Battery energy storage systems offering instantaneous reserve

Consultation paper

Submissions close: 5 pm, Thursday 6 May 2021

8 April 2021

Executive summary

New technology will enable New Zealand's transition to low-emissions energy

New technologies will play a critical role as New Zealand transitions towards a low-emissions energy system.

Within this context, battery technology has reached a tipping point as a solution to several operational needs underpinning the reliable supply of electricity in the long-term interests of consumers. Costs are falling dramatically and batteries are being deployed at significant scale internationally.

The Electricity Authority (Authority) has taken this technology shift onboard and recognised that changes are required to the Electricity Industry Participation Code 2010 (the Code).

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.

This consultation paper takes the next step and focuses on battery technology's ability to provide short-term, 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 100-200 MW. 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.

Instantaneous reserves support system stability

Instantaneous reserve consists of generating capacity made available to increase output, or connected load made available to disconnect or rapidly reduce its level of load. Instantaneous reserve is procured by the system operator in the wholesale electricity market in each half-hour trading period.

The system operator schedules sufficient instantaneous reserve to arrest a fall in system frequency following an under frequency event. Under frequency events are falls in system frequency caused by pre-defined losses of generation or transmission capacity.

When an under frequency event occurs, instantaneous reserve responds automatically to:

(a) prevent system frequency from falling to a level where power system collapse can occur

(b) restore frequency to within the normal operating band (49.8 Hz – 50.2 Hz).

There are three types of instantaneous reserve defined in the Code:

(a) partly loaded spinning reserve

(b) tail water depressed reserve

(c) interruptible load.

The three types of instantaneous reserve provide the same category of ancillary service and receive the same market price. However, the Code provides for offer and performance differences between the three types of technology so as to permit each to perform in an efficient manner.

Batteries can also provide system-stability services

A grid-scale battery energy storage system (BESS) consists of large batteries connected to transmission or distribution networks through inverters and transformers. Inverters convert DC electricity (used by batteries) into AC electricity (used by the power system) and vice versa. A BESS control system enables a BESS to both charge from, and discharge into, a power system.

The ability to both charge and discharge allows a BESS to act as a generating unit, and as a load, at different times. This characteristic enables a BESS to provide instantaneous reserve in two different modes – firstly as load that is able to be reduced (when charging) and secondly as generation that is able to be increased (when injecting). A BESS can transition rapidly and smoothly from charging to discharging and thereby, when charging at maximum capacity, could provide a quantity of instantaneous reserve equal to the full charge-discharge range, subject to the amount of electrical charge stored in the BESS.

Changes to the rules are required to enable batteries to participate in the reserves market

While a BESS is not intentionally barred from providing instantaneous reserve in the wholesale market, a BESS cannot fully comply with the requirements of any of the three existing types of instantaneous reserve. This consultation paper proposes a Code amendment to introduce a set of offer and performance arrangements to include BESSs as a new type of instantaneous reserve.

There are currently two instantaneous reserve products specified in the Code: fast instantaneous reserve and sustained instantaneous reserve. This paper does not propose changes to the core settings of the two instantaneous reserve products. The Authority and the system operator previously carried out an extensive review of the instantaneous reserve products. In 2018, the Authority decided there was no economic case supporting a change to the settings for instantaneous reserve in the medium-term.[1]

Accordingly, the Code amendment proposed in this consultation paper seeks only to enable BESSs to act as an additional type of fast or sustained instantaneous reserve, with minimal complexity. However, a subsequent, wider review will investigate the future needs of the system in relation to system stability and how these needs could be met by the full range of services provided by technologies such as BESS.

The future is bright for network-connected distributed energy resources

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.

We are actively engaged with the system operator to scope the next stage of work that will develop provisions for reliable, coordinated and secure operation of inverter-connected distributed energy resources, enabling aggregations of smaller distributed BESSs as potential providers of ancillary service.

[1] The relevant decision paper is available at: https://www.ea.govt.nz/assets/dms-assets/23/23192Review-of-instantaneous-reserve-markets-project.pdf

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1 What you need to know to make a submission

What this consultation paper is about

1.1 The purpose of this paper is to consult with interested parties on the Authority's proposal to amend the Code to enable grid-scale battery energy storage systems (BESSs) to participate in the instantaneous reserve market.

1.2 Enabling owners to offer BESSs as instantaneous reserve will improve competition in the ancillary services market and place downward pressure on instantaneous reserve offer prices, while improving the reliability of supply to consumers. This will better align with the Authority's statutory objective.

