Contingent Project
Palmerston to Sheffield 220 kV augmentation

TasNetworks Project Needs Analysis

Regulatory Control Period: 1 July 2019 to 30 June 2024

Authorisations

Action	Name and title	Date
Prepared by	Andrew Jin – Senior Network Planning Engineer	26/07/2018
Reviewed by	James Teirney – Network Development Engineer Chantal Hopwood – Pricing and Revenue Strategy Team Leader	30/07/2018
Authorised by	Ewan Sherman – Network Planning Team Leader	27/11/2018

Responsibilities

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

Enquiries regarding this document should be addressed to:

Revenue Reset Program Leader
PO Box 606
Moonah TAS 7009
Email: revenue.resets@tasnetworks.com.au

Contents

Tables

Figures

1 Introduction

1.1 Purpose of this document

In January 2018, TasNetworks submitted our combined Revenue Proposal for transmission and distribution for the regulatory period commencing on 1 July 2019 and ending on 30 June 2024. On 27 September 2018, the Australian Energy Regulator (AER) released its draft decision. This document responds to the AER's draft decision in relation to one of TasNetworks' contingent projects, that is, the Palmerston to Sheffield 220 kV augmentation.

1.2 Overview of the AER's draft decision

Contingent projects are significant network augmentation projects that are reasonably required to be undertaken in order to achieve the capital expenditure objectives as defined in the Rules. However, unlike other proposed capital expenditure projects, the need for the project within the regulatory control period and the associated costs are relatively uncertain.

The AER rejected our contingent projects on the basis that we had not demonstrated that the contingent project triggers are:

- reasonably specific and capable of objective verification
- probable to occur during the regulatory control period[1].

To address the AER's draft decision TasNetworks has prepared this project needs analysis report, providing further discussion on the need for reinforcing the Palmerston to Sheffield 220 kV corridor to facilitate significant generation developments in the North West and/or West Coast of Tasmania, or to facilitate a connection of a second Bass Strait interconnector in North West Tasmania.

The inclusion of the Sheffield to Palmerston 220 kV augmentation as a contingent project in our revised Regulatory Proposal ensures that provisions are made to allow this significant infrastructure project to proceed if it is demonstrated to deliver a net economic benefit.

This report is provided as a supporting document to this revised Regulatory Proposal. The Project Needs Analysis sets out the following information:

- background on the existing network capacity and configuration;
- the issues or 'identified need' that would arise if particular 'triggers' eventuate;
- high level options for addressing the identified need;
- preliminary analysis of the net benefits that would arise from the proposed contingent project; and
- specific trigger events that are consistent with the analysis presented.

[1] AER, draft decision, TasNetworks Transmission Determination 2019 to 2024, Attachment 5, Capital Expenditure, page 50.

2 Background

The existing Palmerston–Sheffield 220 kV transmission line (TL503) is a 79 km single circuit line, built in 1957. It uses Goat conductor strung at a 65°C design operating temperature, with a rating of 298 MVA/239 MVA (Winter/Summer). Based on existing maintenance practices, this line is expected to remain serviceable through the 2019–24 period.

We have received a number of connection applications from potential new generators in North West Tasmania and on the West Coast of Tasmania – currently totalling approximately 680 MW of new generation. This includes Granville Harbour Wind Farm on the West Coast of Tasmania (112 MW), which has a signed connection agreement, has commenced construction but is not yet technically *committed*. There are also other significant proposals still at the connection enquiry stage.

In order to accommodate a significant amount of new generation in North West Tasmania and on the West Coast of Tasmania, the augmentation of the existing Palmerston to Sheffield 220 kV corridor will result in a new double circuit 220 kV transmission line. This line will avoid the need to constrain generation in order to maintain a secure operating state.[2] The estimated cost of this project is $117 million.

In addition, a second Bass Strait interconnector that connects into the network in North West Tasmania would also require the upgrade of the existing Palmerston–Sheffield 220 kV corridor with a new double circuit 220 kV transmission line. This augmentation would be required in order to address the thermal limitations caused by the additional energy transferred across the second Bass Strait interconnector (for both import and export scenarios), and is independent of the development of new generation.

This augmentation had previously been identified as a possible solution to address limitations caused by either high wind generation in North West Tasmania or high import from Victoria to Tasmania through a second Bass Strait interconnector, in the Australian Energy Market Operators (**AEMO**'s) 2016 National Transmission Network Development Plan (**NTNDP**).[3]

[2] Tasmania Core Grid plan 2014 (R3174)

[3] http://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/NTNDP/2016/Dec/2016-NATIONAL-TRANSMISSION-NETWORK-DEVELOPMENT-PLAN.pdf

