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1 Summary

The transmission network development proposal (the ***Transmission Proposal***) for the connection of the Project into the existing and future shared transmission network has progressed since the Feasibility Study, through internal design activity and in response to changes in the external environment.[1] In particular, since the completion of the Feasibility Study, there has been widespread acceptance and recognition including by COAG Energy Council, the Energy Security Board and AEMO of the need for an integrated system plan that is consistent with the initial Transmission Proposal. AEMO's Integrated System Plan shows that the deep augmentation of the shared network is required with or without Snowy 2.0 in order to meet the future requirements of the NEM.

While solid progress has been made, more work remains to be done after Final Investment Decision (***FID***).

1.1 Introduction

The Transmission Proposal for the connection of the Project into the existing and future shared transmission network has progressed since the Feasibility Study and has been updated relative to the Feasibility Study.

The Transmission Proposal is considered as five key work streams:

1. 'Shallow' connection works;
2. 'Deep' transmission network development, which is reflected in the Integrated System Plan (***ISP***);
3. National Electricity Rules (***NER***);
4. Transmission Connection Agreement (***TCA***); and
5. Construction supplies (a new work stream since the Feasibility Study).

Since the Feasibility Study was completed in December 2017, there has been significant activity in the external National Electricity Market (***NEM***) transmission space which has required changes from the initial Snowy 2.0 Transmission Proposal. These changes have been made to maintain alignment of the Proposal with the Australian Energy Market Operator (***AEMO***)'s ISP,[2] and other deep

[1] Snowy 2.0 Feasibility Study, Available at: http://www.snowyhydro.com.au/our-scheme/snowy20/snowy-2-0-feasibility-study/
[2] AEMO, 2018. AEMO - Integrated System Plan. Available at: https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Integrated-System-Plan [Accessed October 23, 2018]

transmission network developments that have progressed since the Feasibility Study.

Figure 1 shows the updated version of the Transmission Proposal 'three-state network development' and includes the relevant deep transmission network developments, particularly 'Bannabylink' (referred to as Snowylink North in the ISP), Riverlink (ElectraNet's SA Energy Transformation Regulatory Investment Test - Transmission (***RIT-T***) preferred option), and the ISP Group 3 'Keranglink' option (referred to as Snowylink South in the ISP).

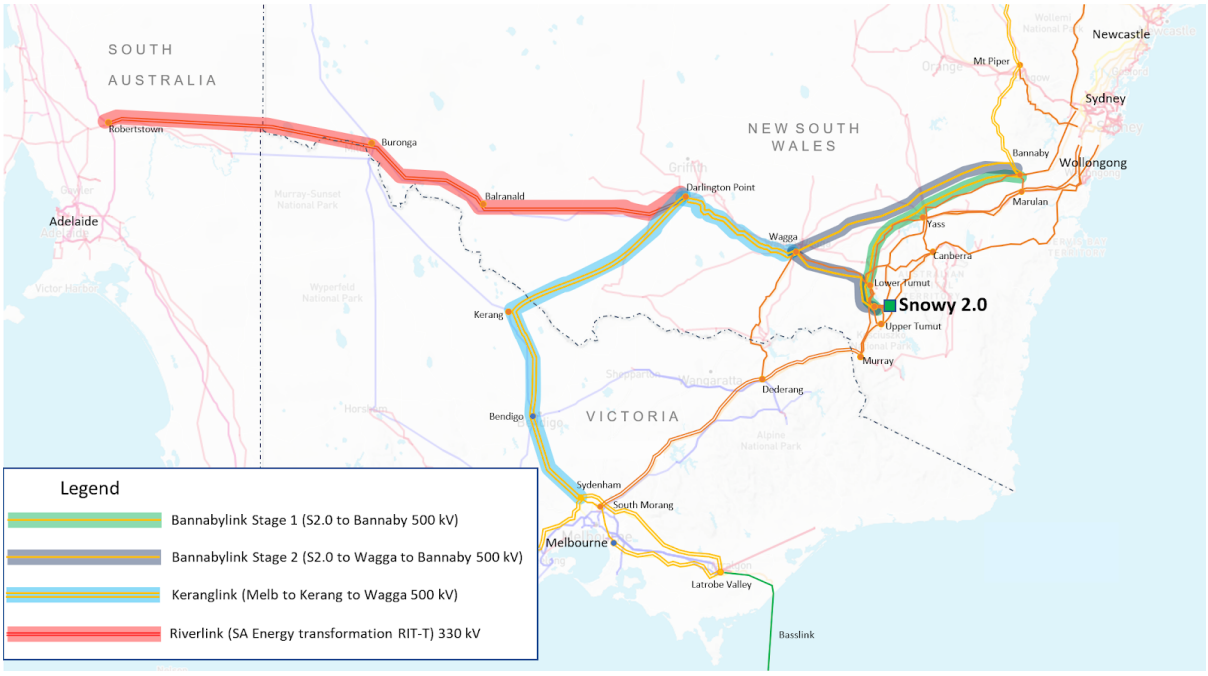

Figure 1: Snowy Preferred network development concept after ISP

Key points:

1. Electricity Security Board (***ESB***) Focus Area 2 (ISP as an actionable strategic network development plan) and its basis for the fast track approval of Bannabylink and Keranglink through broader-based benefits assessments in the RIT-T, that recognises the need to facilitate orderly transition in the context of rapid and fundamental changes to the generation mix;
2. Bringing construction of stage 1 of Bannabylink forward to release approximately 1,000 MW of southern NSW and VIC capacity into the major NSW load centres by the closure date of the Liddell power station in 2022;
3. Ensuring stage 2 of Bannabylink is completed by the Project commissioning date to meet the Project NSW connection objectives, release south-west NSW Renewable Energy Zone (***REZ***) capacity and integrate Riverlink into the NSW and SA market regions;
4. Bringing the Keranglink option forward to align with the Snowy 2.0 commissioning date through review of the consumer benefits and system security implications in Victoria under Victorian Renewable Energy Target

(***VRET***) and potential rapid changes to the generation mix including early or unplanned closure of coal fired power stations;
5. Strong opposition to the application of Transmission Use of System (***TUOS***) charges to generator participants which provide energy firming services which are actually required to facilitate the orderly transition to renewables;
6. Timely completion of temporary construction supplies; and
7. Timely completion of the shallow connection works

1.2 Scope and exclusions

This chapter reflects updates to the Transmission Proposal as modified since the Feasibility Study. Activities and actions remaining to achieve connection of the Facilities to the NEM are discussed, as is coordination of these activities with future key Project dates and the other project work streams.

Details of the Reference Design which impact on the shallow connection works configuration and associated NER requirements are explained in *Supporting Chapter Twelve - Facilities*.

1.3 Activities undertaken

Work has progressed as follows:

1. **Shallow connection works:**
    a. **Snowy Hydro** - Reference Design development, construction coordination activities and interface definition; and
    b. **TransGrid** - Early Works Agreement (***EWA***) to advance connection works, advancement of approvals, contractual development, engagement and coordination with Snowy Hydro.
2. **Deep transmission network development** - discussion and stakeholder engagement with applicable State and Federal departments, Transgrid, NEM operational and governance bodies, and Council of Australian Governments (***COAG***);
3. **NER-related activities** - monitoring and communication of AEMO and COAG Rule changes, communication of AEMO updates to Electrical / Mechanical (***E&M***) contractors, and development of NER requirements for the E&M Contract;
4. **TCA** - submission of the Connection Enquiry, update of the deep transmission network development concept, site visits with Transgrid and AEMO for variable speed machine familiarisation, execution of the Connection Process Agreement (***CPA***) supply by Transgrid of connection point data to the E&M Contractors;
5. **Construction supplies** - refinement of construction supply requirements and execution of the construction supply CPA with Transgrid and Connection Investigation and Services Agreement (***CISA***) with Essential Energy; and
6. **Risk assessment and review** - ongoing Identification and management of transmission-related risks integrated with the Overall Project Risk Management (see Supporting *Chapter Seventeen - Risk management*).

1.4 Transmission Proposal

While the objectives of the Transmission Proposal remain the same as for the Feasibility Study, internal design changes and external developments have required some changes to the Transmission Proposal to ensure it remains relevant to the Project.

The initial Transmission Proposal dealt with deep transmission augmentations and integrated grid planning as separate topics. These are now combined as 'deep transmission network development' following the recognition by COAG Energy Council, the Energy Security Board and AEMO of the need of an integrated system plan that is consistent with the initial Transmission Proposal with or without Snowy 2.0.

Changes have also been made to the shallow connection works to reflect the evolution of the Project design and to incorporate increased knowledge of local conditions and/or requirements since the Feasibility Study. However these shallow works changes do not directly influence the deep transmission network concept.

A number of important developments have also occurred in the deep transmission network since the Feasibility Study, as follows:

1. **Liddell power station closure** - the planned closure of the Liddell power station in 2022 has increased focus on changing generation mix and energy security;
2. **Riverlink option** - Riverlink (a new 330 kV interconnector between mid-north South Australia and Wagga Wagga in New South Wales, via Buronga) has advanced as a preferred option in SA.
3. **AEMO Inaugural ISP** - AEMO released its inaugural ISP;
4. **Australian Energy Regulator (*AER*) review of Draft RIT-T** - AER's review essentially maintained the status quo for benefits assessment;
5. **ESB ISP Action Plan** - focus on actioning ISP Group 1 projects and progressing Group 2 projects, and treating ISP as an actionable strategic network development plan;
6. **Australian Energy Market Commission (*AEMC*) COGATI Options Paper** - the AEMC released its 'Coordination of generation and transmission investment (***COGATI***) review Options Paper';
7. **VRET 1st Reverse Auction Results** - the Victorian Government released the VRET 1st Reverse Auction Results for 930 MW new renewable energy in Victoria;[3] and
8. **Multi-party NEM workshops** - the AEMC, ESB, AEMO and the AER conducted NEM workshops around the main transmission planning and associated regulatory review areas;[4]

[3] Victorian Government, 11 September 2018. MORE RENEWABLE ENERGY TO DRIVE DOWN POWER PRICES. Available at: https://www.premier.vic.gov.au/wp-content/uploads/2018/09/180911-More-Renewable-Energy-To-Drive-Down-Power-Prices.pdf

[4] AEMC Market Reviews, Coordination of Generation and Transmission Investment October 2018. Available at: https://www.aemc.gov.au/markets-reviews-advice/reporting-on-drivers-of-change-that-impact-transmi [Accessed October 23, 2018]

9. **NSW Transmission Infrastructure Strategy** - NSW Government identified four (4) priority transmission projects, including Bannabylink, and provided a funding guarantee to TransGrid to accelerate the development of those projects and committed to take a 'leadership role' in COAG to ensure the regulatory processes are 'fit for purpose' for the approval of those projects; and
10. **Victoria to NSW Interconnector Upgrade RIT-T** - AEMO and TransGrid's Project Specification Consultation Report (***PSCR***) which includes Bannabylink Stage 1 as an option.

1.5 Shallow connection works

Since the Feasibility Study the Project's shallow connection configuration has been further refined through two mechanisms:

1. **Station general arrangement** - the reduction of shallow connection transmission lines from six to four through the introduction of a 330 kV Gas Insulated Switchgear (***GIS***) and bus; and
2. **Shallow connection works layout** - the selection of a more suitable location for the TransGrid connection substation, and further optimisation of the transmission line routes from the Project cableyard to the TransGrid connection substation.

The classification of the connection assets under the NER (ERC0192) has changed so that connection-related assets can now be defined as:

1. Shared transmission network;
2. Identified user shared assets (***IUSA***); or
3. Dedicated assets.

Whilst the Snowy 2.0 Connection Enquiry was lodged prior to the commencement of the ERC0192 Rule change, Snowy Hydro has the option to adopt the new connection classification through withdrawal of the initial connection enquiry and re-submission.

Since the Feasibility Study, there has been significant activity in the layout and design of the Lobs Hole area in preparation for Project execution. TransGrid (as the transmission asset owner) is a critical stakeholder in this area and must be consulted during both the Exploratory Works and the Main Works to ensure designs and activities around transmission assets meet TransGrid's requirements for the safety of personnel and protection of assets.

1.6 Deep transmission network development

For the Feasibility Study the Transmission Proposal adopted TransGrid's 'Option 10' (dual 500 kV single circuit lines direct from the Project connection substation (at that time known as 'Long Creek') to the Bannaby 500 kV substation located near Marulan) as the Snowy Hydro option for NSW that best suited the Transmission Proposal objectives.

Transgrid has since proposed a revised NSW deep transmission network development referred to in this chapter as 'Bannabylink' and this has been adopted into the AEMO ISP as a Group 2 project. Bannabylink diverts one of the 500 kV lines to Wagga Wagga to facilitate connection of Riverlink and the NSW SW Energy Zones into the Transmission backbone.

Snowy Hydro has reviewed the technical capability of the revised Bannabylink topology including dynamic stability studies and finds that it still meets the objectives of the Transmission Proposal.

Breaking Bannabylink into two stages and advancing Bannabylink Stage 1 (effectively the direct connection from Snowy 2.0 to Bannaby) to meet the Liddell closure date is currently being investigated by both TransGrid and NSW Department of Planning and Environment (***DPE***).

From the Feasibility Study, the preferred option to meet the VIC augmentation objectives was 'Option 1C', which was a reinforcement of the existing eastern corridor (Murray-Dederang-Sth Morang) However the AEMO ISP has proposed an alternate topology which is referred to as Keranglink in this document (Snowylink South in the ISP).

Riverlink (see Figure 1 above) was identified by Snowy Hydro in the Feasibility Study Report (Three-state network development concept) as the preferred SA Energy Transformation solution. Since the Feasibility Study, ElectraNet has advanced the RIT-T to the Project Assessment Draft Report (***PADR***), which identified that Riverlink is expected to deliver the highest net market benefits, and therefore becomes the preferred option for continued investigation and implementation.

1.7 NER-related activities

NER-related activities since the Feasibility Study have been dominated by the AEMC ERC0222 Rule change (generator technical requirements (***GTR***)).[5] This Rule makes significant changes to technical performance standards for generators seeking to connect to the national electricity grid and the process for negotiating those access standards.

Since the Feasibility Study, AEMO has lodged the Rule change proposal, the AEMC has progressed the Rule change to final determination in September 2018 and it came into effect with NER version 113 (5th October). As a Rule change directly relating to system security, there is a heightened emphasis on compliance with this Rule and all prospective E&M contractors / suppliers needed to be made fully aware of the requirements to ensure their bids and engineering designs incorporated the changes.

The main focus of the Project team was to ensure that E&M bidders were fully aware of the Rule change, their obligations for the supply of technically compliant plant, and that the changed Rule requirements was reflected in the Employer's Requirements.

[5] ('Generator Technical Performance Standards' n.d.).

1.8 Transmission Connection Agreement

The TCA is the key agreement/instrument under the NER by which physical connection to the NEM is authorised. The TCA comprises terms and conditions for connection over the life of the TCA, the Project Agreement (for construction of the shallow connection works), and the generator performance standards (***GPS***).

As at the Feasibility Study, it was too early to progress the TCA. As at FID it is theoretically possible to submit the Connection Agreement, subject to sufficient technical information being provided by the prospective E&M Contractors/Suppliers. As at FID, technical submissions from E&M Contractors/Suppliers are being evaluated for completeness and submission as a Connection Application.

The TCA cannot be signed until the GPS are agreed and approved by AEMO and the Transmission Network Service Provider (***TNSP***). The major risk associated with the TCA typically arises from time delays caused by technical verification and clarification during the normal course of negotiating the terms and conditions of a connection agreement.

As the Project is a very large connection (the largest since the commencement of the NEM) and includes new equipment never before connected to the NEM, AEMO is expected to request a significant number of verification studies.

