Consultation paper - removal of the in-band frequency keeping constrained on and off compensation

Consultation Paper

Submissions close: 5pm 17 September 2013

Executive summary

1. Frequency keeping (FK) ancillary services are procured separately in the North and South Islands. Currently three companies compete to provide the services in the North Island, and two in the South Island. Each company submits an offer price for the service in an island and the system operator selects the provider or providers[1] that have the lowest cost for each half hour.

2. FK providers are currently paid the following:

   (a) The FK offer price, also referred to as the availability fee, which is a fixed dollar amount for undertaking the service.

   (b) To-the-band constrained on and off compensation, if required, to move the frequency keeper from its natural dispatch point so that its control maximum or control minimum operating points are not exceeded within the FK band.

   (c) In-band constrained on or off compensation, if required, to compensate for any forgone energy market revenue. For example:

      (i) if a generator reduces output (to compensate for an increase in system frequency) when the energy price was above its energy offer price, it receives a constrained off payment

      (ii) conversely, if a generator increases output (to compensate for a decline in system frequency) when the energy price was below its energy offer price, it receives a constrained on payment.

3. In addition, providers are paid via the energy market for any generation produced, although this is not treated or reported as part of the FK costs.

4. Illustrated examples of constrained on and off situations are provided in Appendix C.

5. The total FK price paid to FK providers cannot be estimated accurately on an ex-ante basis because in-band constrained on or off compensation payments are not known ahead of real time. As a result, the system operator's FK selection tool is not well-designed to select the lowest priced provider.

6. Prior to November 2011, the selection tool assumed zero in-band constrained on or off compensation and under certain market conditions it became quite inefficient at selecting the lowest priced provider.

7. In November 2011 the Electricity Authority (Authority) directed the system operator to modify its selection tool to include a worst case assessment of in-band constrained on costs instead of zero cost. This change significantly improved the efficiency of the selection tool and lowered the constrained on

[1] Since 1 July 2013 more than one FK provider can be selected for FK in the North Island. Currently only one FK provider in the South Island can be selected. A shift to multiple frequency keeping (MFK) in the South Island is due to be implemented 4 August 2014.

payments to FK providers from an average of $3,000,000 to $160,000 per month.

8. This was a relatively simple solution that could be implemented quickly and improved the efficiency of the selection methodology. However, it did not ensure the lowest priced provider is selected under all circumstances and a more reliable solution is required.

9. The proposal described in this paper provides a more reliable and longer-term solution by removing the in-band constrained on and off payments for FK providers. This would require a change to the system operator market tools, and an amendment to the Electricity Industry Participation Code 2010 (Code).

10. The proposal would ensure that the frequency keeper selection methodology always selects the lowest priced FK provider in all trading periods.

Glossary of abbreviations and terms

Act	Electricity Industry Act 2010
Authority	Electricity Authority
Code	Electricity Industry Participation Code 2010
Constrained costs	FK constrained on and off costs only
Control max	The upper MW limit a frequency keeper is capable of operating to in order to maintain frequency within normal frequency band
Control min	The lower MW limit a frequency keeper is capable of operating to in order to maintain frequency within normal frequency band
FK	Frequency keeping ancillary service
FK band	The MW range over which dispatched FK providers collectively adjust their output
FK providers	Providers that offer the FK to the market
In-band	Changes to a FK providers output within the FK band
MFK	Multiple FK providers to manage frequency in the frequency keeping market
Normal frequency band	49.8Hz - 50.2Hz
NZX	New Zealand Exchange
To-the-band	Changes to a frequency keeper's natural dispatch point so that its control maximum or control minimum operating points are not exceeded within the FK band

Contents

1. Introduction and purpose of this paper

1.1 Introduction

1.1.2 The system operator is responsible for ensuring real time coordination of the electricity system. In practice this means ensuring that electrical supply and demand are always balanced. The balance of supply and demand is primarily achieved by issuing dispatch instructions to generators to produce supply to match the forecast demand over the dispatch interval which is typically five minutes.

1.1.3 Within any dispatch interval there are typically small imbalances between dispatched supply and actual demand. Too much generation will cause the synchronous speed of the power system to increase and frequency to rise above 50 Hz, while a shortfall in generation will cause synchronous speed to decrease and frequency to fall below 50 Hz.

1.1.4 To manage these short-term supply and demand imbalances, the system operator currently procures an FK ancillary service from dedicated generating plant at unit, station or block level.[2] In the North Island, the system operator monitors frequency and automatically adjusts the output of these FK providers to maintain the system frequency at 50 Hz. In the South Island, the FK providers monitor frequency themselves and adjust their output independently.

1.1.5 The range over which FK providers must be able to adjust their output is known as the FK band. The band is set to ±50 MW in the North Island and ±25 MW in the South Island. Experience has shown that these bands are typically large enough to allow FK providers to compensate for any frequency deviations caused by short-term supply and demand imbalances.

