PROJECT MARINUS

Project Specification Consultation Report

Additional interconnection between Victoria and Tasmania

July 2018

This document is the responsibility of the Project Marinus Team, Tasmanian Networks Pty Ltd, ABN 24 167 357 299 (hereafter referred to as "TasNetworks").

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Message from the CEO

This Project Specification Consultation Report is the first step in the regulatory process to examine the case for further electricity transmission interconnection between Victoria and Tasmania. It follows the establishment in November 2017 of a joint project between TasNetworks and the Australian Renewable Energy Agency (ARENA) to undertake a detailed feasibility and business case assessment.

The changes which are occurring in Australia's electricity sector have been discussed widely. Much of Australia's traditional coal-fuelled generation fleet is approaching the end of its life and there is an increase the amount of renewable generation in the National Electricity Market (NEM). The technical characteristics of the two generation types are not the same; new variable renewable energy technology such as wind and solar requires additional support to be able to substitute for traditional dispatchable generators. Hydro-electric 'hydro' generation is renewable and dispatchable, with a range of beneficial technical generation characteristics.

The unprecedented changes in the electricity industry are creating new challenges and opportunities for the sector, our customers and Governments. One area of concern is that there should be better coordination of generation and transmission network investments to deliver the best outcome for customers. We must deliver the right strategic projects in a timely way to meet the long term interests of customers in an inherently uncertain and changing environment.

Tasmania has the potential to provide diversified renewable generation, including vast quantities of dispatchable renewable generation, to the NEM. Further interconnection is needed to realise this potential. This is why TasNetworks, with support from ARENA, is investigating the viability of a second Bass Strait interconnector. A second interconnector would support more secure and reliable electricity services for Tasmanian and Victorian customers, and the broader national market. Its benefits to the national market have been recognised by Infrastructure Australia with listing as a Priority Initiative.

Analysis undertaken by Hydro Tasmania, supported by ARENA, suggests that over the longer term there are likely to be market benefits from a number of new Bass Strait interconnectors. We are presently focussed on the next interconnector, with either approximately 600 megaWatts (MW) or 1,200 MW capacity. These options are both referred to as a 'second interconnector' or 'second Bass Strait interconnector', and have a range of sub-options with regards to route location and detailed technology solutions. TasNetworks has registered a business name for this potential new interconnector: Marinus Link.

The Australian Energy Market Operator (AEMO) has recently published its Integrated System Plan (ISP). The ISP responds to the requirement for a clear generation and transmission pathway for the NEM. Interconnection is a key part of this plan, including further interconnection between Tasmania and Victoria. TasNetworks is engaging further with AEMO to understand the details of AEMO's modelling methodology, and is using updated information, some alternative scenarios and more detailed modelling to assess the optimal timing of additional Bass Strait interconnection. Our work to date suggests that Tasmania has lower cost hydro and pumped-hydro resources than other parts of the national market, and high capacity wind resources that will also complement wind and solar resources in other parts of Australia. We will continue to work closely with AEMO to ensure the optimum timing of further interconnection.

This document marks our first formal step in applying the regulatory framework to test rigorously whether further interconnection is in the long term interests of customers. It explains why we consider further interconnection between Victoria and Tasmania is needed, the interconnector options we are examining, and the benefits to both states that we believe further interconnection will bring.

We invite stakeholders to provide feedback on this consultation paper by Friday 26 October 2018 as we proceed with the next phase of the regulatory process.

This consultation, and feedback received, will also be an input to our Initial Feasibility Report on Further Interconnection, due to be delivered to the Tasmanian Government and ARENA in December this year. The Feasibility Report will take into account economic benefits assessed under the regulated investment test. It will also consider broader benefits that further Bass Strait interconnection can deliver.

We look forward to working with our customers, stakeholders, regulators and governments to assess the costs and benefits of this major infrastructure project.

Lance Balcombe

Chief Executive Officer, TasNetworks

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Abbreviations

AC	alternating current
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
ARENA	Australian Renewable Energy Agency
CCGT	combined cycle gas turbine
DC	direct current
FCAS	Frequency Control Ancillary Services
FFR	Fast frequency response
GW	gigaWatt
HVDC	high voltage direct current
ISP	Integrated System Plan
kV	kiloVolt
MW	megaWatt
MNSP	Market Network Service Provider
NEG	National Energy Guarantee
NEM	National Energy Market
NER	National Electricity Rules
NSCAS	Network Support and Control Ancillary Services
OCGT	open cycle gas turbine
PSCR	Project Specification Consultation Report
REZ	Renewable Energy Zone
RIT-T	Regulatory Investment Test for Transmission
SRAS	System Restart Ancillary Services
TNSP	Transmission Network Service Provider
TWh	terraWatt-hour

1 Introduction

1.1 This Project Specification Consultation Report

This Project Specification Consultation Report is the first step in determining whether further interconnection between Victoria and Tasmania will deliver a 'net economic benefit' as defined by the Regulatory Investment Test for Transmission (RIT-T) in the National Electricity Rules. The purpose of this document is to describe the 'identified need' that further interconnection would address. It also provides details of the assumptions underpinning this need, credible options that would address this need, how we intend to evaluate the benefits of these options, the likely implementation timetable, and indicative costs.

The objective of the RIT-T is to select the option that addresses the identified need and maximises "the present value of net economic benefit to all those who produce, consume and transport electricity in the market."[1] The minimum process for the RIT-T consultation is shown in Figure 1-1.

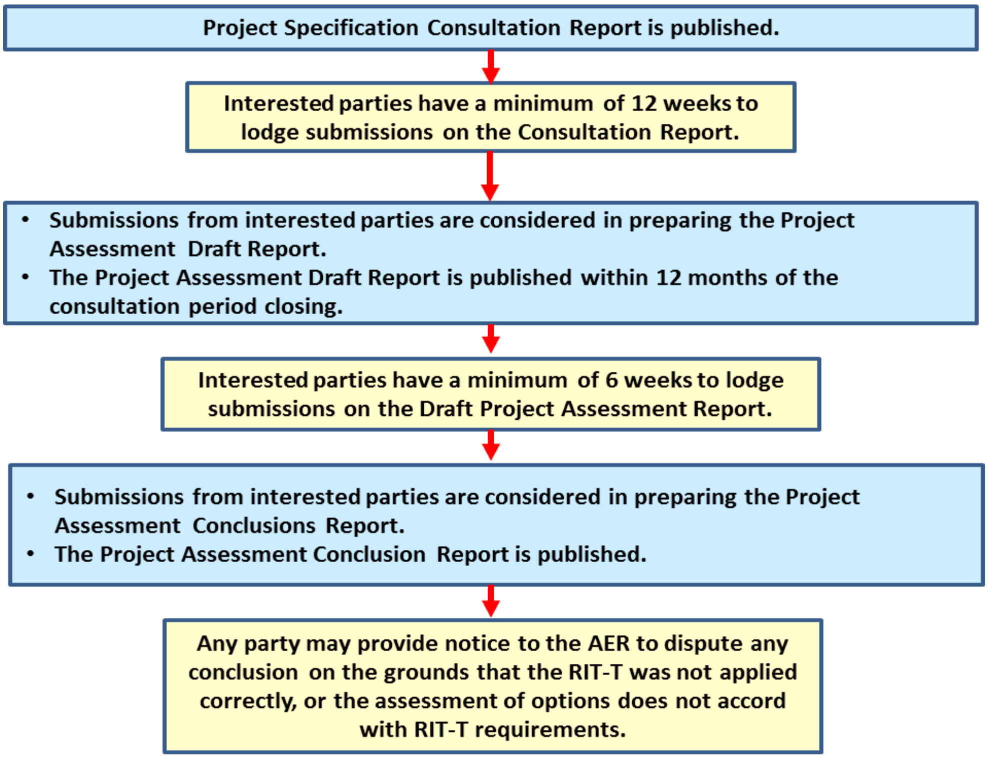

Figure 1-1: RIT-T consultation process

At this stage we have not undertaken all of the analysis required to assess whether further interconnection will stand up under the present RIT-T. The purpose of releasing the Project

[1] National Electricity Rules, clause 5.16.1(b)

Specification Consultation Report now, rather than after we have done the analysis, is to be transparent about our approach and assumptions and allow stakeholders to influence our approach.

1.2 Feasibility reports

In addition to the RIT-T process TasNetworks will be publishing an initial Feasibility Report at the end of 2018 and a Final Feasibility Report and Business Case Assessment at the end of 2019. These reports will have a broader scope than the economic analysis required by the RIT-T.

1.3 Overview of credible options

The RIT-T requires that we should consider all 'credible options' that would meet the 'identified need'.

The identified need is stated as follows:

> The characteristics of customer demand, generation and storage resources vary significantly between Tasmania and the rest of the NEM. Increased interconnection capacity between Tasmania the other NEM regions has the potential to realise a net economic benefit by capitalising on this diversity.

As discussed further in Section 7, the only credible options we have identified relate to the construction of additional Bass Strait interconnection. We propose that one credible option is the addition of a new high voltage direct current (HVDC) interconnector 'pole' with capacity of approximately 600 MW, and that another credible option is the addition of two new 'poles' with capacity of 600 MW each, or 1,200 MW in total. This 600 MW sizing approximately aligns with both the capacity of the existing interconnector, Basslink, and the largest Victorian generator contingency event. It is the largest capacity that could readily be accommodated by both the Victorian and Tasmanian power systems.

One possibility of achieving a new interconnector is to build it in the current Basslink corridor. This would require an agreement on appropriate commercial terms with the owners of the Basslink interconnector. Other alternatives include constructing the link in a new corridor between Victoria and Tasmania, which would be expected to increase the security benefits of a new interconnector more than if the existing Basslink corridor were to be used.

Analysis undertaken by Hydro Tasmania, supported by ARENA, suggested that over the longer term there may be market benefits from a number of new Bass Strait interconnectors. This RIT-T is only considering the next interconnector with either approximately 600 MW or 1,200 MW capacity. These options are both referred to as a 'second interconnector' or 'second Bass Strait interconnector', and have a range of sub-options with regards to route location and detailed technology solutions. TasNetworks has registered a business name for this potential new interconnector: Marinus Link.

Importantly, the RIT-T does not prevent a non-market participant funding all or part of an interconnector connection project if, for example, it is considered to provide additional benefits that are not captured by the RIT-T. Alternatively, further interconnection may proceed as a Market Network Service, where revenues are derived from differences in spot market prices in the Victorian and Tasmanian regions rather than from increased transmission charges. No decisions have yet been made on these matters, which are outside the scope of this report.

1.4 Next steps

AEMO has recently published its first ISP. This is an important development in AEMO's planning role in response to the Finkel Review recommendations. The role of the ISP in the RIT-T process is a matter that is currently being considered by the Australian Energy Market Commission (AEMC) in its "Coordination of generation and transmission investment" review. One possibility is that the ISP may "fast track" transmission projects through the RIT-T process if AEMO classifies these projects as "least regret" investments. As discussed in Section 5, we will consider AEMO's ISP and its supporting information and modelling assumptions in the next stage of our analysis. Where it is appropriate to adopt different assumptions or forecasts to those presented in the ISP, we will provide an explanation in our Draft Project Assessment Report, which is the next stage of the RIT-T process.

