless its facility includes a load. This approach means that end user loads remain within the RRO framework, as intended, without creating incentives to install ESS with a load to avoid the RRO obligation.<sup>270</sup>

#### **Issues to consider in relation to AEMO’s proposed solution**

In considering AEMO’s proposal to provide storage a conditional exemption under the RRO, it may be helpful to consider whether these assets would or would not contribute to reliability issues, and whether the implementation issues associated with identifying the behaviour of storage assets within hybrid facilities can be overcome.

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<sup>266</sup> Energy Security Board, 2018, *Retailer Reliability Obligation Decision Regulation Impact Statement*, 19 December 2018, p. 4. Italics our emphasis. Accessed [here](#).

<sup>267</sup> AEMO, 2019, *Integrating energy storage systems into the NEM - rule change request*, pp. 23-24.

<sup>268</sup> Ibid, p. 23.

<sup>269</sup> AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 23.

<sup>270</sup> Ibid, p. 24.

***Is it correct to assume that storage would not contribute to reliability issues?***

Whether it is appropriate to make the load component of storage and hybrids liable under the RRO depends, at a high level, on the extent to which they contribute to reliability gaps. Storage and hybrids would help contribute to reliability if they discharge energy during a reliability gap. However, they would reduce system reliability if they consumed electricity during a reliability gap.

Reliability gaps occur when the system is at peak demand, and peak system demand often correlates with high prices. There is no obvious reason why storage or hybrid facilities would charge from the grid when prices are very high. However, it is not absolutely guaranteed that they would never charge from the grid during a high price period, and the data indicates that some batteries do charge during high price periods.

There is currently load and generation available for five grid-scale batteries in the NEM: the Ballarat Battery Energy Storage System ('Ballarat'), the Dalrymple ESCRI Battery ('Dalrymple'), the Gannawarra Energy Storage System ('Gannawarra'), the Hornsdale Power Reserve ('Hornsdale') and the Lake Bonney Battery Energy Storage System ('Lake Bonney'). Table 6.2 summarises the behaviour of grid-scale storage in the relevant energy spot market during high price events (over \$5,000/MWh) as of 16 June 2020.<sup>271</sup> It shows that although historically unlikely, some batteries do charge from the grid during high price periods, with the Dalrymple ESCRI Battery and Hornsdale Power Reserve having approximately five per cent of their activity (in MWh) attributable to load during high price events.

**Table 6.2: Behaviour of grid-scale batteries during high price events (>\$5,000/MWh) as of 16 June 2020**

ENERGY STORAGE SYSTEM	# HIGH PRICE INTERVALS	# OF GENERATION INTERVALS DURING HIGH PRICE EVENT INTERVALS	# LOAD INTERVALS DURING HIGH PRICE EVENT INTERVALS	TOTAL GENERATION (MWH)	TOTAL LOAD (MWH)	% ACTIVITY IN MWH AS LOAD
Ballarat	166	52	0	1106	0	0%
Dalrymple	170	21	37	264	16	5.77%
Gannawarra	166	93	18	1136	22	1.88%
Hornsdale	242	180	27	4621	218	4.51%
Lake Bonney	150	42	5	933	38	3.94%

Source: NEOPoint

<sup>271</sup> This figure was chosen because the AER is required to publish a report whenever the spot price for electricity exceeds this level - NER clause 3.13.7(d).

Further, high prices do not always correlate with reliability gaps. Prices could be moderate or low during system peak demand if there is sufficient generation deployed. Market Participants also cannot be certain exactly when a reliability gap will occur. In fact, a reliability gap period can be declared after it has occurred. As such, there is a risk that storage assets could charge during a reliability gap if prices are low.

The current rules count load for a storage unit towards a liable entity's liable load, while the proposed rule would not. It is not clear whether either of these arrangements are appropriate if a storage unit actually charges during a reliability gap.

As discussed above, it is possible that a storage unit may charge during a reliability gap. If this occurs, it would contribute to the need for additional supply or demand reduction. To assess whether it is appropriate to exclude this load from a liable entity's liable load under the proposed rule, it may be necessary to consider:

- the options storage units have to identify when a reliability gap will occur and to avoid charging from the grid during peak demand
- whether exempting storage units from RRO liability could establish perverse incentives that may allow these loads to charge during peak demand and avoid RRO obligations
- whether placing obligations on storage units to procure additional capacity to cover their load component is in line with the objectives and intention of the RRO
- whether the current framework unintentionally creates a 'feedback loop' where ESS units built to provide firmness under the RRO also increase the need for additional firm capacity
- whether it is justifiable (in light of the benefits of technology neutrality) to treat the controllable load used by storage facilities differently, for the purposes of the RRO, from other forms of controllable load.

#### QUESTION 32: RRO - ISSUES

1. Is it appropriate for the electricity imported from the grid for the purposes of energy storage to form part of a liable entity's liable load under the RRO?
2. Should operators of storage assets be liable entities under the RRO?

#### QUESTION 33: RRO - SOLUTIONS

1. Do stakeholders agree with AEMO that the RRO should apply to storage only when the storage system is co-located with a separate load in a hybrid facility (this does not refer to the battery's own load)?
2. Would alternative or additional changes to the application of the RRO to load for storage be more appropriate?

#### QUESTION 34: RRO - STORAGE CONTRIBUTION TO RELIABILITY ISSUES

1. What are your views on the issues outlined above which relate to whether or not storage contributes to reliability issues?
2. Are there any other issues to consider when evaluating the treatment of load used for storage under the RRO?

#### **Implementation issues**

Implementing AEMO's proposal to exempt storage under the RRO, conditional on not being co-located with a separate load, depends on whether it is appropriate, and possible, to effectively identify the energy flows of storage assets within hybrid facilities. Although this issue has already been discussed in chapter 5, its resolution is critical for implementing AEMO's proposed changes to how storage assets in hybrid facilities are liable under the RRO. When discussing the problems with implementing a conditional RRO exemption AEMO notes that:

A liable entity's liable load is currently calculated at the connection point; this will need to be considered when accommodating hybrid facilities... AEMO has identified there are challenges measuring the energy flows of assets within a 'hybrid' facility which need to be addressed. While there are potential solutions to these, if the policy is to recover RRO liabilities for the actual consumption of loads within 'hybrid' facilities instead of at the connection point, the rule will need to prescribe how the recovery mechanism will work.

Any change to the point at which a liable entity's liable load is calculated, to consider flows behind the connection point, should be considered in light of the participation framework proposed in the ESB's two-sided market design, which focuses on services provided at connection points.<sup>272</sup>

#### QUESTION 35: RRO - IMPLEMENTATION ISSUES

Should RRO liabilities for hybrid facilities continue to be calculated at the connection point? If not, where?

### 6.3.3

#### **Does storage require special treatment under the RRO?**

As the Commission will need to determine if there are issues with how the RRO applies to storage and hybrid facilities, and evaluate if this warrants the development of a separate market participant category, we request stakeholder feedback on the following questions.

<sup>272</sup> ESB, Moving to a two-sided market, April 2020, chapter 3. Accessed [here](#).

### QUESTION 36: RRO - OTHER OPTIONS

Can the issues (if any) related to the application of the RRO to storage and hybrids be resolved without establishing a new market participant category for these facilities?

## 6.4 Network losses and marginal loss factors

As part of considering how the various obligations should apply to storage and hybrid facilities, AEMO has considered how network losses and marginal loss factors should apply to these assets. As AEMO has not proposed any significant changes to how MLFs are calculated for storage and hybrids from the current arrangements, this section seeks feedback on whether stakeholders believe these arrangements are appropriate.

### 6.4.1 How network losses and marginal loss factors currently apply to storage and hybrids

MLFs notionally describe the marginal electrical energy losses for electricity transmitted between a regional reference node and a transmission connection point in the same region for a defined time period and associated set of operating conditions.<sup>273</sup> MLFs are also commonly referred to as intra-regional loss factors, transmission loss factors and static loss factors.

The requirements in relation to the calculation of MLFs and inter-regional loss factors for the NEM transmission networks are found in clauses 3.6.1, 3.6.2 and 3.6.2A of the NER. In addition to these provisions, AEMO also publishes its calculation methodology.<sup>274</sup>

These requirements were the topic of a rule change process, the *Transmission Loss Factors* rule change<sup>275</sup>, which concluded in February 2020. This rule change made several improvements to the MLF methodology, which mainly focused around permitting more flexibility in their calculation to better suit AEMO and stakeholders.<sup>276</sup>

#### How marginal loss factors currently apply to storage and hybrids

In its rule change request, AEMO describes how MLFs currently apply to storage and hybrid assets. Using a stand-alone battery system as an example of a storage asset, AEMO notes that separate loss factors are required for both the load and generation components of the battery.<sup>277</sup> For hybrid facilities the same principle applies: separate MLFs are given for both the load and generation components of the facility, whereby both MLFs together account for all load and generation components of all the assets within the facility.<sup>278</sup> This approach is

273 Clause 3.6.2(b)(1) of the NER.

274 This can be found on AEMO's website available [here](#).

275 Project page available [here](#).

276 AEMC, *Transmission loss factors, Final Determination*, p. iv.

277 AEMO, *Integrating energy storage systems into the NEM - rule change request*, p. 11.

278 *Ibid*, p. 12.

consistent with the NER,<sup>279</sup> which stipulate the use of two MLFs for assets where one does not, as closely as is reasonably practicable,:

the average of the marginal electrical energy losses for electricity transmitted between a transmission network connection point and the regional reference node for the active energy generation and consumption at that transmission network connection point.

#### **QUESTION 37: MARGINAL LOSS FACTORS - ISSUES**

Are the current arrangements for calculating and applying MLFs to storage and hybrids appropriate in light of the increasing numbers of these facilities in the NEM? If not, what changes do you consider are required?

### **6.4.2**

#### **How AEMO proposes network losses and marginal loss factors to apply to storage and hybrids in the rule change request**

In its rule change request, AEMO identifies that the treatment of MLFs for bi-directional resource providers should be consistent with the current arrangements. When considering how MLFs should apply to bi-directional resource providers, AEMO considers that<sup>280</sup>:

'MLFs are calculated for a registered participant at the connection point in accordance with AEMO's Forward-Looking Transmission Loss Factor methodology. Typically, where there are bi-directional flows two loss factors will be calculated.'