1.3 Section 39(1)(c) of the Act requires the Authority to consult on any proposed amendment to the Code and corresponding regulatory statement. Section 39(2) provides that the regulatory statement must include a statement of the objectives of the proposed amendment, an evaluation of the costs and benefits of the proposed amendment, and an evaluation of alternative means of achieving the objectives of the proposed amendment. The regulatory statement is set out in section 3 of this paper.

How to make a submission

1.4 Our preference is to receive submissions in electronic format (Microsoft Word) in the format shown in Appendix C. Submissions in electronic form should be emailed to battery@ea.govt.nz with "Consultation Paper - Battery energy storage systems offering instantaneous reserve" in the subject line.

1.5 If you cannot send your submission electronically, post one hard copy to either of the addresses below, or fax it to 04 460 8879.

Postal address	Physical address
Submissions Electricity Authority PO Box 10041 Wellington 6143	Submissions Electricity Authority Level 7, Harbour Tower 2 Hunter Street Wellington

1.6 Please note the Authority wants to publish all submissions it receives. If you consider that we should not publish any part of your submission, please

(a) Indicate which part should not be published

(b) Explain why you consider we should not publish that part

(c) Provide a version of your submission that we can publish (if we agree not to publish your full submission).

1.7 If you indicate there is part of your submission that should not be published, we will discuss with you before deciding whether to not publish that part of your submission.

1.8 However, please note that all submissions we receive, including any parts that we do not publish, can be requested under the Official Information Act 1982. This means we would be required to release material that we did not publish unless good reason existed under the Official Information Act to withhold it. We would normally consult with you before releasing any material that you said should not be published.

When to make a submission

1.9 Please deliver your submissions by **5 pm** on **Thursday, 6 May 2021**.

1.10 This deadline allows four weeks for submissions. We will acknowledge receipt of all submissions electronically. Please contact the Authority at battery@ea.govt.nz or 04 460 8860 if you do not receive electronic acknowledgement of your submission within two business days.

Further information

1.11 Please direct any specific questions to: battery@ea.govt.nz.

2 Issue the Authority would like to address

The existing arrangements for instantaneous reserve

2.1 The system operator procures ancillary services to support the reliable operation of the power system and to assist it to meet the principal performance obligations specified in the Code. Instantaneous reserve is one of the five ancillary services the system operator may procure.

2.2 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 service.[2]

2.3 Instantaneous reserve seeks to assist the system operator to avoid cascade failure of assets resulting in a loss of electricity supply to consumers arising from a frequency excursion outside of:

(a) the normal band, which is the frequency operating band between 49.8 Hz and 50.2 Hz within which frequency is normally maintained, except during momentary fluctuations

(b) defined limits for specified contingencies, in compliance with sections 31 to 33B of the policy statement.[3]

2.4 In practice, the system operator procures instantaneous reserve to arrest a fall in frequency following a contingent event (CE) or extended contingent event (ECE), and to return frequency to within the normal band. Comprehensive definitions of CE and ECE are provided in clauses 12.3 and 12.4 of the policy statement.

2.5 In simple terms, a CE includes the loss of:

(a) a single transmission circuit

(b) a single HVDC link pole

(c) a single generating unit

(d) a double transmission circuit in certain elevated-risk circumstances

(e) reactive power injections into the grid

(f) the largest possible load block in any of the above circumstances.

2.6 The system operator must procure enough instantaneous reserve to prevent the frequency falling below 48 Hz following the onset of a CE.

2.7 An ECE includes the loss of the HVDC link bipole.

2.8 In addition, certain high voltage busbar and interconnecting transformer faults can also qualify as elevated-risk events, depending on the circumstances.

2.9 ECEs occur less frequently than CEs and the risk they pose to reliable supply is mitigated by a combination of instantaneous reserve and automatic under frequency

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2 The system operator's website provides further information about ancillary services at: https://www.transpower.co.nz/system-operator/electricity-market/ancillary-services-overview and, in respect of instantaneous reserve: https://www.transpower.co.nz/system-operator/electricity-market/instantaneous-reserve

3 The policy statement is a document incorporated by reference into the Code and is available at: https://www.ea.govt.nz/code-and-compliance/the-code/documents-incorporated-into-the-code-by-reference/

load shedding (AUFLS). For an ECE, the system operator must procure enough instantaneous reserve to prevent the frequency falling below 47 Hz in the North Island and 45 Hz in the South Island.

2.10 The system operator procures instantaneous reserve to mitigate the risk posed by contingent events to the stable and secure operation of the grid.

