QUARTERLY SYSTEM OPERATOR AND SYSTEM PERFORMANCE REPORT

FOR THE ELECTRICITY AUTHORITY

Transpower New Zealand Limited
January to March 2019

Keeping the energy flowing




TRANSPOWER

Transpower New Zealand Limited The National Grid

Report Purpose

This report is Transpower's review of its performance as system operator for Q3 (January to March) 2019, in accordance with clause 3.14 of the Electricity Industry Participation Code 2010 (the Code).

As this is the final self-review report of the quarter, additional information is included as per SOSPA clause 12.3. This includes performance against the performance metrics year to date, and actions taken in regard to the system operator business plan, statutory objective work plan, participant survey responses, and any remedial plan agreed under clause 14.1(i). A summary of technical advisory services for the quarter is also provided.

A detailed system performance report (Code obligated) is provided for the information of the Electricity Authority (Authority).

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Commentary

This section provides an update for this quarter, any new initiatives that we have instigated, the current investigations we are progressing and areas of business that are under review. The remainder of the report provides supporting detail in two sections:

- System operator performance, and
- System performance.

Update (January to March 2019)

Security of Supply

- The 1% Hydro Risk Curve (HRC) was crossed for one day in March before a major rain event increased national storage back to the historic mean in the space of two days.
- The latest Simulated Storage Trajectories (SSTs) indicate no foreseeable chance of an official conservation campaign being required over this winter. While a dry winter is always possible the risk period is now post June-July.
- Based on our assumptions in the 2019 Security of Supply Annual Assessment, we expect to require new generation in the mid-2020s in order to maintain an efficient level of reliability.

Outage Planning

- The new consolidated Outage Planning Policy has been shared with industry.
- We held an Outage Planning Forum to provide participants a final opportunity to comment on the annual outage plan prior to it being published.
- In anticipation of continued low inflows, we created a watchlist of outages that may be affected by a dry winter.

Real Time Pricing (RTP)

- We assisted the Authority present the high-level market design work to the Authority Board in February and hosted an Authority workshop on 29 March.

Dispatch Service Enhancement (DSE)

- We held two workshops with the industry this quarter.
- Work continues around planning with industry participants to prepare for their transition from GENCO to one of the two new dispatch options.

Black Start Simulation

- We ran a South Island joint Black Start simulation, with industry participants from Contact, Meridian and NZAS taking part.

New initiatives

National Market for Instantaneous Reserves (NMIR) refinements

- This system operator initiative adjusts the way the market tool models reserves. The refinement minimises oscillations in HVDC transfer and improves price certainty for participants.

Increase Capacity of Special Protection Schemes (SPS)

- Special Protection Schemes increase transmission capacity by taking automatic action to reconfigure the grid if an event occurs. This project delivers automation that will enable the system operator manage an increasing number of these schemes and their settings.

New Zealand Generation Balance (NZGB)

- We had improved our 4-week window load forecasting methodology.
- We are providing further analysis to reflect peak winter loads, as well as the gas scenario we developed for the March report.

HVDC lessons-learned working group

- A working group is progressing short-term improvements to outage planning and real-time outage management.
- We shared this work with the wider industry during the outage planning forum.
- We have published a guideline document to explain when we, as system operator, will publish notifications and assessments.

Current investigations

Inverter Standard AS/NZS 4777.2

- The Australian market operator (AEMO) has approached Transpower to review and contribute to proposed changes of the inverter standard AS/NZS 4777.2.

Independent review of HVDC cable setting

- An independent review into the HVDC current limit setting error has been completed. We have shared the findings of this review and our response with Authority management.

Review of NEM separation August 2018

- We have carried out a review of the AEMO report into the Queensland and South Australia system separation on 25 August 2018.
- We will provide a summary of our findings of how the report's recommendations apply New Zealand context to the May SOC meeting.

Areas under review

Reserves Management Tool (RMT) modelling issue

- An error in an RMT update resulted in additional reserves being purchased. We are working with the Authority to establish the market impact of this error.
- The terms of reference for a review of the change management and assurance around RMT has been agreed and discussed with our auditors, Deloitte.

NZGB Modelling error

- Potential generation shortfalls in May and June, highlighted an error in the way Huntly unit 4 was modelled. The February NZGB report was amended.

Special Protection Schemes (SPS) project modelling error

- A modelling error occurred during deployment of the project to the production environment. The error has been fixed and an investigation is underway.

System operator performance

1 Compliance

January

We reported one breach of the Electricity Industry Participation Code 2010 in January. This related to an error in the non-response long schedules which indicated $0 generation at Stratford. The error was detected, the modelling updated, and day-ahead schedules correctly modelled the generation.

February

We reported one breach of the Electricity Industry Participation Code 2010 in February. This related to an error in an update to the Reserves Management Tool (RMT) in January 2018. The impact meant that reserves from a generator were not recognised as procured during scheduling, so additional reserves were purchased. We are working with the Electricity Authority to establish the market impact of this error. The error was not identified for 12 months; analysis found this affected 76 trading periods across the year. We are instigating an independent audit of change controls for RMT. At no time was the system less secure as a result of this error, however given the market impact and that it was not identified quickly an independent audit of the change control process for RMT has commenced.

March

We reported two breaches of the Electricity Industry Participation Code 2010 in March. Both errors relate to the incorrect application of risk settings to generators in real-time.

- The first occurred at Ohau when scheduled testing by Meridian was cancelled close to real-time and the added reserve risk associated with the testing was not correctly removed. The error caused additional reserves to be procured for one 30-minute trading period.
- The second was human error when an unintended mouse click created added risk to Manapouri for one trading period in the forward-looking schedules. There was no market impact from this error.

There are two other recent events which are being investigated and likely to be reported as breaches of the Electricity Industry Participation Code 2010 in April.

- The first is in relation to security of supply, specifically around making publicly available scenarios for potential gas supply disruptions and updating these scenarios to ensure they remain current. Updated gas scenarios were re-introduced in February.
- The second is in relation to changes made to automate the alignment of Special Protection Schemes (SPS) between SCADA and the Market Systems. The rollout of the changes introduced errors in SPS status in the Market System, which had flow on effects to published schedules.

Refer to Appendix A for instances where the system operator has applied discretion under 13.70 of the Code.

1.1 Update on South Island AUFLS event (2 March 2017)

We are continuing to make progress on the 3 remaining actions from the 13 identified. This progress will be reported in the next Quarterly report (April to June 2019). The 3 outstanding actions are as follows:

- Action 7. Review procedures across Transpower regarding handover of tools and systems to ensure the tools and systems are able to be effectively operationalised
- Action 12. Identify, review and address performance of risk management controls, specifically focused on high impact low probability event interactions
- Action 13. Review Transpower's processes for reporting of major power system events, compliance breaches and material failures by Transpower to comply with its own standards and procedures

The complaint raised by the Electricity Authority with the Rulings Panel concerning 12 alleged breaches relating to the 2 March 2017 event is progressing. The Rulings Panel has tentatively scheduled a hearing for the first available date after 27 May 2019.

