14 October 2021

Tasmanian energy security scenario analysis

For Tasmanian Gas Pipeline (TGP)

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Overview

- TGP engaged ACIL Allen to conduct an analysis of the contribution Tamar Valley Power Station (TVPS) can be expected to make to Tasmania's energy security in future years.
- This slide pack is a summary of our October 2021 analysis and is provided to TGP in advance of a complete report which will contain a more detailed description of this analysis.
- This slide pack summarises the methodology used and the results of our analysis. It is in four parts:
  - Background to Tasmania's water storage management framework
  - Methodology used
  - Electricity supply results
  - Additional analysis of water storage levels in times of drought.

Background

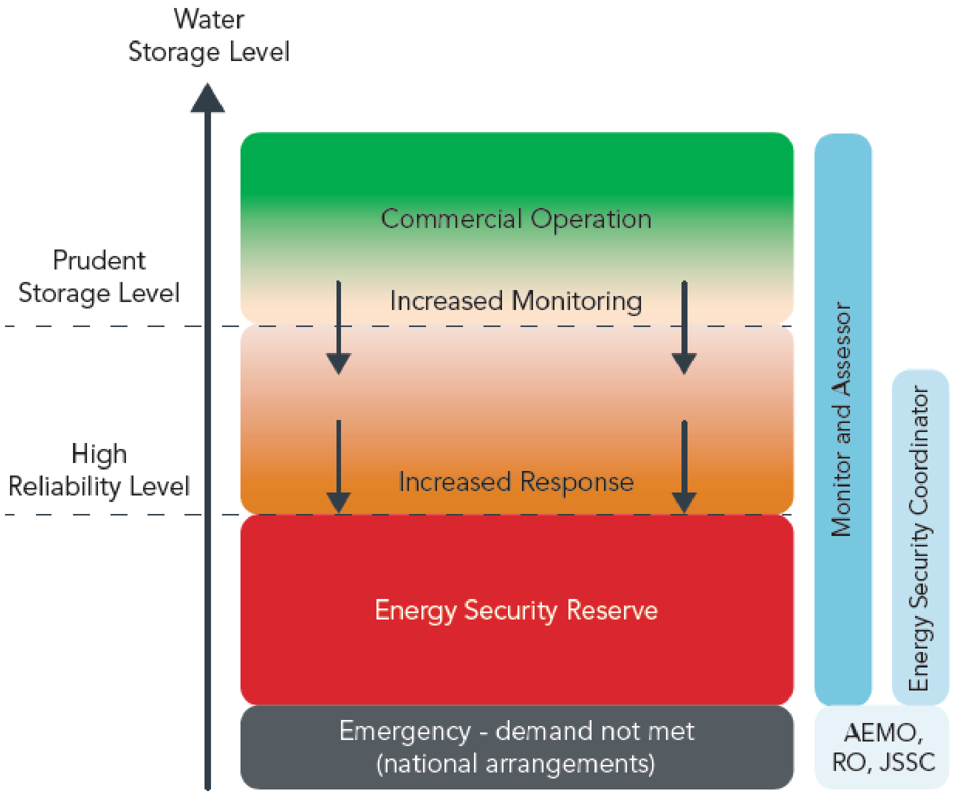
Tasmania’s energy security

Background

- In 2015-16 Tasmania experienced record low rainfall which coincided with a prolonged outage of the Basslink interconnector, leading to record low water storage levels for Hydro generation.
- The Tasmanian Government convened the Tasmanian Energy Security Taskforce to advise on how to improve energy security in the future.
  - *"Due to the dominance of hydro-electricity generation in Tasmania and the observed variability of rainfall, the volume of energy supply in Tasmania's water storages prevails as the most important factor in setting Tasmania's energy security." (Tasmanian Energy Security Taskforce, Final Report, June 2017).*
- Five key recommendations were made in 2017, including:
  - **Recommendation #3:** Establish a more rigorous and more widely understood framework for the management of water storages
  - **Recommendation #4:** Retain the TVPS as a backup power station for the present and provide clarity to the Tasmanian gas market.
- The devised water management framework includes two storage buffer levels which **vary by month** of the year:
  - Prudent storage level (PSL)
  - High reliability level (HRL).
- The HRL and PSL profiles were revised in September 2021 such that the HRL profile is on average 2 percentage points higher (the PSL profile is very similar to the 2017 profile).

Water management framework

- Water storage levels above the PSL relate to the *green zone*
  - Tasmania's water storages are high and the electricity supply is secure
  - Hydro Tasmania has more operational flexibility to pursue its commercial interests by generating electricity for export to the mainland.
- Below the PSL water storages are lower
  - the remaining water should be 'defended' to protect future energy security
  - exports are curtailed
  - TVPS could be used to contribute to meeting any residual energy requirements.



Source: Tasmanian Energy Security Taskforce Final Report, June 2017 (Figure 1.1)

Potential hydrogen projects

- There is interest in building green hydrogen plants in Tasmania from Fortescue Future Industries (FFI), Origin Energy, and Woodside Energy
  - with initial capacity ranging between 250 MW and 500 MW
- In June 2021, FFI announced that it had signed an Option Agreement with TasPorts to exclusively negotiate all land and operating access requirements for its proposed electrolyser plant in Bell Bay
- In September 2021 it was reported by the shadow minister for Energy that the Tasmanian Premier had intervened in FFI's negotiations with Hydro Tasmania for supply of power to the proposed plant, after FFI was advised that Hydro Tasmania could not provide the 250 MW of power.

- ACIL Allen's view is it will be difficult to produce green hydrogen at a competitive price in the near-to-medium term without government subsidy
  - Although this is not the focus of our analysis
- Given the Tasmanian Government's interest in a hydrogen project, we have included a project of 250 MW or 500 MW (two sensitivities) in the demand assumptions in our analysis
- The project's annual energy consumption will depend on the electricity supply contract it can secure and the subsidy it would receive. Since this is difficult to estimate, we have assumed a range of annual capacity factors: 50%, 75%, and 90%.

Model methodology

Model objective and inputs

- The objective is to analyse the probability that
  - the water available for electricity generation in Tasmania will fall below either, or both, of the PSL and HRL target levels
  - Tasmania's energy requirement will be satisfied, or whether there will be unserved energy.
- The model is run *twice*: once in the absence of TVPS, and then again with TVPS available. When TVPS is available, it is used only to prevent, or limit, shortfalls below PSL and HRL and in energy supply
- The difference in outcomes allows us to **quantify the contribution TVPS can be expected to make** to Tasmania's energy security[1].

- Monte-Carlo analysis is used to simulate Tasmania's hydro and wind generation
  - Half yearly basis to reflect seasonal water inflow patterns (~64% between July and December)
  - 10,000 annual simulations
  - Incorporate variability in
    - water inflows – based on past 70 years of actual data, with the mean of the distribution adjusted down in line with the past 24 years[2]
    - wind farm output – based on ACIL Allen's wholesale market modelling
    - Basslink availability – assuming a 1 in 10 year chance of a 6-month outage.

1: We note that this is not an economic analysis of the least cost solution for securing Tasmania's energy supply because it does not compare the cost of meeting supply shortfalls using TVPS with other options (including load shedding).

2: There has been a reduction in the average annual inflow in the past 20 or so years as compared to average annual inflow since 1950. To take this into account we have fitted a distribution to the full data set (from 1950) and adjusted the expected value of this distribution downward to reflect the lower average inflow in the period from 1997.

Model assumptions

- This analysis is based on an 'energy balance' model of the Tasmanian electricity sector and uses a single pond approach to modelling hydro generation
  - We model hydro generation on the basis that there are no constraints within Tasmania's hydro system on power delivery, provided there is sufficient water in storage in aggregate to meet energy requirements
  - We do not take account of spillage within each of Hydro's catchment areas, but we consider this at a whole of hydro system level
  - Nor does the model consider the generation sector's ability to meet peak demand, which the Taskforce found that it can do comfortably - scheduled hydro capacity in Tasmania is over 2,200 MW, well in excess of Tasmania's scheduled peak electricity demand of about 1,670 MW.
- This analysis is performed for a year in the near-term future
  - It assumes Tasmania's energy requirements remain at current levels, aside from the inclusion of the hydrogen project (in the relevant scenario)
  - It assumes no further investment in generation beyond the current tranche of committed wind farm developments
- In the scenarios including the hydrogen plant, TGP has requested us to assume that no further development in generation occurs or is brought forward, in response to the additional energy requirements of the hydrogen plant.

Model output

- There are four possible outcomes from the Monte Carlo analysis
  - And TVPS plays a different role depending on the outcome.

Outcome	Description	Role of TVPS
1	Supply all electricity demand AND meet all storage targets	Not used
2	Supply all electricity demand, but fall short of PSL but not HRL (final storage level between PSL and HRL)	'Defend' PSL and enable exports
3	Supply all electricity demand, but fall short of HRL (and therefore also PSL)	Defend HRL
4	Fail to supply all of electricity demand – loss of load/ unserved energy experienced	Keep the lights on[1]

1: In a small number of simulations, TVPS' generation capacity reduces unserved energy but is insufficient to prevent all unserved energy.