1.9 Construction supplies

The Project includes three locations for construction power supplies in close proximity to construction worksites and/or tunnel portals. The agreed timing for energisation of the Construction Supplies (at all three nominated locations) is 01 October 2020. The three construction supplies are:

1. **Lobs Hole (TransGrid)** - a 330 kV / 33 kV 50 MVA permanent substation in the Ravine south of the Yarrangobilly River and adjacent to existing transmission line 2 (TL2). This substation will provide 33 kV power for construction and future operations;
2. **Marica (TransGrid)** - a 330 kV / 33 kV 50 MVA temporary substation on the Plateau adjacent to the Marica Trail and Snowy Mountains Highway intersection. This substation will provide construction power for contractors working in the headrace area, and eventually a backup for the Lobs Hole construction supply; and
3. **Tantangara (Essential Energy)** - a 33 kV / 17 MVA supply to be obtained by upgrading the existing 11 kV line that supplies the Tantangara dam auxiliary electrical equipment. The existing supply has insufficient capacity to meet Civil Contractor requirements.

Further planning and approvals work will be required to secure these supplies post-FID.

2 Activities undertaken

2.1 Shallow connection works

2.1.1 General

Progress in the shallow connection works area since the Feasibility Study has included activities in two key areas: advancement of the Reference Design and clarification of requirements, and TransGrid activities under the EWA.

2.1.2 Design and requirements

Together with the Owner's Engineer, SMEC Australia Pty Ltd (***SMEC***), Snowy Hydro has continued to progress development of the transmission-related aspects of the Reference Design (see *Supporting Chapter Twelve - Facilities* for a detailed explanation) including connection configuration changes.

Snowy Hydro has undertaken construction coordination activities (Exploratory Works and access roads), and has continued to clarify contractual boundaries and define interfaces.

2.2 Deep transmission network development

Snowy Hydro has engaged in a number of stakeholder-related activities and stakeholder engagement since the Feasibility Study in relation to the deep transmission network development.

2.3 NER-related activities

Since the Feasibility Study a significant range of NER-related activities have required incorporation into the Project plan, in particular, incorporation of NER Rule changes into the Project E&M Contract and Tender. The activities in this area include:

1. GTR (AEMO proposed Rule change which updates the technical performance requirements for generators and pumps connecting to the NEM) - the AEMC made a draft determination in May 2018 and a final determination in September 2018 of this Rule change which significantly updated the technical requirements for generators seeking connection to the NEM. Prospective E&M Contractors were kept up-to-date on the progress of the Rule change and its contents to ensure they were preparing bids that matched the requirements of the new rule;
2. Transmission planning and connection arrangements (COAG proposed Rule change) - this Rule change became effective in July 2018, altering the process and asset categories around network connections and which needed to be incorporated into the shallow connection works agreements with TransGrid;

3. AEMO updates to generator technical data and model requirements to match the requirements of the new GTR. The Rule changes that needed to be incorporated into the Project were communicated to the prospective E&M Contractors to ensure they were fully aware of the NEM requirements for technical models;
4. Development of the E&M Contract (Employer's Requirements, Technical Specifications and Tender Schedules (see Supporting *Chapter Twelve* for details) to ensure the Contract held the E&M contractor responsible for meeting NER technical compliance requirements.

2.4 Transmission Connection Agreement

Since the Feasibility Study Snowy Hydro has undertaken a number of activities which directly support the progress of the TCA:

1. The Connection Enquiry (the formal initiating activity in the NER connection process) was submitted to TransGrid. TransGrid responded to the Connection Enquiry in accordance with NER requirements and provided a number of technical clarifications;
2. The deep transmission network development concept was updated in accordance with TransGrid regional planning strategy, the NSW Transmission Infrastructure Strategy and the AEMO ISP;
3. Snowy Hydro organised technical site visits for TransGrid and AEMO to Pumped Hydro Energy Storage (***PHES***) sites, and to meetings with Transmission System Operators (TSO) in Europe, to familiarise them with variable speed pump-turbines from both an owner's and system operator's perspective. Snowy Hydro technical and regulatory staff also attended the visits;
4. The CPA which TransGrid uses to manage the TCA process is on-foot and currently progressing a range of connection-related activities:
    a. Preparing the commercial terms and conditions of the TCA for Snowy Hydro legal review;
    b. Preparing the connection works Project Agreement; and
    c. Compiling network data scenarios for the design and performance assessment of the Project.

    As the E&M Contractor selection process continues it will become possible to also progress the GPS assessment (see the *Transmission Connection Agreement* section for further details);
5. TransGrid has provided connection point harmonic allocations and harmonic impedance plots for use by the successful E&M contractor in their designs.

2.5 Construction supplies

Construction supply requirements were identified at the time of the Feasibility Study through early Contractor consultation. They have since been further refined from both a capacity and location perspective. Discussions with the relevant local Network Service Providers (***NSP***): TransGrid for the Ravine and Plateau sites, and

Essential Energy for the Tantangara supply, have been ongoing and CPAs are now in place for all three locations as follows:

1. TransGrid CPA is underway to progress the following two construction supplies:
    a. Lobs Hole (Ravine) 330 kV / 33 kV Line 2 cut-in substation with 50 MVA capacity; and
    b. Marica (Plateau) 330 kV / 33 kV Line 1 cut-in substation with 50 MVA capacity.
2. Essential Energy CISA is underway to progress the Tantangara 33 kV / 17 MVA construction supply.

Note that the Lobs Hole (Ravine) substation is proposed to be retained as a permanent auxiliary supply for the Facilities.

3 Transmission Proposal

3.1 Overview

This section updates the Transmission Proposal since the Feasibility Study, with a focus on the external or 'deep' transmission network. Overall the objectives of the Transmission Proposal remain the same as for the Feasibility Study, but there have been changes as a result of internal design activities and external network and market-related developments. In particular, since the completion of the Feasibility Study, there has been widespread acceptance and recognition including by COAG Energy Council, the Energy Security Board and AEMO of the need for an integrated system plan. AEMO's inaugural Integrated System Plan was released in July 2018 and clearly shows that the deep augmentation of the shared network is required with or without Snowy 2.0 and is consistent with the Snowy 2.0 Transmission Proposal

3.2 Context

3.2.1 General

The Feasibility Study presented a Transmission Proposal that included shallow connection works, deep network augmentations and integrated grid planning. Since the Feasibility Study was released there have been a number of important developments in the external transmission network sector and the associated national planning structure which have resulted in the need to update the Transmission Proposal.

The initial Transmission Proposal also dealt with deep transmission augmentations and integrated grid planning as separate topics, however, in this update, the two are merged under the title of 'deep transmission network development' to reflect the influence of AEMO's ISP on the national planning focus.

Changes have also been made to the shallow connection works but these were required to reflect the evolution of the Project design (from the Feasibility Study

design to the Tender Reference Design), and to incorporate increased knowledge of local conditions and/or requirements gained since the Feasibility Study. While these shallow works changes are important to the overall Project they do not directly influence the deep transmission network concept and so are not discussed further in this section - refer to Section 4 for details of shallow works changes.

3.2.2 Externalities and Developments

Summary

Key external drivers and developments in the deep transmission network since the Feasibility Study and which have influenced the revision of the Transmission Proposal are summarised in Table 1.

Event	When announced/ undertaken	Impact
Liddell power station closure	2018	From 2022
Riverlink option (SA Energy Transformations RIT-T PADR)	June 2018	Ongoing
AEMO Inaugural ISP	July 2018	Ongoing
AER review of Draft RIT-T	July 2018	Ongoing
ESB ISP Action Plan	September 2018	Ongoing
AEMC COGATI Options Paper	September 2018	Ongoing
VRET 1st Reverse Auction Results	September 2018	Ongoing
AEMC/ESB/AEMO and AER Workshops	October 2018	Ongoing
Victoria to NSW Interconnector Upgrade RIT-T PSCR	November 2018	Includes Bannabylink Stage 1 as an option
NSW Transmission Infrastructure Strategy - funding guarantee for priority transmission projects	November 2018	Includes for acceleration of Bannabylink Stage 2

Table 1: Key externalities and developments

Liddell power station closure

Throughout 2018 AGL has consistently confirmed its intention to close the 2,000 MW Liddell power station in 2022.

The closure of this particular plant and the ageing NEM coal-fired power station fleet (on the back of the steady stream of coal-fired plant exits over the last five years) has brought the focus of State and Federal Governments onto the potential impacts of disorderly transition of the generation mix in an essential service area, and the need to consider energy security in policy and action plans.

Within NSW this has prompted consideration of transmission upgrades that increase NSW access to intrastate and interstate generation, which in turn has lead to the possibility of advancing Bannabylink stage 1 (the Snowy 2.0 to Bannaby leg) to meet the closure date for Liddell power station.

Riverlink option

In June 2018 ElectraNet released its SA Energy Transformation RIT-T PADR,[6] which identified Riverlink as the preferred option (see detailed description below).[7]

The Riverlink Project is an important externality for the Project because it alters the regional interconnection structure of the NEM by introducing a new SA-NSW interconnection, and creates a loop between the VIC-SA-NSW regions which will require a fundamental change to many of the constraint equations controlling dispatch in the three-state supply/demand balance. Additionally, the Riverlink development competes with SW-NSW REZ developments for access to Snowy 2.0 pumping capacity and NSW load centres to the east and north of Wagga Wagga.

The Riverlink option was included in the initial Snowy Hydro 'three-state fix' Transmission Proposal and, following the ElectraNet PADR, is retained in the FID NEM modelling.

Inaugural ISP

AEMO released the inaugural ISP in July 2018.[8] The ISP provides a long-term (20-year) view of strategic infrastructure development, identifying the transmission investments that can best unlock the value of existing and new resources in the NEM, at the lowest cost. The ISP also considers the transmission investment required to develop REZ to provide customers access to the lowest cost renewable resources. It is noted that the ISP shows that the deep augmentation of the shared network is required with or without Snowy 2.0.

The ISP identified three groups of projects with different time priorities. across which there was strong technical and timing alignment with the initial Transmission Proposal NSW augmentation, but with some differences in timing that need to be resolved:

1. **Group 1** - Near-term construction to maximise economic use of existing resources;
2. **Group 2** - Developments in the medium term to enhance trade between regions, provide access to storage, and support the extensive development of REZ; and

[6] ElectraNet, June 2018. SA Energy Transformation RIT-T Project Assessment Draft Report (PADR). Available at: https://www.electranet.com.au/projects/south-australian-energy-transformation/ [Accessed October 23, 2018].

[7] 'Riverlink' is a double circuit 330 kV transmission line from Robertstown in South Australia to Wagga Wagga in New South Wales. It was one of 5 options considered in the ElectraNet RIT-T project scoping report. Riverlink will increase transfer capacity in/out of SA by approximately 750 MW. Refer also to the ElectraNet PADR for additional details.

[8] AEMO, 2018. AEMO - Integrated System Plan. Available at: https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Integrated-System-Plan [Accessed October 23, 2018]

3. **Group 3** - Longer-term developments (2030 to 2040) to support REZ and system reliability and security.

The ISP included options around the topology and capacity of various network development possibilities including a technically equivalent version of the Transmission Proposal NSW augmentation as a Group 2 project ('Bannabylink'), and a technically upgraded (and more expensive) version of the the initial Transmission Proposal VIC augmentation ('Keranglink') as a group three project.

Snowy Hydro has focussed assessment and actions arising from the ISP on:

1. Confirming the ISP NSW Augmentation option ('Bannabylink') meets the Snowy Hydro Transmission Proposal NSW connection capability objectives of ±2,000 MW including preliminary dynamic stability assessment,[9]
2. Bringing one limb of Bannabylink into an ISP Group 1 category time frame (in effect to complete Stage 1 of Bannabylink early) to release additional southern NSW generation capacity to meet the closure date of the Liddell power station in 2022;
3. Identifying the ISP VIC-NSW upgrade option that best matched the Snowy Hydro Transmission Proposal VIC augmentation;
4. Confirming all updated transfer capabilities to the Independent Market modelling workstream (NEM modelling); and
5. Bringing the ISP VIC augmentation ('Keranglink') forward to an ISP Group 2 project timescale, to meet the Project commissioning date.

TransGrid made a submission to the ISP consultation that identified the need for transmission development in southern and south-west NSW, to support the Riverlink project, SW-NSW REZ and the Project itself. Figure 2 below shows TransGrid's connection enquiries at the time of the ISP submission with particular attention focussed on the southern and south-west NSW zones.

[9] TransGrid July 2018. TransGrid - Snowy Hydro 2.0 Assessment of Additional Network Options

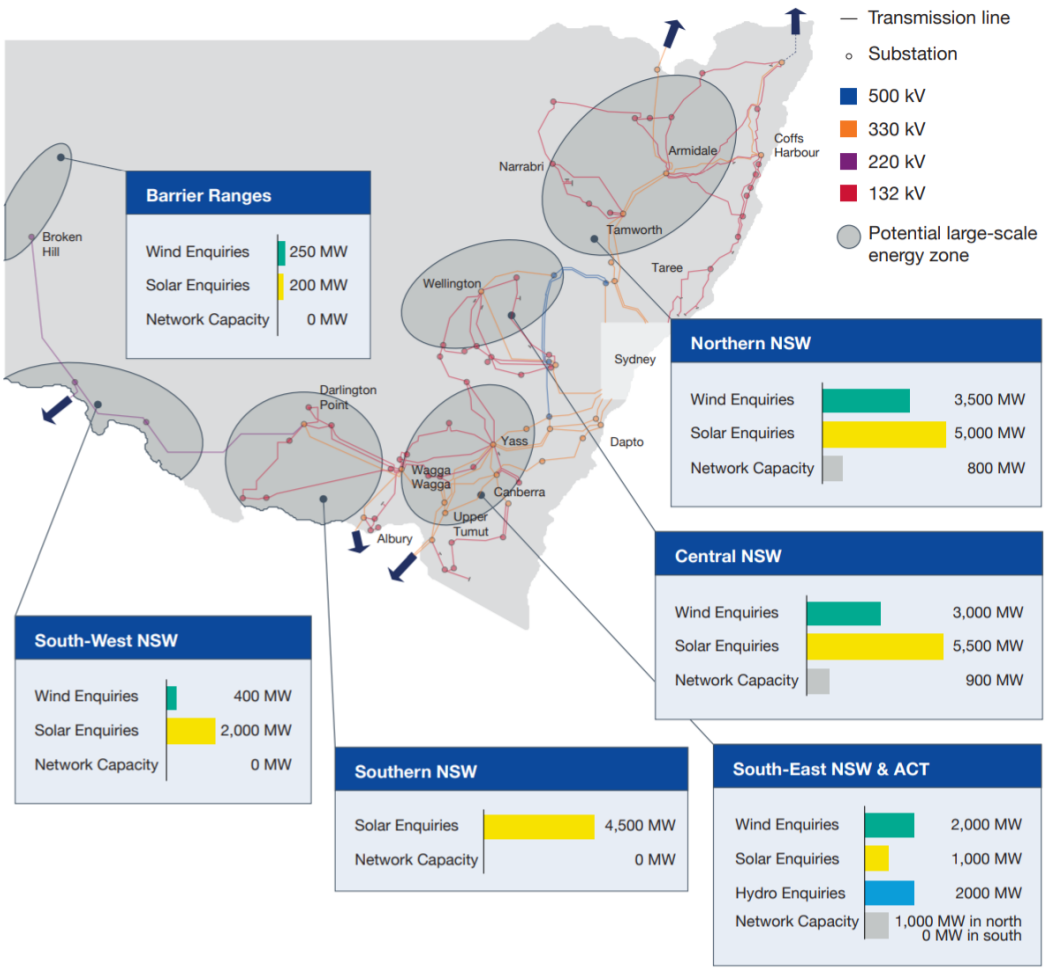

Figure 2: TransGrid ISP submission highlighting Energy Zones[10]

AER review of Draft RIT-T

In July 2018 the AER released their draft review of the RIT-T Draft which,[11] while acknowledging the possible need for change in the application of the cost/benefit test to reflect a broader range of drivers under the renewables transition, essentially maintained the status quo for benefits assessment subject to a Rules change in respect of the application of the Regulatory Test to approve transmission works.