In the meantime, we are seeking feedback on this Project Specification Consultation Report by **5pm on Friday 26 October 2018.** We are interested in feedback on any aspect of this report, but we are particularly interested in your views on three topics:

1. Are there any other benefits that further interconnection will provide and/or are there benefits that we have presented that you disagree with?
2. Do you agree with our assumptions and our proposed approach to analysing the net market benefits under the RIT-T?
3. Do you agree that we have identified the appropriate credible options to address the identified need?

Submissions can be provided electronically to the email address provided below, or lodged by mail and sent to:

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All enquiries relating to this document or requests for information should also be directed to the person named above.

2 Background

2.1 The changing energy landscape

The future energy mix in the NEM, and how it will be managed to maintain a secure and reliable supply, is the subject of much discussion.

In the past, Australia's electricity needs have predominantly been met by coal-fuelled power stations. The recent retirement of coal-fuelled power stations[2] has caused both technical and economic impacts in the operation of the NEM.[3] More than 13,000 MW of coal-fuelled generation, representing more than 50 per cent of installed coal-fuelled generation capacity, is expected to reach the end of its economic life within the next two decades.[4]

At the same time, the need to decarbonise the world's energy supply is now well understood. Australia's Renewable Energy Target (RET), coupled with the reduction in the capital cost of renewable generation technologies, notably wind and solar, has led to a surge in renewable energy developments. State-based renewable energy targets, such as the Victorian Renewable Energy Target, are also facilitating large-scale renewable energy projects. 47 GW of renewable generation is currently proposed in the NEM, a stark contrast to the 4.8 GW of proposed fossil-fuelled generation[5]. Distributed generation, notably solar, has also increased dramatically during the past ten years, and Australia leads the world in terms of solar uptake.

While these developments are positive from the perspective of reducing emissions, they introduce new challenges in terms of operating a power system. Wind and solar generation is not dispatchable like traditional fossil-fuelled generators or hydro, which means the tasks of balancing load and generation, and maintaining the stability and security of the power system, become progressively more difficult as the amount of non-dispatchable generation increases.

If left unchecked, this combination of increasing non-dispatchable generation and progressive retirement of low-cost dispatchable generation will lead to greater wholesale price volatility. This is because higher-cost dispatchable generation or storage will be operated to fill the gap left by coal-fuelled generation at times that insufficient renewable generation is available.[6]

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[2] E.g., Hazelwood (Vic) in 2017; Northern Power Station (SA) in 2016; Playford B (SA) in 2016; Wallerawang (NSW) in 2014; Munmorah (NSW) in 2012.

[3] AER electricity wholesale performance monitoring – Hazelwood advice, March 2018.

[4] AEMO Integrated System Plan, July 2018, page 22. Stations expected to reach end of operating life by 2038 are Liddell, Vales Point, Gladstone, Yallourn, Eraring, Bayswater and Tarong.

[5] Sourced from AEMO Generator Information Page, data current at 16 June 2018. Figures quoted are the total of "committed" and "proposed" capacities; renewable generation is the sum of solar (excluding rooftop PV installations), wind, hydro and biomass; fossil fuelled generation is the sum of coal, CCGT, OCGT and other gas. Web site accessed at: https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information.

[6] Dr Alan Finkel *et al*, Independent Review into the Future Security of the National Electricity Market – A Blueprint for the Future, June 2017, page 79

Traditional generation inherently provides certain ancillary services, such as frequency control, inertia and fault level, which are essential for maintaining the stable operation of the power system. Wind and solar generation do not provide these services to the same degree as traditional generation and the reducing availability of such traditional sources for these services, paired with the impact this reduction has on power system security, has been acknowledged via recent Rule changes.[7]

Energy storage technology, such as batteries or pumped hydro, will provide part of the solution to these issues. Whilst battery storage has the advantage of flexibility of location and competitive cost, it does not provide all the ancillary services that a synchronous generator can deliver. Pumped hydro is able to provide greater quantities of stored energy and it can contribute ancillary services, but its implementation is restricted to geographically suitable locations.

These factors have raised questions regarding the overall resilience of the power system, leading to a number of industry reviews and short-term measures to address the emerging challenges. A general consensus is that the changing generation mix and energy consumption patterns warrants a greater degree of interconnection between the regions to improve resilience, leverage diversity of resources, and reduce dispatch costs.

2.2 Tasmania's electricity system

Tasmania's electricity sector is significantly different to the rest of Australia. Tasmania's energy generation is underpinned by hydropower, which typically provides around 80 per cent of the state's total electricity output. Wind power provides the second largest contribution to electricity generation in Tasmania, providing approximately ten per cent of the state's output. Other sources of generation in Tasmania include natural gas, small-scale solar, oil products and biomass.[8]

The figure below shows the generation capacity by fuel source in Tasmania compared to other regions in the NEM.

[7] National Electricity Amendment (Managing power system fault levels) Rule 2017, 19 September 2017; National Electricity Amendment (Managing the rate of change of power system frequency) Rule 2017, 19 September 2017.

[8] The gas generation indicated in Figure 2-1 is only used for backup.

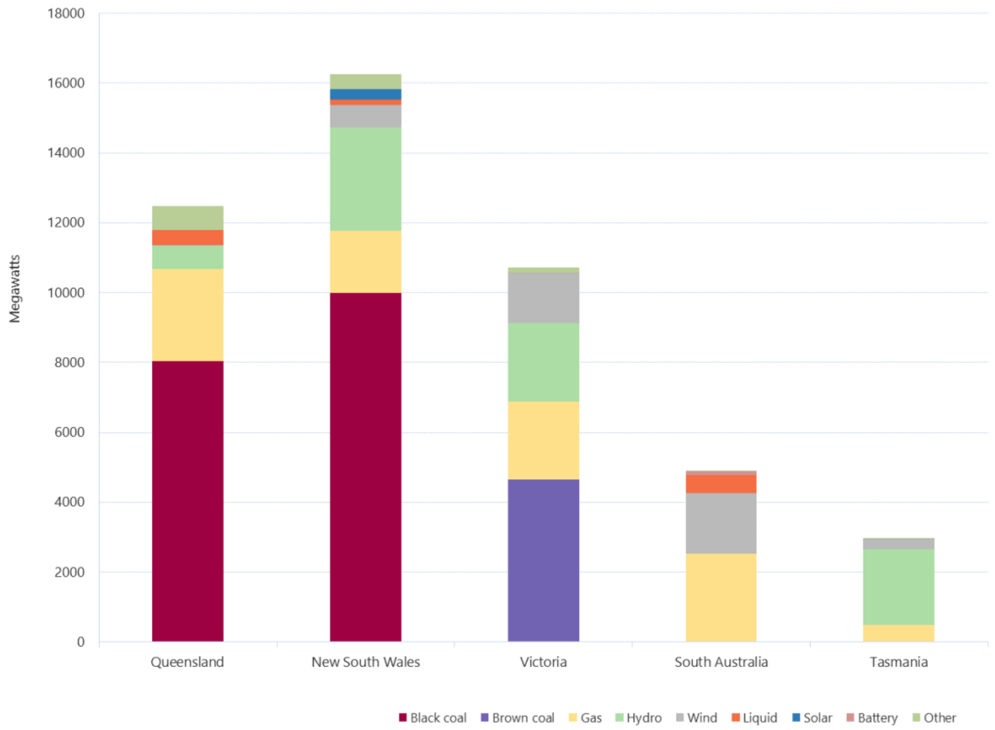

Figure 2-1: NEM generation capacity by region and fuel source, April 2018[9]

In contrast to other states, Tasmania's ability to generate electricity is constrained by the availability of water, rather than the capacity of its power stations. The yield from Tasmania's water catchments and storages is affected by climate, leading to significant variability and unpredictability in Tasmania's available generation. Based on long-term average inflows, however, Tasmania has a deficit of on-island generation compared to consumption of approximately 700 GWh to 1,000 GWh per annum (approximately 7 per cent to 10 per cent). As a consequence, Tasmania imports a small portion of its electricity from Victoria via Basslink to meet its energy needs.

Basslink is a 400 kV direct current (DC) electricity interconnector linking Loy Yang in Gippsland, Victoria, across Bass Strait to Bell Bay in Northern Tasmania. It was commissioned on 1 December 2005 and became fully operational on 28 April 2006. Basslink is rated to transmit 500 MW of power on a continuous basis in either direction, and up to 630 MW of exports from Tasmania for limited periods.

Tasmania's interconnection with the NEM enables interstate generators to supplement Tasmania's generation, while providing opportunities for on-island generators to sell electricity in other NEM regions, particularly at times of peak demand (and prices) interstate. Basslink's import capacity means that it can meet up to approximately a quarter of Tasmania's maximum demand and can provide up to 40 per cent of Tasmania's electrical energy needs.

[9] AER website, https://www.aer.gov.au/wholesale-markets/wholesale-statistics/registered-capacity-in-regions-by-fuel-source.

During 2015–16, Tasmania experienced one of the most significant energy security challenges in its history. The combined impact of two rare events – record low rainfall during spring following already low storage levels, and the Basslink interconnector unexpectedly being out of service for an extended period – resulted in Hydro Tasmania's water storage levels falling to historically low levels. At the time, energy security was maintained by a combination of existing gas-fired generation in Tasmania, voluntary load reductions from large energy users and the temporary installation of 220 MW of mobile diesel generating units. Water storage levels have now recovered to the 35–40 per cent range, from a low point of 12.5 per cent in late April 2016, but the event highlighted the potential vulnerabilities in Tasmania's long term energy security. As a result of this event, Hydro Tasmania is now required to maintain higher average water storage levels.

TasNetworks is currently processing Connection Applications for more than 700 MW of large-scale renewable generation. Whilst these projects are not all committed, our forecasts show that there will be sufficient new generation installed within the next five years to make Tasmania a net energy exporter in the long term.

In April 2016, the Australian and Tasmanian governments established a study of the feasibility of a second interconnector between Tasmania and Victoria. In his report Dr John Tamblyn concluded that further monitoring of NEM developments and analysis was required to establish an economic case for a second interconnector.[10] Dr Tamblyn also identified that the construction of a new interconnector between South Australia and the eastern states significantly alters the economics in favour of a second Bass Strait interconnector. In November 2017, the Federal Government announced that it supported TasNetworks and ARENA undertaking work to further investigate the case for a second interconnector.

Increased interconnection with the NEM is perhaps the most significant strategic opportunity facing Tasmania over the medium to long term. Greater interconnection is required to realise Tasmania's renewable energy potential, including the provision of dispatchable hydropower to the rest of the NEM and taking advantage of the diversity between renewable energy sources in the NEM. Further interconnection would also provide benefits in terms of improved energy security for Tasmania, Victoria and the rest of the NEM.

Further interconnection would require augmentation of the existing Tasmanian and Victorian transmission networks to facilitate the increased energy flows. While the total costs would be significant, these costs will only be incurred where they deliver greater benefits. These benefits are expected to be significant as we transition towards a lower carbon economy.

2.3 Victoria's electricity system

Victoria's electricity is predominantly sourced from brown coal-fuelled generation (approximately 75 per cent of Victorian generation), with gas, hydro, wind and rooftop photovoltaic (PV) making up the remainder in roughly equal proportions. Victoria's total demand averages 5,100 MW, with summer peak demand of about 9,000 MW. The load is largely concentrated in the greater Melbourne area and Geelong.

