SECURITY AND RELIABILITY COUNCIL

ACTION LIST

The following are actions to be completed after meeting number 26 on Thursday, 28 March 2019.

Action #	Meeting created	Action	Date for completion	Status
1	13	SRC Secretariat to arrange ENA's Smart Technologies Working Group presentation once its investigation is sufficiently developed.	Once ENA's investigation has progressed	**Complete.** Included as agenda item #11
2	16	Secretariat to engage with industry and the Commerce Commission in further development of the risk management framework (RMF).	1st meeting of 2019	**Closed.** Refer agenda item #12
3	16	Secretariat to assess what the threshold should be for a risk that the SRC 'can live with', and incorporate into further development of the RMF.	1st meeting of 2019	**Closed.** Refer agenda item #12
4	17	The secretariat is to keep the SRC updated with the progress of Transpower's major capital project for voltage stability issues in the upper North Island. Updates of milestones should be provided until the investment decision is made.	As needed until investment decision made	**On hold.** Several updates already given. There is material for an update, but for logistical reasons this has been scheduled for the 24 October 2019 meeting.
5	25	Secretariat to provide more information about how gas production outage risks are managed.	20 June 2019 meeting	**Complete.** Included as agenda item #6
6	26	Secretariat to add a separate section to the standard disclosure of interests paper that records the Chair's professional activities and involvements.	20 June 2019 meeting	**Complete.**
7	26	Secretariat to prepare a paper that explains what the hydro risk curves represent and how they work.	24 October 2019	**Complete.** Included within agenda item #9
8	26	Secretariat to prepare a paper that explains what the grid reliability standards are and how they were derived, how they are used, how n-	24 October 2019	**On hold.**

Action #	Meeting created	Action	Date for completion	Status
		security outages are decided upon and planned for, and includes any available data on the uses of n-security and any related lessons learned.		
9	26	Secretariat to book diaries to allow an extra two hours at the 20 June 2019 SRC meeting for a discussion of risk and strategy.	As soon as possible	**Complete.**
10	26	Secretariat to book time in members' diaries for a provisional SRC meeting in August 2019.	As soon as possible	**Complete.** Provisionally booked for 21 August 2019.

1. Updates

1.1. This section provides information on matters that don't warrant a dedicated agenda item, such as updates on matters that have previously been discussed by the SRC.

The current security of supply situation

1.2. As at 2 June, New Zealand and South Island controlled storage is above average. The risk meters for the New Zealand and the South Island are set to normal.

Meridian modelling of climate change impacts

1.3. Meridian has recently released analysis showing that:

1.4. Waitaki catchment rainfall is forecast to increase by 0-10% by 2050 (relative to 1995) – with the increase being more in winter than in summer

1.5. April-October inflows to the Waitaki, Clutha and Manapouri catchments are forecast to increase

1.6. September-March inflows to the Waitaki and Clutha catchments are forecast to decrease.[1]

Waikato outages lead to Rulings Panel complaint

1.7. In January of 2018 a transformer at the Transpower-owned Hamilton substation tripped, leading to a loss of about 185 MWh of supply across Waikato. The Electricity Authority laid a complaint with the Rulings Panel on 4 April, stating that:

1.8. failure to maintain protection equipment contributed to the outage

1.9. the incident had a severe impact, with the value of the lost load estimated to be between $3 and $4 million. [2]

Further recent evidence of investment in electricity generation

1.10. Mercury has committed to the construction of the first 33 of 60 consented wind turbines at Turitea near Palmerston North. Commissioning is expected to begin from late 2020.[3]

1.11. When complete, the 119 MW Turitea wind farm is expected to generate 470 GWh per annum on average.

1.12. Contact Energy has announced that the company is drilling a series of appraisal wells on the Tauhara geothermal field as it builds towards a final investment decision in 2020.[4]

1.13. The drilling programme will commence in August and complete in early 2020, with an approximate cost of $30 million.

1.14. These announcements add weight to evidence that suggests market forces are incentivising additional investment in electricity generation.

