Hydro Tasmania

Battery of the Nation

Unlocking Tasmania's energy capacity

The potential of Tasmania's renewable generation assets with more interconnection

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Foreword

As the National Electricity Market (NEM) transitions away from baseload fossil-fuel generation, and as the penetration of wind and solar generation increases, flexible supply and storage solutions are needed to 'firm' variable generation.

Tasmania could play a greater role in providing flexible supply, but the capacity of the existing interconnection between Tasmania and mainland Australia constrains how much support the Tasmanian power system can offer the NEM.

Additional Bass Strait interconnection would unlock the Tasmanian hydropower system's latent dispatchable capacity and make it available to the NEM with little or no extra investment required.

The presence of more interconnection would immediately deliver benefits from Tasmania's latent dispatchable capacity, made available through relatively minor adjustments to the operation of existing hydropower assets.

Analysis by Hydro Tasmania has found that 400 MW of reliable, latent dispatchable capacity can be unlocked with no new generation investment. It would be available over the summer months, when demand is at its peak in Victoria and the system under greatest pressure. This coincides with the period of lowest demand in Tasmania, which means supporting the NEM can coexist with meeting domestic energy needs.

With the right market signals, a similar amount of additional dispatchable capacity could be made available with a minimal amount of investment, through upgrading assets and altering operations at higher lake levels (increased 'head effect') and demand side opportunities.

Steve Davy

Hydro Tasmania Chief Executive Officer

December 2018

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1. Executive Summary

The National Electricity Market (NEM) is undergoing a transformation away from the dominance of baseload fossil-fuel generation towards greater proportions of low-cost variable renewable energy. To 'firm' this variable renewable energy, flexible supply and storage solutions are needed.

This will shift the generation focus from "peak demand" to "peak supply-demand imbalance[1]". As more variable generation enters the market, flexible generation options such as hydropower will become increasingly valuable due to their ability to firm variable generation. Interconnection will also become more valuable, enabling NEM regions to share diverse resources more effectively.

1.1 More interconnection offers opportunities for Tasmania and the NEM

Across the NEM there is a general shortage of available capacity, evidenced by the utilisation of the Australian Energy Market Operator's (AEMO's) Reliability and Emergency Reserve Trader (RERT) function. By contrast, Tasmania typically has excess capacity beyond demand plus maximum export.

Tasmania is connected to the rest of the NEM via a 500 MW high voltage direct current (HVDC) interconnector (Basslink). The capacity of the link constrains Tasmania's ability to support the NEM with a greater amount of flexible supply.

More interconnection would unlock the full potential of Tasmania's existing hydropower generation assets: latent potential, minimal investment upgrades and new pumped hydro opportunities. It would also stimulate investment in new high-quality, diverse wind energy generation. Further interconnection and additional wind generation would enhance energy security and enable greater opportunities for flexible hydropower to support the NEM.

The simple presence of more interconnection would immediately deliver benefits from Tasmania's latent dispatchable capacity. With greater interconnection, this latent dispatchable capacity in the Tasmanian hydropower system could be made available to a transforming NEM with little or no extra investment.

Tasmania typically has excess capacity well beyond the combined total of the state's own demand plus the maximum export possible via Basslink. With increased interconnection, Tasmanian assets can make a greater contribution and provide least cost solutions for the NEM.

[1] Prices in the market will be highest when there is a mismatch between demand and the available variable energy (e.g. from wind and solar generation); both the supply and the demand vary and the difference between the two will be the challenge that needs to be managed. This is a change from a system with primarily dispatchable generation where the demand was the main variable, thus peak demand.

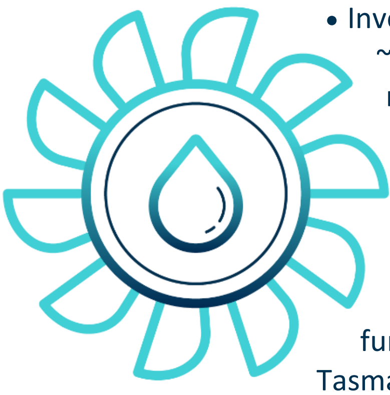
1.2 Tasmania's hydropower system has significant latent capacity, available with no new investment needed

There is already 400 MW of latent dispatchable capacity in the Tasmanian system, but this is not currently available to the market due to insufficient means of delivery. With greater interconnection, this potential renewable dispatchable capacity can be accessible to the NEM, with no new investment required. This would provide invaluable support in the NEM particularly over summer, when demand is at its peak.

Of this 400 MW, there is 350 MW of surplus capacity from Tasmania's large-scale hydropower assets during summer peak periods, which is not currently deliverable to the NEM. The other 50 MW is the excess capacity available to the market from Hydro Tasmania's 111 MW of flexible 'small' generation units. Currently, NEM modelling treats these as non-scheduled (uncontrolled) generation, with an average generation of 61 MW. Better modelling of these assets would recognise the remaining 50 MW of excess capacity and further interconnection would provide access to the market. Further potential in existing assets could be unlocked at minimal cost.