2 Risk & Assurance

Annual software audit

The annual audit of both the SPD and RMT tools has been completed by Robinson Bowmaker Paul. The audit was passed with one minor recommendation made. This recommendation is currently being followed up. Note: the scope of the RMT audit does not include factors that resulted in the breach identified in February 2019

Independent review of HVDC cable setting

An independent review into the HVDC current limit setting error, which was self-reported to the Authority by Transpower on 12 April 2018, undertaken by Erik Westergaard of Advisian, has been completed. The scope included reviewing the two internal investigations undertaken by Transpower as well as identifying whether there were any wider systemic issues contributing to this event or other recent major events. The findings of this review and our response were provided to the Authority in early April.

Reserve Management Tool (RMT) Change Management Review

Following the identification of the data input error in RMT (refer February compliance section above) we are initiating a further audit of RMT. We have agreed the terms of reference for a review of this change management and assurance with Deloitte, our auditors for this business process.

3 Market design and system enhancement project updates

Progress against high value, in-flight market design and service enhancement projects is included below along with details of any variances from the current Capex Plan.

Real Time Pricing (RTP)

At the Authority February Board meeting we supported the Authority staff provide a high-level description of the elements of RTP design, focussing specifically on pricing in reserve shortfall conditions.

The consultation paper on the remaining elements of the RTP design went out for consultation on 19 March 2019 and the submissions are due on 30 April 2019.

The system operator hosted an Authority-run workshop on 29 March 2019 to enable the industry to discuss the Code amendments in the consultation. The team is preparing for endorsement of the capital phase of the project.

Dispatch Service Enhancement (DSE)

We held two workshops with the industry this quarter, one on 29 January 2019 and one on 1 March 2019, to discuss the migration from the GENCO dispatch to new dispatch options.

The design of the IST changes to implement the new ICCP and web services connection service for DSE have been completed, and build is nearing completion. The cost allocation model was drafted and socialised with the Authority in time for the industry workshop held on 1 March 2019. It was agreed at the workshop that we would be working with the Authority on whether the costs to participants could be capitalised and would signal this to the industry. Agreement to continue on-charging transition costs was agreed at the end of March. The Authority is now preparing a paper on this topic for Board approval.

Work continues around planning with industry participants to prepare for their transition from GENCO to one of the two new dispatch options being delivered by the project from 30 June 2019.

Situational Intelligence

The Situation Intelligence project will deliver a visual analytics tool for operations. It is targeted at assisting our system controllers.

We completed reference checks on the preferred vendor in January. We are now working with the preferred vendor to refine the approach and estimates for the pilot phase. The delivery business case is due to be completed in mid-May 2019.

National Market for Instantaneous Reserves (NMIR) refinements

The NMIR refinement project is a small service maintenance project, initiated by the system operator, to adjust the way the market tool models reserves. NMIR delivered a $20m reduction in reserve costs when introduced in 2016. The refinement minimises oscillations in HVDC transfer and improves price certainty for participants.

The consultation with the industry to collect comments closed on 31 January 2019, and changes to NMIR were successfully deployed into market system production environment on 28 March 2019. The project will enable operational and market benefits.

Increase Capacity of Special Protection Schemes (SPS)

Special Protection Schemes increase transmission capacity by taking automatic action to reconfigure the grid if an event occurs. The first SPS was introduced in 2000 and the number of schemes has grown significantly. Management of the schemes and their settings is an onerous task with risk of errors. The project officially went live on 3 April 2019.

When changes were deployed into the market system production environment on 28 March 2019, a modelling error in a script required ahead of the formal SCADA failover process resulted in incorrect SPS states being implemented. The error has been fixed and an investigation is underway.

Wind Offer Arrangements

The project was approved by the Authority Board on 7 November 2018 and is on track to go live on 1 September 2019. The design is now in the final approval process and build is progressing well. Initial industry communications are scheduled for early April 2019.

4 Outage planning and coordination

Outage Planning Policy

This went live in February and can be found on our website. This is an internal policy we have discussed with industry and is provided to enable transparency of the different roles in this process. It draws on our Electricity Industry Participation Code obligations, particularly those which deal with the considerations Transpower, as grid owner, must make in planning outages, and those that are relevant to our system operator role in assessing outages and notifying interested parties. These are areas where we want to be clearer about our approach and how we maintain impartiality in our system operator service.

New Zealand Generation Balance (NZGB)

New 4-week window load forecasting methodology

From 1 April, NZGB will be using a 4-week window load forecasting methodology. This provides a more accurate load assumption, using data 2 weeks either side of last year's date (plus load growth), ensuring forecast peak loads are considered based on date rather than month. For our April report, we have also provided further

analysis to reflect the 2018 peak winter loads over the 2019 winter period, as well as the gas scenario we developed for the March report.

Modelling error

The January NZGB report forecast potential generation shortfalls in May and June. This prompted us to analyse the load forecasting and generation data assumptions used in the calculations. An error related to Huntly unit 4 was uncovered; it had not been included in our calculation since it was recommissioned in 2018. Correcting the error has reduced the forecast shortfalls over the winter period. Participants were notified of the error via a CAN on 29 January 2019, and the February NZGB report was amended accordingly.

Outage Planning Forum

The Outage Planning Forum was held on the 18 March 2019, across multiple Transpower venues. The forum is an important step in developing the annual outage plan, providing participants a final opportunity to comment on the plan prior to it being published. We also used this forum as an opportunity to gain feedback from customers on NZGB, the Planned Outage Co-ordination Process (POCP) and improvements we are making on notifications following the November 2018 HVDC outages.

Outage Planning

February and March have been busy months for outages. Many of these outages are 'key' outages that we expect will need extra system operator assessment or could potentially cause security violations through timing or currency issues.

We were advised by the grid owner of a safety related situation during reconductoring work in progress affecting supply to Central Park (Wellington). As a result, the only viable option was to place the GXP on N security for an extended period to complete the work. We advised the grid owner to ensure they have a suitable recovery plan and provided other suggestions which were adopted.

In anticipation of continued low inflows, we created a watchlist of outages that may be affected by a dry winter. We have identified possible outages that would constrain thermal generation, constrain on hydro generation or limit HVDC transfer.

HVDC lessons-learned working group

A working group with system operator and relevant grid owner groups are progressing short-term improvements to outage planning and real-time outage management which will:

- improve communication and understanding within Transpower and with industry before and during 'sensitive' outages
- provide earlier, predictable signals to participants of tight situations where actions may be needed from generators, load or transmission
- clarify decision-making processes
- improve clarity around our grid owner and system operator roles.