3 Need analysis – new generation in North West and West Coast Tasmania

3.1 Overview

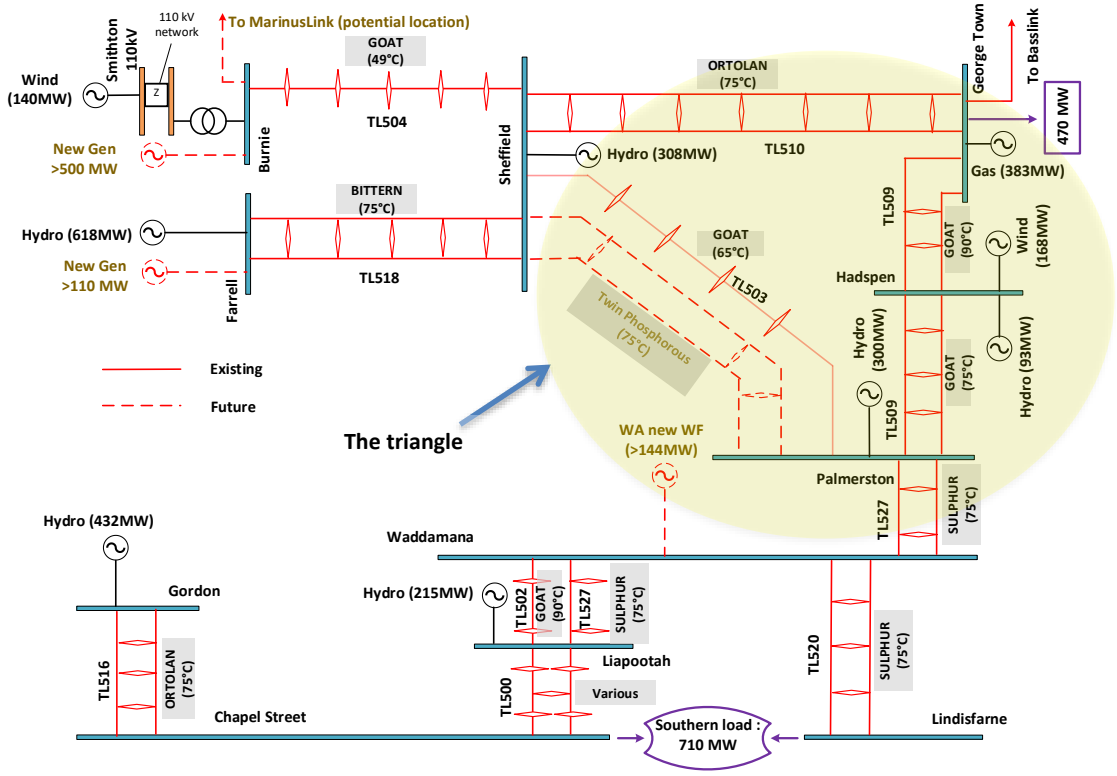
3.1.1 The Palmerston–Sheffield–George Town triangle

Figure 1 presents the 220 kV core grid and the lumped generation at each 220 kV bus. Also shown are the two major load centres, George Town and Hobart. The maximum demand for these two load centres was 470 and 710 MW[4] respectively in 2017–18.

The Palmerston–Sheffield–George Town triangle (the triangle) is part of the core grid transmission network (ref yellow circle in Figure 1). The triangle:

- Connects the North West and West Coast areas of Tasmania with George Town and the rest of the network;
- Supplies the major industrial customers in George Town from either the North West and the West Coast of Tasmania (via the Sheffield–George Town 220 kV transmission lines) or the rest of Tasmania (via the Palmerston–Hadspen–George Town 220 kV transmission lines);
- Enables Basslink export and import from George Town Substation; and
- Transmits generation from North West and West Coast Tasmania to Hobart and other load centres.

Figure 1: Tasmanian 220 kV core grid



[4] Rounded to 10 MW

The Network Control System Protection Scheme **(NCSPS**) makes it possible for the transmission network in Tasmania to operate to non-firm during Basslink export. The NCSPS monitors the Sheffield–George Town, Hadspen–George Town and Palmerston–Hadspen transmission corridors such that potential overloading as a result of any circuit contingency could be relieved by either ramping back or tripping of relevant generators. The Palmerston–Sheffield transmission line is not monitored under N system but is indirectly protected by NCSPS action on the other corridors. When Basslink is on import, the NCSPS is not active and the network is operated firm.

3.1.2 Proposed new generation developments

There is approximately 680 MW of new generation currently under connection application in North West and West Coast Tasmania, all proposed to connect within the 2019–24 regulatory control period. These are presented in Table 1. Granville Harbour Wind Farm has a signed connection agreement with TasNetworks – though is not yet technically committed.

There is significantly more proposed generation proposals that have submitted connection enquiries, but have not yet submitted connection applications.

Table 1: Connection applications

Generation Development	Capacity (MW)	Timing
Connection application to 110 kV network North West Tasmania	77.5	2019
Connection application to 220 kV network North West Tasmania	500	2023
Connection application to 220 kV network West Coast of Tasmania	112	2019
Connection enquiries	+1000	+2024

3.2 The issue

The *Electricity Supply Industry (Network Planning Requirements) Regulations 2018*[5] (the regulations) require certain single asset failures to be planned for, including the failure of a double circuit transmission line. A failure of the double circuit Sheffield–George Town 220 kV transmission line, under various operation scenarios, would result in system instability and the subsequent loss of the Palmerston–Sheffield 220 kV transmission line. This results in a split of the system and significant interruption to supply or in the worst case, a black system. This would not meet the requirements of clause 5(1)(a)(ii) and 5(1)(a)(iii) of the regulations. Refer Figure 2 below.

Figure 2: Clause 5(1)(a) ESI (Network Planning Requirements) Regulations 2018

5. Minimum network performance requirements

(1) Power system planning in respect of a relevant transmission system must be such that the system is likely to meet the following network performance requirements:

(a) in respect of an intact transmission system –

(ii) no more than 850 MW of load is to be capable of being interrupted by a single asset failure; and

(iii) load that is interrupted by a single asset failure is not to be capable of resulting in a black system;

[5] Electricity Supply Industry (Network Planning Requirements) Regulations 2018

The operational scenarios leading to system instability are currently rare, but would increase with the connection of the new wind developments in North West Tasmania and on the West Coast of Tasmania, as power flows both in quantum and duration increase through the Palmerston–Sheffield–George Town triangle. To maintain system stability, and avoid a significant supply interruption or a black system, a constraint equation (1)[6] will be required for loss of the double circuit Sheffield–George Town 220 kV transmission line:

$$SH_{Exp} \leq 497 + 0.341 \times BL_{Exp} + 0.165 \times TotalTasLoad \quad (1)$$

Where:

SH_{Exp}: the summation of MW flow from Sheffield Substation on the three circuits of Sheffield–George Town and Palmerston–Sheffield transmission lines;

BL_{Exp}: Basslink export (+) or import (-) MW flow; and

TotalTasLoad: the summation of MW load (excluding Basslink) in Tasmania.

