Joint Select Committee on Energy Matters – Tuesday 10 March 2026

SYSTEM YIELD PROJECTIONS

Hydro Tasmania experiences year-on-year variability in its system energy yield and historical data indicates a slight downward trend that is projected to continue.

Hydro Tasmania partnered with CSIRO to upgrade the full spectrum of inflow predictions including short term, medium, and long-term projections. This paper focuses on the long-term component, introducing the Trend and Uncertainty in Long Inflow Predictions ('TULIP') model as a significant outcome of this collaborative effort.

TULIP is a Bayesian model[1] developed to overcome modelling limitations by incorporating several sophisticated statistical methods. The model has been developed with CSIRO. TULIP produces more reliable long-range projections than is possible if a static climate is assumed. This allows TULIP to produce ensembles and more realistic projections of future floods and droughts, enabling Hydro Tasmania to better plan for the long-range sustainability of its system.

The system yield assumption serves as a critical reference for the generation optimisation, investment decisions, corporate planning, climate disclosure, and annual valuation of hydro generation assets. This paper presents an updated system yield projection for Hydro Tasmania, leveraging advanced modelling techniques and incorporating climate change impacts to support strategic planning for sustainable system performance and resilience to future drought conditions.

Key findings include:

- an average system yield of **8,780 GWh/year** for 2026;
- an annual average reduction to the system yield of **21 GWh/year** or 0.2%/year from CY2026 to CY2050 due to climate change, consistent with Representative Concentration Pathway **RCP 4.5[2] projections**;
- a standard deviation of **±1,330 GWh/year**, reflecting the variability in projections in an individual year; and
- no further reduction (**0 GWh/year**) from CY2051 onwards, reflecting the stabilisation predicted under **RCP 4.5**.

[1] A Bayesian model is a statistical model that uses distributions rather than point estimates for parameters, providing a method for reasoning under uncertainty.

[2] RCP 4.5 is a moderate climate change scenario used by the Intergovernmental Panel on Climate Change (IPCC) in which strong but achievable climate policies are implemented, leading to approximately 2.0 - 3.0°C of global average warming by 2100, relative to pre-industrial levels.

System yield as a function of inflows

System yield refers to the amount of water (typically measured in GWh) that flows into water storages and is available for electricity generation. It differs from inflows, which represent the total volume of water flowing into a storage, as yield accounts for real-world conditions that stop water from being fully available for electricity generation. Several factors influence system yield:

- *Physical factors*: these include natural characteristics of the system, such as weather and climate patterns, catchment topology, storage size and power station ratings.
- *Operational factors*: these are operational conditions that affect yield, such as Hydro Tasmania's outage program and prevailing spot market conditions.

The following graphic illustrates the key components considered when calculating net system yield:

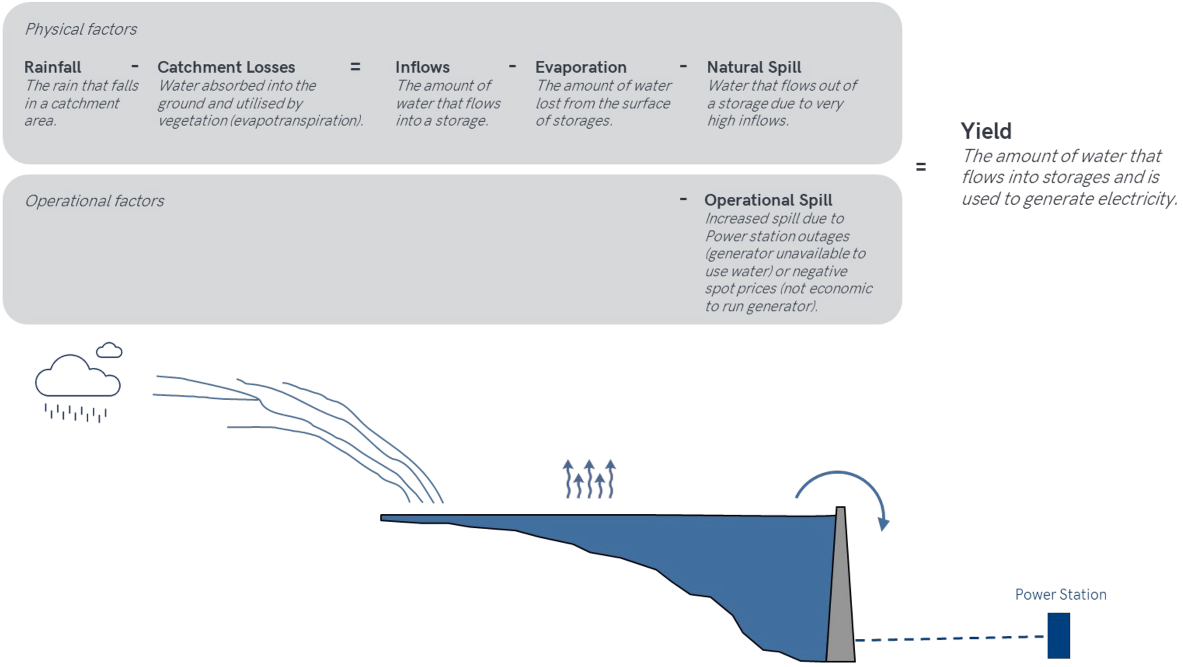

Figure 1 *Components of system yield.*

Hydro Tasmania has partnered with leading research organisations who developed long-range projections of inflows that account for increased concentrations of greenhouse gases and associated climate change impacts. These include the CSIRO-led Tasmania Sustainable Yields Project, the UTAS-led Climate Futures for Tasmania project, and CSIRO-led decadal forecasting project.

Hydro Tasmania conducted a review of assumptions and undertook a comprehensive historical yield trend analysis in 2021. The key findings revealed a decline of approximately 26 GWh per annum to the total system yield since 1970 (Figure 2), aligning closely with an estimate identified by the UTAS Climate Futures Team analysis.

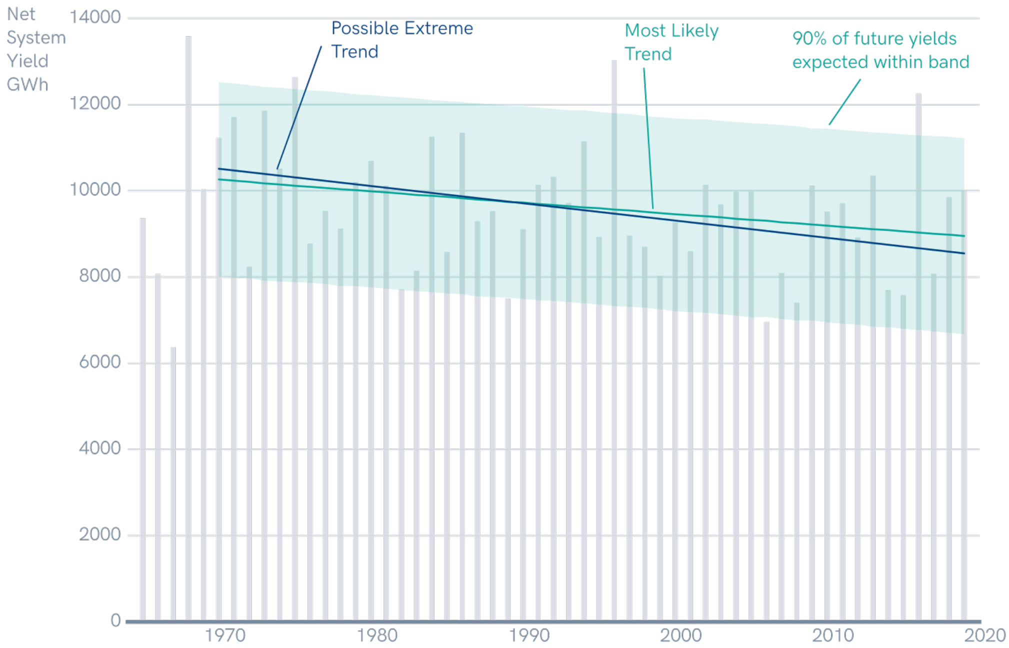

Figure 2 Yearly net system yields and fitted trend over 1970-2019. Grey bars are measured net system yields.