[10] Dr John Tamblyn, Feasibility of a second Tasmanian interconnector, Final Study, April 2017.

Victoria has traditionally been self-reliant for its electricity needs due to the abundant supply of easily accessible brown coal in the Latrobe Valley. Until 2017, Victoria was a net exporter of electricity to other regions.

The reliability of Victoria's electricity supply is most at risk during the summer months, when high temperatures lead to high demand conditions. This risk to supply is exacerbated by:

- thermal generating units' capacity potentially being constrained due to high ambient temperatures;
- coincident high demand in adjacent mainland states reducing the possibility of those states exporting electricity to Victoria; and
- the increased risk of bushfires leading to transmission constraints.

Because Tasmania's peak demand occurs in winter, electricity imports via Basslink have significantly contributed to ensuring Victorian supply reliability during summer heatwaves. During Victoria's peak demand of 9,153 MW on 19 January 2018, Basslink supplied 490 MW, which was more than half of Victorian imports at the time.[11] At the time, Victoria was exporting power to New South Wales due to coincident high demand in that region. Basslink's contribution during this time was almost 20 per cent less than it had provided during previous summers due to operational restrictions that were imposed in December 2017 and that still have not been resolved. In its review of 2017-18 summer operations, AEMO has stated that this capacity reduction impacted on Victorian reserves and operational decisions during the time of peak demand.[12]

The closure of the 1,600 MW Hazelwood Power Station in March 2017 has had a significant impact on Victorian electricity supply. Hazelwood, which previously supplied about 25 per cent of Victoria's baseload electricity demand, closed with only five months' notice. According to Australian Energy Regulator (AER) analysis following the retirement of Hazelwood

- Annual average wholesale electricity prices in Victoria in 2017 were the highest they have been since the commencement of the NEM, with the average Victorian wholesale price in 2017 almost double that of 2016.
- Victoria has historically been a key exporter of cheap base-load generation. It was the largest exporter in 2014–15 and 2015–16. Victoria switched to become a net importer from mid-2017.
- Hazelwood's output was largely replaced by increased output from existing black coal-fuelled generators in Queensland and NSW and gas-fired generators in Victoria and South Australia.[13]

Hazelwood's closure was a major contributing factor to the increased readiness planning undertaken by AEMO during the lead-up to the 2017–18 summer.

According to AEMO's 2018 Victorian Annual Planning report, two significant emerging issues in Victoria are voltage control during light load conditions and a reduction of system strength. Both are due to expected displacement of synchronous generation by non-synchronous

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[11] Australian Energy Market Operator, Victorian Annual Planning Report, July 2018, page 11.
[12] Australian Energy Market Operator, Summer 2017–18 operations review, May 2018, page 27.
[13] AER electricity wholesale performance monitoring - Hazelwood advice, March 2018

renewable generation. 1,400 MW of renewable generation located in western Victoria has become committed or with connection agreements signed during the last 12 months. AEMO expects that 5,200 MW of new renewable generation will be installed in the Western Victoria and Murray Valley Renewable Energy Zones by 2025. Although this renewable generation will relieve the energy deficit left by Hazelwood's closure, its non-dispatchable nature will not allow it to provide the same baseload capability and ancillary services support.

As discussed in later sections of this report, increased interconnection with Tasmania could make a substantial contribution to all of the issues discussed previously: assisting Victorian supply reliability during summer, filling the energy gap when Victoria's renewable sources are not generating, and providing system strength and voltage control services.

2.4 Recent developments

2.4.1 AEMO's Integrated System Plan

AEMO has recently published its first ISP.[14] Amongst other things, the ISP identifies Renewable Energy Zones (REZs) that should be developed as a matter of priority, and also prioritises further interconnections between state electricity networks.

The ISP has identified REZs across all NEM jurisdictions, four of which are in Tasmania. The renewable generation Connection Applications which TasNetworks is currently processing generally align with these REZs.

With regard to interconnectors, the ISP recommends that

- work immediately be undertaken to increase the transfer capacity of existing interconnectors between Victoria and NSW, and NSW and Queensland;
- by the mid 2020s, the transfer capacity of interconnectors between Victoria and South Australia, and NSW and Queensland, be further increased; and
- a project be initiated now, to deliver by the mid-2020s, a new interconnector between South Australia and NSW.

The ISP finds that additional transmission capacity between Victoria and Tasmania

> *would be beneficial if further renewable generation development in Tasmania delivers the potential value highlighted by Battery of the Nation studies.* [15]

We are of the view that refinement of some ISP assumptions and data is likely to demonstrate value from additional interconnection between Victoria and Tasmania under a range of plausible scenarios. This could warrant additional interconnection being required by the mid 2020s. TasNetworks will continue to work with AEMO and to refine the key inputs and modelling approach.

The lead time to plan, design, gain approvals for, achieve financial close, then construct and commission a second Bass Strait interconnector means that such an interconnector is not

[14] Australian Energy Market Operator, Integrated System Plan, July 2018.
[15] Australian Energy Market Operator, Integrated System Plan, July 2018, page 7.

likely to be in service until 2025 at the earliest. Given such a long lead time, we consider there is benefit in commencing the analysis now. This means that the project will be sufficiently progressed to support its delivery, should analysis suggest that additional interconnection provides sufficient benefits to proceed from 2025 onwards.

2.4.2 ElectraNet's Energy Transformation RIT-T

ElectraNet has recently released its Project Assessment Draft Report for the South Australian Energy Transformation RIT-T.[16] This report concludes that "a new high capacity interconnector between South Australia and New South Wales would deliver substantial economic benefits as soon as it can be built", a finding consistent with the ISP. This conclusion was consistent across a range of different economic scenarios. The preferred SA-NSW interconnector option also delivered the highest net market benefits of all options considered, in all economic scenarios.

It is highly likely that a new interconnector will be built between South Australia and New South Wales, and therefore one of the pre-conditions Dr John Tamblyn had identified for the investigation of a second Bass Strait interconnector will be met: that a detailed business case for a second Tasmanian interconnector should be established when additional interconnection is approved for construction between South Australia and the eastern states.[17]

2.4.3 Dynamic network support for Northern Tasmania RIT-T

In parallel with this investigation of further interconnection between Tasmania and Victoria, we are progressing a project to address a range of power system stability issues in northern Tasmania. We will publish a separate Project Specification Consultation Report for that project in the coming months.

A number of voltage stability issues affect the George Town area in northern Tasmania. These issues are currently managed by the application of constraints, the major impact of which is to limit Basslink power transfer, especially at times of high import or high export. It is at such times when Basslink can provide the most economic value, but the application of constraints which restrict Basslink's transfer capacity act to erode this value. Our Dynamic Network Support for Northern Tasmania RIT-T will examine whether the benefits of relieving these constraints outweigh the costs of doing so.

Whilst the two projects are related, in that they both address interconnector capacity, they deal with two distinctly different scopes. This report deals with a bulk increase of interconnector capacity over what is currently available, in the order of hundreds of megaWatts. The Dynamic Network Support for Northern Tasmania project deals with the alleviation of constraints that reduce the power flows across Basslink below its design limits, in the order of tens of megaWatts.

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[16] Electranet, SA Energy Transformation RIT-T Project Assessment Draft Report, 29 June 2018.
[17] Dr John Tamblyn, Feasibility of a second Tasmanian interconnector, Final Study, April 2017, page 72.

We acknowledge that the two projects are related, and in particular, that the outcome of this RIT-T will have a bearing on the Dynamic Network Support project.[18] We plan to undertake the analysis of both projects concurrently to ensure this interdependency is captured.

18 Depending on location of the Tasmanian HVDC converter station, an additional interconnector may provide some of the same ancillary services benefits that the dynamic network support project could provide.

3 Description of the identified need

The Rules define an *identified need* as:

> *The objective a Network Service Provider (or a group of Network Service Providers) seeks to achieve by investing in the network.*

In relation to further interconnection between Victoria and Tasmania, the *identified need* is not linked to TasNetworks' need to satisfy a compliance obligation. Instead, the *identified need* or objective for the interconnection is to deliver 'market benefits' as defined by the RIT-T.

> The characteristics of customer demand, generation and storage resources vary significantly between Tasmania and the rest of the NEM. Increased interconnection capacity between Tasmania and the other NEM regions has the potential to realise a net economic benefit by capitalising on this diversity.

Increasing the interconnection capacity between Victoria and Tasmania would deliver five broad categories of market benefits, as discussed in the following sections.

3.1 Facilitating access to increased dispatchable generation

In contrast to other systems, Tasmanian hydro offers significant energy storage (14.4 TWh maximum) and flexibility of how the generation can be used. Depending on local demand and Basslink power flow, the power required from Tasmanian hydro generation can vary from a minimum of 200 MW up to 2,300 MW. This controllability makes Tasmania an attractive provider of dispatchable capacity to the NEM. In addition, the Tasmanian power system demand is at its lowest during the summer months when mainland NEM regions experience their highest demand. As a result there is up to 1,200 MW of excess dispatchable capacity in Tasmania during the high demand periods in Victoria that could be accessed with increased interconnection capability.

In addition to the current capability of the Tasmanian hydro system there are also significant opportunities to develop pumped hydro energy storage projects in Tasmania. Hydro Tasmania recently released its report "Battery of the Nation - Analysis of the future National Electricity Market", which indicates there are opportunities to develop over 4,800 MW of pumped hydro energy storage with a cost to construct in the range of $1.05M–$1.5M / MW. This could provide significant low-cost storage which will support greater penetration of variable renewable energy both in Tasmania and mainland Australia.

Although the details are currently uncertain, the National Energy Guarantee (NEG) will result in an economic value being placed on dispatchable capacity (as opposed to semi-scheduled or non-scheduled capacity). The ability to supply an increased volume of dispatchable hydro generation to other NEM regions will therefore have a market benefit in terms of meeting reliability requirements in the future.

The ultimate impact on end-use customers is reduced energy prices, due to reduced fuel usage and the reduced need to invest in gas peaking plant or more expensive mainland energy storage options.

3.2 Increasing energy security

As discussed in Sections 2.2 and 2.3, the protracted outage of Basslink in 2016, the closure of Hazelwood Power Station, and operational restrictions placed on Basslink since December 2017, have highlighted the risks to both Tasmanian and Victorian supply security.

In response to this risk, a range of short-term measures have been put in place to support security. For example, in Tasmania, Hydro Tasmania must now keep more water in storage in order to manage the potential convergence of an extended Basslink outage and low rainfall reducing inflows to its catchments. In Victoria, the summer readiness planning for 2017–18 was given increased attention following the retirement of the 1,600 MW Hazelwood Power Station. This resulted in the procurement of a strategic reserve of off-market generation in order to ensure customer supply reliability through the summer months.

Reduced transfer capacity across Basslink in 2018 and a subsequent unplanned, extended outage in 2018 have reinforced the reliability challenges associated with a single interconnector across Bass Strait.

While the development of new renewable generation in Tasmania and Victoria will help address average energy shortfalls in the respective states over the long term, a second interconnector would provide a parallel flow-path to Basslink. This firm transfer capability will mean inter-regional energy transfer, including dispatchable energy to Victoria, can continue in the event either interconnector is out of service.