As should be clear from the summary of the current arrangements given above, AEMO is not proposing any changes to how MLFs are applied to storage and hybrid assets. The only thing to note is that these applications would be formally recognised using AEMO's proposed bi-directional resource provider market participant category.

#### **QUESTION 38: MARGINAL LOSS FACTORS - SOLUTION**

Do you agree with AEMO's proposed solution of applying the existing arrangements for applying MLFs to its proposed new market participant category (if this category were to be established)?

### **6.5**

#### **Other integration issues**

AEMO also identified several other issues during the preparation of its detailed drafting proposal, and has proposed solutions to resolve them. While the majority of these issues relate to omissions or mistakes identified in the existing rules by AEMO, the issue of representation on the Reliability Panel is also considered. Therefore, the Commission is

<sup>279</sup> Clause 3.6.2(b)(2)(i).

<sup>280</sup> Ibid, p. 63.



seeking stakeholder feedback on the gravity of these issues for stakeholders and whether AEMO’s identified solutions reflect this.

### 6.5.1 Reliability Panel membership

AEMO has proposed for storage and hybrids to be formally represented on the Reliability Panel.<sup>281</sup>The Reliability Panel reviews and reports on the safety, security and reliability of the national electricity system and also sets a number of technical standards and guidelines.<sup>282</sup>

The NER require that the panel comprises members that represent Generators, Market Customers, TNSPs, DNSPs, and end use customers.<sup>283</sup> The NER do not currently require the Panel to include a member that specifically represents storage and hybrid proponents. However, the Commission has discretion to appoint up to three members who may have expertise in areas that are not otherwise represented by other Panel members.<sup>284</sup>

#### QUESTION 39: RELIABILITY PANEL REPRESENTATION

Is it appropriate to require that the Reliability Panel include a member to specifically represent storage and hybrid asset proponents, or are the current mandatory and discretionary membership provisions adequate?

### 6.5.2 Feedback is sought on the range of other drafting issues AEMO has identified

When writing its detailed drafting proposal for Chapters 2, 3 and 10 of the rules AEMO also identified a collection of additional issues in the existing drafting of the NER. AEMO has suggested the Commission consider these in the rule change request process. However, these issues do not necessarily relate to storage and hybrid facilities. The table which identifies and summarises these issues in the rule change request has been replicated below in Table 6.3.

**Table 6.3: Other drafting issues in the NER identified by AEMO**

CLAUSE	ISSUE
2.2.1(c) and (d)	Note in paragraph (c) is incomplete and therefore inaccurate. Paragraph (d) only identifies that AEMO can exempt a person or class of persons from the requirement to register as a Generator for only a generating system or class of generating systems. This should also include generating units.
2.2.6(b), (e)(2), 2.3.5(b)(1)(e)(1A)	Where occurring, the references should be to an ‘applicant’ since the person is not yet a registered participant.

<sup>281</sup> Ibid, p. 46.

<sup>282</sup> More information available [here](#).

<sup>283</sup> Clause 8.8.2(a)(3) of the NER.

<sup>284</sup> Clause 8.8.2(a)(3)(F) of the NER.

CLAUSE	ISSUE
), (2)	
2.2.6(d), 2.3.5(d), 2.9.1(c) and 2.9A.2(d)	These clauses require AEMO to deem an application as withdrawn if AEMO has not received all the necessary information or clarifications within 15 business days of AEMO requesting the information. It is more appropriate to allow AEMO the discretion to withdraw an application instead.
3.6.3(c)and (d)(1)	References to 'predominant load flows' is incorrect. These flows refer to NER clauses 3.6.3(b)(2)(A) and (B), which refers to consumed and sent out electricity.
3.6.5(4) and (4A)	"then" is duplicated.
3.8.4(c)(3)	Should refer to 'energy constrained scheduled generating units'.
3.8.5(b)	Repetitive and extraneous information. Requirement for off-loading prices in the generation dispatch offer is also incorrect, this information is not required.
3.8.6(c), (h)(3)(ii), (f), (h)(1)and (2), 3.12.2(2)	Duplicated use of terms.
3.8.7(m)	The reference to 'may' is incorrect. Other references in the clause refer to 'must'. Where a scheduled generating unit has an energy constraint it must indicate its daily energy availability.
3.7C, 3.8.10, 3.9.3D	Consistent with other provisions, new paragraphs have been included to allow AEMO to make minor and administrative changes to the Constraint Formulation Guidelines, EAAP Guidelines and reliability standard implementation guidelines without undertaking a Rules consultation.
3.8.17(c), 3.8.18(a)	Should refer to Scheduled Generator, not Generator.
3.8.21(d)	Dispatch instructions are not always issued using automatic generation control (AGC) system and not via an electronic display in the plant control room. For future proofing, the drafting should only refer to electronic communication.
3.13.3(a)(3)	Refers to 'Scheduled Generators' and Semi-Scheduled Generators', this is an error since only Market Participants can be suspended.
3.13.3(l2)	This clause misinterprets the requirements in S5.2.4, which currently only applies to 30MW+generating systems, whether pre-or post-registration. Therefore, the requirement is not separate from a registered Generator's obligation and can be covered by slightly expanding 3.13.3(a).
3.13.3(l2)(5)	Transmission Network Service Provider is not italicised.
3.13.4(p)(5)	Inappropriate reference to "as measured by AEMO's telemetry system".

CLAUSE	ISSUE
	The Market Participant's SCADA measures and AEMO receives via SCADA.
3.15.8(f)(2), 3.15.8A(g)(2),3.1 5.10C(b)(7)(i),(c) (3)(iii)(B)	Delete 'TSRP', this is not defined.
3.15.8(f)(2)	Delete 'TRSP', this is not defined.
3.15.21(c2)(2)(ii)	Market Ancillary Service Provider omitted from the clause. Under the Ancillary Services Unbundling Rule 2016 this provision was to exclude retailers (Market Customers) only. Although it is unlikely that a MASP would incur liabilities, excluding them was not the intent.
3.8.18(e)	Reference to 'Market Participant' is incorrect, the obligation is only on Scheduled Generators.
3.8.20(g)	Reference to scheduled generating unit and semi-scheduled generating unit omitted.
3.8.20(i)	AEMO should make documentation on the operation of the pre-dispatch process available only to Market Participants.
3.8.20(j)(2)	This should refer to a unit instead of an entity.
3.8.20(k)	'Scheduled load' omitted.
7.4.1(e)	MSGAs omitted from this clause.
dispatched load	Redundant definition, this is the same as scheduled load.
peak load definition	Definition is circular.

Source: AEMO, *Integrating energy storage systems into the NEM - rule change request*, pp. 24-25.

#### QUESTION 40: OTHER DRAFTING ISSUES - ISSUES

1. Do you consider it appropriate to address these additional drafting issues identified by AEMO in the course of this rule change process?
2. Are there any other issues similar to those presented in Table 6.3 which have not been identified by AEMO, which you consider should be addressed in the course of this rule change process?

### 6.5.3

#### Feedback is sought on AEMO's proposed solutions to these drafting issues

After identifying these other drafting issues in the NER, AEMO proposed how to resolve these in the rule change request. The table in the rule change request which nominates the proposed rules to address the issues listed above has been replicated below.

**Table 6.4: Proposed rules to resolve other drafting issues in the NER**

<b>CLAUSE</b>	<b>PROPOSED CHANGE</b>
2.2.1(c), (d)	Delete note in paragraph (c). In paragraph (d) add a new subparagraph to clarify that AEMO can also provide an exemption to a person or class of persons from the requirement to register as a Generator for generating units.
2.2.7(i)- (l)	Delete. Clause 3.8.3 amendments to include semi-scheduled generating unit aggregation.
2.2.6(b), (e)(2), 2.3.5(b)(1), (e)(1A), (2)	Amend references to the registered participant category and replace with 'applicant'.
2.2.6(d), 2.3.5(d), 2.9A.2 (d)	Amend to allow AEMO the discretion to withdraw an application for registration.
3.6.3(c) and (d)(1)	Delete reference to 'load'.
3.6.5(4), (4A)	Delete.
3.7C, 3.8.10, 3.9.3D	Add new paragraph to allow AEMO to make minor and administrative changes to the Constraint Formulation Guidelines, EAAP Guidelines and reliability standard implementation guidelines without complying with the Rules consultation procedures.
3.8.4(c)(3)	Add 'scheduled'.
3.8.5(b)	Remove (b)(1) – (3) and ensure that MW quantities in the dispatch bid can be submitted after the relevant deadline in the timetable.
3.8.6(c), (h)(3)(ii),(f), (h)(1), (2), 3.12.2(2)	Delete either 'multiplied by' or 'product of'.
3.8.7(m)	Delete 'may' and replace with 'must'.
3.8.17(c), 3.8.18(a)	Add 'scheduled'.
3.8.18(e)	Delete 'or Market Participant'.
3.8.20(g)	Semi-scheduled and scheduled generating unit included and clause simplified by referring to 'scheduled plant' and 'market ancillary service'.
3.8.20(i)	Delete 'Scheduled Generators' and 'Semi-Scheduled Generators'.
3.8.20(j)(2)	Delete 'entity' and replace with 'unit'.
3.8.20(k)	Include 'scheduled load'.
3.8.21(d)	Delete "where possible" and "via the automatic generation control system or electronic communication system via an electronic display in the plant control room (which may be

CLAUSE	PROPOSED CHANGE
	onsite or offsite)". Replace with "dispatch instructions will be issued electronically to the relevant Registered Participant."
3.13.3(a)(3)	Delete references to 'Scheduled Generators' and 'Semi-Scheduled Generators'.
3.13.3(l2)	Delete and refer to 3.13.3(a) amendment.
3.13.3(l2)(5)	Italicise 'Transmission Network Service Provider'.
3.13.4(p)(5)	Remove reference to "as measured by AEMO's telemetry system".
3.15.8(f)(2), 3.15.8A(g)(2), 3.15.10C(b)(7)(i), (c)(3)(iii)(B)	Delete references to 'TSRP', this is not defined.
3.15.8(f)(2)	Delete references to 'TRSP', this is not defined.
3.15.21(c2)(2)(ii)	Amend to include 'Market Ancillary Service Provider' and 'Market Bi-directional Resource Provider'.
7.4.1(e)	Include 'Market Small Generation Aggregator'.