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1 https://www.meridianenergy.co.nz/assets/Sustainability/8d965d2519/Climate-change-Meridian-modelling-May-2019.pdf

2 https://www.energynews.co.nz/news-story/regulation/42639/transpower-role-2018-outage-referred-rulings-panel

3 https://www.mercury.co.nz/news/mercury-new-wind-farm-at-turitea-palmerston-north

4 http://www.thinkgeoenergy.com/contact-energy-to-drill-several-appraisal-wells-on-the-tauhara-geothermal-field/

Explanation of the risk curves and simulated storage trajectories

1.15. Action #7, from the last SRC meeting of 28 March 2019, is for the "Secretariat to prepare a paper that explains what the hydro risk curves represent and how they work". That paper has been prepared and is attached overleaf.

1.16. In general, the secretariat does not append papers to the 'actions and updates' paper. With the Chair's permission, we have done so in this case because:

1.17. the paper is for information only; no advice is requested

1.18. the agenda for 20 June is full.

Meeting Date: 20 June 2019

EXPLANATION OF THE RISK CURVES AND SIMULATED STORAGE TRAJECTORIES

SECURITY AND RELIABILITY COUNCIL

This paper explains what the risk curves and simulated storage trajectories represent, how they work, and (broadly) how they are prepared.

Note: This paper has been prepared for the purpose of informing the Security and Reliability Council. Content should not be interpreted as representing the views or policy of the Electricity Authority.

1. Background

1.1 This paper provides briefing material on the risk curves, as requested by the SRC

1.1.1 At the last SRC meeting, on 28 March 2019, the Secretariat was tasked with "preparing a paper that explains what the hydro risk curves represent and how they work" (refer action item #7). This is that paper.

1.1.2 The discussion of the risk curves on 28 March 2019 was in the context of an item "Implementation of changes affecting the hydro risk curves". In that item, the Authority sought the SRC's views on whether potential changes to the risk curves and the official conservation campaign framework should be implemented before or after winter 2019. The SRC responded that "on balance, the SRC is slightly in favour of the earlier implementation option". At the time of writing, we have no further updates on what changes will be made (if any) or when the implementation date will be.

1.1.3 The explanation of the risk curves in this paper is at a fairly high level. The focus is on providing a good working understanding of what the risk curves are for and how they operate, rather than on exhaustively cataloguing all the assumptions that go into their preparation. More detailed information can be found on Transpower's website – an animation explaining the risk curves may be of particular interest.[1]

1.1.4 This paper also addresses some of the 'myths' surrounding the risk curves. For example, a common misapprehension is that they are not realistic or useful because the assumptions used in preparing the curves are not consistent with the way the market operates.

1.2 This paper also covers the simulated storage trajectories

1.2.1 This paper also briefly covers the simulated storage trajectories (sometimes referred to as 'spaghetti diagrams') that are published by the system operator.

1.2.2 The SRC did not specifically request briefing on the simulated storage trajectories, but it seemed worthwhile as they are closely related to the risk curves. Both tools describe aspects of energy security (i.e. the adequacy of hydro storage and thermal fuel) over a forecast period of weeks to months.

2. The risk curves

2.1 The risk curves show the *capability* of the market to avoid shortage of energy supply

2.1.1 The risk curve framework has been in place for many years, but has evolved over time. In its current form, it dates back to 2010. Before 2010, the similar 'minzone' framework was used.[2]