Modelled results

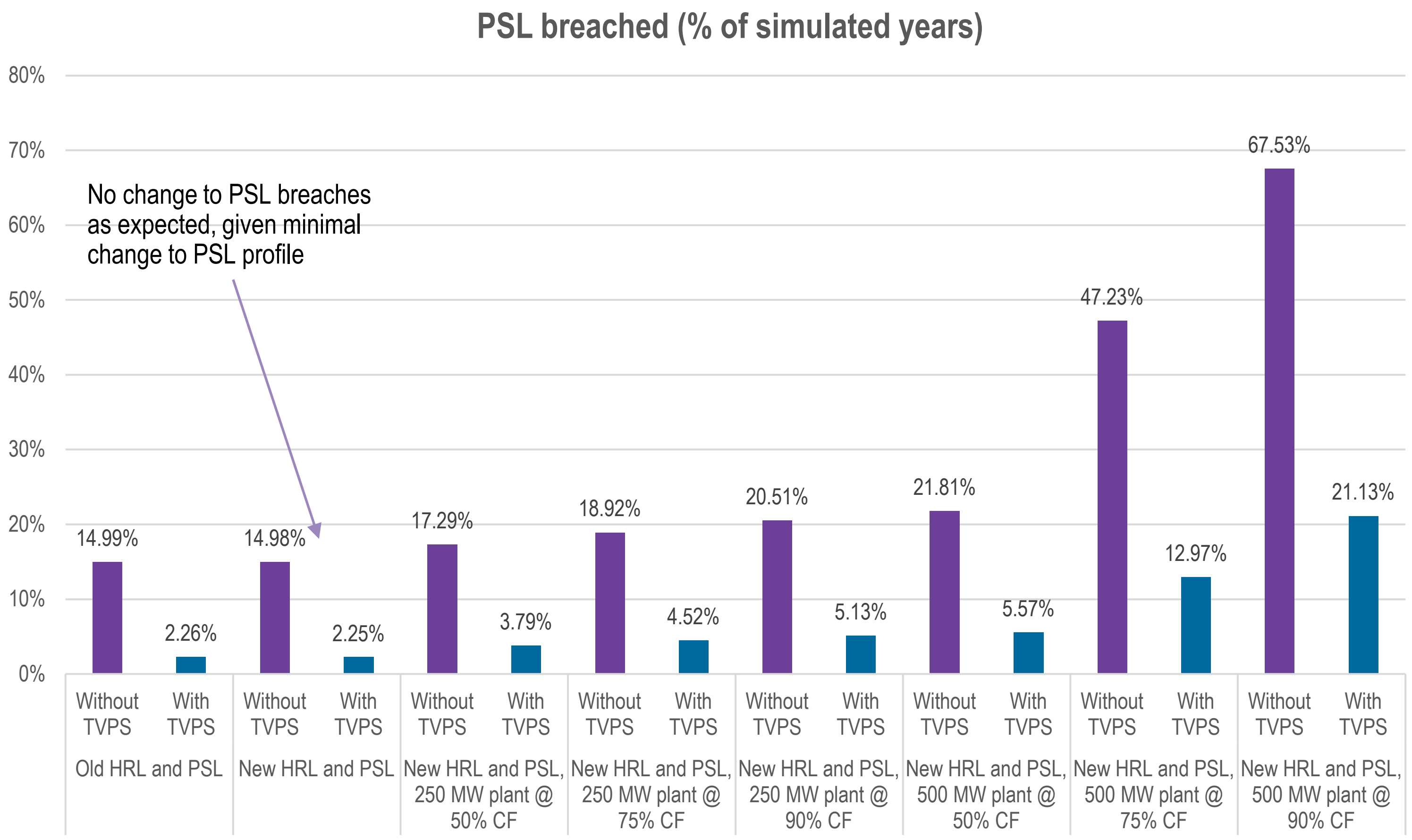
Overview

- The following slides summarise the modelled results for a number of scenarios, including:
  1. Current Tasmanian supply/demand balance, with 2017 (old) HRL and PSL profiles
  2. Current Tasmanian supply/demand balance, with 2021 (new) HRL and PSL profiles
  3. As for #2, with the addition of a 250 MW hydrogen project at varying capacity factors (50%, 75%, 90%)
  4. As for #2, with the addition of a 500 MW hydrogen project at varying capacity factors (50%, 75%, 90%)

  In each scenario, two sensitivities were run: one with and one without the availability of TVPS.
- The results shown include:
  - Frequency of breaches of the PSL
  - Frequency of breaches of the HRL
  - Frequency of breaches of the NEM reliability standard

Results – PSL breaches

- The inclusion of the new HRL and PSL profiles had no impact on PSL breaches – which is as expected given the very minimal change in PSL profile
- As expected, the larger the hydrogen plant and the higher its capacity factor, the more frequently the PSL is breached
- Without investment in additional wind farms or Marinus Link, TVPS, when available, plays an important role in conserving water storage levels above the PSL, materially reducing the number of breaches.



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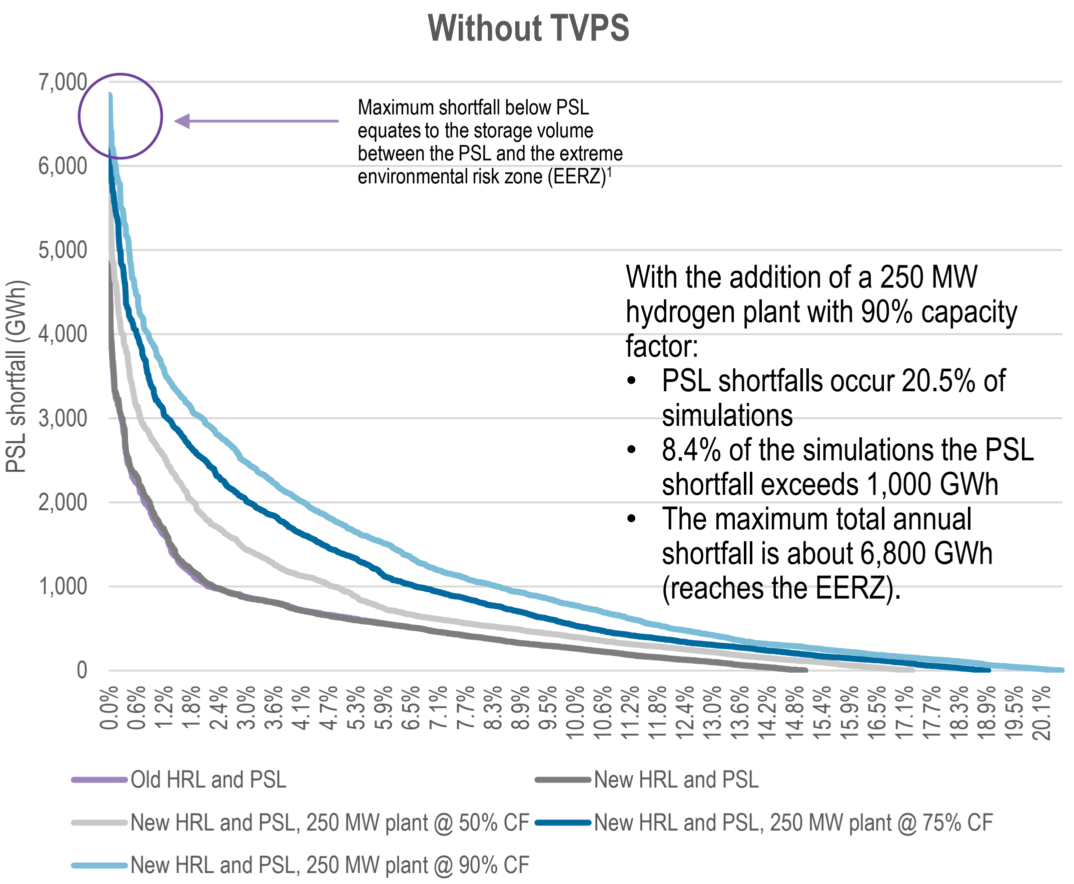
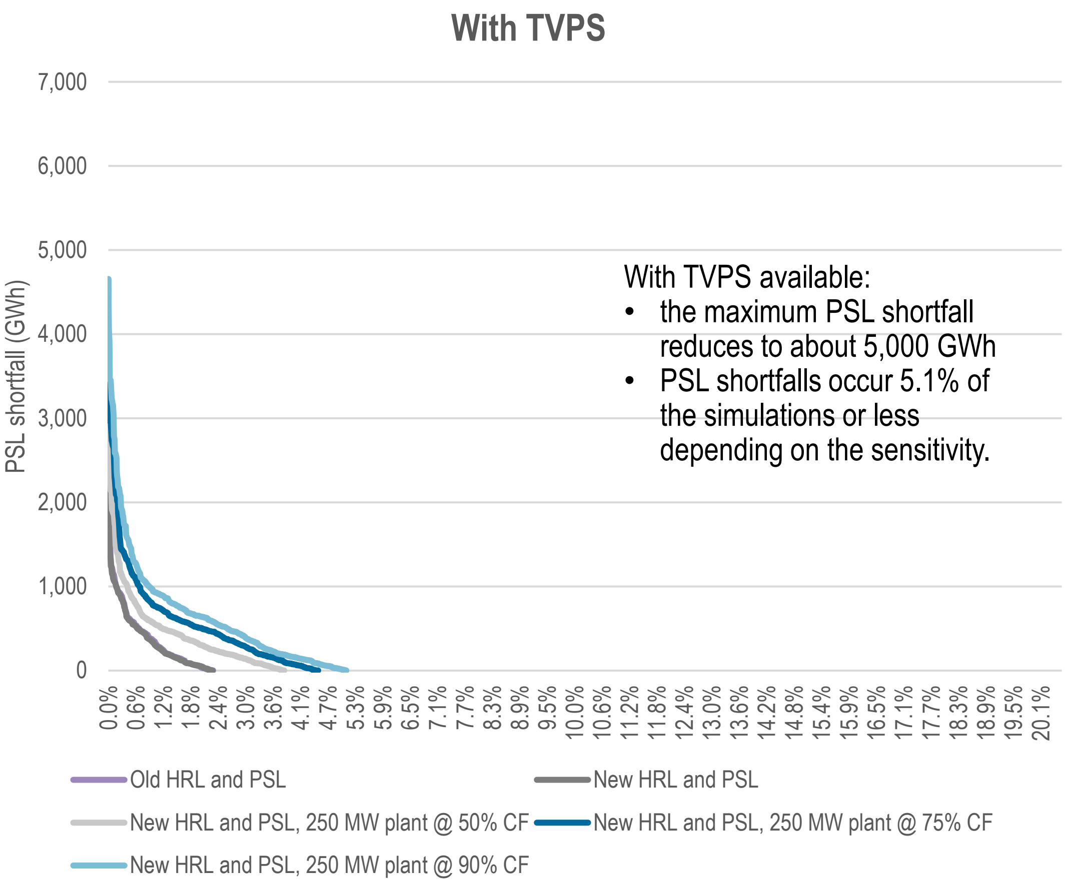
Results – PSL breaches (duration curves)