Source: AEMO, Integrating energy storage systems into the NEM - rule change request, pp. 46 – 47.

#### QUESTION 41: OTHER DRAFTING ISSUES - SOLUTION

Do these solutions proposed by AEMO in table 6.3 effectively resolve the issues identified in table 6.2 ? If not, what solution would be preferable?

## ABBREVIATIONS

AEC	Australian Energy Council
ACE	Adjusted consumed energy
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AGE	Adjusted gross energy
ARENA	Australian Renewable Energy Agency
ASOE	Adjusted sent out energy
BDRP	Bi-directional resource provider
BNEF	Bloomberg New Energy Finance
CEFC	Clean Energy Finance Corporation
COGATI	Coordination of Generation and Transmission Investment project (currently referred to as the Commission's Transmission Access Reforms)
Commission	See AEMC
DEIP	Distributed energy integration program
DER	Distributed energy resources
DNISP	Distribution Network Service Provider
DRSP	Demand response service provider
DUID	Dispatchable unit identifier
DUOS	Distribution use of system
EAAP	Energy adequacy assessment projection
EGES	Emerging Generation and Energy Storage
ESB	Energy Security Board
ESOO	Electricity Statement of Opportunities
ESS	Energy storage system
FCAS	Frequency control and ancillary services
FTRs	Financial transmission rights
ISP	Integrated system plan
LMP	Locational marginal pricing
MCE	Ministerial Council on Energy
MLF	Marginal loss factor
MSGA	Market Small Generation Aggregator
MT-PASA	Medium term projected assessment of system adequacy
NEL	National Electricity Law
NEM	National electricity market

NEO	National electricity objective
NER	National Electricity Rules
NERL	National Energy Retail Law
NERO	National energy retail objective
NGL	National Gas Law
NGO	National gas objective
NSP	Network Service Provider
PASA	Projected assessment of system adequacy
PV	Photovoltaic
RRO	Retailer reliability obligation
SCADA	Supervisory control and data acquisition
ST-PASA	Short term projected assessment of system adequacy
TAR	Transmission access reform (formerly known as COGATI)
TNSP	Transmission Network Service Provider
TUOS	Transmission use of system
VRE	Variable renewable energy
VPP	Virtual power plant

## A STORAGE TECHNOLOGIES

This appendix provides further details on storage technologies, including their possible benefits and future scope, as background for AEMO's rule change request.

### A.1 Types of storage technologies

The exact set of technologies that comprise 'storage' is not precisely defined. Storage can include many different technologies, such as:

- **rechargeable batteries**, including lithium ion and flow batteries
- **mechanical technologies** such as flywheels, pumped hydroelectric units, and compressed air storage
- **thermal storage** such as steam accumulators and molten salt storage
- **chemical storage technologies** including hydrogen and synthetic gas production
- **electrical storage** devices like capacitors and superconducting magnetic energy storage.

### A.2 Capabilities and benefits of storage technologies

All of these technologies can consume electricity and store energy for later export. The most evident benefit of storage is that it allows market participants to engage in 'temporal arbitrage'. Temporal arbitrage is what occurs when a battery operator increases their store of potential energy when prices are low and exports electricity when prices are high.

Some types of technologies, such as batteries and flywheels, can provide fast frequency response (FFR). As AEMO describes, FFR generally refers "to the delivery of a rapid active power increase or decrease by generation or load in a timeframe of two seconds or less, to correct a supply-demand imbalance and assist in managing power system frequency."<sup>285</sup> This allows batteries to provide frequency and voltage control services, such as primary frequency control, contingency FCAS, regulation FCAS and emergency response. It also potentially allows batteries to provide 'simulated inertia' where inverters can mimic the inertial response of mechanical synchronous units and provide 'grid forming' services, helping set and maintain the frequency of the power system in the absence of large synchronous generators.

FFR can respond quicker than mechanical frequency control services. This means some storage technologies can potentially:

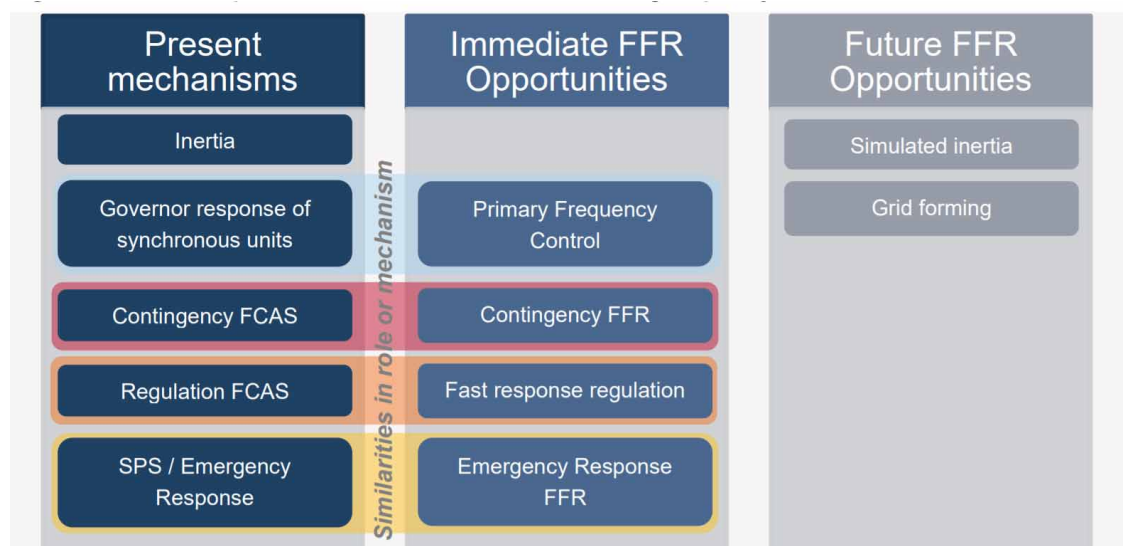
- deliver frequency response faster and potentially at lower cost than thermal generators
- deliver existing frequency control services more efficiently
- assist in managing challenges related to high rates of change of frequency (RoCoF).

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<sup>285</sup> AEMO, 2017, *Fast Frequency Response in the NEM*, working paper: Future Power System Security program, p. 3. Accessed [here](#).



Figure A.1: Relationship of described FFR services with existing frequency control services



Source: AEMO, 2017, *Fast Frequency Response in the NEM*, working paper: Future Power System Security program, Executive Summary, Figure 1, p. 3. Accessed at: [https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security\\_and\\_Reliability/Reports/2017/FFR-Working-Paper—Final.pdf](https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Reports/2017/FFR-Working-Paper—Final.pdf)

The ability to provide energy and FCAS services allows storage to provide benefits to all consumers and market participants:

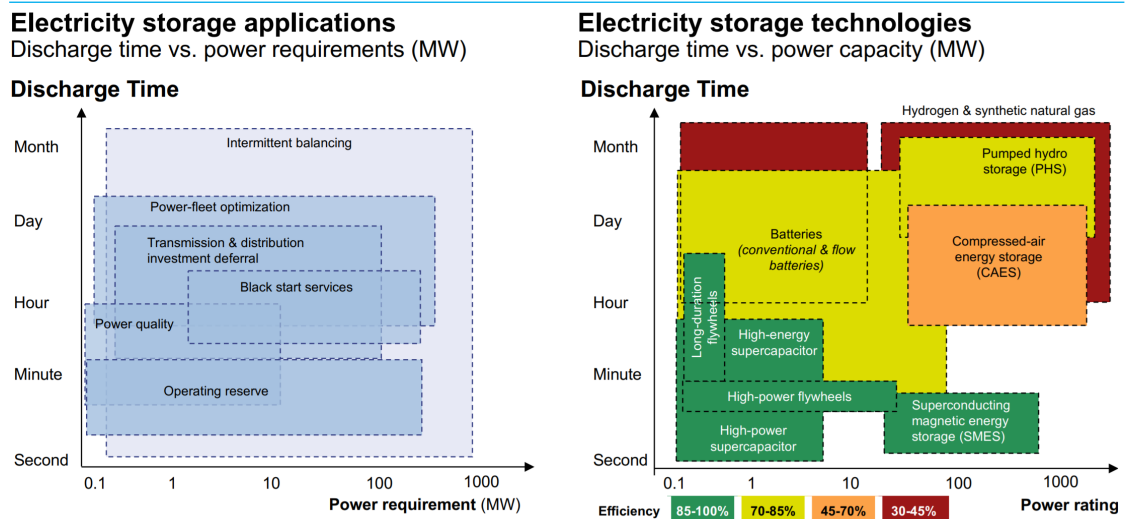
- Some **thermal generators** like coal plants operate most efficiently when they are run 24 hours a day: they can take many hours to start up and need to operate above a certain level of their overall capacity (their minimum generation level). If system demand and prices are volatile, with extreme peaks and troughs, these units may need to either shut down or keep operating at minimum level without exporting electricity, both of which may increase costs of operating these plants. If prices are low during troughs and high during peaks, storage units might charge during the troughs and export during peaks, reducing price and demand volatility. This could help these thermal units run constantly and avoid the need to regularly shut down. This can help extend the lifetime of these thermal generators..
- **Large industrial and commercial customers** can use storage to provide additional security for critical activities by installing storage to provide backup in the event of disconnection or to improve power quality. They can also use storage to help reduce network charges based on their maximum demand, and reduce their exposure to peak tariffs.
- **Network businesses** can potentially install batteries within congested parts of the network to avoid and defer the need to increase network capacity, improve power quality, improve system reliability, and achieve more optimal use of assets.
- **Households and small businesses** can use batteries to reduce the amount of electricity they consume during peak tariffs. If they have on-site generation like rooftop

solar photovoltaic panels, they can use batteries to reduce their overall consumption. Households can use batteries to ensure they have power during blackouts.

