Enabling energy storage systems to offer instantaneous reserve

Final Decision paper

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1 We have decided to amend the Code

Consumers will benefit from advances in energy storage technology

1.1 Consumers are poised to benefit as battery energy storage system capabilities improve and costs fall rapidly. The Electricity Authority (Authority) has taken this technology shift onboard and recognises that changes are required to the Electricity Industry Participation Code 2010 (the Code) to unlock the associated long-term benefits to consumers.

1.2 The Authority made interim clarifications to the Code in 2018 to allow battery owners to offer energy into the wholesale market. That amendment enabled participation of batteries and solar farms in the energy market, opening the door for these technologies to participate and bring benefits to consumers.

1.3 Stakeholders consider that further changes to the market rules should be made now, so that New Zealanders can begin to benefit from more of the services provided by batteries as soon as possible.

We received strong support to amend the Code to provide market access for energy storage systems

1.4 In April and May, we consulted on a proposal to take the next step, focused on battery technology's ability to provide instantaneous reserve to support power system stability. This is particularly timely as several parties have already invested in network-connected battery technology in New Zealand, and others have announced their interest in battery options at significant scale, in the order of 100 MW or more.

We received 19 submissions on our consultation paper, expressing strong support for our Code amendment proposal.

1.5 To take this next step, the Authority has decided to amend Parts 1 and 13 of the Code to enable new types of instantaneous reserve being offered as a service in the wholesale market.

1.6 The Code amendment will:

(a) generalise the meaning of the defined term **instantaneous reserve**, by restructuring the definition into two categories:

  (i) **interruptible load**, which describes all forms of offtake reserve

  (ii) **generation reserve**, which describes all forms of injectable reserve.

(b) generalise the meaning of **interruptible load** to refer to load (ie, network 'offtake') that is able to be reduced at a controlled rate, or interrupted by switching it off, in accordance with the specifications and performance requirements set out in the **procurement plan**.

(c) define a new term **energy storage system** (ESS) to refer to all equipment functioning together as a single entity that is able to take **electricity** from a **network**, store the energy in another form, and provide **injection.**

(d) define a new term **generation reserve** to refer to all forms of 'injectable' reserve. Once amended, the procurement plan would include the performance requirements for the different forms of **generation reserve**, including (without limitation):

(i) **partly loaded spinning reserve** (PLSR), which always includes an associated energy offer

(ii) **generation reserve** that does not require an associated energy offer, including (without limitation):

1. **tail water depressed reserve** (TWDR)

2. injectable reserve from an **energy storage system**

(iii) any future form of injectable reserve not covered by (i) or (ii) above.

(e) update the existing definitions of **partly loaded spinning reserve** and **tail water depressed reserve,** and add a definition for **energy storage system** to provide better internal consistency as defined Code terms, with some of the existing technical detail proposed to be relocated into the procurement plan.

(f) update the existing definitions of **fast instantaneous reserve** and **sustained instantaneous reserve** to account for the changes in (a) to (e) above.

(g) update how the quantity of reserve is specified in **instantaneous reserve** offers to account for the changes in (a) to (e) above

(h) update references throughout the Code to reflect the changes to the defined terms **partly loaded spinning reserve** and **tail water depressed reserve**

(i) make a number of consequential improvements to Code drafting, including to various uses of the defined term **demand**

(j) remove the linkage in the Code between **instantaneous reserve** *performance requirements* and *offer types*. Offer types will remain within the Code, however, an associated amendment to the **procurement plan** will move **instantaneous reserve** performance requirements into the **procurement plan**.

1.7 The Code amendment is forward-looking, as it allows future technologies to offer instantaneous reserve that:

(a) conform to the Code definitions for the relevant reserve category or categories

(b) satisfy the requirements of the procurement plan, administered by the system operator.

1.8 When the Code amendment comes into effect, it will enable an ESS, such as a battery or a pumped hydro storage system, to offer an instantaneous reserve service in the wholesale market, *both when charging from and injecting electricity into the power system*. The Code, as currently drafted, does not allow for forms of 'injectable' instantaneous reserve other than partly loaded spinning reserve (PLSR) and tail water depressed reserve (TWDR).

1.9 In addition to the Code amendment, changes have been made to the procurement plan to ensure a battery ESS can be offered as instantaneous reserve. The procurement plan sets out the mechanisms the system operator uses to procure instantaneous reserve, as well as the technical requirements and key contractual terms applying to each type of instantaneous reserve service.

1.10 While in the process of consulting on the complementary procurement plan amendment, we identified two minor technical changes to the draft Code amendment that was included as Appendix A in the Draft Decision paper. These are shown marked up in green text in Appendix A of this Final Decision paper and affect:

(a) the definition of "energy storage system", which clarifies the original intent that an energy storage system takes electrical energy from a network, stores that energy in another form and later injects the stored energy back into the network as electrical energy

(b) clause 8 of Schedule 13.3 (the objective function), by adding the missing word "reserve" to one of the offer price defined terms.

1.11 The Authority now intends to formalise approval of the Code amendment outlined in paragraph 1.6. The Code amendment is expected to come into force from 3 May 2022. See section 6, Next Steps, for further details.

2 The amendment will remedy a problem affecting instantaneous reserve

2.1 On 8 April 2021, we published a consultation paper titled *Battery energy storage systems offering instantaneous reserve*.[1] We consulted on a proposal to amend the Code to enable an ESS[2] to offer instantaneous reserve by discharging its stored energy as electricity into the network.