With the right market signals, a similar amount of dispatchable capacity (approximately 340 MW made up from the combination of options listed below) can be made available with relatively small investments by upgrading assets and adapting hydropower operations to take advantage of the 'head effect' (the extra capacity and efficiency of generation when there is a greater altitude difference between the top of the storage and the power station).

- With further interconnection, approximately 100 MW of 'new' capacity can be made available through optimisation choices during mid-life asset refurbishments in western Tasmania with small incremental cost.
- The capacity of the Gordon Power Station could be increased by up to 90 MW and the efficiency by up to 15% by operating for longer periods towards the top of its range. There is an opportunity cost of deferring generation to store more water. Despite this cost, with the right market signals this would be among the cheapest of the capacity options in the NEM and very low risk.
- Investment in the ageing Tarraleah Power Station could change it from a ~70 MW baseload generator to a ~220 MW peaking plant, potentially raising the capacity by 150 MW (designs are still underway). This would also improve the ability to deliver maximum capacity at peak times of the hydropower generators in the Lower Derwent System ensuring more water was available at the most valuable times.



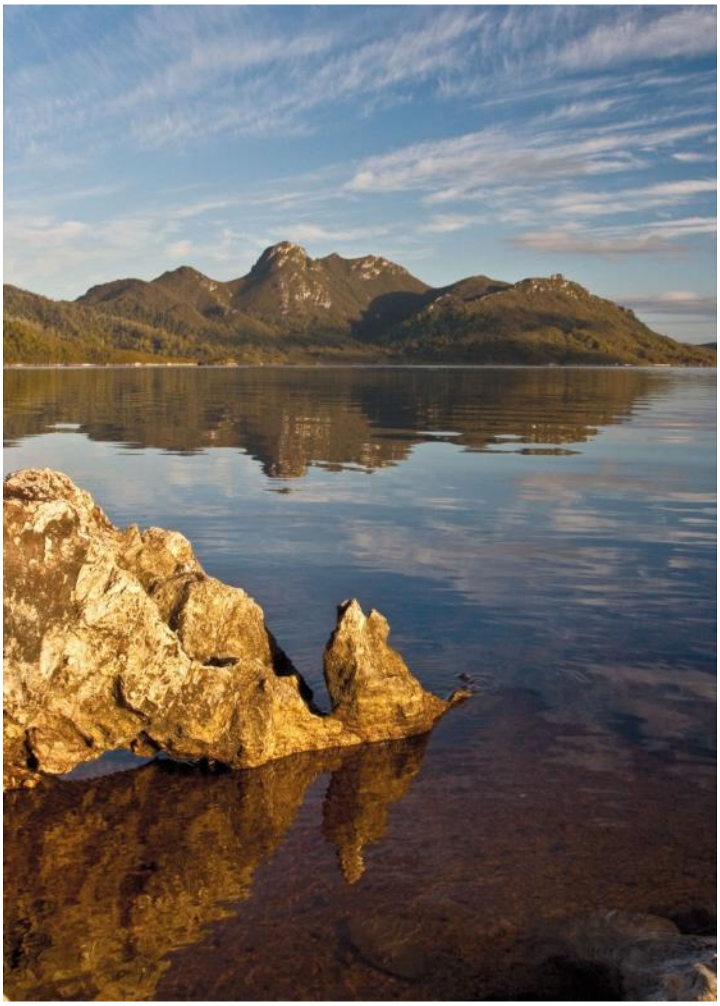
This capacity is all from controllable and flexible renewable supply options. High-quality, diverse Tasmanian wind generation would further increase the potential capacity. Interconnection between Tasmania and the mainland would act as a delivery mechanism, exposing Tasmanian assets to a market requiring additional options for flexible supply.

More accurately quantifying and recognising the latent potential and minimum-cost opportunities in Tasmania's generation fleet (as well as opportunities for new assets such as wind and pumped hydro energy storage) will enable a clearer understanding of the contribution that Tasmania can make to the NEM with further interconnection.

2. More interconnection will enhance Tasmania's power system and support the NEM

Tasmania has been part of Australia's National Electricity Market for over a decade, connected to Victoria by the high voltage direct current (HVDC) undersea cable known as Basslink. Basslink currently operates at 500 MW.

The limited capacity and lack of redundancy of the interconnector has meant that independent energy security and reliability remained the top priority for Tasmania's power system. The interconnector has largely been used to manage drought risk and to capture short-term market opportunities.



Mainland access to Tasmania's valuable flexible generation has also been restricted due to the limits of the interconnector.

There are currently three key drivers of the interconnector flows:

- exporting excess hydro energy that cannot be practically stored
- increasing energy security during times of lower water availability (through import)
- opportunistically importing energy during low-value periods (saving water in Tasmania and reducing spill of wind and solar on the mainland) and exporting energy to the mainland when the prices are high or as the system requires.

2.1 An overview of the current Tasmanian power system

Tasmania's electricity system is primarily renewable, supplied mostly by hydropower with some wind, residential solar photovoltaics (PV), and gas backup (infrequently used). The majority of this generation is operated by Hydro Tasmania, including over 2400 MW of hydro nameplate capacity (~2300 MW accounting for typical 'head effects'), 386 MW of gas, and minority ownership of 308 MW of wind generation.