- **Retailers** can potentially build or contract batteries to hedge their exposure to volatile prices. They can also use batteries to reduce their liability under the Retailer Reliability Obligation.
- **Variable renewable generators** can use storage to firm up their output and reduce their exposure to causer-pays charges, arbitrage their output and export when prices are high, and store their consumption if they are curtailed.

More generally, increased deployment of storage can help reduce price volatility, as well as help improve system security and reliability. The specific capabilities and benefits of each storage technology depend on multiple factors, including their scalability, duration of charge, cost and maturity.

**Figure A.2: Potential applications of different ESS technologies based on power rating and discharge time**



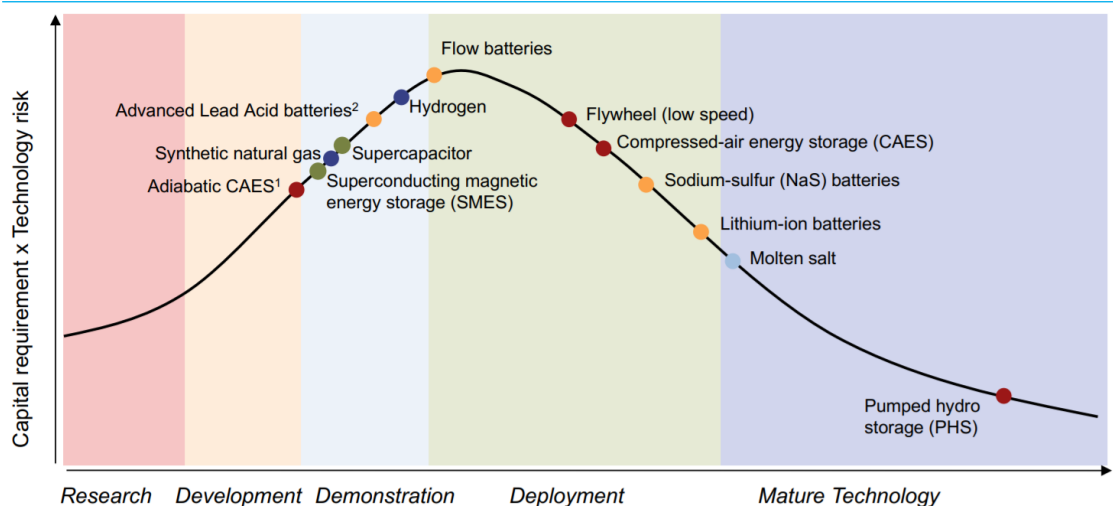
Source: Benoit Decourt, Romain Debarre, Sylvain Alias and Prashant Gahlot., 2017, *Electricity Storage Gaining Momentum*, factbook, A.T. Kearney Energy Transition Institute: Paris, France, slide 24. Accessed [here](#). ; cf. A.T. Kearney Energy Transition Institute analysis; EPRI (2010), "Electricity Energy Storage Technology Options", Bradbury (2010), "Energy Storage Technology Review"

Figure A.3: Potential applications of ESS based on available discharge time and grid location

	Short duration < 2 min	Medium duration 2 min – 1 hour	Long duration > 1 hour
<b>Generation side</b>		Provide spinning & non-spinning reserves	Provide replacement reserves Provide black-start services Firm renewable output Perform price arbitrage Avoid curtailment
<b>Transmission Grid</b>	Smooth intermittent resource output	Improve system reliability	Defer upgrades
<b>Distribution grid</b>	Improve power quality	Mitigate outages Integrate distributed variable renewable generation	Defer upgrades
<b>End-user Side</b>	Maintain power quality	Provide uninterruptible power supply	Optimize retail rate

Source: Ibid, slide 17. ; cf. A.T. Kearney Energy Transition Institute analysis based on Southern California Edison (2010), "Moving Energy Storage from Concept to Reality".

Figure A.4: Maturity of different ESS technologies



Source: Ibid, slide 21.

### A.3 Batteries currently connected to the NEM

As discussed in chapter 2, the Hornsdale Power Reserve became the first utility-scale battery in the NEM (and the largest utility-scale battery in the world) when it connected to the grid in December 2017. Since then, four more batteries, all lithium-ion, have connected across the network. Of these five projects, two connected adjacent to wind and solar power plants, one

behind the same connection point, and two were deployed at network substations. These projects have storage capacities that range from 15 minutes to 2 hours.

A list of grid-scale battery systems that currently connected in the NEM are listed below in Table A.1.

**Table A.1: Grid-scale battery systems connected to the NEM since 2017**

<b>PROJECT</b>	<b>LOCATION &amp; CONFIGURATION</b>	<b>COMMISSIONED</b>
Hornsedale Power Reserve* (100MW/129MWh)	Co-located with the Hornsdale Wind Farm (but with its own connection point) 15 km north of Jamestown in South Australia.	December 2017
Dalrymple ESCRI battery (30MW/8MWh)	Installed at the Dalrymple substation near the Wattle Point wind farm on the Yorke Peninsula, South Australia.	September 2018
Ballarat Energy Storage System (30MW/30MWh)	A stand-alone system located at the Ballarat Area Terminal Station in Warrenheip, Victoria	November 2018
Gannawarra Energy Storage System (30MW/25MWh)	Co-located with the Gannawarra Solar Farm in Gannawarra, Victoria.	March 2019
Lake Bonney (25MW/52MWh)	Co-located with Lake Bonney Wind Farm and shares connection point at the Mayurra substation in Mount Gambier, South Australia.	October 2019

Source: Hornsdale: Barker, Stephanie, 2019, *Showcase Project: Hornsdale Power Reserve Project, Australia*, Global Infrastructure Hub: Sydney. Accessed [here](#); Dalrymple, Gannawarra, Ballarat and Lake Bonney: Aurecon, 2019, *Large -Scale Battery Storage Knowledge Sharing Report*, September 2019, updated November 2019, ARENA: Sydney. Accessed [here](#); Lake Bonney: ESCOSA, *Application form for the issue of an Electricity Generation Licence (Lake Bonney Wind Farm)*, licence variation request for Lake Bonney Wind Power Pty Ltd, August 2019. Accessed [here](#).

\* The Hornsdale Power Reserve has recently commenced testing for a 50MW/64.5MWh expansion of the facility<sup>286</sup>

<sup>286</sup> <https://hornsdalepowerreserve.com.au/testing-on-the-expansion-has-commenced/>

## A.4 Forecasts and future needs for storage

### A.4.1 Future storage duration required in the NEM

AEMO's *2020 Integrated System Plan* explores the mix of storage duration required to firm the growing share of renewables as thermal generators exit the system.<sup>287</sup> The ISP identifies three different 'depth classes' of dispatchable storage:

- **Shallow storage for capacity, ramping and FCAS** – includes VPP battery and 2-hour large-scale batteries. This category of storage is more for capacity, fast ramping, and FCAS than it is for its energy value.
- **Medium storage for intra-day shifting** – includes 4-hour batteries, 6-hour pumped hydro, 12-hour pumped hydro, and the existing pumped hydro stations, Shoalhaven and Wivenhoe. The value of this category of storage is in its intra-day shifting capability, driven by demand and solar cycles.
- **Deep storage for VRE 'droughts' and seasonal smoothing** – includes 24-hour pumped hydro and 48-hour pumped hydro and includes Snowy 2.0 and Tumut 3. The value of this category of storage is in covering VRE 'droughts' (that is, long periods of lower-than-expected VRE availability), and seasonal smoothing of energy over weeks or months.<sup>288</sup>

It found that "initially, relatively shallow 1- to 2-hour storage is needed to provide firming capacity and intra-day energy shifting. However, as more coal-fired generation retires, medium 4- to 12-hour storage comes into play to shift energy over longer time scales."<sup>289</sup> This is shown in Figure A.5.

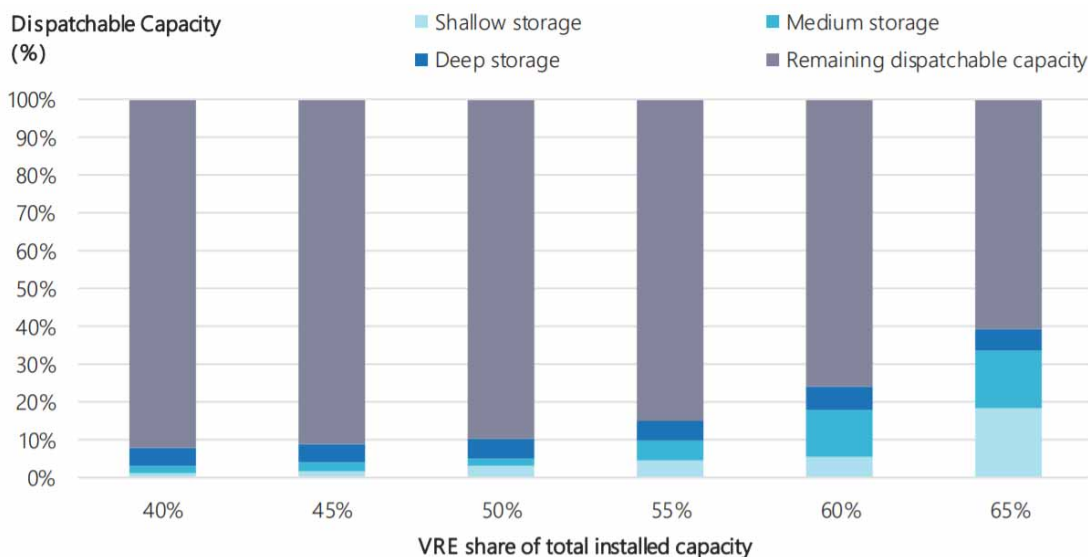
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<sup>287</sup> AEMO, *2020 Integrated System Plan (ISP)*, 30 July 2020, p. 51. Accessed [here](#).

<sup>288</sup> Ibid.

<sup>289</sup> Ibid.