2.2 While an ESS is not intentionally barred from providing instantaneous reserve in the wholesale market, an ESS cannot fully comply with the requirements of any of the three types of instantaneous reserve currently permitted in the Code.

2.3 The consultation paper proposed a Code amendment to introduce a set of offer and performance arrangements to include ESSs as a new type of instantaneous reserve when they discharge electricity into the network.

2.4 At the same time, we have taken the opportunity afforded by the technical and legal review work to:

(a) tidy up some of the definitions related to instantaneous reserve to make them more consistent within the Code and the procurement plan

(b) retain definitions relevant to instantaneous reserve offer types within the Code but move some of the technical detail describing instantaneous reserve performance requirements into the procurement plan.

2.5 This paper sets out the Authority's decision to amend the Code and gives reasons for that decision.

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1 The consultation paper and the submissions received are available at: https://www.ea.govt.nz/development/work-programme/evolving-tech-business/batteries-as-instantaneous-reserve/consultations/#c18857

2 The consultation paper used the term "battery energy storage system", or BESS. This paper explains why we have decided to adopt the more generic term "energy storage system", or ESS.

2.6 More information about the *Batteries as instantaneous reserve* project is available on our website at:. https://www.ea.govt.nz/development/work-programme/evolving-tech-business/batteries-as-instantaneous-reserve/consultations/.[3]

3 The amendment promotes our statutory objective

3.1 The Authority's statutory objective is to promote competition in, reliable supply by, and the efficient operation of, the electricity industry for the long-term benefit of consumers.

The amendment promotes competition and reliability

3.2 After considering all submissions on the Code amendment proposal, the Authority believes the final Code amendment will deliver long-term benefits to consumers, as set out below.

3.3 The Code amendment:

(a) will promote competition in the electricity industry by enabling new types of technology to participate in the instantaneous reserve market. This is expected to provide downward pressure on the prices offered by existing technologies.

(b) will promote the reliable supply of electricity to consumers by broadening the range of technologies able to provide instantaneous reserve. New technologies foreshadow potentially more diverse and capable resources that can provide instantaneous reserve.

(c) is not expected to materially impact the efficient operation of the electricity industry.

3.4 The effectiveness of the Code amendment is dependent on making an associated amendment to the system operator's procurement plan. This is because the procurement plan relies on certain Code definitions and a consistent structure in the way the two regulatory instruments separate instantaneous reserve:

(a) *offer types*, which are located in the Code

(b) technical *performance requirements* for specific technologies, which are located in the procurement plan.

3.5 To highlight the interdependencies, the consultation paper included a complementary draft procurement plan amendment in an appendix. The decision to amend the Code set out in this decision paper is made following completion of the process to amend the procurement plan in accordance with clause 8.42A of the Code.

3.6 The Authority does not expect the Code amendment to have a material impact on the efficient operation of the electricity industry.

The benefits of the proposal are greater than the costs

3.7 The Authority has assessed the economic benefits and costs of the amendment, and expects it to deliver a net economic benefit. Put simply, enabling additional low-priced instantaneous reserve from ESSs (battery ESSs initially) will increase competition in the wholesale market.

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[3] Note that we have used the shorthand word "batteries" in the project title but will update future website references to use the more generic and descriptive term "energy storage systems" (ESS).

3.8 We estimate a net present value of the proposal of $43.3 million.

3.9 This is represented by expected benefits with a present value of $43.7 million exceeding expected costs with a present value of $0.4 million. We have assessed annual benefits of the proposal of $4.5 million and applied a discount rate of 6% over 15 years in our analysis.

3.10 Benefits are assessed to accrue from the downward pressure that battery ESS will put on instantaneous reserve offer prices. The costs include the one-off costs necessary to amend the Code and procurement plan and apply some straightforward enhancements to the Wholesale Information and Trading System (WITS) and Clearing and Settlements System (CHASM) administered by NZX, and Reserve Management Tool (RMT) administered by the system operator.[4] None of these IT system changes are complex.

3.11 Section 3 of the consultation paper, starting at paragraph 3.11, describes the costs and benefits of the proposal in more detail.

The amendment is consistent with regulatory requirements

3.12 The Code amendment is consistent with the requirements of section 32(1) of the Electricity Industry Act 2010.

3.13 The amendment is also consistent with the Authority's Code amendment principles: it is lawful and it will improve the reliability and efficiency of the electricity industry for the long-term benefit of consumers. The Authority has clearly identified a regulatory gap in the market rules and has used a quantitative cost benefit analysis to assess long-term net benefits for consumers.

4 The Authority considered the following matters in making this decision

4.1 We received submissions on our 8 April 2021 consultation paper from the 19 parties listed in Table 1. Submissions are available on our website at: https://www.ea.govt.nz/development/work-programme/evolving-tech-business/batteries-as-instantaneous-reserve/consultations/.

Table 1: List of submitters

Submitter	Category
PowerIt Fwd	Consultancy
Geoghegan Consulting	
Beca	
Meridian Energy	Generator/retailer
Contact Energy	

[4] WITS is the Wholesale Information and Trading System – see https://www.ea.govt.nz/operations/wholesale/spot-pricing/wits/.
RMT is the Reserve Management Tool – see https://www.transpower.co.nz/system-operator/electricity-market/instantaneous-reserve.