1.2 Current selection methodology

1.2.1 FK providers offer into a half hourly market separately in the North and South Islands. FK payments to the providers are made up of the following three components, as explained in more detail in section 2.1:

(a) an as-offered availability fee; plus

(b) to-the-band constrained on or off compensation; plus

(c) in-band constrained on or off compensation.

[2] The Authority has recently consulted on proposed amendments to Part 1 and Part 13 of the Electricity Industry Participation Code 2010 to remove technology specific references from the Code. This would have the practical effect of enabling participation in the frequency keeping market by demand-side participants and other non-generators.

1.2.2 The in-band constrained on or off compensation depends on the cleared energy price and the degree to which FK providers are required to increase or decrease output in response to frequency deviations. Because this compensation cannot be reliably estimated prior to dispatch, the current selection methodology does not always select the lowest priced provider under all market conditions.

1.2.3 As a consequence, the Authority proposes to make changes to the frequency keeper payments to simplify and improve the selection methodology so that the lowest priced provider is always selected.

1.3 Purpose of this paper

1.3.1 The purpose of this paper is to consult with participants and persons that the Authority thinks are likely to be affected by the Authority's proposal to amend the Code by:

(a) removing in-band constrained on compensation

(b) removing in-band constrained off compensation.

1.3.2 To-the-band compensation for constraining FK providers above their control minimum or below their control maximum operating points remain payable under this proposal.

1.4 Requirements of the Act

1.4.1 Section 39(1)(c) of the Electricity Industry Act 2010 (Act) requires the Authority to consult on any proposed amendment to the Code and the regulatory statement.

1.4.2 Section 39(2) provides that the regulatory statement must include:

(a) a statement of the objectives of the proposed amendment

(b) an evaluation of the costs and benefits of the proposed amendment

(c) an evaluation of alternative means of achieving the objectives of the proposed amendment.

1.4.3 The regulatory statement is set out in part 3 of this paper.

1.4.4 The proposed amendment is attached as Appendix B.

1.4.5 The Authority invites submissions on the regulatory statement and the proposed amendment, including drafting comments.

1.5 Submissions

The Authority's preference is to receive submissions in electronic format (Microsoft Word). It is not necessary to send hard copies of submissions to

the Authority, unless it is not possible to do so electronically. Submissions in electronic form should be emailed to submissions@ea.govt.nz with — Consultation paper - removal of the in-band frequency keeping constrained on and off compensation in the subject line.

If submitters do not wish to send their submission electronically, they should post one hard copy of their submission to either of the addresses provided below.

Submissions
Electricity Authority
PO Box 10041
Wellington 6143

Submissions
Electricity Authority
Level 7, ASB Bank Tower
2 Hunter Street
Wellington

Tel: 0-4-460 8860

Fax: 0-4-460 8879

1.5.1 Submissions should be received by 5 pm on 17 September 2013. Please note that late submissions are unlikely to be considered.

1.5.2 The Authority will acknowledge receipt of all submissions electronically. Please contact the Submissions' Administrator if you do not receive electronic acknowledgement of your submission within two business days.

1.5.3 If possible, submissions should be provided in the format shown in Appendix A. Your submission is likely to be made available to the public on the Authority's website. Submitters should indicate any documents attached, in support of the submission, in a covering letter and clearly indicate any information that is provided to the Authority on a confidential basis. However, all information provided to the Authority is subject to the Official Information Act 1982.

2. Frequency keeping ancillary service

2.1 Frequency keeper costs

2.1.1 FK services are procured separately in the North and South Islands. Currently three companies compete to provide the services in the North Island, and two in the South Island. Each company submits an offer price for the service in an island and the system operator selects the provider or providers that have the lowest cost for each half hour.

2.1.2 If selected, FK providers are paid:

(a) an availability fee[3]

(b) to-the-band constrained on or off payments, if required, to move the frequency keeper from its natural dispatch point so that its control maximum or control minimum operating points are not exceeded within the FK band

(c) in-band constrained on or off compensation for any generation changes within the band post-dispatch, calculated using the formula in the Code.

2.1.3 Constrained on or constrained off payments are paid to compensate the frequency keeper for revenue that it may otherwise have been able to make in the energy market. For example:

(a) if the generator reduced output when the energy price was above its energy offer price, it receives a constrained off payment

(b) conversely, if the generator increased output when the energy price was below its energy offer price, it receives a constrained on payment.

2.1.4 The lowest priced provider is selected by assessing the lowest combination of:

(a) the availability fee, plus

(b) an estimate of the to-the-band constrained on or off compensation, plus

(c) a worst case assessment of the in-band constrained on compensation.

2.1.5 The in-band constrained on or off compensation depends on the cleared energy price and the degree to which FK providers are required to increase or decrease output in response to frequency deviations. It cannot be reliably estimated prior to dispatch and the selection methodology uses

[3] The availability fee compensates for various inefficiencies and plant-related costs for performing the frequency keeping service.

a worst case assessment of this cost to prevent providers from exploiting the in-band compensation payments.