Without hydrogen plant (old and new HRL & PSL); 250 MW hydrogen plant sensitivities

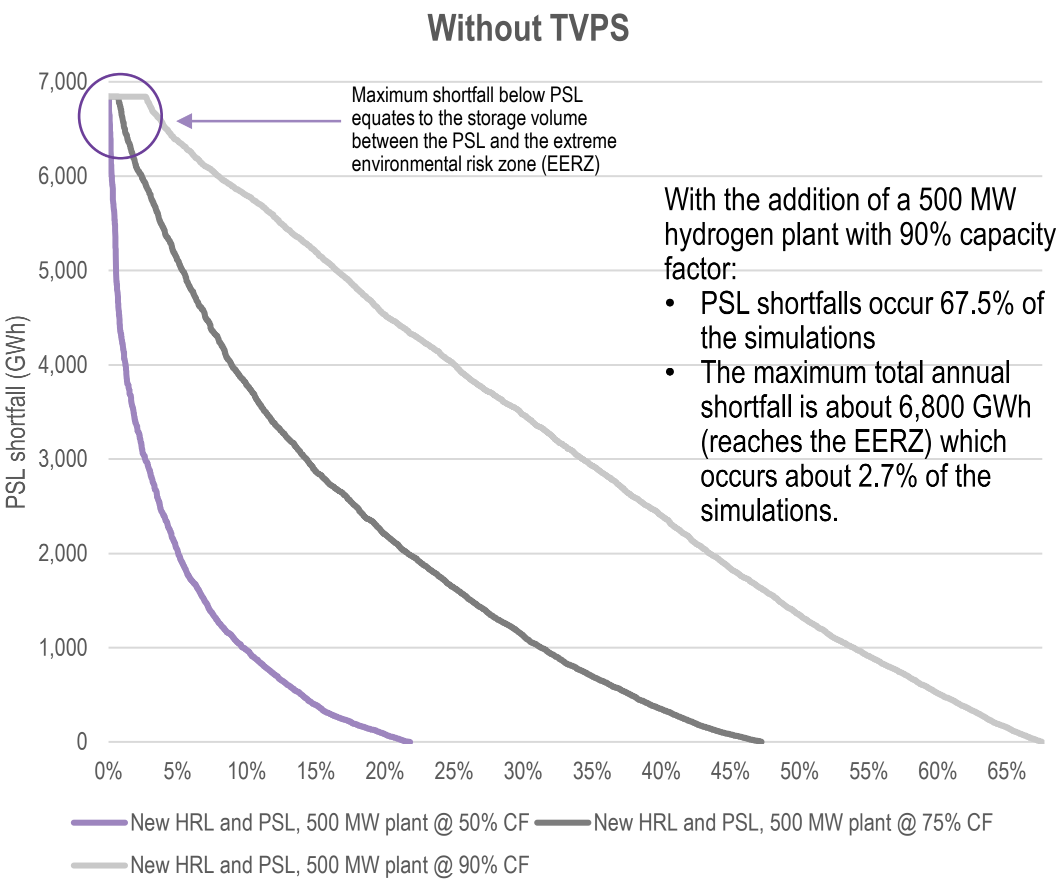


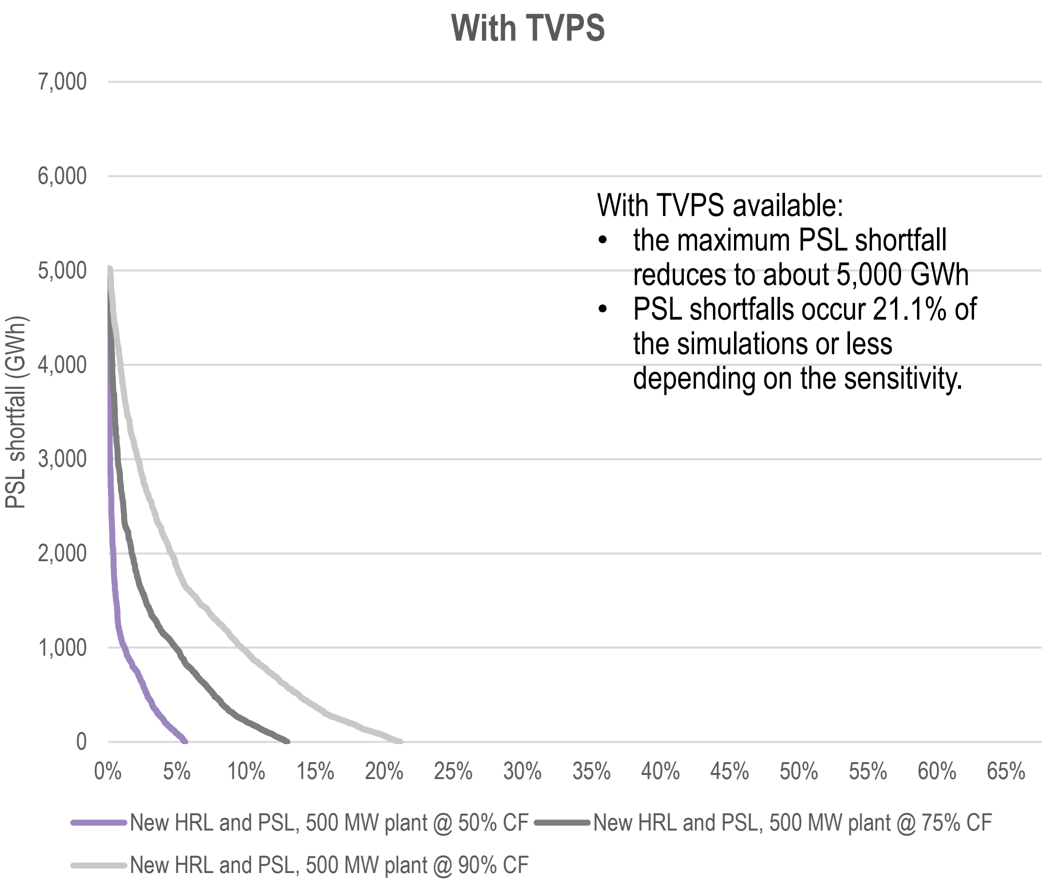


1: EERZ is assumed to be entered when energy in storage is at about 10 per cent of total storage capacity.

