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Optimising the 'Battery of the Nation'

How Tasmania could profit from electricity storage and dispatchable generation by hoarding water in hydro dams

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Key Findings

Tasmania could significantly reduce its energy costs by optimising its energy assets: importing more cheap electricity, exporting more high-priced electricity, and slashing electricity costs of residential and commercial buildings.

By optimising its existing and planned assets, Tasmania could multiply its winter exports five-fold, meeting up to 18% of Victoria's maximum daily winter electricity demand.

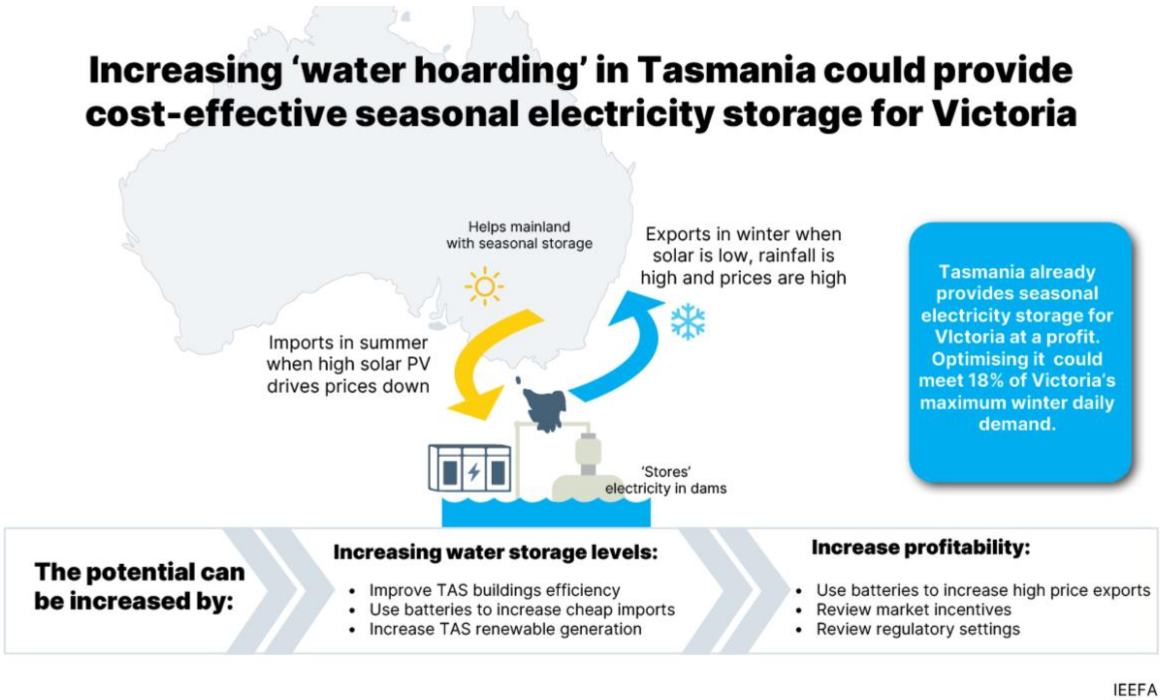
Improving the energy productivity of its buildings and expanding renewable generation would help Tasmania to 'hoard water' in existing dams, freeing up hydro generation for higher-value uses.

Batteries could help Tasmania cost-effectively increase both imports and exports of energy, while a broader review of market incentives and rules may be required to optimise the opportunity represented by water hoarding.

Executive Summary

With its 'Battery of the Nation' project, Tasmania is seeking to become a key source of electricity storage for mainland Australia by maximising the state's hydro power capacity.

Hydro generation is a valuable asset as it can provide dispatchable, zero emissions electricity and long-duration storage. Today, however, Tasmania's hydro generation is used in large volumes to meet local daily electricity demand. This report investigates how it could be better utilised at times of higher value for the whole Australian energy system, with significant benefits for Tasmania.



In future, Victoria will likely have an increasing need for seasonal electricity storage, with higher electricity demand in winter, and higher renewable generation in summer. Victoria's ambitious emissions reduction targets and fast-declining gas reserves make it important to develop zero emissions, cost-effective electricity solutions to complement this seasonal profile.

Tasmania already provides substantial seasonal storage profitably for mainland Australia. In recent years, it has imported electricity via the Basslink interconnector in summer and exported hydroelectricity in winter. However, these imports and exports are often materially lower than Basslink's capacity of around 500 megawatts (MW). In principle, there is scope to increase Basslink utilisation. We analysed which factors may drive or constrain imports and exports.

We found that low water storage reserves sometimes seem to constrain winter exports, as reserves must be maintained at a certain level to ensure energy security for the state. However, it seems that Tasmania has substantial unutilised water storage capacity. The two major lakes within the hydro generation system, which offer the best opportunity for long-term water storage, utilised less than 45% of their total capacity over the last six years. This represents unused long-term storage of up to 6,200 gigawatt-hours (GWh). To make greater use of this storage capacity, some water could be 'hoarded' – not releasing it from the lakes to generate power for daily Tasmanian demand, which is met instead with demand reduction options or alternative electricity supply sources.

Another major driver for utilisation of Basslink seems to come from the financial attractiveness of imports and exports. While operational or environmental factors (such as rainfall and water storage levels) have some influence over levels of imports and exports, financial considerations also exert a large influence. Large export volumes often seem to correspond to times of high mainland wholesale prices, while large import volumes often coincide with low or negative mainland wholesale prices. This presents a pricing arbitrage and revenue opportunity for the government-owned electricity generator Hydro Tasmania, but it means Basslink utilisation is not at its maximal level.

Various actions could increase seasonal imports and exports

IEEFA's report explored ways in which seasonal import and export levels could be increased.

Energy productivity: We examined ways in which water hoarding could be increased by reducing local electricity demand through profitable, socially beneficial energy productivity improvements. The heating of buildings accounts for a significant share of Tasmanian winter electricity use. The state uses more electricity in winter than other regions with similar climates, partly due to inefficient electric heating equipment. Resistive heating remains dominant and consumes three to five times more electricity than reverse cycle air conditioners (RCACs). Recent IEEFA analysis found that each year of delay to shift to efficient appliances is costing Tasmanian households $146 million in additional lifetime costs.

Upgrading Tasmania's aging building stock could also deliver significant savings. Recent research shows that detached homes with timber framing, which are common in the state, offer the largest, most cost-effective target for building upgrades. Improving thermal and equipment efficiency could yield significant energy and peak demand savings, as well as health and comfort benefits, especially for the least efficient buildings. Heating electricity use could be decreased by 70%, even accounting for increased consumption for improved comfort. Similar savings could be gained by upgrading water heating equipment from resistive to heat pumps.

There is also likely to be large potential to improve winter energy performance in the commercial sector. Commercial buildings are typically poor thermal performers in extreme weather, with significant energy distribution losses from central heating and hot water systems.

Together, residential and commercial energy efficiency improvements could deliver annual energy savings of about 1,200GWh, some of it at times of high electricity demand.

New renewables: IEEFA explored how planned new Tasmanian generation capacity could also increase water storage reserves. The state plans to double renewable energy production and reach 200% of its electricity needs by 2040. This would mean an additional 10,500GWh of renewable generation per year, which would decrease the requirement to use hydro generation to meet daily Tasmanian demand, leaving more water in storage. This would free up hydro power to be used at times of highest potential benefit for Tasmania.

Mainland battery storage: The report explored how Tasmania could profitably export more electricity by utilising mainland battery storage as 'virtual transmission' capacity to increase Basslink utilisation. It would allow Hydro Tasmania to increase undersea cable utilisation for imports and exports by charging the mainland battery when mainland prices or demand are relatively low, then feed it to Tasmania when cable capacity is available or into the mainland grid when prices are high. Such batteries are likely to be more cost-effective and present lower implementation risk than increasing transmission capacity. They could help Tasmania access low wholesale spot prices from the mainland.

Marinus: We briefly analysed the additional export opportunity provided by the 750MW Marinus 1 undersea cable from Tasmania to the mainland. Federal and Victorian governments have committed to helping fund Marinus. This would more than double current interstate transmission capacity. Similar actions could be taken to optimise its usage.

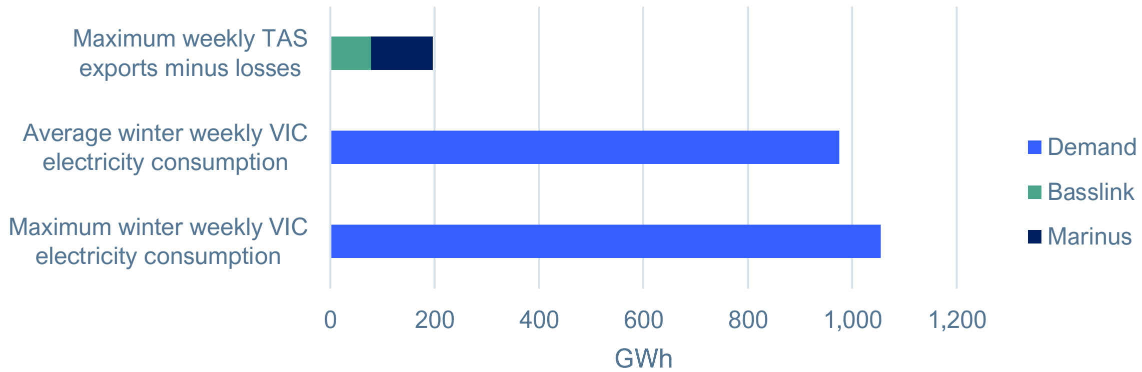
Maximising storage could benefit Victoria and Tasmania

The report then estimated the scale of the opportunity. We calculated the potential uplift in winter exports that could be realised through these interventions. We found that there seems to be more than enough potential to displace hydro generation and allow water to be 'hoarded' in existing Tasmanian dams, within environmental limits. We also found that by optimising Basslink and Marinus 1 capacity, winter exports could be increased five-fold to more than 5,000GWh per year. Energy productivity improvements alone would free up enough hydro generation to optimise Basslink exports.

Just utilising Basslink at full capacity could meet 8% of the average Victorian winter weekly demand, or 7.5% of maximum weekly demand. If Marinus 1 is built, we calculated that exports from Tasmania could meet 20% of average Victorian winter weekly demand, 19% of maximum winter weekly demand in Victoria, and 18% of Victorian maximum daily winter demand.

Maximising the value of Tasmanian hydro generation could therefore deliver material benefits for Victoria's electricity system. It could also deliver large benefits for Tasmania by increasing government revenue from its hydro generation assets, as well as delivering lower electricity bills and improved comfort for Tasmanian households.

Potential Tasmanian exports to Australian mainland compared with Victorian weekly winter demand (average and maximum across June-August period)



While some financial incentives are already available to capture this potential, they may not be sufficient to drive the behaviours required to optimise the system benefits. In particular, the interventions and investments suggested in this report would require coordination by a number of actors, including Hydro Tasmania, the Tasmanian government, as well as public or private owners of new batteries in Victoria. Regulatory changes may also be required.

IEEFA recommends that the Australian Energy Market Operator (AEMO), as well as relevant state energy bodies such as VicGrid and Victoria's State Electricity Commission (SEC), further investigate these issues. This would require more detailed modelling of the potential to confirm the findings from this report, accounting for the full complexity of Tasmania and Victoria's electricity systems, as well as a review of current regulatory and market settings.

Introduction

The Tasmanian government's 'Battery of the Nation' project is an ambitious plan to establish the state as a key source of electricity storage for mainland Australia, by maximising the state's hydro power capacity.[1]

Hydro generation has multiple benefits: it provides zero emissions electricity, but is also a dispatchable electricity generation technology and can provide long-duration storage in its reservoirs. As such, it can reduce the use of high-emissions gas-fired peaking generation. It can also provide Frequency Control Ancillary Services (FCAS) services to help with grid stability. These characteristics make it extremely valuable in the transition towards a zero emissions electricity system. Optimising hydro generation assets can maximise these benefits.

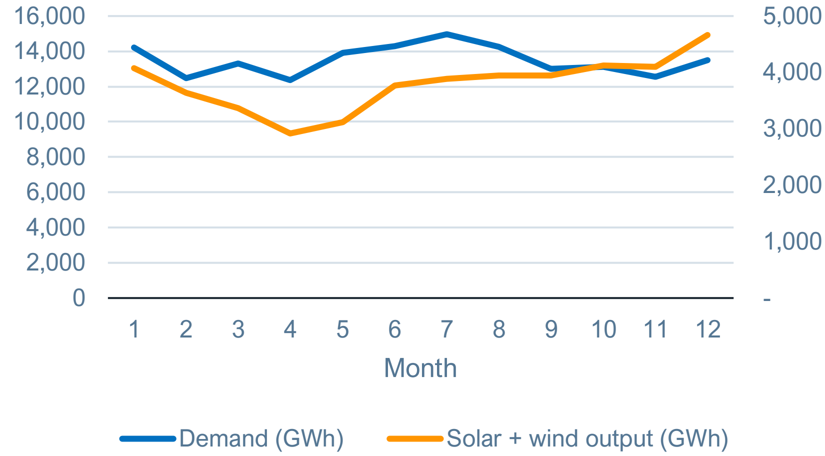
> **Hydro generation has multiple benefits: it provides zero emissions electricity, but is also a dispatchable electricity generation technology and can provide long-duration storage in its reservoirs.**

The Australian Energy Market Operator (AEMO) in its 2022 Integrated System Plan (ISP) identified the need to "treble the firming capacity from dispatchable storage, hydro and gas-fired generation" to accompany the shift from coal to renewable generation.[2] In particular, 'deep' storage (with durations greater than 12 hours) and flexible generation solutions are considered "vital to manage seasonal and long duration variations in renewable resource availability".[3,4] Assets that can provide this type of service – pumped hydro storage facilities or gas peaking generation – typically come at a significant cost and have low utilisation.

Tasmania's existing hydro generation assets are well placed to provide deep storage and flexible generation for Australia's mainland, in particular Victoria, at a lower cost. Victoria already has opposing seasonal patterns for electricity demand and renewable generation, with its highest weekly and monthly electricity demand period in winter, while its highest solar and wind output is in summer (see Figure 1). This dynamic could increase as heating gets further electrified and solar generation grows. Energy resources that can smooth the seasonal profile throughout the year, like seasonal operation of hydro generation assets, can complement this dynamic and reduce the overbuilding of renewables.

[1] Tasmanian Government, Department of State Growth. Battery of the Nation.
[2] AEMO. 2022 ISP. June 2022. Page 10.
[3] Ibid. Page 54.
[4] Ibid. Page 56-57.