Submitter	Category
Mercury Energy	
Bryan Leyland	Individual
Electric Kiwi & Haast Energy Trading	Trader/retailer
Powerco	Distributor
Vector	
Electra	
WEL Networks	
Infratec	Technology provider
solarZero	
EnergyBank	Technology developer
Solagri Energy	
Far North Solar Farm Ltd	
Transpower	Grid asset owner and system operator
MEUG	Industry association (major users)

Submitters strongly agreed there is an issue and expressed broad support for the Authority's proposal

4.2 The Authority identified a regulatory gap in that the Code does not currently permit an ESS to offer its electricity discharge capability as instantaneous reserve.

4.3 Submitters expressed their views in written responses to the seven questions asked in the consultation paper and/or in covering letters/emails.

4.4 **Question 1** in the consultation paper asked whether the issue is worthy of attention.

(a) Submitters that expressed a view on this question (ie, 13 of 19) unanimously supported the Authority's view that the issue is worthy of attention.

(b) Those that did not explicitly provide a response to the question expressed unanimously supportive views in covering letters.

4.5 **Question 2** asked if submitters agreed with the objective of the proposed Code amendment.

(a) Submitters that expressed a view on this question (ie, 13 of 19) unanimously supported the objective of the proposed Code amendment.

4.6 **Question 3** asked if submitters agree that the benefits of the proposal outweigh the costs.

(a) Submitters that expressed a view on this question (ie, 12 of 19) agree that the benefits of the proposal outweigh the costs.

(b) One submitter, *Electra*, was unsure.

4.7 **Question 4** asked if submitters agreed that the proposed amendment is preferable to the other options.

(a) Most that expressed a view on this question (ie, 12 of 19) agreed with the Authority's preferred option.

(b) *Vector* preferred option d), which would be to take the time necessary to broaden the scope to include smaller scale distributed energy resources.

(c) *MEUG* considered there was no rush to proceed with the proposal now due to Rio Tinto's announcement to maintain smelting operations at Tiwai Point until 2024 (see also the discussion below in the section headed *The Authority is rushing the amendment or is taking too long in this space*).

(d) *Electra* was unsure about the preferred option and wondered if pausing to take a wider look at more inclusive options might provide a better path.

4.8 **Question 5** asked if submitters agreed that the proposed amendment complies with section 32(1) of the Act.

(a) Most that expressed a view on this question (ie, 12 of 19) agreed that the proposed amendment would comply with section 32(1) of the Act.

(b) *MEUG* answered the question by referring back to its answer to question 4, which appears to be non-responsive, or out of context, to the question asked.

(c) *Electra* agreed but expressed concern that the proposal would open the floodgates to distributed energy resources being able to offer instantaneous reserve in the ancillary services market without proper consideration of the impact on distribution networks or providing sufficient time for consultation with distributors.

4.9 **Questions 6 and 7** requested feedback on the technical drafting of the proposed Code amendment (Appendix A in the consultation paper) and the complementary draft procurement plan amendment (Appendix B in the consultation paper).

(a) Submitters expressed a range of technical drafting suggestions.

(b) We further discuss the key themes raised in the sections below headed *Make the defined term describing energy storage system more generic* and *The defined term 'generation reserve' is unnecessary or incorrect.*

(c) We have referred the technical drafting submissions related to the draft procurement plan to the system operator to address as it considers possible procurement plan amendments.

Submitters raised a number of issues and made improvement suggestions

4.10 Issues and suggestions raised by submitters fell into five categories:

(a) The Authority should not rush the Code amendment but pause and take time to widen the scope to include distributed ESS technologies. Conversely, a commonly expressed view from other submitters was that the Authority has taken too much time to get to this point and needs to complete the tasks set out in the consultation paper, requiring amendments to both the Code and the procurement plan over the course of the next 10 months.

(b) The proposed term describing energy storage technologies can be made more generic by replacing the proposed new term 'battery energy storage system (BESS)' with 'energy storage system (ESS)'.

(c) The new defined term 'generation reserve' is unnecessary or is ambiguously defined.

(d) The definition of 'fast instantaneous reserve' could be improved.

(e) Various uses of the similar words 'demand', 'load' and 'consumption' could be standardised.

4.11 Each of these issues and improvement suggestions are discussed below.

The Authority is rushing the amendment or is taking too long in this space

What we proposed

4.12 Noting recent successful deployments both locally and overseas, and diminishing costs, the proposal focused on electrochemical battery technology's ability to provide instantaneous reserve to support power system stability. Others have announced interest in battery options at significant scale – in the order of 100-200 MW.

4.13 The Authority considered that changes to the market rules should be made now to provide regulatory certainty so that New Zealand electricity consumers can begin to benefit from more of the services provided by batteries, as soon as possible.

4.14 The Authority considered options and proposed a relatively simple Code amendment that would also require a complementary amendment to the system operator's procurement plan. The proposed amendment would take a first step to providing network access to new technologies that can provide ancillary services, increasing capacity and competition in the instantaneous reserve market.

4.15 Paragraphs 2.33-2.37 of the consultation paper emphasised the Authority's work programme to deliver these outcomes.

Submitters' views

4.16 *MEUG and Electra* considered the immediate impetus to amend the Code had receded with Rio Tinto's announcement to maintain operations at Tiwai Point until 2024. They were not convinced that the proposal should proceed as a priority.

4.17 Conversely, *Mercury* considered the Code changes are overdue. Mercury stated that it engaged with the Authority and Transpower in late 2017, ahead of its 2018 commissioning date for a 1 MW prototype grid-connected BESS at Southdown in Auckland. *Mercury's* project signalled the need to update the Code and the affected market systems to enable the full capacity of battery technology to be utilised in the energy and reserve markets. *Mercury* was concerned that there are potentially smaller-scale investments and innovations that have been delayed or shelved due to the protracted process involved in obtaining a Code amendment.