**Figure A.5: Mix of dispatchable storage durations selected to firm renewables.**



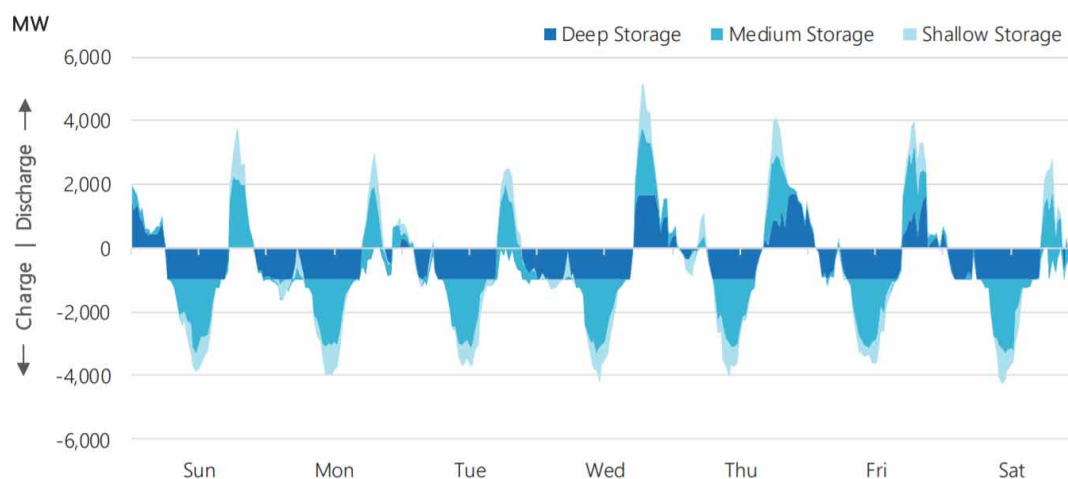
Source: AEMO, *2020 Integrated System Plan (ISP)*, 30 July 2020, figure 14, p. 51.

Note: The dark blue bands of deep pumped hydro represent Snowy 2.0 and other committed projects, so are constant throughout.

AEMO illustrates how the NEM’s suite of storage types would operate for a week in Spring 2035 in the Central scenario, where penetration of renewables is 56% in Figure A.6: “storage acts predominantly as intra-day energy shifters: absorbing excess energy from VRE in the middle of the day and releasing it during the evening peaks.”<sup>290</sup>

290 Ibid, p. 52

**Figure A.6:** Indicative dispatchable storage operation in Spring 2034-35, AEMO 2020 ISP Central scenario



Source: AEMO, *2020 Integrated System Plan (ISP)*, 30 July 2020, figure 15, p. 52.

#### A.4.2

#### Current storage costs and forecasts

Chapter 2 of this consultation paper summarises AEMO’s forecasts for storage in the 2020 ISP. Other analysis, discussed below in this section, also indicates that storage is currently a viable investment and is expected to become cheaper over time.

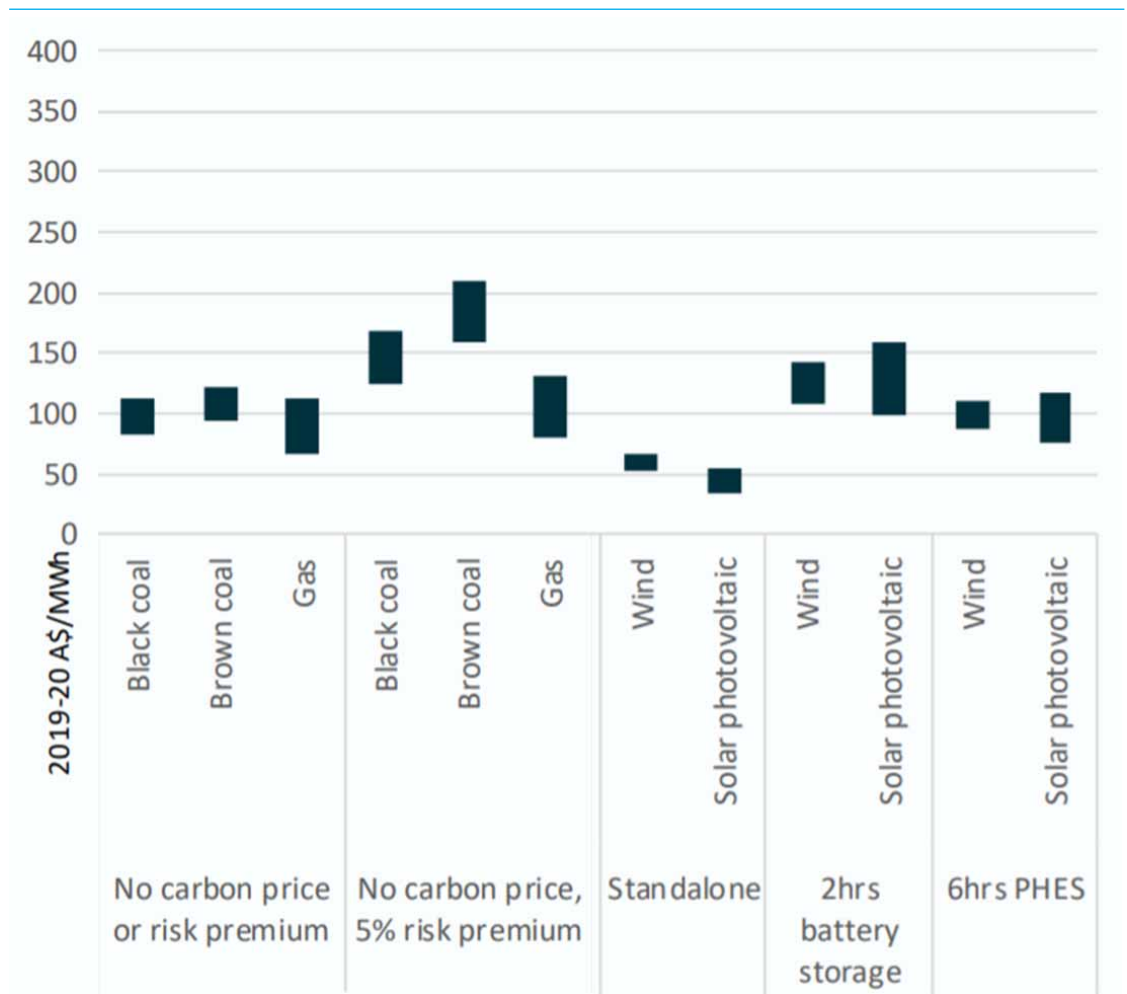
The cost of utility-scale storage technologies has significantly decreased over the past decade. For example, Bloomberg New Energy Finance (BNEF) identifies that between 2010 and 2019, the cost of lithium ion batteries fell by 87%.<sup>291</sup>

CSIRO analysis indicates the levelised cost of energy for wind and solar plant combined with batteries is similar to that for coal and gas plant.<sup>292</sup>

<sup>291</sup> BNEF, *Battery Pack Prices Fall As Market Ramps Up With Market Average at \$156/kWh In 2019*, 3 December 2019. Accessed [here](#).

<sup>292</sup> CSIRO, *GenCost 2019-20: preliminary results for stakeholder review*, December 2019, figure 4.1, p. 22.

**Figure A.7:** CSIRO: LCOE by technology and category for 2020



Source: CSIRO, *GenCost 2019-20: preliminary results for stakeholder review*, December 2019, figure 4.1, p. 22.

Some modelling suggests that standalone grid-scale battery storage projects are now profitable without government support. For example, Lazard modelling suggests that a hypothetical utility scale PV and storage project built in Australia in 2019 could potentially generate a levelised internal rate of return of 22.5% over 20 years, as shown in Figure A.8.



**Figure A.8: Potential revenue from a hypothetical 100MW PV and 50MW/200MWh storage project in Australia**

Australia	2019	2020	2021	2022	2023	2024	2029	2034	2038
<b>Total Revenue</b>	-	\$ 24,495.5	\$ 25,173.8	\$ 25,903.1	\$ 26,656.7	\$ 27,435.6	\$ 31,740.4	\$ 36,826.2	\$ 42,845.4
Energy Arbitrage <sup>(1)</sup>	-	14,681.5	15,133.7	15,600.7	16,082.8	16,580.7	19,325.8	22,554.3	26,356.3
Frequency Regulation	-	5,191.7	5,399.4	5,615.3	5,840.0	6,073.6	7,389.4	8,990.3	10,938.1
Spinning/Non-Spinning Reserves	-	-	-	-	-	-	-	-	-
Resource Adequacy	-	4,622.3	4,640.7	4,687.1	4,734.0	4,781.3	5,025.2	5,281.6	5,551.0
Distribution Deferral	-	-	-	-	-	-	-	-	-
Demand Response-Wholesale	-	-	-	-	-	-	-	-	-
Demand Response-Utility	-	-	-	-	-	-	-	-	-
Bill Management	-	-	-	-	-	-	-	-	-
Local Incentive Payments	-	-	-	-	-	-	-	-	-
<b>Total Operating Costs</b>	-	\$ (4,560.4)	\$ (4,593.7)	\$ (6,221.0)	\$ (6,256.0)	\$ (6,291.9)	\$ (6,485.0)	\$ (6,703.6)	\$ (6,950.9)
Storage O&M	-	(1,314.3)	(1,347.2)	(1,380.9)	(1,415.4)	(1,450.8)	(1,641.4)	(1,857.1)	(2,101.1)
Storage Warranty	-	-	-	(1,593.2)	(1,593.2)	(1,593.2)	(1,593.2)	(1,593.2)	(1,593.2)
Storage Augmentation Costs	-	(3,228.6)	(3,228.6)	(3,228.6)	(3,228.6)	(3,228.6)	(3,228.6)	(3,228.6)	(3,228.6)
Solar O&M	-	(17.5)	(17.9)	(18.4)	(18.8)	(19.3)	(21.9)	(24.7)	(28.0)
Storage Charging	-	-	-	-	-	-	-	-	-
<b>EBITDA</b>	-	\$ 19,935.1	\$ 20,580.1	\$ 19,682.1	\$ 20,400.8	\$ 21,143.7	\$ 25,255.4	\$ 30,122.6	\$ 35,894.5
Less: MACRS D&A	-	(20,209.5)	(32,335.2)	(19,401.1)	(11,640.7)	(11,640.7)	-	-	-
<b>EBIT</b>	-	\$ (274.4)	\$ (11,755.0)	\$ 281.0	\$ 8,760.1	\$ 9,503.1	\$ 25,255.4	\$ 30,122.6	\$ 35,894.5
Less: Interest Expense	-	(1,616.8)	(1,581.4)	(1,543.3)	(1,502.1)	(1,457.6)	(1,175.6)	(761.3)	(152.5)
Less: Cash Taxes	-	-	-	-	-	-	(9,831.9)	(11,744.5)	(14,295.8)
<b>Tax Net Income</b>	-	\$ (1,891.1)	\$ (13,336.5)	\$ (1,262.3)	\$ 7,258.0	\$ 8,045.5	\$ 14,447.9	\$ 17,616.8	\$ 21,445.2
MACRS D&A	-	20,209.5	32,335.2	19,401.1	11,640.7	11,640.7	-	-	-
EPC	(25,448.6)	-	-	-	-	-	-	-	-
Storage Module Capital	(47,803.9)	-	-	-	-	-	-	-	-
Inverter / AC System Capital	(9,135.3)	-	-	-	-	-	-	-	-
Balance of System Capital	(16,309.6)	-	-	-	-	-	-	-	-
Solar Capital	(2,350.0)	-	-	-	-	-	-	-	-
ITC	-	-	-	-	-	-	-	-	-
Debt	20,209.5	-	-	-	-	-	-	-	-
Principal	-	(441.6)	(477.0)	(515.1)	(556.3)	(600.8)	(882.8)	(1,297.1)	(1,905.9)
<b>After-Tax Levered Cash Flow</b>	\$ (80,837.9)	\$ 17,876.7	\$ 18,521.8	\$ 17,623.7	\$ 18,342.4	\$ 19,085.3	\$ 13,565.1	\$ 16,319.7	\$ 19,539.3
Levered Project IRR	22.5%								
Levered Project NPV	54,407.34								