Figure 1: Monthly Victorian electricity demand (left axis) and total solar and wind output (right axis), averaged over 2021-2023



Source: OpenNEM data.[5]

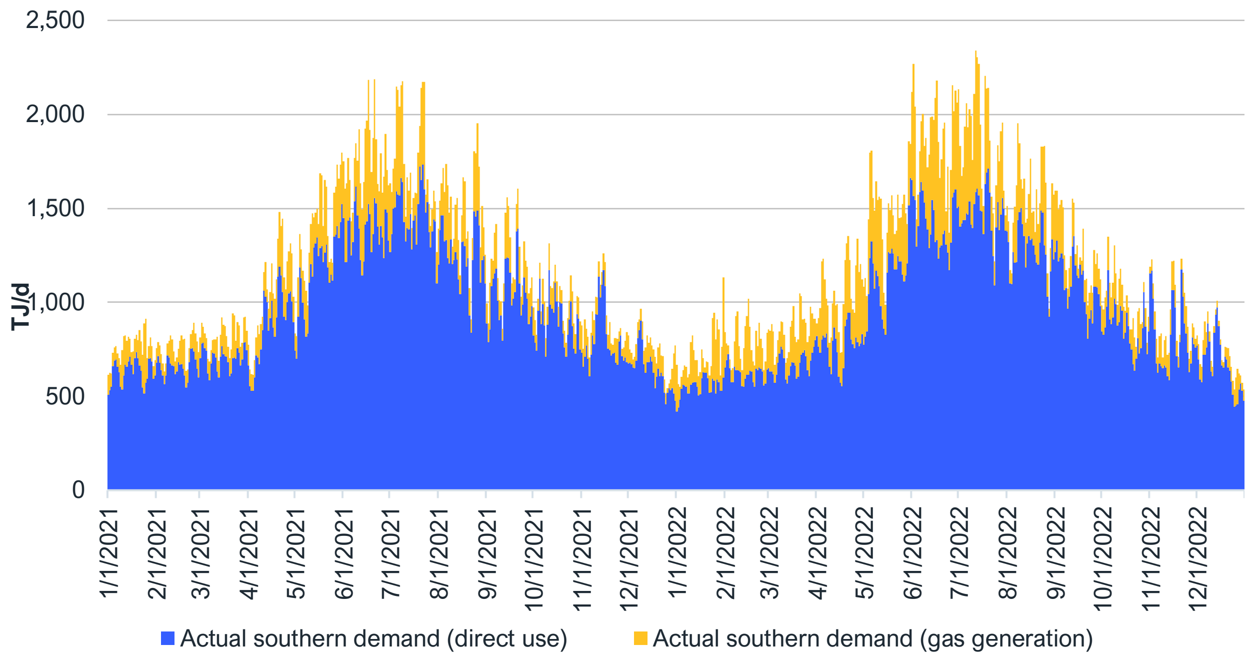
Victoria will also need occasional flexible generation to help cover abnormally high demand or low generation periods, which Tasmanian hydro generation assets can assist with. In the 2022 ISP and draft 2024 ISP, AEMO estimates that in its central scenario, Victoria will require up to about 4,000GWh of gas peaking generation and a 70%-90% increase in gas peaking capacity to help manage those issues.[6]

Victoria's historically high gas production is declining, increasing the risk of shortfalls across southern states, initially in winter, as forecast by AEMO.[7] At present, winter gas demand in southern states (including gas-fired electricity generation) is about two and a half times higher than summer, as shown in Figure 2.[8,9] Reducing southern Australia's gas and gas-fired electricity demand through renewable electrification and energy efficiency improvements, especially in winter, can cut carbon emissions and address emerging gas shortfalls.[10] Beyond this, increased use of hydro generation assets could reduce gas powered generation, reducing power sector gas demand. This could also alleviate the risk of gas supply shortfalls.

> **Increased use of hydro generation assets could reduce gas powered generation, reducing power sector gas demand.**

[5] OpenNEM. National Electricity Market Data. VIC. All. Month. Data extracted on 07/02/2024.
[6] AEMO. 2022 ISP. Generation Outlook; and AEMO. Draft 2024 ISP Consultation. Draft 2024 ISP generation and storage outlook.
[7] AEMO. Gas Statement of Opportunities. March 2023.
[8] Includes New South Wales (NSW), Australian Capital Territory (ACT), Victoria, South Australia and Tasmania.
[9] Total gas demand in winter months (June to August) is 2.3 times higher than in summer months (December to February) across 2021 and 2022.
[10] IEEFA. Reducing demand: A better way to bridge the gas supply gap. 16 November 2023.

Figure 2: Actual daily southern gas demand, 2021 and 2022



Source: AEMO[11]

This paper provides an initial exploration of how the Basslink interconnector to the mainland and existing hydro resources are being operated in relation to imports and exports. It considers ways to optimise utilisation of Tasmanian hydro generation and Basslink by hoarding water in hydro dams. This can be done by improving Tasmanian energy productivity and increasing renewable electricity generation. This has potential implications for other hydro generators and broader energy market participants. Optimisation of existing Tasmanian assets could provide dispatchable power to the mainland when needed, helping reduce the need for costly, emissions-intensive peaking gas generation or new-build pumped hydro projects. It would deliver increased revenue for the state, and could also put downward pressure on energy bills for Tasmanians.

IEEFA recognises that Tasmania's 'Battery of the Nation' project initially involves maximising Tasmania's hydro power capacity, including the potential redevelopment of the Tarraleah hydro power scheme and adding pumped hydro at Lake Cethana.[12] We also note that federal, Victorian and Tasmanian governments have recently reached agreement on shares of funding for the Marinus undersea power cable. This report does not analyse the economic value of those projects, but instead looks at opportunities to optimise existing and planned assets to support Victoria's energy transition while benefiting Tasmanians.

[11] AEMO. 2023 Gas Statement of Opportunities – report figures and data. April 2023. Figure 4.
[12] Hydro Tasmania. Battery of the Nation.

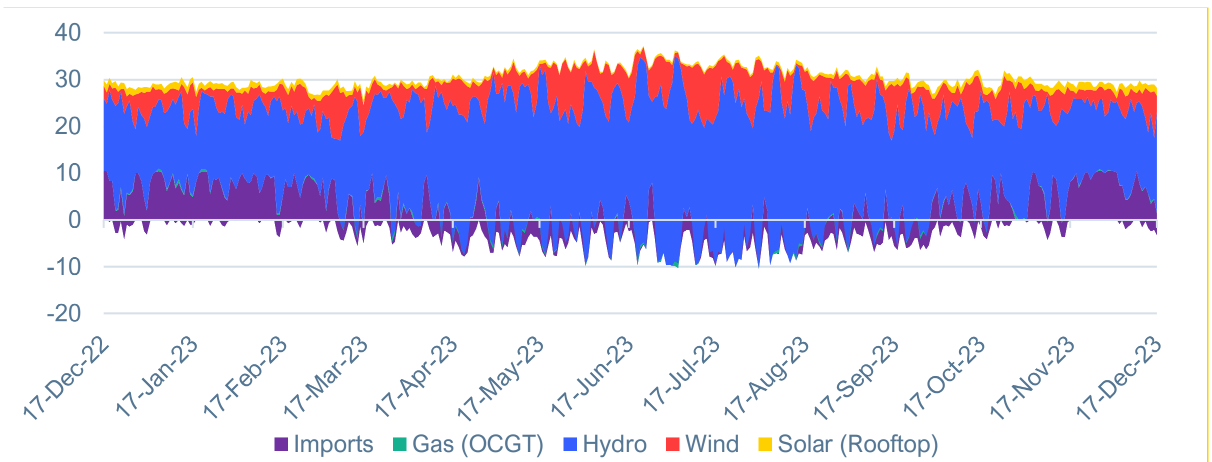
Optimising Tasmania's electricity storage potential

Tasmania already provides seasonal storage for Australia

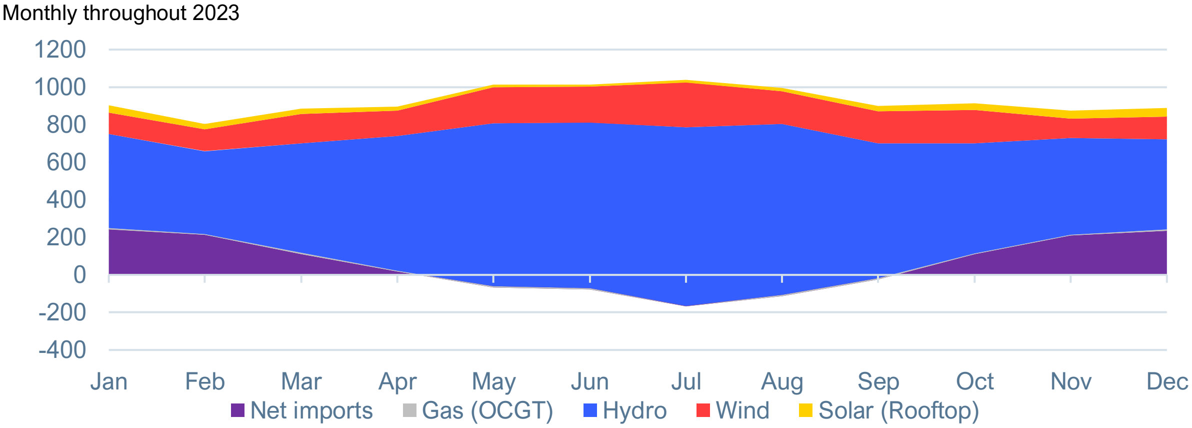
Figure 3 provides an overview of recent operation of the Tasmanian electricity system. This shows the key role played by hydro, the useful-but-variable role of wind, the small, seasonal role of solar, and the significance of summer imports and winter exports (exports are equal to the generation volumes below the horizontal axis). Electricity consumption peaks in winter, mainly driven by heating for buildings, while heavy industry drives substantial demand all year.

Figure 3: Tasmanian electricity generation, GWh

Daily from 17 December 2022 to 16 December 2023



Monthly throughout 2023



Source: OpenNEM data.[13]

[13] OpenNEM. National Electricity Market Data. Energy; Tasmania; One year; By day. Accessed 18 December 2023. And Energy; Tasmania; All; By Month. Accessed 7 February 2024.

Exports appear below the horizontal axis. The upper chart shows both exports and imports on each day, while the bottom chart shows net imports (imports minus exports) for each month.

Tasmania is already providing some seasonal storage for mainland Australia. Over the months October 2022 to March 2023, Tasmania imported a net total of 1,100GWh from the mainland. Over the months of May to September, it exported a net total of 450GWh to the mainland.[14]

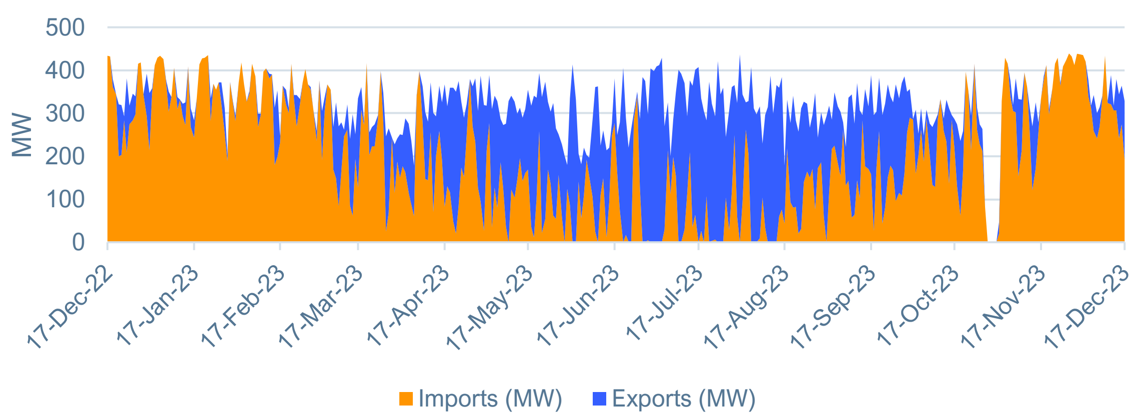
Tasmania's approach is more cost-effective and energy-efficient than many pumped hydro systems because it utilises existing system capacity and has limited losses. Losses for the cable and associated infrastructure are relatively low at between 3.5% and 6.5% each way, depending on the rate of power transfer, so round trip losses are between 7% and 13%.[15] Typical pumped hydro losses are around 20%.[16]

Figure 3 shows that hydro generation is currently used in large volumes to meet daily demand in Tasmania. Hydro generation could be used more strategically at times of best value, while the majority of daily demand could be met by other means, including renewable sources like wind and solar, and demand-side measures to limit and manage demand, as discussed later in this report.

Basslink utilisation could be increased for imports and exports

Figure 4 shows the average daily imports and exports in megawatts, so that export and import demand can be compared with the capacity of the powerline.

Figure 4: Total daily Tasmanian imports and exports, 17 December 2022 to 17 December 2023



Source: Derived from OpenNEM datafile Tasmania, downloaded 6/10/2023

[14] OpenNEM. National Electricity Market Data. Energy; Tasmania; One year; By day. Accessed 18 December 2023.
[15] IEEFA calculations using equations from AEMO. Marginal Loss Factors: Financial Year 2022-23. April 2022. Page 56.
[16] Project Finance. Storage efficiencies. 12 April 2021.

Tasmania often imported and exported 300MW to 400MW of electricity for significant periods in winter, with several days presenting much lower volumes.[17] This is often materially lower than Basslink's capacity. Basslink can export continuously at around 500MW (from Tasmania) and import at 480MW; it can export for short times at up to 630MW, though it then needs time to cool down at lower output.[18] Energy losses in the cable reduce the net amount of electricity delivered to Victoria by up to 6.5% (see previous section), but Figure 4 presents data for Tasmania, the source of electricity for exports to the mainland, so IEEFA has referred to the output at the Tasmanian end of the cable.

Tasmania often imported and exported 300MW to 400MW of electricity for significant periods in winter, with several days presenting much lower volumes.

At times, even in winter, Basslink is used to import electricity. This may be because that is when importing is more profitable – for example during mild, sunny Victorian weather – and it leaves more water stored in hydro dams for Tasmania to export when export prices are high.

In principle, it seems that Basslink has the technical capacity to import and export more electricity than it does now. It is frequently not using close to the capacity of the cable, even in winter. Increasing the utilisation of Basslink appears to be technically feasible. In particular, it seems feasible to materially increase exports in winter both by increasing the utilisation of Basslink, and by reducing imports.