When this equation binds, generation in North West and West Coast Tasmania will be constrained. In this analysis, it is assumed constrained generation (wind and hydro) will result in spill.[7]

3.3 Options to address the issue

To maintain a secure operating state in the presence of increasing generation in North West Tasmania and on the West Coast of Tasmania, as presented in Section 0, the credible options identified are:

- Option 0: Maintain power system security by invoking a constraint equation; or
- Option 1: Construct a new double circuit Palmerston–Sheffield 220 kV transmission line.

Option 0 will avoid the cost of undertaking the augmentation, but customers may suffer economic loss from not having access to this new generation.

Option 1 would avoid the need to introduce a new constraint equation (Option 0), and therefore would allow additional generation to be dispatched in North West Tasmania and on the West Coast of Tasmania. Where the market benefits from having access to this additional generation exceeds the costs of the augmentation, this option will deliver an overall positive net market benefit.

Option 1 is feasible after extension of the existing easements. A detailed options analysis will be undertaken once the project reaches the Regulatory Investment Test for Transmission (**RIT-T**) stage (and therefore prior to any contingent project application by TasNetworks).

3.3.1 Cost estimate

The cost estimate to construct a new double circuit Palmerston–Sheffield 220 kV transmission line is $117 million. This includes construction of the transmission line alongside the existing line, the required substation work at both Palmerston and Sheffield substations, and all other associated activity. Table 2 presents the cost breakdown of the project.

[6] This equation has been developed for this analysis. It is not an existing equation.

[7] The West Coast hydro power stations have relatively small water storages, and those in North West Tasmania are essentially run-of-the-river power stations.

Table 2: Cost breakdown of the project[8]

Item description	Base estimate ($m)
Double circuit 220 kV transmission line within the existing transmission corridor	100
Palmerston and Sheffield Substation	17
Total	**117**

3.4 Benefits of the augmentation

Preliminary analysis has been undertaken to identify the magnitude of the key market benefits associated with an augmentation to construct a new double circuit Palmerston–Sheffield 220 kV transmission line (Option 1) against invoking the constraint equation to maintain power system security (Option 0). This analysis has been used to identify the amount of new generation capacity (MW) in North West Tasmania and on the West Coast of Tasmania beyond which the benefits of relieving the constraint equation are expected to be greater than the costs of the augmentation.

3.4.1 Benefits quantified

The two key market benefits quantified in this analysis:

- Avoided water or wind spill in North West Tasmania and on the West Coast of Tasmania, which results in avoided dispatch and costs; and
- Reduction in transmission network losses in Tasmania.

Two further benefits may arise as the result of a reduction in the application of intra-regional constraints, but have not been included in this preliminary analysis. These other benefits are detailed in Section 3.4.5.

3.4.2 Assumptions made

To quantify the market benefits, the following assumptions were adopted in the analysis:

- Actual operational scenarios for the Tasmanian transmission system from July 2011 to June 2015 and July 2016 to June 2018[9] (half hourly) were used to model the existing network for both the spill and loss assessments;
- The historic output of Bluff Point and Studland Bay wind farms (only established transmission scale wind generation in the greater North West and West Coast areas) was applied uniformly to all the new wind farms in North West Tasmania and on the West Coast of Tasmania;
- New wind farm output is exported to Victoria via Basslink up to the short-term export limit of 630 MW, then displaces hydro generation in the remainder of the network (i.e. excluding North West Tasmanian and on the West Coast of Tasmania);

[8] Base Level 1 estimate only

[9] 2015–16 financial year is considered abnormal due to the prolonged Basslink outage.

- In the spill assessments, generation (wind and hydro) exceeding the limit is as determined by Equation (1) was considered to be spilled;[7]
- The annual market benefit was derived by multiplying the annual energy curtailed with the annual volume weighted average spot price in Victoria[10] in 2017–18, which was $99/MWh, where the market is assumed to be fully competitive, and the spot price has been used to represent the underlying cost of generation; and
- The reduction in transmission network losses was calculated by comparing losses from the historic operation against what they would have been with the new transmission line in service.