Tasmania has a minimum demand of ~1000 MW (in summer) and a maximum demand of ~1800 MW (in winter). Tasmania's annual demand is ~10.5 TWh, with ~90% supplied by hydro generation, depending on annual rainfall.

Tasmania's hydropower has surplus capacity and is highly flexible; although, at times, there are constraints on energy (water). The energy yield from the smaller storages is heavily influenced by hydrology and weather patterns; nevertheless, even when water is comparably scarce, some water is retained above minimum operating levels meaning that there is still capacity available.

2.2 The NEM is transforming as the market moves to renewables

The mainland regions in the NEM are presently dominated by inflexible baseload generation, primarily sourced from black or brown coal. This is underpinned by responsive generation from open-cycle gas turbines and some hydropower generation for energy security.

The Australian NEM is undergoing a major transformation, from domination by baseload fossil-fuel generation, towards increased proportions of variable renewable energy. Over the last decade there has been substantial growth of variable generation in the form of wind and solar PV. As coal generation plant retires, variable generation grows, as does the requirement for flexible supply options to 'firm' that variable generation. Traditionally, this 'firming' has been provided by gas, but gas prices have affected the cost-effectiveness of this option – especially for frequent use. Storage, particularly long-duration storage, is expected to be a major contributor to solving this future challenge.

As the generation mix changes, the market is shifting. Focus is changing from "peak demand" to "peak supply-demand imbalance", with market prices highest when there is a mismatch between demand and the available wind and solar energy. Flexible generation that can efficiently respond to sub-daily market signals will become increasingly valuable, as will interconnection between regions to share diverse resources and balance load profiles.

2.3 Resource sharing in the NEM

A number of characteristics differentiate Tasmania's electricity system from the rest of the NEM, see Table 1. Through interconnection, the diverse strengths of the regions can be better leveraged to achieve lower cost outcomes for all regions.

Table 1. Comparison of characteristics of the Tasmanian power system compared with the rest of the NEM

Tasmania	Mainland
80%-90% generation from flexible sources	20% flexible generation
~10% variable renewable energy	~10% variable renewable energy
Available combined and open cycle gas generation	70% baseload generation
Small demand (10-11 TWh p.a.)	Large demand (~200 TWh p.a.)
Plentiful short term capacity	Capacity constrained Evidence: price spikes, ESOO projections & RERT contracts
Operate to manage long-term energy security (i.e. protect against droughts)	Plentiful long term energy supply (subject to fuel price)
Renewable dominated	Fossil fuel dominated
Very little exposure to international fuel prices	Increasing exposure to international fuel prices
Seasonal impact on supply availability	Limited seasonal impact on supply (some high ambient temperature limitations, lack of cooling water availability for thermal stations and occasional drought conditions impacting mainland hydro generation)
Demand profile strongly influenced by heating (winter peak)	Demand profile strongly influenced by cooling (summer peak)

Tasmanian demand is approximately 5–6% of the total NEM energy demand, and yet Tasmania supplies almost 40% of the flexible generation capacity.

Figure 1 shows the difference between the generation in Tasmania and the remainder of the NEM (based on actual generation statistics from NEM data) according to the following categories:

- variable: wind, solar
- inflexible: coal, combined-cycle gas turbines
- flexible: open-cycle gas, diesel, hydro, biomass, battery.

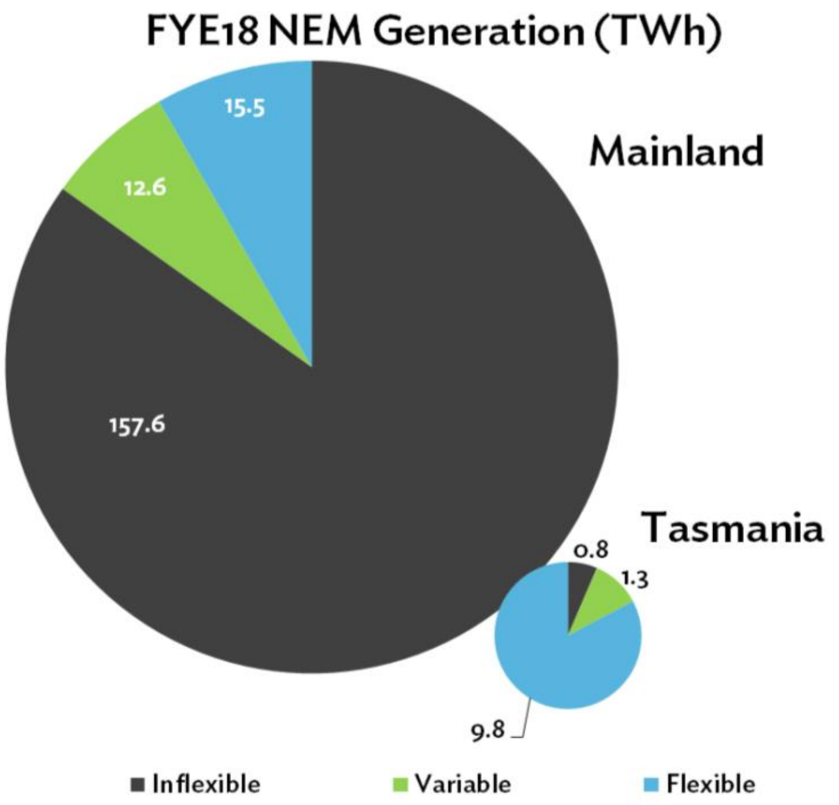


Figure 1. NEM generation during FYE18 (TWh)

As the NEM transforms, with retirement of existing coal generation and replacement by variable renewable energy sources, the importance of flexible generation will increase. The change in generation mix will require understanding of flexibility and the services needed to help manage the power system (to be explored in future papers).