Results – PSL breaches (duration curves)

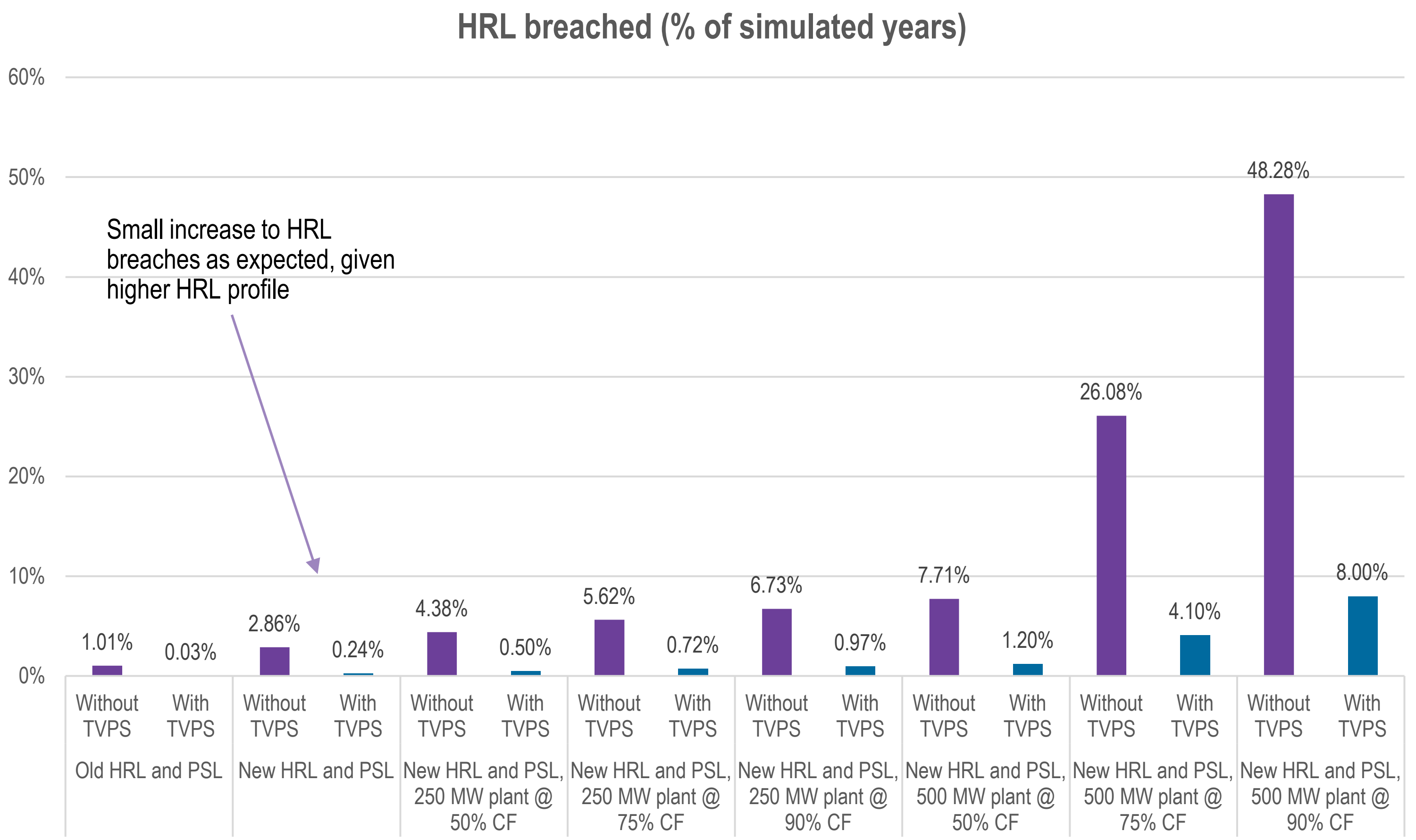
500 MW hydrogen plant sensitivities





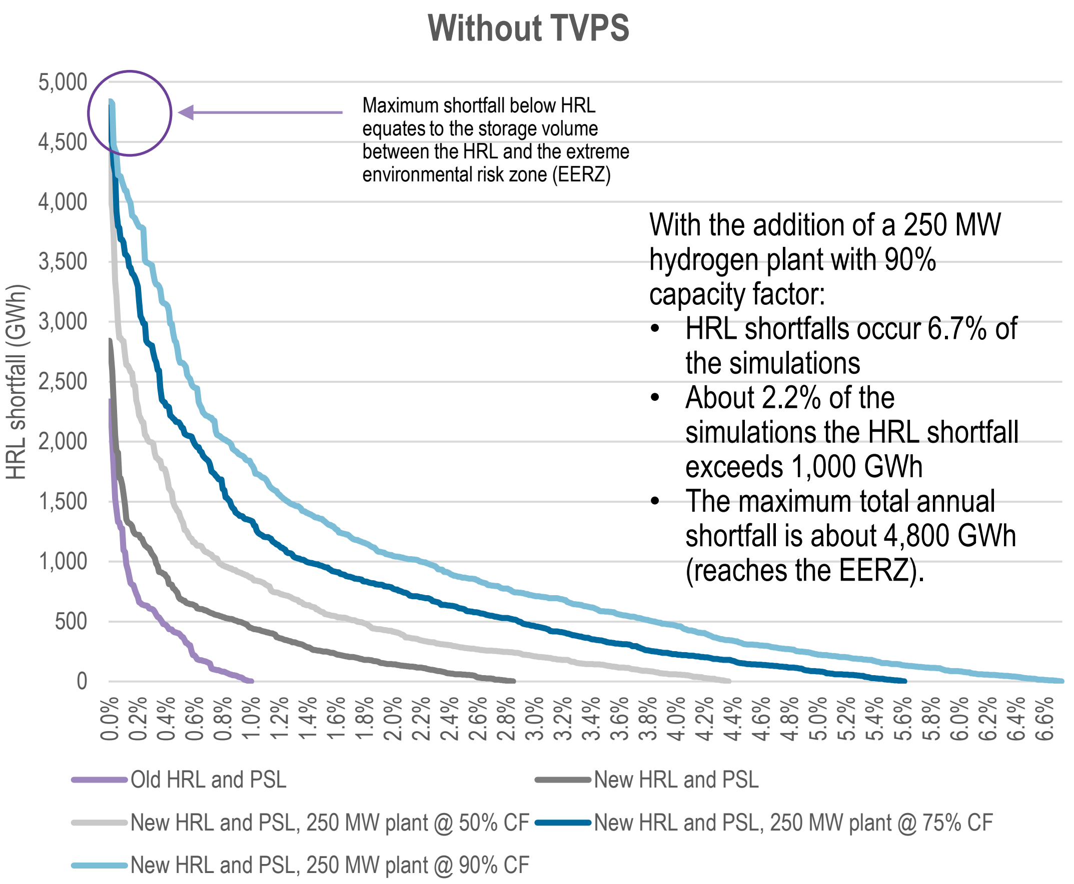
Results – HRL breaches

- The inclusion of the new HRL and PSL profiles had a small impact on HRL breaches due to the higher HRL profile
- The HRL is breached up to 48% of simulations in the scenario with a 500 MW hydrogen plant and a 90% capacity factor
- Without investment in additional wind farms or Marinus Link, TVPS plays an important role in conserving water storage levels above the HRL



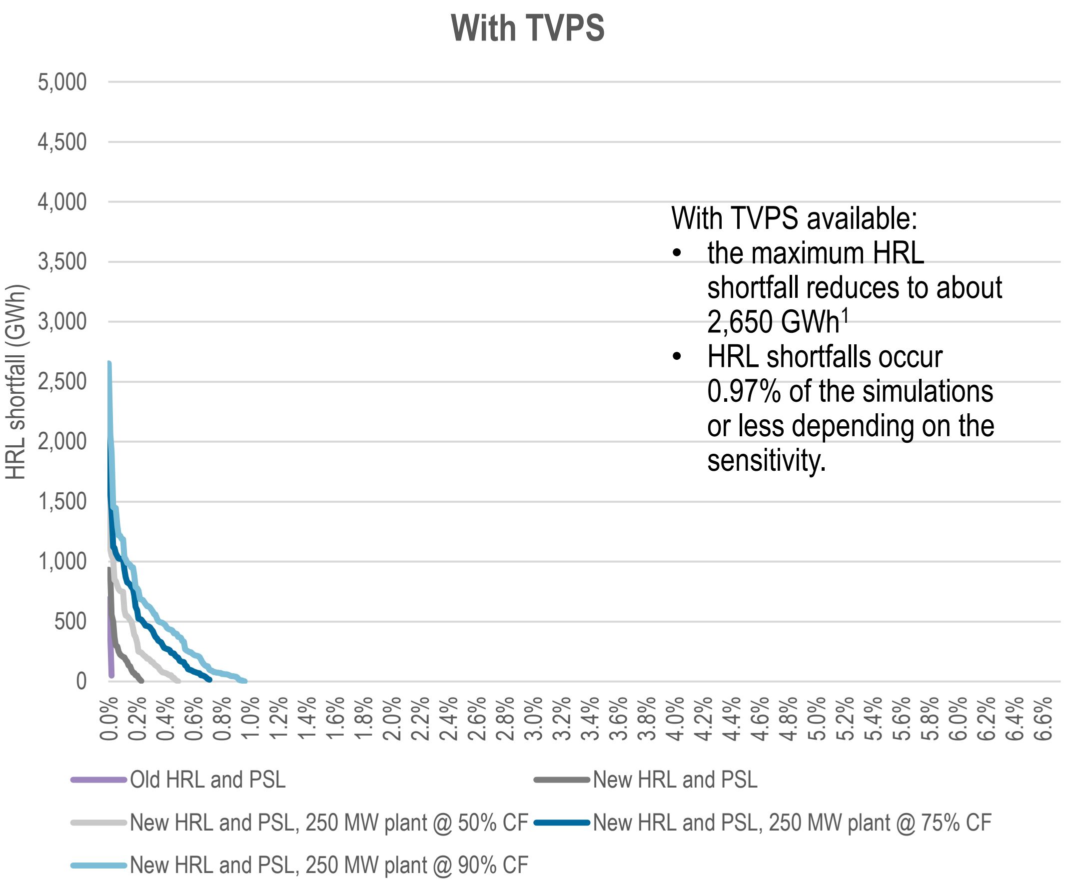
Results – HRL breaches (duration curves)

Without hydrogen plant (old and new HRL & PSL); 250 MW hydrogen plant sensitivities



With the addition of a 250 MW hydrogen plant with 90% capacity factor:

- HRL shortfalls occur 6.7% of the simulations
- About 2.2% of the simulations the HRL shortfall exceeds 1,000 GWh
- The maximum total annual shortfall is about 4,800 GWh (reaches the EERZ).