There are certain times where it would be desirable to increase the exports from Tasmania to Victoria, for example when power prices on the mainland are high. Higher Basslink exports could reduce National Electricity Market (NEM) spot market prices by adding more competition, driving down the marginal bidding price that sets the price for all generators operating at that time. Higher Basslink exports at this time could also generate additional revenue for Hydro Tasmania, the predominant electricity generator in the state. As Hydro Tasmania is a state government-owned entity, this would help to raise revenue for government services.

Increased Basslink exports from Tasmania to Victoria could also provide valuable dispatchable generation at times when the mainland requires it, reducing the need for high-emissions gas-powered generation or expensive new pumped hydro assets.

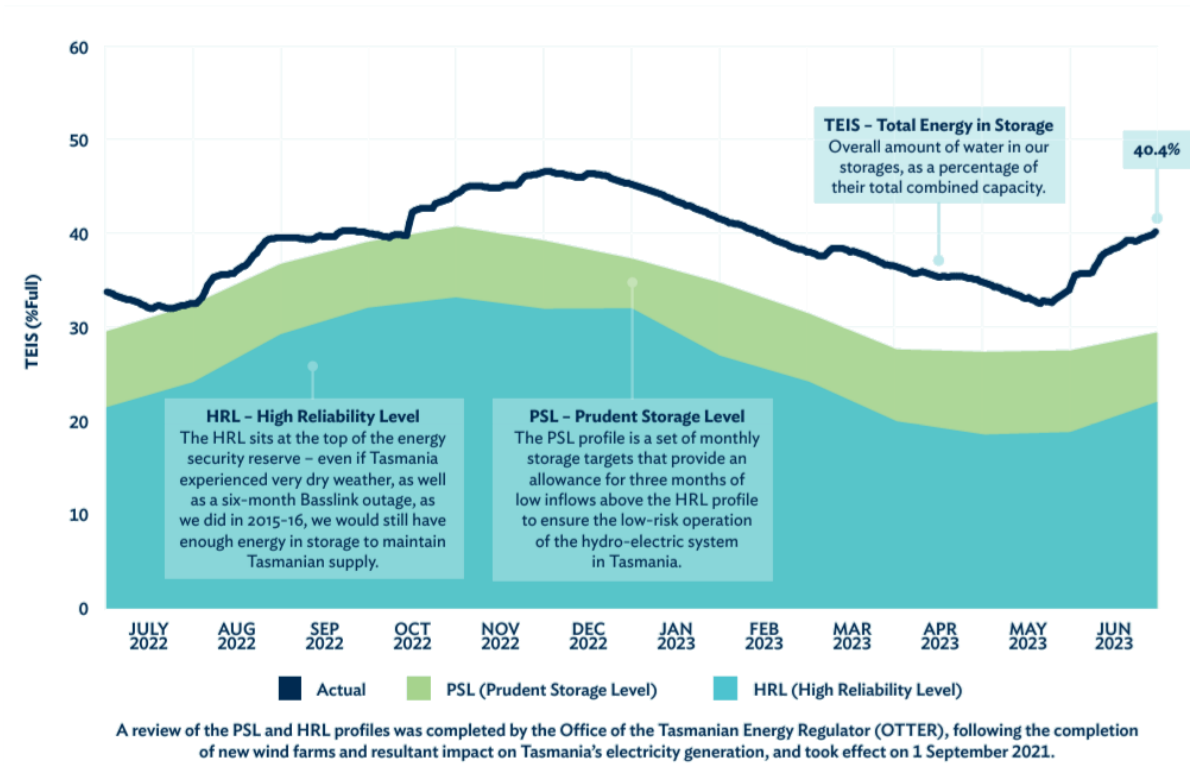
Various strategies, discussed below, could help increase exports and improve Basslink utilisation.

[17] OpenNEM. National Electricity Market Data. Accessed 6 October 2023.
[18] Office of the Tasmanian Economic Regulator. Tasmanian Market Watch – Reader guide and glossary.

Hoarding water in Tasmanian dams could unlock more exports

To ensure low-risk operation of the hydroelectric system, Hydro Tasmania, sets a Prudent Storage Level (PSL) for its dams, which varies depending on the month, year and rainfall. Figure 5 shows that in financial year 2022-23 water storage reserves dropped to within the PSL in July and October 2022. This suggests that low water storage was a key factor limiting winter exports at times in the second half of 2022.

Figure 5: Hydroelectricity storage compared with energy security levels



Source: Hydro Tasmania[19]

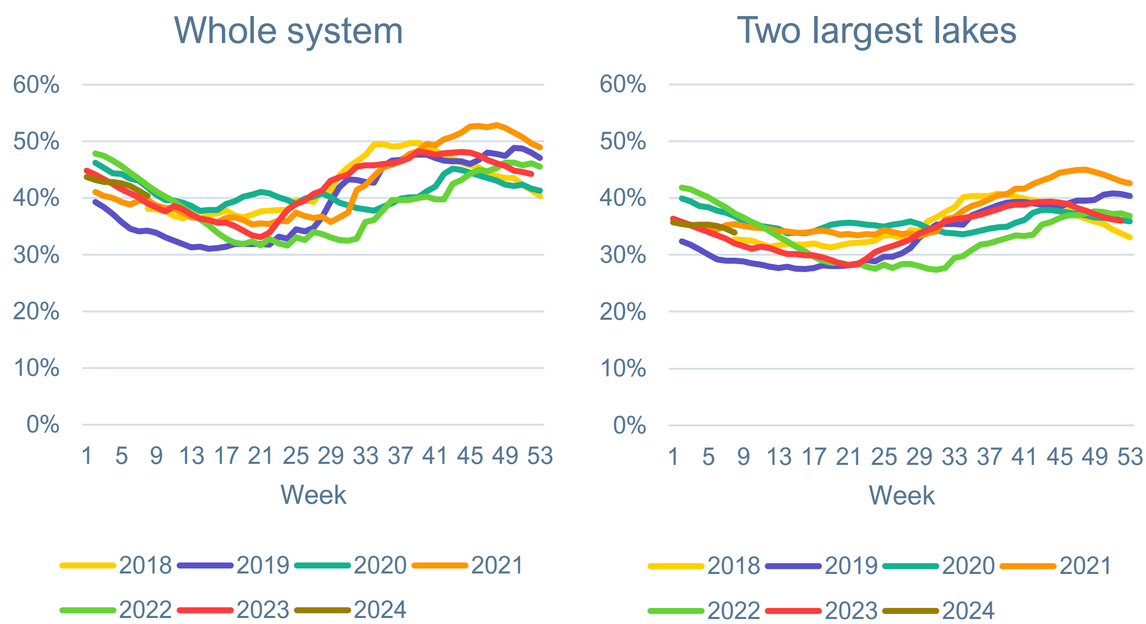
However, to alleviate this constraint, it seems that Tasmania has substantial opportunities to increase its water storage reserves beyond its usual utilisation of stored water before or during winter. Improved winter energy efficiency would also reduce local demand for hydro generation in winter, potentially lowering the PSL.

Figure 6 shows that maximum capacity utilised by stored water is typically less than 50% of the total storage capacity. The total storage capacity of the system is 14,437GWh equivalent.[20] This implies that, if more Tasmanian electricity demand could be reduced or met from sources other than hydro –

[19] Hydro Tasmania. Annual report 2023. September 2023. Page 13.
[20] Hydro Tasmania. Energy storage – historical data. February 2024.

such as wind, other generation or imports – there is the potential to build up additional storage. Hoarding water like this could materially increase the capacity for winter exports to improve mainland grid security, as well as increase Tasmania's energy security.

Figure 6: Water storage reserves for hydroelectricity, Tasmania, 2018 to 2024, % total storage capacity



Source: Hydro Tasmania[21]

It is worth noting that the Tasmanian water storage system is very complex, consisting of "52 lakes, 54 large dams, 140 small dams and weirs and 30 hydro power stations around Tasmania".[22] Some of the smaller lakes, dams and weirs will not have the capacity to hoard water over long periods of time for seasonal storage. Some aspects of the 'Battery of a Nation' project are intended to enhance flexibility and capacity of the overall system.[23]

The two largest water storage assets – Lake Gordon/Pedder and *yingina*/Great Lake – which represent about two thirds of overall storage capacity, are potentially the most promising for longer-term storage. Focusing on those two lakes from a storage perspective, we found that water storage reserves were always below 45% in the last six years, only rising above 40% for a few months in 2021. This suggests in theory that in those two lakes alone there is an untapped storage potential of

[21] Hydro Tasmania. Energy storage – historical data. February 2024.
[22] Hydro Tasmania. Water.
[23] See for example, Hydro Tasmania. Repurposing Tarraleah hydropower scheme for the future electricity market. January 2018.

at least 6,200GWh.[24] However, it should be noted that environmental issues may have some influence on utilisation and reduce this potential.[25]

The two lakes each supply a single power station, which may also place limitations on their ability to dispatch stored energy when needed. The Gordon/Pedder power station has a capacity of 450MW,[26] with the Poatina Power Station at *yingina*/Great Lake has a capacity of 363MW.[27] This adds up to a minimum of 813MW of dispatchable capacity associated with long-term storage. This is higher than Basslink's capacity. More detailed analysis would be required to properly assess the capacity of the full Tasmanian system to provide dispatchable seasonal storage and factor in environmental factors.

Other factors such as Tasmanian electricity demand, wind generation and hydro generation levels do not seem to significantly constrain exports (see Appendix A).

Wholesale spot electricity prices influence Basslink utilisation

Rainfall patterns are a major driver of import/export levels. Winter months in Tasmania typically get nearly twice as much rainfall as summer months.[28] With limited storage capacity available in the smaller dams and weirs, Hydro Tasmania may have to generate hydroelectricity even when there is no local demand for it, or allow spillage that generates no revenue.

> **Data also suggests that a material share of imports and exports are driven by price considerations.**

However, data also suggests that a material share of imports and exports are driven by price considerations – typically there are high levels of imports when prices are low in Victoria, and high levels of exports when prices are high in Victoria (see analysis below). This pricing arbitrage delivers a financial benefit for Hydro Tasmania, which then benefits the state by increasing the government's revenues. Electricity losses and Basslink utilisation costs would be deducted from the gross revenue.[29]

Additional revenue can also be achieved from participation in FCAS markets, which are evolving and becoming more valuable as large rotating generators are phased out. FCAS involves injecting or reducing electricity demand quickly to maintain network system stability. Unlike the other DC lines in the NEM, Basslink has a frequency controller and is able to transfer FCAS between Victoria and Tasmania.[30]

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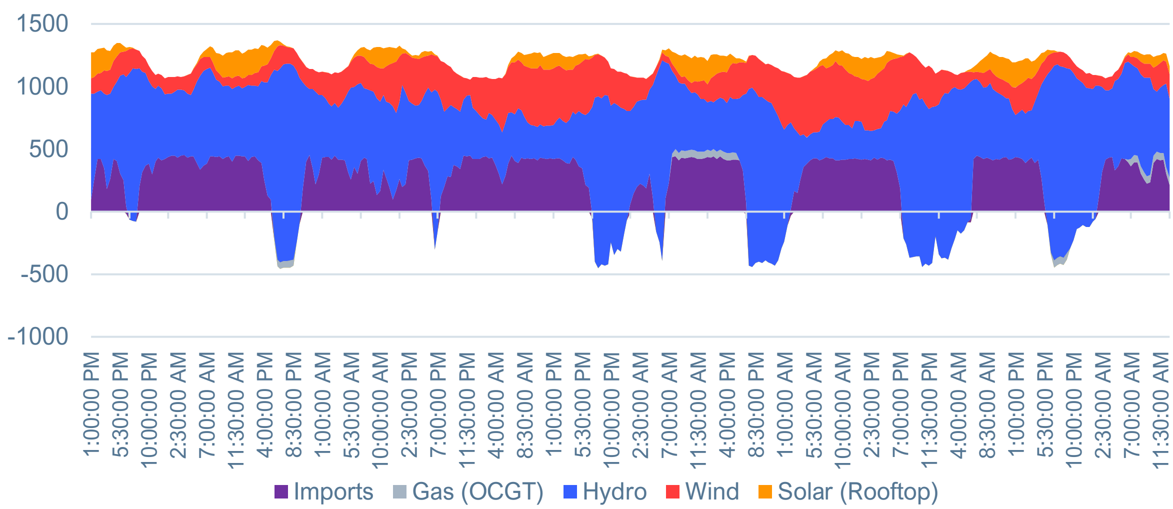
[24] Hydro Tasmania. Energy storage – historical data. February 2024.
[25] For example, see Restore Lake Pedder
[26] Hydro Tasmania. Our power stations. Gordon-Pedder.
[27] Hydro Tasmania. Our power stations. yingina / Great Lake.
[28] Bureau of Meteorology (BOM). Climate data online. Monthly rainfall. Miena Dam. Accessed 21 February 2024.
[29] APA Group. Basslink. APA Group currently owns Basslink. "A revenue contract is in place with Hydro Tasmania until 30 June 2025, by which point it is expected that Basslink will become a regulated asset."
[30] AEMO. Interconnector Capabilities for the National Electricity Market. November 2017.

IEEFA has analysed whether mainland wholesale electricity prices are correlated with Basslink electricity flow direction. IEEFA analysed half-hourly data for the week of 11 December 2023 and found partial correlation. Figure 7 presents the half-hourly generation profile for Tasmania. It shows that hydro generation dramatically increases around the evening peak each day to feed net exports of electricity when mainland demand and prices are high. In contrast, hydro generation generally drops in late evening and throughout the day and is replaced by imports of lower-priced electricity.[31]

Figure 7: Tasmania half-hourly electricity generation by source during the week of 11 December 2023, MW



Source: OpenNEM data.[32] Exports appear below the horizontal axis.