As shown in Figure 1, the Tasmanian power system has substantial flexible generation that can respond to daily price variation. With additional interconnection between Tasmania and Victoria, the valuable flexible generation would be able to be exported to where it is needed.

Displacing gas-fired generation can deliver a substantial reduction in the fuel cost required to provide flexible generation. For example, in the financial year ending in 2017–18 there was over 8 TWh of open-cycle gas turbine operation across the NEM. Using a station efficiency of 98%, heat rate 12.8 GJ/MWh, fuel price of $9/GJ and transportation charges of $2.5/GJ, the fuel cost of incumbent gas generation is ~$150/MWh. This means that for every TWh of open-cycle gas-fired generation, $150 million of gas needs to be consumed.

With further interconnection, a substantial portion of Tasmania's hydropower generation can be repurposed. *The Battery of the Nation Future State NEM Analysis report*[2] has demonstrated that repurposed hydropower and new pumped hydro are more cost-effective firming solutions than open-cycle gas.

2.4 Further interconnection offers opportunities for Tasmania to support the NEM

As the generation mix in the NEM transitions towards increased proportions of variable renewables, further interconnection between Tasmania and the mainland would unlock the full potential of Tasmania's existing flexible hydropower generation, enable better resource sharing and increase the value of the contrasting characteristics of the Tasmanian power system compared to other NEM states.

With greater interconnection, the flexibility of Hydro Tasmania's plant, currently used to balance the energy security needs of the Tasmanian system, could be repurposed to export high-value flexible capacity to the mainland. There are opportunities to increase the capacity of the Tasmanian hydropower system with little new generation investment. There are also opportunities to leverage the latent capacity in the system that is not currently seen by the market due to limited interconnection, and to recognise the inherent flexibility of smaller plant not currently adequately captured in planning or modelling.

2 https://www.hydro.com.au/docs/default-source/clean-energy/battery-of-the-nation/future-state-nem-analysis-full-report.pdf?sfvrsn=25ce928_0

More connection between Tasmania and the mainland can help to manage the energy security and reliability of the Tasmanian power system, as well as help to manage the capacity needs of the mainland energy system.

Tasmania's power system generally has excess power station capacity. In contrast, while the mainland typically has plentiful energy at times it has insufficient capacity. This is underlined by the recent utilisation of the Reliability and Emergency Reserve Trader (RERT) mechanism. In the summer of 2017–18, over 266 MW of emergency generation was brought online across Victoria and South Australia and almost 900 MW of emergency demand response was contracted – nearly all of which was in Victoria[3].

Tasmania's opportunity to support mainland loads would need to account for transmission losses – although to date Tasmania has not experienced the same level of losses as some other parts of the NEM.

3. Latent capacity in the existing Tasmanian hydropower system is available with no investment

There is approximately 400 MW of excess latent dispatchable capacity in the Tasmanian system, summarised in Table 2. This capacity is not currently available to the market due to insufficient means of delivery.

Table 2. Existing latent dispatchable capacity in Tasmania

Source	Magnitude of potential renewable dispatchable capacity options
System-wide surplus scheduled capacity	350 MW
Capturing true value of "small" hydro generators	50 MW
TOTAL	400 MW

There is approximately 350 MW of surplus capacity from Tasmania's large-scale hydropower assets during summer peak periods. Considering some capacity value for wind would increase the size of this surplus.

Hydro Tasmania has 111 MW of flexible 'small' generation units. However, NEM modelling has treated these as non-scheduled (uncontrolled) generation, with an average generation of 61 MW. Further interconnection would expose the remaining 50 MW of excess capacity to the market, providing opportunity for these smaller assets to respond to mainland-driven price signals and market imbalance.

[3] https://www.aemo.com.au/-/media/Files/Media_Centre/2017/AEMO_Summer-operations-2017-18-report_FINAL.pdf

With greater interconnection, this 400 MW of surplus renewable dispatchable capacity can be accessed by the NEM with no new investment, as seen in Figure 2.

