Introduction to the Electricity Risk Curves

Introduction

This series of 101s is aimed at helping participants better understand the Electricity Risk Curves (ERCs) and other elements of the security of supply framework. This first guide covers general information on the ERCs and explains how they are calculated.

We will also include some insight into the assumptions and modelling used to create the Simulated Storage Trajectories (SSTs).

A full set of historic ERCs can be found on the EMI website.

This 101 will outline the methodology used to derive the Percentage Risk Electricity Risk Curves. The Watch and Alert Curves are derived using a different method, more on this can be found here.

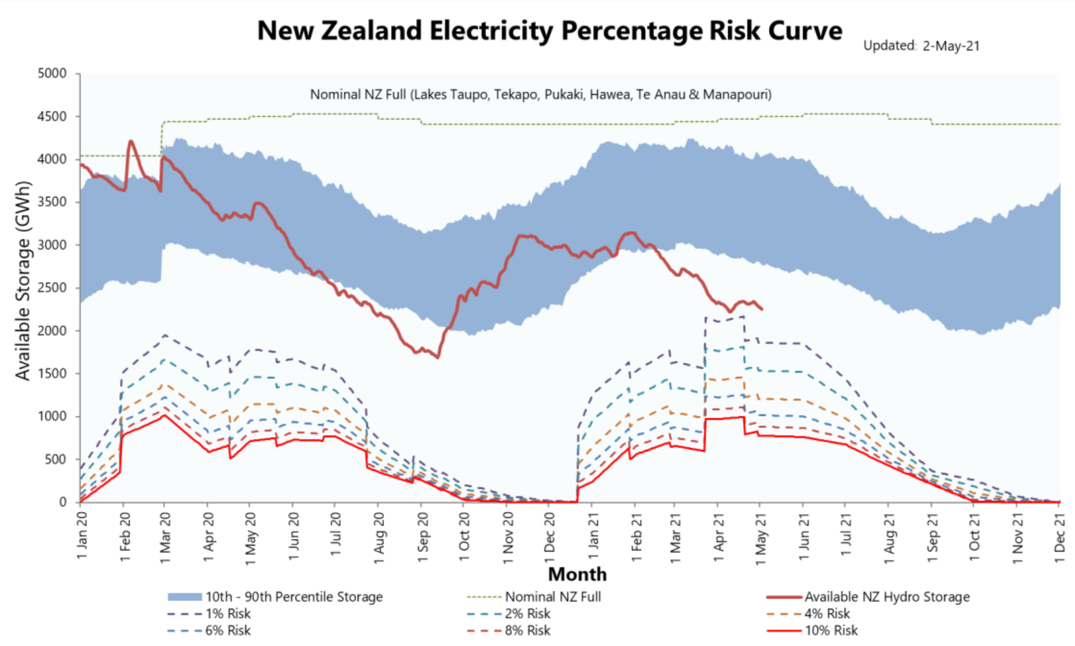
What are the ERCs?

The ERCs were developed in 2010, named Hydro Risk Curves or HRCs at this time, to reflect the risk of extended energy shortages in a straightforward way and using a standardised set of assumptions. The HRCs were renamed to acknowledge the role that fuels other than hydro storage have in the management of New Zealand's medium-term security of supply. Prior to 2010, a similar method of evaluating energy shortage risk was used by the then Electricity Commission; these were the "Minzone" charts.

The ERCs are updated monthly[1] to ensure the most up to date information is included in the model. They can be found on the Transpower website.

The ERCs show how stored hydro energy is tracking relative to a calculated risk of energy shortage. On the New Zealand Percentage Risk Curve below, available storage is tracked over time. As lake levels rise, the line marking storage moves up the graph and vice-versa. The dashed lines are the ERCs and represent the chance of energy shortage if hydro storage were to fall to that level. If storage were to reach the 1% ERC, this would mean that storage is at a level that, from then on, there is a 1% risk, based on historic inflow sequences of hydro storage dripping to zero. We produce charts for both New Zealand and the South Island on its own.