As a part of the Portfolio Optimisation project, the team has developed a new advanced Trend and Uncertainty in Long Inflow Predictions (TULIP) model[3], with input from CSIRO. TULIP better represents uncertainties in the future inflows, including inflow trends, and will be among the most advanced methods of stochastic data generation available. This will give Hydro Tasmania the best estimates of the future 20-year inflows available.

Modelling methods

TULIP is a Bayesian model that generates long-range predictions of inflows at a monthly time step. Inflows series, including gross inflows in the IPS dataset, can exhibit skewed distributions and non-normal tails. The model captures these non-normalities, and accounts for the seasonal and long-term variations in the statistics. The model accounts for the spatial nature of the data, allowing the long running streamflow network to inform the shorter record sites.

TULIP produces long-range projections of inflows to power stations with the following properties:

- Realistic spatial correlations between inflow sites;
- Realistic seasonal cycles and zero values with censoring;
- Realistic autocorrelation accounting for seasonality;
- Reflects trends in historical inflows;
- Incorporates uncertainty in properties above and represents uncertainty in all properties; and

[3] HEPEX workshop on forecasting across spatial scales and time horizons, Sweden, 2023 https://hepex.org.au/wp-content/uploads/2023/05/2.Horsley_TULIP.pdf

- Generates very large ensembles capable of representing extreme sequences of wet and dry that may not have been present in the recent historical record.

The TULIP model has been developed and benchmarked to previous methods in partnership with CSIRO and provides benefit over previous modelling approaches. Hydro Tasmania's improved hydrological modelling methods, including TULIP, are designed to be adaptive and dynamic, allowing for adjustments based on continuous research or emerging climate trends. Advances in the science of seasonal prediction, improvements in the observations and how they are incorporated into the model, as well as advances in supercomputing power will support improvement in model accuracy over time. This flexibility ensures that the modelling output remains relevant and accurate over time.

Analysis results

The updated system yield projection was calculated using the TULIP model, a Bayesian model designed to generate robust long-range inflow predictions while addressing the limitations of traditional stationary-climate assumptions.

Key findings include:

- an average system yield of **8,780 GWh/year** for 2026;
- an annual average reduction to the system yield of **21 GWh/year** or 0.2%/year from 2026 due to climate change (i.e., increased evaporation and changes in rainfall patterns); and
- a standard deviation of **±1,330 GWh/year**, reflecting the variability in projections in any individual year.

Using TULIP's long-term inflow projections, net system yield projections were derived using Temsim, maintaining alignment with the existing modelling approach. The analysis confirms that the system yield will continue to follow historical trends, with a projected decline over time, as shown in Figure 3 and Figure 4.