In respect of the AER RIT-T review Snowy Hydro has focussed efforts on highlighting:

1. Impacts arising from the current RIT-T process, which favours smaller incremental projects and a short to medium-term focus, but which has

[10] TransGrid, Feb 2018. TransGrid, Integrated System Plan Consultation submission. Available at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/ISP/2018/Round-2-Submissions/TransGrid---Integrated-System-Plan-submission.PDF

[11] AER, 2018. AER - Review of the application guidelines for the regulatory investment tests for transmission and distribution. Available at: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/review-of-the-application-guidelines-for-the-regulatory-investment-tests-for-transmission-and-distribution [Accessed October 23, 2018].

success vulnerabilities when being applied to large longer-term strategic network development projects (which tend to occur rarely in any case);
2. Comparison with international experience whereby transmission needs are driven by public policy requirements established by state and federal laws or regulation (such as decarbonisation policy and/or fundamental changes to the nature and location of the generation mix, such as the transition to renewable energy). With public policy requiring firm generation to be connected to the NEM, this approach may be appropriate and timely; and
3. The 'chicken and egg' dilemma arising in terms of commitment to generation at ideal resource locations that are poorly serviced by transmission.

ESB response

In September 2018 the ESB responded to the COAG Energy Council (COAG EC) directive to develop an action plan for the ISP recommendations (the ISP Action Plan) which identified two focus areas:[12]

1. **Focus Area 1** - Actioning ISP Group 1 projects and progressing Group 2 projects; and
2. **Focus Area 2** - ISP as an actionable strategic network development plan.

The ESB is now coordinating activities between its direct NEM-facing members (the AEMC, the AER and AEMO) and their respective review and planning activities.

AEMC COGATI Review Options Paper

In September 2018 the AEMC released its COGATI review Options Paper'.[13]

The COGATI Review focuses on the following areas:

1. ISP action plan (ESB Focus Area 2);
2. Implications for the RIT-T;
3. REZ;
4. Connection and access; and
5. Treatment of storage.

While the links between the ESB and AER review areas are clear, the AEMC has introduced the new issue of the treatment of 'storage' which includes consideration of the need for utility-scale storage providers to register as customer participants, or even the possible requirement for a new NEM participant class ('storage service provider'). Within the context of the treatment of storage, the AEMC has raised the possibility of TUOS charges for 'storage service providers' and notes the precedent set around the 'Tesla' battery located in SA.

[12] Energy Security Board, 21 September 2018. ESB - Converting the Integrated System Plan into Action. Available at: https://www.aemc.gov.au/sites/default/files/2018-09/ESB-%20Converting%20the%20Integrated%20System%20Plan%20into%20action.pdf [Accessed October 23, 2018].

[13] AEMC, September 2018. AEMC - Coordination of generation and transmission investment. Available at: https://www.aemc.gov.au/sites/default/files/2018-09/Options%20paper.pdf [Accessed October 23, 2018].

VRET 1st Reverse Auction Results

In September 2018 the Victorian Government released the VRET 1st Reverse Auction Results for 930 MW new renewable energy in Victoria.[14] The result was an increase of almost 300 MW on the initial capacity objectives of the Reverse Auction and comprised:

1. Berrybank Wind Farm west of Geelong, which will produce 180 MW;
2. Cawarp Solar Farm south of Mildura, which will produce 121.6 MW;
3. Cohuna Solar Farm north-west of Echuca, which will produce 34.2 MW;
4. Dundonnell Wind Farm north-east of Warrnambool, which will produce 336 MW;
5. Mortlake South Wind Farm south of Mortlake, which will produce 157.5 MW; and
6. Winton Solar Farm near Benalla, which will produce 98.8 MW.

The increase in 1st round capacity acquisition signalled the strong intent of the VIC Government to aggressively pursue the VRET target (40% renewables by 2025) and also signalled the need for earlier VIC firming capacity by 2025 (also the first operational year of the Project).[15]

Multi-party NEM workshops

In October 2018 the AEMC ESB, AEMO and the AER conducted NEM workshops around the main transmission planning and associated regulatory review areas,[16] being the AER RIT-T review, the AEMC COGATI review, the AEMO ISP, and the ESB Action Plan.

The agglomeration of these reviews and the issues they seek to address is resulting in a complex mix of regulatory policy and strategic objectives against a backdrop of rapid industry change, however, the key emerging issues for Snowy Hydro and the deep transmission network development at the time of writing are:

1. ESB Focus Area 2 (ISP as an actionable strategic network development plan) and its basis for the fast track approval of Bannabylink and Keranglink,
2. Broader-based benefit assessments under the RIT-T that recognise the need to facilitate an orderly transition in the context of rapid and fundamental changes to the generation mix,
3. Bringing the Keranglink option forward to align with the Project commissioning date through review of the benefits test and the system security implications in Victoria under VRET and rapid changes to the generation mix, and in NSW under the early or unplanned closure of coal fired power stations,

[14] Victorian Government, 11 September 2018. MORE RENEWABLE ENERGY TO DRIVE DOWN POWER PRICES. Available at: https://www.premier.vic.gov.au/wp-content/uploads/2018/09/180911-More-Renewable-Energy-To-Drive-Down-Power-Prices.pdf

[15] See *Supporting Chapter Five - Market Modelling* for further discussion of firming services / products.
[16] AEMC Market Reviews, Coordination of Generation and Transmission Investment October 2018. Available at: https://www.aemc.gov.au/markets-reviews-advice/reporting-on-drivers-of-change-that-impact-transmi [Accessed October 23, 2018]

4. Bringing construction of stage 1 of Bannabylink forward to release approximately 1,000 MW of southern NSW and VIC capacity into the major NSW load centres by the closure date of the Liddell power station in 2022,
5. Ensuring stage 2 of Bannabylink is completed by the Project commissioning date to meet the Project's NSW connection objectives, release south-west NSW REZ zones and integrate Riverlink into the NSW and SA market regions; and
6. Strongly oppose the application of TUOS charges to generator participants who provide energy firming services to facilitate the orderly transition.

Victoria to NSW Interconnector Upgrade

In November AEMO and TransGrid released the Victoria to NSW Interconnector Upgrade PSCR as the first step of the RIT-T process. The identified need in the PSCR was described as being the need to alleviate projected limitations on the power transfer capability between Victoria and NSW currently caused by thermal and stability limits.

The significance of this RIT-T and its relevance to the Transmission Proposal is that it is directed to ISP Group 1 projects but includes one section of the ISP Group 2 Bannabylink (Snowylink North) project as an option. If it can be shown that the Bannabylink option satisfies the needs statement best when compared to the other options it will effectively advance that portion of the Banabylink Group 2 project to a Group 1 timing, thereby meeting the closure date of Liddell Power Station in late 2022.

NSW Transmission Infrastructure Strategy

On 12 November 2018, the NSW Government published its Transmission Infrastructure Strategy. This Strategy identified four (4) priority transmission projects, including Bannabylink, and provided a funding guarantee to TransGrid to accelerate the development of those projects and committed to take a 'leadership role' in COAG to ensure the regulatory processes are 'fit for purpose' for the approval of those projects.

3.3 Updated Transmission Proposal

As a result of the significant level of activity in the external transmission space since the Feasibility Study, Snowy Hydro has updated the Transmission Proposal first presented at the time. Details of the changes are summarised here and discussed in more detail in subsequent sections of this chapter.

Overall the main change to the Transmission Proposal has been to:

1. Alter the Victorian market access topology to match the AEMO ISP Group 3 Project proposal (Keranglink), and
2. Incorporate the TransGrid proposal to divert one of the NSW 500 kV lines from the Facility to Bannaby via Wagga Wagga (Bannabylink).

Bannabylink is considered a relatively minor departure from the initial Transmission Proposal but Keranglink represents a significant change and therefore required detailed consideration in the business case modelling. The

following two figures compare the updated Transmission Proposal (at FID) to that at the time of the Feasibility Study, showing the overall consistency with the specific changes for the Bannabylink and Keranglink developments.

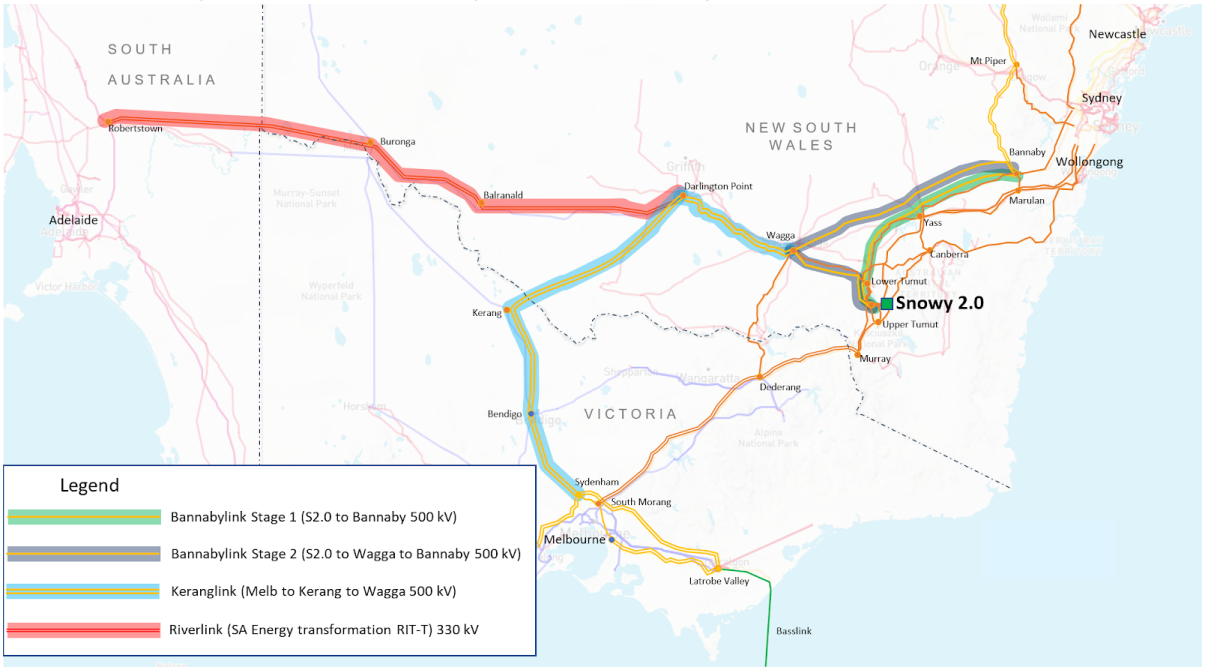

Figure 3: Updated three-state network development concept (FID 2018)

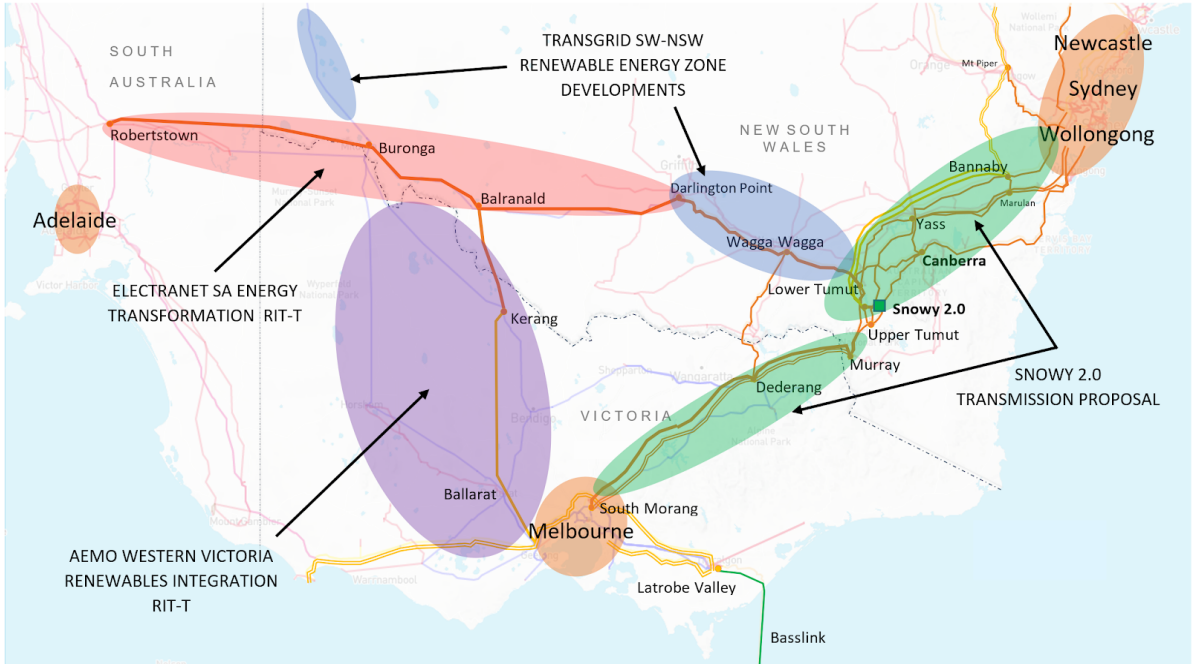

Figure 4: Three-state network development concept (Feasibility Study 2017)

The underlying network topology of the major transmission developments providing market access for the Facility are shown in the following figure.

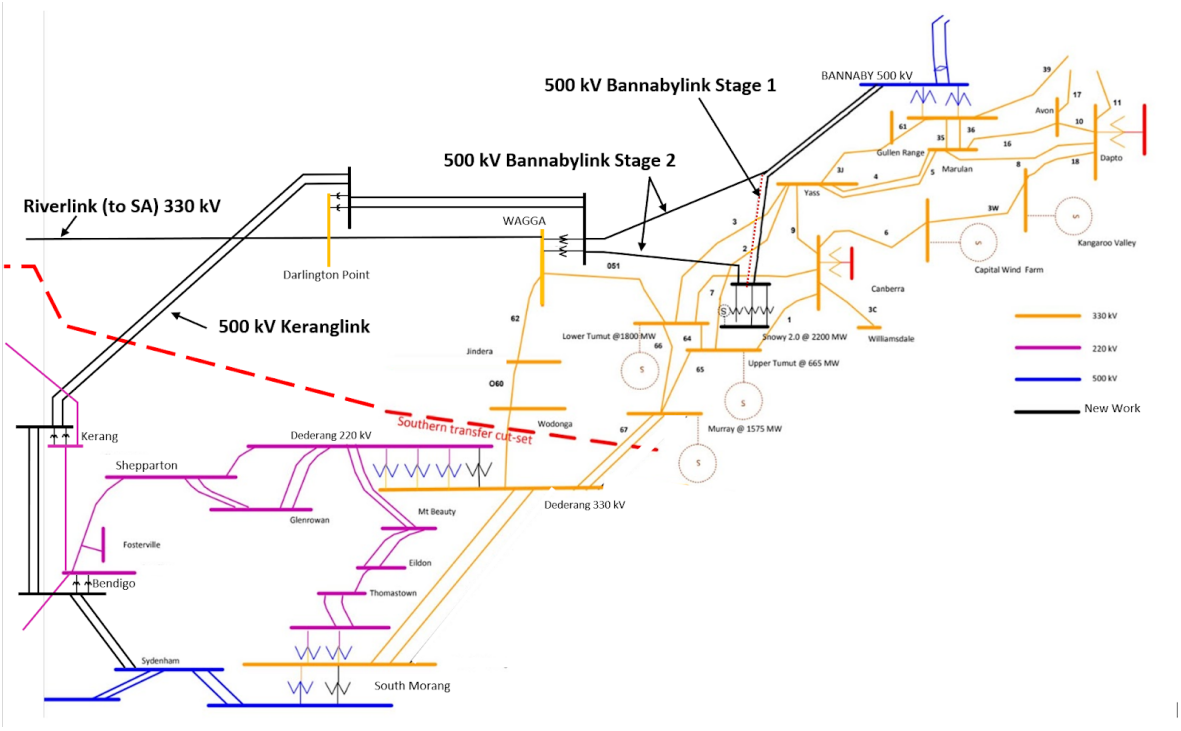

Figure 5: Network diagram showing ISP Bannabylink and Keranglink (FID 2018)

While the Keranglink represents a significant increment in works compared with the original Option 1c, it can be clearly seen that overall it integrates with the Western Victoria Renewables Integration RIT-T and therefore meets the criteria of the Integrated System Plan and the renewables transformation.