This would result in the following market benefits:

- A reduced requirement for off-market reserves in Victoria during summer months
- A reduction of gas usage in Victoria during summer peak demand events
- A reduction in voluntary load reductions or involuntary load shedding in either of the events above
- A potential relaxation of more conservative minimum water storage targets that have been implemented since the 2016 Tasmanian energy challenge. This would allow Hydro Tasmania greater flexibility in operating their generators, further increasing the benefits to Tasmania and Victoria which can be obtained from this dispatchable generation
- A reduction in gas use in Tasmania, with corresponding reduction in wholesale prices, in the event of a protracted Basslink outage or an extended low rainfall period

3.3 Reduction of ancillary services costs

The importance of ancillary services to the stable operation of the power system has come to prominence recently. There are a number of different ancillary services procured in the NEM: frequency control ancillary services (FCAS) is procured via the wholesale market; system restart ancillary services (SRAS) are procured via contracts; network support and control ancillary services (NSCAS), inertia and system strength services are procured by contracts when required.

Basslink was designed to transfer FCAS between Tasmania and Victoria under most operating conditions, thereby reducing the requirement for, and cost of, FCAS services in both regions. For the other categories of ancillary services, the two regions are totally independent.

If Basslink is not operational, or operating conditions arise under which FCAS cannot be transferred across Basslink, Tasmania must be totally self-sufficient for FCAS. Shortage of FCAS, notably fast raise services, is a problematic issue in Tasmania and the unavailability of FCAS services can impact on the ability to reverse Basslink power flow. A shortage of fast FCAS services can give rise to counter-price power flows on Basslink.

Further interconnection would allow transfer of some or possibly all of these ancillary services between Tasmania and Victoria. This would result in:

- the elimination of FCAS shortages giving rise to counter-price flows on the Basslink interconnector, which leads to lower wholesale energy prices during such periods;
- reduced prices for those services (currently only contingency FCAS), which are traded on the spot market;
- greater market liquidity and reduced contract prices for those services that are procured via contract arrangements; and
- the provision of greater regulation in FCAS services that may be required as increased solar PV makes the daily demand curve less predictable.

3.4 Increased inter-regional market access

A single contingency event on Basslink can reduce the transmission capacity between the Tasmanian and Victorian regions to zero. This presents a risk to Tasmanian generators when entering into supply contracts with mainland retailers, or mainland generators contracting with Tasmanian retailers. Although details are not publically available, it is reasonable to assume that any such inter-regional contracts must be backed by other products to mitigate the risk of a Basslink outage, and such backing would increase the contract costs.

A second interconnector would increase the reliability of the Tasmania to Victoria inter-regional flowpath, thereby increasing the firmness of Tasmanian generators' access to mainland regions and vice versa. This has two major market benefits:

- reducing contract costs between Tasmanian and mainland generators and retailers;

- increasing the possibility of retail competition in Tasmania due to the increased certainty of a new-entrant retailer in Tasmania being able to contract with mainland generators.

3.5 Avoiding future network investment

Construction of further Bass Strait interconnection would require the extension, and potential upgrade, of both the Victorian and Tasmanian transmission networks to connect the respective HVDC converter stations to the shared network, and support transfer of power between generation and load centres.

Depending on the precise design and route chosen these network extensions and/or upgrades may also provide opportunities for more efficient connection and power transfer for future generation developments in Tasmania and Victoria. Such augmentations could conceivably provide part of the transmission capacity required to develop a renewable energy zone. This would result in cost savings by avoiding the need for future network augmentations.

Consultation Question:

Are there any other benefits that further interconnection will provide and/or are there benefits that we have presented that you disagree with?

4 Assumptions underpinning the identified need

The cost benefit analysis, which is the cornerstone of the RIT-T, will assess the credible options for addressing the identified need compared to a base case against a number of scenarios. In doing so, the RIT-T will consider whether further interconnection is likely to be in the long term interest of electricity consumers. The RIT-T assessment will include a consideration of the optimal size of the interconnector capacity, its location, construction costs, and timing in order to select the credible option (if any) that maximises the net economic benefit.

At this stage of the RIT-T process, we have not undertaken the economic analysis. This Project Specification Consultation Report allows us to explain the identified need and the credible options for addressing it, and how we propose to undertake the economic analysis. In this section of the report, we explain the assumptions that underpin the identified need, which was described in the previous section.

4.1 Generation outlook

The next 20 years will be characterised by unprecedented transformation in the power industry as it transitions to a low carbon future. This is driven by four key factors:

- The reducing financial viability of ageing, emissions-intensive coal-fuelled generation
- Legislated and advanced emissions reduction policy objectives (such as Australia's 2015 Paris Agreement commitment (COP21), its Large-scale Renewable Energy Target (LRET), Victoria's Renewable Energy Target (VRET) and the NEG)
- Further improved operating flexibility and reductions in the costs of technologies such as wind turbines, solar PV and batteries
- Meeting forecast system demand, characterised by relatively low growth but increasing volatility as the penetration of distributed generation increases

Over the next 20 years, AEMO projects a decreasing market share for baseload coal-fuelled generation and increasing penetration of intermittent renewable generation as the market continues to evolve. AEMO's ISP assumes that within the next two decades, more than 50 per cent (or 14 GW) of the existing coal-fuelled generation fleet may retire.[19] Due to a lower capacity factor, approximately 38 GW of new generation may be required to replace it.

The figure below shows AEMO's projected total installed generation capacity in the NEM, categorised by fuel type. An increase in installed NEM capacity is forecast as a result of the increase in intermittent generation capacity.

[19] AEMO Integrated System Plan, July 2018, page 21.

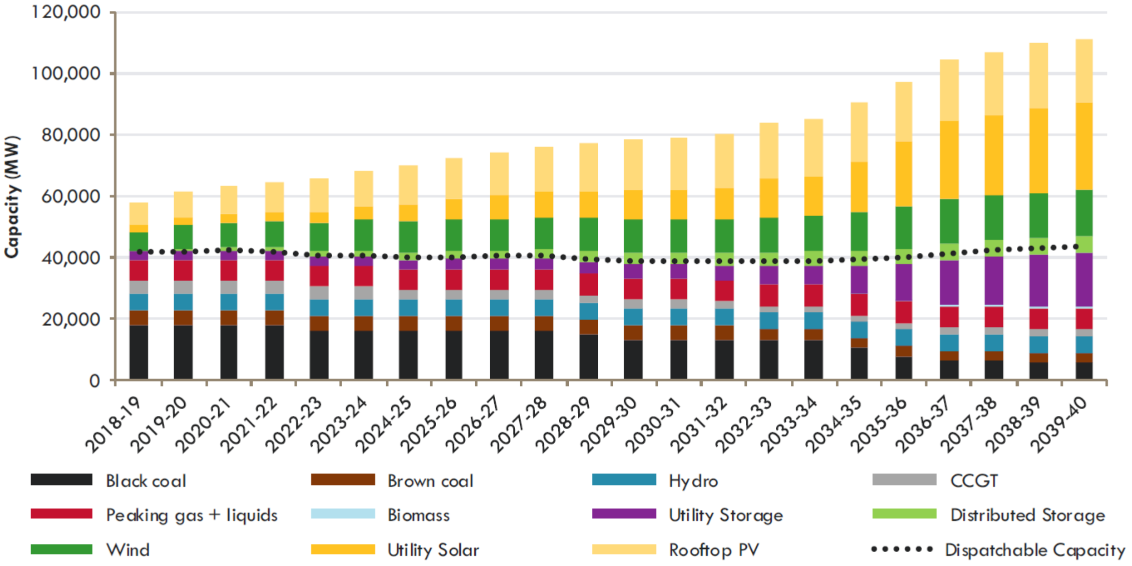

Figure 4-1: Projected total installed generation capacity in the NEM by fuel type[20]

The rapid growth in intermittent renewable generation and its projected future increases are creating significant challenges for our energy systems as well as opportunities to derive value from greater interconnection between regions. One potential benefit of increased interconnection is improved diversity in these renewable resources.

For example, as Figure 4-2 shows, the resource profiles of wind farms across the NEM regions are quite different. Tasmania's wind has greater daytime production and higher overall capacity factor than that of any other region. The wind generation in the northern Australian regions is lowest on average at times when solar generation will be relatively high. In addition to average daytime variation, even greater diversity will occur on particular days as wind patterns vary across the states.

Interconnectors exploit the geographic diversity of intermittent generation sources, smoothing intermittency across the NEM. This reduces the need to dispatch higher marginal cost generation at times when the renewable resources within a region are not available but excess renewable generation is available from another region.

[20] AEMO Integrated System Plan, July 2018, page 37. Figure shows projected capacity in the ISP's Neutral case.

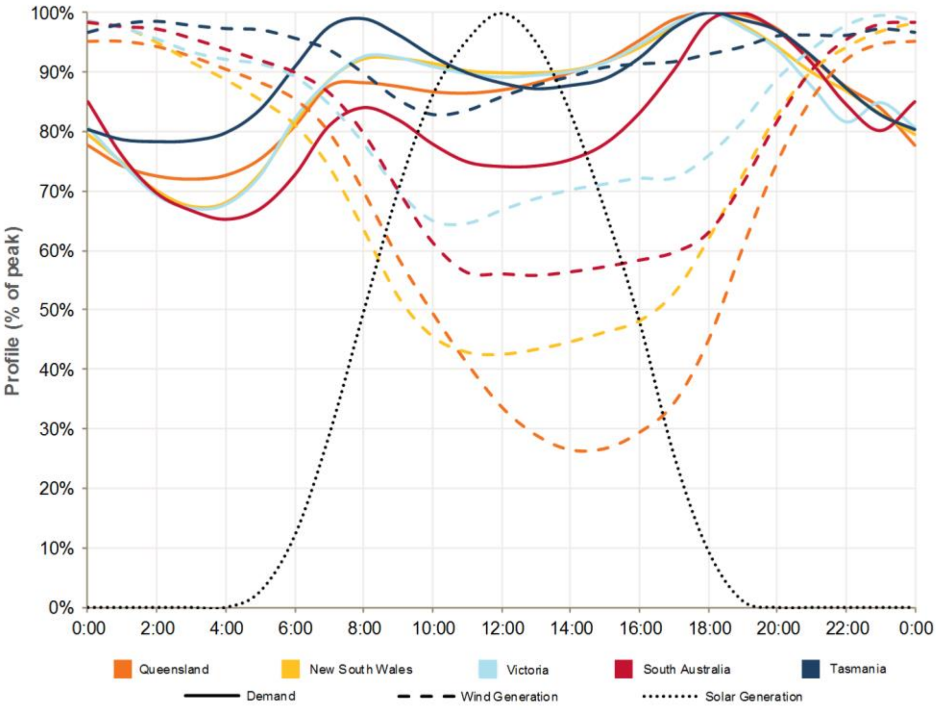

Figure 4-2: Average wind farm operation per region, by time of day[21]

The importance of increased interconnection to improve diversity was highlighted by AEMO in its report for the Tasmanian Energy Security Taskforce:

> *Projected net market benefits of a second Bass Strait interconnector increase if an additional South Australian interconnector is built first. This is mainly because the development of more interconnection uses the diversity of renewable generation across the regions more effectively. It reduces the need for higher-cost gas generation by allowing renewable generation in one region to complement the intermittency of renewable generation in another region.*[22]

The benefits from improved interconnection between Tasmania and Victoria largely arise from the opportunity it will provide to substitute generation on the mainland with cheaper generation from Tasmania, or vice versa. In a sense, this is a form of market arbitrage, where a product bought in one low price market is then sold for a profit in a higher price market.