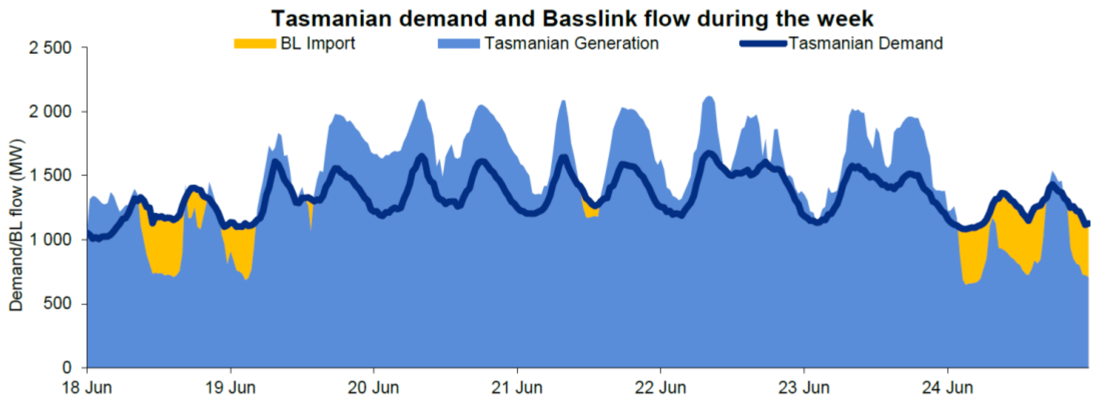
IEEFA correlated the net exports from Tasmania with Victorian wholesale price data for that week using AEMO data accessed through OpenNEM. The results can be seen in Appendix A. Large volumes of exports tend to correlate with relatively high Victorian wholesale prices. In particular, there are no exports below a wholesale price of $58 per megawatt-hour (MWh). On the contrary, large import volumes often correspond to relatively low Victorian wholesale prices, with many of the highest import times corresponding to prices below $0/MWh.

While IEEFA does not have access to this detailed data for the winter months, the following graphs illustrate how Basslink was used at various times throughout 2023.[33] The June week shows substantial exports on weekdays and some imports on weekends, presumably when Victorian prices are lower, possibly due to lower business demand and/or mild weather. January shows extensive imports, apart from the evenings of Tuesday 17 and Wednesday 18, possibly due to mainland hot weather or plant failure. The November week shows some exports in evenings and overnight, similar to the December week analysed above.

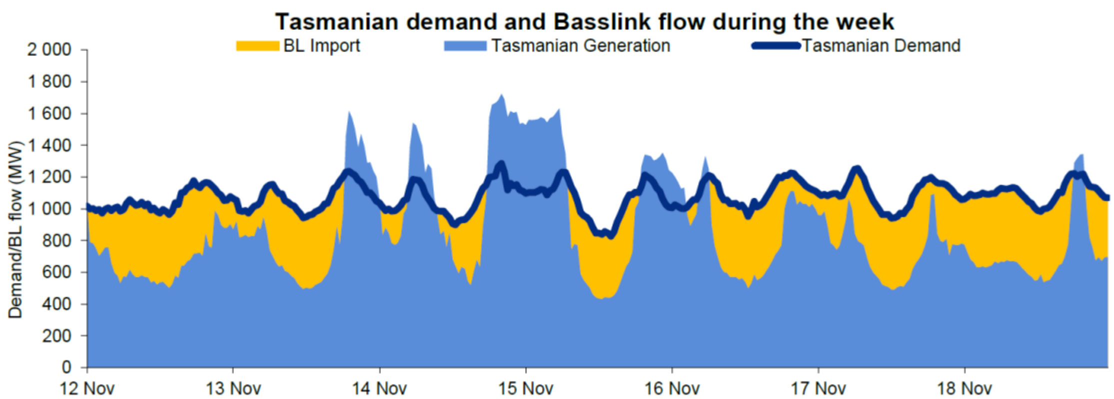
[31] OpenNEM. National Electricity Market Data. Energy; Tasmania; Seven days; 30 minutes. Accessed 18 December 2023.
[32] OpenNEM. National Electricity Market Data. Energy; Tasmania; Seven days; 30 minutes. Accessed 18 December 2023.
[33] Office of the Tasmanian Economic Regulator. Tasmanian Market Watch.

Figure 8: Examples of weekly Basslink flows and Tasmanian demand

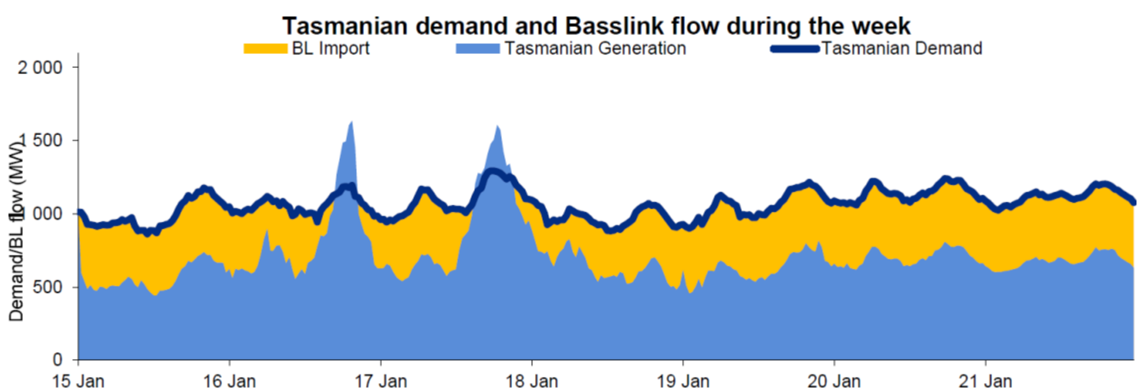
Week of 18 June 2023



Week of 12 November 2023



Week of 15 January 2023

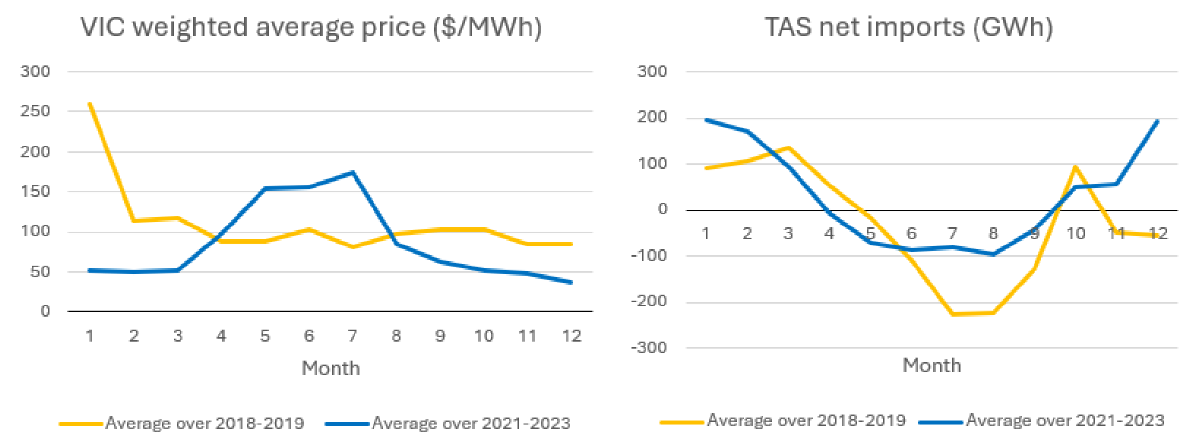


Source: Office of the Tasmanian Economic Regulator[34] Exports appear above the demand line.

[34] Office of the Tasmanian Economic Regulator. (a) Tasmanian Market Watch, Week 25. 18-24 June 2023, Page 1. (b) Tasmanian Market Watch, Week 46. 12-19 November 2023, Page 1. (c) Tasmanian Market Watch, Week 3. 15-21 January 2023, Page 1.

IEEFA also looked at the trends over the last six years to see how imports and exports have changed over time. We found that Tasmania's net imports profile changed when Victoria's wholesale price profile changed. As Victorian prices used to peak in summer, imports were low or even negative over the months of November-January. However, with the increase in rooftop solar photovoltaic (PV), prices have declined dramatically in summer and are now higher in the winter months. Imports have correspondingly increased materially in summer, while exports are focused on the winter months, leading to a more seasonal profile.

Figure 9: Victorian weighted average price ($/MWh) and net Tasmanian electricity imports (GWh) by month, comparison between 2018-19 and 2021-23



Source: OpenNEM.[35]

While wholesale spot prices do appear to provide an incentive for seasonal operation of Tasmania's power system, it appears that they do not fully maximise potential Basslink imports and exports, as the interconnector is frequently operating below its full capacity. Therefore, there may be further mechanisms or incentives needed to increase Basslink's utilisation to optimise the use of Tasmanian hydro generation from a broader societal perspective.

Summary of issues and opportunities to increase winter exports to mainland

What this analysis suggests is that:

- There is significant capacity to use Basslink to export more electricity in winter if increased hydro generation is available.
- One major limiting factor appears to be staying above prudent water storage levels throughout winter, which could be overcome by increasing storage reserves before and

[35] OpenNEM. National Electricity Market Data. VIC/TAS. All. Month. Extracted 08/02/2024.

during winter given the substantial under-utilised water storage capacity in Tasmanian hydroelectric dams.

- Victorian wholesale spot electricity prices strongly influence utilisation of Basslink.

Subsequent sections of this report suggest opportunities to address these opportunities and issues.

Energy productivity improvements

Reducing local electricity demand could reduce the required draw on hydro generation throughout the year and increase water storage reserves, while also delivering multiple benefits for Tasmanians such as improved health (and reduced public healthcare costs), comfort, productivity and lower electricity bills.

Electricity efficiency improvements can be achieved year-round in all sectors of the economy. Residential and commercial annual electricity consumption is more than 4,300GWh. At an indicative $0.25 per kilowatt-hour, this leads to residential and commercial retail energy bills of more than $1 billion annually, of which hundreds of millions of dollars could potentially be saved. While reducing this consumption reduces revenue from electricity sales, it provides extra stored water that can drive more profitable electricity exports, and may reduce electricity network costs, for example by reducing network congestion and powerline losses.

Residential equipment offers opportunities for efficiency gains

Detailed analysis of Tasmania's electricity usage is shown in Appendix B. It suggests that heating electricity consumption contributes around 2,700 kilowatt-hours (kWh) per year per household, more than a quarter of annual residential electricity consumption. There is significant potential to reduce this consumption cost-effectively.

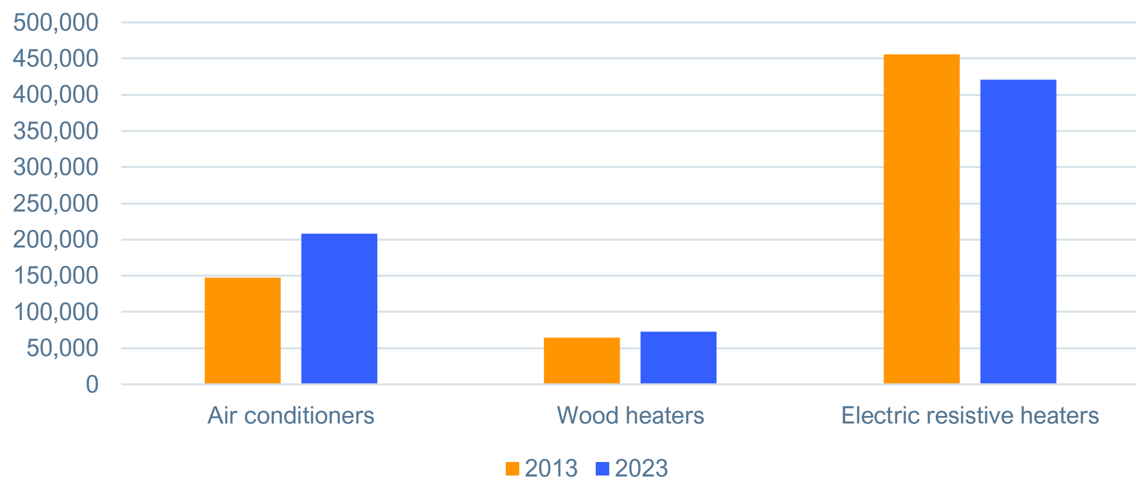
As shown in Figure 10, a large proportion of Tasmanian households now seem to own air conditioners, but resistive electric heating is still dominant. In 2023, a government study estimated that there were more than 400,000 resistive electric heaters, compared with about 200,000 air conditioners.[36] Many homes are likely to have multiple heating appliances. In 2023, the same study estimated there were about 258,650 households in Tasmania.[37] This means there were about 1.6 resistive electric heaters per household, in addition to about 0.8 RCACs and 0.28 wood heaters per household.

[36] Australian Government, Energy Rating. 2021 Residential Baseline Study for Australia and New Zealand for 2000 — 2040. Output tables for Australia. November 2022.
[37] Ibid.

Based on 2012 household survey data from the Australian Bureau of Statistics (ABS), nearly all air conditioners in Tasmania are RCACs.[38] This is not surprising given its winter-dominated climate. In addition, RCACs seemed to be used for more hours (13.2 hours a day on average) than resistive heaters (11.7 hours a day on average) to provide heating.[39] We estimate that the total residential electricity use from resistive space heaters is about 537GWh.[40]

Resistive heaters have poor efficiency compared with RCACs – they use three to 5.5 times more electricity for the same heating output.[41] Replacing resistive heaters with RCACs would help improve the efficiency of heating buildings in the state, reducing winter electricity consumption while also reducing peak electricity demand. Encouraging the purchase of higher-efficiency RCACs would further reduce electricity demand, as would more emphasis on regular cleaning of filters.[42]

Figure 10: Stock of heating equipment, Tasmania 2013 and 2023



Source: Australian government.[43]

A similar opportunity exists to upgrade water heaters. Almost all water heaters in Tasmania (85%) are resistive today. However, heat pump hot water systems are now available that can also deliver a three to five times reduction in electricity use[44]. We estimate that the total residential electricity use

[38] ABS. Household Energy Consumption Survey, Australia: Summary of Results, 2012. September 2013. HECS additional tables. Table 24A.
[39] Ibid.
[40] IEEFA calculations: based on the number of resistive heaters vs RCACs per households, the relative number of hours used, and assuming that on average resistive heaters consume twice as much energy as RCACs (assuming that RCACs are bigger in size, partially offsetting the higher efficiency), resistive heaters would contribute 78% of space-heating energy use, about 537GWh. While this is materially higher than the Residential Baseline Study, that study estimated total residential electricity use in Tasmania well below the national energy statistics.
[41] Assumes a typical Coefficient of Performance of 3 relative to resistive heating efficiency
[42] Choice. Why cleaning your air con filters (and other filters) saves you money. February 2024.
[43] Australian Government, Energy Rating. 2021 Residential Baseline Study for Australia and New Zealand for 2000 — 2040. Output tables for Australia. November 2022.
[44] Switched On. Ignore the efficiency claims made by heat pump manufacturers. 11 December 2023.

from water heaters is about 585GWh.[45] Electricity consumption could be reduced by about 70% by switching from a resistive to a heat pump hot water system, accounting for lower efficiency of heat pumps in colder temperatures.[46] This could deliver total savings of more than 400GWh per year. Recent IEEFA analysis found that each year of delay to shift to efficient appliances is costing Tasmanian households $146 million in additional lifetime costs.[47]

Upgrading residential buildings could deliver significant savings

The Nationwide House Energy Rating Scheme (NatHERS) building rating scheme models residential building thermal performance around Australia, and is used to comply with the National Construction Code (NCC). It uses hourly simulation of thermal energy flows to estimate annual heating and cooling thermal energy requirements per square metre of conditioned space. Typical existing Australian homes built before 2006 rate around one to three stars. At present a six-star rating is required for new buildings in Tasmania.[48] This will potentially be increased to seven stars in 2025, but timing is uncertain (introduction of seven-star regulations has been deferred until the 2025 NCC update).[49]

Tasmania's building stock is old. In 2012, about two thirds of buildings were estimated to be more than 20 years old.[50] Basic national residential building insulation regulations were only introduced in 2003, followed by more comprehensive five-star rating regulations in 2006, though Tasmania only introduced this in 2009.[51] Tasmania raised the required rating from five to six stars in mid-2013.[52]

Based on the NatHERS simulations, a two-star (typical) home using a RCAC with a Coefficient of Performance (COP) of 3.5 might consume around 3,800kWh each year for space conditioning of 100 square metres (sqm) of floor area in the Hobart climate zone. Most of this space conditioning energy use would be for heating. If resistive electric heating was used to maintain a similar level of comfort, it would use more than 10,000kWh. Given an estimated annual electric heating consumption of around 2,700kWh (see Appendix B), it seems likely that many Tasmanian homes heat areas smaller than 100sqm, are uncomfortably cold and unhealthy, or rely on wood heating to top up electric heating. Further research in this area seems warranted.