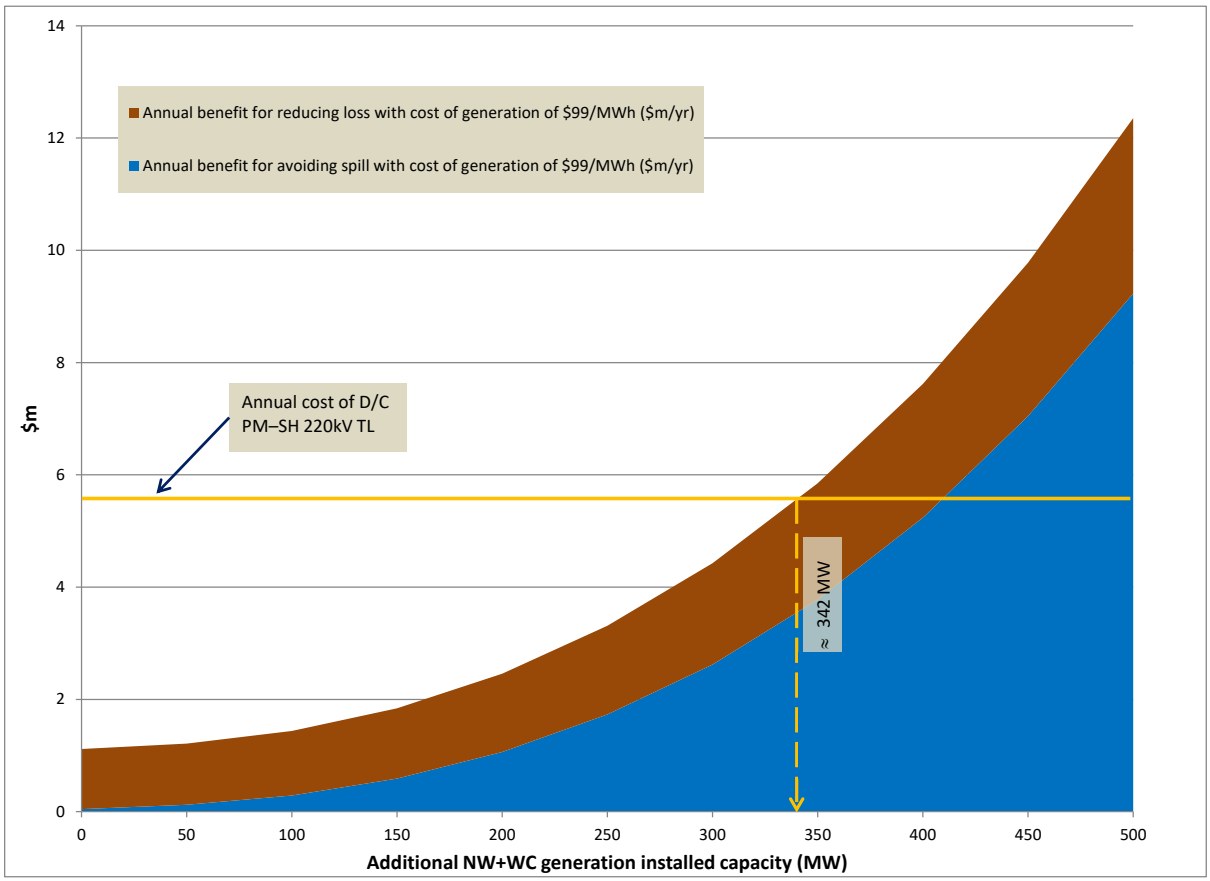
3.4.3 Market benefit assessment

The annual market benefits realised by implementing a new double circuit Palmerston–Sheffield 220 kV transmission line are presented in Figure 3. The total benefit is the contribution from avoided spill and reduced losses. The benefit increases with increasing amounts of new generation in North West and West Coast Tasmania. The point at which the proposed transmission line augmentation is expected to become economic is when the annual market benefit exceeds the annualised cost of the augmentation. As shown in Figure 3 the augmentation becomes economic when approximately 342 MW of new generation connects in North West Tasmania and on the West Coast of Tasmania.

This is based on valuing the generation that would otherwise be constrained if the augmentation did not proceed and the associated reduction in losses based on a cost of generation in Victoria, of $99/MWh.

[10] Annual volume weighted average spot prices

Figure 3: Annual market benefits of a new Palmerston–Sheffield 220 kV transmission line

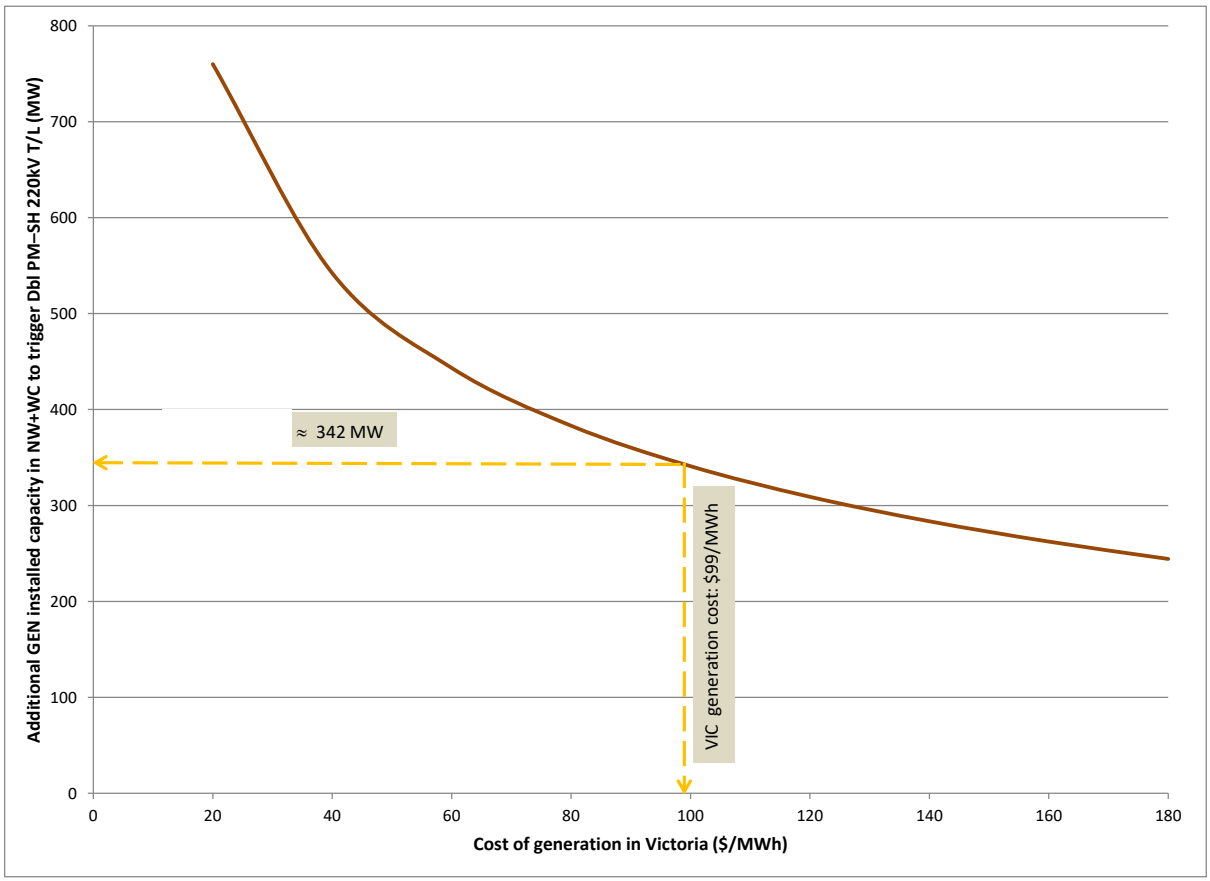


The point at which augmenting the existing transmission line with a new double circuit Palmerston–Sheffield 220 kV transmission line becomes economic is approximately 342 MW of new generation in North West Tasmania and on the West Coast of Tasmania.