2.11 The following technologies provide a pool of instantaneous reserve to the system operator via ancillary service contracts:

(a) interruptible load (IL) – load that is able to be automatically electrically disconnected or reduced following a drop in system frequency

(b) partly loaded spinning reserve (PLSR) – available capacity on a generating unit that is generating but is not operating at its full capacity, which can increase its output following a drop in system frequency

(c) tail water depressed reserve (TWDR) – capacity available on a motoring (synchronised) hydro generating unit with no water flowing through the turbine, which can automatically switch into generating mode and increase its output to its full capacity following a drop in system frequency.

2.12 The system operator procures two types of instantaneous reserve in each half hour trading period:

(a) fast instantaneous reserve (FIR)

(b) sustained instantaneous reserve (SIR).

2.13 FIR acts to counter the under frequency excursion resulting from a CE. FIR is provided by PLSR, TWDR and IL. Contracted FIR capacity must be provided:

(a) for PLSR and TWDR, within six seconds after the onset of a CE

(b) for IL, within one second after the frequency falls to 49.2 Hz.

2.14 Once activated, FIR must be sustained for a minimum of 60 seconds.

2.15 SIR acts to recover the frequency back to or above 49.25 Hz after an under frequency excursion resulting from a CE. SIR must be provided within 60 seconds after the onset of a CE, and:

(a) for PLSR and TWDR, sustained for at least 15 minutes

(b) for IL, sustained until the provider is instructed by the system operator that the provider may reconnect the interrupted load.

Issues with the existing arrangements

2.16 The existing types of instantaneous reserve were introduced to the New Zealand power system over 20 years ago. In the time since its introduction, instantaneous reserve has been offered by two types of resources: synchronous generating units (such as hydro, thermal, combustion turbine and geothermal generating units) and interruptible load. The Code-defined performance capabilities and offer requirements for instantaneous reserve reflect the characteristics of real-world synchronous generating units and interruptible load.

2.17 Electrical storage batteries are an established technology used at one time to provide direct current (DC) electricity before large scale synchronous generating units came into use in alternating current (AC) power systems. Batteries have undergone significant

technological advances in more recent years to make them suitable for modern, high energy density storage needs, such as in electric vehicles and for use in power systems.

2.18 The main components that make up a BESS are a bank of electrochemical storage batteries combined with an electronic control system and one or more power inverters. Power inverters are electronic devices designed to convert between DC and AC electricity in either direction.

2.19 In modern power systems, BESSs provide services that support the secure and reliable operation of the power system, including voltage management, load management and instantaneous reserve. Through ongoing development of the technology, BESSs are now performance- and cost-competitive with the established technologies, and can provide enhanced capability and flexibility.

2.20 When charging, BESSs act like load[4] and are able to provide IL by interrupting or reducing the power being used to charge the battery.

2.21 When discharging, BESSs can act in a manner similar to conventional synchronous generating units. Importantly, they are able to provide a useful reserve response to CE or ECE events.

2.22 The issue this paper seeks to address is that a BESS cannot offer instantaneous reserve when discharging (ie, injecting power into the power system), or when connected and charged but neither charging nor discharging, because the Code as currently drafted does not allow for forms of 'injectable' instantaneous reserve other than PLSR and TWDR.

2.23 This represents a gap in the existing framework for instantaneous reserve provided in the Code because an ancillary services provider is precluded from offering a viable technology as instantaneous reserve to the system operator. The main problems that must be resolved to address the regulatory gap generally relate to existing Code definitions or specifications that are relatively technical in nature.

Why the Authority is addressing these issues now

2.24 In 2018, Mercury Energy developed a small prototype grid-connected BESS in Auckland. Commissioning of this BESS in July 2018 signalled a need to update the Code and the affected market systems to enable the full capability of BESS technology to be utilised in the energy and reserves markets.

2.25 The Authority made interim clarifications to the Code in 2018 to allow BESS owners to offer energy in the wholesale market and subsequently amended the Code in February 2020. The amendment formally recognised participation of BESSs and solar farms in the energy market.

2.26 The Code and market systems require other more substantial changes to properly incorporate performance requirements relevant to BESSs providing instantaneous reserve when injecting power into a network (i.e. when discharging). When it made recommendations to the Authority in June 2020 on the use of generating technologies in the wholesale market, the Market Development Advisory Group (MDAG) noted that this work should be given priority.