4.18 *Geoghegan Consulting, Solagri, solarZero* and *Electra* strongly encouraged the Authority to progress workstreams necessary to enable market participation by resources at all scales and connection locations in networks. *Electra* also warned that rushed developments and short consultation periods would preclude proper consideration of issues and options, particularly in regard to the issues faced by distribution network owners.

Our decision

4.19 We acknowledge that Rio Tinto's announcement to maintain operations until 2024 takes away some of the impetus that withdrawal of several hundred megawatts of load from the wholesale market would have made. Nevertheless, we are in changing times as the economy grapples with decarbonisation imperatives – both the capacity and nature of generation and consumption is expected to vary in ways not experienced in the past. Rates of battery investment overseas are increasing rapidly, and overseas experience shows batteries can be installed and connected to the grid in a matter of months.

4.20 In this climate of uncertainty driving rapid changes, it is important to provide regulatory certainty where possible.

4.21 Accordingly, our decision is to:

(a) continue with the proposed Code amendment, changed in only relatively minor ways, as we explain in the following sections.

(b) progress a more comprehensive workstream that examines the potential evolution of the power system, how the needs of the power system in relation to ancillary services may evolve over time, and how those needs can best be met, including by new technologies and smaller-scale distributed energy resources. We would also ensure this workstream provides opportunities to engage with all stakeholders, including distributors in respect of distribution network issues and options, and distributed energy resource developers.

Make the defined term describing energy storage system more generic

What we proposed

4.22 The proposal added the new defined term **battery energy storage system** or **BESS**, to Part 1 of the Code, meaning "all equipment functioning together as a single entity that is both able to store **electricity** from a **network** and provide **injection"**.

Submitters' views

4.23 Several submitters (including *Electric Kiwi/Haast Energy Trading, Geoghegan Consulting, Solagri, EnergyBank, Beca, MEUG*) considered that the word 'battery' at the start of the definition implies an explicit technology restriction that is not in keeping with the consultation paper's preference to make the Code less technology-specific where possible.

Our decision

4.24 We agree that the defined term BESS can be made more generic and potentially applicable to a wide range of developing and future technologies, not just electrochemical batteries.

4.25 We note that an energy storage system (ESS) could potentially include a wide range of technologies, especially considering current research and development investments:

(a) mechanical storage e.g. pumped hydro, compressed air energy storage, flywheels

(b) electrochemical energy storage (i.e. batteries), e.g. conventional batteries, high temperature batteries, flow batteries

(c) chemical energy storage, e.g. hydrogen, synthetic natural gas

(d) high temperature thermal energy storage e.g. thermo-chemical storage, pumped heat electrical storage, liquid air energy storage

(e) electromagnetic storage e.g. capacitors, superconducting magnetic energy storage.

4.26 We acknowledge that the consultation paper frequently referred to batteries (specifically *electrochemical batteries*) because this is the specific storage technology currently driving the need for a Code amendment.

4.27 However, we agree that 'ESS' is a more futureproof term; it refers to any energy storage technology that can:

(a) charge using electricity from the network

(b) store that energy in some form

(c) and, at a later time, discharge electricity back to the network.

4.28 To the extent there are differences (e.g. in performance) between different types of ESS, these will be picked up by the technical details in the procurement plan, amended over time as new ESS technologies near commercial deployment as energy storage resources, and are able to participate in the energy and reserve markets.

4.29 We have decided to change both the defined term and the wording of the definition as follows:

(a) We have removed the word "battery" from the defined term "battery energy storage system"

(b) We have reworded the definition of "energy storage system" to more clearly highlight that electrical energy is first transformed into another form of energy for storage, and later transformed back into electrical energy.

4.30 In summary, the new defined term is as follows:

> "**energy storage system** means all equipment functioning together as a single entity that is able to take **electricity** from a **network**, store the energy in another form, and provide **injection**"

4.31 We have also updated the Code amendment to make all consequential changes.

The defined term 'generation reserve' is unnecessary or incorrect

What we proposed

4.32 The proposal added the new defined term **generation reserve** to Part 1 of the Code, meaning "a form of **instantaneous reserve** (including **partly loaded spinning reserve**, **tail water depressed reserve** and that provided by **battery energy storage systems)** which comprises generating capacity that is able to provide **fast instantaneous reserve** or **sustained instantaneous reserve** in accordance with the **procurement plan**".

Submitters' views

4.33 *Meridian* considered that the new defined term 'generation reserve' could be deleted and the three technologies listed in the parenthetical simply added to the definition of instantaneous reserve.

4.34 *MEUG* submitted that the first word in the parenthetical (i.e. the word 'included') was ambiguous as to whether it describes an *exclusive* list or *a sample* list of technologies.

Our decision

4.35 Firstly, both the Code and draft procurement plan amendments frequently rely on the new term 'generation reserve' to simplify the drafting. Collectively, the three technologies in the parenthetical are all injectable reserves, and their value is to inject electricity into the network to provide instantaneous reserve to help stabilise the power system in response to an under-frequency event. We therefore consider the defined term is valuable to help with maintaining logical and clear drafting.

4.36 Secondly, we consider the three technologies PLSR, TWDR and ESS are not exclusive. They represent the three currently deployed technologies that make (or seek to make) instantaneous reserve offers.

4.37 The main criterion for generation reserve is that its underlying technology is capable of injecting, or increasing injection of, electricity into the network, as fast instantaneous reserve and/or sustained instantaneous reserve.