3.4.4 Sensitivity

The benefits assessment is weighted towards the value of generation cost. Going forward should the cost of generation in Victoria increase; the point at which the annual market benefit exceeds the annualised cost of the augmentation will reduce. Alternatively, if cost decreases, the point will increase. The relationship between the new generation connecting in North West and West Coast Tasmania and the cost of generation is presented in Figure 4.

Figure 4: Sensitivity variance against cost of generation in Victoria



3.4.5 Other benefits

Two further benefits are expected from a new double circuit Palmerston–Sheffield 220 kV transmission line. They were not included in this preliminary analysis, as they are expected to be of a lower order of magnitude and are not directly related to an external contingent project trigger, but are discussed below. The materiality of these benefit categories would be considered as part of any RIT-T assessment.

3.4.5.1 Release voltage constraints on Basslink export

Basslink export is occasionally constrained by a voltage stability requirement. A new double circuit Palmerston–Sheffield 220 kV transmission line would provide around 12 MVAr additional voltage support. This, plus the network reinforcement introduced by the new transmission line, would release the voltage constraint on Basslink export by around 10 MW.

The market benefit provided by releasing this constraint is expected to be of a lower order of magnitude to that associated with avoiding constraints on the generation in North West Tasmania and on the West Coast of Tasmania. However, this benefit would be further considered in any subsequent analysis undertaken to complete RIT-T.

3.4.5.2 Release North – South oscillations constraints for loss of Palmerston–Sheffield circuit

Currently there are two sets of constraint equations to prevent poorly damped oscillations following network contingencies in Tasmania; North – South oscillations following loss of the Palmerston–Sheffield circuit. These equations bound for 1,053 dispatch intervals (5,265 minutes) in the past four years with an average marginal value of -$545. Additional wind penetration in Tasmania, particularly in North West Tasmania and on the West Coast of Tasmania, would make these constraints bind more frequently and likely with more increased marginal values. A new double circuit Palmerston–Sheffield 220 kV transmission line would remove these constraints.

The other constraint set only bound for 5,265 minutes (or 0.25 % of time) in the past four years with a non-significant marginal value. In addition, how the binding scenarios would evolve as more wind penetration takes place is heavily dependent on the operating regime following the connection of new wind generation. These uncertainties make the quantification of this component of market benefit challenging. Therefore, this market benefit was not included in this preliminary analysis, but its materiality would be further considered as part of any subsequent RIT-T assessment.

4 Need analysis – a second Bass Strait interconnector

4.1 Overview

TasNetworks has established Project Marinus to assess the feasibility of a second Bass Strait interconnector between Tasmania and Victoria. A second interconnector will be supported by network augmentation in Tasmania. Connection of a second interconnector in North West Tasmania will increase power flows in the Palmerston–Sheffield–George Town triangle.

4.2 The need

The Project Specification Consultation Report for Project Marinus identified a new double circuit Palmerston–Sheffield 220 kV transmission line is likely to be required to support a second interconnector, where it connects in North West Tasmania.[11] This requirement is to support the second interconnector itself (in both import and export scenarios), and is not co-dependent on new generation also being developed.

4.3 Requirement for the augmentation

Similarly, to the driver of new generation in North West Tasmania and on the West Coast of Tasmania, augmentation of the Palmerston–Sheffield 220 kV corridor is required to release thermal constraints on Palmerston–Sheffield–George Town triangle. This section presents preliminary analysis of the effect of a second interconnector, which will be analysed in much more detail as part of Project Marinus.

4.3.1 Export from Tasmania

For the existing network when Basslink is on export generally, the Palmerston–Sheffield transmission line is less loaded than the Sheffield–George Town line (when generation is from the North West and West Coast) or the Hadspen–George Town line (when generation is from the rest of the network). Therefore, the Palmerston–Sheffield transmission line was not included as the Network Control System Protection Scheme (**NCSPS**)[12] monitored circuit when NCSPS was initially designed.

This situation would change if a second interconnector (termed Marinus Link) is established in North West Tasmania. This is presented in Figure 5 and Figure 6. For export via Basslink and loss of a Hadspen–George Town circuit, the remaining Hadspen–George Town circuit would overload before the Palmerston–Sheffield circuit. However if export was via Marinus Link, then the Palmerston–Sheffield circuit would overload first. Augmenting the existing Palmerston–Sheffield 220 kV corridor with a new double circuit line would prevent this corridor from becoming a bottleneck under certain export scenarios.

[11] Page 29, Additional interconnection between Victoria and Tasmania, Project Specification Consultation Report, TasNetworks, July 2018. https://projectmarinus.tasnetworks.com.au/

[12] The initial NCSPS only covers the N system.