The ongoing efforts in the deep transmission network development workstream is to ensure the Transmission Proposal is implemented in a topology that matches the requirements of the Project and a timeframe that matches the commissioning of the facility.

4 Shallow connection works

4.1 Overview

Since the Feasibility Study the Project's shallow connection configuration has been further refined through two mechanisms:

1. SMEC's Project Reference Design; and
2. TransGrid's ongoing shallow connection works design.

As part of SMEC's Project Reference Design, the connection configuration has been altered to reduce the number of cables and external overhead connection transmission lines from six to four. The reduction was achieved by introducing a 330 kV GIS and bus into the underground cavern which allows for sharing of cables among generating units.

Since the Feasibility Study, Snowy Hydro has engaged TransGrid to further advance the design of the shallow connection works. This has resulted in the

selection of a more suitable location for the TransGrid connection substation, and further optimisation of the transmission line routes from the Project cableyard to the TransGrid connection substation.

Overall these design changes and locational refinements are beneficial to the Project from both an approvals and cost perspective.

In addition to these design and configuration changes, there has been one significant regulatory change: the Transmission Connection and Planning Arrangements Rule Change. This change was in respect to the classification of connection assets under the NER which was introduced to enhance contestability in making connections to the transmission network. This is discussed in the *Regulatory changes* section below.

4.2 Changes from the Feasibility Study

4.2.1 Station general arrangement

For the Feasibility Study, the base case configuration assumed one transformer, one cable and one transmission line per pump/turbine unit as per the single-line diagram in Figure 7. This configuration is broadly referred to as a 'unit'-principle configuration in which a minimum sharing of assets between units is sought. This configuration resulted in a requirement for six individually-switched transmission lines (one for each unit in the base case), and an easement width of up to 180 m.

As part of the design review from the Feasibility Study to the Reference Design, a 330 kV GIS bus and switchgear was introduced into the cableyard or underground cavern. This allowed for a reduction in the number of external overhead transmission lines from 6 to 4, saving between 60 to 90 meters of easement. Figure 6 shows the effect of including the GIS bus and reduced transmission line requirement. Figure 7 shows the layout from the Feasibility Study.

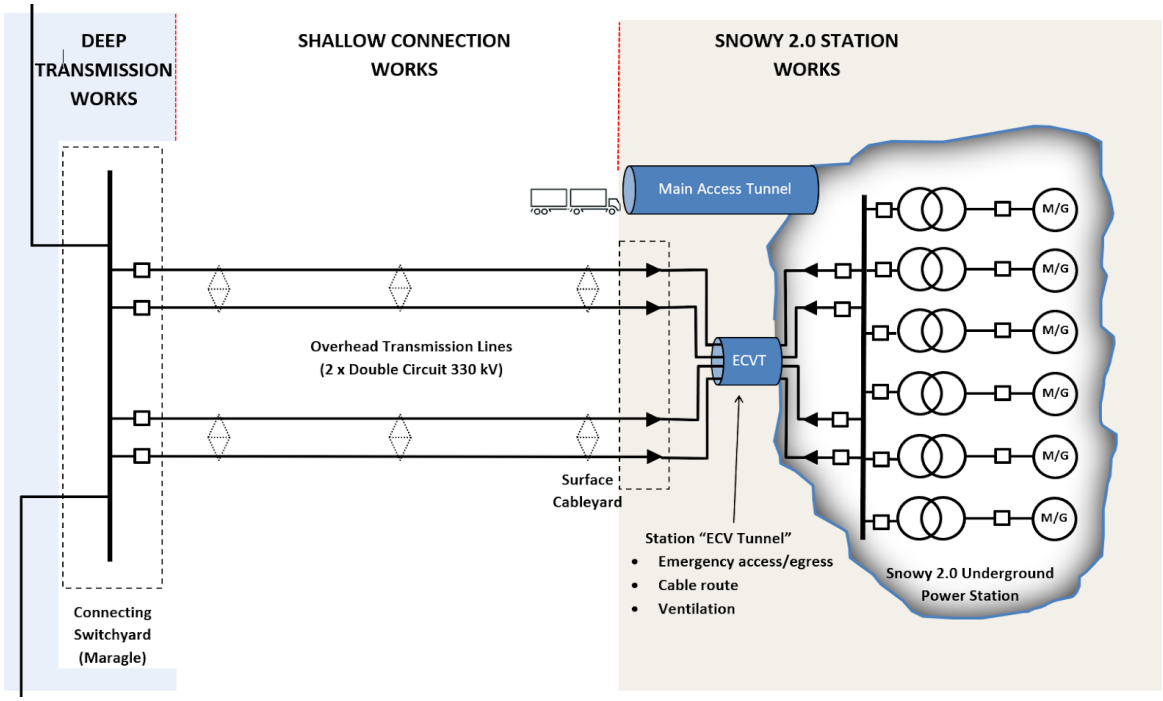

Figure 6: Shallow connection works arrangement (FID 2018)

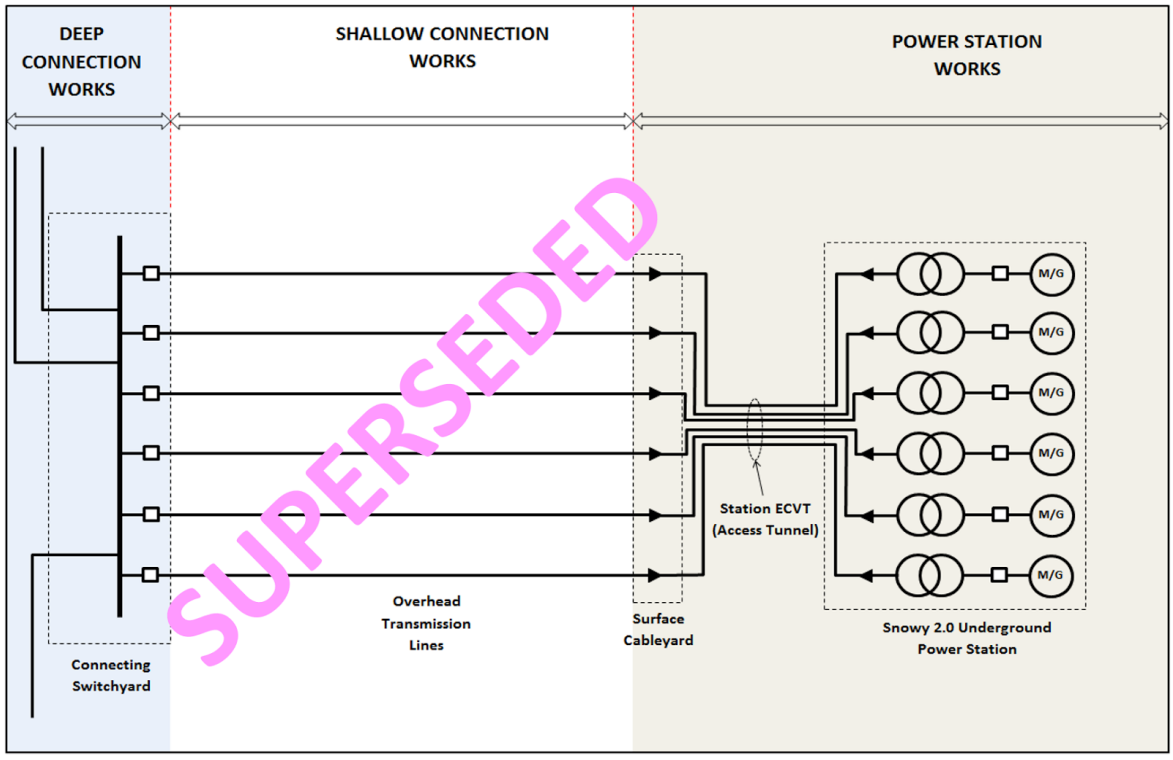

Figure 7: Shallow connection works arrangement (Feasibility Study 2017)

4.2.2 Shallow connection works layout

Since the Feasibility Study, Transgrid has continued to refine the shallow connection works transmission line routes and the location of the connection

switchyard (now referred to by TransGrid as the 'Maragle Switchyard' as it is located in the Maragle State Forest).

The revised transmission line routes and switchyard location have followed from further route and terrain assessments, site surveys, local conditions including initial reviews of environmental factors and local utilisation. Figure 9 compares the transmission line routes from Feasibility Study to FID and it can be seen that:

1. The line routes are now approaching the shortest possible path out of KNP (minimising the impact on the Park); and
2. The switchyard location has been moved to the south, away from some sensitive environmental areas which were identified in the Feasibility Study location on further investigation.

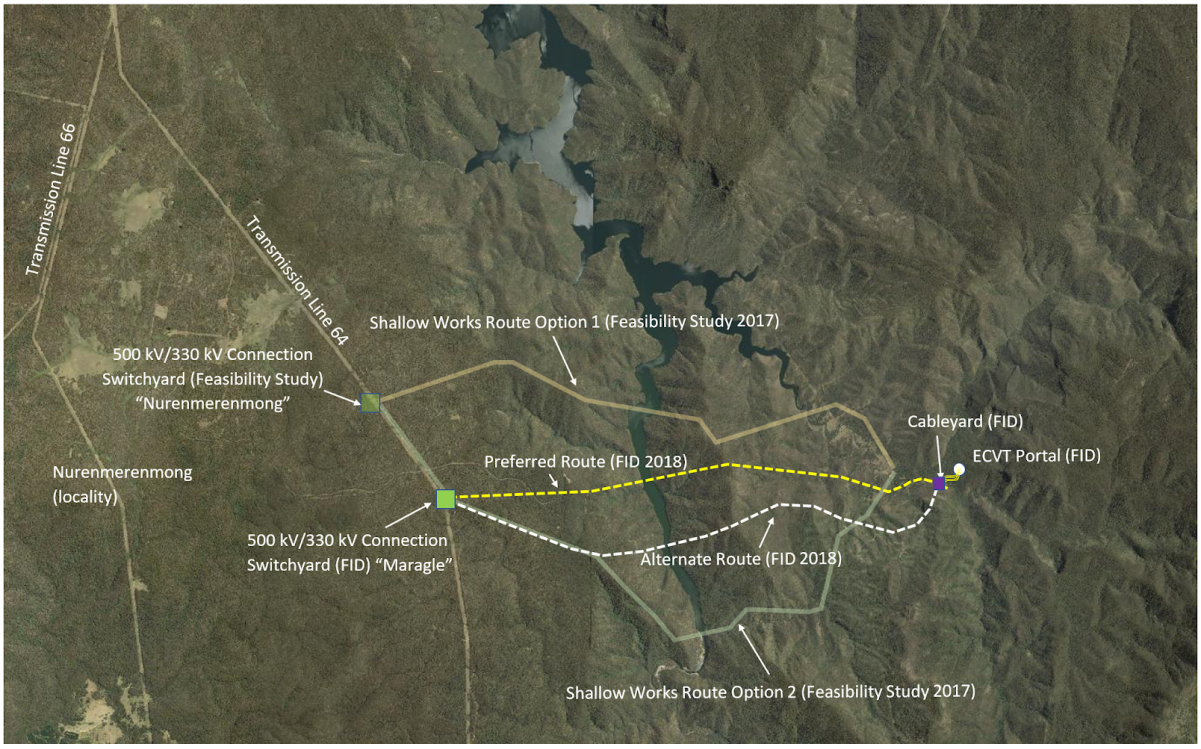

Figure 8: Changes in Shallow Connection Works (Feasibility Study to FID)

Based on the preferred and alternate routes (FID 2018) and the new Maragle Switchyard location shown in Figure 9. TransGrid has established the boundary for the environmental impact survey as per Figure 10. Snowy Hydro has engaged TransGrid to undertake the PEA, EIS and Environment Protection and Biodiversity Conservation (***EPBC***) referral for the shallow connection works based on the boundary in Figure 9.[17]

At the time of writing, both Snowy Hydro and TransGrid have submitted their respective PEA's (EIS scoping reports) for the Main Works,[18] and the shallow

[17] Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The EPBC Act prohibits certain actions that, without approval, are likely to or will have a significant impact on the environment. Refer to https://www.environment.gov.au/system/files/resources/5f863f7f-5a6e-4f40-b43f-40b17548abe8/files/epbc-act-policy-definition-environment.docx

[18] See *Supporting Chapter Eleven - Environment, Permits and Approvals* for details of the approvals process.

connection works, and will run these activities in parallel for the purpose of obtaining both approvals at the same time in late 2019.

TransGrid and Snowy Hydro continue to cooperate, share information and resources where possible, and jointly undertake public engagement activities in relation to the Project and transmission connection works, permits and approvals.

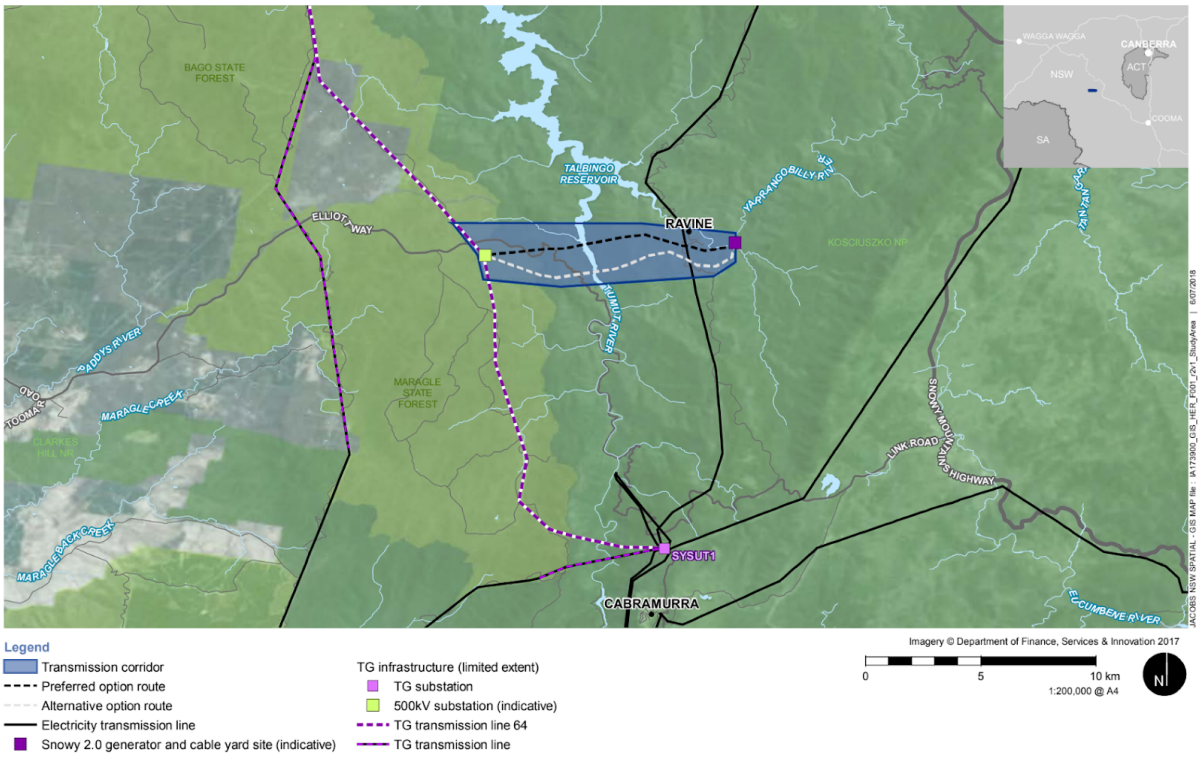

Figure 9: Shallow connection works: proposed EIS corridor[19]

4.2.3 Regulatory changes

The term 'shallow connection works' is not used in NEM regulatory frameworks for classification of shared or dedicated transmission assets, but has been used here as per the Feasibility Study: to describe those works which specifically connect the power station to the main transmission network and to distinguish them from the deep transmission upgrades being proposed for the main NEM flow paths to accommodate the transition to renewable energy.

At the time of the Feasibility Study, the classification of transmission assets around connections was changing due to a Rule change proposed by the COAG EC which sought to amend those aspects of the NER that relate to transmission connection and planning arrangements to enable more transparency and competition in the provision of transmission connections.