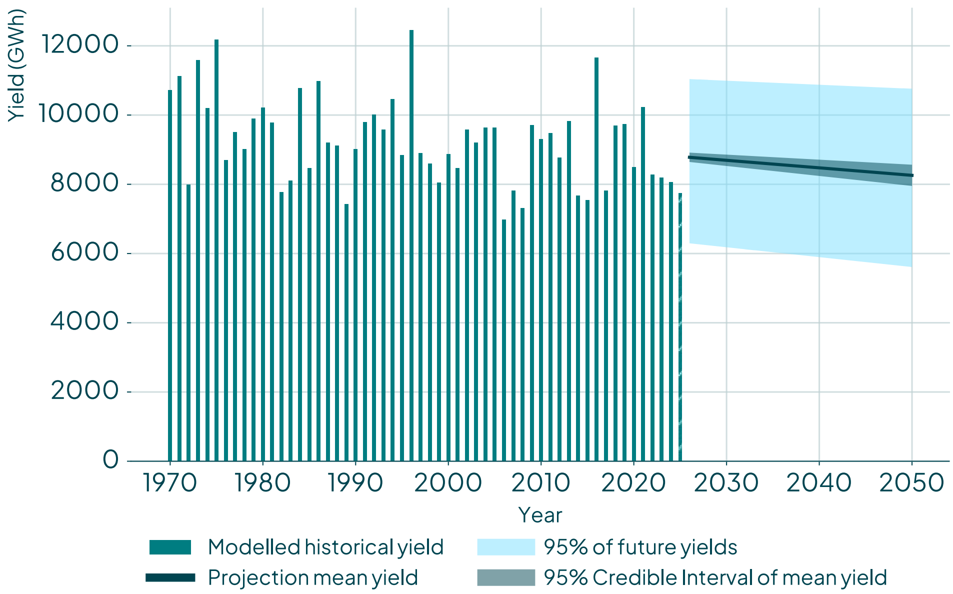

Figure 3 *Modelled Historical and TULIP projected annual net system yield.*

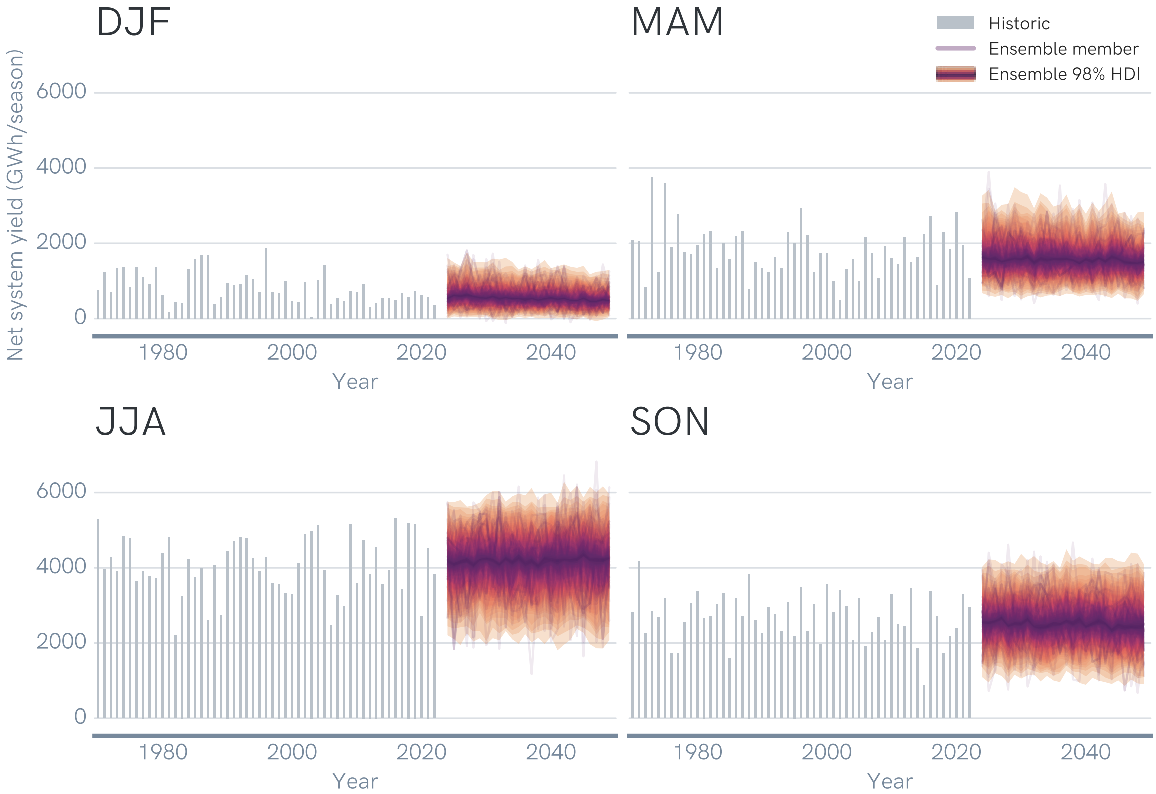

__Figure 4__ Historical and TULIP projected net system yield by season.

Impact of climate change on yield projections

The Bureau of Meteorology's Australian Water Outlook (AWO) National Hydrological Projections provide valuable validation for our method, offering runoff estimates for two Representative Concentration Pathways (RCPs) extending to the end of the century: RCP 4.5 (intermediate emissions) and RCP 8.5 (worst-case emissions).

__Table 1__ Representative Concentration Pathways: RCP 4.5 vs. RCP 8.5

	RCP 4.5	RCP 8.5
Description	A moderate climate change scenario where strong but achievable climate policies are implemented, stabilising greenhouse gas emissions by mid-century.	A high-emissions, worst-case scenario where greenhouse gas emissions continue to rise throughout the century with little or no climate policies.
Warming by 2100	~ 2.0 - 3.0°C above pre-industrial levels	~ 4.0 - 5.5°C above pre-industrial levels
Emissions	Emissions peak around 2040 and level off afterward.	Emissions continue increasing through 2100.