Figure 11 shows the non-linear energy impacts of improving building NatHERS star ratings and the related impacts on electricity demand for major Tasmanian climate zones. Upgrading a one-star

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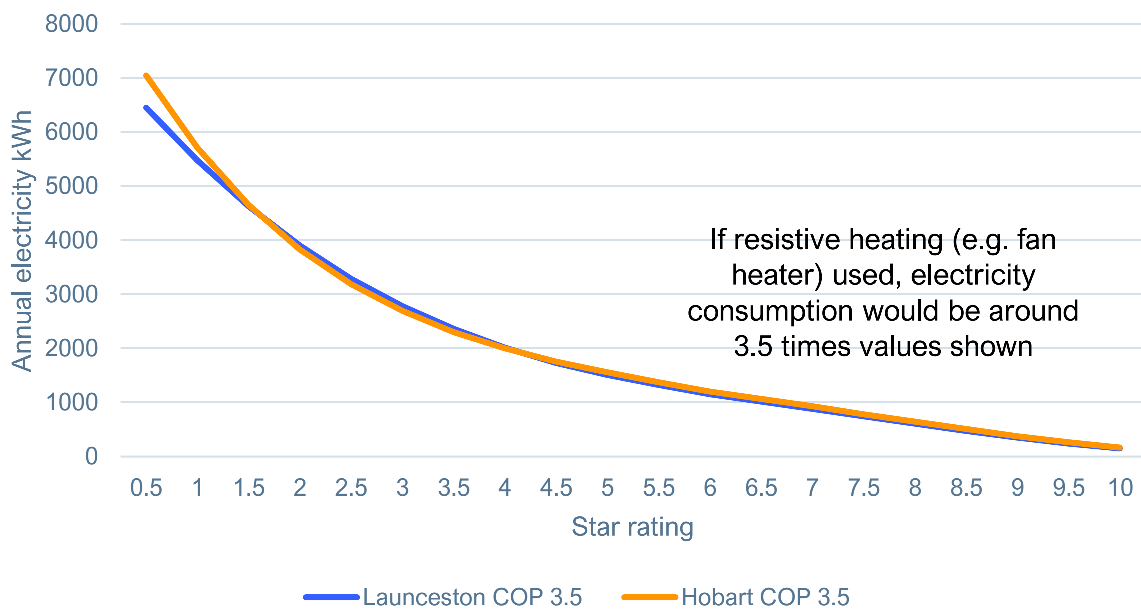
[45] IEEFA calculations: baseline estimates of 3,555kWh per household for medium-to-large resistive water heating systems, and half this consumption for small systems. This is also materially higher than the Residential Baseline Study; however, total estimated household electricity use with our heating and water heating estimates are still below the national energy statistics.
[46] Based on a bottom-up analysis of monthly electricity consumption for a 250-300-litre tank heating 125 litres per day of hot water to 60°C from monthly base temperatures, accounting for standby losses. Annual consumption was approximately 3,555kWh/year for a resistive system. Switching to a heat pump system with a Coefficient of Performance (COP) of 3 in winter and an average COP of 3.26 over the year in Hobart climate, gave annual savings of approximately 2,490kWh per household, including large winter savings.
[47] IEEFA. How efficient appliances could ease Tasmania's cost of living. March 2024.
[48] Consumer, Building and Occupational Services. Energy efficiency for new homes.
[49] Consumer, Building and Occupational Services. National Construction Code 2022.
[50] ABS. Household Energy Consumption Survey, Australia: Summary of Results, 2012. HECS summary tables. Table 19. September 2013.
[51] Torple Energy Ratings. 6 Star Energy Efficiency requirement for Tasmania Update.
[52] Building eValuate. House Energy Ratings.

house to two stars would cut space-conditioning energy use by about one third; to three stars by about half; and to four stars by about two thirds.

Figure 11: Annual electricity use by a RCAC (with COP of 3.5) required for 100sqm floor area as star rating varies



Source: NatHERS, IEEFA analysis[53]

Research released in December 2023 by Climateworks Centre has shown that detached homes with timber framing offer the most cost-effective and largest target for building upgrades, as they can have ceiling and wall (and often underfloor) insulation and draft-proofing installed at lowest cost.[54] These are the most common homes in Tasmania, where 87.7% of people live in houses, as opposed to apartments or other types of dwelling.[55] Most existing houses in Tasmania have timber frames with various cladding.[56]

Large energy savings can likely be achieved from thermal efficiency improvements to Tasmania's housing stock. For older houses, heating energy requirements can almost be halved through cost-effective measures (though some of the savings achieved may be offset by increased consumption as improved home comfort levels become more affordable). A shift from resistive heating to reverse cycle air conditioning would multiply this saving. As a result, we estimated that an overall 70%

[53] Nationwide House Energy Rating Scheme (NatHERS). NatHERS 2022 Starbands. Annual electricity consumption for heating and cooling using a RCAC with COP 3.5 based on NatHERS thermal energy flows 2022 values.
[54] The Conversation. Australian homes can be made climate-ready, reducing bills and emissions – a new report shows how. 6 December 2023.
[55] ABS. Snapshot of Tasmania. June 2022.
[56] CSIRO. Construction overview.

reduction in space heating electricity use could be achieved through a combination of equipment and thermal efficiency upgrades. This could deliver savings of about 376GWh a year.

While the resulting increase in thermal heating energy requirements may reduce total energy savings, it would also probably deliver significant improvements in health and wellbeing, and material savings to the government. A program by Sustainability Victoria found that energy efficiency upgrades delivered 10 times the amount of savings in healthcare costs as in energy costs for a sample of older people.[57] Further investigation is needed to better understand the scale of the opportunity in Tasmania.

Improving commercial buildings' efficiency has major potential

Electricity makes up 83% of Tasmanian commercial buildings' energy use, and therefore also the majority of commercial heating energy use. There is also significant use of oil, which is expensive.[58] Commercial buildings are typically poor thermal performers in extreme weather due to high levels of single glazing, high air leakage due to open doors, poor draft-sealing and other factors. They also often have significant energy distribution losses from central heating and hot water systems.[59]

Data on energy use and performance of commercial buildings is limited. Energy performance is generally very poor, as reflected in the improvements in National Australian Built Environment Rating System (NABERS)-rated commercial buildings, which have typically improved efficiency by more than 40% in recent years for participating buildings.[60] This demonstrates the significant scale of the "low-hanging fruit" opportunity.

> **National Australian Built Environment Rating System (NABERS)-rated commercial buildings... have typically improved efficiency by more than 40% in recent years for participating buildings**

National programs like NABERS and the Green Building Council of Australia's Green Star rating system mainly cover large commercial buildings: mandatory energy disclosure at time of sale or lease now applies to spaces of 1,000sqm and above. This leaves a large untapped opportunity to improve efficiency in smaller buildings and building categories not covered by NABERS. The National Construction Code – and more stringent planning requirements in New South Wales (NSW) – are driving performance improvements for new commercial buildings and major renovations.[61] However, these do not focus on existing building stock.

[57] Sustainability Victoria. Energy upgrades make 1,000 homes warmer and healthier. July 2022.
[58] Department of Climate Change, Energy, the Environment and Water (DCCEEW). Australian Energy Update 2022. Table K. September 2022.
[59] DCCEEW. Commercial Building Baseline Study 2022. August 2022.
[60] National Australian Built Environment Rating System. NABERS.
[61] NSW Government. Sustainable Buildings SEPP.

Building regulations and NABERS ratings focus on annual energy and carbon emissions, and not on delivering high performance in extreme winter conditions. Annual ratings tend to dilute the focus away from extreme weather performance because the significant internal heat generation from equipment and people in most commercial buildings means they use less heating than expected in mild weather but may be high energy users in extreme heat and cold weather.

If about 20% of commercial electricity use could be saved on average through the building stock, it would add up to about 416GWh. The scale of savings achieved by the NABERS program suggests that this is a conservative estimate.

In IEEFA's opinion there is large potential to improve peak winter energy performance and peak summer performance, not just in the Tasmanian commercial sector, but also nationally.

Upgrading building and equipment performance would free up electricity supply capacity at the time of year when it is most needed, and when it is most potentially profitable if the electricity saved was exported to the mainland. However, it does a lot more. It improves productivity, comfort and health, reduces government healthcare costs and energy subsidies, reduces consumer energy bills, increases utilisation of existing infrastructure, and accelerates decarbonisation.[62]

Demand response could help free up capacity for exports

Another demand-side opportunity is to maximise use of demand response – shifting the timing of demand. Demand response measures can be applied across many activities: for example, electric water heaters are often programmed to run in off-peak periods due to lower prices. With growing solar generation, it makes increasing sense to encourage higher electricity use in the middle of the day rather than overnight.

Large industrial sites that dominate Tasmania's overall electricity consumption may offer significant demand response potential. Small reductions in large electricity loads can be significant. Often large industrial sites can save what others see as large amounts of electricity through small changes. For example, one of this report's authors visited a large electrolytic metal refining plant where it was found that simply cleaning the busbars on which electrodes sat reduced the system voltage, saving many kilowatts of power.

Manufacturing accounts for more than half of Tasmania's electricity consumption, and more than 80% of manufacturing electricity use is not separately reported in the Australian Energy Statistics, so it presumably involves energy-intensive activities such as metal smelting and refining. Shifting some of this manufacturing consumption into lower-priced time periods may become profitable, subject to availability of undersea cable capacity. Because energy-intensive businesses typically pay low prices for energy, it can be difficult to make a business case for energy efficiency and demand management measures. As energy market rules change to allow payment for demand-side ancillary

[62] Green Building Council of Australia

services that help to maintain system stability, heavy industry may utilise demand response more. Research by Climateworks Centre and the Department of Industry found in 2014 that the demand response potential in Australian industry amounted to more than 40% of the sector's demand during system peaks.[63]

The commercial and industry sector offers substantial opportunity for demand management, which should be further investigated.

Adding generation, transmission and storage

Expanding generation capacity could increase water storage

The Tasmanian government has significant plans to expand renewable electricity generation, pumped hydro storage and interconnection with the mainland.[64] In particular, the state intends to double its renewable energy production and generate 200% of its electricity needs by 2040.[65]

> **The state intends to double its renewable energy production and generate 200% of its electricity needs by 2040.**

The state is targeting new renewable energy projects across distributed energy resources (DER) and large-scale hydro, wind and solar generation.[66] Tasmania currently utilises only about half of its water storage capacity. Doubling renewable generation from those new sources could substitute for some hydro generation now used to supply local electricity demand, conserving stored water for use at other times, including for exports. It may also directly support exports depending on Tasmanian demand and supply profiles.

The Tasmanian Renewable Energy Target translates to 21,000GWh of renewable electricity generation by 2040, double the average current levels of renewable generation.[67] This means about 10,500GWh of additional renewable generation by 2040. Both the 2022 ISP and the draft 2024 ISP proposed higher levels of new renewable generation in Tasmania (mostly wind), with about 13,000GWh by the mid 2030s.[68]

[63] ClimateWorks Australia and Australian government, Department of Industry. Industrial demand side response potential. February 2014. Page 3.
[64] Hydro Tasmania. Battery of the Nation. April 2018.
[65] Tasmanian Government. Renewables, Climate and Future Industries Tasmania – 200% Tasmanian Renewable Energy Target.
[66] Tasmanian Government. Tasmanian renewable energy action plan. December 2020. Page 10.
[67] Ibid. Page 3.
[68] AEMO. 2022 ISP. Generation Outlook; and AEMO. Draft 2024 ISP Consultation. Draft 2024 ISP generation and storage outlook.