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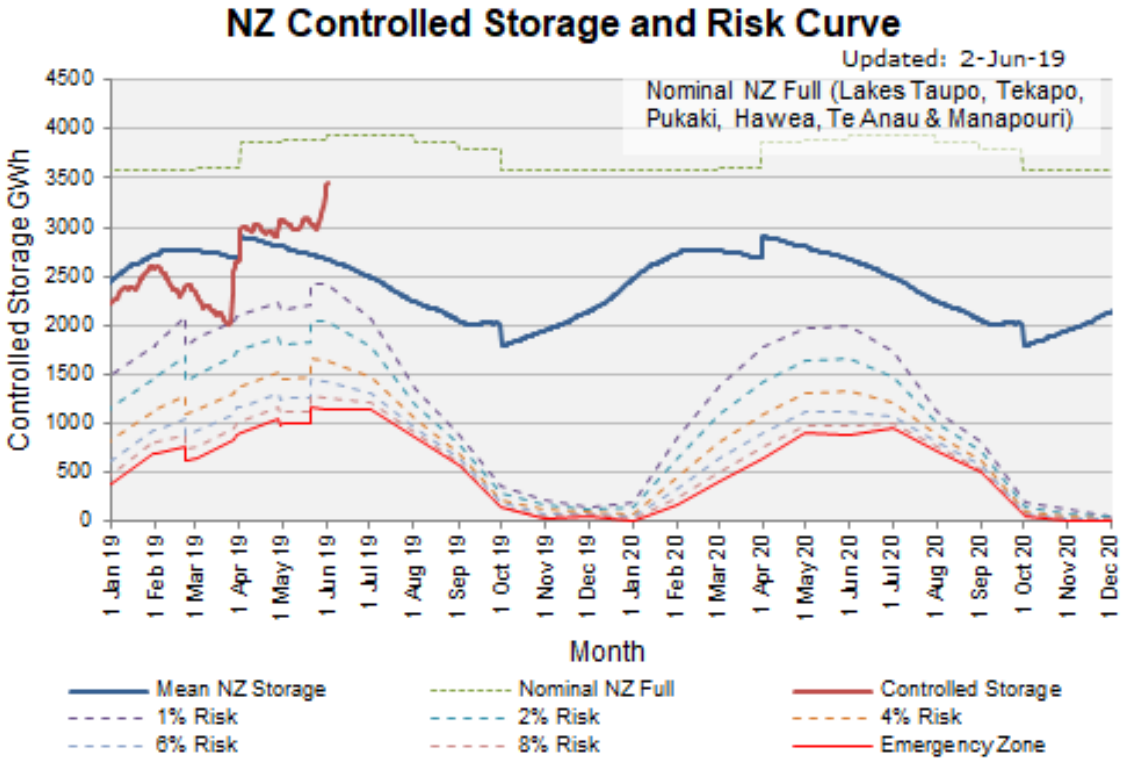
1 https://www.youtube.com/watch?v=pNjjDoajlK4

2 See e.g. http://img.scoop.co.nz/media/pdfs/0604/Mizone.pdf

2.1.2 The risk curves are a set of lines, expressed in GWh and changing over time. The X% curve is the level of energy storage (i.e. controlled storage in hydro lakes) at which the probability of such storage falling to zero in the next 8-20 months is modelled as being X% – subject to various assumptions discussed later in this paper.

2.1.3 Figure 1 below shows a recent set of risk curves for New Zealand as a whole, as published on Transpower's website.[3] The system operator also publishes risk curves for South Island storage only.

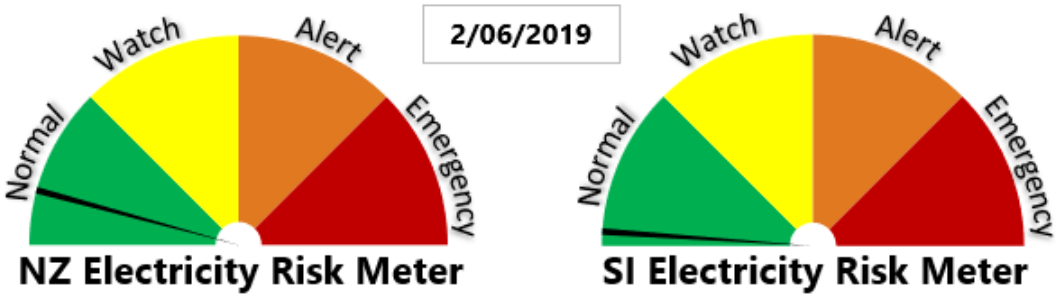
Figure 1: Risk curves and actual storage for NZ as a whole, as of 2 June 2019



Source: Transpower (https://www.transpower.co.nz/system-operator/security-supply/hydro-risk-curves)

2.1.4 The graph above shows that at time of publication, actual storage was well above the 1% risk curve. As a result, the system operator's risk meter for New Zealand was set to 'normal' – as was the risk meter for the South Island (Figure 2 below).