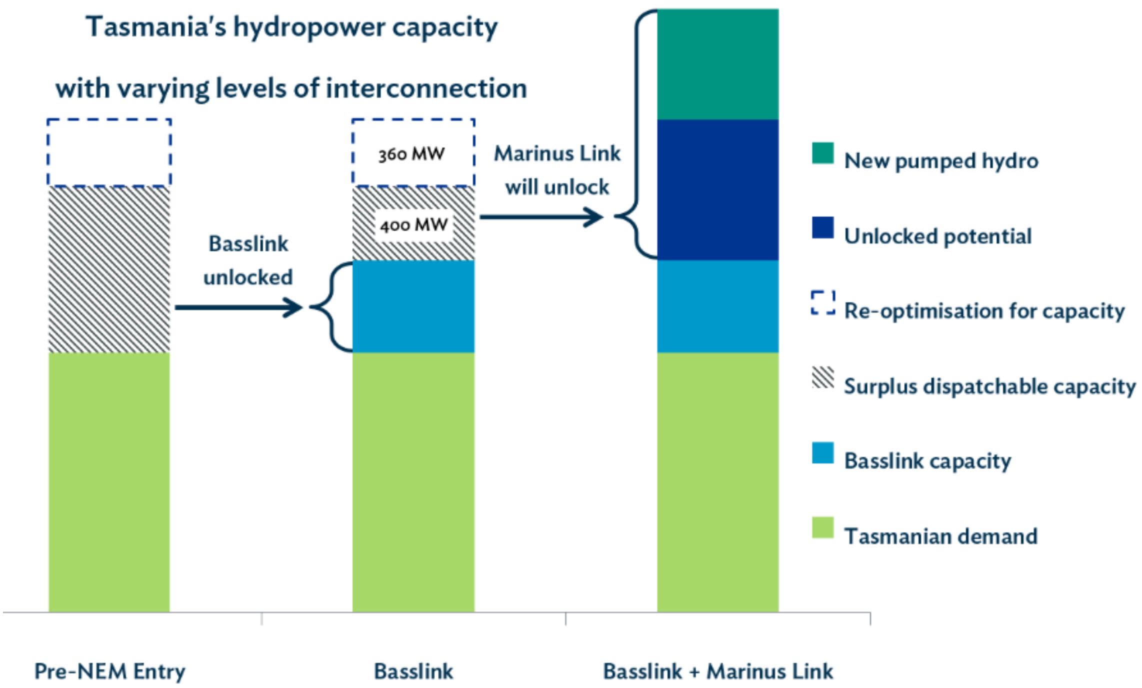


Figure 2. Increasing interconnection between Tasmania and the mainland will unlock existing potential and new cost-effective development

Currently, the Tasmanian power system is rich in flexible generation and can be typified as being capacity rich and, on average, slightly energy constrained[4]. As such, there is little incentive to pursue realisation of latent capacity, even if available at low incremental cost.

In the decade since Tasmania joined the NEM, relatively simple representations of the Tasmanian hydropower system have been sufficient to represent Tasmania's impact on the mainland. However, when considering further interconnection, particularly in the context of the rapidly changing NEM, tools and models must be updated to capture the full flexibility, capacity and value of Tasmanian hydropower.

3.1 Greater availability of existing assets means greater latent capacity

When there is a very high price in Victoria, Tasmania typically exports at the full capacity of Basslink. Reviewing the financial year 2017–18, when there was a significant market opportunity (i.e. >$1000/MWh in the Victorian regional market), Tasmania's interconnection was utilised at on average 99% of its full capacity. Since there is sufficient capacity to meet both local demand and maximum export during the highest price events, there is presently little incentive to increase capacity in Tasmania.

[4] It is worth noting that Tasmania's energy system generates from ~7 TWh to ~12 TWh depending largely on natural inflows from rainfall. The long-term average is approximately 9 TWh.

Further interconnection will expose Tasmanian hydropower capacity to the broader market and it is expected that there will be value in making Tasmania's full hydropower asset base more available. Existing maintenance methodology is designed to align with existing market drivers. At present, a failed start of a generating unit can be compensated with alternative assets. With further interconnection there would be incentives to manage Tasmania's assets to be more available during times when capacity is required.

More exposure to the market may result in different management of the asset lifecycle. A comparison of the bid availability data for Snowy Hydro's two largest generators (Murray and Tumut 3) and Tasmania's two largest hydropower generators (Gordon and Poatina) shows that the Snowy Hydro plant have been over 10% more available over the last three years[5]. Snowy Hydro is already exposed to a market that values flexible capacity. This comparison indicates that with incentives for available capacity, Tasmanian hydropower plant of similar age could be operated and maintained to increase availability.

If Hydro Tasmania's hydropower assets become more available and more frequently achieve the maximum scheduled capacity of ~2300 MW, this is equivalent to around 130 MW more hydropower capacity compared with the availability assumed by AEMO in the Integrated System Plan (ISP).

[5] The comparison is based on the ratio of average availability with 98th percentile availability over FYE16 to FYE18.

Energy security requirements have previously resulted in conservative operation of generation assets. Enough water is maintained in storages to provide a sufficient reliability buffer or safety margin in case of long-term outage of Basslink coinciding with low inflows. With further interconnection and additional wind generation, energy security will be enhanced and the flexibility of the hydropower system can be repurposed to address broader NEM challenges.

