

# Review of August 2011 frequency keeping costs

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## Market performance review

16 November 2011



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## Investigation stages

An in-depth investigation will typically be the final step of a sequence of escalating investigation stages. The investigations are targeted at gathering sufficient information to decide whether a Code amendment or market facilitation measure should be considered.

**Market Performance Enquiry (Stage I):** At the first stage, routine monitoring results in the identification of circumstances that require follow-up. This stage may entail the design of low-cost ad hoc analysis, using existing data and resources, to better characterise and understand what has been observed. The Authority would not usually announce it is carrying out this work.

This stage may result in no further action being taken if the enquiry is unlikely to have any implications for the competitive, reliable and efficient operation of the electricity industry. In this case, the Authority publishes its enquiry only if the matter is likely to be of interest to industry participants.

**Market Performance Review (Stage II):** A second stage of investigation occurs if there is insufficient information available to understand the issue and it could be significant for the competitive, reliable or efficient operation of the electricity industry. Relatively informal requests for information are made to relevant service providers and industry participants. There is typically a period of iterative information-gathering and analysis. The Authority would usually publish the results of these reviews but would not announce it is undertaking this work unless a high level of stakeholder or media interest was evident.

**Market Performance Formal Investigation (Stage III):** The Authority may exercise statutory information-gathering powers under section 46 of the Act to acquire the information it needs to fully investigate an issue. The Authority would generally announce early in the process that it is undertaking the investigation and indicate when it expects to complete the work. Draft reports will go to the Board of the Authority for publication approval.

The outcome of any of the three stages of investigation can be either a recommendation for a Code amendment, provision of information to a Code amendment process already underway, a brief report provided to industry as a market facilitation measure, or a no further action.

From the point of view of participants, repeated information requests are generally concerned with Stage II; trying to understand the issue to such an extent that a decision can be made about materiality.

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## Executive summary

Mighty River Power (MRP) wrote to the Electricity Authority (Authority) on 1 September 2011 in relation to concerns about a rise in constrained on payments associated with the North Island frequency keeping service.

The August 2011 frequency keeping costs were the highest since December 2009, which was when the system operator (SO) included the revised frequency keeper selection method in its new market system. The majority of these costs (\$6.4m) were due to constrained on costs for the selected frequency keeper. The major recipient of these constrained on payments was Genesis Energy (Genesis).

The Authority's analysis indicates that these costs predominantly arose because Genesis structured its offer tranches for energy in such a way that the low priced tranches were used in the frequency keeping selection process but the high priced tranches were used when it was selected as the frequency keeper and was required to move up in its regulation band to control the frequency, resulting in high constrained on payments to Genesis.

The underlying problem was due to inadequacies in the then current<sup>1</sup> frequency keeping selection methodology. The underlying cost structure for providing frequency keeping is three tiered (availability costs, constrained on costs to centre-of-band, and regulation costs), whereas the selection methodology was effectively a two-part pricing structure (availability offer and expected constrained on costs for frequency keeping to centre-of-band). The frequency keeper was being selected without full information on the potential regulation<sup>2</sup> cost risks. The Authority considers that this shortcoming in the selection process resulted in the August 2011 frequency keeping costs in the North Island being \$5.9m higher than the least cost alternative, calculated on an ex-post basis.

The Authority met with the SO to discuss both short and long term solutions to this issue. The long term solutions involved altering constrained on and constrained off (CO) payments to frequency keepers, which would require amendments to the Electricity Industry Participation Code 2010 (Code). These could take several months to progress. In the meantime the Authority issued a Technical Advisory Services Contract (TASC) request to the SO to evaluate a modification to include a worst-case constrained on cost estimate in the evaluation of the lowest cost frequency keeper. The SO subsequently provided a frequency keeping selection report to the Authority on 26 October 2011. The report indicated that the modification, which includes a worst-case constrained on cost estimate, provides a more transparent view of the potential total costs associated with the frequency keeping service, and could be implemented at minimal cost in a relatively short timeframe. The expected implementation date outlined in the report was between 10 and 24 November 2011 provided the SO received notification from the Authority to proceed by 4 November 2011.

On the 27 October 2011, the Authority wrote to providers of frequency keeping ancillary services proposing changes to the selection methodology. The letter was subsequently sent to a broader range of industry participants including large industrial consumers via the Major Electricity Users' Group (MEUG) and TrustPower. The proposal was also discussed by telephone with Todd Energy (Todd). The majority of the responses received were in favour of the change. The

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<sup>1</sup> The frequency keeping selection process has since been modified. The modified selection process came into effect on 17 November 2011.

<sup>2</sup> Regulation (for frequency) is the term used to describe the change in generator output within the regulation band to control the frequency.

Authority did not identify any issues from the responses that suggested any delays or changes were warranted. The Authority requested the SO to proceed with the change outlined in their report. The Authority has been notified by the SO that the change took effect from 17 November 2011.

## 1 Introduction and purpose of this report

- 1.1 Mighty River Power (MRP) wrote to the Electricity Authority (Authority) on 1 September 2011 in relation to concerns about a rise in constrained on payments associated with the North Island frequency keeping service. MRP alleged that Genesis was earning economic rents by taking advantage of the frequency keeper selection methodology which was in place at the time.
- 1.2 The Authority received a response from Genesis which indicated there are some reasons for potential differences in frequency keeping offer strategies between Genesis and MRP.
- 1.3 The SO also wrote to the Authority confirming the issue raised by MRP. A copy of the SO's letter is shown in Appendix A.
- 1.4 The total frequency keeping cost in August 2011 was \$8.6m. This was the highest frequency keeping cost observed since December 2009, which is when the SO included the revised frequency keeper selection method in its new market system. The majority of these costs (\$6.4m) were due to constrained on costs for the selected frequency keeper.
- 1.5 Ninety-seven percent of these constrained on costs (\$6.2m) were attributable to Genesis<sup>3</sup>. These costs predominantly arose because Genesis structured its offer tranches for energy in such a way that the low priced tranches were used in the frequency keeping selection process but the high priced tranches were used when it was selected as the frequency keeper and was required to move up in its regulation band to control the frequency, resulting in high constrained on payments to Genesis.
- 1.6 The following review outlines the details of the previous frequency keeping selection process and its shortcomings which made it susceptible to unanticipated costs. An analysis of the August 2011 frequency keeping costs is also provided to understand the potential magnitude of this shortcoming. Both the short and long term solutions to this issue are also discussed. The developments leading to the subsequent change in the frequency keeping selection method are also highlighted.