Figure 2: Risk meter as of 2 June 2019



[3] https://www.transpower.co.nz/sites/default/files/bulk-upload/documents/Simulated%20Storage%20Trajectories.pdf

Source: Transpower (https://www.transpower.co.nz/system-operator/security-supply/hydro-risk-curves)

2.1.5 The comparison between the risk curves and actual storage is indicative of the current level of energy security. Specifically, it shows the level of security that the market is able to provide, assuming no major unexpected adverse events, and without considering the potential benefits of emergency measures. Actual outcomes may differ:

(a) if the market does not act to conserve energy storage

(b) if some event such as a major unplanned asset outage impacts the power system[4]

(c) if contingent hydro storage (hydro storage that is only made available when there is an elevated level of risk to energy security) is accessed or rolling outages are put into action.

2.1.6 Sometimes the risk curve framework is criticised on the basis that it does not attempt to predict market behaviour. Such criticism is based on a misapprehension of the purpose of the risk curves. The framework deliberately does not seek to determine the *likelihood* of storage falling to a low level. Rather, it assesses the *ability* of the power system to prevent this from happening (in the absence of rolling outages). The result is that the risk curves are more stable and can be estimated more accurately.

2.2 The risk curves can trigger various actions

2.2.1 The risk curves are an important part of the security of supply framework. As a simplified summary, under current settings:

(a) storage falling below a 1% risk curve can trigger ‘watch’ status on a risk meter, and also triggers the system operator to begin preparations for an official conservation campaign

(b) storage falling below a 4% risk curve can trigger ‘alert’ status on a risk meter’, which in turn triggers access to some contingent storage

(c) storage falling below a 10% risk curve can trigger ‘emergency’ status on a risk meter and an official conservation campaign, which in turn triggers payments by retailers to their eligible customers under the customer compensation scheme

(d) storage rising above the 8% risk curve can trigger the end of an official conservation campaign

(e) storage falling below any of the above risk curves can trigger the system operator to provide more frequent and/or detailed updates on security of supply.

2.2.2 It is possible that some of the triggers above may change soon. The Authority is currently reviewing the triggers for starting and ending an official conservation campaign and for enabling access to contingent hydro storage.

[4] Once such an event had taken place, the system operator would update the risk curves accordingly.

2.3 How the risk curves are produced

2.3.1 The risk curves are produced by the system operator, based on modelling.

2.3.2 The **first key assumption** used in producing the risk curves is that discretionary generation operates so as to conserve (controlled hydro) storage. As set out above, this is a valid assumption when determining the *ability* of the power system to prevent storage from falling to a low level.

2.3.3 The **second key assumption** is that there is unlimited fuel for thermal generation – or, more precisely, that the probability of falling to zero storage is not increased by the risk of running out of coal, gas or diesel.

2.3.4 The system operator validates this assumption using scenario analysis,[5] commenting that: *"based on the validation completed in [December 2019] we believe there will be sufficient thermal fuel made available during a security of supply emergency such that generation output is consistent with our modelling assumptions, should an emergency arise. This is not based on existing contractual arrangements, but arrangements we believe would be put in place in an emergency."*

2.3.5 As such, the system operator uses a default assumption of unlimited thermal fuel unless it has sufficient evidence to the contrary. In the case of Whirinaki, the system operator believes that diesel storage and transportation limitations will mean Whirinaki is unable to operate continuously.

2.3.6 The **third key assumption** is that rolling outages are not included. This is done for three reasons:

(a) rolling outages are a 'last ditch' measure and it is not considered desirable to build them into normal security evaluation

(b) the framework is meant to assess the ability of the *market* to conserve storage, and rolling outages are outside the market

(c) in any case, incorporating rolling outages could collapse all risk curves to zero. This is because if rolling outages are actually effective, then the real risk of exhausting storage is always nil.

2.3.7 The **fourth key assumption** is that contingent storage is not included. By this we mean that the 'actual storage' value does not include contingent storage, and the risk curves are calculated as if contingent storage was never available.