2.1.6 As a consequence, the current selection methodology is not well-designed to ensure the lowest (overall) priced FK provider is selected and dispatched in each trading period.

2.2 The selection methodology has had previous refinements

2.2.1 In 2005, in response to the need to improve the FK market, the five major generator-retailers[4] formed a Frequency Issues Group (FIG). The FIG developed a methodology to improve the system operator's forecast accuracy in selecting the least cost FK provider for each trading period.

2.2.2 The methodology was designed to provide a better forecast of FK providers' potential constrained on and off amounts within the FK band.

2.2.3 In 2006 this proposal was revised to include the removal of constrained on and off payments within the FK band. However, this proposed change was never implemented.

2.2.4 In June 2008 the system operator implemented a solution in their market systems to take account of to-the-band constrained on costs associated with frequency keeper dispatch to be incorporated in the least-cost selection methodology. No change to the Electricity Governance Rules was required to achieve this.[5] This functionality was lost briefly when the system operator implemented the new market systems in June 2009 but was reintroduced shortly afterwards.

2.2.5 Constrained costs, as a percentage of total FK costs, remained reasonably low from December 2009 to January 2011 (averaging 27% of across the both Islands), but started to increase after that time (averaging 60% by October 2011).

2.2.6 It is possible for a frequency keeper to structure its offers to maximise in-band constrained costs. A high energy price tranche placed just above the expected dispatch point at the middle of the FK band can result in high constrained on payment to the frequency keeper which is not taken into account in the least-cost selection methodology.[6]

2.2.7 Participants became concerned about the rising constrained on costs that occurred during 2011 and one participant wrote to the Authority in August 2011 requesting an investigation be carried out. The Authority requested

[4] Meridian, Trustpower, Contact, Genesis and Mighty River Power.

[5] The Electricity Governance Rules were replaced by the Code in 2010.

[6] Figure 4 in Appendix C illustrates the occurrence.

the system operator to explore the feasibility of an alternative way to select FK providers. The system operator reported back on 26 October 2011, and this report was provided to participants for comment.[7] Feedback was generally positive, and the Authority asked the system operator to change the way it selected FK providers.

2.2.8 A change was made on 17 November 2011 to select FK providers taking into account the assumed maximum possible in-band constrained- on costs. FK constrained on payments fell significantly as a result of this change from $28,598,681 for year ending October 2011 to $1,961,573 for year ending October 2012 and for the 12 months to June 2013 the payments were $2,380,090.

2.3 Further refinements are proposed to ensure the lowest priced provider is always selected

2.3.1 The change to the methodology made in late 2011 significantly lowered the constrained on costs to the market and improved the efficiency of the selection methodology. However, there is scope to make further improvements.

2.3.2 To ensure the lowest priced provider is always selected, the methodology needs to address the issue of the unknown in-band constrained on and off compensation. The Authority's proposed solution, as a follow on from the 17 November 2011 change, is to remove the payment of these costs. This would involve some system operator tool changes as well as a Code amendment.

2.3.3 Under the proposed methodology, payment for FK ancillary services would have two components:

(a) an availability fee determined by the frequency keeper, calculated to reflect its assessment of the cost/risk/opportunity of needing to move away from the midpoint of their offered FK band

(b) to-the-band constrained on or off compensation:

(i) constrained on compensation for the difference between the scheduled quantity and the dispatched quantity the FK provider is required to produce in order to generate above its control minimum operating point within the FK band; or

(ii) constrained off compensation for the difference between the scheduled quantity and the dispatched quantity in order to

[7] http://www.ea.govt.nz/our-work/programmes/pso-cq/frequency-keeper-selection/

generate below its control maximum operating point within the FK band.[8]

2.3.4 The frequency keeper would be selected on the basis of the lowest total cost of the availability fee and the to-the-band constrained cost.

2.3.5 No additional payments for any generation changes (constrained on or off post-dispatch) within the FK band would be made, other than normal energy market payments for generation produced at the cleared price.

2.3.6 The Authority proposes a Code amendment to achieve the outcome sought.

2.4 Other initiatives that this proposal supports

2.4.1 The Authority has a project underway to achieve greater competition in FK by allowing multiple FK providers (MFK) in each island in each period. This will enable providers that are not able to provide the full control band to enter the market, and allow all providers to make offers for FK in bands of less than ±50 MW in the North Island and ±25 MW in the South Island if they choose to do so.

2.4.2 MFK was introduced on 1 July 2013 in the North Island and is planned to be introduced on 4 August 2014 in the South Island. Under the initial MFK arrangements providers will still be paid 'as bid' but, in the longer term, it is proposed that providers be paid a uniform cleared offer price, consistent with the energy and reserves markets. Removal of in-band constraints payments would allow an accurate cleared offer price to be calculated for the FK band that is required to be dispatched.