## 2 Previous frequency keeping selection method

- 2.1 Frequency keepers are currently scheduled from two hours ahead of each trading period<sup>4</sup>. The dispatch schedule (which is executed every 30 minutes on a rolling 8 trading period horizon) is used to obtain a forecast of the nodal price.
- 2.2 The nodal price was used to calculate the constrained on costs to bring the frequency keeping candidate to the centre-of-band<sup>5</sup> (shaded in blue) in Figure 1. This cost was added to the frequency keeper's availability offer to calculate the total cost of each frequency keeping candidate. The frequency keeper with the lowest total cost was scheduled. The final selection for a given trading period was undertaken fifteen minutes before the start of the trading period using the same methodology.
- 2.3 The selected frequency keeper cannot be scheduled by the market clearing engine<sup>6</sup> below its 'centre-of-band' for the trading period it is selected as the frequency keeper. The constraining of the frequency keeper above this level is achieved by adding a constraint into SPD (as indicated

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<sup>3</sup> \$5.7m of Genesis constrained on costs for frequency keeping were incurred at Waikaremoana, and \$0.5m incurred at Tokaanu.

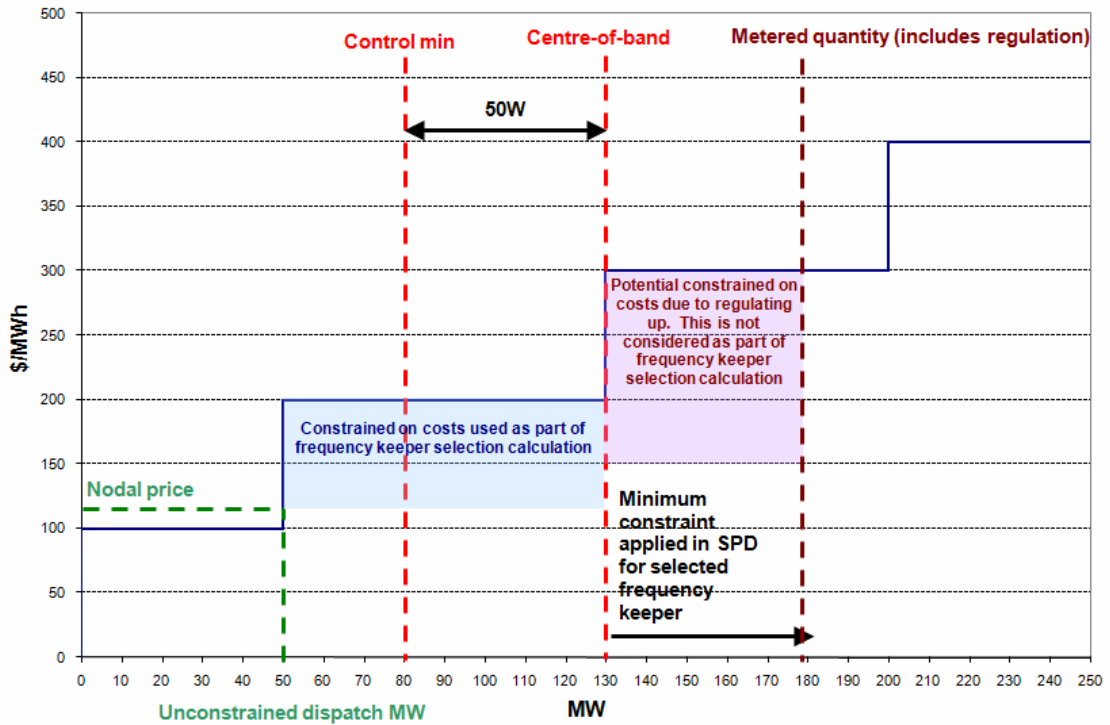
<sup>4</sup> Frequency keeping indications are also published with the pre dispatch schedule (PDS). This gives participants an indication of the likely frequency keeper selection, up to 36 hours ahead for some trading periods.

<sup>5</sup> This has been changed on 17 November 2011 to estimate the full constrained on costs using the top of the band.

<sup>6</sup> This is more commonly referred to as SPD (scheduling, pricing and dispatch).

by the black arrow in Figure 1). There are potentially other constrained on costs associated with the selected frequency keeper when regulating. These are not known ahead of time and were not considered as part of the previous frequency keeper selection process (shaded in pink) in Figure 1.