4.38 Our decision is to:

(a) retain the defined term 'generation reserve' (but apply the decision discussed in the last section to delete the word 'battery')

(b) change its meaning to clarify that the three listed technologies are not exclusive, by changing the word 'including' to 'including, without limitation'.

The definition of 'fast instantaneous reserve' could be improved

What we proposed

4.39 The proposal amended the defined term **fast instantaneous reserve** to mean "the increase in generation or reduction in load (in MW) provided by **instantaneous reserve** no later than 6 seconds after the start of a "Contingent Event" (as defined in the **policy statement**) and that is sustained until at least 60 seconds after the start of the "Contingent Event".

Submitters' views

4.40 *Transpower* proposed the following wording to clarify the definition:

fast instantaneous reserve means- the increase in generation or reduction in **demand** (in **MW**) provided no later than 6 seconds, and measured at 6 seconds, after the start of a "Contingent Event" (as defined in the **policy statement**) and that is sustained until at least 60 seconds after the start of the "Contingent Event".

Our decision

4.41 We agree the definition could be improved and, following further engagement with the submitter to clarify their submission, our decision is to adopt Transpower's wording.

Demand, load or consumption?

What we proposed

4.42 We proposed no specific changes to the Code regarding the use of the words 'demand', 'load' and 'consumption'.

Submitters' views

4.43 *Transpower* noted that the terms 'demand', 'load', and 'consumption' are used interchangeably in various places in the Code and the procurement plan. Only **demand** is currently a defined term in the Code, meaning '*the rate of consumption of electrical energy'.* Transpower suggested that we consider standardising the terminology used when referring to what is essentially the same thing.

Our decision

4.44 We have reviewed the relevant Code clauses but limited that review to only those cases within the scope of the current proposal. A wider review related to standardisation of these terms across the whole Code is not practical at this time and we are mindful that changes, for example to the defined term '**demand**', could have unintended consequences.

4.45 We have decided to retain without amendment the defined term '**demand**' but have made a small number of technical drafting changes involving use of that term. The cases are as follows:

(a) in the definition of **fast instantaneous reserve**, as described in more detail in the relevant section above, we have replaced 'load' with '**demand**'.

(b) in the definition of interruptible load, we have replaced 'energy being consumed' with '**demand**'.

(c) in the definition of **sustained instantaneous reserve**, we have replaced 'load' with '**demand**'.

(d) in clause 13.44(1)(c), we have replaced ‘quantity of consumption’ with ‘**demand**’.

5 Other matters considered

What is meant by grid-scale?

What we proposed

5.1 As noted in section 4, the preferred option set out in the consultation paper was to develop a relatively simple solution that would, as a practical matter, initially allow larger-scale battery installations to offer instantaneous reserve as injectable reserve (noting that owners of such batteries can already make energy offers and interruptible load offers).

Submitters’ views

5.2 *Electra* and *Vector* noted the use of the term ‘grid-scale’ in the consultation paper and considered the term should be defined. The definition of ‘grid-scale’ was also queried by participants in our technical briefing.

5.3 Additionally, preferring development options that would maximise participation of distributed energy resources in ancillary services markets, *solarZero* considered that the proposal should not be restricted to larger-scale installations, which use of the term ‘grid-scale’ would preclude.

Our decision

5.4 The Executive Summary in the consultation paper noted the following:
“While we use the term “grid-scale” to refer to the size of batteries focussed on in this consultation paper, the size and location of BESSs across the network will become increasingly blurred. We expect that BESSs will rapidly find valuable application at all levels in the power system, from the grid to distribution networks, and embedded within consumer premises. Further development work will continue to enable a wider range of services to be provided.”

5.5 Our intention was to not define explicit capacity limits for ‘grid-scale’. Rather, we intended to explain that our preferred, simple Code/procurement plan amendment approach would (initially at least) enable ancillary services market participation, limited to those participants that are able to:

(a) comply with the non-trivial testing, monitoring and performance requirements for instantaneous reserve that are set out in detail in Appendix B of the procurement plan

(b) enter into an ancillary services contract with the system operator.

5.6 The term ‘grid-scale’ is not used in either the Code amendment or the draft procurement plan amendment.

5.7 Our decision is to:

(a) continue with the proposed Code amendment, changed in only minor or technical ways, as we explained in section 4

(b) progress a more comprehensive workstream that examines the potential evolution of the power system, how the needs of the power system in relation to ancillary services may evolve over time, and how those needs can best be met, including by new technologies and smaller-scale distributed energy resources. We would also ensure this workstream provides opportunities to engage with all stakeholders, including distributors in respect of distribution network issues and options, and distributed energy resource developers.

6 Next steps

6.1 To be fully effective, the Code amendment set out in Appendix A required a complementary amendment to the procurement plan. This has now been done and a separate paper sets out the decisions made in respect of changes to the procurement plan.

6.2 The finalised procurement plan amendment complements the Code amendment finalised in this Decision paper and is ready to be Gazetted.

6.3 We intend that both amendments are Gazetted simultaneously, with an effective date of 3 May 2022.

Appendix A Approved Code amendment

Appendix A Enabling energy storage systems to offer instantaneous reserve Code amendment

This version of the approved Code amendment shows the changes (tracked in red) since the version that was consulted on in April and May 2021, and the Authority's additional minor and technical changes (tracked in green) since the draft decision paper was published on 5 July 2021.