Q1.	**Are there any interdependencies between the timing of the introduction of MFK in the North and South Islands and the date when the Code amendment proposal should be brought into effect?**

2.4.3 The Authority is also considering the introduction of a nationwide market for FK, utilising the upgraded HVDC link control system to transfer FK energy between islands. Efficiencies gained from a uniform cleared offer price are expected to increase under a national market, although it is recognised that it may not be possible to procure all FK on a national basis and that a portion may remain island based.

[8] The amount required to compensate for the difference between what would have otherwise been an economic dispatch (the scheduled quantity) and the set point (middle of the band point) required for frequency keeping. This typically reflects the variation in fuel usage to provide frequency keeping that otherwise would not have been required (particularly at times of fuel scarcity).

3. Regulatory Statement

3.1 Authority's proposal

3.1.1 The Authority proposes to amend the Code to remove constrained on and off compensation payments for FK within the FK band by:

(a) adding a clause 13.201A to the Code that specifies limits to constrained off compensation payable for frequency keeping

(b) adding a clause 13.212A to the Code that specifies limits to constrained on compensation payable for frequency keeping.

3.1.2 Appendix B contains the draft Code amendment.

3.1.3 These proposed changes to the payments made to FK providers would serve to simplify and improve the FK selection methodology so that the lowest priced provider is always selected.

3.1.4 The proposal would allow all providers to compete in the FK market on a more equal basis and effectively prevent any type of exploitation of the in-band compensation payments.

3.2 Statement of the objective of the proposed amendment

3.2.1 The objective of the proposed amendment is to enhance the efficiency of the FK market by improving the likelihood the most efficient provider is selected.

Q2.	**Do you have any comments on the objective of this Code amendment proposal?**

3.3 Evaluation of the costs and benefits of the proposed amendment

Economic costs

3.3.1 The expected costs of the proposed amendment are:

(a) the cost of processing the Code amendment

(b) the cost of changing the system operator market tools to give effect to the Code change[9]

[9] The system operator has confirmed that the cost of this is in the order of $20-30,000. NZX has confirmed that no change is required in the settlement process.

(c) the cost of any risk premiums that FK providers decide to include in their offer price to cover for foregone energy market revenue due to movement within the FK band.

Q3.	**Do you think there is a reduced incentive for the generators to participate in the frequency keeping market after the proposed amendment?**

Economic benefits

3.3.2 The current FK selection methodology uses a worst-case assessment of the in-band constrained on compensation because this cost cannot be reliably estimated by the system operator prior to dispatch. This method does not select the lowest (overall) priced FK provider under all market conditions.

3.3.3 The proposal would achieve selection of the lowest priced provider in each trading period. FK providers would be required to estimate in-band constrained on and off costs themselves, and incorporate these costs into their offered availability fee.

3.3.4 The guaranteed selection of the lowest priced FK provider would ensure the most efficient provider is more likely to be selected in each trading period.

Q4.	**Do you have any comments on the assessment presented?**
Q5.	**Are there any additional costs or benefits that need to be considered?**

3.4 Evaluation of alternative means of achieving the objectives of the proposed amendment

Alternative 1 – status quo

Costs

3.4.1 No changes are required, so there are no implementation costs.

3.4.2 As the current regime is not well-designed to be able to select the lowest cost provider, the economic cost of FK services is likely to be higher than under the proposal.

3.4.3 The FK market would remain somewhat vulnerable to exploitation.

Benefits

3.4.4 There are no benefits relative to the recommended proposal.

Comparison with the proposed amendment

3.4.5 Alternative 1 is not preferred over the proposed Code amendment as it is less efficient.

Q6.	**Are there any other alternatives the Authority should consider apart from the status quo?**

3.5 Assessment under section 32(1)

3.5.1 Section 32(1) of the Act provides that Code provisions must be consistent with the Authority's objective and be necessary or desirable to promote any or all of the following:

(a) competition in the electricity industry

(b) the reliable supply of electricity to consumers

(c) the efficient operation of the electricity industry

(d) the performance by the Authority of its functions

(e) any other matters specifically referred to in this Act as a matter for inclusion in the Code.

3.5.2 An assessment of the proposed amendment against the requirements of section 32(1) of the Act is set out in Table 1 below.

Table 1

Section 32(1) requirements:	**Response**
The proposed amendment is consistent with the Authority's objective under section 15 of the Act, which is as follows:	
(a) to promote competition in, reliable supply by, and the efficient operation of, the electricity industry for the long-term benefit of consumers	The proposal is neutral with regards to reliable supply of electricity to consumers, but delivers more efficient operation of the electricity industry by ensuring that the most efficient FK provider is more likely to be selected in each trading period.
The proposed amendment is necessary or desirable to promote any or all of the following:	
(b) competition in the electricity industry;	Improves competition by ensuring FK providers compete on a transparent and equal footing.
(c) the reliable supply of electricity to consumers;	No impact.

(d) the efficient operation of the electricity industry;	Refer to (a) above.
(e) the performance by the Authority of its functions;	No impact.
(f) any other matter specifically referred to in this Act as a matter for inclusion in the Code.	Not applicable.

Q7. Do you have any comments on the Authority's assessment of the proposed amendment against the requirements of section 32(1) of the Act?