[4] While they act 'like load' when charging from a network, aside from the losses incurred in the conversions between forms of energy, BESSs do not consume energy as loads do, rather they store energy for later transfer back to the network.

2.27 The announcement by Rio Tinto in July 2020, confirming its intentions to close the Tiwai Point aluminium smelter within a very short timeframe, placed greater emphasis on completing this work. While Rio Tinto now intends to provide a longer wind-down period, the likelihood of a shutdown has stimulated interest amongst market participants to address a probable need to move more South Island generated energy northwards across the HVDC link.

2.28 Transpower has now brought forward its Clutha Upper Waitaki Lines Project, targeting completion by May 2022. The project will increase transmission capacity between the Clutha River and the Upper Waitaki Valley and consequently allow additional electricity to be exported from Southland to the North Island through the HVDC link.

2.29 Northward transfers on the HVDC link are constrained at times below the link's capacity of 1200 MW. Constraints arise when North Island instantaneous reserve prices are at high levels, or offered reserve quantities are insufficient to cover the risk of the HVDC bi-pole tripping.

2.30 When additional exports of electricity from the Southland area are able to increase from May 2022, northward transfers on the HVDC link will likely increase and cause constraints to bind more often.

2.31 To increase the supply of North Island instantaneous reserve and reduce the risk of the HVDC link constraint binding, two participants have proposed a project to build a 100 MW BESS in the North Island. The target completion date announced for the project is currently March 2022.

2.32 Whether or not the 100 MW BESS project proceeds as planned, the Authority expects interest in grid-scale BESS to grow significantly in the near-term future. The cost of grid-scale storage batteries is reducing and is forecast to fall by 50% in the next 10 years,[5] and rates of deployment of batteries internationally are increasing rapidly.

The proposed draft Code amendment lays the groundwork for all BESSs

2.33 While the Code changes proposed in this consultation paper are focussed on enabling wider participation by grid-scale BESSs, we understand that smaller, more distributed batteries are being connected to distribution networks with increasing frequency. These batteries are deployed as either standalone, directly-connected batteries,[6] and as a component in consumer embedded solar power installations.[7] Over time, we expect further technology options involving network-connected batteries will eventuate.

2.34 While larger-scale, directly connected single BESS installations may currently qualify as ancillary service providers, an important distinction is that aggregations of smaller-scale batteries will require additional development work, affecting both the Code and the system operator's procurement plan.

2.35 This additional work will develop suitable procurement arrangements, including operational protocols and inverter performance standards, specific to battery aggregations that may provide instantaneous reserve.

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5 U.S. Department of Energy's National Renewable Energy Laboratory Technical Report NREL/TP-6A20-75385, June 2020.

6 For example, Counties Power's collaboration with Relectrify: https://www.countiespower.com/news/id/262

7 For example, the SolarZero initiative: https://www.solarcity.co.nz/expert-advice/batteries

2.36 The Authority is actively engaged with the system operator to scope this additional development work, which includes development of a roadmap that will provide guidance about the scope and timeline of developments. We intend to engage with interested parties as this work progresses.

2.37 The Code amendment proposal in this consultation paper will lay the groundwork for participation of all network-connected batteries.

Q1. Do you agree the issue identified by the Authority is worthy of attention?

2.38 The proposed Code amendment is described in detail in section 3.

3 Regulatory Statement for the proposed amendment

Objectives of the proposed amendment

3.1 The proposed Code amendment would enable a grid-scale BESS to offer an instantaneous reserve service in the wholesale market, both when charging from and injecting into the power system.

Q2. Do you agree with the objectives of the proposed Code amendment? If not, why not?

The proposed amendment

3.2 The proposed Code amendment would make the following changes.

(a) **Generalise the meaning of instantaneous reserve**: The meaning of instantaneous reserve would be generalised to refer to two forms of reserve (reduced from the current three forms):

(i) interruptible load

(ii) generation reserve.

(b) **Add a definition for generation reserve**: A new term would be added covering all forms of 'injectable' reserve. The procurement plan would include the performance requirements for the different forms of generation reserve, including:

(i) PLSR (which, by definition, always has an associated energy offer)

(ii) generation reserve not requiring an associated energy offer, including TWDR and BESS injectable reserve

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

(c) **Generalise the meaning of interruptible load**: The meaning of interruptible load would be generalised to refer to load that is able to be reduced in accordance with the procurement plan. The procurement plan would include performance requirements for both load that can be interrupted and load that can be ramped down at a controlled rate, such as a BESS when charging.

(d) **Update how quantity is to be specified**: The quantity of reserve to be specified in instantaneous reserve offers would be updated to account for the changes in (a) to (c) above.