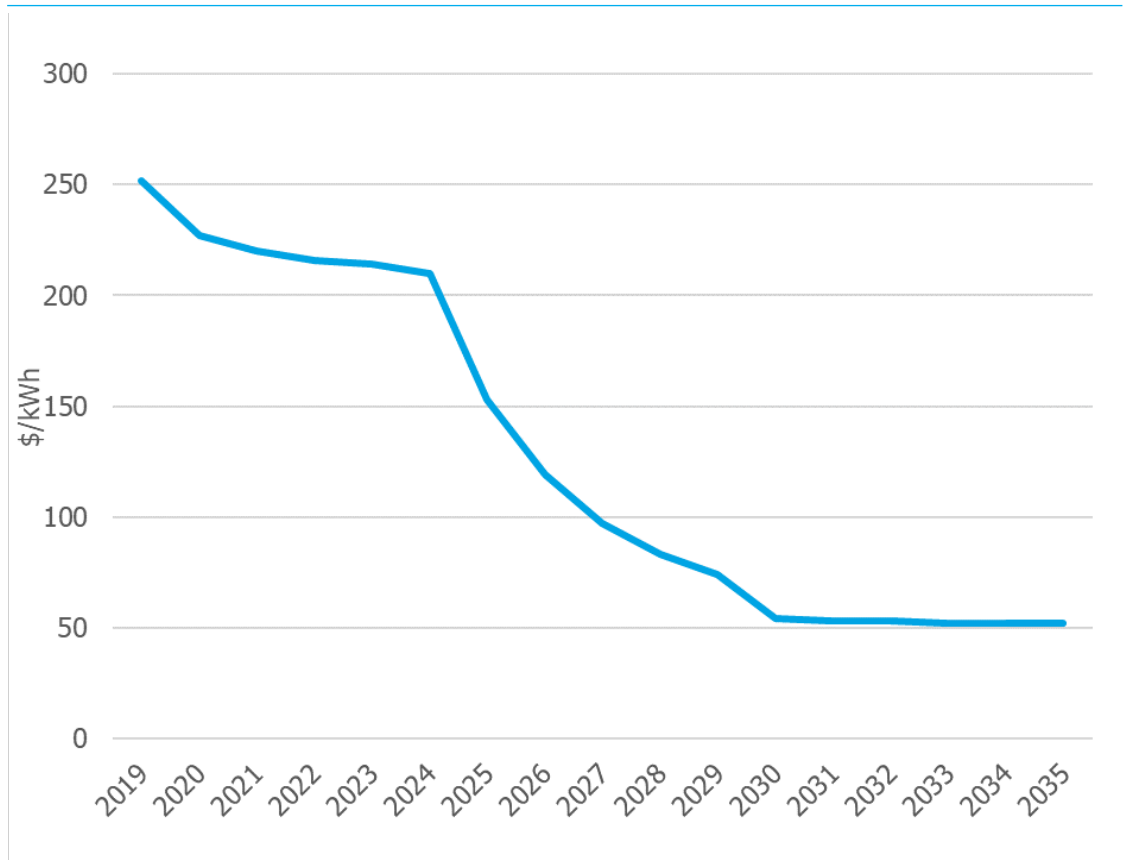
Model Assumptions							
Storage Size (MW)	50,000	Storage Extended Warranty (%)	2.0%	Debt	20%	Combined Tax Rate	40%
Storage Capacity (MWh)	200,000	Storage EPC Cost (%)	21%	Cost of Debt	8%	Charging Cost Escalation	0%
Solar Sizing (MW)	100,000	Storage O&M Cost (%)	1.5%	Equity	80%	O&M Escalation	2.5%
Full DOD Cycles Per Year	350	Storage Efficiency (% RT)	89%	Cost of Equity	12%	Regional EPC Scalar	1
Depth of Discharge (%)	100%	Solar Fixed O&M (\$/kW-yr.)	10.50	WACC	11%	Useful Life (years)	20

Source: Lazard, 2019, *Levelised cost of storage analysis version 5.0*, p. 33. Accessed [here](#).

Note: Charging costs are zero with all energy self-generated by the PV portion of the system; uses 5-year modified accelerated cost recovery system; all figures presented in USD using the following exchange rate: USD/AUD 1.39. Includes revenue generated from the sale of excess solar generation to wholesale power markets.

Capital costs for batteries are also forecast to fall in the future. CSIRO predicts that grid-scale battery storage with two hours' charge could fall from \$227/kWh in 2020 to \$53/kWh in 2030.

**Figure A.9:** CSIRO: Projected capital costs for battery storage (2 hrs) to 2035, \$/kWh, central scenario



Source: CSIRO, *GenCost 2019-20: preliminary results for stakeholder review*, December 2019, figure 4.1, p. 22.

## B SUMMARY OF AEMO'S PROPOSED SOLUTION

In summary, AEMO has proposed to amend the NER to create a new registered participant category and a new unit classification, and set rights and obligations for this new registration category and unit classification throughout the NER. More specifically, AEMO's proposed rule would:

- create a new registered participant category in Chapter 2 of the NER titled 'Bi-directional Resource Provider'<sup>293</sup>
- create a new technology-neutral unit classification in Chapter 2 of the NER titled 'bi-directional unit' that can accommodate different storage technologies, including (but not limited to) batteries, pumped hydro and flywheels<sup>294</sup>
- create a new definition in Chapter 10 of the NER titled 'bi-directional facility', which is a facility connected to the grid which contains either:
  - bi-directional units (either by themselves or co-located with generation and/or load); or
  - generation units and market loads<sup>295</sup>
- insert further consequential amendments throughout the NER to integrate the amendments outlined above, for example, to amend clause 3.6.1(3)(ii) of the NER to include scheduled bi-directional units and specify scheduled generating units.<sup>296</sup>

Broadly, AEMO's proposed rule would apply the current obligations for Market Generators to the Bi-directional Resource Provider registered participant category.<sup>297</sup> However, the proposed rule would also set the following additional obligations:

- A market scheduled bi-directional unit (i.e. a storage unit) would:
  - participate in central dispatch as a single asset with one DUID<sup>298</sup>
  - use a single dispatch bid with 10 price bands comprising either positive or negative band volumes<sup>299</sup>
  - submit a dispatch bid that reflects its stored energy capacity<sup>300</sup>
  - operate its load with the same degree of control as its generation<sup>301</sup>
  - would not attract TUOS charges, but would be charged DUOS based on its sent out electricity.<sup>302</sup>

<sup>293</sup> Australian Energy Market Operator (AEMO), *Integrating energy storage systems into the NEM*, rule change proposal, August 2019, Sydney, pp. 2, 3, 6, 26, 27, 30, 31, 49, 63.

<sup>294</sup> *Ibid*, pp. 2, 6, 26, 30, 49, 63.

<sup>295</sup> *Ibid*, pp. 30, 49, 63.

<sup>296</sup> *Ibid*, pp. 2, 3, 6, 22-23, 26-27, 29-52.

<sup>297</sup> *Ibid*, pp. 30-46, 63.

<sup>298</sup> *Ibid*, pp. 6, 23, 26, 27, 56, 63.

<sup>299</sup> *Ibid*, pp. 2, 26, 27, 56, 63.

<sup>300</sup> *Ibid*, pp. 28, 33-35, 36.

<sup>301</sup> *Ibid*, p. 18.

<sup>302</sup> *Ibid*, p. 2, 6, 18, 20, 29, 46, 54, 63.