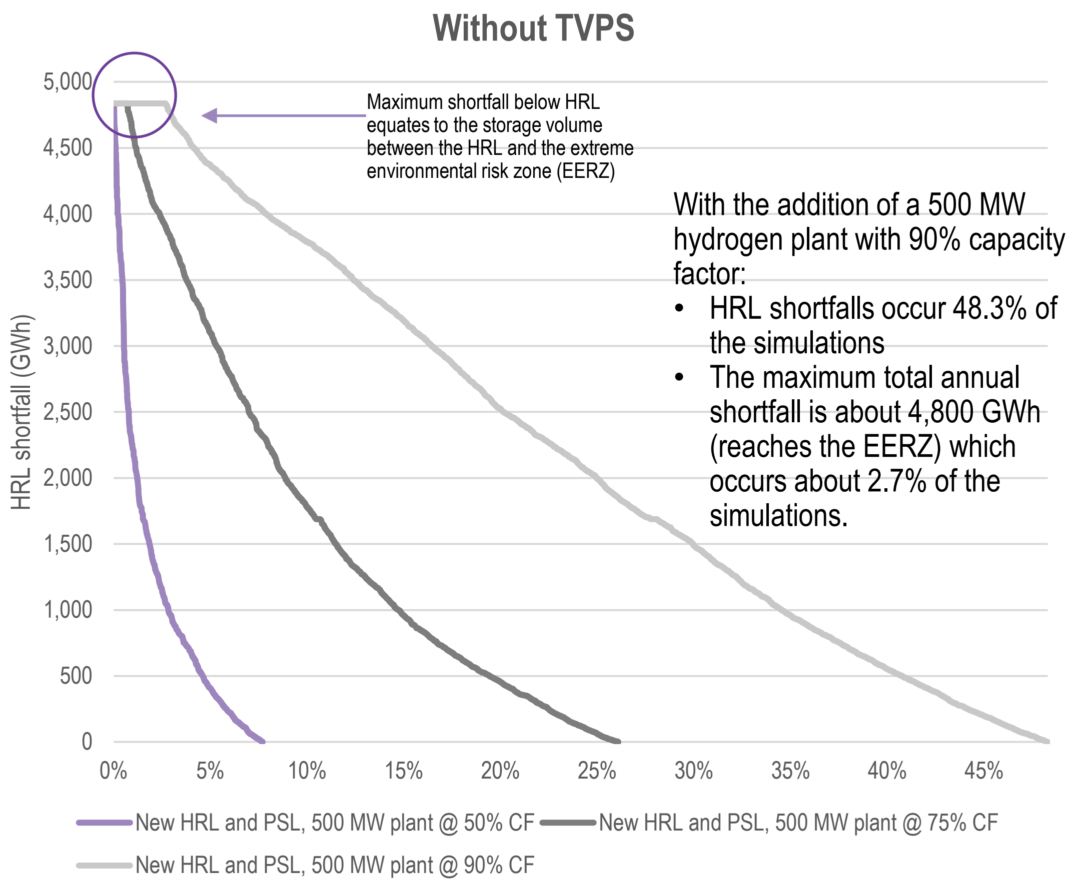


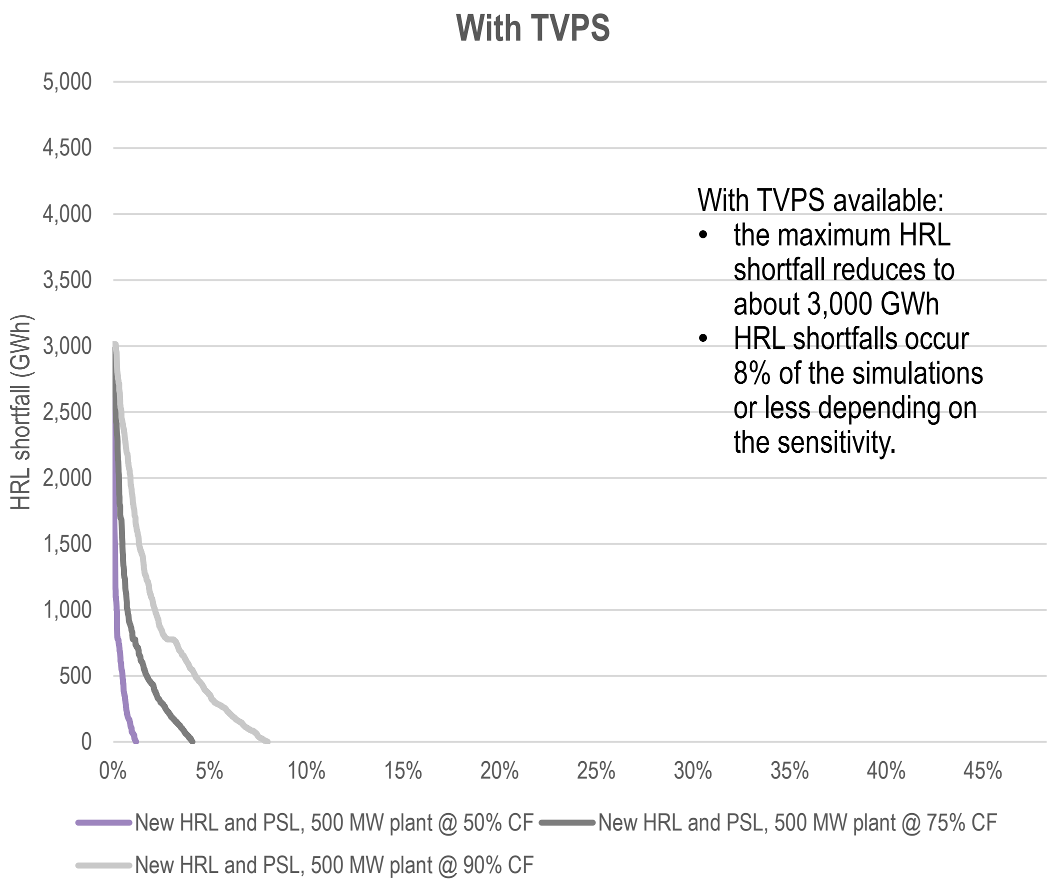
With TVPS available:

- the maximum HRL shortfall reduces to about 2,650 GWh[1]
- HRL shortfalls occur 0.97% of the simulations or less depending on the sensitivity.

Results – HRL breaches (duration curves)