**Figure 1 Illustration of estimated constrained on costs used in previous frequency-keeper selection process**



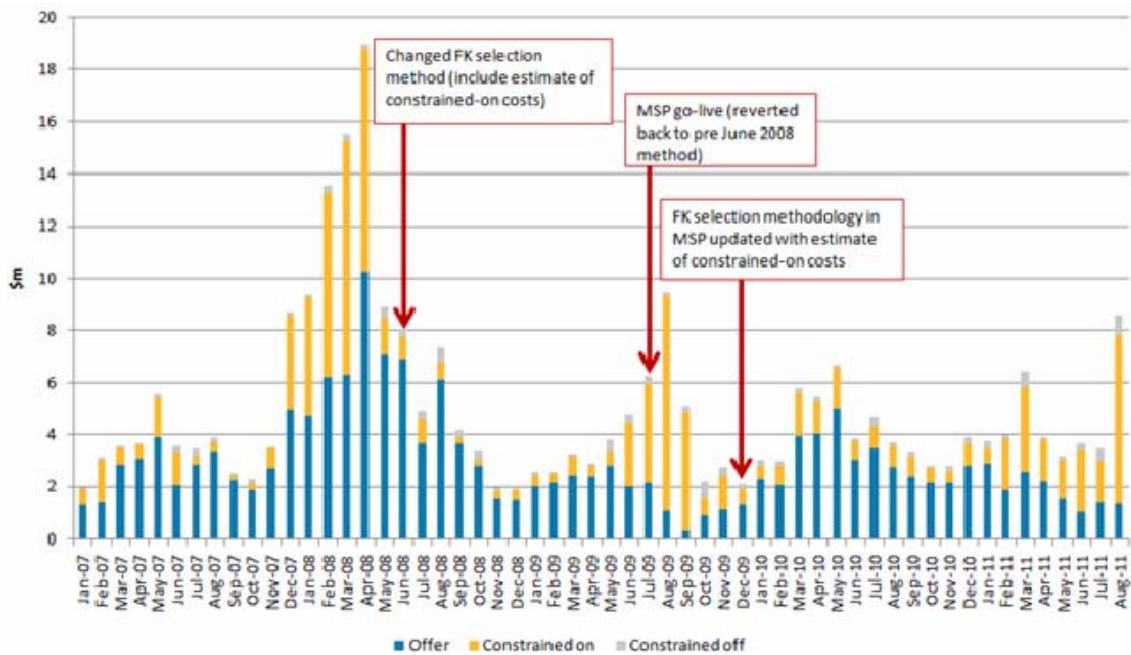
Source: Electricity Authority

### 3 Frequency keeping costs

- 3.1 Prior to June 2008, the frequency keeper selection method only considered the capacity offers for frequency keeping. The selected frequency keeper was also compensated for CO payments to maintain its output within the required band, and also when required to regulate. The increase in frequency keeping costs in 2007/2008 (as illustrated in Figure 2) prompted a change in frequency keeping selection methodology. The revised process attempted to estimate a portion of the constrained on costs that would have been incurred with each frequency keeper (as discussed in section 2). This addressed part of the issue, but there remained an unaccounted CO cost which could be incurred when regulating.
- 3.2 The revised method was suspended temporarily (reverting to the old method) following the introduction of the new market system in July 2009. Following this suspension, increases in frequency keeping costs were observed in August 2009 and September 2009, as illustrated in Figure 2, with the majority of these costs being constrained on costs. The revised frequency keeper selection method was implemented within the new market system in December 2009.



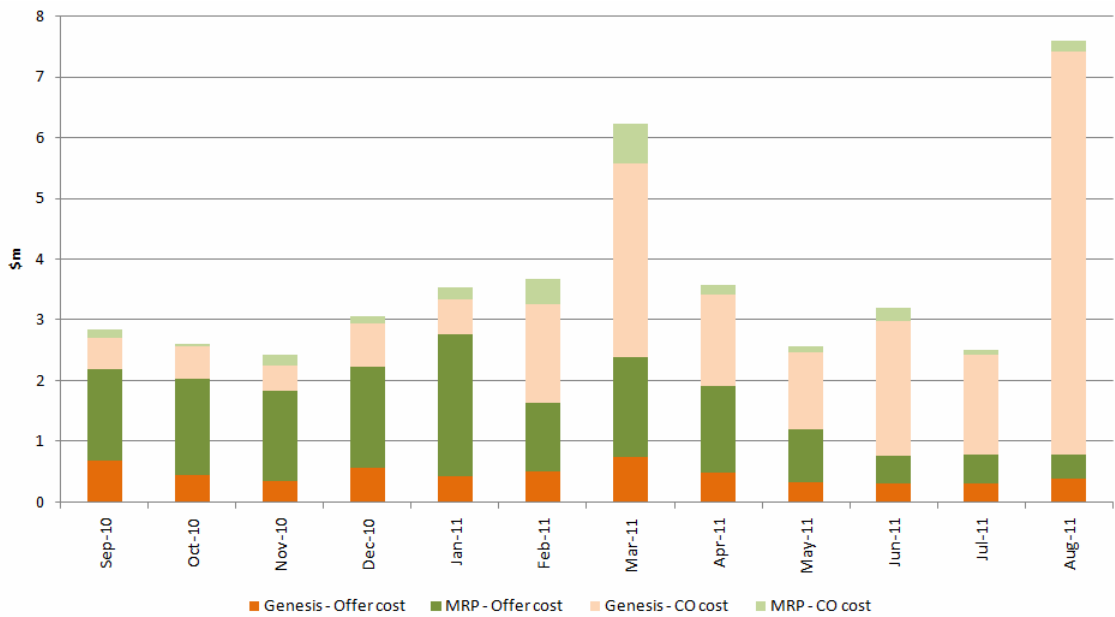
**Figure 2 Frequency keeping costs breakdown**



Source: System Operator and Electricity Authority

- 3.3 Since February 2011, CO costs, predominantly constrained on, had been comprising an increasing proportion of frequency keeping costs. August 2011 had the largest frequency keeping costs, following the implementation of the revised method in the post MSP system, with 84% of the costs due to CO costs incurred by the selected frequency keeper.
- 3.4 A breakdown of the frequency keeping costs by provider in the North and South Islands over the 12 months from September 2010 to August 2011 is shown in Figure 3 and Figure 4. This shows the majority of the frequency keeping costs during this time were attributed to North Island providers, with the majority of the costs from June 2011 to August 2011 attributed to CO costs. Genesis had been the major recipient of the CO payments for frequency keeping.