Journey of an Outage Animation

Our 'Journey of an Outage' animation has been shared with external customers, with very positive feedback received. It can be accessed using this shareable link: Journey of an outage animation

Guideline for publishing notifications and assessments

We have published a guideline document to explain when we, as system operator, will publish notifications and assessments. This outlines the triggers we will use in providing the assessments. It covers general situations but particularly two key regions of the electricity system:

- Upper North Island or Zone 1 voltage stability
- The HVDC

The development and publication of this document was additionally influenced by the 'HVDC lessons learned work'.

5 Power systems investigations

Review of NEM separation August 2018

We have carried out a review of the report into the Queensland and South Australia system separation on 25 August 2018 prepared by AEMO. We have considered the event in the New Zealand context and have identified a number of actions and areas to explore further. We will discuss actions that may require Code changes before providing a summary of our review to the May SOC meeting.

6 Performance metrics

The following dashboard shows system operator performance against the performance metrics for the financial year to date as required by SOSPA 12.3 (a).

Our customers are informed and satisfied		Annual Target	Actual to Date
Improved annual participant survey result		80%	Not currently available
Improved annual participant survey result response rate		25%	Not currently available
On-time special event preliminary reports		90% ≤ 10 business days	No projects to date
Industry leadership and insights	Edge technology report	≥ 1	0
	Publicly available market insights	≥ 8	8

We maintain Code compliance and meet our SOSPA obligations		
Market breaches remain below threshold	≤ 3 @ ≥ $45k	1
Breaches creating a security risk remain below threshold/within acceptable range	≤3	0
On-time Code and SOSPA deliverables	100% (47)	100% (24)

We deliver projects successfully			
Improved project delivery	Service Maintenance projects	≥ 60% achieved for approved time/budget	50%
	Market Design and Service Enhancement projects	≥ 60% achieved for approved time/budget	None completed
Accurate capital planning		≥ 50%	58%

We are committed to optimal real time operation		
Sustained infeasibility resolution	100% ≤ 2 business days	100%
	80% ≤ 1 business day	98%
High spring washer resolution	100% ≤ Code obligations	100%
	80% ≤ 1 business day	100%

Our tools are fit for purpose		
Improved capability functional fit assessment score	74.74%	Not currently available
Improved technical quality assessment score	50.60%	Not currently available
Sustained SCADA availability	99.90%	99.99%
Maintained timeliness of schedule publication	99%	99.99%

7 SOSPA deliverables

System Operator Strategic Plan

We tabled a Board paper with March Transpower Board on the 2019-24 strategic plan for the system operator service. An early working draft of the plan had been discussed with the Authority's SOC Committee at its February meeting. The draft plan was approved by the Transpower Board for submission to the Authority.

8 Actions taken

The following table contains a full list of actions taken during Q3 regarding the system operator business plan, statutory objective work plan, participant survey responses and any remedial plan, as required by SOSPA 12.3 (b).

Item of interest	Actions taken
(i) To give effect to the **system operator business plan**:	• As part of Transpower's efficiency programme, we have continued to progress the various technology, process and people changes as per the schedule. • We completed the outage planning policy which went live in February 2019. • We are currently preparing to run this year's annual participant survey and reviewing the process as part of this procedure. • We have developed a working draft of an internal strategy for security of supply. Current work is focussed on building on the strategy to align with internal strategy and deliver on future needs. • We have completed 5 of the 9 actions resulting from recommendations from the review of role impartiality between Transpower's grid owner and system operator roles. These are planned for completion in April 2019 and a Transpower-wide conflict of interest policy will be produced in May 2019. • We have delivered increased capacity for Special Protection Schemes. • We have completed the draft version of the cost of services reporting and will present it to the Authority in in April 2019.
(ii) To comply with the **statutory objective work plan**:	**Review of the Security of Supply Forecasting and Information Policy (SOSFIP)** • We completed the SOSFIP review and the decision paper was presented to the Authority Board in April 2019. **Develop methodology for weighting critical success factors and metrics** • We provided a report to the Authority on 1 April which outlines the proposed methodology. **Develop measure for quality of written reports** • We have created a proposed measure to be included in the discussions on the Performance Metrics and Incentives proposed for 2019/20

Item of interest	Actions taken
	Consider measure against the reserve management objective • We have documented a brief paper investigating a measure for the reserve management objective which we presented to the Authority on 1 April.
(iii) In response to participant responses to any **participant survey**:	**Areas of growth identified in the May 2018 survey** • *Communications around operations* – We have been very active with communications this quarter - we have held an outage management forum, two workshops for the DSE project, a workshop and a consultation for the RTP project, as well as delivering the outage planning policy. • *Promotion and growth of education and information provision* – Two initiatives this quarter have been producing the 'Journey of an Outage' animation and publishing a guideline document to explain when we, as system operator, will publish notifications and assessments.
(iv) To comply with any **remedial plan** agreed by the parties under SOSPA 14.1	N/A – No remedial plan in place.

9 Cost-of-services reporting

The feasibility study into implementing annual cost-of-services reporting to the Authority is required in financial year 2 (SOSPA 12.6). This was completed in September 2017. We will present the draft version of the reporting to the Authority in April 2019. Reporting will start in the 2019/20 year.

10 Technical advisory hours and services

The following table provides the technical advisory hours for Q3 and a summary of technical advisory services to which those hours related (SOSPA 12.3 (d) refers).

TAS Statement of Work (SOW)	Status	Hours worked during Q3
TAS SOW 82 – Real Time Pricing	In progress	250.50
TAS SOW 83 - Provide ROM for system changes to support removal of constrained on payments for ramp-constrained generation	In progress	9.00
Total hours		**259.50**

The maximum carry-over of 25% of unused base technical advisory hours (110 hours) will be rolled over to Q4 (SOSPA 15.8).

11 Separation of Transpower roles

Since the creation of the Operations division and implementation of Transpower-wide training on role impartiality and conflict of interest, we have had a number of issues raised on the conflict of interest register. These issues are being handled in accordance with Transpower's policy for managing conflicts of interest.

January: There were no new issues raised in the conflict of interest register.

February: There were two issues raised and one closed in the conflict of interest register. The first new issue relates to a staff interest declared in a planned generator build and commissioning. The second new issue relates to security and availability of data after recent software updates. The closed issue related to potential interactions between EMS and system operator functions.

March: One new issue was raised in the conflict of interest register. This relates to confidential information supplied to the Outage Planning group. Two issues were closed both related to aspects of the release of the Outage Planning Policy, which was fully implemented in Feb 2019.

As noted in section 4 of this report, the Outage Planning Policy particularly looked at areas where perceived conflict may occur. We want our approach to be clearer to the industry on how we plan and assess outages and how we maintain impartiality in our roles.

A summary of the open items raised on the conflict of interest register is set out below:

- Management of actions from role impartiality review
- Actions during HVDC outage
- Staff interest in an industry participant project
- Security and availability of data
- Staff advised of confidential generator outage plans
- Staff interest in power system training organisation

12 Customers and other relationships

Mercury, Genesis and Meridian customer visits

The Senior Leadership team met with both Mercury and Genesis in Auckland in February 2019. These meetings were an opportunity for us to receive direct feedback from our customers around our performance and the deliverables we produce, including whether they are still fit for purpose.