3.6 Assessment against the code amendment principles

3.6.1 When considering amendments to the Code, the Authority is required by its Consultation Charter to have regard to the following Code amendment principles, to the extent that the Authority considers that they are applicable.

3.6.2 ***Principle 1 – Lawfulness:*** The Authority and its advisory groups will only consider amendments to the Code that are lawful and that are consistent with the Act (and therefore consistent with the Authority's statutory objective and its obligations under the Act).

3.6.3 The Authority considers the proposed amendment to be lawful.

3.6.4 ***Principle 2 – Clearly Identified Efficiency Gain or Market or Regulatory Failure:*** Within the legal framework specified in Principle 1, the Authority and its advisory groups will consider using the Code to regulate market activity only if:

(a) it can be demonstrated that amendments to the Code will improve the efficiency of the electricity[10] industry for the long-term benefit of consumers

(b) market failure is clearly identified, such as may arise from market power, externalities, asymmetric information and prohibitive transaction costs; or

[10] Where efficiency refers to allocative, productive and dynamic efficiency, and improvements to efficiency include, for example, a reduction in transaction costs or a reduction in the scope for disputes between industry participants.

(c) a problem is created by the existing Code, which either requires an amendment to the Code, or an amendment to the way in which the Code is applied.

3.6.5 The proposed amendment delivers improvements to the efficiency of the electricity industry for the long-term benefit of consumers by making changes that improve the efficiency of the FK market.

3.6.6 ***Principle 3 – Quantitative Assessment:*** When considering possible amendments to the Code, the Authority and its advisory groups will ensure disclosure of key assumptions and sensitivities, and use quantitative cost-benefit analysis to assess long-term net benefits for consumers, although the Authority recognises that quantitative analysis will not always be possible. This approach means that competition and reliability are assessed solely in regard to their economic efficiency effects. Particular care will be taken to include dynamic efficiency effects in the assessment, and the assessment will include sensitivity analysis when there is uncertainty about key parameters.

3.6.7 The proposal would achieve the selection of the lowest priced provider in each trading period and allow all providers to compete in the FK market on an equal basis.

3.6.8 The guaranteed selection of the lowest priced FK provider would ensure the most efficient provider is more likely to be selected in each trading period.

Q8.	**Do you have any comments on the Authority's assessment of the proposed amendment against the Code amendment principles?**

Appendix A Format for submissions

Question No.	General comments in regards to the:	Response
Q1	Are there any interdependencies between the timing of the introduction of MFK in the North and South Islands and the date when the Code amendment proposal should be brought into effect?	
Q2	Do you have any comments on the Objective of this Code change proposal?	
Q3	Do you think there is a reduced incentive for the generators to participate in the frequency keeping market after the proposed amendment?	
Q4	Do you have any comments on the assessment presented?	
Q5	Are there any additional costs or benefits that need to be considered?	
Q6	Are there any other alternatives the Authority should consider apart from the status quo?	
Q7	Do you have any comments on the Authority's assessment of the proposed amendment against the requirements of section 32(1) of the Act?	
Q8	Do you have any comments on the Authority's assessment of the proposed amendment against the Code amendment principles?	
Q9	Do you have any comments on the Authority's proposed code amendment?	

Appendix B Proposed Code amendment

1.1 Interpretation

dispatched quantity means, for the purposes of clauses 13.201A and 13.212A, the level of output of active power in **MW dispatched** to **generating plant** in a **trading period**

metered quantity means, for the purposes of clauses 13.201A and 13.212A, the level of output of active power in **MW** of **generating plant** measured by a **metering installation** in a **trading period**

13.201 Generators do not get paid constrained off compensation

(1) A **generator** is not entitled to be paid compensation in respect of any **constrained off situation** except as provided for in an **ancillary service arrangement** entered into by the **system operator** and the **generator**.

(2) This clause does not affect the rights that a **participant** has under this Code against the **system operator** for a failure by the **system operator** to comply with this Code.

13.201A Limits to constrained off compensation payable for frequency keeping

A **frequency keeping ancillary service agent** is not entitled to be paid **constrained off compensation** in respect of any **constrained off situation** for any **reconciled quantity** of **electricity** it produces between the **dispatched quantity** and **metered quantity** while providing **frequency keeping**.

13.212 **Payment of constrained on compensation**

(1) For each **trading period**, a **generator**, or **ancillary service agent** is entitled to be paid **constrained on compensation** for **constrained on amounts** determined under clauses 13.204 and 13.205.

(2) The **system operator** must pay to a **generator**, or **ancillary service agent** any **constrained on amount** calculated under clause 13.205.

(3) Any **constrained on compensation**, except that payable by the **system operator** under subclause (2), owing to a **generator**, or **ancillary service agent** in relation to a **billing period,** must be included in any invoice issued to the **generator**, or **ancillary service** agent by the **clearing manager** under clause 14.44(a).