Tasmania's peak demand occurs in winter while the rest of Australia's peak demand occurs in summer[6]. Tasmania's flexible generation is in highest demand during hot weather events on the mainland – particularly given that high temperatures can cause de-rating of both generation and transmission assets. Tasmania's reliable export capacity can be established as 850 MW from the large-scale hydropower stations alone. This is based on 2300 MW of generation capacity, minus 50 MW for the average impact of planned outages, minus 1400 MW of peak summer demand. Only 500 MW of this potential capacity can be delivered to the market via Basslink, leaving 350 MW[7] of capacity that is presently unavailable to the market. Moreover, any generation from other sources (i.e. wind, gas or small hydro) and demand response[8] will further increase this undeliverable surplus capacity.

3.2 The impact of short-duration hydro requires greater recognition

A number of Hydro Tasmania's power stations, fed by smaller storages, are presently thought of as 'run of river'. When forecasting or modelling NEM-wide operations, short-duration storages have usually been represented as performing exactly as they behaved in the past, regardless of market situations – even down to selecting the same time of day to operate.

[6] https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Electricity-Forecasting-Insights/2017-Electricity-Forecasting-Insights/Summary-Forecasts/Maximum-and-minimum-demand

[7] Tasmania's small-scale hydropower stations add a further 50 MW and are described in more detail later in the paper.

[8] Tasmanian major industrial customers have historically responded to market signals by reducing load at times. This active demand side response is not included in this summary. It is likely that Tasmanian customers would respond with up to 250MW with the right market signals.

However, the increasing penetration of variable renewable energy, particularly solar, will change daily price cycles. It will also amplify the significance of daily price cycles in the energy system. Assuming historic daily generation cycles for these storages significantly undervalues the flexibility that they can contribute to the energy system. Detailed consideration of pricing during each interval of the day will be critical to efficient outcomes.

Understanding the degree of controllability in Tasmania’s power system, particularly with respect to large headwater storages above a cascade of smaller storages, will better represent the impact Tasmanian flexible generation can have in the NEM. Hydro Tasmania is presently working with AEMO to improve this representation for the next stage of the ISP modelling.

This is not represented as an increase in total available capacity – and is not counted in any summary table in this paper – but will materially affect the way that Tasmania’s power system is considered for future planning and the value of further interconnection.

3.3 Small and Non-Scheduled (SaNS) assets add to the total latent capacity

When planning (and modelling) the operation of the NEM, some generating assets are categorised as ‘Small and Non-Scheduled’ (SaNS). These are currently considered to be uncontrollable, and are modelled as negative demand. While this is true of the non-scheduled portion of this category, it is not necessarily true of small dispatchable generators.

Elsewhere in the NEM, SaNS generators are often directly related to a large industrial load[9] and this approach may be appropriate in these circumstances. However, much of the Tasmanian SaNS generation consists of small, but flexible, hydropower which is scheduled and operated in the same way as the rest of Hydro Tasmania’s portfolio. This generation is not bid into the market, but forms a critical part of Tasmania’s integrated hydropower system.

Rowallan Power Station (a SaNS generator) is the headwater for the Mersey-Forth Scheme, a cascaded scheme with 341 MW of capacity. Lake Rowallan is a large storage capable of storing enough energy to operate the power station at maximum capacity continuously for over 50 days, even without inflows. This is a key element in the Mersey-Forth Scheme and considering it as ‘negative load’ underestimates the role it plays in the power system and the value of further Tasmanian interconnection.

[9] Many SaNS units are heat recovery units – operated when the non-generating plant is operating.

Reviewing information from AEMO's generation information page[10] (for 31 July 2018) it is possible to derive Table 3. For the purpose of this analysis, combined cycle gas turbines, solar PV, wind and sub-critical steam have not been counted as flexible since they are not able to be dispatched at short notice.

Table 3. Flexible small and non-scheduled generation per region

Region	Installed capacity (MW)	Percentage of summer peak (%)
NSW	494	3.8%
QLD	282	2.8%
SA	38	1.3%
TAS	122	8.6%
VIC	187	2.0%

During the summer peaks, Tasmania's small SaNS hydro generation can meet over 8% of the region's maximum demand. This is more than twice the percentage supplied in New South Wales (the next highest region) and more than four times the ratio of Victoria, the region to which further interconnection could occur. It is material in terms of Tasmania's ability to meet local demand and export during periods of high demand on the mainland.

Of Tasmania's 122 MW of dispatchable SaNS generation, the vast majority, 111 MW, is in Hydro Tasmania's hydropower portfolio.

When considering the value of interconnection and the role Tasmania can play in the future NEM, the 111 MW operated as part of Hydro Tasmania's portfolio should be treated in the same way as any other larger generator. At present, this SaNS generation is treated as negative demand, with average generation of 61 MW, underestimating its capacity by 50 MW.

Flexible non-scheduled generation on the mainland may also be worth reviewing – especially if not associated directly with a load. This may improve the dynamics of the market planning and modelling. However, it is expected that the impact in Tasmania (and on the relative value of interconnection between Tasmania and the mainland) will be greatest due to the relative scale and generation mix.