Part 1

1.1 Interpretation

(1) …

~~**battery** **energy storage system** means all equipment functioning together as a single entity that is both able to storetake **electricity** from a **network**, store the energy in another form, and provide **injection**~~

bona fide physical reason includes,—

(a) in relation to a **generator**, or a **purchaser**, or an **ancillary service agent** or a **grid owner**, a situation where personnel or plant safety is at risk; and

(b) in relation to a **generator** or an **ancillary service agent** providing ~~**partly loaded spinning reserve**, **tail water depressed**~~ **generation** **reserve** or **frequency keeping**,—

(i) a reasonably unforeseeable change in generating capability, reserve capability, or **frequency keeping** capability (as the case may be) from an item of **generating plant** that is the subject of an existing **offer**, **reserve offer**, or offer to provide **frequency keeping** by that **generator** or **ancillary service agent**; or

(ii) a reasonably unforeseeable change in the level of expected uncontrollable water inflows into the head pond of a hydro station that is the subject of an existing **offer**, **reserve offer**, or offer to provide **frequency keeping** by that **generator** or **ancillary service agent**; or

(iii) a reasonably unforeseeable change in circumstances such that the **generator** or **ancillary service agent** will breach any consent held by it under the Resource Management Act 1991; or

(iv) a reasonably unforeseeable physical infeasibility that arises from a **price- responsive schedule**, a **non-response schedule**, or a **dispatch schedule**; and

(ba) in relation to an **intermittent generator**, a situation in which–

(i) variable resource conditions prevent the **intermittent generator** from generating at the level expected; or

(ii) the **intermittent generator** reduces the output of an **intermittent generating station**—

(A) to prevent an **un-modelled transmission asset** from exceeding its ratings; or

(B) in order to comply with an automated signal to maintain frequency; or

(C) in light of reasonably unforeseeable circumstances that require the output of the **intermittent generating station** to be reduced to enable the **intermittent generator** to comply with the conditions of

a resource consent or other law; or

(D) in anticipation of the expected onset of a weather event that would be likely to cause the **intermittent generating station's** asset protection systems to shut down assets forming part of the **intermittent generating station**; and

(c) in relation to a **purchaser**, or an **ancillary service agent** providing **interruptible load**,—

(i) a reasonably unforeseeable full or partial loss of demand or reserve capability (as the case may be) at a **grid exit point** that is the subject of an existing **bid** or **reserve offer** by the **purchaser** or the **ancillary service agent**; or

(ii) a reasonably unforeseeable change in circumstances such that the **purchaser** or **ancillary service agent** will breach any consent held by it under the Resource Management Act 1991; or

(iii) a reasonably unforeseeable full or partial loss of generating capability from an item of **generating plant** owned by, or the subject of a supply contract with, that **purchaser** during the relevant **trading periods**; and

(d) in relation to a **grid owner**, a reasonably unforeseeable loss of full or partial capacity on transmission plant forming part of the **grid**

fast instantaneous reserve means—

~~(a) for providers of **partly loaded spinning reserve** and **tail water depressed reserve**, the additional capacity~~ the increase in generation or reduction in **demand** ~~load~~ (in **MW**) provided ~~by **instantaneous reserve**~~ no later than 6 seconds, and measured at 6 seconds, after the start of a "Contingent Event" (as defined in the **policy statement**) and that is sustained until at least 60 seconds after the start of the "Contingent Event" ~~for a period of at least 60 seconds; and~~

~~(b) for providers of **interruptible load**, the drop in load (in **MW**) that occurs within 1 second of the **grid** system frequency falling to or below 49.2 Hertz that is sustained for a period of at least 60 seconds~~

generation reserve means a form of **instantaneous reserve** (including, without limitation, **partly loaded spinning reserve**, **tail water depressed reserve** and that provided by ~~**battery**~~ **energy storage systems)** which comprises generating capacity that is able to provide **fast instantaneous reserve** or **sustained instantaneous reserve** in accordance with the **procurement plan**

instantaneous reserve means an **ancillary service** provided to balance the injection of **electricity** into the **grid** with the offtake of **electricity** from the **grid** following a drop in system frequency to the level specified in the **procurement plan**, comprising 1 or more of the following:

(a) **interruptible load**:

~~(b) **partly loaded spinning reserve**:~~

(~~c~~b) ~~**tail water depressed** **generation** **reserve**~~

interruptible load means a form of **instantaneous reserve** comprised of **demand** ~~energy being consumed~~ that is able to be ~~**electrically disconnected**~~ reduced to provide **fast instantaneous reserve** or **sustained instantaneous reserve** following a drop in system frequency, in accordance with the **procurement plan** ~~to balance the **injection supply** and the **offtake** of **electricity** following a drop in system frequency to a specified level below 50 Hz~~

partly loaded spinning reserve means a form of **generation** ~~**instantaneous**~~ **reserve** consisting of spare capacity, held in reserve on a **generating unit**, generating, but not operating at full output, but excludes the spare capacity provided by an ~~**battery**~~ **energy storage system** ~~which is able to provide **fast instantaneous reserve** or **sustained instantaneous reserve** following a drop in system frequency to a specified level below 50 Hz~~

sustained instantaneous reserve means—

~~(a) for providers of **partly loaded spinning reserve** and **tail water depressed reserve**,~~ the average increase in generation or reduction in **demand** ~~load~~ ~~additional output~~ (in **MW**) provided by **instantaneous reserve** during the first 60 seconds after the start of a "Contingent Event" (as defined in the **policy statement**) and that is sustained for at least 15 minutes after the start of the "Contingent Event" (unless a new **dispatch instruction** is given before the expiry of that 15 minute period)~~; and~~

~~(b) for providers of **interruptible load**, the average drop in load (in **MW**) that occurs over the first 60 seconds after the **grid** system frequency falls to or below 49.2 Hz that is sustained until instructed by the **system operator**~~

tail water depressed reserve means a form of ~~**instantaneous**~~**generation reserve** comprising a generating capacity on a motoring hydro generation set with no water flowing through the turbine that is available following a drop in system frequency

Part 13 Trading arrangements

13.38 Ancillary service agents to submit reserve offers to system operator

(1) Each **ancillary service agent** who has a contract described in clause 13.37 may submit **reserve offers** to the **system operator**.