(4) **Constrained on compensation** received by the **clearing manager** is payable to the **generator**, or **ancillary service agent** at the same time as any other amounts owing to that **generator**, or **ancillary service agent** as set out in clause 14.46 are payable.

(5) Each **purchaser** who purchases electricity at a **grid exit point** must pay **constrained on compensation** to **generators** who generate **electricity** at a **grid injection point** in accordance with subclause (7). The payment must be made in accordance with clauses 14.36 to 14.43.

(6) **Instantaneous reserve constrained on compensation** is an **instantaneous reserve** cost that must be allocated in accordance with clauses 8.59 to 8.66.

(7) The **clearing manager** must calculate and invoice **purchasers** for **constrained on compensation** for each **trading period** in accordance with the following formula:

COCp = (COCg - COCso) * (Pq / TPq)

where

COCp is the **constrained on compensation** payable by a **purchaser**

COCg is the sum of **constrained on compensation** owing to **generators** injecting **electricity** for that **trading period** calculated in accordance with clause 13.204

COCso is the sum of **constrained on compensation** for that **trading period** payable by the **system operator** to **generators** under subclause (2)

Pq is the **total electricity** purchased by that **purchaser** from the **clearing manager** during the **trading period** as shown by the **reconciliation information** calculated by the **reconciliation manager** under Part 15

TPq is the total **electricity** purchased by all **purchasers** from the **clearing manager** during the **trading period** as shown by **reconciliation information** calculated by the **reconciliation manager** under Part 15.

(8) Any **constrained on compensation** owing by a **purchaser** in relation to a **billing period** must be included in the invoice issued to the **purchaser** by the **clearing manager** under clause 14.36(1). **Constrained on compensation** is payable by the **purchaser** at the same time as any other amounts owing by that **purchaser** are payable under clause 14.37.

13.212A Limits to constrained on compensation payable for frequency keeping

Despite clause 13.212, a **frequency keeping ancillary service agent** is not entitled to be paid **constrained on compensation** in respect of any **constrained on situation** for any **reconciled quantity** of **electricity** it produces between the **dispatched quantity** and **metered quantity** while providing **frequency keeping**.

Q9.	**Do you have any comments on the Authority's proposed code amendment?**

Appendix C Constrained on and off examples[11]

C.1 Figure1 illustrates a situation where generating plant:

(a) is constrained off from its scheduled quantity to the dispatched quantity shown in order to provide 50 MW of operating range below the plant's Control Max (to-the-band constrained off, paid currently and paid under the proposal)

(b) produces a metered quantity below the dispatched quantity (in-band constrained off, currently paid but not to be paid under the proposal).

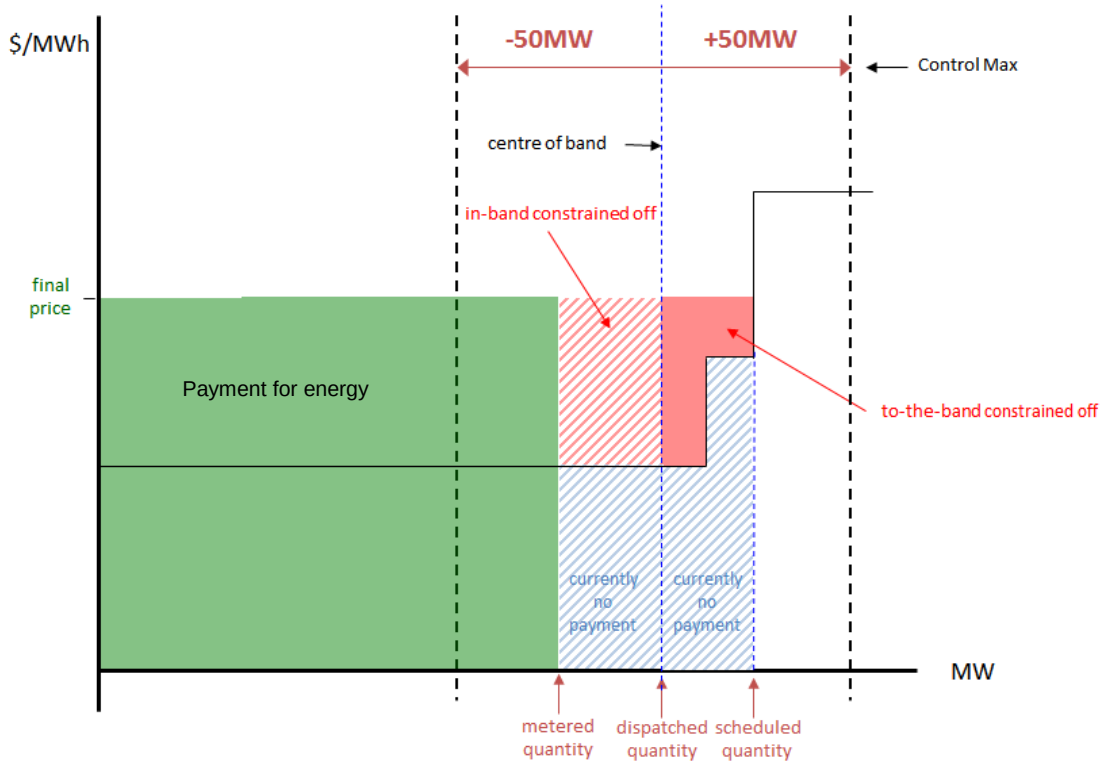

Figure 1

[11] These are simplified illustrations only. For instance these diagrams do not illustrate the situation of block dispatch of a number of generation stations selected for frequency keeping.