A similar meeting was held in March 2019 with Meridian. This was a good discussion ranging from security of supply to the information Meridian is using to help inform their longer-term market position, which included Transpower's RCP3 submission. Meridian has also shared the journey they are on to streamline their night shift by having Generation Controller's being able to undertake the Energy Trader role as well, with on call support if required.

AEMO - Inverter Standard AS/NZS 4777.2

The Australian market operator (AEMO) has approached Transpower to review and contribute to proposed changes of the inverter standard AS/NZS 4777.2. This is an important standard to ensure we get the correct behaviour from inverted connected distributed energy resources. We have agreed to contribute and support these changes.

System performance

13 Operational and system events

January

High Temperatures

As temperatures at Haywards rose above 28 degrees, this had the potential to impact on the HVDC pole 3 transfer maximum limit. However, although temperatures of over 30 degrees did cause the pole limit to be reduced on 29 January, the transfer at the time was lower than the reduced limit and therefore did not result in any impact. All lessons from the investigations, carried out in anticipation of the impact of nationwide high temperatures, have been recorded in a process document to be referenced in future high temperature situations.

February

Black Start Simulation

We ran a South Island joint Black Start simulation on the 19 February which was once again a valuable exercise. All four simulation rooms were used with industry participants from Contact, Meridian and NZAS taking part. Transpower's system operations and grid owner teams ran the two South Island Black Start contingency plans in parallel and then automatically synchronised the islands at Waitaki. As part of this exercise, we used the new automated control switching sequence, which replaces voice-given instructions. This functionality worked well, and it is likely be built into the actual plan as an option.

March

Te Kowhai

A planned outage of Huntly-Te Kowhai which placed Te Kowhai on N-security over a period of approximately two weeks, contributed to high voltages during low load and low-wind periods, and resulted in a Grid Emergency Notice (GEN) being issued. We are undertaking a review of the planning and events surrounding the high-voltages and will be engaging with WEL Networks Limited to understand what improvements can be made.

Central Park-Wilton outages

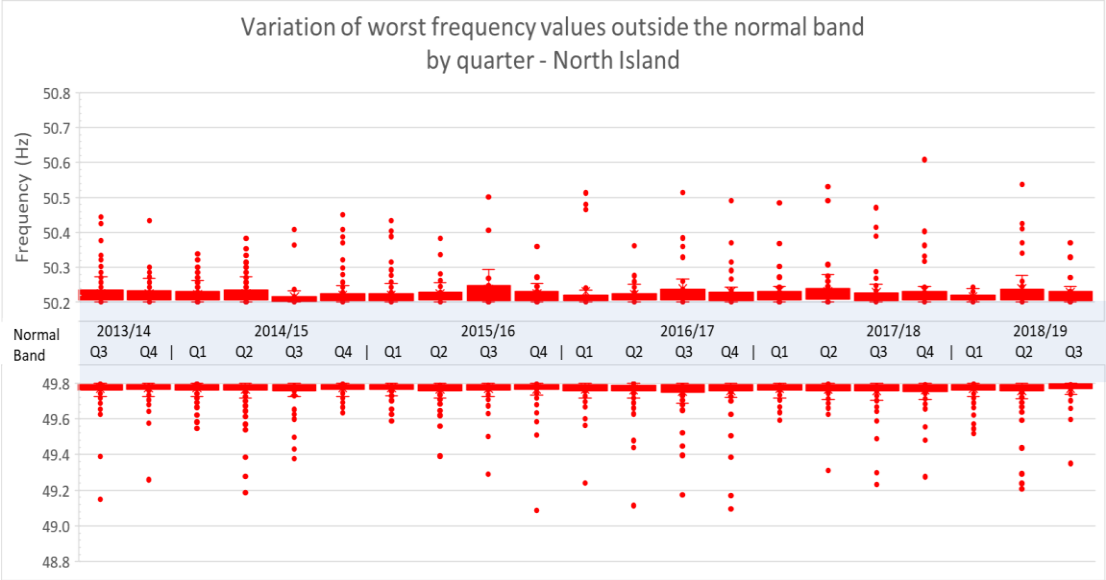
Both the operations planning and real-time teams have been involved in the outages to support the reconductoring work on the Central Park-Wilton line and developing contingency plans for the periods that Central Park is on N-security.

14 Frequency fluctuations

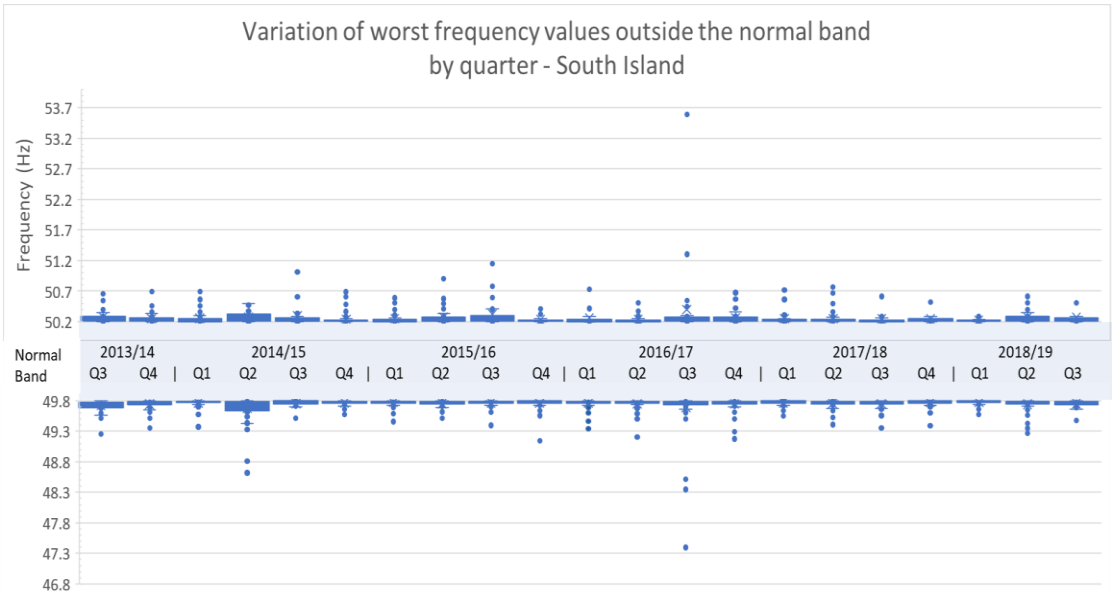
14.1 Maintain frequency in normal band (Frequency value)

The following charts show the distribution of the worst frequency excursion outside the normal band (49.8 to 50.2 Hz) by quarter since July 2014, including the reporting period.