(e) **Update definitions of partly loaded spinning reserve, tail water depressed reserve, instantaneous reserve and add a definition for battery energy storage system**: These definitions would be amended to provide better consistency as defined Code terms, with some technical detail moved into the procurement plan. BESS would attain a Code definition.

(f) **Update the definitions of fast instantaneous reserve and sustained instantaneous reserve**: The definitions of fast instantaneous reserve and sustained instantaneous reserve would be updated to account for the changes in (a) to (c) above.

(g) **References updated throughout the Code:** All references to PLSR and TWDR would be updated to reflect the change in (b) above.

3.3 The amendment would allow early adoption of BESS injectable reserve into the wholesale market. The proposal is intended to be an intermediate step towards a future more comprehensive integration of BESSs – and other inverter-connected devices – into the wholesale market, at all levels in the power system.

3.4 As outlined in section 2, further changes that enable secure operational control and dispatch of aggregated distributed energy resources will require development of necessary protocols. These future changes are likely to be justifiable after the system operator gains operational experience with BESSs and as levels of new technology penetration increase.

3.5 The proposed amendment would remove the linkage in the Code between instantaneous reserve performance requirements and offer types. Offer types are proposed to remain within the Code. However, if the Code amendment proceeds following consideration of submissions, the system operator will progress an associated amendment to the procurement plan that would shift instantaneous reserve performance requirements into the procurement plan.

3.6 This is an appropriate change because instantaneous reserve performance requirements are technical in nature and are better maintained by the system operator in the procurement plan. While the procurement plan sits outside of the Code, it is a 'document incorporated by reference' into the Code; as such, proposed procurement plan amendments are subject to specific consultation obligations, involving consultation rounds administered firstly by the system operator (under clause 8.42A) and secondly by the Authority (under clause 8.44).

3.7 If the Authority approves the proposed Code amendment, this would trigger the start of the formal process to amend the procurement plan. Both the Code and procurement plan amendments would be timed to come into effect simultaneously at the end of the respective amendment processes. Both amendments, if approved, are currently planned to come into effect on 1 April 2022.

3.8 A draft of the proposed Code amendment is included in Appendix A.

We have included an indicative associated amendment to the procurement plan

3.9 We have attached as Appendix B a draft of a procurement plan amendment that aligns with the proposed Code amendment.[8] The purpose of providing this draft now is not to undertake a formal consultation on the procurement plan itself but to provide a companion procurement plan draft that would give overall effect to the proposed Code amendment. Nevertheless, the two documents work closely together and we welcome submissions on both the draft Code and draft procurement plan amendments.

3.10 As outlined above, if the Authority decides to amend the Code, the system operator and then the Authority itself will need to conduct formal consultation rounds in accordance with the Code to amend the procurement plan.

[8] Appendix B of this paper provides a version of Appendix B of the procurement plan showing the proposed amendments as tracked changes. No other amendments are proposed to the rest of the procurement plan.

The proposed amendment's benefits are expected to outweigh the costs

Net benefits

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

3.12 This is represented by expected benefits with a present value of $43.71 million outweighing expected costs with a present value of $0.41 million. We have assessed annual benefits of the proposal of $4.5 million and applied a discount rate of 6% over 15 years.

Benefits

3.13 Our assessment modelled the impact of a project that has been publicly announced, which is the 100 MW BESS located in the North Island and offered as instantaneous reserve. Other future projects enabled by the proposed amendment would potentially provide additional net benefits.

3.14 Our assessment assumes that the North Island BESS would be used primarily to relieve northward transfer HVDC constraints and would therefore be offered as a price taker in both the FIR and SIR markets.

3.15 Our analysis used historical offer data from the date the national market for instantaneous reserve came into force in October 2016, through to September 2020. We added 100 MW of low cost FIR and SIR to the historical offers and re-solved prices in each trading period.

3.16 The additional low cost FIR and SIR alters the instantaneous reserve supply curve in the manner shown in Figure 1 below.

3.17 Assuming offer prices indicate the marginal cost of supply, the total cost of instantaneous reserve procured in a trading period is represented by the area under the supply curve bounded by the quantity of instantaneous reserve purchased.

3.18 This is shown diagrammatically in Figure 1 as areas A plus B in the case of the original historical offers, and area B in the case of 100 MW of low cost FIR and SIR added to the historical offers. The difference between the two cases (area A) is the cost saving achieved by adding 100 MW of low cost FIR and SIR to the instantaneous reserve market.