Since the Feasibility Study, the AEMC has made its final determination in respect of the COAG proposal, and the Rule commenced on 1 July 2018. Under the final Rule, connection-related assets are now classified as:

[19] (including preferred and alternate line route options).

1. Shared transmission network;
2. IUSA; or
3. Dedicated assets.

The three asset classifications are shown (as per the AEMC Rule determination information note) in Figure 10.

By comparison with Figure 6 above, it can be seen that the Project connection assets will span a range of classifications under the new Rule, with the lines from the cableyard to the connecting switchyard (Maragle Switchyard) likely to be classified as dedicated connection assets, the Maragle switchyard likely to be classified as either a shared network asset or a IUSA, and the deep transmission network development (see below) as a shared transmission asset. IUSA classifications are further defined as either non-regulated or negotiated services under the Rule.

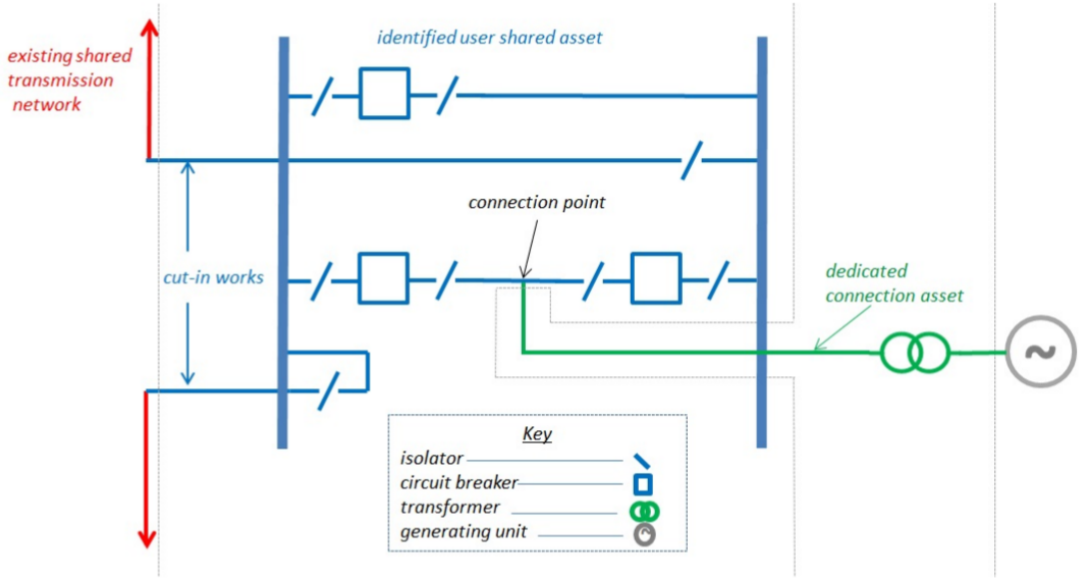

Figure 10: AEMC classification of connection assets[20]

4.3 Site Works Coordination

Since the Feasibility Study, there has been significant activity in the layout and design of the Lobs Hole area in preparation for Project execution. Due to the terrain in the Lobs Hole area, there is limited space and in some areas congestion and competition for space are inevitable. Having a coordinated approach to the layout and design of the construction facilities and other infrastructure within the Lobs Hole area is therefore very important.

[20] (under the Transmission Connection and Planning Arrangements Rule Change 2017). AEMC Figure 2 Illustration of key concepts and terms in the final rule and final, from 'RULE DETERMINATION National Electricity Amendment (Transmission Connection and Planning Arrangements) Rule 2017' . Available at https://www.aemc.gov.au/sites/default/files/content/906c54d0-8546-4a83-8172-2a5fb4d5bd93/Final-determination.pdf

In relation to transmission, the shallow connection works and the construction supplies are the major activities that need to be coordinated with the Snowy Hydro design team both pre- and post-FID, and with the Civil and Electrical & Mechanical contractors during the Project execution phase.

In terms of the Exploratory Works (access) the construction of roads and infrastructure around existing and future transmission assets and easements is the major activity to be coordinated. TransGrid (as the transmission asset owner) is a critical stakeholder in this regard and must be consulted to ensure designs and activities around transmission assets meet TransGrid's requirements for the safety of personnel and protection of assets. During the Main Works execution phase, the Civil Contractor will have management and control of the site and therefore must undertake the coordination role with TransGrid during that phase of the Project. Figure 12 below shows an overlay of the shallow connection works on the Project construction site and associated infrastructure and access locations, highlighting areas of congestion and crossing points which will require ongoing coordination and management with TransGrid during the Exploratory Works and Main Works execution phases.

Figure 11: Lobs Hole works area with transmission overlay

4.4 Communications Networks

Snowy Hydro also needs to locate a number of communications lines, both for construction and for operation of Snowy 2.0. In many areas these lines have been shown as located within TransGrid and Essential Energy easements, as they are well located to provide connections, maintain physical route diversity for the communications assets and avoid further impacts on the Park.

5 Deep transmission network development

5.1 Overview

The following section describes updates to the main components of the deep transmission network development since the feasibility study and incorporates the relevant components of the three-state network development concept which forms the basis of the Transmission Proposal used in the overall Project market assessments.

5.2 NSW Transmission development

5.2.1 Overview

For the Project connection in NSW the Feasibility Study recommended TransGrid's 'Option 10' comprising dual 500 kV single circuit lines from the Project connection substation (at that time known as 'Long Creek') to the existing Bannaby 500 kV substation located near Marulan. This option best suited the objectives of the Transmission Proposal because it:

1. Eliminated Snowy 2.0 operational constraints - providing better market access;
2. Had very low losses;
3. Was robust in terms of voltage stability in southern NSW;
4. Was scalable for future developments (eg Snowy 3.0);
5. Utilised the 500 kV backbone around Sydney and reduced loading on Line 39 relative to 330 kV connection options into Bannaby); and
6. Was a better fit with the (at that time) National Transmission Network Development Plan (***NTNDP***) and broader renewables integration.[21]

Figure 13 below shows TransGrid's 'Option 10' from the Feasibility Study, and is repeated here to allow direct comparison with changes made to the NSW section of the Transmission Proposal since the Feasibility Study (see Figure 14 in the following section).

[21] Refer to NER 5.20.2 for a description of AEMO's responsibilities regarding the NTNDP. Since the Feasibility Study the NTNDP has been effectively replaced by the ISP although the Rule change has not yet been progressed.

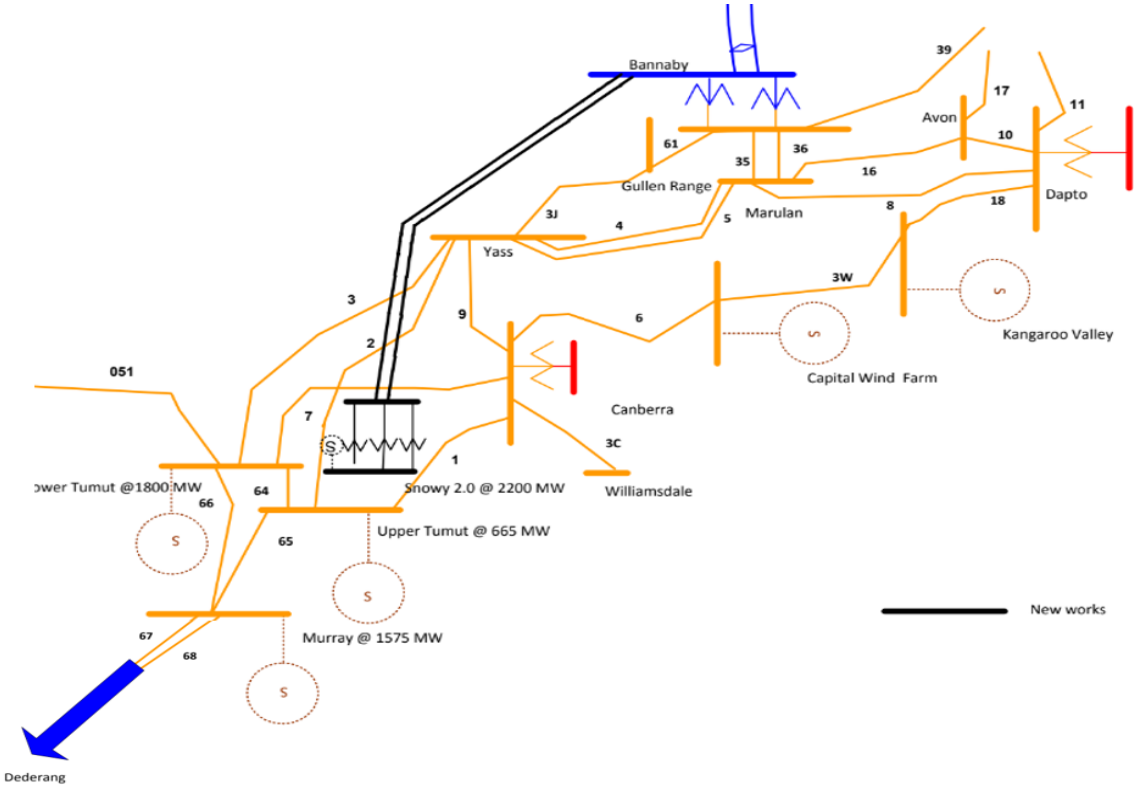

Figure 12: TransGrid Option 10 (new 500 kV lines and switchyard) (Feasibility Study 2017)

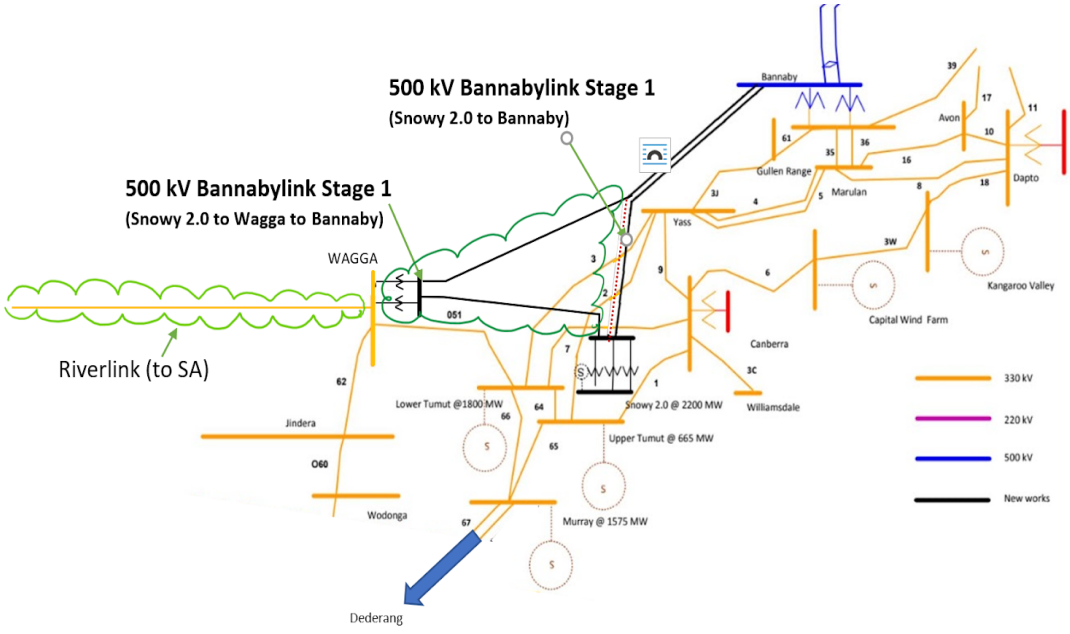

Figure 13: Revised NSW connection proposal 'Bannabylink' (FID 2018)

5.2.2 NSW upgrade and the AEMO ISP

Figure 13 above shows the revised NSW augmentation as proposed by TransGrid and adopted into the AEMO ISP as a Group 2 project. This topology is referred to as 'Bannabylink' (sometimes also the 'Wagga triangle', and in the ISP as

'Snowylink North').[22] The only significant difference between 'Option 10' from the Feasibility Study and Bannabylink is the diversion of one 500 kV line to Wagga Wagga then onto Bannaby as highlighted in Figure 13.

This change from 'Option 10' was proposed by TransGrid for a number of reasons but mainly to:

1. Realise Riverlink market benefits by relieving constraints between Wagga Wagga and the NSW load centres to the northeast (Newcastle, Sydney and Wollongong),
2. Provide a route diverse and robust transmission connection in southern NSW,
3. Release renewable energy zone capacity in south west-NSW and northwest-Vic, and
4. Provide a robust connection point for future VIC interconnection to NSW.

Snowy Hydro has reviewed the technical capability of the Bannabylink topology including dynamic stability studies and finds that it still meets the objectives of the Transmission Proposal for Project market access and better integrates with the broader system requirements under the renewables transformation.

An updated inter-regional constraint set matching Bannabylink topology has been provided for inclusion in the NEM market modelling. The NEM modelling has considered the impacts of the revised topology for the purpose of building the demand/supply PROPHET model.

5.2.3 Early completion of Bannabylink stage 1

During the technical review of the Bannabylink option, it became apparent that early completion of the Bannabylink section between the new Facility connection substation and Bannaby (referred to as Stage 1) would provide benefits to the NSW region by making a significant contribution to NSW energy security post-Liddell closure in 2022.

The benefit achieved by Bannabylink Stage 1 is to effectively bypass two of the three constraining cutsets in southern NSW (see Figure 14). With some additional works in the 330 kV network south of Sydney (to divert power up the 500 kV lines to Mt Piper, and matching completion of the Project's Maragle switchyard to connect to the southern end of the new 500 kV line, Stage 1 of Bannabylink would allow approximately 1200 MW - 1500 MW additional flow from northeast-VIC and southeast-NSW including the existing Snowy scheme to reach the greater NSW load centre.

[22] In their ISP AEMO refer to the NSW augmentation as 'Snowylink north' with the inference being that the new interconnection is solely required for Snowy 2.0. This is misleading, particularly as the revised Snowylink north topology addresses a much broader range of market access and customer benefits. Snowy Hydro is recommending that the AEMO option be called Bannabylink, reflecting its significantly broader role in the NEM.

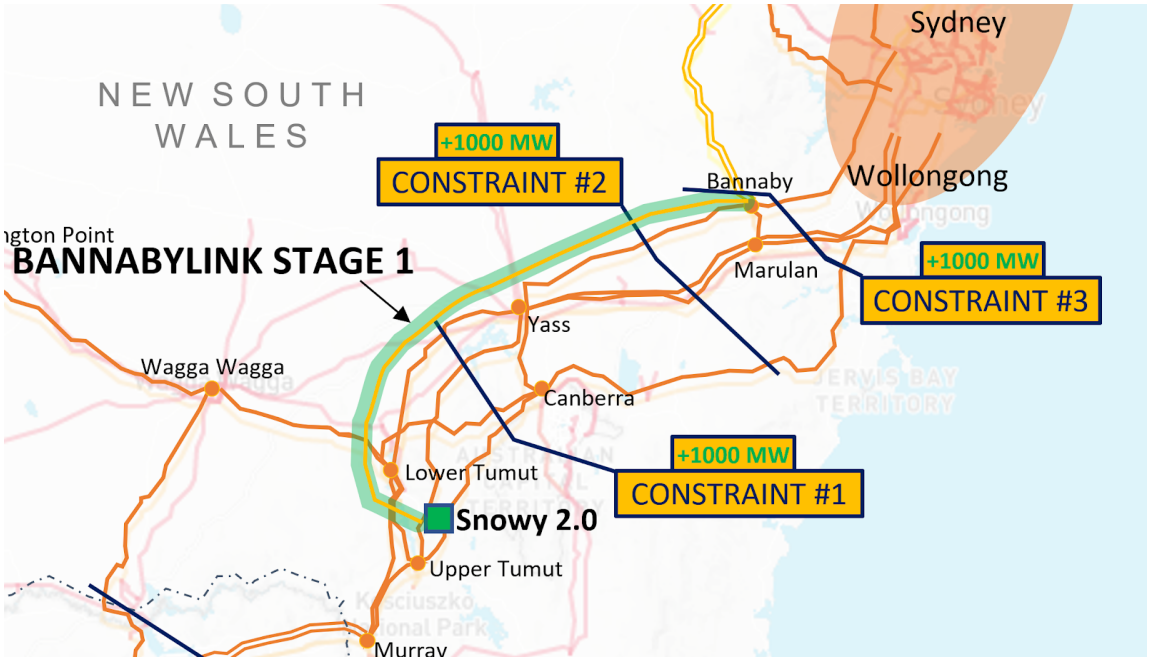

Figure 14: Bannabylink Stage 1 increases /VIC and southern NSW transfer capability by up to 1,000 MW

Advancing Bannabylink Stage 1 to meet the Liddell closure date is currently being investigated by TransGrid and NSW DPE to understand the feasibility of meeting the end of 2022 target date. To this end Stage 1 has been included in the AEMO TransGrid Victoria to New South Wales Interconnector Upgrade PSCR as an option.