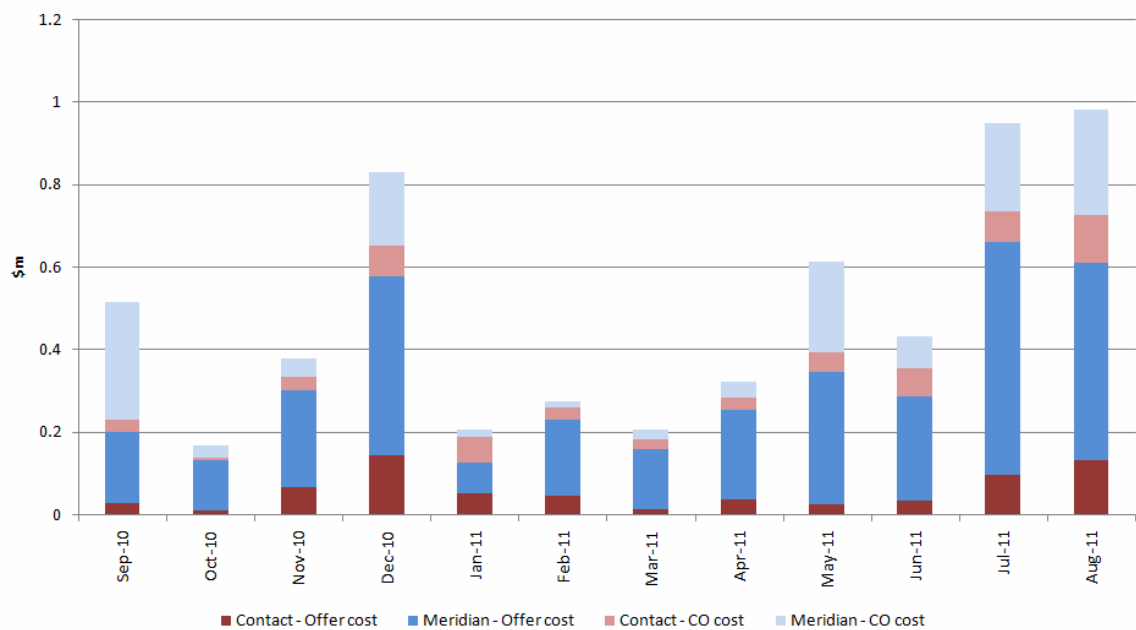
**Figure 3 Frequency keeping costs breakdown by participant in the North Island**



Source: System Operator and Electricity Authority

Notes: 1. CO costs include both constrained on and constrained off costs

**Figure 4 Frequency keeping costs breakdown by participant in the South Island**



Source: System Operator and Electricity Authority

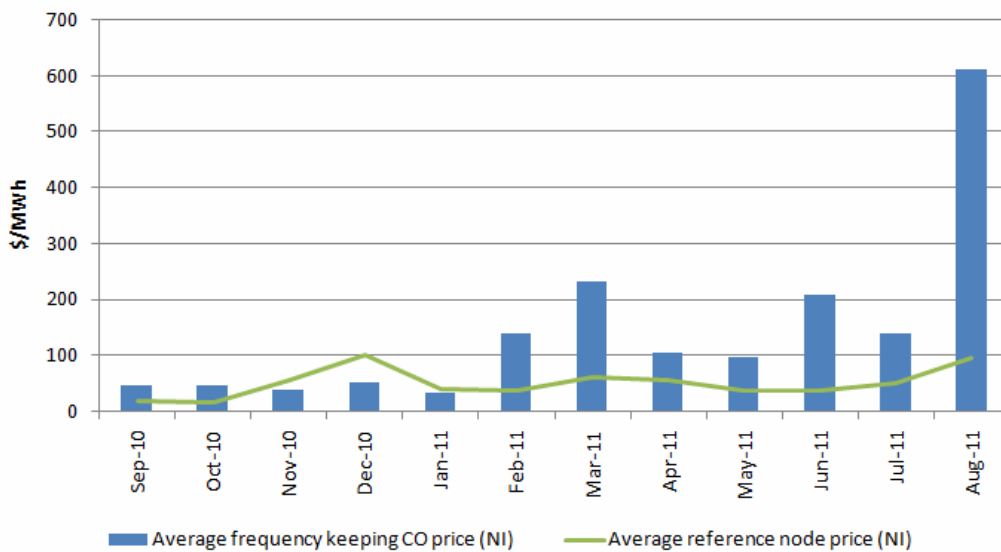
Notes: 1. CO costs include both constrained on and constrained off costs

3.5 Figure 5 and Figure 6 show the frequency keeping CO costs incurred in each island over the 12 months from September 2010 to August 2011 divided by the total regulation energy within each month. This provides the average frequency keeping CO price (\$ per MWh) in each island. This illustrates that increases in North Island CO costs, and to a lesser extent South Island CO costs,

are not due to increased regulation requirements from the system but rather due to increased CO prices paid to frequency keepers when requiring them to regulate.

- 3.6 In the South Island the average CO price increase in August 2011 is less than the observed increase in the South Island energy price, but in the North Island this far exceeds the observed increase in the North Island energy price. In August 2011, the average CO price in the North Island was over \$600 per MWh (a 342% increase from July 2011), whereas the average energy price in the North Island was \$95 per MWh (an 86% increase from July 2011).