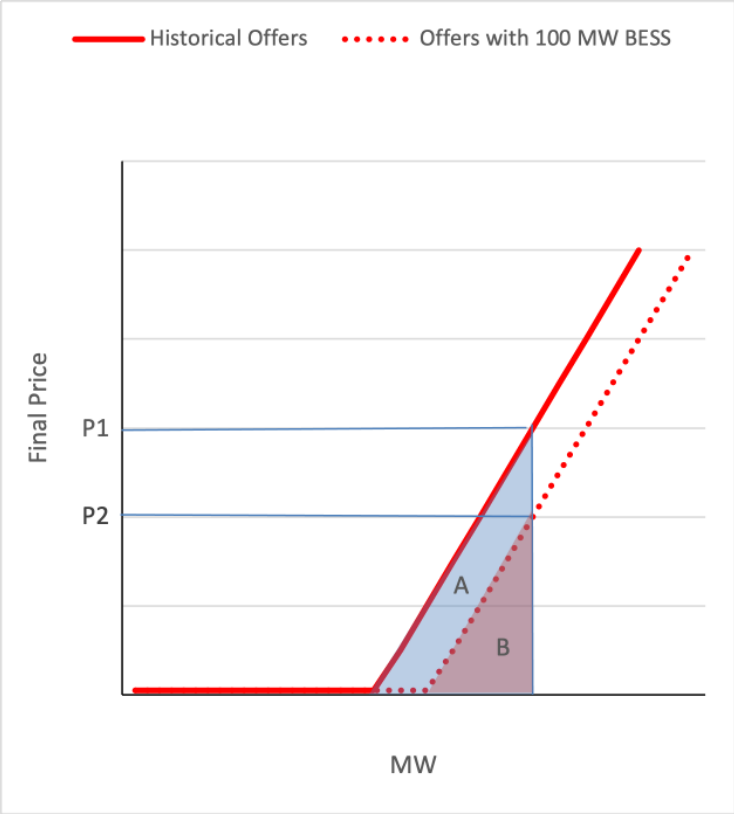
3.19 The Authority ran simulations using vSPD (its version of the system operator's scheduling pricing and dispatch software) to calculate the costs savings in all trading periods between October 2016 and September 2020 using historical offers. As the additional instantaneous reserve alters HVDC flows, there are associated changes in dispatched generation and changes in energy market costs. The value of these changes was also calculated in the vSPD simulations.

3.20 The average annual savings were assessed to be $4.5 million using this method.

3.21 While this estimate does not account for any competitive response (noting the sensitivity analysis discussed in the following section), this figure is still likely to be a conservative estimate. A BESS can transition rapidly and smoothly from charging to discharging and thereby, when charging at its maximum rate, could provide a quantity of instantaneous reserve equal to the full charge-discharge range, subject to the amount of electrical charge stored in the BESS. At times of excess supply in the South Island, prices may be low and a BESS may choose to charge. At these times, a BESS may be able to offer up

to the full charge-discharge range as reserve, rather than just the full discharge alone, enabling even greater transfers north across the link.

Figure 1: Reserve Supply Curves



Costs

3.22 The Authority has estimated implementation costs for market operator service providers and the Authority itself. The implementation costs are one-off costs and are modelled to arise prior to any benefits flowing from the proposal. The results are shown in Table 1.

Table 1: Proposal costs

Party	Initial costs ($)	Annual operational costs ($)
Market operator service providers	350,000	0
The Authority	60,000	0

3.23 These costs have a total value of $410,000.

Sensitivity analysis

3.24 Firstly, we assessed the impact of applying a higher discount rate, which would make the analysis more conservative. A discount rate of 8% reduces the estimated net present value to $38 million but it clearly remains strongly positive.

3.25 Secondly, we assessed the impact of market response, which would place downward pressure on offer prices.

3.26 The incumbent instantaneous reserve providers are likely to respond to 100 MW of low priced FIR and SIR entering the reserve market. For example, providers of PLSR may make more generating capacity available to the energy market and less available as reserve.

3.27 To test this, we modelled an extreme case where 100 MW of the lowest priced FIR and SIR was removed from historical offers. Under this scenario, the net present value calculated using vSPD reduced to $29 million, but again remains strongly positive.

3.28 While we could attempt to model a wide range of market response and additional battery installation scenarios, examination of the order of magnitude of the benefits and costs respectively indicates a strongly positive net present value. Enabling additional low priced instantaneous reserve from batteries is simply good for competition in the wholesale market.