In general terms, the benefit from improved interconnection will be proportional to the price differences between the two regions. Because power can flow across the interconnector in either direction, it is not the average of the price differences that is important, but rather their variance at a point in time. Bass Strait interconnection can be used to export power from

[21] AEMO, Integrated System Plan Consultation for the National Electricity Market, December 2017, page 22.
[22] AEMO, Second Tasmanian Interconnector, Report For The Tasmanian Energy Security Taskforce, January 2017, page 1.

Tasmania when the rest of the NEM has insufficient generation, and import when the mainland NEM experiences an excess of low-price generation.

In the next two sections, we explore the projected developments in Tasmania and Victoria that may affect the value of the arbitrage opportunities between the two regions. It should be noted, however, that further interconnection would deliver benefits in addition to these arbitrage opportunities, such as improved energy security and reducing the cost impact from Basslink outages and lower ancillary service costs. These further benefits are discussed in Sections 4.4 and 4.5, while some other potential benefits outside the current scope of the RIT-T are noted in Section 4.6.

4.2 Developments in Tasmania

Tasmania has an abundance of locations with high quality wind resources because it lies directly in the path of the Roaring Forties, some of the strongest sustained winds on the planet. These resources typically coincide with areas of relatively low population density, meaning a lower likelihood of community opposition and also a lower cost of land purchase or rent. In contrast, many wind development opportunities on mainland Australia are located closer to established communities.

Given its natural advantages, Tasmania is expected to experience further growth in wind generation. Figure 4-3 shows that AEMO is forecasting an increasing proportion of Tasmania's generation capacity will be wind generation, commencing in the mid 2020s. Our recent experience indicates wind generation is likely to expand more rapidly than indicated in Figure 4-3. We are currently processing connection applications for over 700 MW of renewable generation, mostly wind, which is not dependent on further interconnector capacity. Two wind generation projects have signed connection agreements. We have received additional connection applications for further wind generation developments which are conditional upon increased interconnection to Victoria.

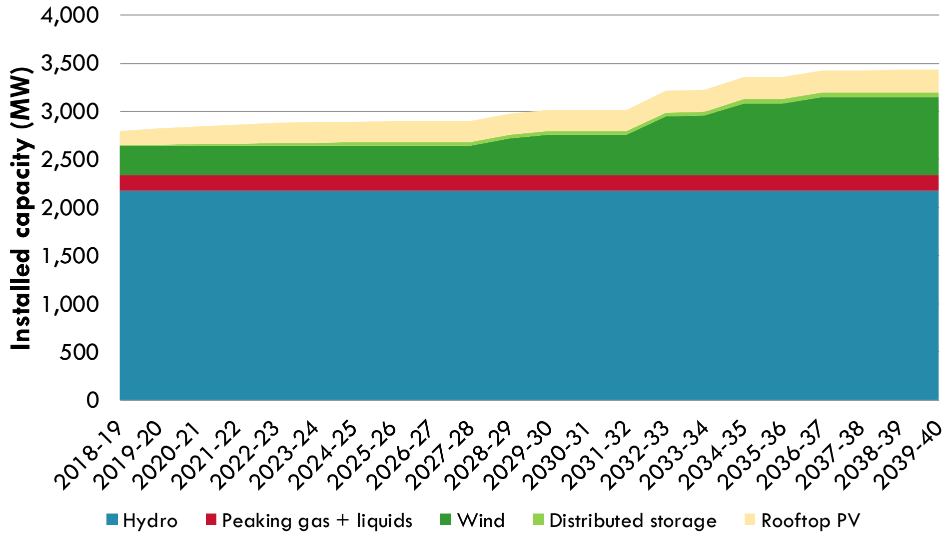

Figure 4-3: Projected total installed capacity in Tasmania by fuel type to 2039–40[23]

Hydro Tasmania has undertaken further analysis of the future of the NEM, including the potential for pumped hydro developments in Tasmania, as part of the *Battery of the Nation* project. Figure 4-4 shows the potential location of additional wind and pumped storage capacity in Tasmanian which the project has identified.

A problem inherent in the high penetration of wind and solar generation is the likelihood of excess generation – and possible curtailment – when the wind is blowing strongly or the sun is shining, and then possible generation shortages, which creates the need for high cost peaking generation, when the wind or solar generation drops. Tasmania, however, is able to exploit its hydro storages to “soak up” the excess renewable generation by holding back water, and then make use of the stored water to provide hydro output when the wind and/or solar drop.

To some extent, this outcome can be achieved by simply reducing hydro output to make room for the wind and solar output. However, as variable renewable generation grows, there is expected to be a growing need to store variable energy for use at other times. This is expected to take the form of batteries and pumped hydro. Batteries are able to provide short-term storage, whereas pumped hydro can provide storage over longer periods.

[23] Data from AEMO Integrated System Plan database, 2018 Generation and Transmission Outlooks, July 2018.

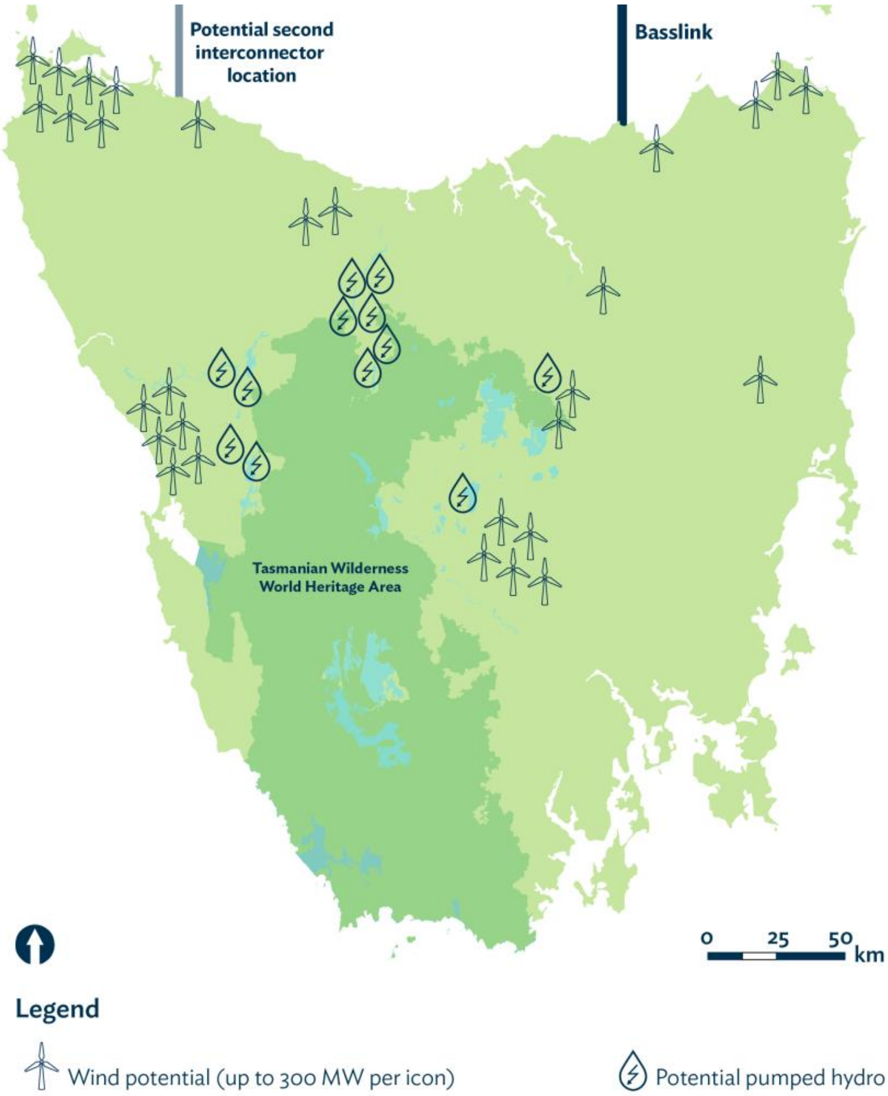

Figure 4-4: Existing and possible future wind farms and pumped storage in Tasmania[24]

Additional pumped storage capacity is able to use excess wind or solar output to drive new pumps. This ensures that the renewable energy is stored for later use rather than being sold at a low price, or being lost. Effective use of renewable energy resources is the underlying philosophy of the "Battery of the Nation" initiative being advanced by Hydro Tasmania with support from ARENA.

Existing and future hydro storage capacity can be used to convert intermittent renewable generation into firm hydro output. Further interconnection would allow this firm output to support both Tasmania and the mainland NEM, particularly at times when mainland renewable generation is limited.

[24] Hydro Tasmania, Battery of the Nation – Analysis of the Future National Electricity Market, April 2018, page 13.

In contrast to variable renewable generation, which often displaces other low-cost generation, 'conversion' of variable renewable resources through the hydro system can be used to displace high-cost dispatchable generation, such as gas-fired generation. This is sometimes referred to as 'generation shifting' where excess generation is stored to be used at a time when it is required. The Tasmanian hydro system can offer much larger generation shifting capability than currently available battery storage technology. Whilst batteries can store energy for several hours, hydro can store energy for 24 to 50 hours, making it suitable for shifting both solar and wind generation.[25]

As a result of this conversion process, it is reasonable to expect additional interconnection to facilitate market benefits in terms of:

- generator operating cost reductions (variable operations and maintenance and fuel), where lower cost dispatchable renewable energy could be substituted for more expensive generation; and
- generator capital cost deferrals, where better use of Tasmania's hydro facilities defers the need for investment in additional high-cost dispatchable generation options in other NEM regions.

The primary factors that may affect the availability of diversified and dispatchable Tasmanian generation for export to Victoria (and the benefits noted above) are:

- Tasmanian rainfall – higher than average rainfall would increase the potential for export;
- Tasmanian demand – a reduction in demand would increase the availability of export capacity; and
- Government policy frameworks for investment in new generation and pumped-hydro schemes in various Australian states, which will affect available capacity in each region.

It should be noted, however, that the identified need is not dependent on specific assumptions regarding rainfall, Tasmanian demand or Government policy initiatives. Instead, the identified need recognises that Tasmania's energy mix provides Tasmania with the potential to play a greater role in meeting the dispatchable energy needs of the mainland NEM regions. This means that Tasmanian generation may be able to displace or delay the installation of more expensive energy sources (peaking generation, storage, etc.) in the NEM, particularly at times of high demand.

It is also important to note that further interconnection will be supported by 'shared network' transmission investments in Tasmania and Victoria.

In Tasmania, the development of the North-West Tasmanian transmission corridor and upgrade of the Sheffield to Palmerston line are likely to be required to support further interconnection if a HVDC converter station is located in the North West of the state.

In Victoria, connection in the Geelong region may require extensions to the network and upgrades that could also facilitate flows from regional Victorian renewable energy zones.

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[25] Pumped hydro storage can actually store energy indefinitely, however the return on investment diminishes if stored energy is not used within about 50 hours.

Connection in the Gippsland region may present opportunities for shared network investment that can also support offshore wind proposals.

4.3 Projected developments in Victoria and other regions

The development of generation, storage, demand-response and network solutions in Victoria and other mainland NEM regions will be affected by a wide range of factors including:

- policy requirements and incentives for renewable generation;
- increased interconnection between the mainland regions;
- the implementation and form of a distributed energy market;
- future developments in storage capacity; and
- future closures of gas and coal fuelled plants.