2.3.8 The treatment of contingent storage in the risk curve framework may change in future.

2.3.9 As well as the four key assumptions above, the system operator makes various assumptions about generation, inter-island transmission, 'normal' demand and demand response.[6]

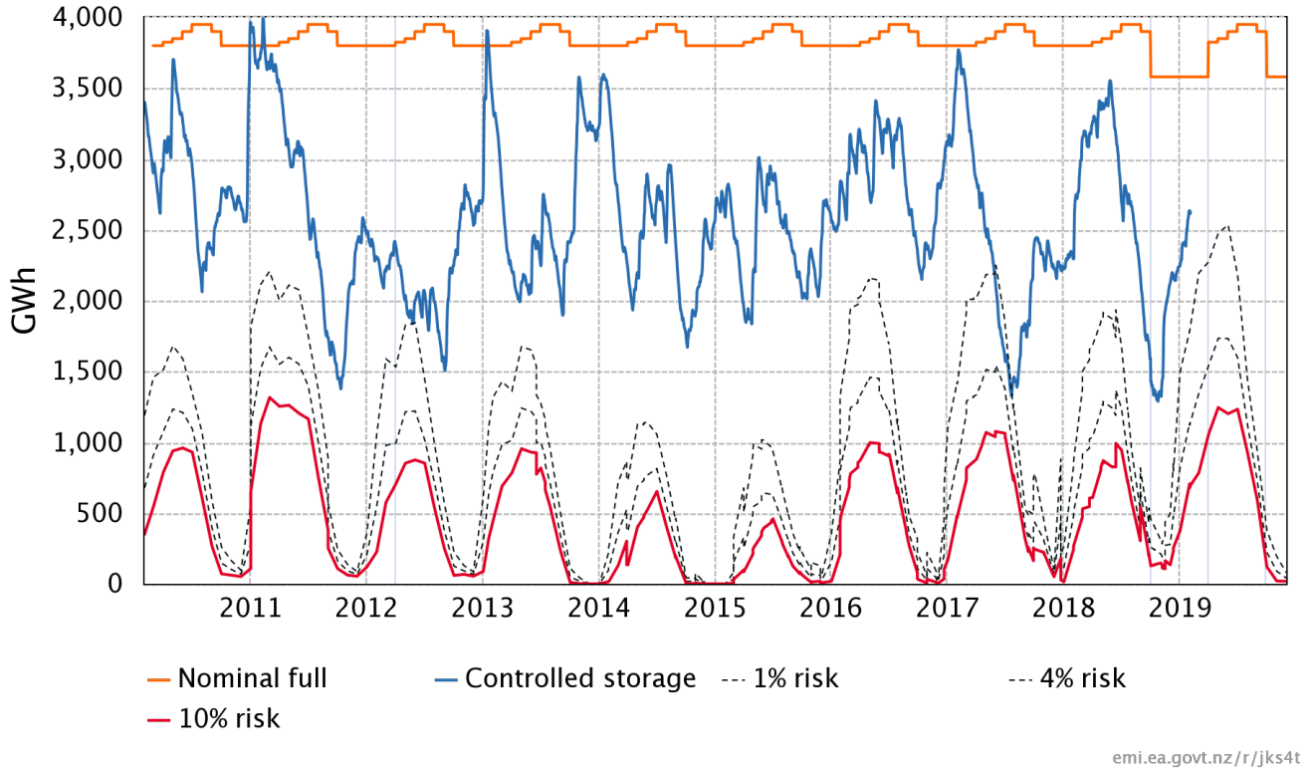
[5] https://www.transpower.co.nz/system-operator/security-supply/hydro-risk-curves

[6] https://www.transpower.co.nz/sites/default/files/bulk-upload/documents/Hydro%20Risk%20Curve%20Assumptions.pdf

2.4 Both the storage level, and the risk curves themselves, change over time

2.4.1 Clearly, actual storage fluctuates. Figure 3 shows how storage has tracked relative to the risk curves over the last decade.

Figure 3: Actual storage and risk curves since 2010



2.4.2 The forecasts of risk curves themselves also change over time, as a result of changes to assumptions. The system operator updates them at least monthly (more often when there is an elevated level of energy risk). Risk curves are never updated retrospectively.

2.4.3 Notably, the risk curves changed multiple times in late 2018 and early 2019, and are currently sitting at rather higher levels in 2019 than had been the case in 2018. The system operator has explained the reasons for these changes.[7] Key reasons were that:

(a) an additional potline was brought online at the Tiwai smelter

(b) the expected commissioning date for Junction Road (a 100 MW gas-fired generator) was pushed out from mid-2019 to 2020

(c) the system operator made a correction to its treatment of Lake Tekapo's contingent hydro storage.