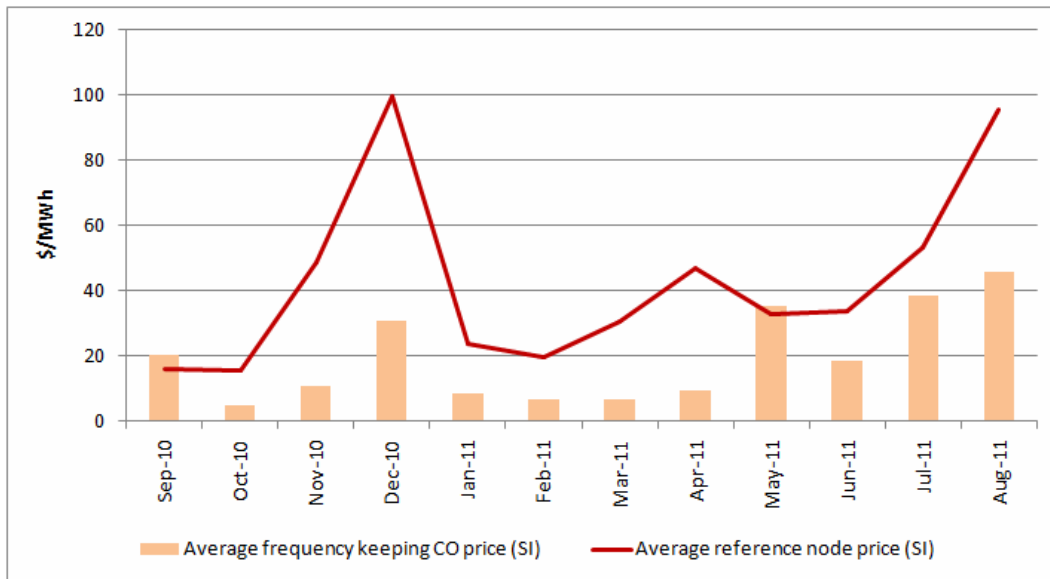
**Figure 5 Average frequency keeping CO price and average energy price for the North Island (Sep 10 – Aug 11)**



Source: System Operator and Electricity Authority

Notes: 2. The North Island reference node is HAY2201

**Figure 6 Average frequency keeping CO price and average energy price for the South Island (Sep 10 – Aug 11)**



Source: System Operator and Electricity Authority

Notes: 3. The South Island reference node is BEN2201

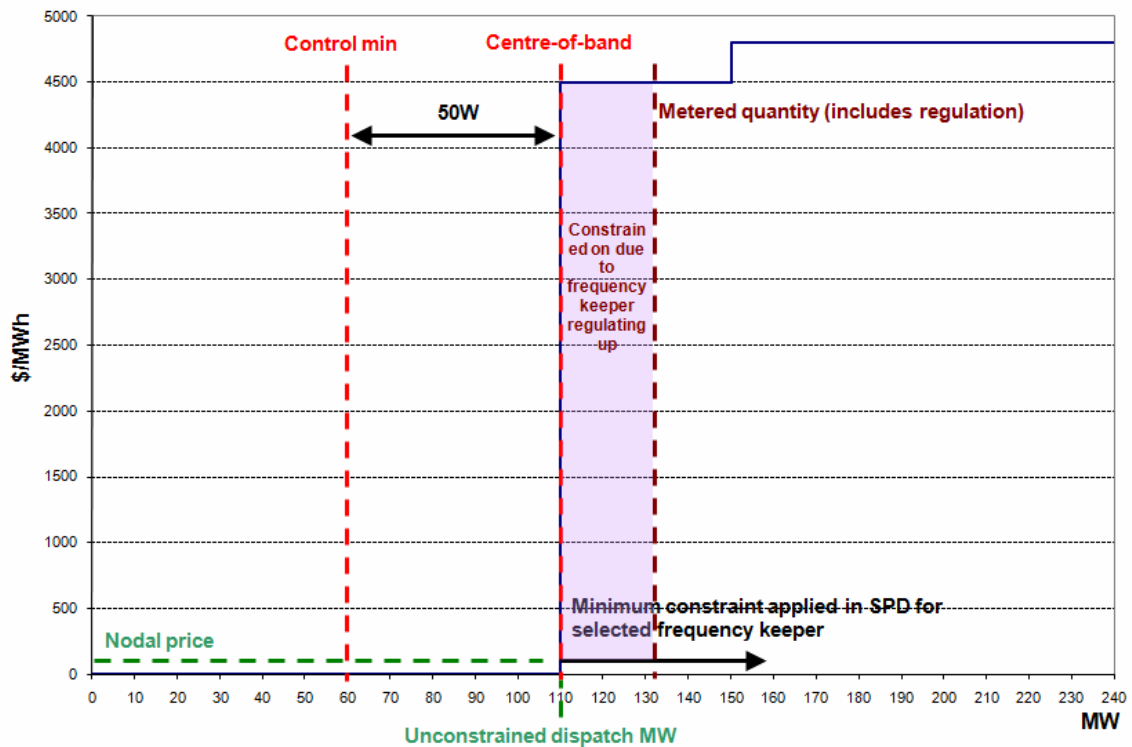
## 4 Analysis of August 2011 frequency keeping costs