(1A) An **ancillary service agent** who submits a **reserve offer** must ensure that the **system operator** receives the **reserve offer** at least 71 **trading periods** before the beginning of the **trading period** to which the **reserve offer** applies.

(2) Each **reserve offer** submitted by an **ancillary service agent** under subclause (1) may be for **fast instantaneous reserve**, **sustained instantaneous reserve** or both and must—

(a) contain all the information required by Form 5(1) in Schedule 13.1 for **partly loaded spinning reserve** or Form 5(2) in Schedule 13.1 for all other categories of ~~**tail water depressed**~~ **generation reserve**; and

(b) contain all the information required by Form 6 in Schedule 13.1 for **interruptible load**; and

(c) be a reasonable estimate of the quantity of **instantaneous reserve** available from the **ancillary service agent** at that **grid injection point**, **grid exit point** or **interruptible load group GXP**.

(3) Each **reserve offer** submitted under subclause (1), by an **ancillary service agent** that is a **generator**, must be made by reference to the same **generating unit** or **generating station** that is the subject of an **offer** under clauses 13.10 or 13.11.

13.40 Inter-relationship between reserve offers of interruptible load and bids

Bids and **reserve offers** of **interruptible load** are inter-related in that **demand electrically connected** in response to an **under-frequency event** and in accordance with a dispatched **reserve offer** may lower the quantity purchased at that **grid exit point**. Accordingly, a **purchaser** does not breach the reasonable estimate requirement in clauses 13.7(3), 13.7AA(2), and 13.8A(4) if the **purchaser** is acting as an **ancillary service agent** and ~~**electrically disconnects**~~reduces corresponding **demand** in response to an **under-frequency event** in accordance with a dispatched **reserve offer**.

13.44 How quantity is to be specified in reserve offers

(1) For each price band, a **reserve offer** must specify the quantity of **instantaneous reserve** offered to respond as **fast instantaneous reserve** and/or **sustained instantaneous reserve**— ~~as a proportion of **electricity** output or consumption up to a specified maximum quantity or as a quantity available to be interrupted, and must be expressed in **MW** to not more than 3 decimal places. The minimum quantity that may be offered in a price band for a **trading period** is 0.000 **MW**.~~

(a) as the generation available to be injected as a proportion of **electricity** output up to a specified maximum quantity for **partly loaded spinning reserve**; or

(b) as the generation available to be injected for all other categories of **generation reserve**; or

(c) as the ~~a quantity of consumption~~**demand** available to be reduced for **interruptible load**.

(2) The quantity that may be offered in a price band for a **trading period** must be expressed in **MW** to not more than 3 decimal places and must not be less than 0.000 **MW**.

13.53 Additional information to be provided by participants

Despite clauses 13.22, 13.23, 13.51, and 13.52, if an **ancillary service agent** submits a **reserve offer** for ~~**partly loaded spinning reserve** or **tail water depressed** **generation** **reserve** in accordance with clauses 13.37 to 13.54, the **ancillary service agent** must also provide the maximum quantity of fast response **generation reserve** expressed in **MW** and/or the maximum quantity of sustained response **generation reserve** expressed in **MW** ~~the following information in relation to the capability to provide **partly loaded spinning reserve** or **tail water depressed reserve** to the **system operator** in a manner and at such times as are approved by the **system operator** (such approval not to be unreasonably withheld).~~

~~(a) the maximum quantity of fast response **partly loaded spinning reserve** expressed in **MW** and the maximum quantity of sustained response **partly**~~

~~**loaded spinning reserve** expressed in **MW**:~~

~~(b) the maximum quantity of fast response **tail water depressed reserve** expressed in **MW** and the maximum quantity of sustained response **tail water depressed reserve** expressed in **MW**.~~

Form 5
Generation Reserve Offer

(1) **Partly Loaded Spinning Reserve**

Band 1:

____% of electricity (**MW**), up to a maximum of_____**MW** as Fast Instantaneous Reserve @ $_____per **MW**

____% of electricity (**MW**), up to a maximum of_____**MW** as Sustained Instantaneous Reserve @ $_____per **MW**

Band 2:

____% of electricity (**MW**), up to a maximum of_____**MW** as Fast Instantaneous Reserve @ $_____per **MW**

____% of electricity (**MW**), up to a maximum of_____**MW** as Sustained Instantaneous Reserve @ $_____per **MW**

Band 3:

____% of electricity (**MW**), up to a maximum of_____**MW** as Fast Instantaneous Reserve @ $_____per **MW**

____% of electricity (**MW**), up to a maximum of_____**MW** as Sustained Instantaneous Reserve @ $_____per **MW**

(2) ~~**Tail water depressed**~~ **All other forms of generation reserve**

Band 1:

Up to a maximum of_____**MW** @ $_____per **MW** as Fast Instantaneous Reserve

Up to a maximum of_____**MW** @ $_____per **MW** as Sustained Instantaneous Reserve