Q3. Do you agree the benefits of the proposed amendment outweigh its costs?

The Authority has identified four other means for addressing the objectives

3.29 The Authority has identified four other means for addressing the objectives:

a) Implement more complex changes to market systems to co-optimise a wider range of dispatch outcomes. This option would require changes to the system operator's Scheduling, Pricing and Dispatch system (SPD), but was discounted due to time, cost and clashes with changes to SPD being made by the Real Time Pricing (RTP) project.

b) Process a request from a participant to use a BESS as an 'alternative ancillary services arrangement' in accordance with clause 8.48 of the Code. The Authority considers the provisions for alternative ancillary services arrangements are more appropriate for one-off, bilateral arrangements invoked by participants. BESS technology development is accelerating and is expected to become an important option to provide ancillary services globally as power systems lose the inertia provided by traditional coal- and gas-fired synchronous generating units. In addition, prospective investors in BESSs would benefit from gaining certainty of the regulatory treatment of a BESS in all its potential operating modes.

c) Changing the core specification of FIR and SIR to an option like an 'area under the curve' approach. This would be a very significant change, previously discounted because of cost, that could not be achieved in the timeframe available.

d) Widening the solution to better accommodate distributed batteries. As noted earlier, we are aware of significant potential aggregations of distributed batteries that will require developments in operational coordination to fully and reliably enable, while assuring adequate system performance. We understand that such developments are underway but will require substantial multi-party effort to develop effective trading arrangements for ancillary services, including at an end-consumer level.

The proposed amendment is preferred to other options

3.30 The Authority has evaluated the other means for addressing the objectives described above and prefers the proposal. The proposal emphasises simplicity and a relatively short amendment process, while enabling potentially significant battery storage resources to participate as instantaneous reserve under broadly similar conditions to existing types of instantaneous reserve.

Further work will continue to harness the full potential of BESS

3.31 However, this is not the final state for BESS development as ancillary services. The proposal lays the groundwork for the more comprehensive developments expected to come that will lead to battery resources participating in energy and ancillary service markets to their full potential.

3.32 The Authority intends to scope this further work as part of the overall review of security, reliability and resilience in the face of technological and other change. The next steps in this review are to determine the future needs of the system in relation to ancillary services. This work will be undertaken in association with the system operator and may eventually recommend amendments to the existing market products and arrangements for ancillary services. New reserve products, for example faster acting and/or shaped reserve response, would require further amendments to the Code.

The proposed Code amendment is consistent with the transmission pricing methodology workstream

3.33 We are conscious that the proposal detailed in this consultation paper runs in parallel with the current stage of the transmission pricing methodology (TPM) project, during which Transpower is developing a proposed TPM for submission to the Authority. In this context, the Transpower and Authority teams have been in discussion regarding the application of the proposed TPM's provisions relating to the residual charge to grid-connected batteries and similar storage.

3.34 The two workstreams have progressed in parallel with appropriate engagement and consideration of possible issues, to ensure consistency in approach. At this stage, we do not envisage problems arising from the parallel activities in the two workstreams.

Q4. Do you agree the proposed amendment is preferable to the other options? If you disagree, please explain your preferred option in terms consistent with the Authority's statutory objective in section 15 of the Electricity Industry Act 2010.

The proposed amendment complies with section 32(1) of the Act

3.35 The Authority's objective under section 15 of the Act is to promote competition in, reliable supply by, and efficient operation of, the electricity industry for the long-term benefit of consumers.

3.36 Section 32(1) of the Act says that the Code may contain any provisions that are consistent with the Authority's objective and is necessary or desirable to promote one or all of the following:

Table 2: How proposal complies with section 32(1) of the Act

(a) competition in the electricity industry;	The proposed amendment will promote competition in the electricity industry by enabling a new type of technology to participate in the instantaneous reserve market. This is expected to provide downward price pressure on incumbent market technologies
(b) the reliable supply of electricity to consumers;	The proposed amendment 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) the efficient operation of the electricity industry;	The proposed amendment is not expected to materially affect the efficient operation of the electricity industry
(d) the performance by the Authority of its functions;	The proposed amendment will not materially affect the performance by the Authority of its functions
(e) any other matter specifically referred to in this Act as a matter for inclusion in the Code.	The proposed amendment will not materially affect any other matter specifically referred to in the Act for inclusion in the Code

Q5. Do you agree the Authority's proposed amendment complies with section 32(1) of the Act?