- 4.1 A more detailed analysis was conducted on the August 2011 frequency keeping costs to better understand the reasons for increased frequency keeping constrained on costs. The analysis also considered how robust the frequency keeping selection method was in choosing the least cost provider. This assessment was made using the frequency keeping selection method which was in effect during August 2011.
- 4.2 Tokaanu was selected as the frequency keeper for trading period (TP) 29 on 2 August 2011, for which the constrained on costs were \$47,358. Tokaanu was required to regulate up during this trading period (10.721 MWh), at a price of \$4,417 per MWh.
- 4.3 The following description of Genesis' offering of Tokaanu for TP 29 illustrates how these costs arose:
- frequency keeping: Availability offer = \$0.01 for a 50 MW regulation band, Control minimum = 60 MW;
  - energy market (first tranche): offer = 110 MW at \$0.01 per MWh. This capacity is the control minimum plus the 50 MW regulation band. This is the centre-of-band considered in the frequency keeper selection method, which was used at the time, as illustrated in Figure 7.
  - other energy market offers: The 2nd and 3rd tranches at Tokaanu were offered in at \$4,500.06 per MWh and \$4,800.06 per MWh.
- 4.4 Offering the first tranche (centre-of-band MW) at a very low price ensures a high likelihood of it being scheduled in the dispatch schedule. This implies the frequency keeping selection method, which was used at the time, would calculate the constrained on costs required to bring Tokaanu to the centre-of-band as zero. With a low availability offer from Tokaanu for this trading period

and the estimated low constrained on costs, Tokaanu was calculated as the lowest cost provider under the frequency keeping selection process for TP 29 on 2 August 2011.

- 4.5 However, when Tokaanu was required to regulate up to control frequency, it was pushed into its high priced offer band. This resulted in large constrained on costs being allocated to frequency keeping costs.

**Figure 7 Tokaanu offer and frequency keeper requirements and costs for TP 29**



Source: Electricity Authority

- 4.6 To understand the frequency keeping costs of the alternatives, the other North Island frequency keeping offers were analysed. Table 1 lists the offers that were submitted for frequency keeping in the North Island for TP 29 on 2 August 2011.

**Table 1 Other North Island frequency keeping offers for 2 August 2011, TP29**

Trader	Node	MW	Price (\$)	Control min	Max
MRPL	WTO	50	100	85	913
GENE	TKU2201	50	0.01	60	240
GENE	WKA	50	6,500.07	35	138

Source: System operator

- 4.7 Table 2 compares the frequency keeping costs used in the previous frequency keeping selection process with an estimate of the total costs involved in frequency keeping (including CO costs) for

each of the offered frequency keepers. This provides an ex-post analysis of the ability to select the lowest cost provider using the previous selection process.

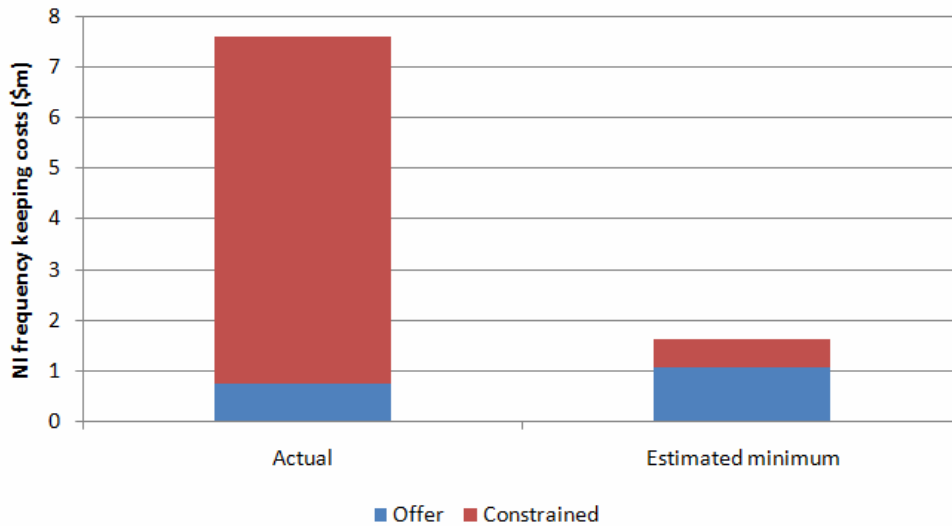
**Table 2 Comparison of frequency keeping costs for 2 August 2011, TP29**

Node	Frequency keeping costs – Used (\$)	CO costs – during regulation (\$)	Frequency keeping costs – Total (\$)
WTO	100	123	223
TKU2201	0.01	47,359	47,359
WKA	6,500	928	7,428

Source: Electricity Authority

- 4.8 As can be seen, the availability offer and the structuring of the energy offers for Tokaanu resulted in Tokaanu being calculated as the lowest cost provider under the previous selection process. However the ex-post analysis indicates that it was the highest cost provider, at over 210 times greater than the lowest cost provider, when the regulation costs are considered. This was because of the high priced energy offer tranches for any movement above its centre-of-band MW. In this ex-post analysis, the Waikato block (WTO) would have been the least cost provider due to its lower constrained on costs when required to regulate.
- 4.9 The above analysis was repeated for all trading periods for August 2011 in the North and South Islands, with results shown in Figure 8 and Figure 9. The shortcomings in the previous selection method are more pronounced in the North Island where the “unseen” frequency keeping CO costs are more prevalent, and result in the selection method deviating substantially from the calculated least cost alternative (\$5.9m difference).
- 4.10 This issue is less severe in the South Island where the estimated minimum frequency keeping costs are around 5% below the observed frequency costs (\$50k difference).
- 4.11 Thus the omission of the costs involved in regulation severely hampered the ability of the previous frequency keeping selection process to choose the overall least-cost provider, where a participant’s offer appears to be the lowest cost, but imposed significant CO costs when required to regulate.

**Figure 8 Comparison of actual and estimated minimum costs for frequency keeping in the North Island**



Source: Electricity Authority

Notes: 4. The estimated minimum is calculated assuming the same regulation amount is needed for the other frequency keepers.

**Figure 9 Comparison of actual and estimated minimum costs for frequency keeping in the South Island**



Source: Electricity Authority

Notes: 5. The estimated minimum is calculated assuming the same regulation amount is needed for the other frequency keepers.