North Island



South Island

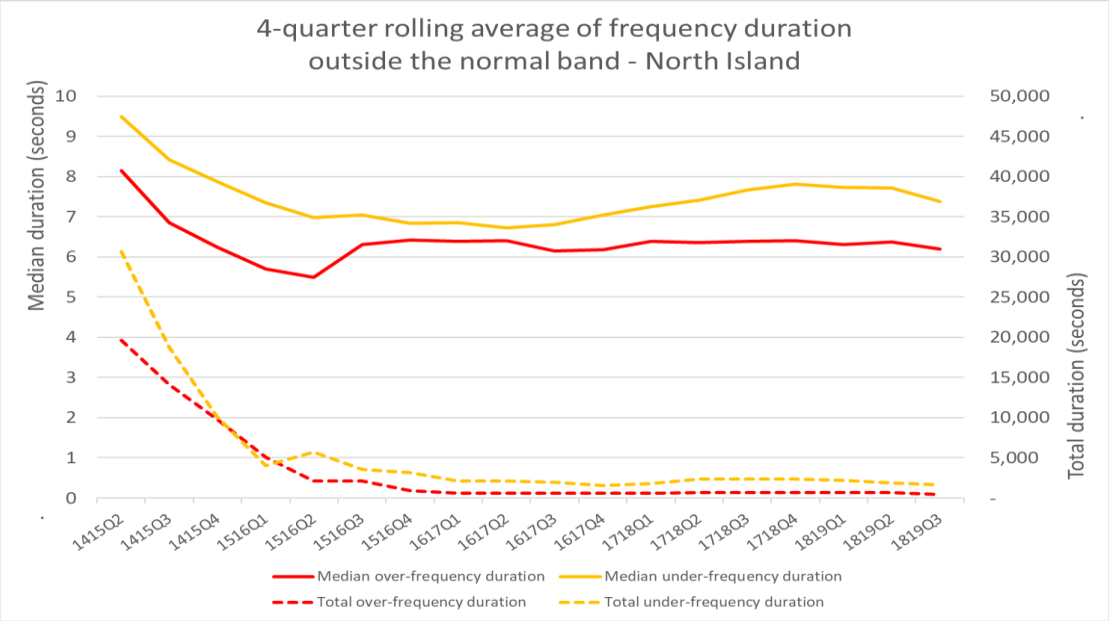


Note: These box and whisker charts show the distribution of data. The “box” represents the distribution of the middle 50% of the data, the “whiskers” indicate variability, and outliers are shown as single data points.

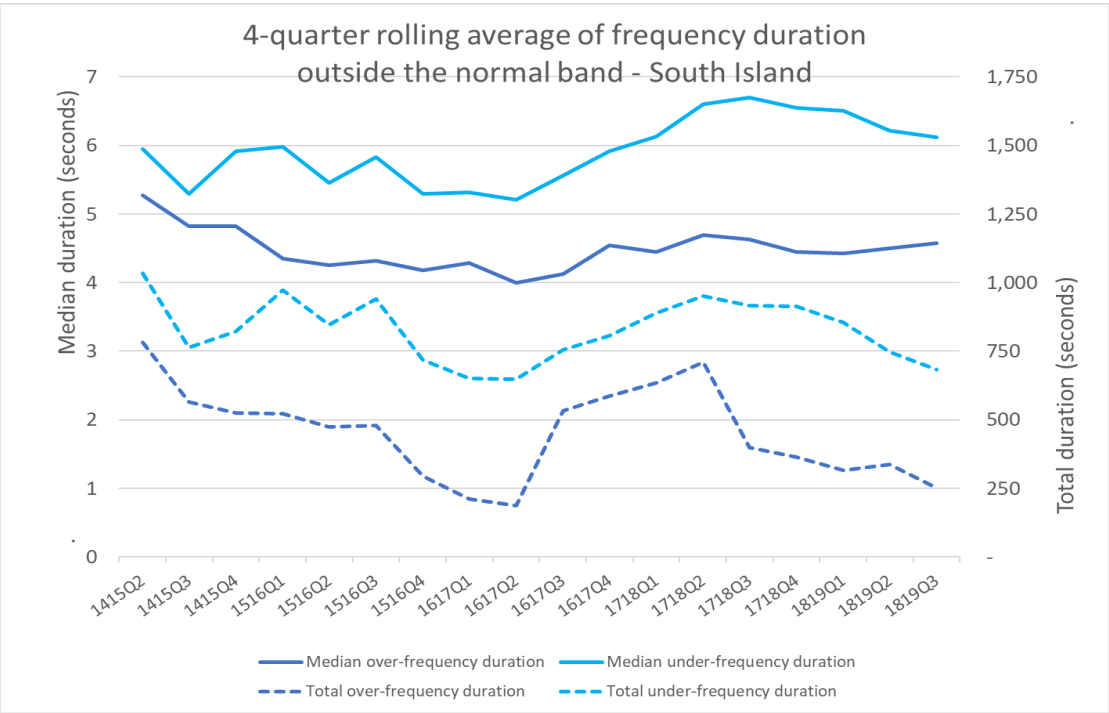
14.2 Recover quickly from a fluctuation (Time)

The following charts show the median and total duration of all the momentary fluctuations above and below the normal band for each island. The information is shown as a 4-quarter rolling average to illustrate trends in the data.