5.2.4 Bannabylink stage 2

Note that BannabLink Stage 2 (500 kV line from Facility to Wagga to Bannaby) generally achieves the same outcome for the Facility as Stage 1 but increases overall market benefits by facilitating Riverlink and SW Energy Zone connection and firming capacity (through regional diversification and inter-connection with the Facilities energy storage capability). Table 2 compares Stage 1 and Stage 2 as first-to-build options.

Compares	Stage 1	Stage 2
Scope	1. 260 km 500 kV line 2. Marangle 500/330 kV substation 3. Bannaby 500 kV yard extension	4. 390 km 500 kV line 5. Marangle 500/330 kV substation 6. Wagga 500/330 kV substation 7. Bannaby 500 kV yard extension
Timing	1. Feasible by 2022	2. Feasible by 2024
Benefit	1. +1000 MW into NSW load centre 2. Vic/Murray access (>1000MW) 3. Facility oriented	4. +1000 MW into NSW 5. Vic/Murray/SW-NSW access (>500 MW) 6. System oriented
Upsides	1. Increases VIC & Murray access	2. Shares Vic, Murray & Riverlink / SW-NSW access

Table 2: First-to-build options

In a recent update to to address NSW future energy delivery the NSW Government has released a Transmission Infrastructure Strategy[23] which incorporates ISP Group 1 and Group 2 projects, and the Riverlink interconnector to leverage existing energy sources to meet NSW future energy requirements.

Of particular relevance to the Transmission Proposal, the NSW government strategy is promoting Bannabylink Stage 2, specifically to integrate with the Riverlink and SW Energy zone developments, with a delivery time of 2024.

The objective of the Transmission Proposal is therefore to see Bannabylink Stage 1 completed as an ISP Group 1 Project to support NSW energy security post Liddell closure in 2022, and Bannabylink Stage 2 as a Group 2 project completed in time to integrate the SW-NSW Energy Zones, the Riverlink interconnector and the Project into the NSW energy supply network by 2024.

5.3 VIC Transmission development

5.3.1 Overview

From the Feasibility Study the preferred option to meet the Project VIC market access objectives was referred to as 'Option 1C' and comprised the following augmentations:

1. Double circuit 330 kV Murray - Dederang line;
2. Single circuit 330 kV Dederang - South Morang line with 50% series compensation;
3. Fourth Dederang 330/220 kV Transformer; and
4. Second South Morang 500/330 kV Transformer.

Figure 15 is taken from the Feasibility Study report and shows Option 1C relative to the existing network, with the line and transformer augmentations shown in black.

[23] NSW Government, November 2018. NSW Transmission Infrastructure Strategy. Available at: https://energy.nsw.gov.au/renewables/emerging-energy/energy-zones

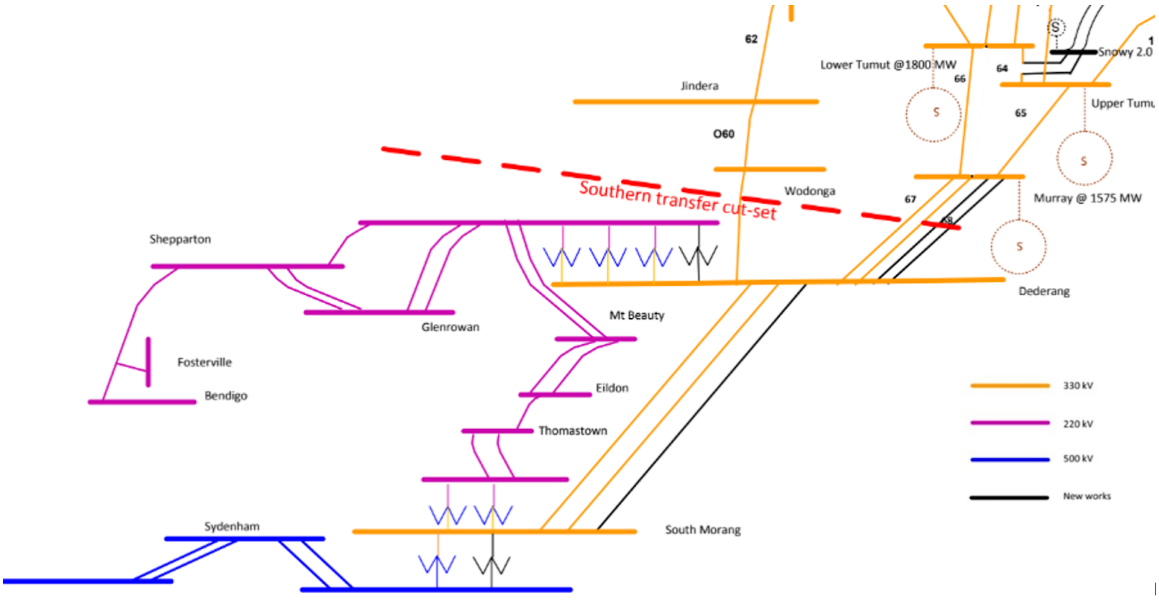

Figure 15: Option 1C development (Feasibility Study 2017)

Following from the Feasibility Study, Snowy Hydro lobbied AEMO (in their VIC and National Planning roles) as to the benefits of the Option 1C upgrade, however, while AEMO acknowledged the history around the 1C Option as being the 'next' VIC-NSW interconnector upgrade in annual planning reports over the last 20 years, their view was that the renewable energy transition is demanding a rethink of the optimal interconnection arrangement between the VIC-NSW.

As a result of this, the AEMO ISP option includes the Second South Morang 500/330 kV Transformer and thermal rating upgrades to the existing Dederang to South Morang lines as a Group 2 project, but not any new lines on this route. Instead AEMO proposed a significantly different interconnector upgrade, as described in the following section.

5.3.2 VIC-NSW interconnection upgrade and the AEMO ISP

AEMO investigated Victorian transmission augmentations and the need for increased interconnection capacity between VIC and NSW in their inaugural ISP. The investigation considered the network development requirements over the 20 plan period (nominally 2018-2038) and, using their modelling methodology, identified that enhanced VIC-NSW interconnection was justified as a group 3 project (projects required beyond 2030). The AEMO proposal for VIC-NSW interconnector 'Snowylink South) is shown in Figure 17 below, extending between the existing Sydenham terminal station in metro north Melbourne, and Wagga Wagga in south-west NSW.

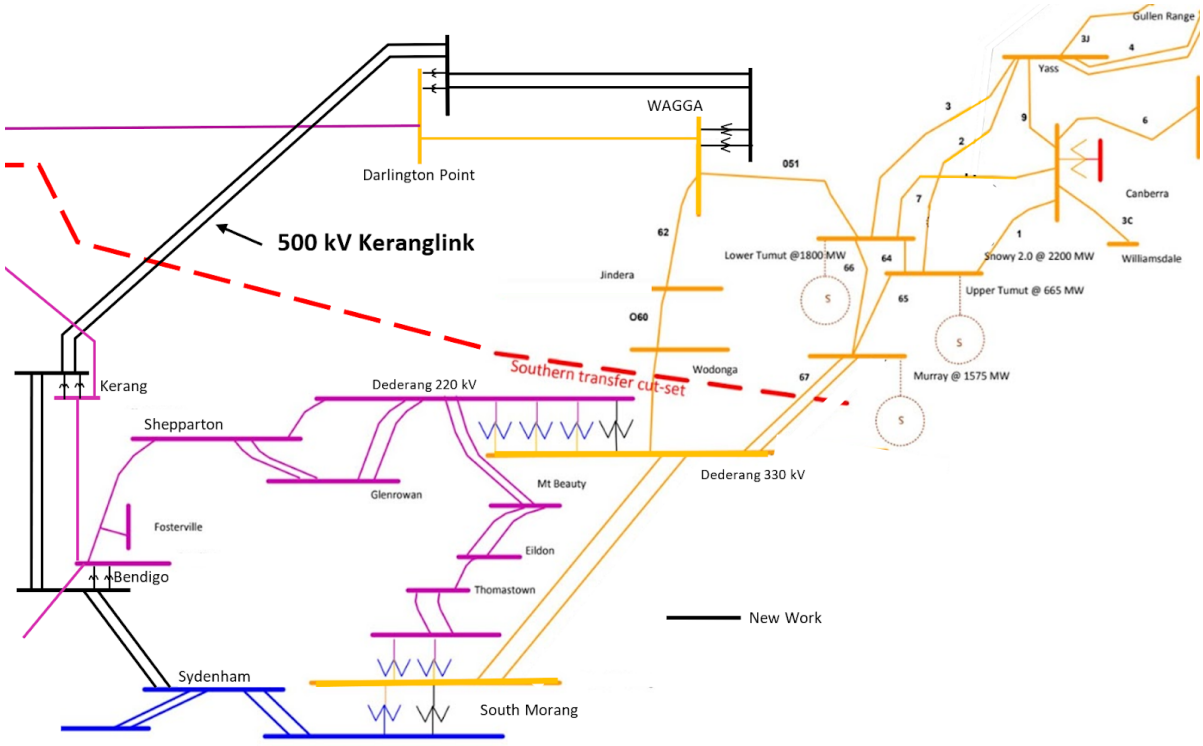

Figure 16: AEMO ISP VIC-NSW Interconnection 'Keranglink' (FID 2018)

Naming

In the ISP AEMO refer to their interconnector proposal as 'Snowylink south', with the inference being that the new interconnection is solely required for Snowy 2.0. This is misleading as Snowylink south does not directly connect to Snowy 2.0. If it were only required for Snowy 2.0 then Snowy Hydro's Option 1C from the Feasibility Study would suffice and cost less than half of AEMO's ISP proposal.

As such Snowy Hydro is recommending that the AEMO option be called Keranglink, reflecting its route from Sydenham to Wagga Wagga via the inland Victorian township of Kerang, rather than as Snowylink South.

Timing

In their justification for making Keranglink a Group 3 project AEMO has stated that its decisive economic drivers are coal retirements and (indirectly) Battery of a Nation (***BotN***),[24] which in AEMO's view connects in 2033. Snowy Hydro has questioned this and suggests that Keranglink is required in the Group 2 time frame (to 2025) for a number of reasons as follows:

1. Hydro Tasmania (HydroTas) has objected to the AEMO timing of BotN, insisting it will be delivered much earlier and therefore requiring stronger interconnection to allow mainland access to its firming capacity.
2. Snowy Hydro has questioned AEMO's 'orderly exit' model for aging brown-coal stations, particularly with the VRET (2025) and other VIC

[24] Hydro Tasmania, 2018. Hydro Tasmania: Battery of the Nation. Available at: https://www.hydro.com.au/clean-energy/battery-of-the-nation

Government initiatives occurring in the Group 2 timeframe (to 2025) and these putting ever more pressure on the aging VIC coal fleet. The inability for these stations to flex in the intermittent renewable dominated energy market and/or catastrophic plant or equipment failure in the Group 2 timeframe could well see coal plants exit earlier that the ISP prediction leaving Victoria seriously exposed to a lengthy period in which either new dispatchable plant or accelerated interconnector development would be urgently required.

3. AEMO themselves have also previously identified substantial market benefit streams arising from further interconnection with NSW, initially from government initiatives such as VRET itself, but more so as the transition to renewables gathers pace and drives the need for energy firming services.
4. AEMO's generation information resource clearly highlights the need for firming services. It currently predicts that by summer 19/20 there will be approximately 8000 MW of variable renewable energy (VRE) in the three-state interconnected region (NSW, VIC & SA), but of that 8000 MW, only about 6% (~500 MW) can be regarded as 'firm' in terms of meeting summer peak demand.

In summary Keranglink is required to:

1. Transfer significant amounts of VRET energy out of VIC (to avoid constrained off VRET plant or early exit of VIC dispatchable plant);
2. Integrate with the western VIC renewables integration, the Riverlink project and possibly the BotN (if it is built in the Group 2 timeframe);
3. Facilitate the market benefits arising from increased diversification of renewable energy sources across REZs located in the Vic, NSW and SA;
4. Provide access to firming services for more than 8000 MW of VRE; and
5. Protect VIC against earlier than expected closure, or forced outage, of aging brown coal power stations,

This could all occur within the timeframe of Group 2 projects, and as such Snowy Hydro is strongly proposing to AEMO that Keranglink be considered a Group 2 project to be completed by 2025.

5.4 Riverlink Transmission development

5.4.1 Overview

Riverlink is a transmission network development option identified by ElectraNet in its South Australian Energy Transformation (***SAET***) RIT-T. Riverlink was identified by Snowy Hydro in the Feasibility Study Report (Three-state network development concept) as the preferred option for the SA Energy Transformation solution because of its function as a bi-directional energy corridor for the Snowy 2.0 storage and supply paths, and to release REZ in south-west-NSW, north-west-VIC and eastern SA.

5.4.2 ElectraNet's Riverlink option

Since the Feasibility Study, ElectraNet has advanced the SA Energy Transformation RIT-T to the PADR, which has identified that Riverlink (a new 330 kV interconnector between mid-north South Australia and Wagga Wagga in New South Wales, via Buronga), is expected to deliver the highest net market benefits and therefore becomes the preferred option for continued investigation and implementation.

The Riverlink option is shown in Figure 17 below and is consistent with the Snowy Hydro Transmission Proposal objectives. The PADR indicated that Riverlink could be delivered between 2022 and 2024.

Figure 17: SA Energy Transformation RIT-T preferred option 'Riverlink'[25]

Note the Riverlink connection into Wagga Wagga (from the west) is identified as being 330 kV in the ElectraNet PADR, but ISP and construction of Keranglink at 500 kV may see the Darlington Point to Wagga section of Riverlink also constructed at 500 kV if Keranglink is routed via Darlington Point.

The Riverlink development has been incorporated into the Project's benefits assessment.

[25] ElectraNet, June 2018. Information Sheet - SA Energy Transformation Available at: https://www.electranet.com.au/wp-content/uploads/projects/2016/11/180629_SAET-RIT-T-PADR_Fact-Sheet_Vg-WEB.pdf [Accessed 25 October 2018]

5.5 Western Victoria Renewables Integration RIT-T

5.5.1 Overview

AEMO had previously published their PSCR for the Western Victoria Renewables Integration RIT-T in early 2017, and this development was included in the Feasibility Study Transmission Proposal. The intention for FID was to update the Transmission Proposal to also include any new information arising from the Western VIC Renewables Integration PADR which was due to be published in July 2018.

However the inaugural ISP was relatively silent on the development and in July 2018 AEMO requested that the AER extend the time allowed for the publication date of the RIT-T PADR to 14 December 2018 so that AEMO could incorporate the outcomes of the ISP process, new rule changes relating to system strength requirements for connecting generators, and the outcomes of the first VRET reverse auction.

The AER provided the extension of time to AEMO and as such Snowy Hydro is not aware of AEMO's current proposal for Western VIC Renewables integration, however what information is available is presented here and has been incorporated into the updated Project Transmission Proposal.