C.2 Figure 2 illustrates a situation where generating plant:

(a) is constrained off from its scheduled quantity to the dispatched quantity shown in order to provide 50 MW of operating range below the plant's Control Max (no constrained off payment arises because the offer price is below the final price)

(b) produces a metered quantity above the dispatched quantity (in-band constrained on, currently paid but not to be paid under the proposal).

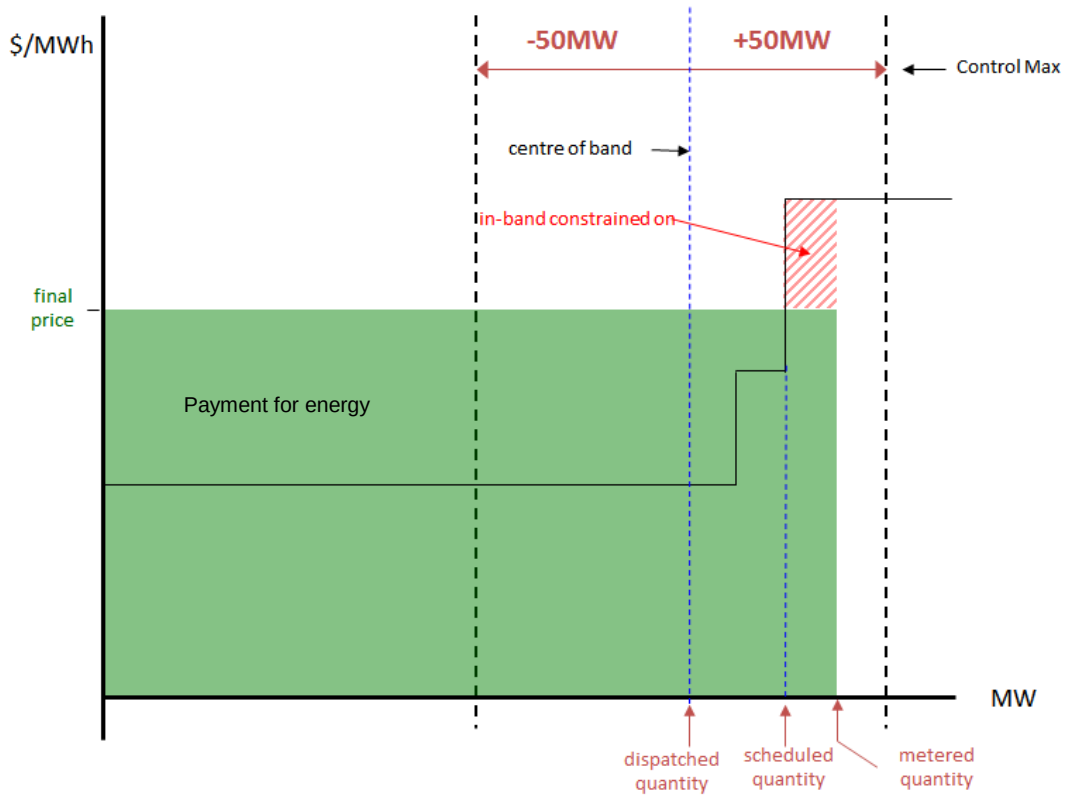

Figure 2

C.3 Figure 3 illustrates a situation where generating plant:

(a) is constrained on from its scheduled quantity to the dispatched quantity shown in order to provide 50 MW of operating range above the plant's Control Min (to-the-band constrained on, currently paid and to continue to be paid under the proposal)

(b) produces a metered quantity below the dispatched quantity (no constrained off payment arises for the generation not produced).