North Island



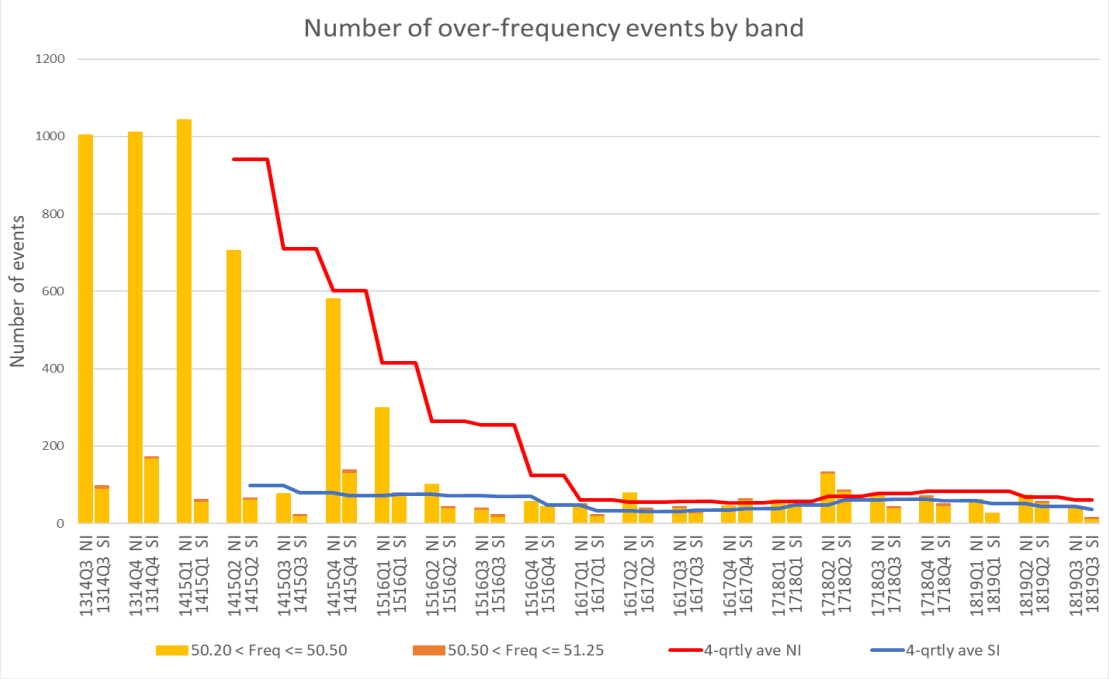
South Island



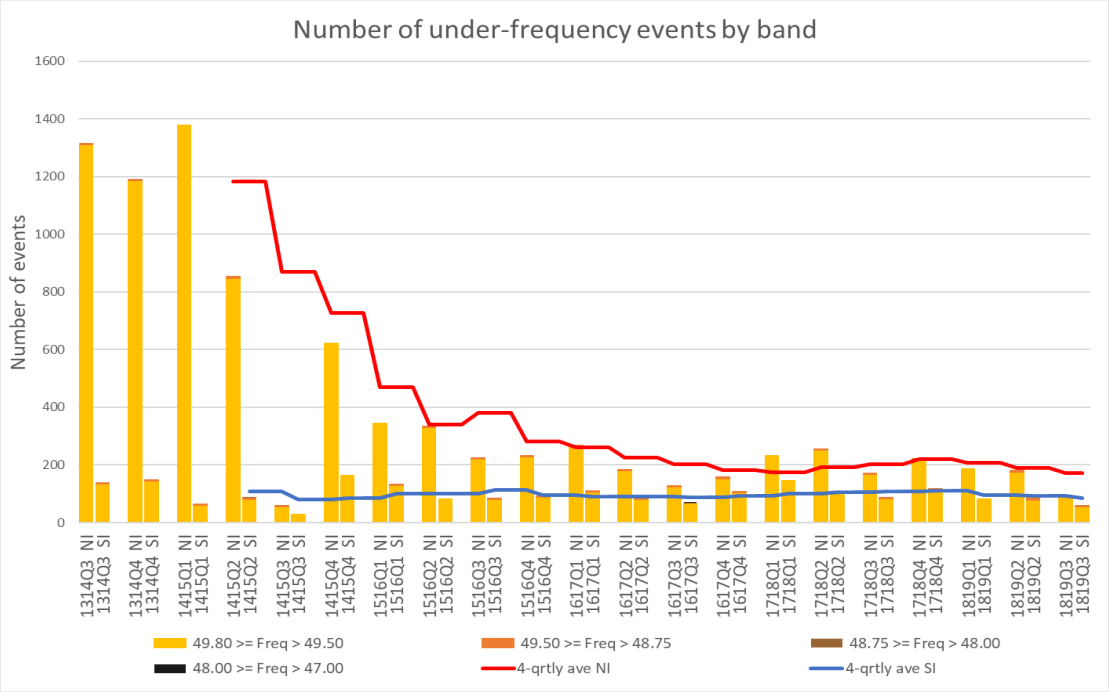
14.3 Manage frequency and limit rate of occurrences during momentary fluctuations (Number)

The following charts show the number of momentary fluctuations outside the frequency normal band, grouped by frequency band, for each quarter since 2014. The information is shown by island, including a 4-quarter rolling average to show the prevailing trend.

Over-frequency events



Under-frequency events



14.4 Manage time error and eliminate time error once per day

There were no time error violations in the reporting period.

15 Voltage management

Grid voltages exceeded code ranges at Te Kowhai on 28 March 2019 for approximately 4 minutes at circa 04:30 during a planned outage of 220 kV of the Huntly – Te Kowhai circuit 1. An investigation into the circumstances surrounding this is underway.

16 Security notices

The following table shows the number of Warning Notices, Grid Emergency Notices and Customer Advice Notices issued over the last 12 months.

Notices issued	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19
Demand Allocation Notice	-	-	-	-	-	-	-	-	-	-	-	-
Grid Emergency Notice	1	1	-	-	1	-	-	-	-	-	-	
Warning Notice	-	-	1	1	-	-	-	1	-	-	-	-
Customer Advice Notice	10	12	4	2	9	9	6	20	20	16	6	7

17 Grid emergencies

The following table shows grid emergencies declared by Transpower as system operator from January to March.

Date	Time	Summary Details	Island
Jan-19		None	
Feb-19		None	
Mar-19	23:58	18-March: A grid emergency was declared to reconfigure the grid to manage high voltages at Te Kowhai during a planned 220 kV Huntly–Te Kowhai circuit 1 outage.	North

18 Security of supply

The immediate gas supply situation was addressed this quarter as the original unplanned Pohokura outage ended. However, smaller planned outages of the Pohokura gas supply during February and March continued to impact the availability of gas-fired generation. Stratford Combined Cycle plant is still not offering into the market which has also had an impact on the security of supply situation.

In January, we were expecting a possible risk of shortage over the next two to three months due to hydro storage remaining low at the start of the year. This expectation was largely dependent on hydro catchment inflows. Overall, during January, North

Island inflows were 75% of average and South Island inflows were 99% of average. National hydro storage increased from 91% to 96% of average from the time of year. The average price at Haywards was $125/MWh.

Overall conditions were dry in February, especially in the North Island. North Island inflows were 59% of average and South Island inflows were 95% of average. National hydro storage decreased from 96% to 86% of average from the time of year. Over this timeframe, prices traded in the $200-$300/MWh range, with occasional price spikes above $700/MWh when wind was light or demand higher than expected.

The dry spell that had continued throughout March was broken in the last week of the month with heavy rains in the South Island; that saw storage levels rise sharply. The magnitude of inflows was at levels not seen since 2013 (over 700 GWh). This resulted in the unusual situation of being at the 1% risk curve at the start of the week and exceeding average inflows by the end of the week. Overall in March, North Island inflows were 55% of average and South Island inflows were 131% of average. National hydro storage increased from 85% to 99% of average for the time of year. Prices dropped to $100-$150/MWh, Huntly generation dropped from 870 MW to 500 MW, and the HVDC peak transfer north increased by 300 MW to 700 MW.

Changes to the Hydro Risk Curves (HRCs)

The HRCs were adjusted in January to include regular outages on the system, but in February there was a significant drop in the Hydro Risk Curves caused by the new demand forecast, prepared by Transpower, which showed a lower demand outlook. Also, in February, Pohokura gas field outages scheduled for March / April 2019 were also included in the derivation of the HRCs - this change moderated the drop in HRCs caused by the lower demand forecast but did not completely offset it.