5.5.2 AEMO western VIC REZ update

In lieu of publishing a PADR, AEMO did publish commentary on the reasons for the extension of time and in that identified the following terminal stations as committed transmission developments projects in western Victorian and the new renewable generation projects they will serve as follows:

1. Crowlands terminal station between Ararat and Horsham Terminal Stations, facilitating the connection of Crowlands Wind Farm (80 MW). This is expected to be completed in late 2018.
2. Bulgana terminal station between Ararat and Horsham Terminal Stations, facilitating the connection of Bulgana Wind Farm (204 MW). This is expected to be completed in early 2019;
3. Murra Warra Terminal station between Horsham and Redcliff Terminal Stations, facilitating the connection of Murra Warra Wind Farm Stage 1 (226 MW). This is expected to be completed in mid-2019; and
4. Haunted Gully Terminal station between Moorabool and Tarrone Terminal Stations, facilitating the connection of Stockyard Hill Wind Farm (532 MW). This is expected to be completed in late 2019.

In addition to these new terminal stations, the 1st VRET reverse auction also identified the following renewable projects also located in the greater western VIC REZ:

7. Berrybank Wind Farm west of Geelong, which will produce 180 MW;
8. Cawarp Solar Farm south of Mildura, which will produce 121.6 MW;
9. Cohuna Solar Farm north-west of Echuca, which will produce 34.2 MW;

10. Dundonnell Wind Farm north-east of Warrnambool, which will produce 336 MW;
11. Mortlake South Wind Farm south of Mortlake, which will produce 157.5 MW; and
12. Winton Solar Farm near Benalla, which will produce 98.8 MW.

With this amount of intermittent renewable energy located in the western VIC REZ, Snowy Hydro is confident the Western VIC Renewables Integration RIT-T will still recommend significant transmission infrastructure development in Western VIC and, as per the Feasibility Study Transmission Proposal, this will in-turn drive the business case for increased interconnection between NSW and VIC (see the VIC Transmission development section below).

Figure 18: Western Victoria renewables zone addressed in the RIT-T

6 NER-related activities

6.1 General

In respect of the Transmission workstream, the NER-related activities undertaken since the Feasibility Study have been dominated by the ERC0222 Rule change (GTR) which was initially proposed by AEMO following the South Australian blackout in 2016.

The main focus of the Transmission workstream activity around the Rule change was to ensure that:

1. Electrical & Mechanical (E&M) bidders were fully aware of the content and intent of the Rule change and their obligations to design, manufacture, construct and commission their plant and equipment to satisfy the NER requirements (also referred to as Grid Code requirements); and
2. The Employers' Requirements and Contract drafting adequately reflected the technical and process requirements around the NER and specifically the pending GTR Rule change (which would be in effect by the time the E&M contract was signed).

6.2 Generator Technical Requirements

The generation and energy source mix is changing and this is creating new challenges for managing the power system efficiently. In particular, maintaining the power system in a secure operating state is becoming more difficult as older (synchronous) generating systems retire and are replaced by newer, asynchronous generating systems such as wind and solar, and distributed generation.

Following the SA blackout in September 2016, AEMO undertook a significant review of existing GTR and identified a number of material deficiencies in the existing technical requirements, particularly in respect of asynchronous and inverter-connected plant (of which the overwhelming majority of new connection applications now nominate as their generator type). The Rule change proposed by AEMO initially reflected their recommendations to the SA Government following the blackout event and focussed on the following areas:

1. The negotiating process used to set the levels of performance required of all equipment connecting to the power system, and
2. A number of access standards (generator technical performance standards) for connecting generating systems, including standards relating to:
    a. Active power capability and control;
    b. Reactive power capability and control;
    c. Inject and absorb reactive current during disturbances; and
    d. Access standards related to the ability to maintain operation in the face of a wide range of system side disturbances and low system

strength conditions (fault ride-through requirements including multiple low voltage fault ride through for example).

This Rule is the most significant change to generator technical performance standards since the Rules were amended to cover the introduction of wind generators in 2007, but now goes much further in regard to requirements for supporting system stability and reliability.

Snowy 2.0 will comprise both synchronous and asynchronous motor/generator sets that operate in both turbine (generation) and pumping (motor) modes, so there will be a requirement to establish four sets of performance standards to meet the new technical requirements. In addition, the asynchronous motor/generator sets are the first of their kind ever installed in Australia, and at over ±300 MW capacity, the system security implications of unexpected or unstable operation will be of prime concern to AEMO and the NSP.

6.3 bidder involvement

During the Feasibility Study, details of the NER requirements for generator connections in the NEM were provided to the prospective E&M contractors/equipment suppliers, and they were also advised of the pending NER GTR Rule change.

Since the Feasibility Study, AEMO has lodged its Rule change proposal and the AEMC has progressed the Rule change to final determination in September 2018. As a Rule change directly relating to system security there is a heightened emphasis on compliance with this Rule and all prospective E&M contractors/suppliers needed to be made fully aware of the requirements to ensure their bids and engineering designs incorporated the changes.

It was also necessary to:

1. Inform the bidders of the timeline for the Rule change process in relation to the Project timeline and tender process;
2. Ensure the bidders were fully aware of related industry reviews and updates to technical guidelines, templates and standards which were occurring in parallel with the Rule change; and
3. To the best extent possible, inform the bidders of the expectations of AEMO and the NSP in respect of the submissions required to progress the technical regulatory compliance functions during the connection application process.

Bidders were kept informed of the NER technical regulatory compliance requirements throughout the period from Feasibility Study to tender close via a number of mechanisms including:

1. The E&M RFI process, with invitations to attend industry forums and workshops at which the proposed Rule change was discussed;
2. By transmittal when associated documents were released;

3. By providing the names of competent and appropriately experienced Australian consultants (that the bidders could use to ensure they were fully informed of NER requirements); and
4. By requiring the submission of compliant models and model-based performance simulations (connection studies) as returnable tender schedules.

7 Transmission Connection Agreement

7.1 Overview

At the time of the Feasibility Study, the TCA had not been progressed because of the early stage of the connection assessment. Since the Feasibility Study, activities have progressed to the point where submission of the Connection Application is possible, subject to receiving technical information of acceptable quality from the prospective E&M contractors/suppliers. This section updates progress and next steps in this workstream.

7.2 TCA Components

The TCA is the key agreement/instrument under the NER by which physical connection to the NEM is authorised. There are three main components to a TCA as illustrated in Figure 19.

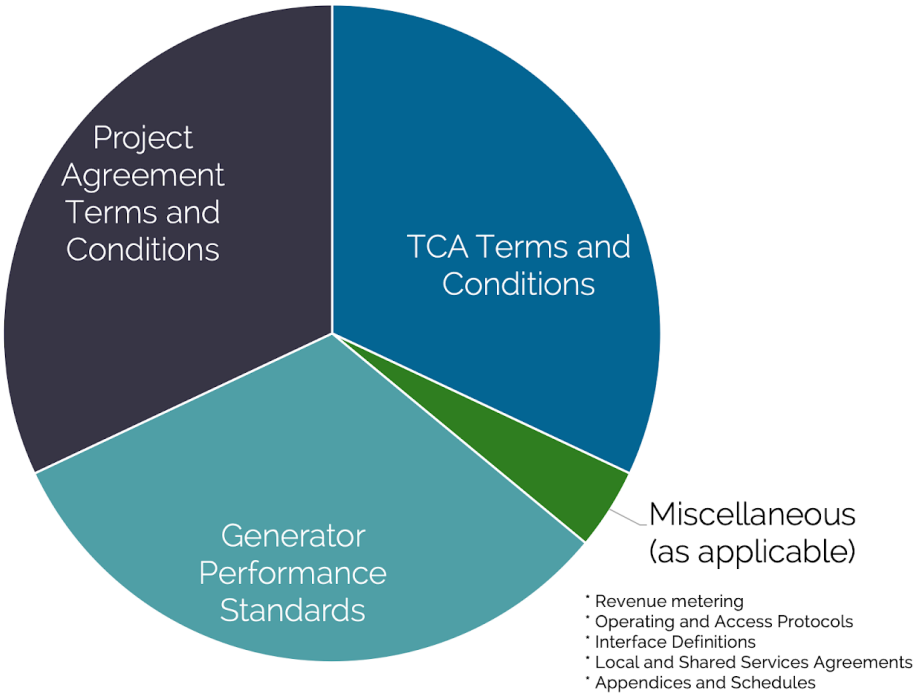

Figure 19: TCA Main Components

1. **TCA Terms and conditions** - are negotiated and set out the conditions for connection over the life of the TCA, typically 30 years. TransGrid is preparing to provide the draft TCA terms and conditions to Snowy Hydro by the end of October 2018 to progress this review and negotiation. The area is not considered to be high risk;
2. **Project Agreement** - an agreement that covers the construction of the shallow connection works and exists only for the construction period. TransGrid is also preparing the terms and conditions of the Project Agreement and pricing for inclusion in the OTC. Because of the early engagement with TransGrid this component of the TCA is also not considered to be high risk, provided Snowy Hydro receives competitively tendered pricing from TransGrid. The procurement strategy around the connection works is that TransGrid would effectively fulfil the role of project management and procurement for the connection works; and
3. **Generator (and pump) performance standards (*GPS*)** - complete the main components of the TCA. The performance standards are established under the NER Section 5.3.4 process and relate specifically to the technical performance characteristics of the generation and pump technology as measured against the Generator Technical Requirements (particularly Section S5.2.2 of the NER). The performance standards place a high emphasis on ensuring the connecting plant do not degrade system security. Because of Snowy Hydro's reliance on the prospective E&M Contractors / Suppliers for this information, and the size and system related impacts of the Project, this component of the TCA is considered medium risk.

7.2.1 TCA process update

Figure 20 shows the connection process followed by TransGrid for generators and large electrical load customers as included in the Feasibility Study. The steps in the process are based on the NER Chapter 5 Part A which provides a framework for connection to the transmission network and access to the national grid, and TransGrid's experience in the area of generator connections. The status of the Project connection process at Feasibility Study and at FID are indicated by the arrows.

Since the Feasibility Study, the activities undertaken in this subsection have focussed on the Connection Enquiry, the Scoping Study and Review, and some early works initiatives also covering preliminary aspects of the application to connect, such as the preparation of the (conditional) OTC, provision of a first draft of the Connection Agreement and connection works Project Agreement Terms and Conditions.

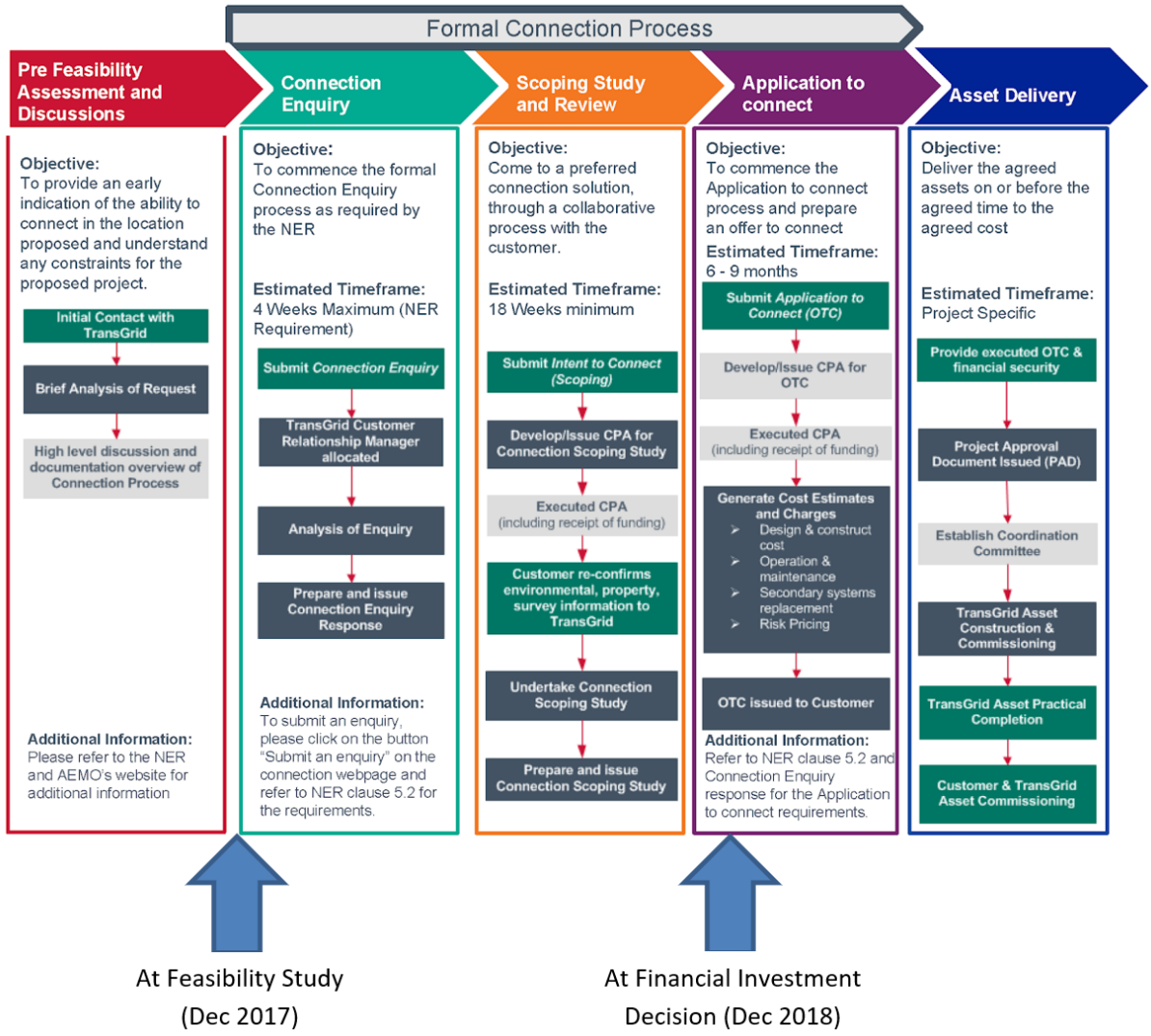

Figure 20: Connection Agreement Progress from feasibility study to FID

As at FID, Snowy Hydro is waiting for generator and pump connection studies by the prospective E&M contractor/suppliers in order to verify their level of conformance with NER GTR. The connection studies reports are critical inputs to the tender evaluation and to progressing the Connection Application.

7.2.2 Next steps

The most significant activity remaining to initiate the formal TCA process is the lodgement of the Connection Application itself and this is dependent on Snowy Hydro receiving technical information from the prospective E&M contractors/suppliers, sufficient to meet the process requirements.

AEMO and the NSP stipulate the content and quality metrics for the technical information that must be supplied and Snowy Hydro has included these in the Employer's Requirements and the returnable tender schedules. As at FID, the E&M tender responses are being evaluated to assess completeness for opening formal connection application technical discussions with AEMO and TransGrid.

7.2.3 TCA risks

The TCA cannot be signed until the GPS are agreed and approved by AEMO and the TNSP. The major risk associated with the TCA typically arises from time delays caused by slow delivery of plant models and/or technical performance data, poor quality of simulations and performance verification studies, poor compliance with data and model guidelines and templates, and/or disagreement on technical study parameters and results during the normal course of negotiating the terms and conditions of a connection agreement.

As the Project is a very large connection (the largest since the commencement of the NEM) and includes new equipment never before connected to the NEM (the variable speed machines), AEMO is expected to request a significant number of verification studies.

8 Construction supplies

8.1 Lobs Hole construction supply

The Lobs Hole construction supply is a 330 kV / 33 kV 50 MVA substation to be located in the Ravine south of the Yarrangobilly River and adjacent to existing transmission line 2 (TL2). The purpose of the substation is to provide power supplies (at 33 kV) for the Civil and E&M Contractors working in the Ravine area, and eventually to provide a permanent auxiliary power supply for Snowy 2.0. The approximate location of the Lobs Hole construction supply is shown in Figure 21.