The growth in renewable generation and large-scale storage will continue to be influenced by State and Federal Government policy initiatives. For example, the advanced VRET policy aims to deliver 25 per cent of total Victorian electricity generation from renewable technologies by 2020, and 40 per cent by 2025. AEMO's modelling suggests that this policy will deliver about 4,800 MW of additional renewable generation to Victoria.[26]

If the VRET policy achieves its objectives it will encourage renewable generation to be located in Victoria rather than other regions, including Tasmania. This is particularly the case if the VRET generation contributes towards the achievement of Federal emissions reduction targets. As a result, the growth in wind generation in Tasmania could be somewhat lower than would otherwise be the case.

This outcome could have two offsetting effects. The lower growth in Tasmanian wind means that there will be less energy available to provide firm output to the mainland, as discussed above. On the other hand, the higher growth in Victorian wind may lead to greater price volatility in that region and so increase the value of interconnector 'arbitrage', particularly if that price volatility prompts the closure of additional coal-fuelled generation.

Energy neutral arbitrage activity (where 'imports' equal 'exports') can be carried out by any storage capacity, whether this is Tasmanian hydro storage using interconnection or mainland storage alternatives such as Snowy 2.0, battery storage or bespoke new pumped hydro. To this extent, mainland storage development acts as a competitor to Tasmanian storage and could reduce the arbitrage value available to additional interconnection. Put another way, mainland storage will act to dampen the volatility of mainland energy prices which storage-based arbitrage relies upon.

While the growth of renewables and storage in other regions may reduce the benefit of additional interconnection across Bass Strait, increased interconnection across other NEM regions may have a countervailing effect by opening up opportunities to displace high cost generation in regions beyond Victoria.

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[26] AEMO, Second Tasmanian Interconnector, Report for the Tasmanian Energy Taskforce, January 2017, page 20.

To summarise, the range of factors influencing future generation prices in Victoria are complex and varied, and will be the subject of detailed market operation modelling through the RIT-T process. The key assumption underpinning the identified need, however, is that the costs, efficiency and profile of generation in Victoria will be sufficiently different from Tasmania to deliver benefits from increased interconnection between the two regions. This assumption is reasonable given Tasmania's comparative strength in renewable generation and hydro storage and the natural diversity in wind generation across the regions. As already noted, a detailed examination of whether the benefits of increased interconnection outweigh the costs is a matter for the next stage of the RIT-T.

4.4 Energy security, supply reliability and risks of a Basslink outage

Energy security, being the long term ability to supply customers' energy demand, is a key issue for electricity customers. With Basslink in service, energy security in Tasmania is high. When Basslink is in service it also supports supply reliability in Victoria.[27]

From December 2015 to May 2016, Tasmania was exposed to the combined impact of low storage levels due to drought conditions and a prolonged Basslink outage. Whilst the extended outage did not lead to any loss of reliability, it led to a substantial increase in expensive gas-fired generation, the temporary connection of large quantities of diesel generation, and voluntary reduction in customer demand. During this period, spot prices increased significantly and then fell abruptly as rain replenished storages and Basslink returned to service.

The Tasmanian Energy Security Taskforce examined the risks of a prolonged Basslink outage in the future given the experience in 2015–16. Although the Taskforce was unable to reach a conclusion on Basslink's likely future reliability performance, it recommended that security planning should assume a future Basslink outage of at least six months in duration.[28] As a consequence, Hydro Tasmania is now required to manage its water storages so as to ensure a higher amount of energy is held in storage.

In March 2018 equipment damage during planned maintenance led to an unplanned 12 week Basslink outage. In contrast to the 2015-16 outage, this outage had no material impact on Tasmanian energy security. The event served to highlight that the more stringent storage management approach now followed by Hydro Tasmania is prudent, and that, as with any electrical infrastructure, the possibility of unplanned Basslink outages remains.

Victorian supply reliability during summer months has received increased attention since the closure of Hazelwood Power Station. Summer supply reliability will remain a critical issue in future years, especially given the expected retirement of Liddell Power Station in New South Wales in 2022. As discussed in Section 3.2, Basslink provides access to a critical source of dispatchable generation during times of Victorian (and other mainland NEM regions') peak demand. This generation only remains accessible whilst Basslink is in service.

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[27] Supply reliability relates to the ability to meet customers' demand at the time it is required, i.e., the avoidance of blackouts or forced load shedding. This is different from energy security, which relates to the certainty of meeting longer term energy needs.
[28] Tasmanian Energy Security Taskforce, Final Report, June 2017, page 46.

A second interconnector would reduce the expected costs of an unplanned Basslink outage on the reasonable assumption that the cause of the Basslink outage would not affect the second cable. These cost reduction benefits apply to Tasmania in terms of long term energy security, and to Victoria (and other mainland NEM regions) in terms of guaranteeing the availability of access to Tasmanian dispatchable generation during critical summer peak-demand periods.

4.5 Ancillary services

The discussion above covers benefits associated with the supply of energy. However, further interconnection may also provide benefits associated with the supply of ancillary services. There are five main categories of ancillary service:

- Contingency and regulation frequency control ancillary services (FCAS)
- Network support and control ancillary services (NSCAS)
- System restart ancillary services (SRAS)
- Inertia
- System strength (also known as fault level)

These are considered in turn below.

Basslink was designed to transfer FCAS from the mainland to Tasmania and vice versa. A second interconnector would also allow the transfer of FCAS between Tasmania and Victoria. This is achieved by a controller that adjusts the interconnector flow in proportion to the difference in system frequency between Tasmania and the mainland. For example, if the frequency in Tasmania dips – perhaps due to a sudden generator outage – the interconnector flow towards Tasmania will automatically be increased (i.e. imports increased or exports decreased), helping to slow and correct the frequency fall.

When AEMO formulates the FCAS requirements for the dispatch calculation, it takes into account interconnector capability. Therefore, a greater transfer capability made available by a second interconnector with FCAS capability will, with all other things being equal, reduce the cost of FCAS supply, both in Tasmania and on the mainland.

The requirement for FCAS in a power system can depend upon the amount of synchronous inertia: i.e. the energy contained in the rotating mass of synchronous generating units. As the penetration of non-synchronous generation, such as wind, solar, batteries and DC interconnectors, increases the synchronous inertia will fall.

Inertia slows the rate of frequency change following a contingency event and so gives more time for FCAS providers to respond. Transmission Network Service Providers (TNSPs) have an obligation to maintain minimum amounts of inertia in their networks and TNSPs are obliged to source inertia from other sources, incurring costs in doing so, if the amount of synchronous inertia is forecast to fall below minimum limits. An evolving concept, which has the potential to reduce minimum inertia requirements, is “fast frequency response” (FFR).[29]

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[29] Australian Energy Markets Commission, Draft Report - Frequency Control Frameworks Review, March 2018

The precise technical definition of FFR, and whether there is merit in modifying FCAS markets to encourage the provision of FFR, have not been determined. However it is generally accepted that FFR refers to the provision or absorption of energy in timeframes substantially faster than the existing FCAS arrangements. HVDC technologies can react sufficiently fast to provide FFR services, and a second interconnector could conceivably allow the transfer of FFR services between regions if such a market eventuates.

Like FCAS, network support and control ancillary services (NSCAS) are needed to maintain power system stability, but in relation to voltage rather than frequency. A second interconnector may be able to provide NSCAS. Depending on its location and design the converter station may be able to supply alternative forms of necessary NSCAS, partially offsetting requirements for stand-alone synchronous condensers or static VAr compensators (SVCs). Again, this could represent a cost saving.

System restart ancillary services (SRAS) are needed for restarting the power system following a system black. SRAS providers need to be able to start-up without grid power and provide supply to the local grid. SRAS suppliers are required across the grid to ensure a fast recovery process. Potentially, a second interconnector based on Voltage Source Converter (VSC) technology (refer Section 7.2) could operate as an SRAS supplier, leading to lower SRAS costs.

In summary, a second interconnector increases the availability of ancillary services, which will tend to produce a cost saving. The extent of any benefit depends on the cost and availability of these services in the absence of a second interconnector. At the time of Dr Tamblyn's report, it was concluded that there would be sufficient synchronous generators to provide the necessary FCAS without the need for additional interconnection with Tasmania.[30] This finding, and the potential for interconnection to reduce ancillary services costs, will be revisited in light of the latest available information.

4.6 Other benefits

A major infrastructure project such as additional interconnection may deliver strategic benefits to Tasmania that are not captured in a narrow definition of 'market benefits'. Clause 5.16.1(c)(4)(x) of the Rules provides for a RIT-T proponent to seek the AER's agreement before the release of this report to include other classes of benefits not listed in the Rules.

At this stage, TasNetworks has not sought the AER's agreement to include other classes of benefits. Nevertheless, such benefits may be identified by TasNetworks, the Tasmanian or Victorian Governments, or other stakeholders during the course of the project assessment. Notwithstanding the current Rules requirements, TasNetworks may seek to have any such benefits recognised in the RIT-T assessment.

As part of our Initial Feasibility Report TasNetworks will consider broader benefits that further Bass Strait interconnection can deliver. This may include benefits to regional economies in Tasmania and Victoria during the development, construction and operation of a second interconnector.

[30] Dr John Tamblyn, Feasibility of a second Tasmanian interconnector, Final Study, April 2017, page 6.

It is possible that additional benefits identified may result in third party funding, which could bridge any potential ‘gap’ between the market benefits and the project costs.

5 Market Modelling Assumptions and Approach

The cost benefit analysis, which is the cornerstone of the RIT-T, will assess the credible options for addressing the identified need compared to a base case under which Basslink remains the only interconnector that links Tasmania and Victoria. The purpose of this analytical approach is to determine:

- the market benefit expected to be delivered by further interconnection compared to the base case;
- the costs of increasing the interconnection capacity; and
- whether increased interconnection capacity results in market benefits that are greater than the costs.

The objective of this RIT-T is to assess whether increased interconnection is likely to be in the long term interest of electricity consumers. This assessment evaluates the market benefits that are expected to be delivered by additional interconnection and compares these with its capital and operating costs to determine the net economic benefit. The RIT-T assessment will include consideration of the two proposed interconnector capacities. Sub-options will consider its location, HVDC technology choice, and construction costs and timing. Where a credible second interconnector option delivers net market benefits the assessment will select the one that maximises the net benefits.

The AER's RIT-T Guidelines explain that the market benefit of a credible option (such as an increase in interconnection capacity) under a wide range of credible development scenarios is obtained by:

1. Comparing, for each relevant reasonable scenario,

   i) the 'state of the world' with the credible option in place, with
   ii) the 'state of the world' in the base case.

2. Weighting any positive or negative benefit derived in (i) by the probability of each relevant reasonable scenario occurring.

In this context, the AER defines 'state of the world' as follows:

> *A state of the world is a detailed description of all of the relevant market supply and demand characteristics and conditions likely to prevail if a credible option proceeds or —if the credible option does not proceed—in the base case. A state of the world should be internally consistent in that all aspects of the state of the world could reasonably coexist.*
>
> *Crucially, the pattern of new generation development (incorporating capacity, technology, location and timing) is likely to vary depending on which credible option (if any) proceeds. Therefore, each credible option—as well as the base case—will be associated with a different state of the world reflecting different patterns of generation investment and other characteristics and conditions.*[31]

[31] Australian Energy Regulator, Regulatory investment test for transmission application guidelines, 18 September 2017, section 3.5, page 14.