As illustrated in Figure 5, the scenarios diverge significantly after 2040. By 2050, RCP 8.5 projects an 8% reduction in runoff by 2050, whereas RCP 4.5 forecasts a reduction about half as severe. Beyond 2050, RCP 8.5 continues a steady decline, while RCP 4.5 levels off. RCP 4.5 is adopted as the central scenario as it represents the emissions trajectory most consistent with national and international climate policy settings, providing a credible and defensible basis for long-term planning.

However, these AWO projections underestimate changes in runoff compared to both observed trends and the TULIP model results. The discrepancy is likely due to the AWO projections not fully accounting for storage evaporation losses, which may explain nearly half of the observed yield decline. When evaporation is factored in, the AWO projections align more closely with TULIP's findings.

Future updates to the TULIP model will include emission scenarios based on Global Climate Models (GCMs) for a more direct comparison. Meanwhile, CSIRO's ongoing work to measure evaporation losses directly will further improve modelling accuracy.

In comparison, the UTAS Climate Future project forecasted an average decline of 25 GWh/year under RCP 8.5 scenario.

To reflect the impact of climate change on system yield, the following assumptions are adopted:

- from CY2026 to CY2050: apply an annual average reduction of 21 GWh/year, consistent with RCP 4.5 projections.
- from CY2051 onwards: assume no further reduction (0 GWh/year), reflecting the stabilisation predicted under RCP 4.5.

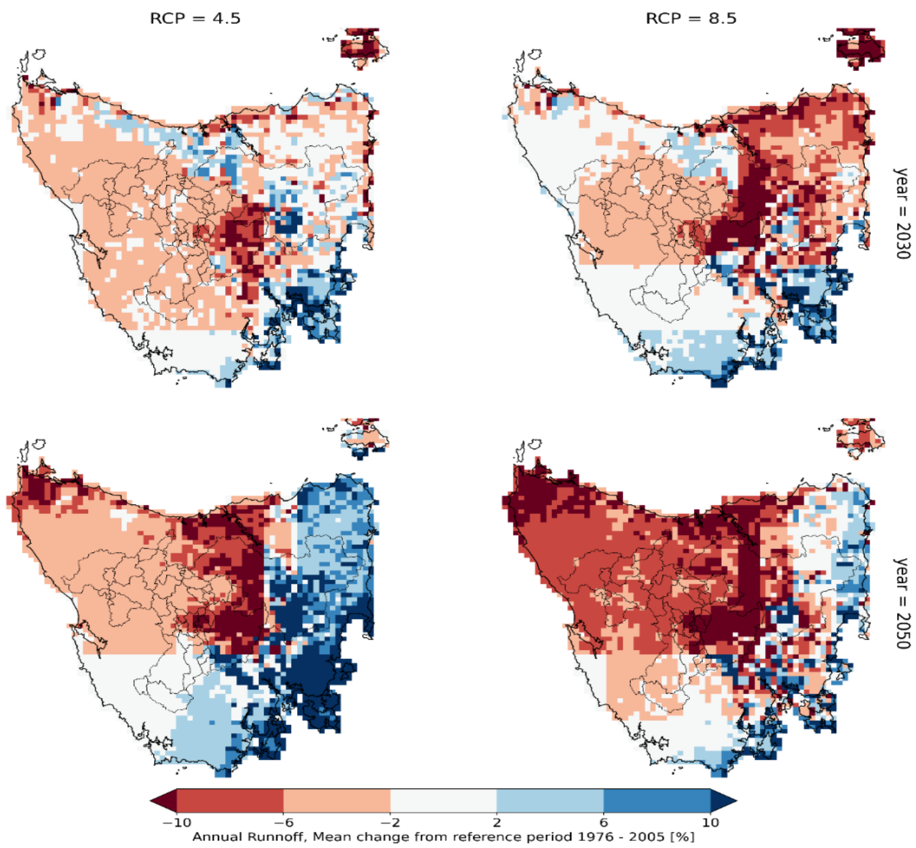

Figure 5 *Mean annual runoff changes from AWO's projections under two emissions scenarios as a percentage of 1990 levels.*