Figure 5: Overload Hadspen–George Town when export 600 MW via Basslink

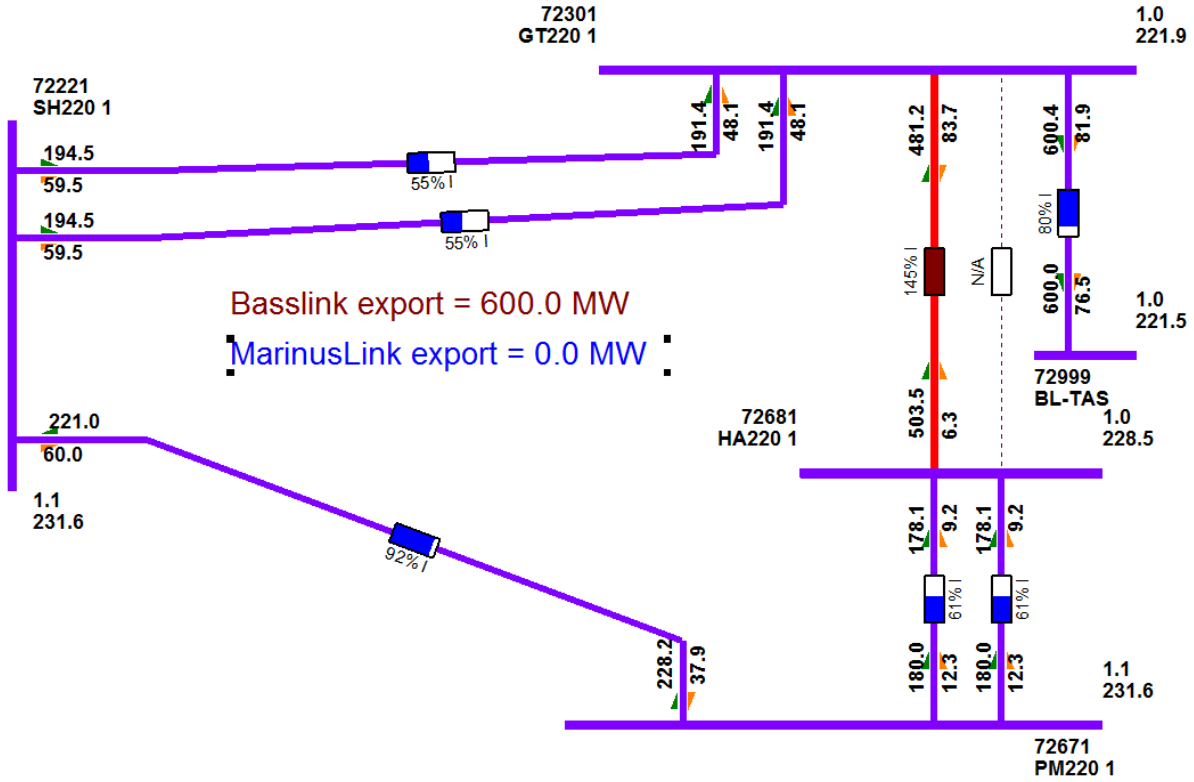
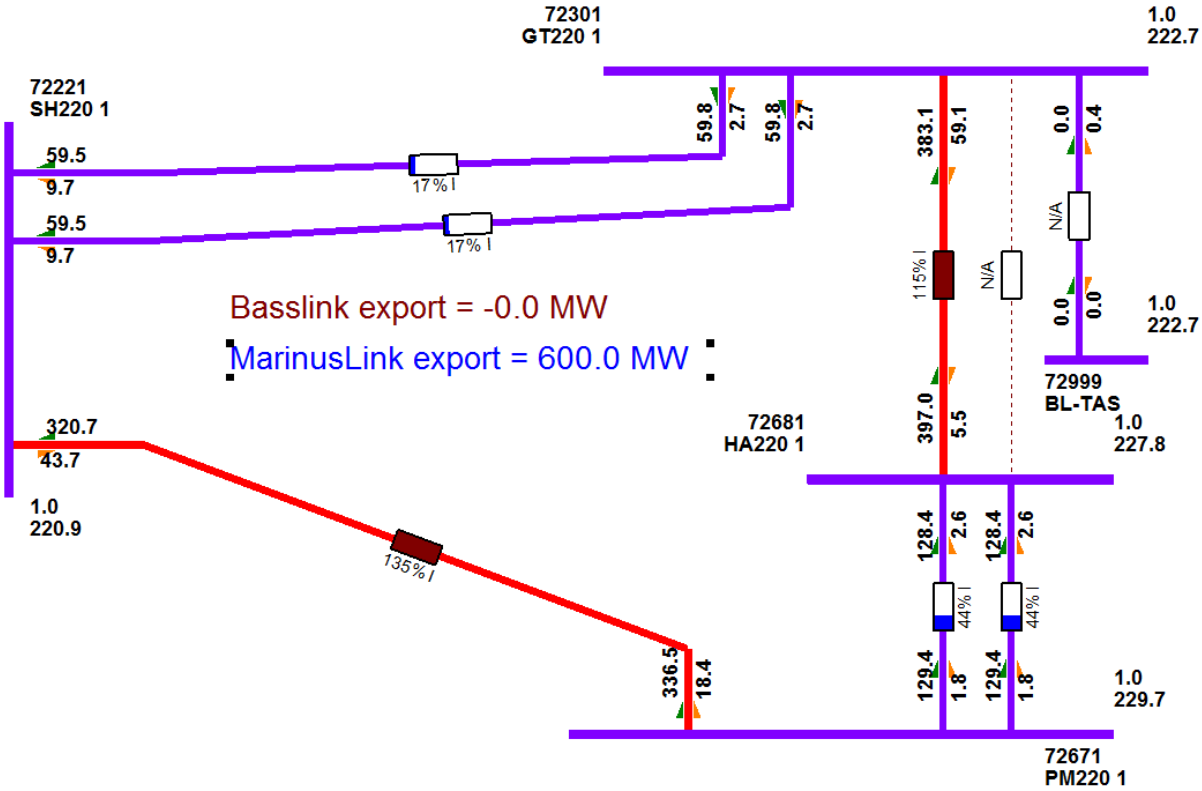