On 1 April, 220 GWh of contingent storage at Tekapo was reclassified and is now included as controlled storage in the hydro risk curve charts, also pushing up storage levels. This information is on the HRC page of our website.

The latest publication of the Hydro Risk Curves, published in late-March, saw a slight increase to the curves. An accompanying Simulated Storage Trajectory chart showed no sequences crossing the 10% HRC (meaning no foreseeable chance of an official conservation campaign being required over this winter). In March, we also published three HRC and Simulated Storage Trajectory (SST) scenarios to explore the impact of thermal fuel restriction on the HRCs. We held an industry teleconference in early April to discuss these – there was general support for continuing the current approach, with some suggestions for minor improvements for clarity.

Changes to the Risk meter

At the beginning of the quarter, we expected the risk of shortage to rise as we headed into winter. The Risk Meter stayed on Normal status throughout. In the last week of March, prior to the large inflow events, we reached the 1% curve. But as we did not expect to stay at this level for a week, the Risk Meter was not raised to Watch

status. The Watch status means there is approximately a 1% chance that we do not have enough supply for the forecast demand in winter.

2019 Security of Supply Annual Assessment

The 2019 Security of Supply Annual Assessment was published on 28 February. The key message in the report is that, based on our assumptions in the Annual Assessment, we expect to require new generation in the mid-2020s in order to maintain an efficient level of reliability.

19 Ancillary services

Ancillary services costs dropped in January after two relatively expensive months. Instantaneous Reserves costs for January 2019 were similar to those for January in 2017 and 2018.

Ancillary services costs increased in February to $4.9m, almost double the January costs of $2.4m, and roughly the same magnitude as in July and August 2018.

This overall increase in costs was driven by two factors:

- Frequency Keeping costs were particularly high for a few trading periods on 18 February 2019. This happened when there were high constrained on costs for frequency keeping as generators were constrained for energy to allow them to keep frequency.
- Instantaneous Reserves costs were 50% higher than January for almost all generators providing spinning reserves this month as energy and reserves were highly valued. Reserve costs from thermal generation increased by 90% from the previous month.

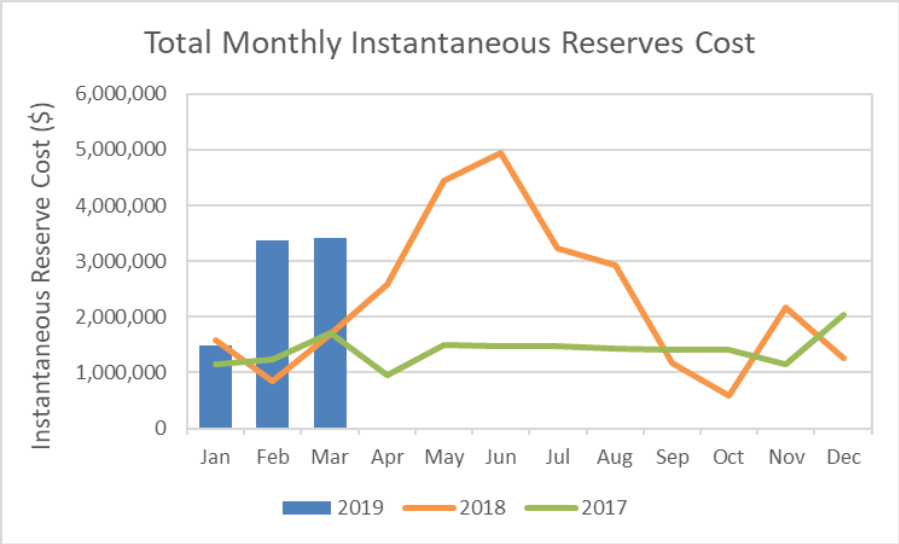
In March 2019, the clearing manager raised an invoice dispute covering amounts going back two years before that date. All those months have been reprocessed and the Clearing Manager is performing washups for every month from September 2014 to December 2018 (except December 2014).

Starting in April 2019, four additional months' washups will be included in each invoice. The amounts that are expected to change are the constrained-on payments, which were previously incorrectly calculated.

In March, the costs for ancillary services increased by $0.2m from the previous month to $5.1m. Both Frequency Keeping costs and Instantaneous Reserves costs increased from February.

- Frequency Keeping constrained off costs for Contact were high over this period (see section 19.1 for more details).
- There were a number of contributing factors to the increased Instantaneous Reserves costs. For the periods 9 to 14 March 2019 and 18 to 22 March 2019, there were high prices in general (both energy and reserves) due to declining South Island hydro storage levels and thermal restrictions with a Stratford Peaker on outage, a tight gas market and the Stratford combined cycle plant not being offered into the market. For 29 to 31 March, there was high north transfer on the HVDC following the rain event which filled the

South Island hydro lakes. This resulted in the HVDC becoming a risk setter along with Huntly, increasing reserve requirements and pushing up the price.

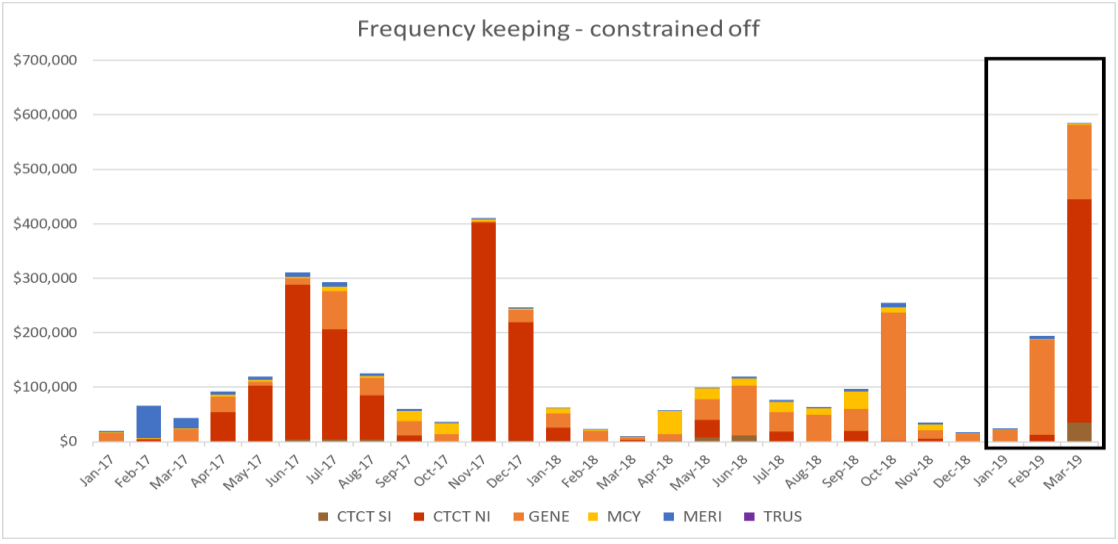


Refer to Appendix B for more detailed Ancillary Services graphs.