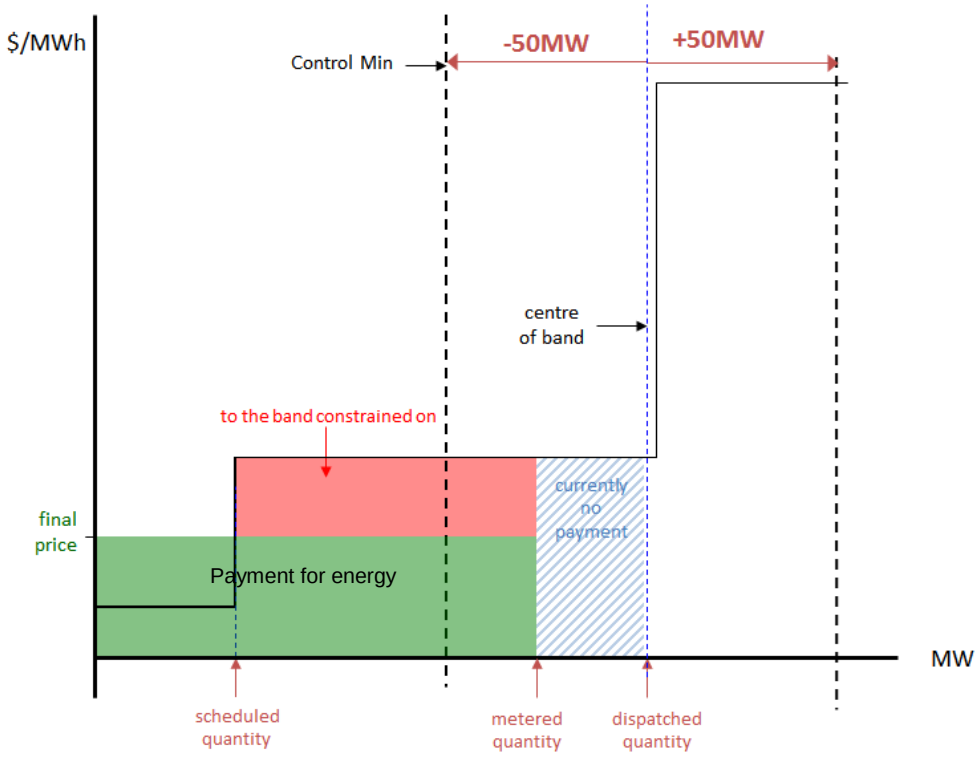

Figure 3

C.4 Figure 4 illustrates a situation where generating plant:

(a) is constrained on from its scheduled quantity to the dispatched quantity shown in order to provide 50 MW of operating range above the plant's Control Min (to-the-band constrained on, currently paid and paid under the proposal)

(b) produces a metered quantity above the dispatched quantity (in-band constrained on, currently paid but not to be paid under the proposal).

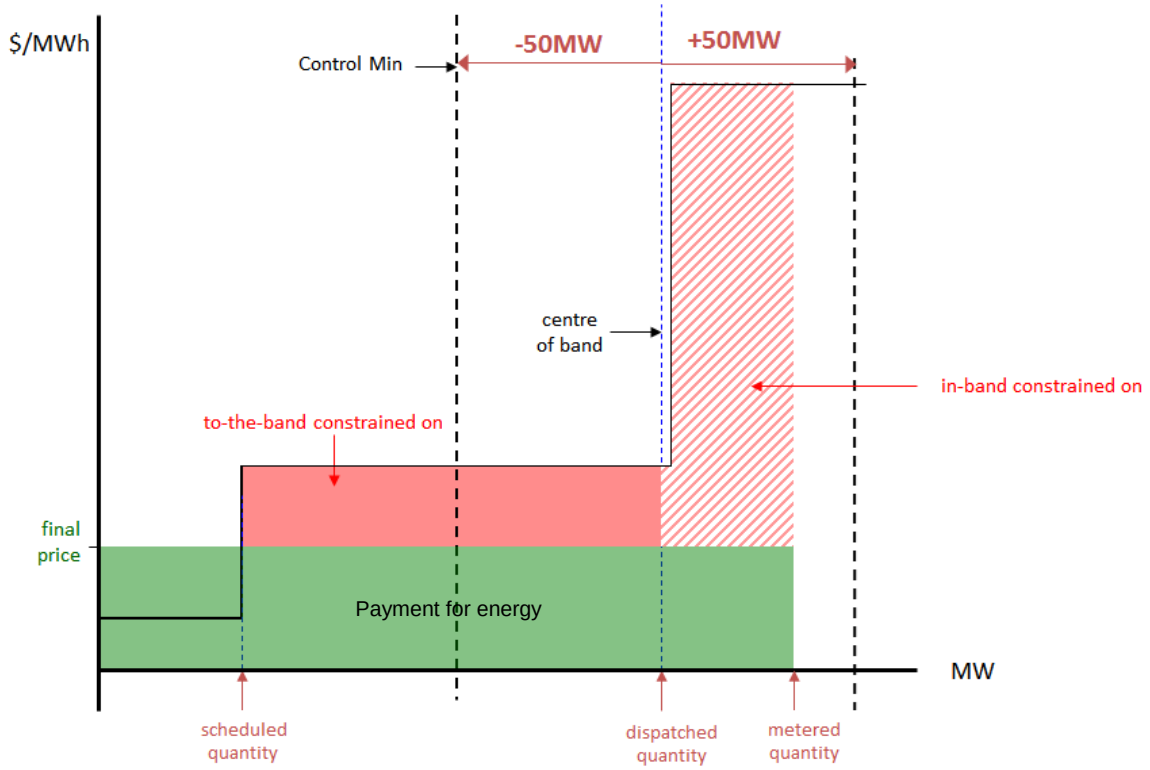

Figure 4