The Authority has given regard to the Code amendment principles

3.37 When considering amendments to the Code, the Authority is required by its Consultation Charter[9] to have regard to the following Code amendment principles, to the extent that the Authority considers that they are applicable. Table 3 (below) describes the Authority's regard for the Code amendment principles in the preparation of the proposal.

[9] The consultation charter is one of the Authority's foundation document and is available at:: http://www.ea.govt.nz/about-us/documents-publications/foundation-documents/

Table 3: Regard for Code amendment principles

Principle	Comment
1. Lawful	The proposal is lawful, and is consistent with the statutory objective (see section 3) and with the empowering provisions of the Act.
2. Provides clearly identified efficiency gains or addresses market or regulatory failure	The efficiency gains are set out in the evaluation of the costs and benefits (section 3). The regulatory failure is that an owner is currently unable to offer a BESS as instantaneous reserve in accordance with current Code provisions.
3. Net benefits are quantified	The extent to which the Authority has been able to estimate the efficiency gains is set out in the evaluation of the costs and benefits (section 3).
4. Preference for small-scale 'trial and error' options	Principles 4 to 9 apply only if it is unclear which option is best (refer clause 2.5 of the Consultation Charter). We regard the preferred option as clearly superior to the alternatives.
5. Preference for greater competition	We regard the preferred option as clearly superior to the alternatives.
6. Preference for market solutions	We regard the preferred option as clearly superior to the alternatives.
7. Preference for flexibility to allow innovation	We regard the preferred option as clearly superior to the alternatives.
8. Preference for non-prescriptive options	We regard the preferred option as clearly superior to the alternatives.
9. Risk reporting	We regard the preferred option as clearly superior to the alternatives.

Appendix A Proposed Code amendment

A.1 The attached draft Code amendment is intended to be read alongside the draft procurement plan included in Appendix B.

A.2 As stated in the paper, we have included a draft version of a procurement plan amendment that would align with and enable the intent of the Code amendment that is the subject of this paper.

A.3 The procurement plan would have its own amendment process that would sequentially follow this Code amendment process and allow two further rounds of consultation on the procurement plan before finalisation.

Q6. Do you have any comments on the drafting of the proposed Code amendment?

Appendix B Draft Procurement Plan amendment

B.1 As stated in the paper, we have included a draft version of a procurement plan amendment that would align with and enable the intent of the draft Code amendment that is the subject of this paper and is included in Appendix A.

B.2 The procurement plan would require a subsequent amendment process that would sequentially follow this Code amendment process and provide two further rounds of consultation on the procurement plan before finalisation.

B.3 Nevertheless, we welcome feedback on the draft procurement plan, particularly about its fit and interface with the draft Code amendment.

Q7. Do you have any comments on the drafting of the proposed procurement plan amendment?

Appendix C Format for submissions

Submitter	

Question		Comment
Q1.	Do you agree the issue identified by the Authority is worthy of attention?	
Q2.	Do you agree with the objectives of the proposed Code amendment? If not, why not?	
Q3.	Do you agree the benefits of the proposed amendment outweigh its costs?	
Q4.	Do you agree the proposed amendment is preferable to the other options? If you disagree, please explain your preferred option in terms consistent with the Authority's statutory objective in section 15 of the Electricity Industry Act 2010.	
Q5.	Do you agree the Authority's proposed amendment complies with section 32(1) of the Act?	
Q6.	Do you have any comments on the drafting of the proposed Code amendment?	
Clause	X.X	
Q7.	Do you have any comments on the drafting of the proposed procurement plan amendment?	
Clause	X.X	

Glossary of abbreviations and terms

Authority	Electricity Authority
Act	Electricity Industry Act 2010
Code	Electricity Industry Participation Code 2010
Regulations	Electricity Industry (Enforcement) Regulations 2010
AC	Alternating current
AUFLS	Automatic under-frequency load shedding
BESS	Battery energy storage system
CE	Contingent event
DC	Direct current
ECE	Extended contingent event
FIR	Fast instantaneous reserve
HVDC	High voltage, direct current
Hz	Hertz, the unit of frequency in an AC power system
IL	Interruptible load
MDAG	Market Development Advisory Group
MW	Megawatt, a unit of power
PLSR	Partly loaded spinning reserve
RPT	Real Time Pricing
SIR	Sustained instantaneous reserve
SPD	Scheduling, Pricing and Dispatch, the market model used by the system operator
TWDR	Tail water depressed reserve
vSPD	Vectorised Scheduling, Pricing and Dispatch, a replica of the market model used by the system operator