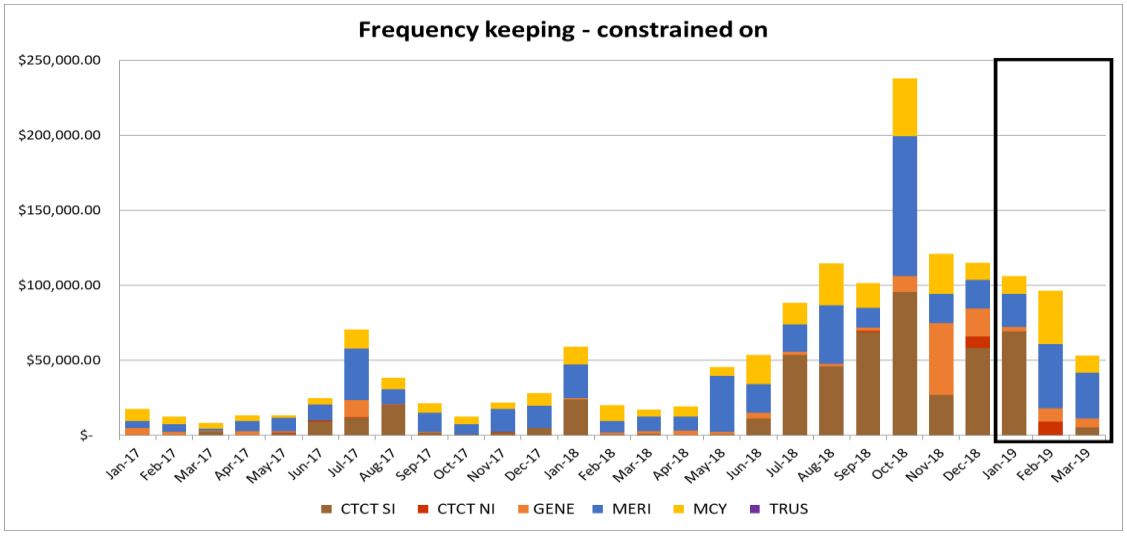
19.1 Constrained on/off costs

Note: Where there is a high payment, as opposed to in increasing/decreasing trend, it will often relate to payments over a small number of trading periods.

Frequency Keeping

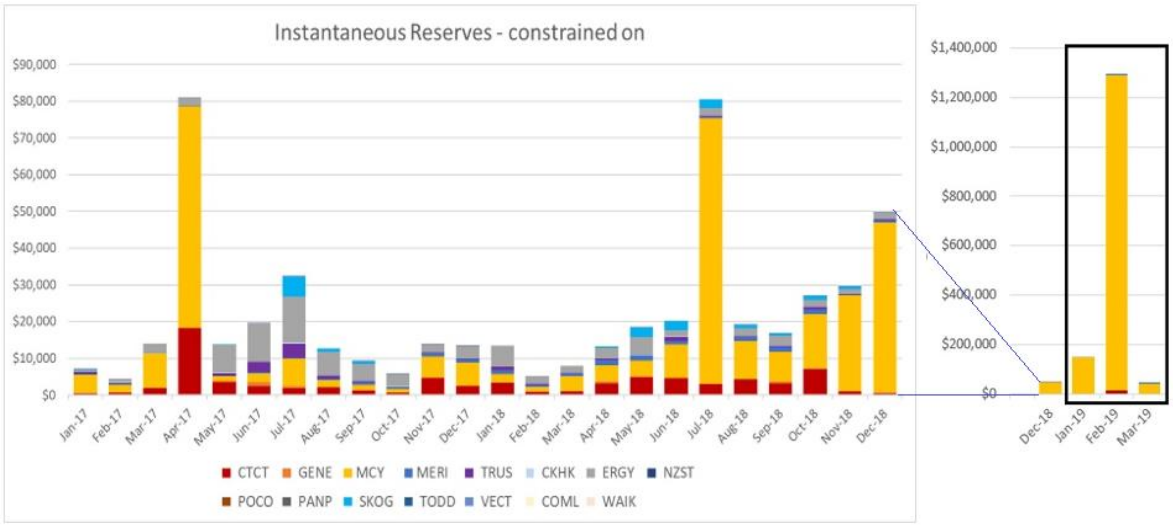


During this quarter, Frequency Keeping constrained-off costs were high due to increase in payments in March to Contact Energy for Stratford. There were nine days of the month when Stratford was constrained down for Frequency Keeping for between 11 and 42 trading periods, with payments for this totalling $410,634. The plant was constrained down as it was offering energy close to the top of its capacity.



Constrained-on costs for Frequency Keeping reduced this quarter, notably in March. In particular the March costs for Mercury were $25k less than for February. Waikato provided Frequency Keeping for less trading periods in March, due to Stratford picking up more Frequency Keeping.

Instantaneous Reserves



The very high constrained-on costs for Instantaneous Reserves prompted an investigation by the Clearing Manager who found an error in the calculations. The constrained-on payment amounts are expected to change as a result of the wash-ups being processed by the Clearing Manager for the period from September 2014; these will correct amounts which were previously incorrectly calculated.

The graph shows the costs for the last 3 months on a different axis as they are considerably higher than constrained on amounts for Instantaneous Reserves for any other period.

The calculations for March are now in the more usual cost range.

Appendix A: Discretion

January

Event Date & Time	Event Description
6/01/2019 22:00	MTI2201 MTI0 : MTI bus trip
6/01/2019 22:00	WPA2201 WPA0 : MTI bus trip
15/01/2019 1:35	MAN2201 MAN0 : To restore Potline 4
15/01/2019 23:05	MAN2201 MAN0 : Return of Extended Potline 4
30/01/2019 18:08	TKA0111 TKA1 : ABY_TKA_1 circuit tripped

February

Event Date & Time	Event Description
10/02/2019 13:16	MAN2201 MAN0 : For TWI Line 4 restoration.
27/02/2019 02:28	SFD2201 SFD21 : Security requirement. On for last resort TWH voltage control to provide -ve Mvar

March

Event Date and Time	Description
08-Mar-2019 08:23:07	BWK1101 WPI0 : Loss of connection to Berwick generation
18-Mar-2019 15:39:22	ARG1101 BRR0 : Discretion to 0MW to facilitate the return of ARG_BLN_1 circuit.
22-Mar-2019 00:35:30	SFD2201 SFD22 : Required to maintain voltage at TWH. Was dispatched off at 00:30. TUK windfarm came off at midnight.
23-Mar-2019 04:54:53	SFD2201 SFD22 : Required to maintain voltage at TWH. Was dispatched off at 05:00.
28-Mar-2019 04:34:14	TWH0331 TRC1 : Required for system security due to the high voltage at TWH
28-Mar-2019 04:38:49	TWH0331 TRC1 : Required for system security due to the high voltage at TWH
28-Mar-2019 16:59:38	ARG1101 BRR0 : Restoration of ARG_KIK_1 Last Dispatched MW: 10

Appendix B: Ancillary Services Graphs