[7] See https://www.transpower.co.nz/sites/default/files/bulk-upload/documents/HRC%20and%20SST%20update%20information%20-%20February%202019.pdf, https://www.transpower.co.nz/sites/default/files/bulk-upload/documents/HRC101%20-%20Impact%20of%20Assumptions.pdf

3. The simulated storage trajectories

3.1 The simulated storage trajectories predict market behaviour

3.1.1 The simulated storage trajectories (sometimes 'spaghetti diagrams') show how the level of stored energy (e.g. hydro storage) may change over the coming weeks to months. They take into account energy market dynamics and uncertainty about hydro inflows.

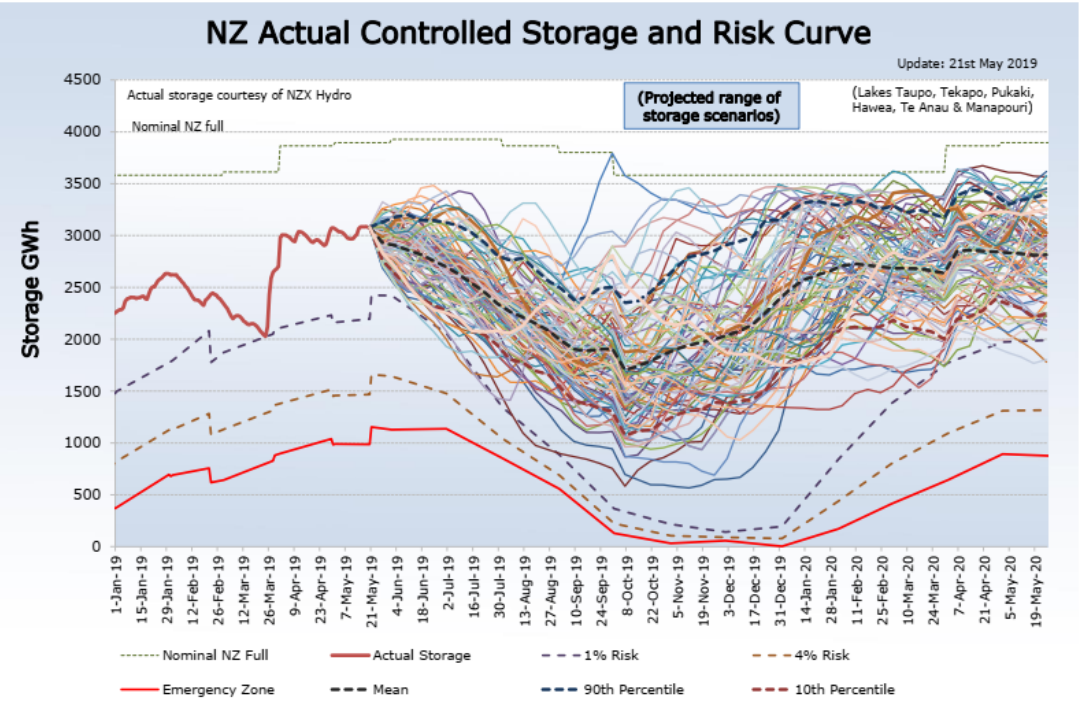
3.1.2 A key difference from the risk curves is that the simulated storage trajectories do not assume that all discretionary generation will act to conserve hydro storage.

3.1.3 The simulated storage trajectories attempt to predict how the wholesale electricity market would use historical inflow sequences and measure the impact on hydro storage. These predictions (the 'spaghetti') are overlaid against the 1%, 4% or 10% risk curves to give an estimate of the risk of storage falling below those risk curves.

3.1.4 The system operator prepares them to better inform stakeholders. They have no other policy function; they do not serve as the trigger for the system operator to take any action.

3.1.5 Figure 4 below shows a recent set of simulated storage trajectories for New Zealand as a whole, as published on Transpower's website.[8] The system operator also publishes them for South Island storage only.

Figure 4: Simulated storage trajectories for NZ as a whole, as of 21 May 2019



Source: Transpower NZ (https://www.transpower.co.nz/sites/default/files/bulk-upload/documents/Simulated%20Storage%20Trajectories.pdf)

8 https://www.transpower.co.nz/sites/default/files/bulk-upload/documents/Simulated%20Storage%20Trajectories.pdf