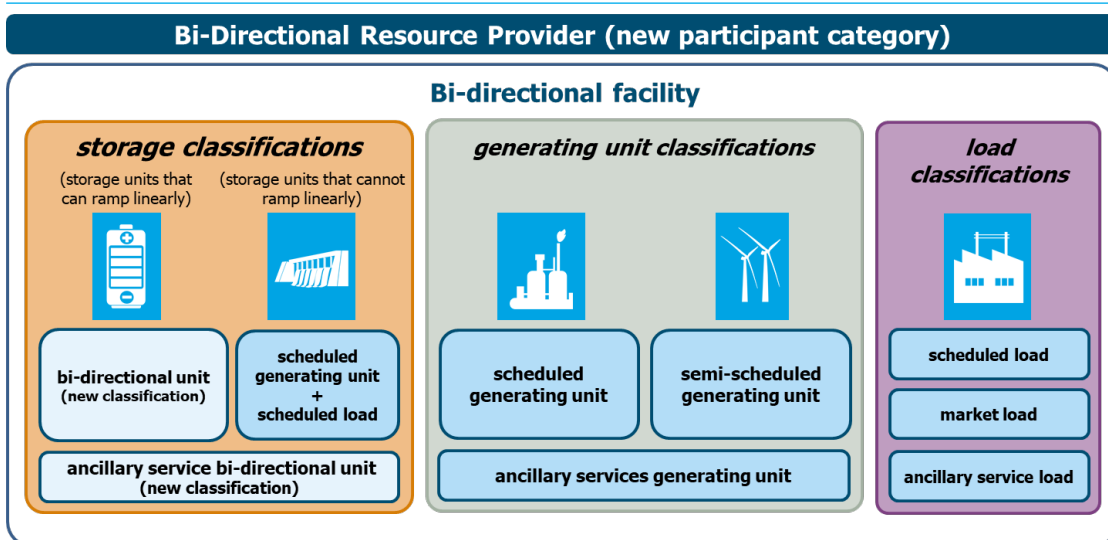
- A Bi-directional Resource Provider would only be a liable entity under the Retailer Reliability Obligation for its market load component (i.e. its bi-directional units would not count).<sup>303</sup>
- Both semi-scheduled generating units and bi-directional units in bi-directional facilities would determine their ramp rates using only the aggregation approach specified in NER clause 3.8.3.<sup>304</sup>

The proposed rule would also:

- set performance standards equivalent to those for scheduled generators to both the 'load' and 'generation' components of a 'bi-directional unit'
- change Market Small Generation Aggregators (MSGAs) participant fees and non-energy costs based on their gross consumption and gross sent out energy (the same way that ESS units are charged as a Market Customer and Market Generator under the NER currently)<sup>305</sup>
- clarify that MSGAs can aggregate and classify exempt ESS into their portfolios.<sup>306</sup>

The range of classifications for assets within a bi-directional facility are shown below in Figure B.1. The asset configurations that would comprise a bi-directional facility are shown in Figure B.2.

**Figure B.1: Asset classifications in a bi-directional facility**



Source: AEMC figure. AEMO, *Integrating energy storage systems into the NEM - rule change request*, pp. 30, 49, 63.

Note: AEMO note that "a non-scheduled generating unit is not proposed to be a classified asset in a bi-directional facility." Ibid, p. 7.

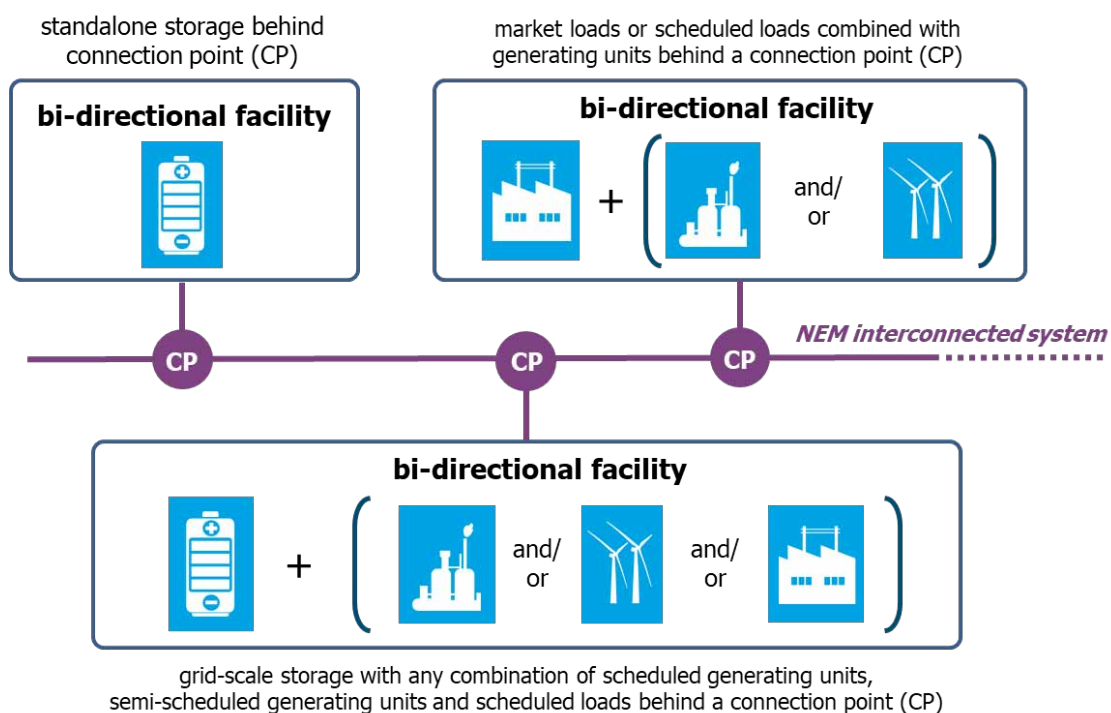
303 Ibid, 23-24.

304 Ibid, pp. 23, 32, 34, 37.

305 Ibid, pp. 2, 19, 20, 28.

306 Ibid, p. 26. AEMO explains that "There are no explicit provisions in [the current] Rule 2.3A that prohibit an SGA from classifying ESS that is treated as a small generating unit." Ibid, p. 13

Figure B.2: Possible asset combinations for a bi-directional facility



Source: AEMC figure. AEMO, *Integrating energy storage systems into the NEM - rule change request*, pp. 30, 49, 63.

Note: Storage units in this example include those that can ramp linearly between consumption and production, which would classify as bi-directional units, and those that cannot ramp linearly, which would classify as both a scheduled generating unit and scheduled load.

The new Bi-directional Resource Provider category would cross-reference to obligations for other registered participant categories depending on what types of assets are included within a bi-directional facility. AEMO's proposed drafting for the Bi-directional Resource Provider category is below:

#### 2.2A.2 Scheduled Bi-directional Resource Provider

(g) A Bi-directional Resource Provider is taken to be:

- (1) a *Scheduled Bi-directional Resource Provider* only in so far as its activities relate to a *scheduled bi-directional unit* or a *scheduled load* that is part of a *bi-directional facility*;
- (2) a *Scheduled Generator* only in respect of a *scheduled generating unit* that is part of a *bi-directional facility*; and
- (3) a *Semi-Scheduled Generator* only in respect of a *semi-scheduled generating unit* that is part of a *bi-directional facility*.

AEMO notes in its rule proposal that if the proposed rule was implemented, it would likely need to include transitional arrangements that would apply to market participants with ESS units and bi-directional facilities that are already connected to the grid. AEMO writes:

...while particular cases may require further consideration, as a general principle AEMO expects it would be appropriate to grandfather the registration, classification and dispatch arrangements in place for registered participants prior to the rule effective date. However, those registered participants should also have the option of applying to AEMO to transition to the Bi-directional Resource Provider category. This can occur either during a window before, or at any time after, the rules effective date.<sup>307</sup>

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307 AEMO, 2019, *Integrating Energy Storage Systems into the NEM*, p.53

## C MANDATORY RESTRICTIONS AND INTERVENTION COMPENSATION FRAMEWORKS

This appendix provides further details on the mandatory restrictions and intervention compensation frameworks as background for AEMO's rule change request.

### C.1 Mandatory restrictions framework

Mandatory restrictions are a means of controlling demand to avert a situation where there is insufficient generation capacity to meet demand, particularly in situations where mandatory load shedding is or would otherwise be necessary. These restrictions may come into effect during periods of extreme demand or instances where a sudden decrease in available capacity occurs.

Under the current regulatory framework, mandatory restrictions on the use of electricity may be imposed by a jurisdiction<sup>308</sup> under state-based legislation. Rule 3.12A of the NER outlines how AEMO is to operate the market if mandatory restrictions are imposed by a jurisdiction.

When restrictions are imposed by a jurisdiction on a region, electricity users are requested to reduce demand (and large electricity users may be required to reduce demand). This reduces the quantity of electricity traded, the spot price, and thus the revenue earned by generators.

The level of demand response that will be achieved by restrictions is difficult to estimate and the actual response by consumers may be more or less than is necessary.<sup>309</sup> If this occurs, this may result in unintended price outcomes and higher than necessary costs to consumers.

The Commission considered this issue in the *Investigation into intervention mechanisms in the NEM* review and recommended that the framework be removed, and AEMO to submit a rule change request to action that recommendation.<sup>310</sup> AEMO submitted several rule change requests in line with recommendation, which are being considered under the *Changes to intervention mechanisms* rule change process. The *Changes to intervention mechanisms* draft determination proposes to remove the mandatory restrictions framework.<sup>311</sup>

In the *Integrating storage* rule change request, AEMO stated that it does not propose any drafting amendments to incorporate bi-directional resource providers into the mandatory restrictions framework given the Commission's recommendation to remove that framework.

308 The National Electricity Market – Memorandum of Understanding on the Use of Emergency Powers 2015 defines jurisdictions as NSW, VIC, QLD, SA, ACT and TAS or any other party who becomes a party to this memorandum.

309 The reduction will not count towards the relevant jurisdiction's share of inter-regional load shedding and, perversely, may reduce the spot price at the height of a shortfall. This is in contrast to the approach whereby the spot price is set to the market price cap if involuntary load shedding occurs.

310 AEMC, *Investigation into intervention mechanisms in the NEM*, Final Report, p. 135.

311 This determination was published on 18 June 2020 and is available [here](#).

## C.2 Intervention compensation frameworks

An AEMO intervention event occurs when AEMO exercises the reliability and emergency reserve trader or issues directions to market participants.<sup>312</sup> Interventions are typically used as a last resort and their use is governed by a number of principles and processes.<sup>313</sup>

When AEMO intervenes in the market, two separate but related frameworks are triggered: one relates to “intervention pricing” and the other to compensation.