Mainland battery capacity could increase profitable exports from Tasmania

For more than two decades there has been increasing global discussion of the potential to use energy storage as 'virtual transmission', to enhance utilisation of transmission lines as well as to provide additional benefits. For example, a 1997 paper explored ten ways of enhancing utilisation of transmission lines and concluded that batteries were second best, and could deliver "significant increases in power transfer".[69]

Virtual transmission has been defined as "the utilization of specifically configured battery energy storage systems in place of transmission capacity to provide combinations of capacity, services, and capabilities that achieve greater value than traditional solutions. Virtual transmission projects can take the form of single assets, pairs of assets working in tandem (as 'virtual transmission lines') to mimic line flows at both ends, or as a portfolio of assets across the system".[70]

Basslink's utilisation could be increased through the use of batteries. Most recently Australian discussion has focused on batteries at each end of a powerline.[71] However, given that Tasmania can use its stored water on its territory as a large battery, batteries would only be needed on the mainland. These could:

- Increase high-value exports by allowing the powerline to transfer electricity delivered at times of low demand/prices to Victoria and storing it there, ready to be dispatched in addition to Basslink supply at peak times.[72]
- Increase low-cost imports to Tasmania by charging the mainland batteries when Victorian wholesale prices are low or negative, then dispatching it to Tasmania during times when Victorian wholesale prices are higher and Basslink has capacity available for imports.
- Provide FCAS (Frequency Control Ancillary Services) to help stabilise the grid.
- 'Top up' electricity supply to Victoria if construction of new powerlines is delayed.[73]

As noted earlier, existing or new distributed batteries on the mainland could also be leveraged to optimise exports from Tasmania. At times of high Victorian demand and low variable renewable electricity generation, Basslink and a mainland 'big battery' could trickle-charge short-duration distributed batteries to reduce transmission and distribution system congestion. This would allow

[69] Electric Power Systems Research. A comparison of alternatives to enhance the utilization of transmission lines. May 1997. *Tam, Kwa-Sur*.
[70] Energy Storage World Forum. Widening Electricity Superhighways with Energy Storage as Virtual Transmission.
[71] Fluence. Lowering Grid Costs by Increasing the Utilisation of Transmission Lines. 12 January 2023; and Call for non-network options – VNI West. March 2020 (which proposes two 250MW/125MWh battery-based energy storage systems).
[72] AEMO. Draft 2024 Integrated System Plan. 15 December 2023. Page 67.
[73] RenewEconomy. Big batteries as "virtual power lines" could be quick solution to unleash wind and solar. 8 May 2023.

short-duration batteries to supply more power after several days of Victorian electricity shortfalls, reducing dependence on other options such as gas-fired generation.

While new batteries would represent additional investments, they typically would cost less than major capital works, and could also be deployed quickly with low implementation risks. They therefore represent an attractive opportunity to optimise existing transmission assets. For example, adding two four-hour batteries of 250MW to double the Basslink export capacity for peak demand times would cost an estimated $1.2 billion at today's costs, or about $0.6 billion in 2030.[74] This compares to an estimated $3-3.3 billion cost for the construction of the Marinus link, which would equate to more than $2 billion pro-rated for up to an additional 500MW of transmission capacity.[75] Batteries can also provide multiple services such as FCAS and local grid resilience.

> **While new batteries would represent additional investments, they typically would cost less than major capital works, and could also be deployed quickly with low implementation risks.**

These batteries could be built and operated by a range of private or public actors. The newly created State Electricity Commission (SEC) in Victoria could for example be a prime candidate to invest or co-invest in such assets aimed at supporting the state's energy transition and minimise energy costs for Victorians. It could also work with the Tasmanian government and its entities to minimise energy costs for both Victorians and Tasmanians.

Planned new undersea cable would increase the opportunity

The federal, Tasmanian and Victorian governments have committed to helping fund the first of two proposed 750MW Marinus undersea cables from Tasmania to the mainland.[76] Therefore in this report, IEEFA has considered the construction of the 750MW Stage 1 cable to be confirmed, but we have not included the Stage 2 cable of the same size that is still under negotiation.[77,78] The Stage 1 cable would significantly increase interconnection between Tasmania and the mainland. Recent policy statements in the lead-up to the Tasmanian state election on 23 March have raised some uncertainty about funding of the Marinus project.

If the Marinus cable is built, it will potentially be possible to apply the approaches outlined above at a much higher level. The Marinus cable could help increase water hoarding by increasing imports in summer, as well as allowing for larger exports in winter.

74 CSIRO. GenCost 2023-24. Consultation draft. December 2023. Page 74 and 77.
75 Marinus Link. FAQs. September 2023.
76 DCCEEW. Joint media release: Investing in the future of Tasmanian energy with Marinus Link. 3 September 2023.
77 AEMO. Draft 2024 ISP. January 2024. Page 57.
78 DCCEEW. Joint media release: Investing in the future of Tasmanian energy with Marinus Link. 3 September 2023.

Assuming the cable would be used about half of the year for imports, and about half of the year for exports, and assuming batteries on the mainland would allow full utilisation of the cable, it could provide about 3,000GWh of both imports and exports each year.

We have not undertaken a cost-benefit analysis of Marinus in this report, but rather focused on the implications for imports and exports.

The scale of the opportunity

Substantial under-utilised water storage could be activated

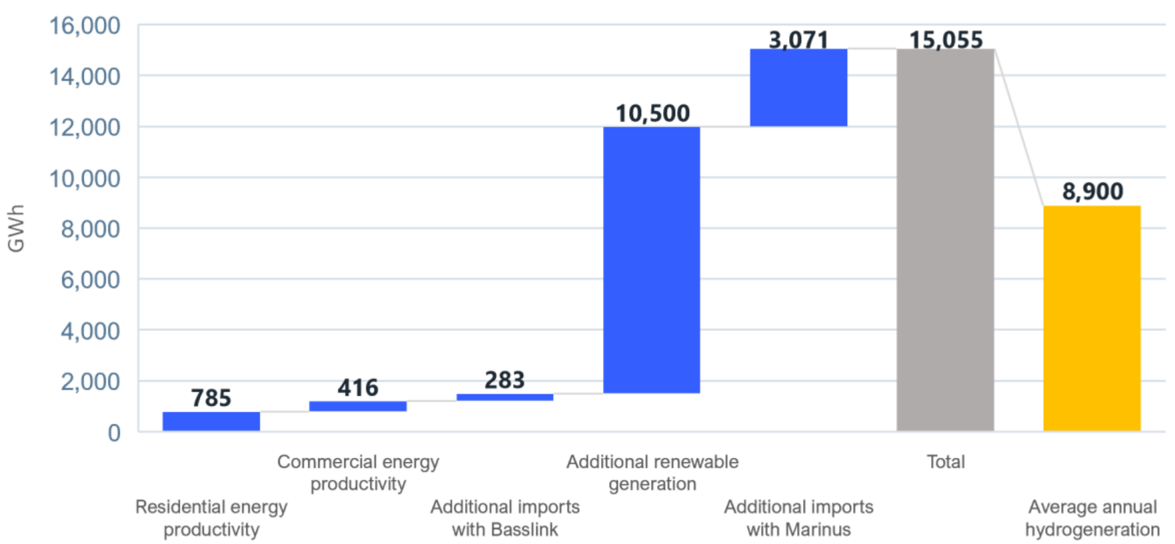
We have calculated an upper limit estimate of the potential for the measures discussed above to displace current hydro generation and increase water storage reserves in existing Tasmanian hydro generation assets. The results are shown in Figure 12 below. We found that there is more than enough potential to maximise existing storage reserves within environmental limits:

- Energy productivity improvements could achieve a reduction in residential and commercial buildings annual electricity use of about 1,200GWh. This is about 10% of Tasmania's total annual electricity consumption today.
- 10,500 GWh of new renewable generation would be added annually in Tasmania, in line with the Tasmanian government's renewable energy target.
- If Basslink and Marinus 1 transmission cables were used at full capacity for half of the year, this could deliver up to 3,350GWh of additional imports (after transmission losses) compared to 2023 levels.

Together, these opportunities add up to more than Tasmania's total annual hydro generation volume. It shows that there is more than enough opportunity to allow water hoarding in existing dams by displacing hydro generation, within environmental limits.

> **We found that there is more than enough potential to maximise existing storage reserves within environmental limits**

Figure 12: Total annual opportunity to displace existing hydro generation relative to existing use and average annual hydro generation volume over 2014-2023



Source: IEEFA analysis.

Measures that could displace hydro generation are more than enough to make usage of the total water storage capacity in existing hydro generation assets, which provides confidence that it will not be a constraint in the longer term.

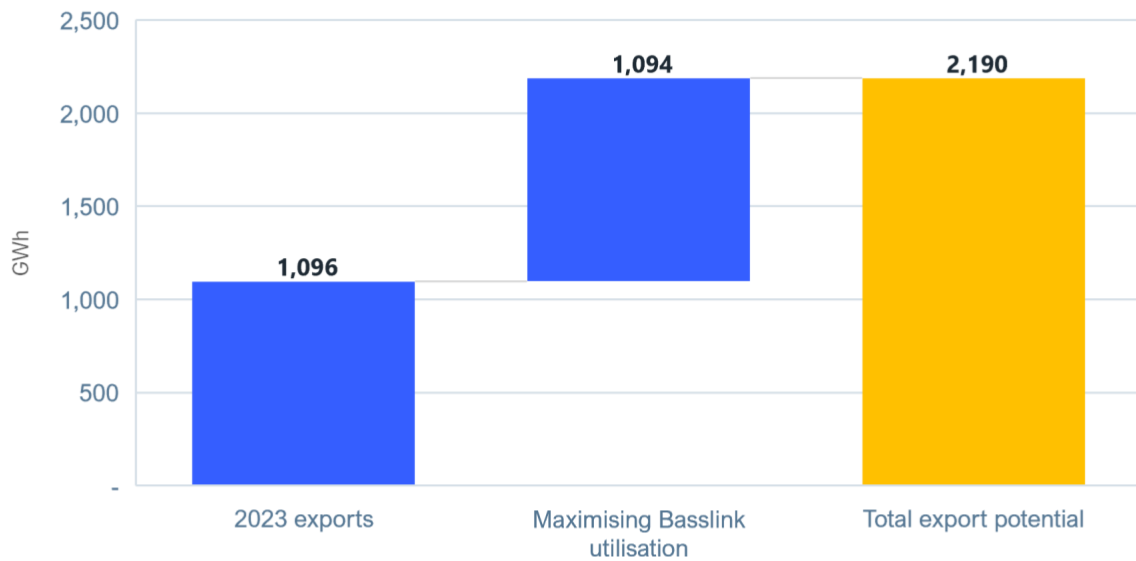
We estimated that energy productivity improvements in both residential and commercial buildings could deliver just above 1,200GWh per year of electricity savings. This is about 10% of Tasmania's total annual electricity consumption today.

Potential to optimise Basslink utilisation

Assuming now that water storage reserves are not a constraint, we estimated by how much exports could be increased if Basslink utilisation was optimised. As per the assumptions above, we assume that the cable is used about 50% of the time for exports, the rest of the time being used for imports. The numbers presented correspond to a maximum potential – if the cables could be used at full capacity all the time thanks to the installation of batteries on the mainland.

As a result, we found that exports could be doubled compared with 2023 levels by optimising the use of Basslink by applying this assumption.

Figure 13: Total annual exports potential, by maximising utilisation of Basslink (GWh)



Source: IEEFA analysis.

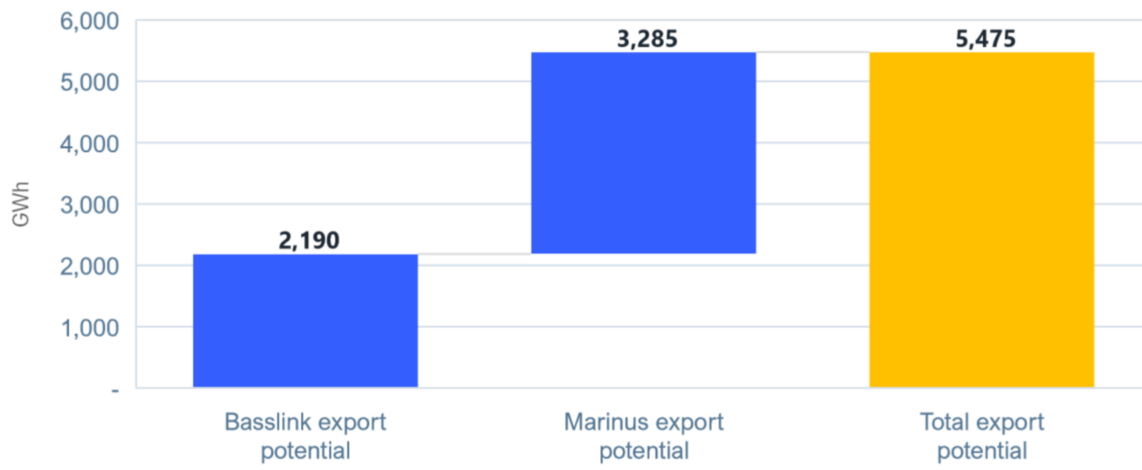
It would require about 1,000GWh more of water storage, which as per the above section could be delivered through a range of interventions. It is worth noting that energy productivity improvements would be enough by themselves to allow the optimum utilisation of Basslink. This would come at no additional net societal cost, and would instead deliver a range of benefits for Tasmanians in the form of reduced energy costs and improved health and wellbeing. The additional 'firming' would replace the use of fossil gas generation.

While we have explicitly analysed the export opportunity, it also follows that the import opportunity for Tasmania would be increased through the use of mainland battery storage. Tasmania could access a greater amount of energy at low wholesale electricity prices from the mainland, putting downward pressure on Tasmanian energy bills.

Potential to optimise Marinus utilisation

We conducted a similar analysis to Basslink for the Stage 1 Marinus cable. Using similar assumptions (maximum potential if cables are used at full capacity all the time thanks to batteries, half for imports and half for exports), we found that together with Basslink, it could deliver about 5,500GWh of annual exports to the mainland (before transmission losses). This would multiply exports more than five-fold compared with levels seen in 2023. Importantly, it could increase exports to assist mainland states at critical times in winter.

Figure 14: Total annual exports potential, maximising Basslink / Marinus Stage 1 utilisation



Source: IEEFA analysis.

The maximum level of exports estimated here is lower than the additional water storage capacity in existing hydro generation assets of at least 6,200GWh annually. However, this storage volume may be limited by environmental constraints, which this report did not cover.

It is also worth noting that the total capacity of power stations associated with the two lakes that present the best potential for long-term storage is only about 800MW, below the total transmission capacity of Basslink and Marinus of 1,250MW. Further analysis would be required to check whether other hydro and renewable generation assets could complement this capacity to provide a reliable 450MW of supply over winter.

The maximum level of exports estimated is also much lower than the total opportunity to displace hydro generation identified in Figure 12. This suggests that there would be more than enough space to both optimise exports and accommodate new electricity demand sources such as electric vehicles and new low-carbon manufacturing.