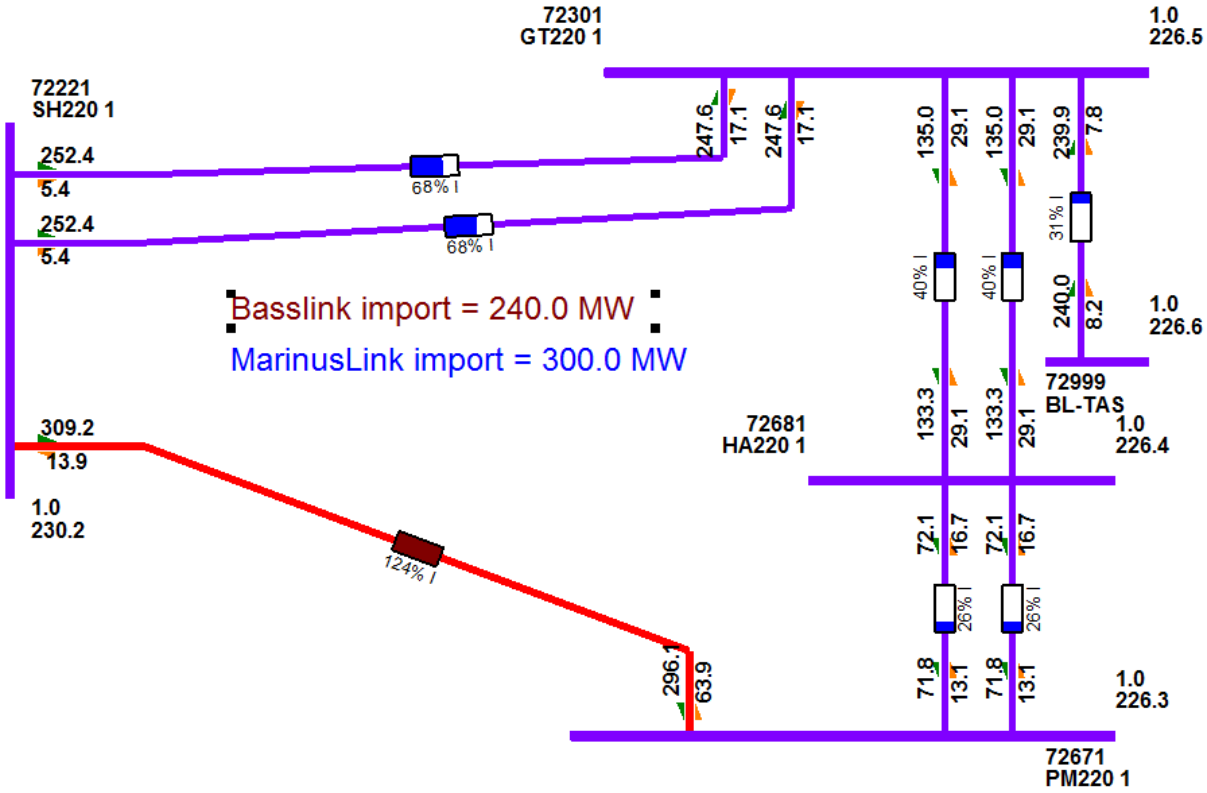
Figure 6: Overload Palmerston–Sheffield when export 600 MW via Marinus Link in North West Tasmania



4.3.2 Import to Tasmania

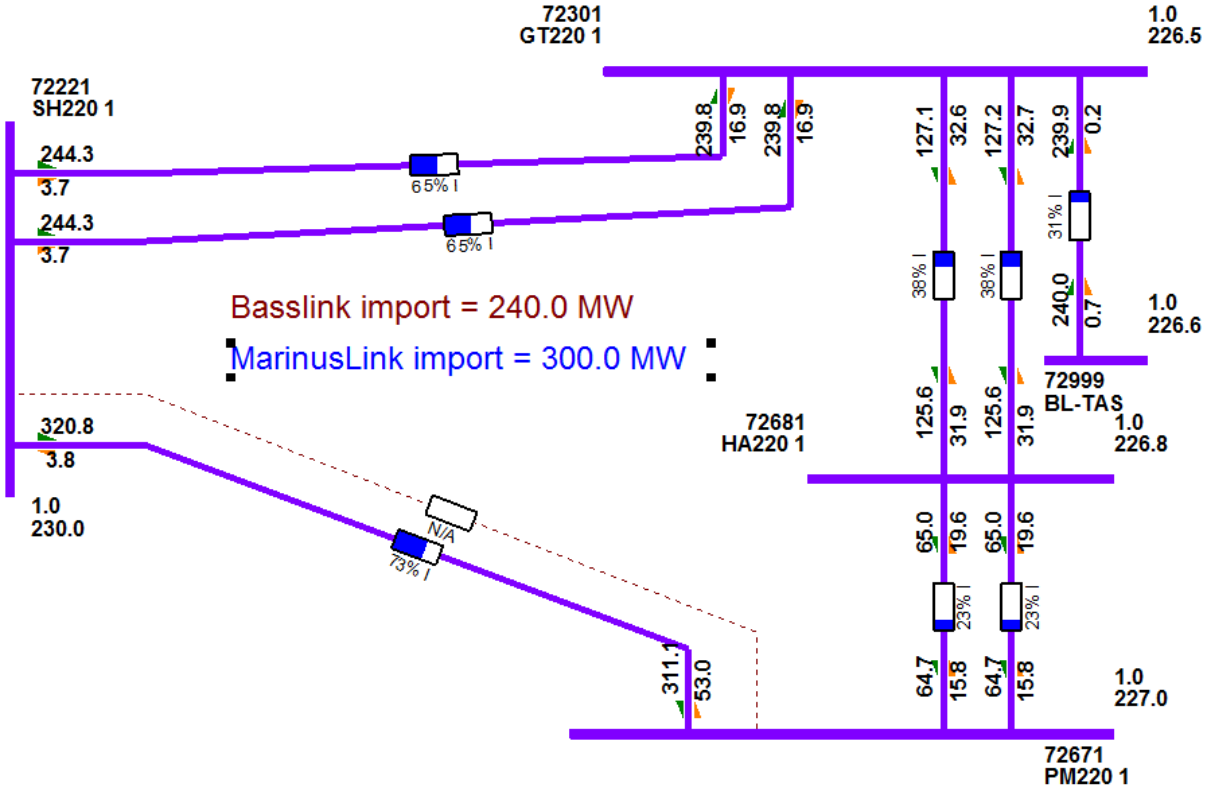
The overload on the Palmerston–Sheffield circuit is more obvious when both Basslink and the Marinus Link are importing. An example is presented in Figure 7, where all generation (including 640 MW of new generation) in North West Tasmania and on the West Coast of Tasmania is generating at 50% of its maximum capacity, while Basslink and Marinus Link were importing 240 MW and 300 MW respectively. In this scenario, the existing Palmerston–Sheffield circuit is loaded to 124% of capacity without any contingency (i.e. all network elements in service).