In the context of increased interconnection, the 'different states of the world' will include different generation and storage outcomes across the NEM. In considering these outcomes with and without increased interconnection, we will draw on the information and analysis contained in AEMO's ISP. TasNetworks therefore expects the ISP to be an important source of information in the RIT-T analysis.

One important issue that will need to be considered is the extent to which interconnection between other NEM regions will proceed with and without increased Bass Strait interconnection. As explained in later sections below, assumptions regarding new interconnector capacity between other regions will affect the benefits associated with increased interconnection between Tasmania and Victoria.

5.1 Scenarios and input assumptions

TasNetworks intends to rely on the central assumptions and scenarios developed by AEMO for the ISP where possible. However, in order to delve more deeply into the benefits of increased Bass Strait interconnection and to test the robustness of any benefits to uncertainty, more detailed modelling will occur in some areas and additional scenarios will be used. In particular the following modelling assumptions and scenarios are expected to be key in understanding the full benefits:

- The cost of new entrant generators including storage, particularly:
    - The relative cost differentiation for terrain-specific resources such as pumped storage
    - Realistic differentiation of resource quality, such as the differing capacity factors of wind and solar in different regions, and the size of energy storage schemes
- Modelling of the hydro system in Tasmania, in both how the hydro storages are represented and how hydro inflows are modelled
- The timing of age-based retirement of thermal generation in the NEM and consideration of economic-based retirement.

5.2 Methods for assessing market benefits

Many of the benefits associated with further interconnection arise due to changes in outcomes in the wholesale electricity market. These benefits are estimated using wholesale market modelling to understand how market outcomes can be expected to differ with and without additional interconnection. There are two main types of wholesale market modelling approaches:

1. Least cost expansion modelling that takes time sequential data such as expected load, wind patterns and hydro inflows as an input and optimises the use of existing and future generation (and demand response) resources to deliver the lowest cost of operating the market over a long term study horizon, usually 20 to 30 years.
2. Stochastic simulations that conduct time sequential dispatch modelling. Stochastic simulations allow a more detailed representation of the power system and better representation of random events such as unplanned generator outages and network failures.

It is expected that most of the benefits of increased interconnection will be from avoided capital investment and reduced fuel costs, which will be quantified via the least cost expansion model. These benefits will be augmented by benefits not considered by market simulation such as energy security impacts, provision of ancillary services, and reduction in energy spill in Tasmania.

The least cost expansion model is an optimisation model that has the objective of finding the least cost mix of generation and storage technologies in the NEM. The model determines investment and retirement decisions that result in lowest cost of generation over the modelling horizon, subject to operational and economic constraints that reflect the operation of the physical electricity market. The development options considered by the model will include (as a minimum):

- Open cycle gas turbines
- Combined cycle gas turbines
- Wind
- Solar
- Storage (both battery and pumped hydro)

To include the impact of new or modified interconnectors between other NEM regions, we will include interconnector expansions in our model as determined by AEMO's ISP.

The least cost expansion model is a time sequential model similar to the modelling used by AEMO in its ISP, except that it will use a one hour resolution rather than eight time slices each day. In addition to the least cost expansion model, other modelling and estimating techniques will be used when appropriate to identify other benefits.

Consultation Question:
Do you agree with our assumptions and our proposed approach to analysing the net market benefits under the RIT-T?

6 Non-network options

Clause 5.16.4(b)(3) of the Rules requires this Project Specification Consultation Report to

> *identify the technical characteristics of the identified need that a non-network option would be required to deliver, such as:*
>
> 1. *the size of load reduction or additional supply;*
> 2. *location; and*
> 3. *operating profile.*

To recap, the identified need is:

The characteristics of customer demand, generation and storage resources vary significantly between Tasmania and the rest of the NEM. Increased interconnection capacity between Tasmania and the other NEM regions has the potential to realise a net economic benefit by capitalising on this diversity.

Taking the broad interpretation that the identified need is to realise a net economic benefit, there are many possible alternative projects – both network and non-network – which could deliver net market benefits. Indeed, AEMO's ISP recommends a number of other projects prior to a second Bass Strait interconnector on the basis that AEMO's modelling indicates these projects would deliver greater market benefits. As explained in Section 4.3, energy neutral arbitrage activity (where "imports" equal "exports ") can be carried out by storage alternatives such as pumped storage (including Snowy 2.0) or battery storage.

It is important that our RIT-T assessment considers whether these non-network alternatives are more cost effective than further interconnection. Our intended RIT-T modelling methodology will look for the lowest cost option to supply electricity. This will include the development of mainland generation and storage options in the absence of increased Bass Strait interconnection, should this be cheaper. In effect, therefore, TasNetworks' approach will therefore inherently consider the competitive market alternatives with the construction of additional interconnection.

Examining the narrower question of whether non-market alternatives can deliver an increase in interconnection capacity between Tasmania and Victoria (or any other NEM region), the existing interconnector capacity is limited by the design characteristics of Basslink: 500 MW maximum transfer in either direction, with a short term capacity of 630 MW when exporting from Tasmania. We are not aware of any non-network alternatives which could increase the inter-regional transfer capacity between Tasmania and Victoria above these limits.

The power transfer on Basslink may at times be constrained below Basslink's design limits. This may reflect a range of variables, such as operational decisions by Basslink's owners, or system constraints, such as voltage stability issues. As discussed in Section 2.4.3, we are currently examining options to remedy some voltage stability issues in a parallel RIT-T.

A new interconnector constructed and operated by a Market Network Service Provider (MNSP) is not a non-network option as defined by the Rules. Given the identified need is to realise net market benefits, no minimum technical requirements of the type contemplated in Clause 5.16.4(b)(3) are applicable to an MNSP option in this instance.

For the purposes of this RIT-T, TasNetworks is open to the possibility of a MNSP owning and operating a second interconnector, including a potential sub-option where a hybrid regulated and unregulated 1,200 MW interconnector is developed. To operate as an MNSP a range of Rules obligations would need to be satisfied, including negotiating connections to both the Tasmanian and Victorian transmission networks as per Rules procedures. The technical requirements of credible options discussed in Section 7 would be equally applicable to a MNSP-owned interconnector.

7 Key features of each credible option

Clause 5.16.4(b)(5) of the Rules requires this Project Specification Consultation Report to set out the key features of each credible option. To qualify as credible, an option must address the identified need, be commercially and technically feasible, and be able to be implemented in sufficient time to meet the identified need. TasNetworks is aware of only one technical solution which satisfies these criteria: construction of a second HVDC interconnector.

We are considering the following two credible options:

- Option 1: A 600 MW monopole HVDC link, including associated alternating current (AC) transmission network augmentation and connection assets.
- Option 2: A 1,200 MW bipolar HVDC link, including associated AC transmission network augmentation and connection assets.

The 600 MW sizing was chosen for two reasons. Firstly, it approximately aligns with the maximum design capacity of Basslink (630 MW maximum export), which gives us a high degree of confidence that Tasmania's existing system protection schemes and other advanced control schemes can be modified to accommodate the presence of additional independent interconnector poles with similar capacity. Secondly, 600 MW is less than the size of the largest generator contingency in the mainland NEM regions.

We do not intend to consider interconnector capacities below 600 MW due to economies of scale: capital costs would not decrease proportionally to the reduction in capacity, and we expect the maximum economic benefits of such an interconnector to be gained at times when power flow is at or near the interconnector's capacity limit. We have therefore chosen 600 MW as the preferred HVDC pole capacity.

It is a moot point whether a different cable design or location constitutes an alternative credible option, or whether it is essentially a design choice. As a practical matter, TasNetworks considers it more appropriate to describe the design and locational choices for a second interconnector, rather than defining each potential cable design and location as alternative credible options. In adopting this approach we will focus on the key choices that need to be made without detailing the numerous combinations of choices that we expect will ultimately deliver similar market benefits. If, during the process of economic analysis, it becomes apparent that particular design choices will lead to materially different net market benefits, we will separate these out as different sub-options.

7.1 Location

Figure 7-1 shows the presently short-listed possible locations for a second interconnector. Each of these locations will have different implications for the transmission investment required in Tasmania and Victoria to support the increased transfer capacity. The choice of location will depend on environmental and land use planning considerations and the cost and feasibility of each option from a power system integration perspective. The most eastward route option shown in Figure 7-1 is the existing Basslink corridor. We expect the use of this route will have lower energy security benefits than the use of an alternative route, due to the possibility of an unexpected event rendering both Basslink and the second interconnector unavailable. TasNetworks is actively working with AEMO and AusNet Services to understand the optimal location of the converter station from a Victorian perspective.

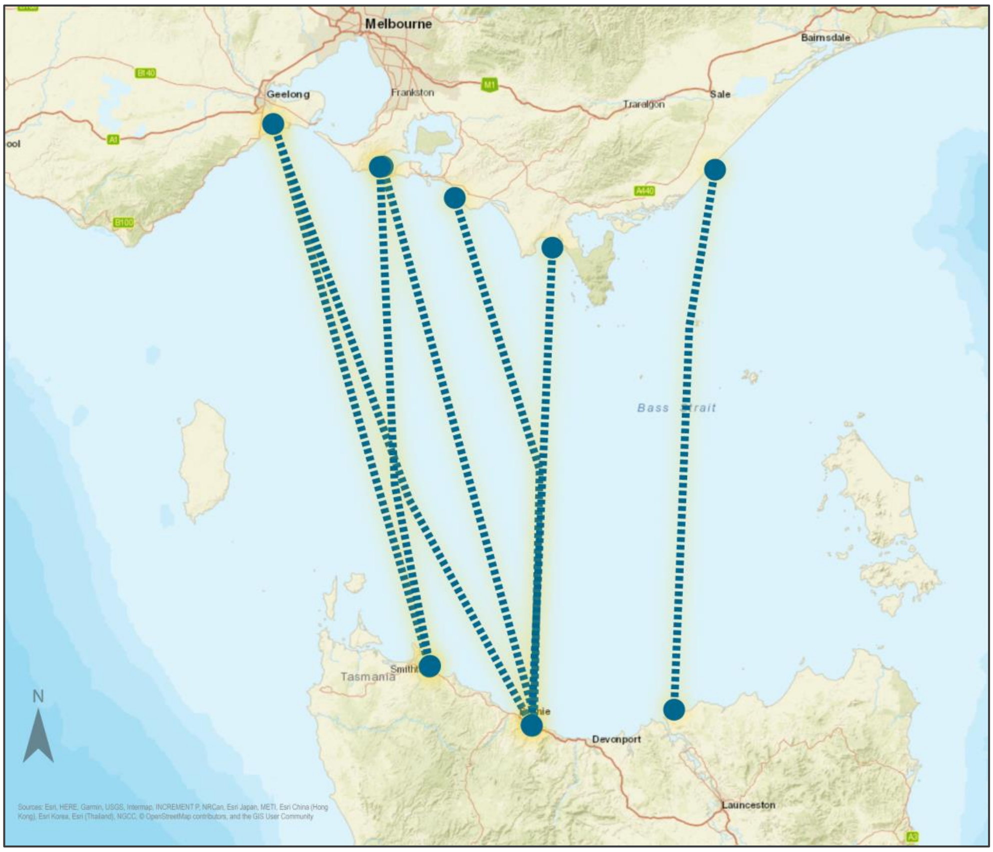

Figure 7-1: Possible locations for a second interconnector

7.2 Alternative technologies

There are a number of technology and configuration choices to be made, particularly around the HVDC technology, such as type of converter, and monopole or bi-pole transmission topology.