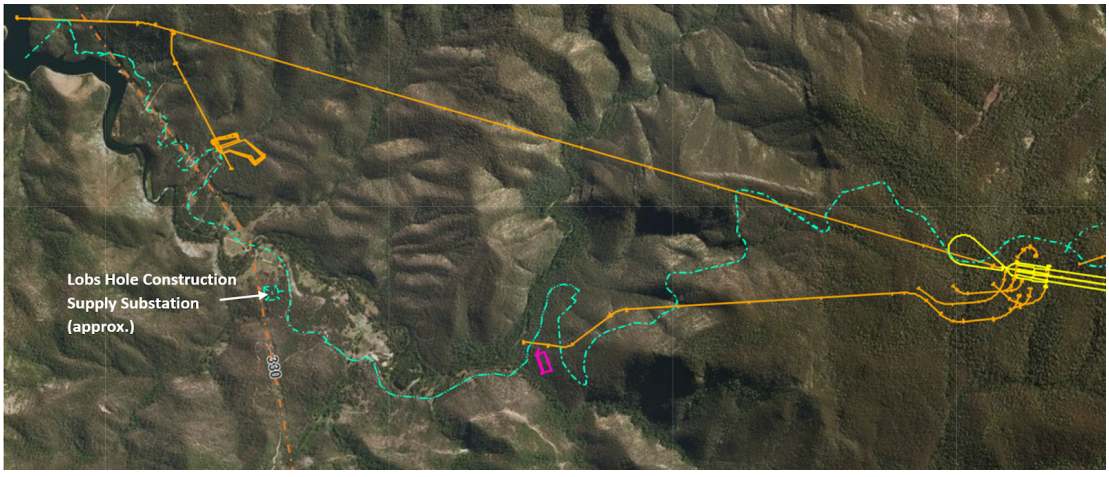

Figure 21: Lobs Hole construction supply substation

The location of the Lobs Hole construction supply substation is remote and there are no suitable distribution lines in the vicinity of the Ravine works which are also located within KNP.

The nearest suitable distribution supply points were identified as the Essential Energy supply points at Talbingo and Cabramurra, which were both underrated to supply the required construction supply capacity. It was not considered feasible

to upgrade these existing distribution connection points and run new high capacity distribution lines or cables to the Ravine area.

Similarly, the nearest existing transmission supply points are the TransGrid Upper and Lower Tumut switching stations, both approximately 20 km from the Ravine area. Again it was not considered feasible to install new or additional distribution supply capability at these substations and then run new high capacity distribution lines or cables through the national park to the Ravine area.

However, TransGrid owns and operates the 330 kV transmission line 2 (TL2) which passes by adjacent to the proposed site for the Lobs Hole construction supply substation. TransGrid was approached to provide a cost and construction time estimate for the substation and TransGrid has now been engaged under a CPA to provide an OTC including the construction of a 330 kV / 33 kV 50 MVA substation adjacent to TL2 in the Ravine at Lobs Hole.

Figure 22 shows the preliminary footprint for the Lobs Hole construction supply substation. Note the small footprint of the 330 kV switchgear which is a gas-insulated type (much smaller than air-insulated switchgear).

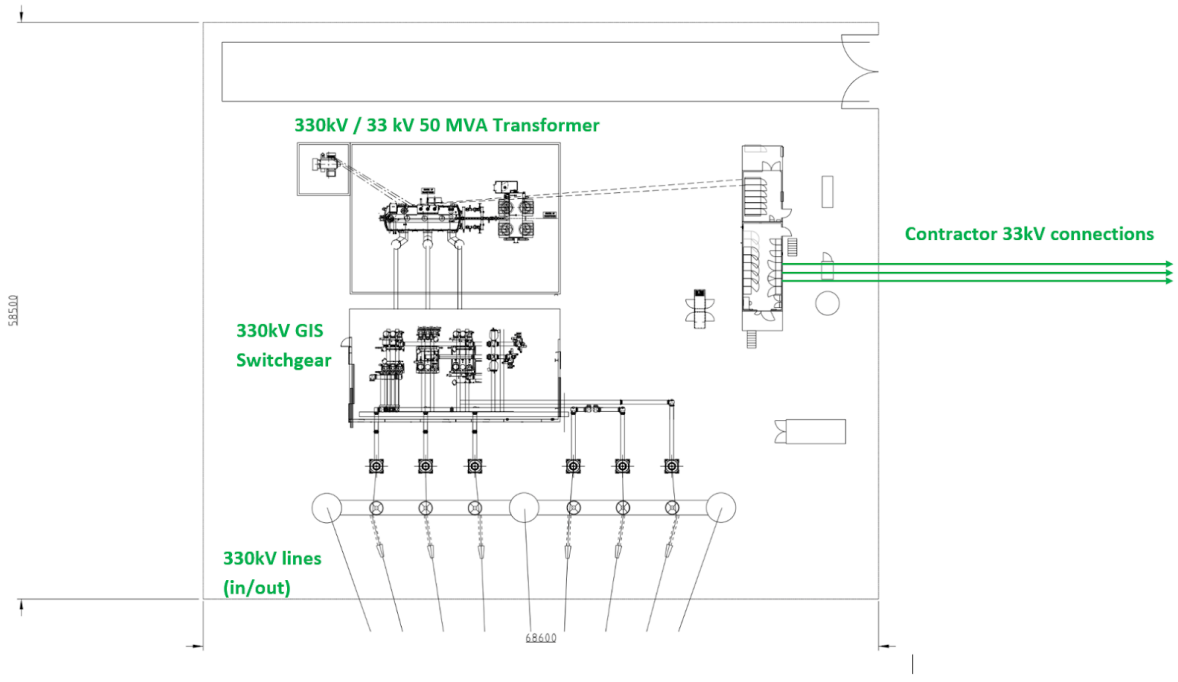

Figure 22: TransGrid 330 kV / 33 kV 50 MVA construction supply substation general arrangement

8.2 Marica construction supply

The Marica construction supply is a 330 kV/33 kV 50 MVA substation to be located on the Plateau adjacent to the Marica Trail and Snowy Mountains Hwy intersection. The purpose of the substation it to provide power supplies for the Civil and E&M contractors working in the headrace area, and eventually to provide a backup power supply for the Lobs Hole construction supply.

The Marica construction supply substation will be temporary. It will operate for the duration of the Project execution phase and then be dismantled and removed, and the site will be rehabilitated. Figure 23 below shows the approximate location of the Marica construction supply substation.

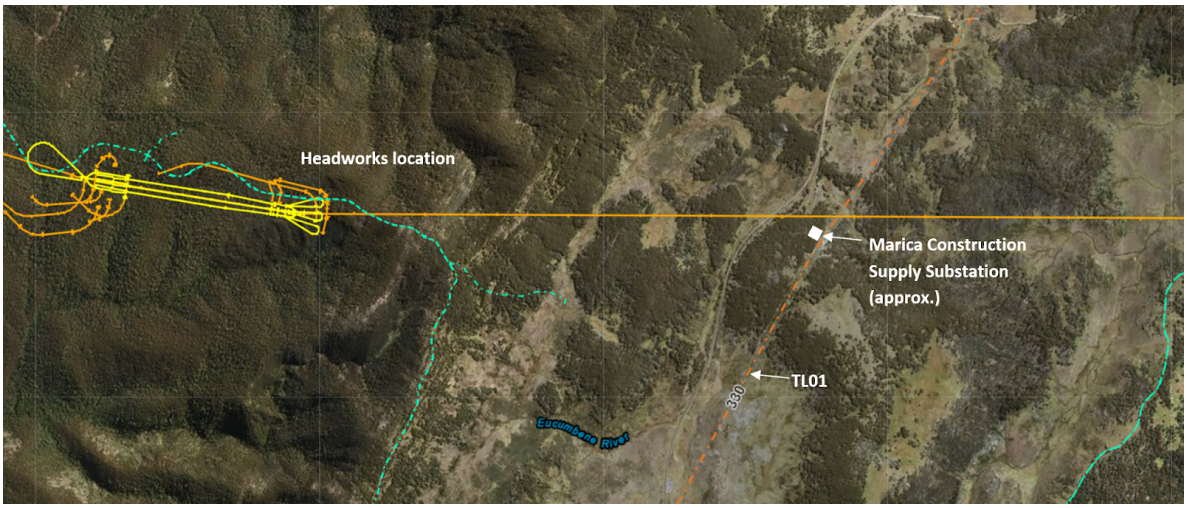

Figure 23: Marica construction supply substation

The location of the Marica construction supply substation is remote and there are no suitable distribution lines in the vicinity of the headworks.

The nearest suitable distribution supply points were the Essential Energy Cabramurra, Tantangara and Providence Portal substations, all of which were insufficiently rated for the required construction supply capacity. It was not considered feasible to upgrade these existing distribution connection points and run high capacity distribution lines or cables to the headworks area.

Similarly, the nearest transmission supply points are the TransGrid Upper and Lower Tumut switching stations, both approximately 20 km from the headworks area. Again it was not considered feasible to install additional distribution supply capability at these substations and run high capacity distribution lines or cables through KNP to the headworks area.

However, TransGrid owns and operates the 330 kV transmission line 01 (TL01) adjacent to the Snowy Mountains Highway which runs across the Plateau and past the Marica Trail intersection. TransGrid was approached to provide a cost and construction time estimate for the Marica construction supply substation. TransGrid has now been engaged under a CPA to provide an OTC including the construction of a 330 kV/33 kV 50 MVA substation adjacent to the Marica Trail.

The Marica construction supply substation is planned to be identical to the Lobs Hole construction supply substation to increase procurement efficiency and reduce spares holding requirements.

8.3 Tantangara 33 kV/17 MVA construction supply

The Tantangara construction supply is a 33 kV / 17 MVA supply to be obtained by upgrading the existing 11 kV line that supplies the Tantangara dam auxiliary

electrical equipment. The existing supply has insufficient capacity to meet the Civil Contractor requirements. Figure 24 below shows the general location.

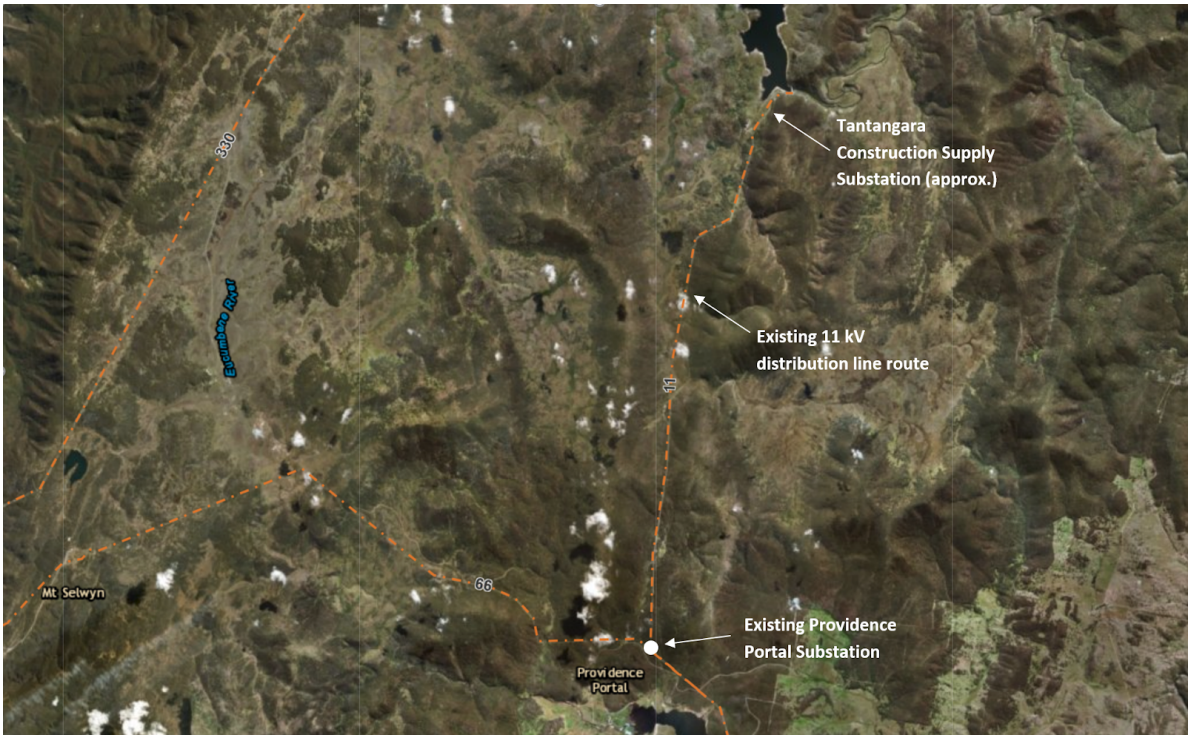

Figure 24: Tantangara construction supply

The line is currently constructed at 11 kV, and as such, a significant line rebuild to 33 kV is required. However, the condition of the lines must first be established by an engineering survey in order to determine the full scope of works. The Tantangara construction supply relies on existing aged distribution assets so there are risks around the scope of work.

Snowy Hydro has signed a CISA with Essential Energy to establish the scope of works required to develop the supply.

8.4 Next Steps

Completion of the construction supplies so that power is available to the successful Civil bidder is a key schedule item and under the proposed Civil EPC contract is a Snowy Hydro risk. Post-FID it is therefore important that:

1. The site for the Marica substation is agreed and included in the Main Works EIS;
2. The scope of work for the Tantangara construction supply is determined in order to establish approval requirements, upgrade cost and construction time;
3. CPA activities continue to conclude the Lobs Hole and Marica substation designs and obtain the OTC;
4. 'CPA' activities continue to conclude the Tantangara connection arrangements with Essential Energy and the scope of those works

5. Early procurement of long lead-time items may be required for specific items of any of the three Construction Supplies

9 Further work required

Activities that are required to continue and progress are as follows:

1. Obtain commitment to the NSW deep transmission network development and its associated funding path from relevant bodies (the deep network augmentation is outside of the Project scope);
2. Clear path to the VIC deep transmission network development and its associated funding path from relevant bodies (the deep network augmentation is outside of the Project scope);
3. OTC accepted and TCA signed; and
4. Connection works Project Agreement signed (or ready for signature).
5. Monitor construction of the shallow connection works;
6. Monitor construction of the NSW and Vlc deep transmission network development and other relevant transmission related;
7. System studies, 'R1' performance standard determination;[26]
8. Market registration;
9. Interface protocols (operating, access, signal lists, protection overlaps etc);
10. Commissioning (planning, modelling, undertaking); and
11. R2 Data Registration.[27]

10 Risks

The key risks related to Transmission and mitigations will be managed in accordance with the Risk Management Plan outlined in Suppoorting *Chapter Seventeen - Risk Management*.

11 Supporting information

There are no supporting documents available for this chapter.

12 Definitions and abbreviations

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AIS	Air-insulated switchgear
BotN	Battery of a Nation
CISA	D Connection Investigation and Services Agreement
COAG	Council of Australian Governments
COGATI	Coordination of generation and transmission investment
CPA	Connection Process Agreement

[26] See AEMO, 2016. Modelling requirements. Available at: https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Network-connections/Modelling-requirements [Accessed November 29, 2017].
[27] Ibid.

DPE	Department of Planning and Environment
ECVT	Emergency, Ventilation and Cable Tunnel
EIS	Environmental Impact Statement
EPBC	Environment Protection and Biodiversity Conservation
EPC	Engineer-Procure-Construct
ESB	Electricity Security Board
EWA	Early Works Agreement
EY	Ernst & Young
FID	Final Investment Decision
GIS	Gas Insulated Switchgear
GPS	Generator performance standards
GTR	Generator technical requirements
ISP	Integrated System Plan
IUSA	Identified user shared assets
KNP	Kosciuszko National Park
NEM	National Electricity Market
NER	National Electricity Rules
NSP	Network Service Providers
NTNDP	National Transmission Network Development Plan
OTC	Offer to Connect
PADR	Project Assessment Draft Report
PEA	Preliminary Environmental Assessment
PHES	Pumped Hydro Energy Storage Sites
PRG	Planning Reference Group
PSCR	Project Specification Consultation Report
RAB	Regulatory asset base
REZ	Renewable Energy Zones
SEAR	Secretary's Environment Approval Requirements
TCA	Transmission Connection Agreement
TNSP	Transmission Network Service Provider
TSO	Transmission System Operators
TUOS	Transmission Use of System
VRE	Variable renewable energy
VRET	Victorian Renewable Energy Target

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