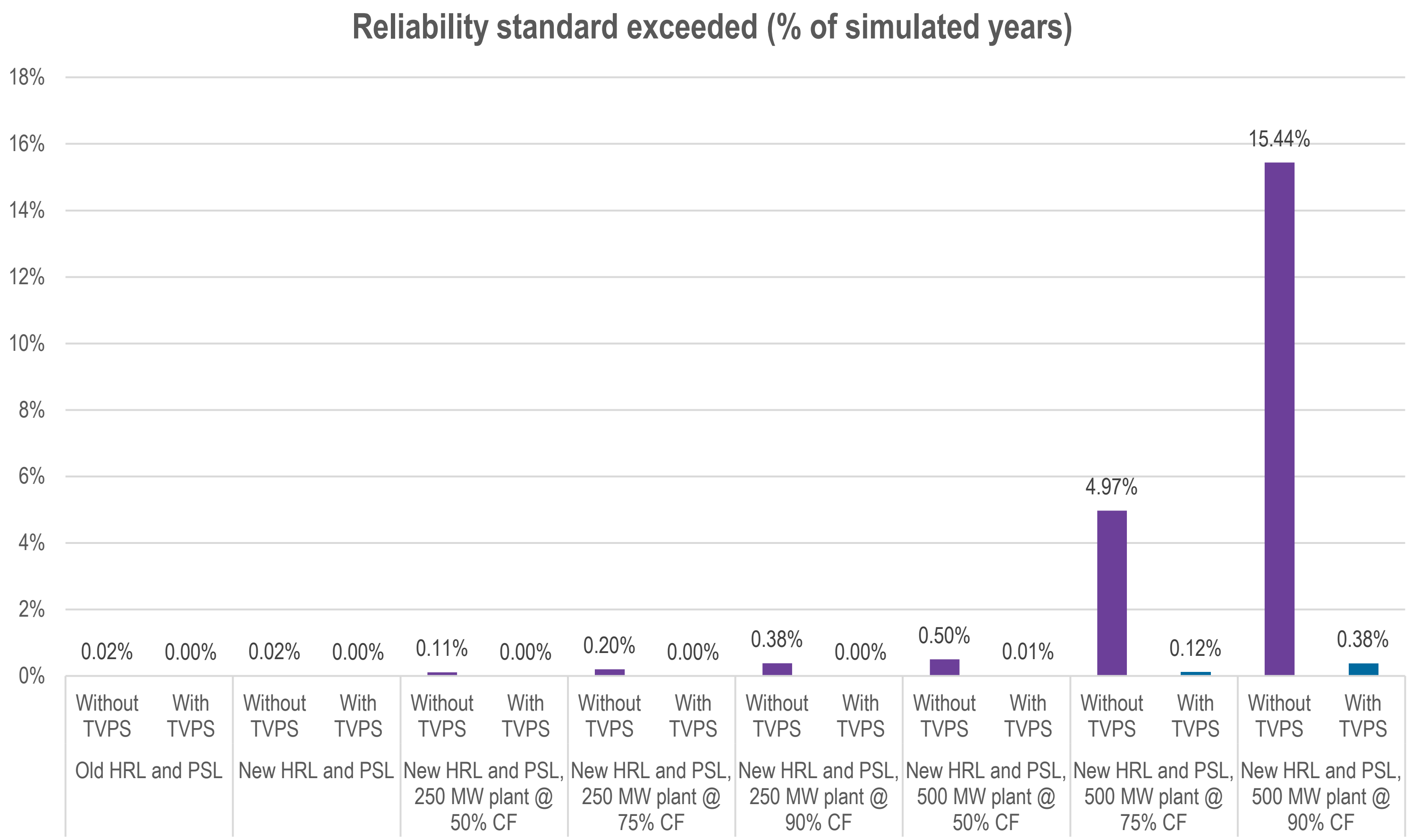
500 MW hydrogen plant sensitivities





Results – reliability standard breaches

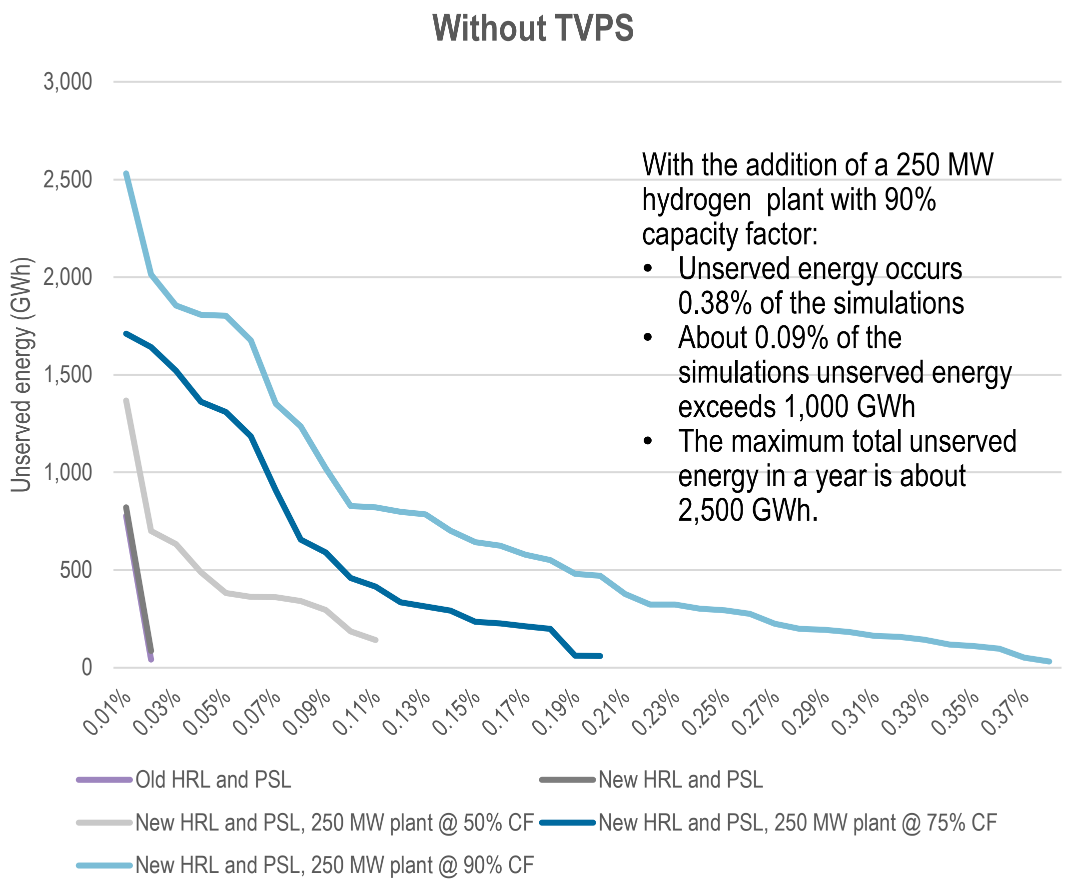
- We also assessed the occurrence of **unserved energy** and how frequently the reliability standard (0.002 % of annual demand for electricity in Tasmania) is breached across the 10,000 simulations.
- Any simulation in which unserved energy occurred, **both** the reliability standard and the interim reliability standard (0.0006 %)[1] **were breached** – this is because **unserved energy occurs as a direct result of a Basslink outage**. Without access to the interconnector, unserved energy breaches the reliability standards.
- With an additional 500 MW hydrogen plant, the reliability standard is projected to be exceeded between 0.5% and 15.4% of simulated years
- TVPS, when present, reduces these breaches substantially.



1: The energy market operator is currently applying an interim reliability measure of 0.0006% until 30 June 2025.

Results – unserved energy (duration curves)

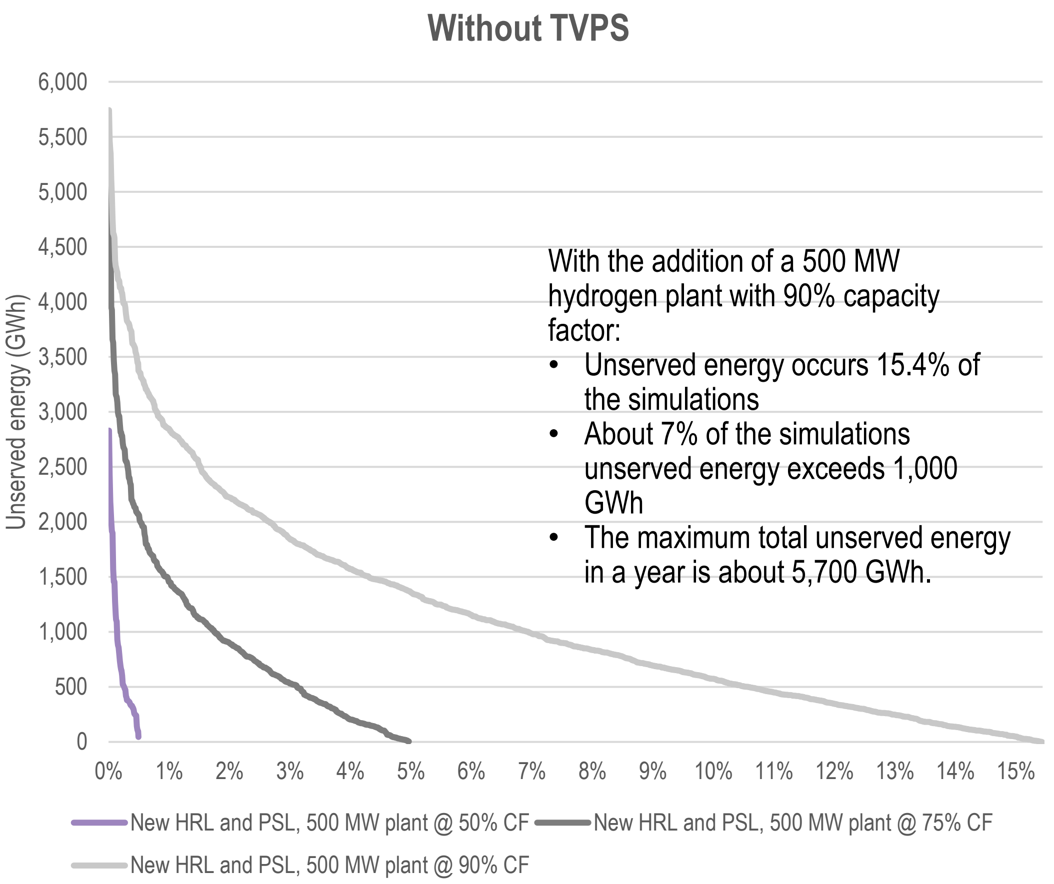
Without hydrogen plant (old and new HRL & PSL); 250 MW hydrogen plant sensitivities