[1] Monthly as a minimum, will be updated fortnightly after crossing the 1% curve



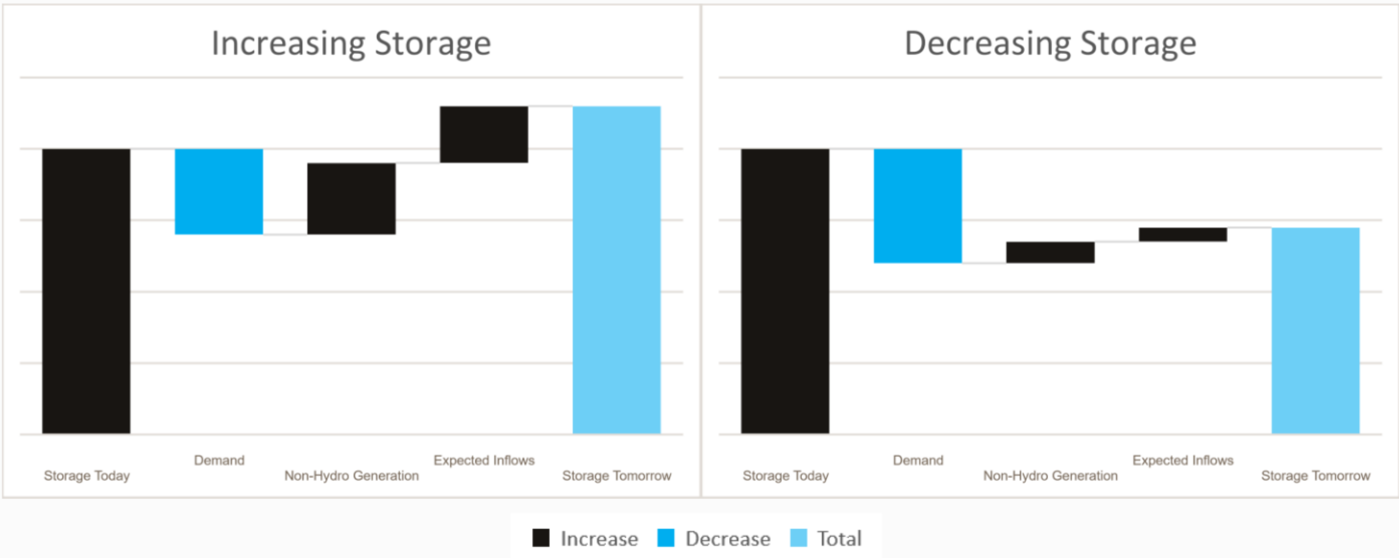
How are the ERCs calculated?

The ERCs are calculated using a simplified model of the current power system that predicts what future storage would look like if the inflows in the coming year were identical to historical inflow sequences. Potential future storage is calculated for each historical inflow sequence since 1931, to create a set of 89 possible future storage scenarios.

Estimating Future Storage

Future storage is calculated using the known capability of the power system; inflows to our storage lakes; assumptions on fuel availability for other types of generation and demand for electricity.

For example, storage at the end of tomorrow can be estimated by taking storage today, subtracting demand for tomorrow, then adding expected non-hydro generation and expected inflows for tomorrow. The waterfall chart below shows how this works under two scenarios: increasing storage and decreasing storage. This exercise can be repeated for each time period under investigation (for the ERCs this is 1-2 years) and for each hydro sequence.



Demand and Non-Hydro Generation

In addition to inflows, the chart above also implies two other very important factors:

- The amount of demand for electricity.
- The expected amount of non-hydro generation.

These three factors underpin the ERC analysis. The demand for electricity is forecast using a combination of econometrics incorporating drivers such as GDP growth, short term trends, long term trends and the Ministry of Business Innovation and Employment's Energy Demand and Generation Scenarios. This is covered in more detail here.