Band 2:

Up to a maximum of_____**MW** @ $_____per **MW** as Fast Instantaneous Reserve

Up to a maximum of_____**MW** @ $_____per **MW** as Sustained Instantaneous Reserve

Band 3:

Up to a maximum of_____**MW** @ $_____per **MW** as Fast Instantaneous Reserve

Up to a maximum of_____**MW** @ $_____per **MW** as Sustained Instantaneous Reserve

Schedule 13.3

8 The objective function

(1) The objective function of the modelling system is described mathematically as:

$$\text{Maximise} \left\{ \begin{array}{c} \overbrace{\sum_{i,j} D_{i,j} \ x \ BP_{i,j}}^{\text{Gross Consumer Benefit}} \\ \text{minus} \\ \overbrace{\sum_{i,j} G_{i,j} \ x \ OP_{i,j}}^{\text{Cost of Generation}} \\ \text{minus} \\ \overbrace{\sum_{i,j} R_{i,j}^{PLSRGR,f} \ x \ OP_{i,j}^{PLSRGR,f} + \sout{\sum_{i,j} R_{i,j}^{TWD,f} \ x \ OP_{i,j}^{TWD,f}} + \sum_{i,j} R_{i,j}^{IL,f} \ x \ OP_{i,j}^{IL,f}}^{\text{Cost of Fast Instantaneous Reserves}} \\ \text{minus} \\ \overbrace{\sum_{i,j} R_{i,j}^{PLSRGR,s} \ x \ OP_{i,j}^{PLSRGR,s} + \sout{\sum_{i,j} R_{i,j}^{TWD,s} \ x \ OP_{i,j}^{TWD,s}} + \sum_{i,j} R_{i,j}^{IL,s} \ x \ OP_{i,j}^{IL,s}}^{\text{Cost of Sustained Instantaneous Reserves}} \end{array} \right\}$$

where

i	is a price band of a **bid** / **offer** or a **reserve offer**
j	is a **generating unit** / **generating station**, or a **purchaser**
$D_{i,j}$	is the scheduled demand corresponding to price band i of the **bid** for **purchaser** j or metered demand, whichever is relevant, and where the relevant **bids** used here are formed from a combination of the following, as appropriate to the schedule being calculated: (a) nominated bids: (b) the forecast prepared under clause 13.7A(1): (c) difference bids (if difference bids are used, the quantities must be added or subtracted, as appropriate, from the forecast prepared under clause 13.7A(1)): (d) the system operator's expectation of the profile of demand during the relevant period covered by the schedule being calculated: (e) a measure of actual demand during the relevant period
$BP_{i,j}$	is the **bid** prices corresponding to price band i of the **bid** for **purchaser** j
$G_{i,j}$	is the scheduled generation corresponding to price band i of the **offer** for unit / station j
$OP_{i,j}$.	is the **offer** price corresponding to price band i of the **offer** for unit / station j
$R_{i,j}^{GR,f}$	is the scheduled fast GR corresponding to price band i of the fast **reserve offer** for unit / station j

$R_{i,j}^{GR,s}$ is the scheduled sustained GR corresponding to price band i of the **reserve offer** for unit / station j

$OP_{i,j}^{GR,f}$ is the **reserve offer** price corresponding to price band i of the fast GR **reserve offer** for unit / station j

$OP_{i,j}^{GR,s}$ is the **reserve offer** price corresponding to price band i of the sustained GR **reserve offer** for unit / station j

~~$R_{i,j}^{PLSR,f}$ is the scheduled fast PLSR corresponding to price band i of the fast **reserve offer** for unit / station j~~

~~$R_{i,j}^{PLSR,s}$ is the scheduled sustained PLSR corresponding to price band i of the **reserve offer** for unit / station j~~

~~$OP_{i,j}^{PLSR,f}$ is the **reserve offer** price corresponding to price band i of the fast PLSR **reserve offer** for unit / station j~~

~~$OP_{i,j}^{PLSR,s}$ is the **offer** price corresponding to price band i of the sustained PLSR **reserve offer** for unit / station j~~

~~$R_{i,j}^{TWD,f}$ is the scheduled fast TWD corresponding to price band i of the **reserve offer** for unit / station j~~

~~$R_{i,j}^{TWD,s}$ is the scheduled sustained TWD corresponding to price band i of the **reserve offer** for unit / station j~~

~~$OP_{i,j}^{TWD,f}$ is the **reserve offer** price corresponding to price band i of the fast TWD **reserve offer** for unit / station j~~

~~$OP_{i,j}^{TWD,s}$ is the **reserve offer** price corresponding to price band i of the sustained TWD **reserve offer** for unit / station j~~

$R_{i,j}^{IL,f}$ is the scheduled fast IL corresponding to price band i of the **reserve offer** for **purchaser** j

$R_{i,j}^{IL,s}$ is the scheduled sustained IL corresponding to price band i of the **reserve offer** for **purchaser** j

$OP_{i,j}^{IL,f}$ is the **reserve offer** price corresponding to price band i of the fast IL **reserve offer** for **purchaser** j

$OP_{i,j}^{IL,s}$ is the **reserve offer** price corresponding to price band i of the sustained IL **reserve offer** for **purchaser** j

and where

GR is **generation reserve**

~~PLSR is **partly loaded spinning reserve**~~

~~TWD is **tail water depressed reserve**~~

IL is **interruptible load**

fast	is **fast instantaneous reserve**
sustained	is **sustained instantaneous reserve**