Significance for Victoria's energy system

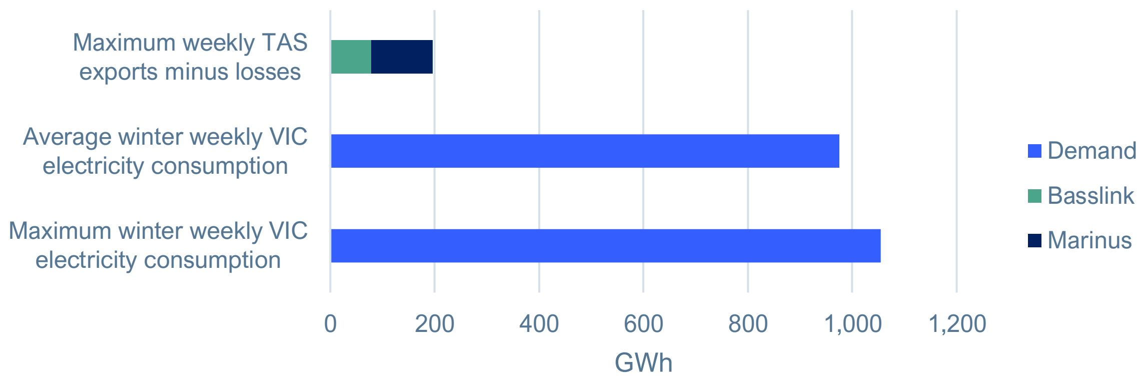
The volume and timing of electricity exports could play a significant role in providing firming for the mainland. For example, in its 2022 ISP, AEMO estimated that Victoria would need up to 4,239GWh of gas peaking generation between now and 2050.[79] These exports from Tasmania could likely replace this generation or at least materially reduce it. As AEMO points out, this gas generation may not be used often, so costs may be high. If it sets the spot price, it may also lead to higher prices at critical

[79] AEMO. 2022 ISP. Generation Outlook.

times. As Victoria shifts from gas, particularly for building heating, this firming will be increasingly important.

Figure 15 below compares the potential weekly exports to the average and maximum weekly winter electricity demand in Victoria in 2023. Exports have been discounted by 6.5% to account for losses in transmission.[80].

Figure 15: Potential Tasmanian exports to Australian mainland compared with Victorian weekly winter demand (average and maximum across June-August period)



Source: OpenNEM data.[81]

This shows that full-capacity, optimised exports from Tasmania could meet 20% of average winter weekly demand and 19% of recent maximum winter weekly demand in Victoria. The results are very similar for maximum daily demand at 18%. Just utilising Basslink at full capacity could meet 8% of the average winter weekly demand, or 7.5% of maximum weekly demand in Victoria. The use of batteries to complement the cables could help use these exports as needed to complement local generation.

This analysis was done at a high level looking at daily and annual energy figures. More detailed modelling, including time profiles and accounting for the full complexity of Tasmania and Victoria's electricity systems, would be required to confirm the findings.

[80] Author calculation for Basslink using equation from AEMO. Marginal Loss Factors: Financial Year 2022-23. 13 July 2022.
[81] OpenNEM. National Electricity Market Data. Victoria. 1Y. Week. Extracted on 09/02/2024.

Reviewing market incentives

How should use of Basslink (and Marinus) be 'optimised'?

As discussed in this paper, there is an opportunity for the optimisation of Tasmania's hydro generation assets to materially contribute to increased reliability and security of supply on the mainland, with zero emissions electricity generation and storage solutions that could reduce dependence on gas-fired electricity and higher cost solutions. This could also deliver benefits for Tasmania by optimising the value of its hydro generation assets, therefore increasing government revenue, which can then benefit all Tasmanians.

Some incentives are already available to encourage the actions discussed in this report. Pricing arbitrage can deliver revenues, benefiting from low import prices and high export prices. Some revenue sources also exist for making capacity available at times of need.

Energy policy makers have recently made commitments to establish the Capacity Investment Scheme, a mechanism to explicitly value generation capacity.[82] This is intended to create a clear, technology-neutral, long-term signal for investment to ensure reliable supply is maintained. This mechanism may support changes in operation of Tasmanian electricity assets.

AEMO can also require energy suppliers to act in ways that maintain reliability and security of supply. For example, AEMO uses the Reliability and Emergency Reserve Trader (RERT) to provide a safety net by contracting for emergency reserves that would not otherwise be available in the market.[83] Several large-scale grid batteries are already contracted to provide system integrity protection services (SIPS) by reserving some capacity.[84] AEMO also recently required the Dandenong Liquefied Natural Gas storage facility to help maintain Victorian winter gas supply.[85] There are precedents for intervention, and mechanisms to do so.

Moreover, the Victorian and federal governments are major investors in the Marinus cable, with Tasmania providing only 17.7% of the project cost.[86] Presumably this allocation of shares of investment cost reflects the importance that Victoria and the federal government place on its firming role for the mainland.

The interventions and investments suggested in this report would require coordination by a number of actors, including Hydro Tasmania, the Tasmanian government, as well as public or private owners of new batteries in Victoria. This adds a level of complexity compared to, for example, the operation of a single large battery. A full analysis of the potential system benefits that would be delivered by optimising the use of existing hydro generation assets, and a review of whether current financial

[82] DCCEEW. Capacity Investment Scheme to power Australian energy market transformation. 8 December 2022
[83] AEMO. Reliability and Emergency Reserve Trader (RERT) Quarterly Report Q2 2021. August 2021.
[84] AEMO. Draft 2024 Integrated System Plan. 15 December 2023. Page 67.
[85] Victorian Government. Victoria's Gas Substitution Roadmap Update. Page 9.
[86] DCCEEW. Joint media release: Investing in the future of Tasmanian energy with Marinus Link. 3 September 2023.

incentives are appropriate to unlock this potential, would be needed to understand whether additional financial incentives or mechanisms are required. For example, recent analysis suggests that current markets and incentives are not sufficient to support longer-duration storage.[87]

Other rule changes might be required to enable Basslink to operate in a way that maximises societal benefit. For example, at the Wind Industry Summit in May 2023, analyst Lara Kruk commented: “Today, a battery-based VTL [Virtual Transmission Line] isn’t possible: there’s no regulatory framework to support using them as a transmission solution while also treating them the same as any other transmission asset […]. But a rule change in 2021 to incentivise the better use of connections could pave the way. The rule change in 2021, which alters how multiple parties connect into a transmission network using the same large dedicated connection asset, could be extended to enable batteries to operate a VTL.”[88]

Further analysis of the role of regulation and market mechanism design may be needed to clarify the situation. IEEFA recommends that AEMO as well as relevant state energy bodies such as VicGrid and the SEC further investigate these issues.

Beyond Tasmania: The broader water hoarding opportunity

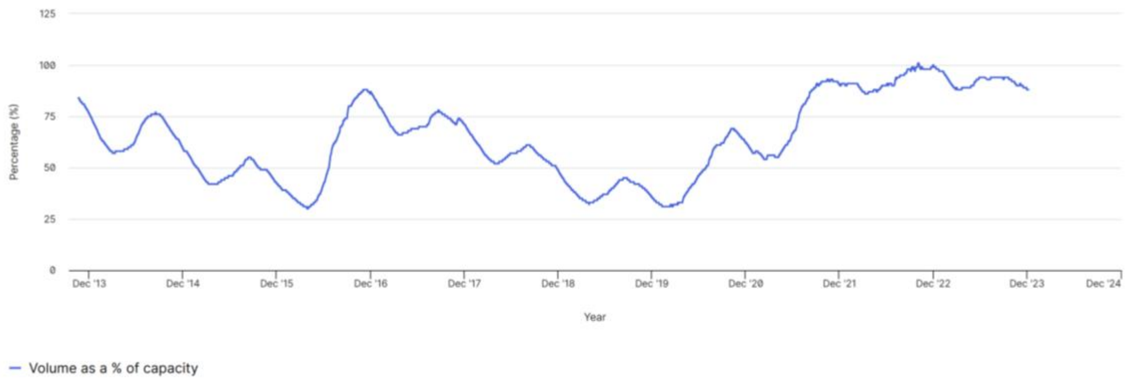
This Tasmanian approach could be applied to other hydro resources. For example, Victorian hydro capacity is over 500MW, and Victoria is entitled to around 1,500MW from Snowy Hydro. If Victorians were energy-efficient, and these hydro systems ‘hoarded’ stored water, this could also help to cover increased demand in winter.

Mainland hydro has obligations to farming irrigators to provide water when they need it, which is not necessarily when it would be useful to maintain reliable electricity supply. Arbitrage might be required when both uses are considered a high priority. Figure 16 below shows water storage at mainland hydro systems. It shows that water storage reserves have been very high in the past three years, which saw high rainfall. However, reserves were very low in 2019 after a prolonged period of drought.

In a context where timelines for Snowy 2.0 are slipping and community opposition to new transmission lines is widespread, it may be necessary for existing infrastructure such as Tasmanian hydro generation and Basslink, as well as improvements in buildings’ energy performance and mainland batteries, to play bigger roles than previously expected.

[87] Nexa Advisory. Energy storage financeability in Australia. March 2024. Page 5.
[88] RenewEconomy. Big batteries as “virtual power lines” could be quick solution to unleash wind and solar. 8 May 2023.

Figure 16: Mainland hydro water storage over time



Source: Bureau of Meteorology[89]
Current as at 7 January 2024

Conclusion

This study has shown that Tasmanian hydro is already playing an important role in seasonal energy storage and the improvement in reliability and cost optimisation of the national electricity grid, while producing revenue for Tasmania. However, it currently appears to be constrained by a number of factors. Energy inefficiencies and high electricity demand (especially in winter) within Tasmania, combined with low levels of variable renewable energy, result in high local consumption of hydroelectricity and low water storage reserves. Limited market incentives also potentially restrain exports.

A broader approach to managing energy in Tasmania – including end-use energy efficiency, demand management and smart utilisation of batteries in Tasmania and on the mainland – will be needed to optimise the state’s contribution to Australia’s transition plans, and provide reliable, affordable, zero-carbon energy solutions. Increasing generation and transmission capacity and utilisation could also deliver benefits beyond the opportunities to maximise the use of current assets.

The Tasmanian government, other Australian governments and energy policymakers will have to play major roles to achieve the necessary outcomes, because key actions are likely to be beyond the scope of Hydro Tasmania’s obligations, including implementation of many demand-side measures and a review of whether current market incentives can drive the desired outcomes in electricity companies.

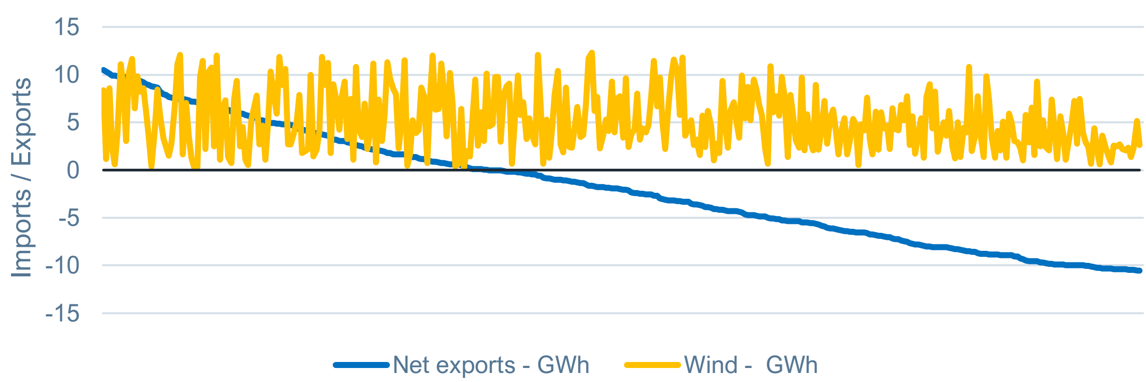
[89] Bureau of Meteorology. Southern Basin catchment.

Appendix A. Correlation of net exports with a range of factors

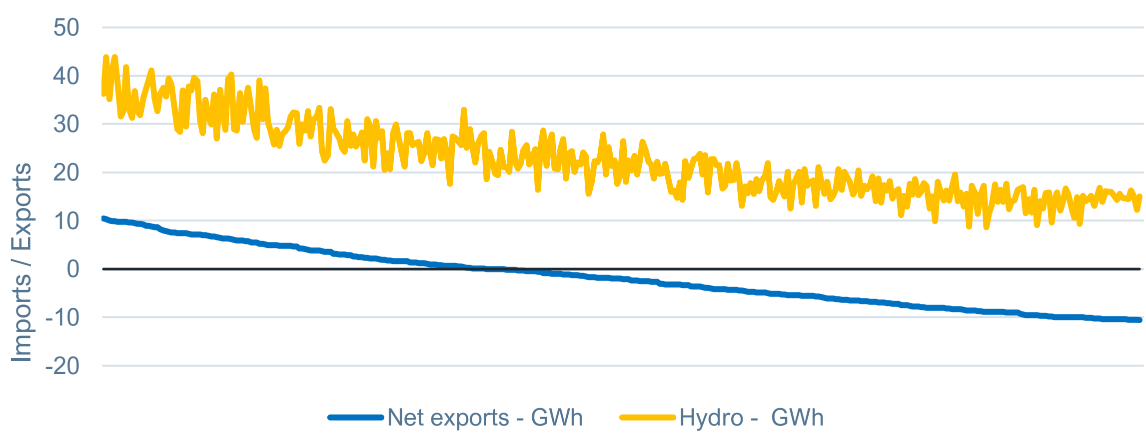
A review of daily Tasmanian wind generation and net exports (exports minus imports) over the past year shows little correlation. Indeed, high levels of exports are achieved on days with either high or low wind generation, as shown in Figure 17 (a). Levels of Tasmanian hydro generation correlate with net exports (see Figure 17 (b)). Hydro generation seems to be flexed to respond to periods of high Victorian wholesale prices. However, it seems that maximum generation capacity is only used on a small number of days (as per Figure 17 (b)) or for very short periods of time, so that hydro capacity does not seem to restrict export levels on many occasions. IEEFA also analysed how total Tasmanian electricity demand correlates with net exports, to see whether high local demand appears to restrict exports. Figure 17 (c) shows that there does not seem to be any correlation between net export levels and total electricity demand in Tasmania.