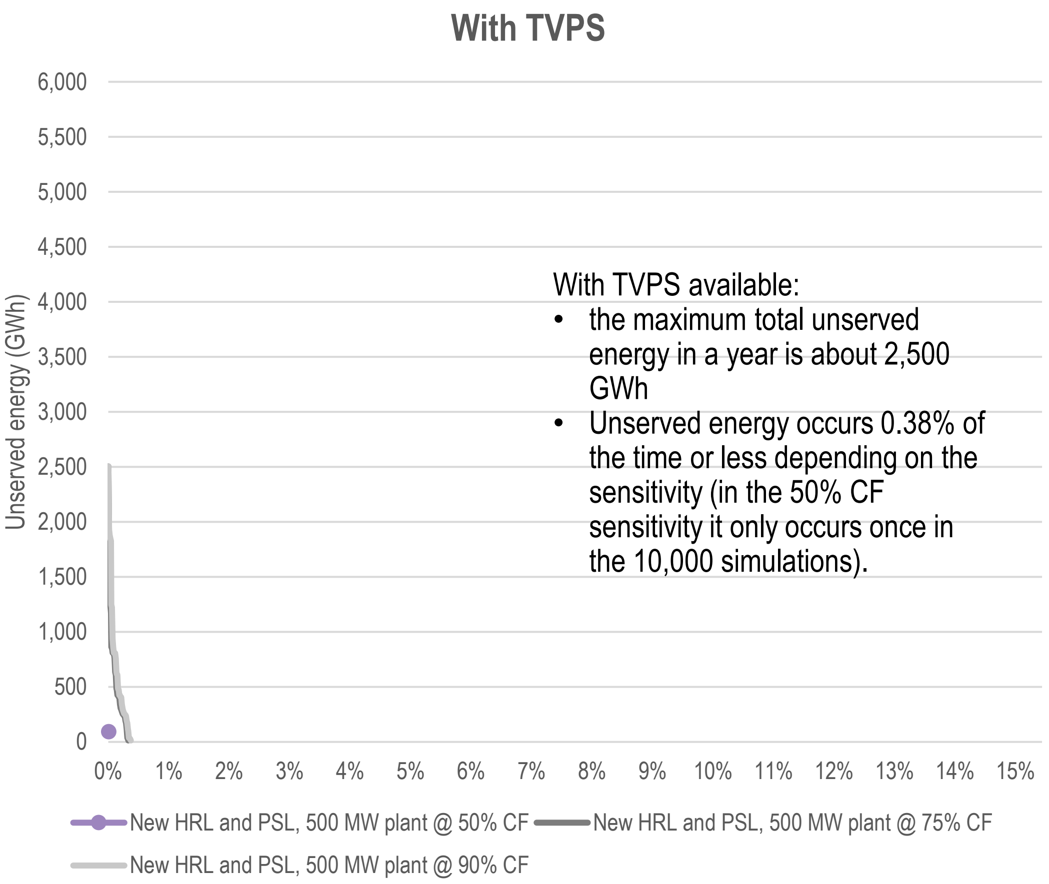


- No unserved energy occurs in these sensitivities when TVPS is available

Results – unserved energy (duration curves)

500 MW hydrogen plant sensitivities





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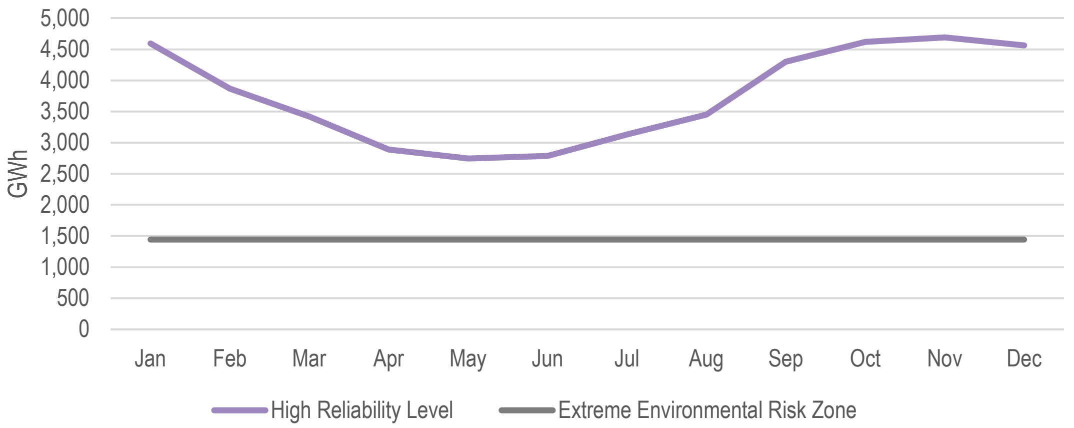
Additional analysis

How long could water storage levels last beyond the HRL in a time of drought during a six-month Basslink outage?

How long could water storage levels last beyond the HRL in a time of drought during a six-month Basslink outage?

- TGP requested ACIL Allen conduct an analysis to determine how many months Hydro's water storage levels could last before entering the extreme environmental risk zone (EERZ) which is assumed to be about 10 per cent of the total storage capacity (14,437 GWh), assuming that:
  - A six-month Basslink outage occurs
  - It is during a period of drought – little or no water inflows
  - Water storage levels are at the HRL at the time the outage occurs
  - POE 50 (median) wind dispatch
  - TVPS is not available (and there are no other emergency energy supply measures).



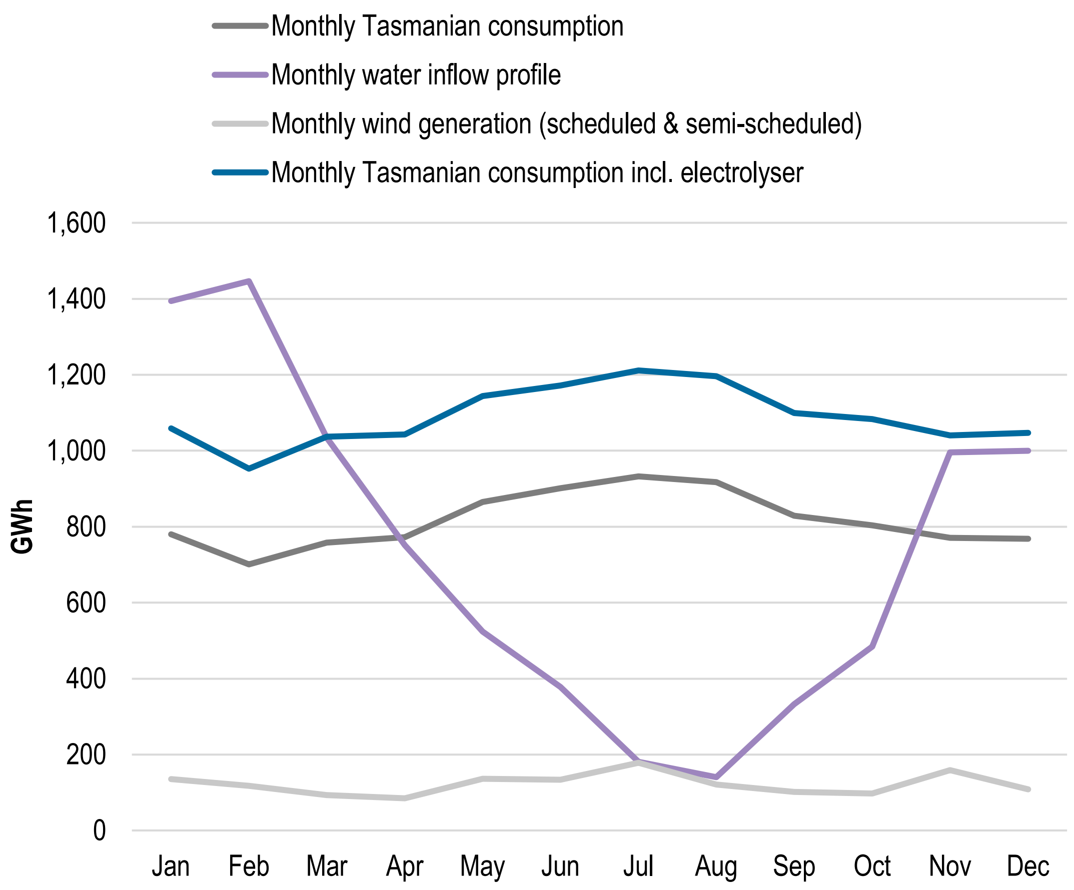
- This analysis is performed for a year in the near-term future
  - It assumes Tasmania's energy requirements remain at current levels, aside from the inclusion of the hydrogen project (in the relevant scenario)
  - It assumes no further investment in generation beyond the current tranche of committed wind farm developments
- In the scenario including the hydrogen plant, TGP has requested us to assume that no further development in generation occurs or is brought forward, in response to the additional energy requirements of the hydrogen plant.

Our approach

- The energy balance model used to obtain the results in the preceding slides is not suitable for this analysis as it operates at a six-monthly resolution
- Instead, ACIL Allen has made some simplifying assumptions about the monthly water inflows, monthly wind dispatch and the monthly Tasmanian electricity consumption and calculated **a range of possible outcomes**
- We have conducted this analysis for **two scenarios**:
  - where there is no hydrogen plant (i.e. the current Tasmanian supply-demand balance)
  - where a 500 MW hydrogen plant is built which is assumed to run at an annual capacity factor of 75 per cent.
- We present results for **three sensitivities** to water inflows:
  - Zero inflows
  - 5% of annual inflows
  - 10% of annual inflows.