[10] https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information

3.4 Demand-side response offers more capacity options

Tasmania has a strong record of innovation in managing a relatively small power system supplied by renewable energy. Demand-side response is actively used in Tasmania to the benefit of both the customers and the operators of the system.

Tasmanian major industrial (MI) customers have experience in responding to market signals and sharing in the benefits. Contractual arrangements recognise the flexibility of their demand in return for reduced cost of supply.

Tasmanian MI customers participate directly in a range of formal arrangements:

- Frequency Control Special Protection Service (FCSPS)
- Generation Contingency Scheme
- Adaptive Under Frequency Load Shedding.

The FCSPS is particularly relevant in the context of the flexibility of Tasmanian load. When commissioned, Basslink presented Tasmania's largest credible contingency on both full import and full export and the FCSPS was established to help manage the impact on the system.

With the right market incentives, MI customers in Tasmania would be likely to continue to participate in demand-side response, offering more capacity options to the broader NEM (as much as 250 MW).

4. Investment in existing assets can yield greater capacity at minimal cost

The likelihood of a more interconnected future market would present opportunities for Hydro Tasmania to proactively invest in its existing assets to maximise their future value, resulting in a possible extra capacity of approximately 340 MW achieved at minimal cost.

A potential extra 100 MW may be able to be made available through mid-life refurbishment opportunities in western Tasmania, up to 90 MW extra could be made available by managing Lake Gordon at the higher end of its operational range, and up to an additional 150 MW could be achieved as part of renewal of the ageing Tarraleah Power Scheme, see Table 4.

Table 4. Opportunities to increase Tasmanian dispatchable capacity from existing renewable generation assets with the right market signals

Source	Required investment to capture potential	Magnitude of potential renewable dispatchable capacity options
Opportunistic upgrades during mid-life refurbishments	Minimal incremental cost	100 MW
Increased capacity and efficiency at Gordon Power Station through storing more water	Low-risk investment (subject to opportunity cost of deferred generation)	90 MW (and 15% efficiency)
Redevelopment of Tarraleah and consequential Derwent System operations	Investment to re-optimise an ageing power station	Up to 150 MW at Tarraleah
TOTAL		340 MW

4.1 Embracing opportunities during mid-life asset refurbishments

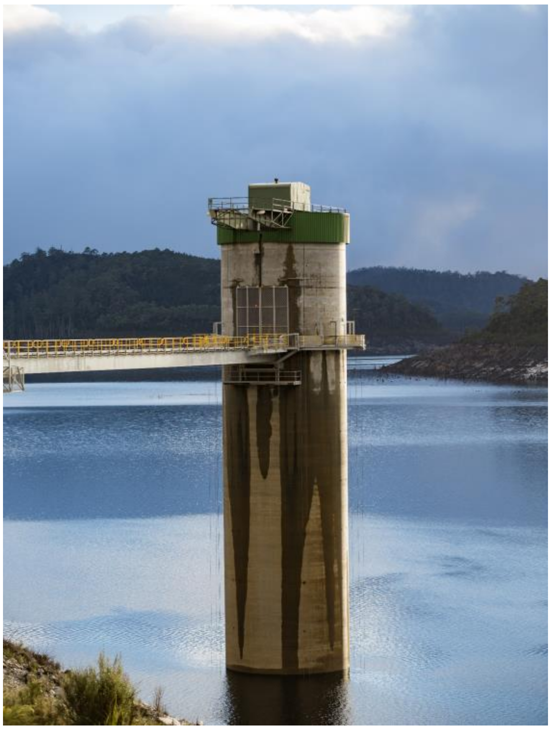
Planned periodic refurbishments of a portfolio of assets present opportunities to optimise assets to better respond to market opportunities. Hydro Tasmania's mid-life generator refurbishments typically include replacement of various parts (such as turbine runners), which allow subtle design changes in response to new technology and changing generation priorities. Hydro Tasmania's mid-life refurbishments have historically focused on increasing efficiency – getting the most energy out of the available water. This has aligned with Tasmania's focus on long-term energy security and drought-proofing.

Further interconnection would unlock new sources of energy to provide long-term security such as new interconnection-enabled on-island wind generation or importing energy from the mainland at times of plentiful supply. Relieving the energy constraint increases the opportunity and value of firming capacity. Future upgrades of hydropower plant could focus on increasing capacity and flexibility, which will be more valuable to Tasmania and the NEM than efficiency alone.

Hydro Tasmania is planning mid-life generator refurbishments on a number of stations in western Tasmania. At the time of their design, the balance-of-plant systems were typically overbuilt to provide a large margin above the rated generation capacity of the machines. Initial analysis indicates that the next tranche of planned refurbishments (beginning in the early 2020s) could add an extra 100 MW capacity with limited additional investment. There is an efficiency trade-off to be made, but not a significant one. The upgrades would also achieve a 1–2% efficiency increase, compared to around 2–3% efficiency increase expected if additional capacity was not sought. This provides a once-in-a-generation opportunity to take advantage of the necessary mid-life refurbishment to increase capacity with minimal additional expenditure.