High voltages allow the efficient transmission of large quantities of power over long distances. High voltages can be transmitted via high voltage AC (HVAC) or HVDC. HVDC is the only technically viable option for the length of cable and power transfer required for a Bass Strait interconnector.

7.2.1 Converter configurations

HVDC interconnectors can be configured as either monopole, symmetrical monopole, or bipole:

- Monopole HVDC links are substantially cheaper than bipole links, however the power transfer capacity of a monopole is only half that of an equivalent bipole and there is less redundancy inherent in the design. A monopole configuration can be the first stage of a bipole configuration. A fault on a monopole link will reduce the link's power transfer capacity to zero.

A further design choice with monopolar links is whether to use the ground or sea for the current return path (the cheapest option) or to install a low-voltage cable to provide a metallic return path. We have discounted the option of a ground/sea return path due to environmental and corrosion concerns and associated planning approval difficulties. Basslink is a monopole HVDC link with metallic return.

- A symmetrical monopole is two high voltage cables with a single converter at each end. It has the same power transfer capacity as an equivalent bipole, although it is marginally cheaper. Like a monopole, a fault on a symmetrical monopole link will mean the entire link is not available.
- A bipole configuration is marginally the most expensive. It has two converters at each end. It has the advantage that the link can run at half capacity (i.e. operate as a monopole) if a fault occurs on one pole, however it still has a low probability of common mode failure.

The choice of configuration is based predominantly on cost and reliability requirements.

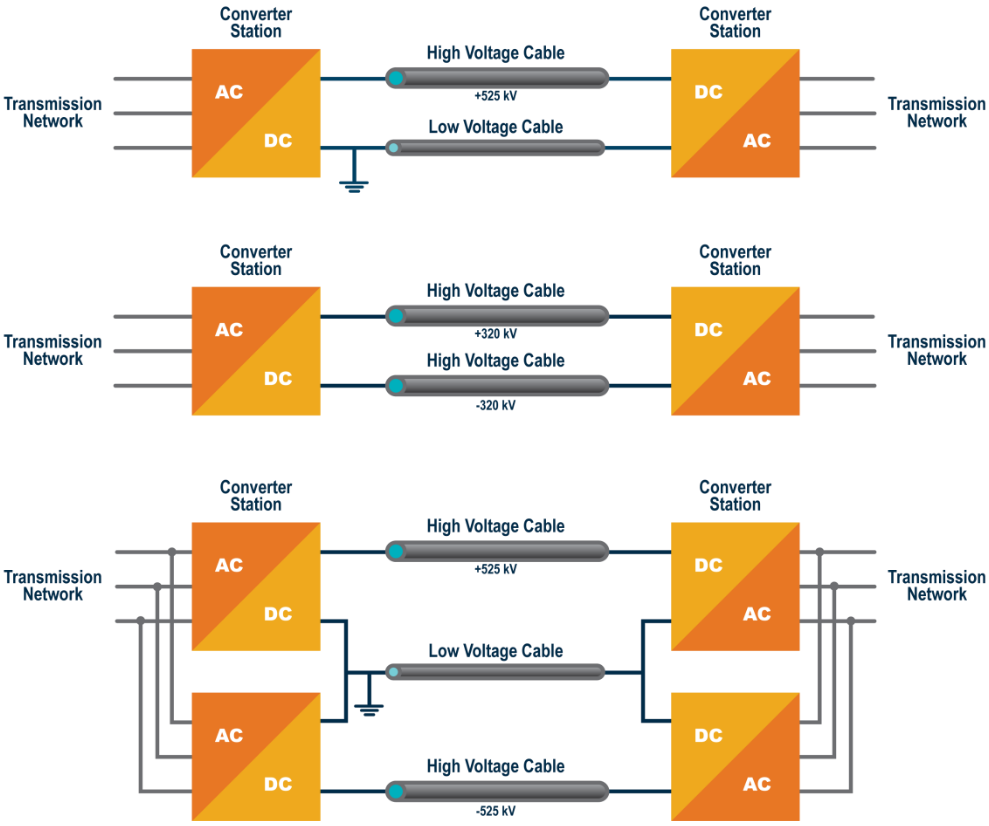

Figure 7-2: HVDC converter configuration examples: Monopole with metallic return (top), symmetrical monopole (centre), bipole (bottom).

7.2.2 Converter types

There are two HVDC converter technologies:

1. Line Commutated Converter (LCC) – used on Basslink, LCC technology has historically been used in subsea interconnectors and long distance high power transmission. LCC technology has the limitation of requiring significant system

strength (fault level) to operate. LCC also imposes constraints on power direction reversal, which limits its ability to provide power balance and FCAS

2. Voltage Source Converter (VSC) – VSC technology with high power transfer capability has only been developed in recent years. VSC converters are becoming more prominent, due to better technical performance and greater operational flexibility. VSC technology has lower fault level requirements than LCC technology (which is important in a market with less synchronous generation), provides significant dynamic reactive power support and can provide black start capability. VSC technology is also easier to connect to AC systems, which is advantageous when connecting to weak energy systems (including those with a high penetration of non-synchronous generation)

These technology choices are important in terms of network losses, system security and system integration, but are not expected to have a significant impact on the net market benefits. Another significant difference between these technologies is reversal of the power flow direction, which is required to provide energy arbitrage. To reverse power flow direction, an LCC link requires a minimum of five minutes break in power flow. This causes a number of market and operational problems. The VSC flow direction reversal can be done continuously without affecting the market. This, plus the avoidance of overvoltages and low fault level requirements, are the main attractions of VSC technology for Tasmanian applications. At this stage we do not consider it technically feasible to use line commutated converters in future Bass Strait HVDC links due to low fault levels (system strength issues) which are likely to be experienced in Tasmania in the future.

In broad terms, it is important that a flexible approach is taken to project design so that we avoid locking in decisions that may prove to be sub-optimal. In this regard, TasNetworks will give careful consideration to the design of the competitive tender process so that tenderers have an opportunity to present alternative technological solutions, where it is appropriate for them to do so. This approach will tap into the prospective service providers’ expertise with the objective of delivering the project as efficiently as possible.

7.2.3 Increase of existing interconnector capacity

It is technically possible to add a second pole to Basslink, thereby converting it from a monopole to a bi-polar link. This would involve the construction of a second HVDC converter at each end, augmenting the overhead DC transmission sections to carry an additional conductor, adding a second high-voltage DC cable (in both the undersea and underground sections), and augmentation of the transmission network into George Town to increase its capacity. The second pole could utilise VSC technology, even though the existing Basslink converters use LCC technology, effectively creating a hybrid bi-pole. The only hybrid bi-pole in service is Skagerrack 3/4 (Norway to Denmark).

As Basslink is a privately owned Market Network Service Provider, such an option would require Basslink’s owner’s agreement.

If it proves feasible, we would consider this as a sub-option of credible option 1, as the implementation costs and some categories of market benefit are likely to differ from building a new, fully independent HVDC interconnector.

7.3 Indicative costs and construction timeframes

The earlier feasibility study by Dr Tamblyn indicated a total capital cost up to $1.1 billion for a 600 MW link; including some network augmentations in Tasmania and Victoria; and operational and maintenance costs of approximately $17 million per annum, all expressed in June 2016 dollars.[32]

At this stage, our preliminary assessment is that the scope and costs of a second interconnector are expected to be somewhat greater than these earlier estimates. This is due to our inclusion of additional AC transmission network upgrades which would be required to support the increased power flows, plus escalation of previous costs to reflect the current values.

Indicative costs for the two credible options, expressed in June 2018 dollars, are:

- Option 1 (600 MW HVDC plus AC network upgrades): Indicative cost range is $1.4–$1.9 billion
- Option 2 (1,200 MW HVDC plus AC network upgrades): Indicative cost range is $1.9–$2.7 billion

In terms of operational and maintenance costs, we consider estimates of approximately $18 million per annum to be reasonable, again expressed in 2018 dollars. At this stage, the above cost estimates are only indicative and will be refined as the assessment process progresses.

The planning, approvals and construction timeframes are likely to be in the order of six to seven years in total, which means that the earliest a second interconnector would be commissioned is 2025. This timeframe includes the regulatory and planning approval processes, the design and completion of the competitive tendering process, and manufacture, construction, testing and commissioning. The manufacturing, transport, construction and commissioning activities are expected to take three and a half to four years after signing the contract.

7.4 Market benefits

The classes of market benefits contemplated by the Rules are listed below:

1. Changes in fuel consumption arising through different patterns of generation dispatch
2. Changes in voluntary load curtailment
3. Changes in involuntary load shedding, with the market benefit to be considered using a reasonable forecast of the value of electricity to consumers
4. Changes in costs for parties, other than the RIT-T proponent, due to:
    i) differences in the timing of new plant;
    ii) differences in capital costs; and
    iii) differences in the operating and maintenance costs

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[32] Dr John Tamblyn, Feasibility of a second Tasmanian interconnector, Final Study, April 2017, page 10.

5. Differences in the timing of expenditure
6. Changes in network losses
7. Changes in ancillary services costs
8. Competition benefits
9. Any additional option value (where this value has not already been included in the other classes of market benefits) gained or foregone from implementing that credible option with respect to the likely future investment needs of the market
10. Other classes of market benefits, determined to be relevant by the RIT-T proponent and agreed to by the AER in writing before the date the relevant project specification consultation report is made available to other parties

The Rules require us to specify the classes of market benefits that we consider are likely not to be material in accordance with clause 5.16.1(c)(6), together with our reasons.

TasNetworks considers that each of the above classes of benefits may be material in relation to a second interconnector, with the possible exceptions of competition benefits and "other classes of market benefits", as explained below. However, the materiality of the different categories of benefits cannot be known with certainty until the market modelling has been completed.

Competition benefits as defined by the Rules arise where the impact of an option on the wholesale market is to reduce the extent to which generators bid above their short run marginal cost, leading to changes in both the investment and dispatch outcomes of the market. Estimating competition benefits requires time and computationally intensive simulations using strategic bidding algorithms for previous interconnector assessments did not identify material benefits. Therefore, TasNetworks proposes to investigate screening methodologies to determine whether there are likely to be material competition benefits before embarking on any detailed modelling.

As noted in Section 4.6, TasNetworks has not sought the AER's agreement to include other classes of benefits in accordance with clause 5.16.1(c)(4)(x) of the Rules. Nevertheless, during our detailed project assessment TasNetworks will consider whether there is a case for including strategic benefits in the RIT-T assessment, which are often associated with major infrastructure projects.

7.5 Inter-network impacts

The Rules require us to state whether the credible option is reasonably likely to have a material inter-network impact, i.e. an impact on constraints or quality of supply in adjacent networks.

TasNetworks confirms that either option is likely to have a material inter-network impact. The nature of the project is such that TasNetworks will be working closely with AEMO, AusNet Services and other TNSPs to ensure that the inter-network impacts are properly understood and addressed where appropriate.