The directed participant compensation framework is designed to make sure that “directed participants” (those who have been directed to provide services) can recover their costs. Where a direction is to obtain energy or market ancillary services (i.e. frequency control ancillary services — FCAS), compensation is calculated based on the 90<sup>th</sup> percentile price in the relevant region in the preceding 12 months.<sup>314</sup> Where a direction is for services other than energy and FCAS, compensation is determined based on a “fair payment price” which is determined by an independent expert in accordance with clause 3.15.7A of the NER.<sup>315</sup>

In both cases, there is no need for the directed participant to make a claim for compensation: it is calculated automatically by AEMO or an independent expert. However, if after this initial calculation of compensation, a directed participant is still out of pocket, it can lodge a claim for additional compensation under clause 3.15.7B of the NER.

Under clause 3.12.2 of the NER, compensation is also payable to, or by, “affected participants” (relevantly, those scheduled generators and network services which are dispatched differently due to an AEMO intervention event which triggers intervention pricing) in order to put them in the position they would have been in but for the intervention. Compensation is also payable to market customers with scheduled loads which are dispatched differently as a result of an AEMO intervention event which triggers intervention pricing.<sup>316</sup>

The cost of compensating both directed participants and those participants affected by a direction to obtain energy is passed through to market customers and thus consumers in the region that benefited from the intervention.<sup>317</sup> Where a direction is for the purpose of obtaining ancillary services, the cost of compensating directed and affected participants will be recovered in accordance with the cost recovery mechanisms applicable to each of the eight ancillary service markets.<sup>318</sup>

As part of the *Investigation into intervention mechanisms in the NEM*, the Commission considered whether the current approach to directed participant compensation for energy

312 “AEMO intervention event”, NER Chapter 10.

313 A detailed discussion of the principles and processes associated with intervention mechanisms is set out in chapter 3 of AEMC, *Investigation into intervention mechanisms and system strength in the NEM, Consultation Paper*, 4 April 2019.

314 Clause 3.15.7 of the NER.

315 The Commission is currently progressing a rule change request relating to fair payment price compensation: see <https://www.aemc.gov.au/rule-changes/compensation-following-directions-services-other-energy-and-market-ancillary-services>.

316 Clause 3.12.2(a)(2) of the NER.

317 See clauses 3.15.8(a) and (b) of the NER.

318 See clauses 3.15.8(e) and (f) which in turn refer to the cost recovery formulae for market ancillary services set out in clause 3.15.6A of the NER.



and FCAS directions is optimally efficient. As noted earlier, compensation for such directions is currently based on the 90th percentile price in the relevant region for the preceding 12 months.<sup>319</sup> The Commission considered whether this “one size fits all” approach was optimal, or whether it has the potential to create incentives for inefficient participant behaviour (encouraging participants to withdraw and await direction when the 90th percentile price is higher than the spot price) and impose higher than necessary costs on consumers.

In response, some stakeholders suggested that compensation should be based on the value of the service provided by the directed participant, calculated by reference to offers or dispatch prices. The Commission did not support this approach given its strong potential to create distortion: incentivising generators to withdraw and await direction, leading to more directions and higher costs for consumers.<sup>320</sup> The Commission concluded that there would be merit in adopting a cost based approach to calculating compensation for directed participants and recommended that AEMO lodge a rule change request to change the basis of the framework and reduce its potential to create market distortions.<sup>321</sup>

### C.3 Concurrent rule change processes that are considering reforming these frameworks

Certain changes to the intervention compensation framework are the subject of the *Compensation for market participants affected by intervention events*<sup>322</sup> and *Compensation following directions for services other than energy and market ancillary services*<sup>323</sup> rule changes.

#### C.3.1 Compensation for market participants affected by intervention events

AEMO lodged two rule change requests in September 2019 related to the framework in clause 3.12.2 for compensating participants affected by intervention events. These were consolidated as the *Compensation for market participants affected by intervention events* rule change.<sup>324</sup>

One of the rule change requests concerns the compensation payable to scheduled generators and scheduled network service providers if they are affected by an intervention event (meaning they are dispatched differently as a result of an intervention event which triggers intervention pricing). Currently, these participants are eligible for compensation in relation to changes in energy revenue but not FCAS revenue. This request seeks to address that by allowing participants to lodge a claim for additional compensation if they incur FCAS losses due to an intervention event.

The other rule change request relates to scheduled loads and the compensation payable if they are dispatched differently as a result of an intervention event which triggers intervention

<sup>319</sup> Clause 3.15.7 of the NER.

<sup>320</sup> AEMC, *Investigation into the intervention mechanism in the NEM*, Final Report, p. 53.

<sup>321</sup> AEMC, *Investigation into intervention mechanisms in the NEM*, Final Report, August 2019, p. 68.

<sup>322</sup> Project page available [here](#).

<sup>323</sup> Project page available [here](#).

<sup>324</sup> Refer to the AEMC project page [here](#).

pricing. Compensation for scheduled loads is currently calculated in accordance with a formula which includes as an input the price of the highest-priced price band specified in a dispatch bid – known as “BidP”. AEMO’s request seeks to change the definition of BidP<sup>325</sup> to address a concern that the current formula could result in scheduled loads being under compensated following intervention events. These rule change requests were consolidated as they both relate to clause 3.12.2 of the NER.

The Commission published a consultation paper on these rule change requests on 11 June 2020. That paper explored options to increase consistency between the compensation frameworks that apply to scheduled generators (which are defined as “affected participants”) and scheduled loads (which are not defined as affected participants), recognising that bi-directional resource providers are subject to both these compensation frameworks.

Given this, the paper examined options that would enable a more symmetrical approach to compensation and reduce the potential market distortion that could arise if compensation frameworks apply differently depending on whether a given unit is charging/pumping or discharging/generating. For example, the paper explored whether scheduled load compensation should cover FCAS in addition to energy (consistent with the proposed approach to scheduled generators).

The consultation paper referred to the rule change request the subject of this consultation paper and noted that the Commission’s deliberations regarding the affected participant compensation rule changes can inform subsequent deliberations regarding the integration of storage and hybrids.<sup>326</sup> It also noted the fact that, according to AEMO, compensation has on some occasions been paid to utility scale batteries which have been dispatched differently as a result of system strength directions.<sup>327</sup> However, this compensation was infrequent due to the application of the \$5,000 per trading interval compensation threshold which applied until December 2019.<sup>328</sup>

Submissions in response to the consultation paper expressed support for greater consistency in the compensation frameworks for generators and loads, both in relation to the scope of the compensation frameworks (i.e. stakeholders supported FCAS being included for both generators and loads) and how they are administered (i.e. automatic calculation of two-way compensation, i.e. for both losses and gains, consistent with the approach to energy).<sup>329</sup> In its submission, Tesla supported a one way approach to compensation (claims for losses only)<sup>330</sup> and AGL<sup>331</sup> queried whether a two-way approach to compensation is appropriate with

<sup>325</sup> Found in clause 3.12.2 of the NER

<sup>326</sup> AEMC, *Compensation for market participants affected by intervention events, Consultation paper*, pp. 10-11.

<sup>327</sup> Ibid, 18.

<sup>328</sup> AEMC, *Threshold for participant compensation following market intervention*, Final Determination. This rule change removed this threshold.

<sup>329</sup> Submissions are available [here](#).

<sup>330</sup> Tesla, *Submission to the Compensation for market participants affected by intervention events consultation paper*, 16 July 2020. Available [here](#).

<sup>331</sup> AGL, *Submission to the Compensation for market participants affected by intervention events consultation paper*, 20 July 2020. Available [here](#).

respect to scheduled loads.<sup>332</sup> This issue will be examined further in the draft determination which is scheduled to be published in September 2020.

Currently, the existing compensation frameworks in the NER apply to storage and hybrids based on the nature of the service being obtained under direction. For example, if AEMO directs a battery to provide FCAS, it is compensated based on the 90th percentile price for the required FCAS service in accordance with clause 3.15.7.

This was the approach adopted when AEMO directed batteries in South Australia to provide contingency FCAS to full availability in February 2020. By contrast, other elements of the directions to the batteries (for example requiring batteries to maintain a state of charge within a specified range) were considered to be directions for services other than energy and FCAS. As such they are subject to “fair payment price” compensation under clause 3.15.7A.<sup>333</sup> The fair payment price compensation framework is the subject of another rule change request, as discussed below.

### C.3.2

#### **Compensation following directions for services other than energy and market ancillary services**

AEMO lodged a rule change request in September 2019 related to the determination of compensation following directions for services other than energy and market ancillary services.<sup>334</sup> Currently, when a participant is directed to provide other services (something which has occurred infrequently until recently), they may be compensated under the “fair payment price” framework. Following this initial compensation process, if a directed participant is still out of pocket, it may lodge a claim for additional compensation through a separate second process.<sup>335</sup> The context of this rule change request is particularly relevant for storage and hybrids. As noted above, during the recent islanding of South Australia, batteries were directed to provide “other services” (as well as FCAS) and compensation is currently being determined for these directions.

AEMO considers that this two-step process is an unnecessary delay in finalising compensation for directed participants and proposes an alternative one-step process, where the fair payment price and additional compensation can be determined at the same time. This may improve the administrative efficiency of the compensation process. The AEMC is considering how the compensation framework for other services directions interacts with the changing mix of services provided by participants in the NEM. This may include services provided by batteries.

The Commission published a consultation paper for this rule changes request on 11 June 2020. That paper explored whether the current compensation arrangements for directions for other services are administratively efficient, whether turning this two-step process into a one-

<sup>332</sup> The AGL submission examined the interaction between intervention pricing and how scheduled loads are dispatched in the NEM. Unlike generators, which are dispatched from least cost to highest cost, scheduled loads are dispatched “top down”, based on willingness to pay – i.e. from highest to lowest.

<sup>333</sup> IES Advisory Services, *AEMO Directions to Participants in South Australia on 2 and 4 February 2020*, Draft Determination.

<sup>334</sup> Refer to the AEMC project page [here](#).

<sup>335</sup> Clause 3.15.7B of the NER.

step process would improve administrative efficiency and if other options to the current arrangements would better benefit the long-term interests of consumers.

Stakeholder feedback broadly supported the moves to increase administrative efficiency, transparency and consistency of the compensation process. However, they suggested the rule change relates to an incremental administrative improvement and was unlikely to have a material impact on customers' bills: total compensation was only \$270,000 for all other services directions between 2016 and 2020. Stakeholders also discussed their desire to have the ability to challenge the outcome of a compensation determination.