## 5 Conclusion

5.1 The underlying problem with the previous frequency keeping selection process arose from inadequacies in the selection methodology. The underlying cost structure for providing frequency

- keeping is three tiered (availability costs, constrained on costs to centre-of-band, and regulation costs), whereas the selection methodology was effectively a two-part pricing structure (availability offer and expected constrained on costs for frequency keeping to centre-of-band). In effect, the SO was making selection decisions without full information on regulation risks and the actual cost of dealing with those risks if they eventuate. Only the frequency keepers knew those costs.
- 5.2 There is a range of long term solutions. One potential solution was to remove CO payments for frequency keepers. As frequency keepers would only provide an availability offer they would need to incorporate their expected CO costs in those offers. The frequency keeper with the lowest offer price in each island would be selected and paid at its offer price. Any constraints on operation due to being selected as the frequency keeper, or movement up or down due to regulation, would be compensated on average through the availability offer rather than through CO payments. This approach would shift the risk and cost of CO events to frequency keepers, make the frequency keeping selection process more robust in selecting the lowest cost provider and less susceptible to unforeseen costs than the status quo.
- 5.3 A variation of the above approach is to only consider the CO costs required to get the frequency keeper to the centre-of-band, with no additional CO payments for regulating within the band<sup>7</sup>. Another option is to require frequency keepers to submit fixed fees for undertaking the regulation component of the frequency keeping service.
- 5.4 Each of those options would require Code amendments, and therefore would take several months to progress. In the interim, an alternative approach was adopted. It was to include a worst case estimate of constrained on payments in the band within the frequency keeping selection process. This allows the frequency keeping selection process to consider high priced offers within the frequency keeping band. No changes were required to be made to the existing frequency keeping payments. This alternative did not require any amendments to the Code and was considered to be an interim solution to address the problem.
- 5.5 The Authority issued a TASC request to the SO on 28 September 2011 to evaluate the implementation of the interim solution.
- 5.6 The SO subsequently provided a frequency keeping selection report to the Authority on 26 October 2011, indicating this change provides a more transparent view of the potential total costs associated with the frequency keeping service and could be implemented at minimal cost in a relatively short timeframe. The expected implementation date outlined in the report was between 10 and 24 November 2011, provided the SO received notification from the Authority to proceed by 4 November 2011.
- 5.7 On the 27 October 2011, the Authority wrote to providers of frequency keeping ancillary services proposing changes to the selection methodology with feedback requested by 03 November 2011.
- 5.8 The majority of the responses received were in favour of the change. The Authority did not identify any issues from the responses that suggested any delays or changes were warranted.
- 5.9 The Authority requested the SO to proceed with the change outlined in their report. The SO issued a Customer Advisory Notice (CAN) on 15 November 2011, indicating that the change will take effect from 13:30 on 17 November 2011. The SO has confirmed with the Authority that this has occurred.
- 5.10 Further information on these implementation issues is available on the Authority's website<sup>8</sup>.

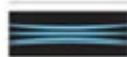
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<sup>7</sup> A similar option (The Hybrid) was proposed by the Frequency Issues Group (FIG) in 2006.

<sup>8</sup> See <http://www.ea.govt.nz/our-work/programmes/pso-cq/frequency-keeper-selection/>



## Appendix A Letter from System Operator



TRANSPOWER

SYSTEM OPERATOR

System Operator  
Transpower NZ Ltd  
Transpower House  
96 The Terrace  
PO Box 1021  
Wellington 6140

26<sup>th</sup> August 2011

Fraser Clarke  
Electricity Authority

Dear Fraser,

### Frequency Keeping Selection and constrained on costs

#### Summary

Mighty River Power has alleged an issue with the Frequency Keeper offer structure employed by Genesis and the method employed by System Operator to select the Frequency Keeper. In a letter to the Electricity Authority and Transpower, MRP assert the System Operator does not consider the impact of constrained on costs when making the FK selection. As these costs are allocated to off-take participants, MRP feels that they and other participants are unacceptably exposed at a retail level to Genesis perceived use of Con-on payments to subsidise their frequency keeping service.

On the 4<sup>th</sup> June 2008, Transpower implemented a solution in the Market System to enable some of the possible constrained on costs associated with FK dispatch to be incorporated in the least cost selection process. This automated functionality was lost with the implementation of the new Market System on the 21<sup>st</sup> June 2009 however; a manual process was implemented until the automated selection could be re-introduced in late 2009.

MRPs proposed solution is to stop constrained on payments to frequency keepers. This would require a rules change proposal and wider industry consultation.

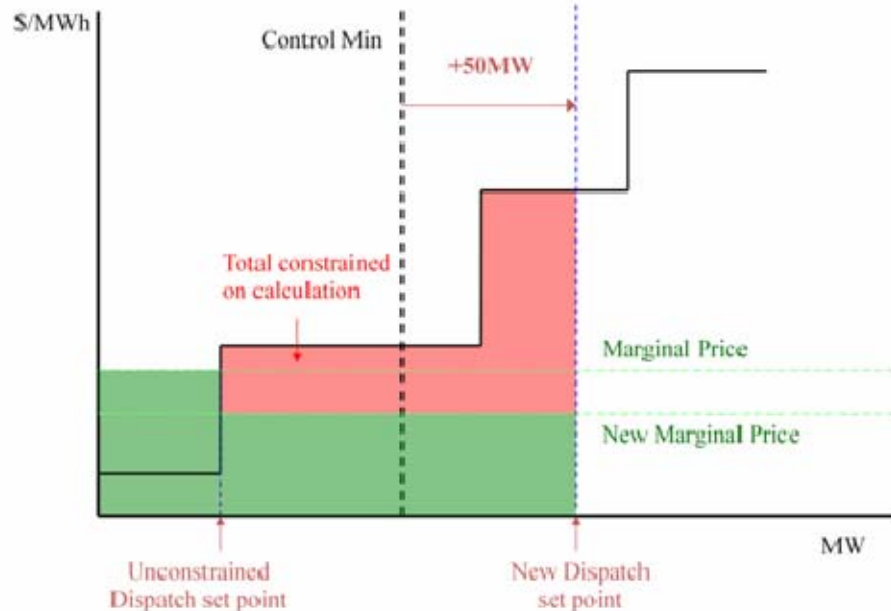
#### Frequency Keeper selection process

In October of 2006, System operator presented an illustration of the then-current FK selection process and a discussion of the calculation, and potential impact on cleared energy prices, of constrained on and off payments for frequency keeping to the CQAG. This included a number of possible options for both frequency Keeper selection and payment and how to incorporate con on/off calculations in both. The three options presented were:

1. Eliminate FK con on/off payments
2. Pay con on/off only to dispatch set point (mid FK band)
3. Full con on/off payment with estimate used for selection

Subsequent rising market costs for FK con on/off in the North Island led to a "Phase 1" implementation of con on/off co-optimisation in the Market System. As this was considered a time sensitive implementation and significant System operator and IST resource was committed to the New Market System Project, a reduced scale version of the co-optimisation was implemented. For the purposes of selection, only the constrained cost associated with moving the FK dispatch point and FK band within the control min and max of the offered plant was calculated. This is illustrated below:

## Control min & Constrained on



The above diagram illustrates an example where the marginal generator has been dispatched down to allow the frequency to be constrained up. This has reduced the cleared market price and thus increased the calculated con on payment to the frequency keeper.

A discussion of this implementation and its effect on the North Island FK market was presented as an update to the CQAG on the 20<sup>th</sup> November 2008.

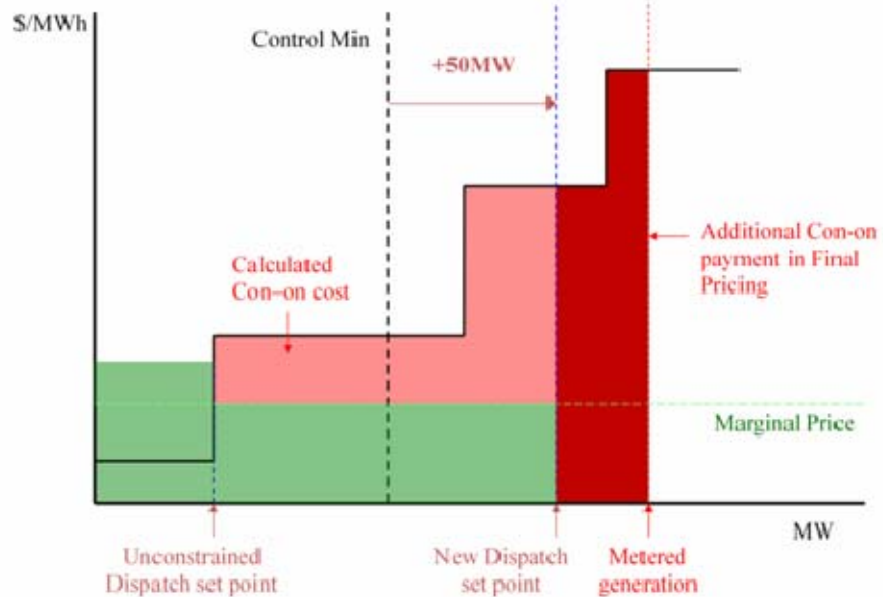
This solution was used operationally until the go-live of the New Market System in June of 2009. Work then began on re-implementation of the Phase 1 FK selection process in the new market System with a manual process for system co-ordinators providing continuity to the market. Automated FK selection was re-introduced to the Market on the 17<sup>th</sup> December 2009.

This calculation assumes that the frequency keeper will, on average, remain at the centre of their dispatched frequency keeper band during the trading period. However, in practice this may not be the case. Governor response or the management of time error may lead to the actual generation level being above the dispatched set point. This could lead to the actual con-on payment to the generator being significantly higher than that calculated in the frequency keeper selection process. The following diagram illustrates this.

The final constrained on costs are then passed on to the demand side participants on a by trading period basis. Each participant is billed for a part of the total constrained costs in proportion to their off-take relative to the total island demand for each trading period.



## Control min & Constrained on



No analysis has been performed to date to substantiate that Genesis are structuring their frequency keeping offers to exploit this.

It is under these market conditions that Mighty River Power asserts that they cannot continue to compete in the frequency keeper market with Genesis without also using con-on payments to subsidise their FK participation. MRP puts forward that, to ensure transparency in the selection and cost to the market of the frequency keeping service, FK participants should not be paid Con-on whilst frequency keeping. It is suggested that this would ensure that the true cost of frequency keeping is reflected in the market offers.

Sincerely

Lisa Dhanji  
Market Services Manager



## **Glossary of abbreviations and terms**

<b>Act</b>	Electricity Industry Act 2010
<b>Authority</b>	Electricity Authority
<b>CO</b>	Constrained on and off
<b>Code</b>	Electricity Industry Participation Code 2010
<b>Genesis</b>	Genesis Power Limited (trading as Genesis Energy)
<b>GXP</b>	Grid exit point
<b>MEUG</b>	Major Electricity Users' Group
<b>MRP</b>	Mighty River Power Limited
<b>MW</b>	Megawatt
<b>MWh</b>	Megawatt hour
<b>SO</b>	System Operator
<b>SPD</b>	Scheduling, Pricing and Dispatch
<b>TASC</b>	Technical Advisory Services Contract
<b>Todd</b>	Todd Energy Limited
<b>TP</b>	Trading period
<b>TrustPower</b>	TrustPower Limited