Figure 7: Overload Palmerston–Sheffield when both Basslink and Marinus Link are on import



This issue would be alleviated with the existing Palmerston–Sheffield transmission line replaced with a new double circuit 220 kV transmission line. This is shown in Figure 8 with a new Palmerston–Sheffield transmission line and the same dispatch scenario as outlined above, although a contingency of one of the Palmerston–Sheffield circuits was applied.

Figure 8: Post Palmerston–Sheffield augmentation when both Basslink and Marinus Link are on import



5 Expected evolution of the operation regime

As indicated in Footnote 6, Equation (1) was developed for this analysis. It is not an existing equation because it would rarely bind under the current generation dispatch scenarios. This situation is expected to change when new generation is connected in North West and/or West Coast Tasmania.

Once the additional generation is committed and before the proposed Palmerston–Sheffield augmentation project is implemented, a new constraint equation similar to Equation (1), is likely to be required. This equation will bind from time to time depending on the availability of wind resource as well as the amount of inflows from the hydro power stations in North West and West Coast Tasmania. As a result, wind and/or water spill may take place.

6 The trigger

TasNetworks has identified two independent drivers for augmentation of the Palmerston to Sheffield 220 kV transmission corridor:

- A net economic benefit from the release of low cost generation committed to connect in North West and/or West Coast of Tasmania; or
- A second Bass Strait interconnector connects in North West Tasmania.

6.1 New generation trigger

As presented in Section **Error! Reference source not found.**, when new generation connects in North West and/or West Coast Tasmania an equation similar to Equation (1) would need to constrain generation in these areas, limiting power flows into Sheffield Substation in order to maintain the power system security requirements as stipulated in the Rules.

Augmentation of the Palmerston to Sheffield 220 kV transmission corridor will alleviate the constraint, allowing low cost generation into the market. The annual market benefit for this augmentation is expected to exceed the annualised cost when new generation connecting in North West and/or West Coast Tasmania exceeds 342 MW. This is based on the cost of generation in Victoria of $99/MWh. The total quantified market benefit for the augmentation only includes two components, these being:

- Avoided water or wind spill in North West Tasmania and on the West Coast of Tasmania, which results in avoided dispatch costs; and
- A reduction in transmission network loss in Tasmania.

As discussed in Section 3.1.2, there is currently 680 MW of new wind generation in North West and West Coast Tasmania, however none are committed. With the amount of new generation proposed we consider that it is probable that more than 342 MW will have committed to connect in this area during the 2019-24 regulatory control period.

6.2 Second Bass Strait interconnector trigger

The feasibility of a second Bass Strait interconnector is currently being assessed under Project Marinus. The outcome of the feasibility study is due in December 2019 and it may recommend proceeding with the second interconnector.

As presented in Section 4, we are currently assessing the feasibility of a second Bass Strait interconnector. A second interconnector will require augmentation of the Palmerston to Sheffield 220 kV transmission corridor.

The outcome of the feasibility study is due in December 2019 and it may recommend proceeding with the interconnector. Therefore, a decision to proceed with a second interconnector in North West Tasmania has been included as a separate trigger for this contingent project.

TasNetworks notes that the augmentation of the Palmerston to Sheffield 220 kV transmission corridor has not been included within the scope of the separate Project Marinus contingent project.

6.3 Proposed trigger events for the augmentation

The Palmerston to Sheffield 220 kV augmentation should be accepted as a contingent project, due to the commitment of either new generation in North West and/or West Coast Tasmania, or a second Bass Strait interconnector in North West Tasmania, being probable in the 2019–24 regulatory control period.

The trigger events for this contingent project are:

a) A net economic benefit can be obtained by increasing transmission capacity for low cost generation committed to connect in North West and/or West Coast of Tasmania; and/or

b) A commitment to proceed with a second Bass Strait interconnector connecting in North West Tasmania.

c) Successful completion of a RIT-T and a determination by the AER that the proposed investment satisfies the RIT-T.

d) TasNetworks Board commitment to proceed with the project subject to the AER amending the revenue determination pursuant to the Rules.

In relation to (a), it is noted that our current analysis indicates that new generation with an aggregate capacity exceeding 342 MW would need to commit in North West and/or West Coast Tasmania in order for the project to provide a net economic benefit. As explained in section 3.4.4, however, the required generation capacity may vary depending on a number of factors, including the wholesale generation price in Victoria.

The proposed triggers address the AER's concerns in its draft decision. In particular, the proposed triggers are specific and capable of objective verification, relate to a specific location, and although probable during the 2019–24 regulatory control period, the project is currently too uncertain to include in the forecast capital expenditure in TasNetworks Revenue Proposal