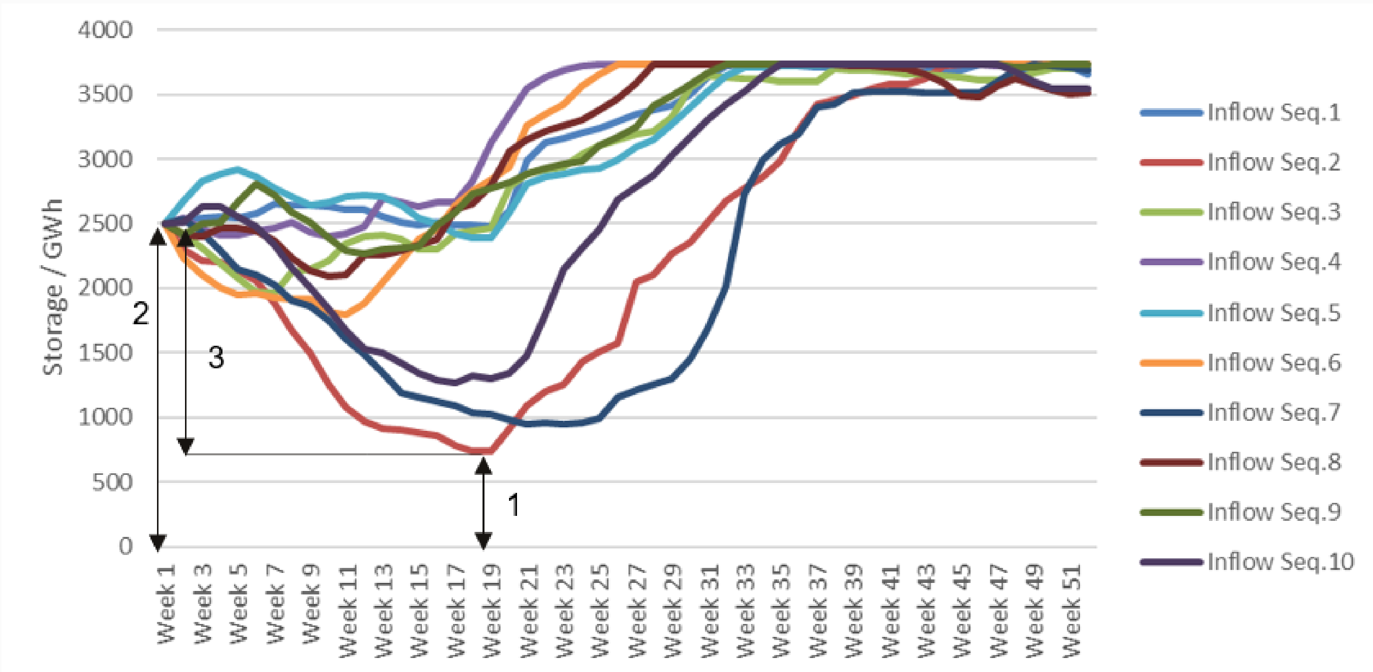
The expected amount of non-hydro generation is estimated using the physical attributes of the system; capacity of plant and estimated capacity factors, and the behaviour of market participants, both based on assumptions. For physical attributes, historical data is generally used as a good indicator of future attributes, unless further information is known; for example, a generator may notify us of planned expansion of their plant. For market behaviour, we adopt the defined standard set out in clause 6.1 (b) of the Security of Supply Forecasting and Information Policy: "[*The hydro risk curves must] assume market behaviour that seeks to minimise the use of hydro storage*".

These assumptions are primarily used to reflect the expected situation in an emergency; typically, hydro is not conserved at all times, but in an emergency very likely would be. Further detail on generation assumptions here.

Example Calculation

Once the future storage scenarios are estimated, we can see if or when the possible future storage scenarios drop to zero, and thus determine the 1%, 4% and 10% risks of shortage in the future. The image below shows a simplified version with the storage trajectories of 10 different inflow sequences. These storage trajectories, not be confused with Simulated Storage Trajectories, are the output of the model of the power system which models a full 12 months. From these trajectories we can see that if we subtract (1) from (2) we get a start storage position from which one trajectory would reach 0 GWh and lead to energy shortages. In this simplified version this would then set the 10% ERC, as 1 out of 10 sequences reaches 0 GWh. In reality, as well as having a larger number of sequences to deal with, we also use a smoothing function over the data to convert the number of inflow sequences to the percentage risk.

The example below represents the process to estimate the risk values for one month. In order to calculate risk values for each subsequent month over the next 1-2 years. The model runs many times, with each month having a different start storage.



This video also helps in the visualisation of this process.

ERC Assumptions

The risk curves are based on a set of assumptions, which are detailed in the latest ERC Input Assumptions document. Some of these assumptions are fixed, in particular:

- geothermal, co-generation, wind, and small hydro plant operate to expected levels
- storable inflows are conserved where possible
- all thermal plant operates at maximum capability to meet demand (capability includes a small forced outage percentage)
- forecast expected demand is reduced by 2% to reflect voluntary reductions in demand due to price
- historic inflow sequences are used to represent the range of possible future inflow sequences.

These assumptions are used because they provide a plausible (in an emergency scenario) and stable benchmark to assess risk when controlled storage levels are low. They may not be accurate when controlled storage is at, or above, average. For example, all thermal plant would not be expected to be operating during times of high hydro storage, which means that the ERCs are less realistic when controlled storage levels are high.

We update the ERCs each month and modify certain assumptions when new information becomes available, in particular:

- Demand forecast: typically updated at the start of each year when new historic data becomes available.
- Supply assumptions, including assumed capacities for each generator and generation profiles if utilised.
- Thermal fuel limitations, including any additional thermal de-rating due to supply constraints.
- Planned outages within the next two months or planned outages within the next eight months that cannot be deferred in an emergency situation.