4.2 Managing Lake Gordon for more capacity and efficiency

Hydropower generates energy from the force of gravity. Increasing the difference in height between the top of the water storage and the outlet of the power station increases the potential energy. This is called 'head'. For a given flow, maximum hydropower generation is proportional to head.



Gordon Power Station is Tasmania's largest hydropower station, connected to Tasmania's largest water storage. It is designed to operate at between 145 and 205 metres of net head (~30% variation). The storage level changes over a multi-year cycle. Given the proportional relationship between head and power output, the amount of water held in storage notably affects the maximum power station output.

However, deferring generation to store the water comes at a significant opportunity cost. As such, the lake has been operated at approximately 40% full on average over the last two decades. However, the level does change significantly year to year – from as high as 93% (1998) to as low as 6% (2016).

Changing market conditions and weather events have driven differences in operation throughout the years. Under present circumstances, the benefits of maintaining a high storage level have not justified the opportunity cost of forgone generation.

With further interconnection, the value of capacity would be higher. Managing Lake Gordon at a higher level within its existing operating range would be equivalent to building up to 90 MW of new, flexible, synchronous generation. The opportunity cost of deferring generation to increase capacity would be of a similar scale to lower cost pumped hydro options – but the increased capacity would be available without any pumping costs. In fact, it would provide an efficiency gain of about 15% more energy (MWh per m3/s) due to the higher head, which increases the amount of energy generated from the same amount of water.

4.3 Renewing the Tarraleah Power Station for capacity and flexibility

The Tarraleah Power Station, built in 1938, is now 80 years old. It requires significant investment in the next five to ten years to manage risks and extend the life of its water conveyance assets and generators. Work is presently underway to investigate the options for life extension.

Presently Tarraleah Power Station is theoretically capable of generating 90 MW of power. However, the water conveyances (canals) from Lake King William to the head storage are ageing and are currently constrained to only transferring ~30 m3/s, enough water to achieve approximately 70 MW. This provides approximately half of the water into the total cascade of the Derwent Power System shown in Figure 3. At present Tarraleah is a manually operated power station and operates almost entirely as baseload to utilise the available water that flows into Lake King William.

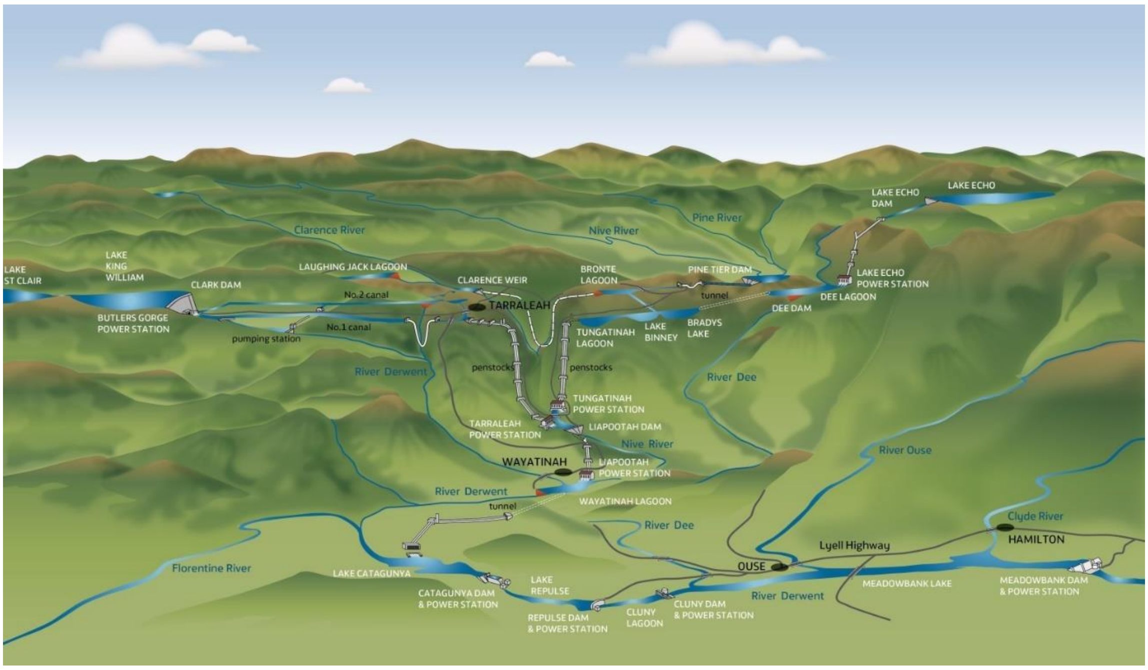


Figure 3. Graphical representation of the Derwent Power System

Although the designs and business case are still in progress, one of the options being considered is to redevelop Tarraleah with improved conveyance options and increased water transfer sufficient to build a new power station with a capacity as large as 220 MW (and an energy efficiency uplift of ~25%). This would substantially increase the capacity of the Tarraleah Scheme.

Increasing the flexibility of Tarraleah Power Station would also affect the downstream stations. A redeveloped Tarraleah Power Station would operate more flexibly, able to release more water at times of higher value. This water would also be available to the stations down the cascade at the same high-value periods, increasing the ability to capture market opportunities.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