Assumptions

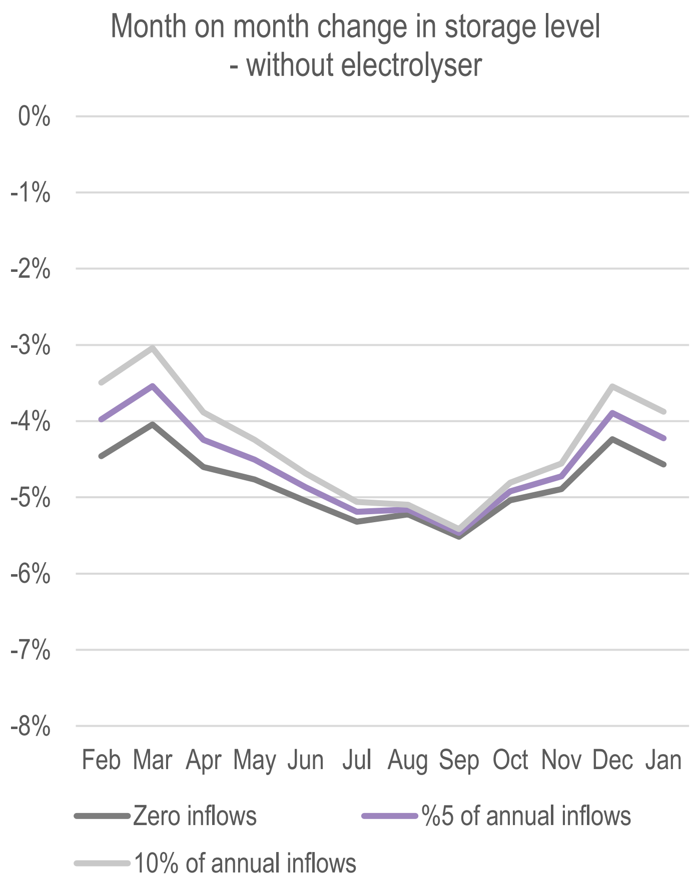
- The average monthly **Tasmanian consumption** profile was calculated from historical data spanning January 2015 to August 2021. Note that Tasmanian consumption is greatest in winter. Total annual consumption is assumed to be 9,800 GWh[1].
- The monthly **water inflow** profile was taken from AEMO's July 2021 Input Assumptions and Scenarios Report (IASR) workbook. Note that the lowest inflows occur in winter. Total annual water inflow is assumed to be 8,663 GWh (average across estimated annual inflows between 1997 and 2020).
- The monthly **wind generation** profile for scheduled & semi-scheduled farms (Musselroe, Granville Harbour and Cattle Hill) is estimated from historical generation[2]. It represents a POE50 (median) generation profile and total annual dispatch is 1,470 GWh.
- The 500 MW **hydrogen electrolyser** is assumed to run as a **flat load** across the year at 75 per cent capacity factor (total of 3,285 GWh).

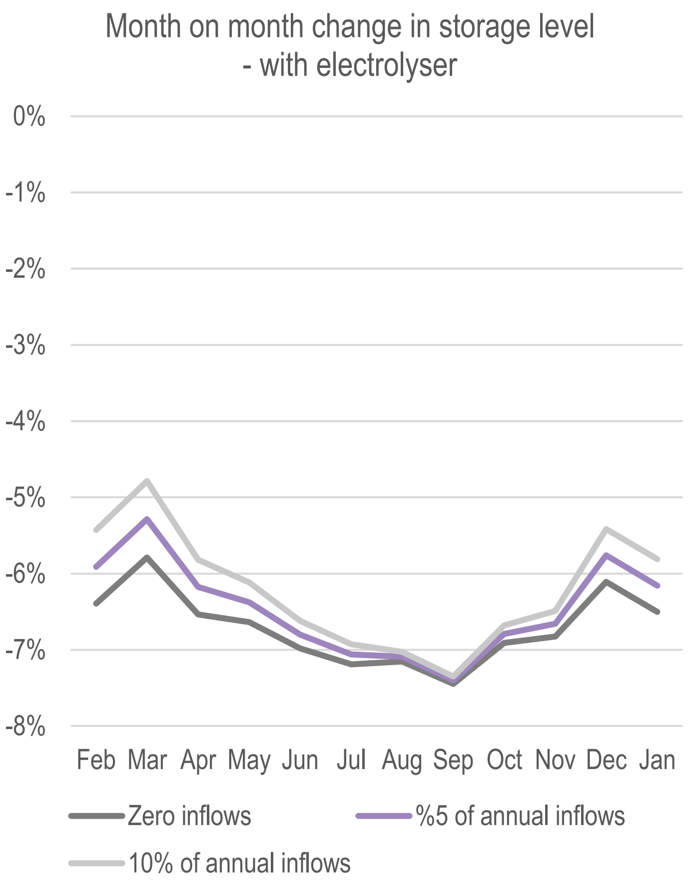


1: Note that this is consumption met by scheduled and semi-scheduled generation, so excludes demand met by behind-the-meter rooftop PV for example.
2: Since modelling scheduled and semi-scheduled demand only, the non-scheduled Woolnorth WF is already accounted for. Also note that this generation profile does not assume any network or commercial curtailment of dispatch i.e. assumes all available wind resource is dispatched into the market.

Results – month on month reduction

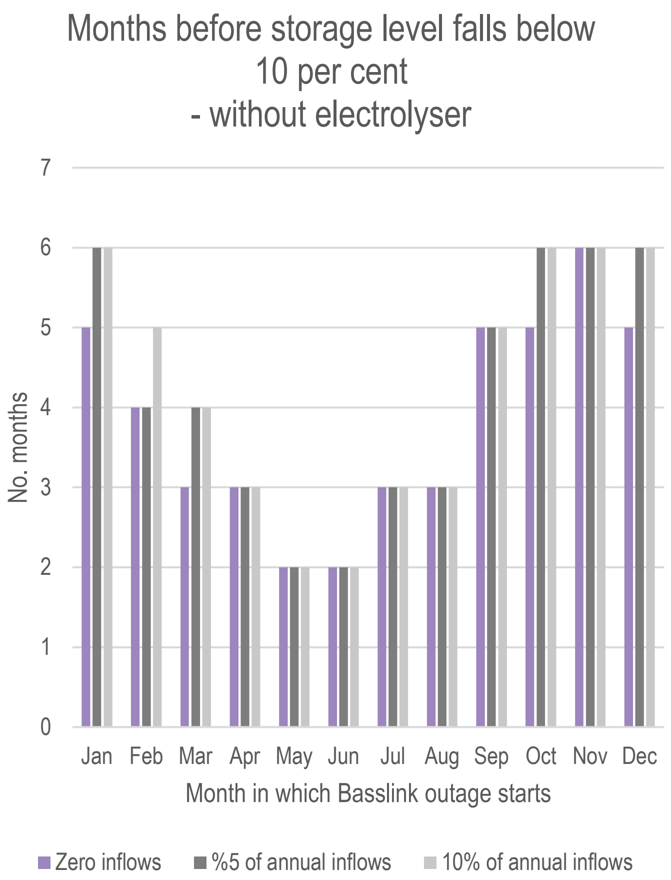
- The month-on-month (MoM) percentage reduction in total water storage level is a function of the assumed monthly wind generation, monthly water inflow and monthly Tasmanian energy consumption
- The MoM reduction varies depending on:
  - The month: greatest reductions occur in the winter months when lower inflows coincide with higher electricity consumption
  - The assumed inflows: higher inflows mean lower MoM reductions, particularly in summer when monthly water inflows are higher
  - The addition of a 500 MW hydrogen electrolyser: which increases the MoM reductions

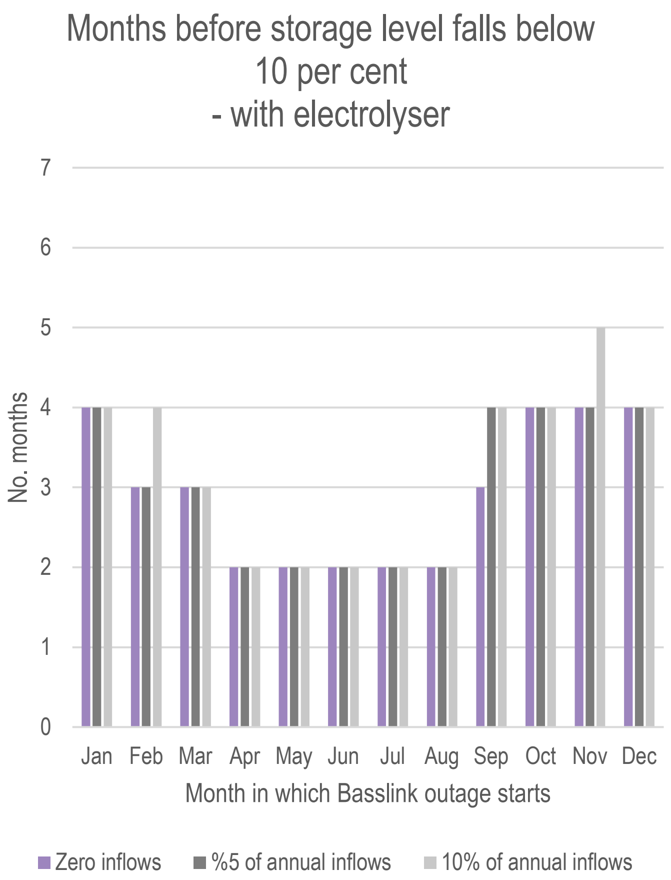




Results – months before storage falls to EERZ

- Depending on the time of year that the six-month Basslink outage occurs, the total storage level can take between 2 and 6 months to fall from the HRL to below 10 per cent (the EERZ), noting that the HRL is lower in the spring months
- Without the hydrogen project, energy security is most at risk if the outage commences in May or June when it would take **2 months (or less[1])** to fall to the EERZ – assuming 10% of annual inflows or less
- With the addition of the hydrogen project, this window widens to April-August, indicating an increased risk that the storage levels will fall to the EERZ.





1: This analysis has been conducted at a monthly resolution. A similar analysis at a finer resolution (e.g. weekly) would show that in some instances the time until storage levels fall to 10% is between 1 and 2 months.

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