Figure 17: Comparison of Tasmanian daily net electricity exports with a range of factors

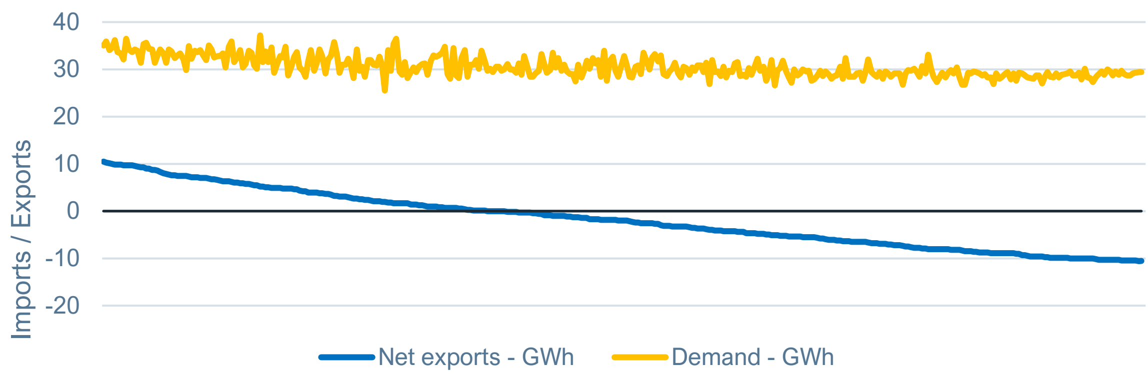
a. Tasmanian wind generation



b. Tasmanian hydro generation



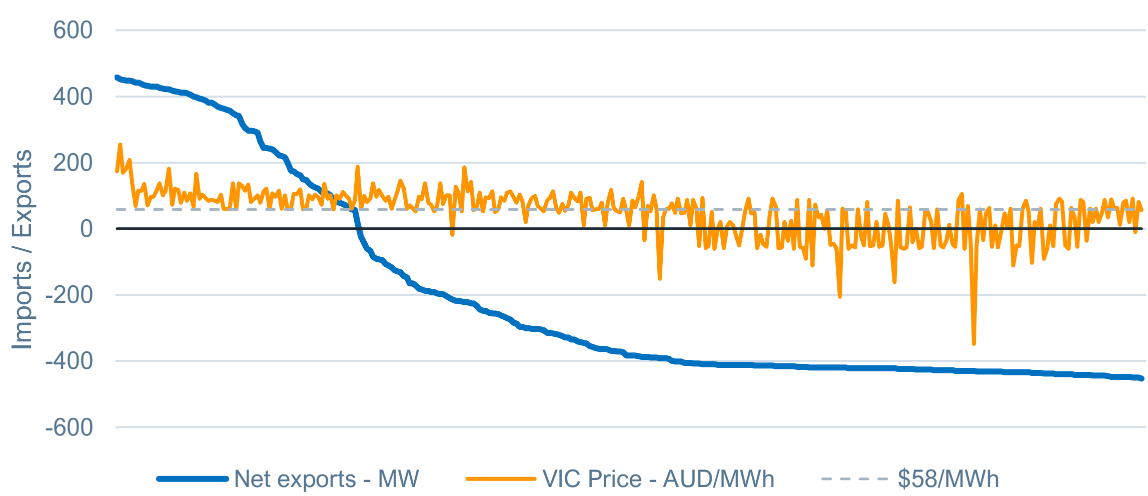
c. Tasmanian electricity demand



Source: OpenNEM data.[90] Daily data from 17 December 2022 to 17 December 2023, ordered by decreasing net exports.

IEEFA correlated the net exports from Tasmania with Victorian wholesale price data for the week of 11 December 2023 using AEMO data accessed through OpenNEM. The results can be seen in Figure 18. There seems to be at least a partial correlation between the two data series. Large volumes of exports tend to correlate with relatively high Victorian wholesale prices. In particular, there are no exports below a wholesale price of $58/MWh in that week. On the contrary, large import volumes often correspond to relatively low Victorian wholesale prices, with many of the highest import times corresponding to prices below $0/MWh (44% of exports over 400MW).

Figure 18: Net electricity exports from Tasmania compared with Victorian electricity wholesale prices during the week of 11 December 2023



Source: IEEFA analysis. Half-hourly data ordered by decreasing net exports.

[90] OpenNEM. National Electricity Market Data. Energy; Tasmania; One year; By day. Accessed 18 December 2023.

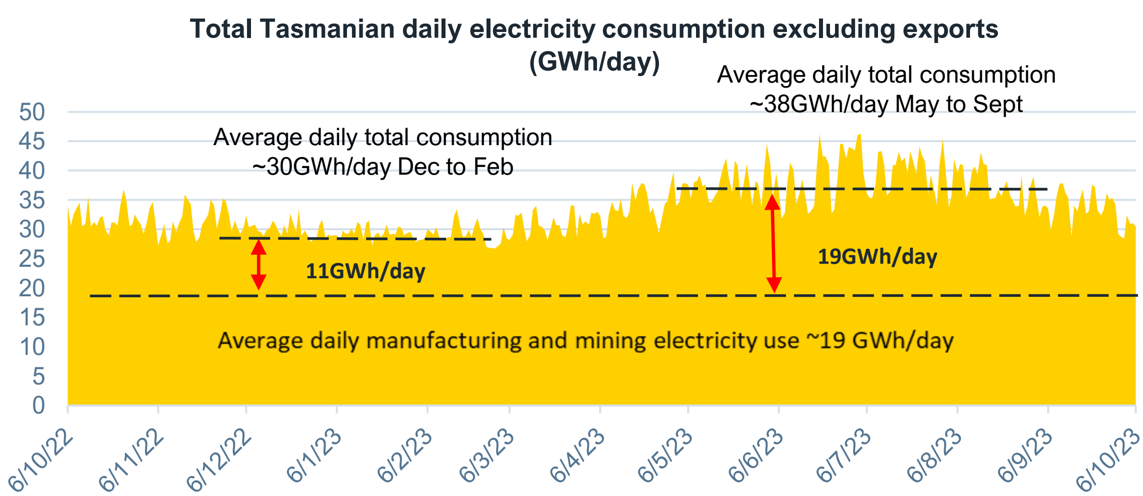
Appendix B. Heating buildings accounts for a big share of Tasmanian winter electricity use

Figure 19 shows daily electricity consumption in Tasmania. Average consumption is materially higher in winter at about 38GWh/day, compared with about 30GWh/day in summer. [91]

Assuming that mining and manufacturing electricity consumption is relatively constant throughout the year, IEEFA calculated that the average daily consumption for those sectors equals about 19GWh/day.[92] According to Australian Energy Statistics, Tasmania's annual residential electricity consumption in 2021-22 was 8.2 petajoules (PJ), equivalent to 6.2GWh/day, and commercial sector consumption was 7.5PJ (5.7GWh/day).[93] After mining and manufacturing electricity consumption, residential and commercial sector consumption makes up the majority of the remaining electricity consumption in Tasmania. While, on average, industrial and mining electricity consumption is 60% higher than the 11.9GWh/day of residential and commercial sectors, in winter, residential and commercial consumption is roughly equal to industrial/mining consumption.

The volume and spiky form of Tasmanian daily electricity consumption in winter suggest that it is strongly influenced by the heating of buildings in response to weather. Figure 19 shows that, on average, winter residential and commercial electricity consumption was around 8GWh/day higher than summer consumption, more than 70% higher than in summer (11GWh/day).

Figure 19: Tasmanian daily electricity consumption (GWh)



Source: OpenNEM, Australian government[94]

[91] OpenNEM. National Electricity Market Data. Energy; Tasmania; One year; By week. Accessed 18 December 2023.
[92] DCCEEW. Australian Energy Update 2022. Table K. September 2022.
[93] Ibid.
[94] Derived from OpenNEM data file, Australian Energy Statistics (Table K7) (actual values for December-February 29.6GWh/day, for May-September 37.75GWh/day).

The above estimates of higher building winter energy requirements due to heating are also confirmed by household survey data. Figure 20 shows seasonal variation in a typical three-person household's electricity consumption, from a 2020 survey conducted by Frontier Economics for the Australian Energy Regulator.[95] This survey is used to provide information on energy bills regarding typical household electricity consumption.

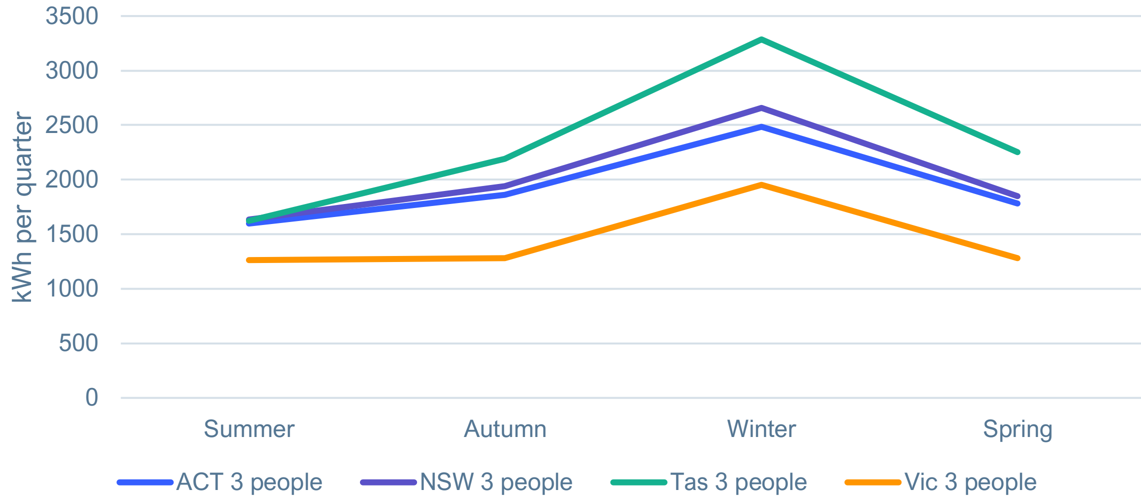
The survey confirms that Tasmanian households use much more electricity in winter than at other times. A typical Tasmanian three-person winter household electricity consumption is 3,286kWh, nearly double its summer consumption of 1,623kWh. This difference is likely to be mostly driven by heating.

Due to cold weather and shorter days, winter electricity consumption tends to be higher for water heating, lighting and some other activities, but this increase is likely to be only a few hundred kilowatt-hours per household over the winter season, much less than the impact of heating buildings. IEEFA calculated that water heating consumption over the coldest three months would likely be only 150kWh higher than over the summer months for a typical household.[96] This is likely to be on par with summer-specific electricity consumption for air conditioning. We are therefore assuming that most of the difference in electricity consumption between summer and other seasons can be attributed to heating.

In total, heating electricity consumption for a three-person household contributes around 3,000kWh/year, more than 30% of the household's total annual electricity consumption based on the household survey data. For a two-person household, it is around 2,460kWh/year. With an average of 2.4 people per household in Tasmania,[97] we have therefore estimated the average household heating electricity consumption at 2,700kWh/year. This is in line with Residential Baseline Study data, which suggests 2,620kWh/year per household for Tasmanian electric space conditioning.[98]

[95] Frontier Economics. Residential energy consumption benchmarks. 9 December 2020.
[96] Based on an assumed large electric hot water system with 125 litres per day of hot water usage.
[97] Tasmanian Government. Department of State Growth. Appendix - Population Strategy - Demographic Data and Related Tasmanian Government Strategies. November 2022.
[98] Australian Government, Energy Rating. 2021 Residential Baseline Study for Australia and New Zealand for 2000 — 2040. Output tables for Australia. November 2022.

Figure 20: Seasonal electricity consumption for a typical three-person household in several jurisdictions in climate zone 7



Source: Frontier Economics[99]

The difference between summer and winter overall usage in Tasmania is bigger than in similar climate zones (zone 7) in other states. All of Tasmania is classified as zone 7, which has hot summers and cold or very cold winters.[100]

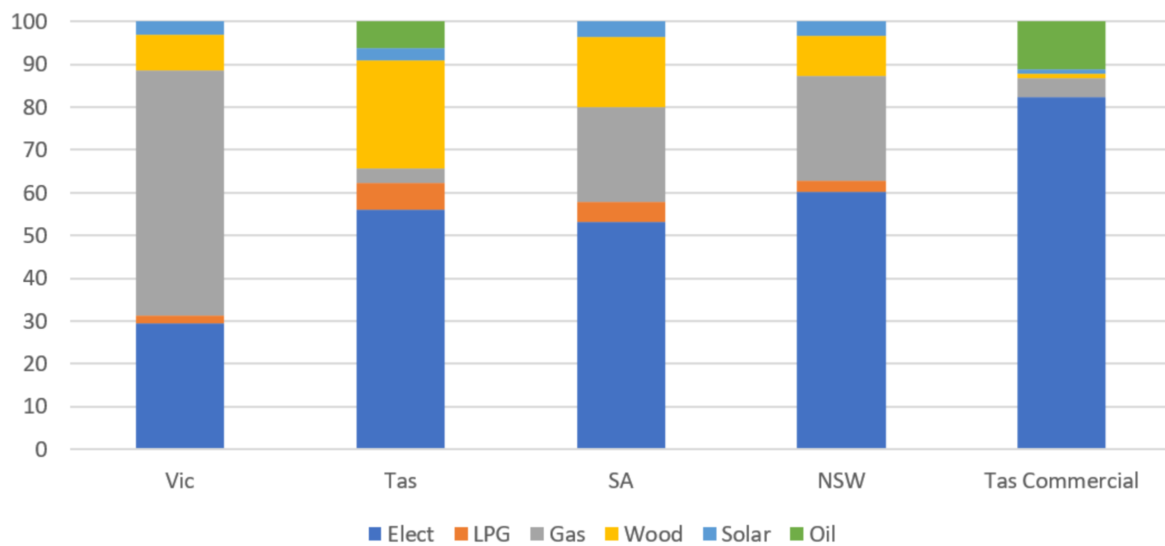
This outcome reflects multiple factors. Tasmania seems to be relying on heating equipment for more hours of the day on average than other states.[101] Tasmanian consumers also have limited access to gas due to limited networks and high costs. Gas is generally relied upon more heavily for heating in other cold climates, so there is higher reliance on electric and wood heating in Tasmania.[102]

This is illustrated in Figure 21, which shows breakdowns of annual residential energy use by energy source in southern states, as well as for the Tasmanian commercial sector. Tasmania has much lower gas consumption than other states, and this is only partially compensated by the use of wood. In future, concerns about air pollution and sustainability of wood resources may drive a shift away from wood heating towards electricity. It will therefore be important to combine building thermal improvements with installation of high-efficiency RCACs when households shift from wood. This would reduce electricity demand but also reduce the capacity and capital cost of heating equipment, and enhance the resilience of buildings.

[99] Frontier Economics. Residential energy consumption benchmarks. 9 December 2020. Page 43.
[100] ABS. Household Energy Consumption Survey, Australia: Summary of Results, 2012. September 2013.
[101] Ibid.
[102] Ibid.

The Tasmanian commercial sector's energy use is dominated by electricity, which would therefore be the main energy source for heating.

Figure 21: Energy consumption in southern states' residential sectors and Tasmania's commercial sector – percentages of energy sources



Source: Australian government.[103]

[103] DCCEEW. Australian Energy Update 2022. Table K. September 2022.

About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

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