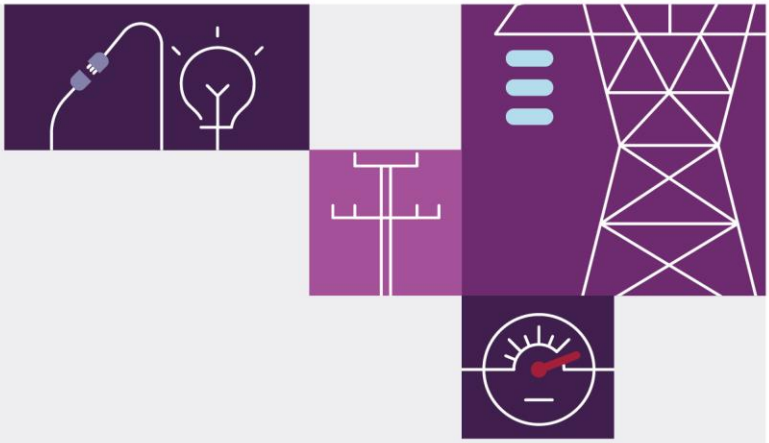
Appendix 5. Network Investments

December 2023

Appendix to the Draft 2024 Integrated System Plan for the National Electricity Market



Important notice

Purpose

This is Appendix 5 to the Draft 2024 Integrated System Plan (ISP) which is available at https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp. AEMO publishes the Draft 2024 *Integrated System Plan* (ISP) pursuant to its functions under section 49(2) of the National Electricity Law (which defines AEMO's functions as National Transmission Planner) and its supporting functions under the National Electricity Rules. This publication is generally based on information available to AEMO as at 30 October 2023 unless otherwise indicated.

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Version control

Version	Release date	Changes
1.0	15/12/2023	Initial release.

AEMO acknowledges the Traditional Owners of country throughout Australia and recognises their continuing connection to land, waters and culture. We pay respect to Elders past and present.

ISP Appendices

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Executive summary

AEMO's *Integrated System Plan* (ISP) is a roadmap for the transition of the NEM power system, with a clear plan for essential infrastructure to meet future energy needs. ISP's optimal development path sets out the needed generation, firming and transmission, which would deliver significant net market benefits for consumers and economic opportunities in Australia's regions.

This appendix explores new transmission that is needed to connect the new and diverse generation and storage capacity to towns, cities and industry across the NEM. The transmission network brings electricity where it is needed, when it is needed, and improves the power system's resilience. Current network capacity is well utilised, and new projects will better share future resources between regions, allow REZs to transfer their energy to where it is needed in future, and maintain a secure and reliable power system.

Close to 10,000 km of transmission is forecast to be needed in total by 2050 under the *Step Change* and *Progressive Change* scenarios. If Australia is to pursue the more transformational *Green Energy Exports*, then over twice as much transmission would be needed, delivered at a much faster pace.

There is a pipeline of urgent projects with a clear need for delivery by 2033, and which are either committed, anticipated and actionable. About half this work is already well underway in committed and anticipated projects.

This Appendix 5 provides detail on the network investments in the optimal development path (ODP) for the Draft 2024 ISP[1]. It sets out:

- **A5.1 Transmission development overview** – this section contains an overview of the network investments in the ODP.
- **A5.2 Committed and anticipated projects** – this section describes the committed and anticipated transmission augmentation projects including timing, project status and technical details. These projects typically have regulatory approval and are highly likely to proceed.
- **A5.3 Actionable projects** – this section describes the optimal timing, costs and technical detail for both actionable ISP projects and projects that are actionable under a jurisdictional scheme[2]. All actionable projects are underway or should commence the relevant regulatory process immediately after publication of the 2024 ISP.
- **A5.4 Future ISP projects** – this section describes the optimal timing, costs and technical detail for the future ISP projects. These projects will deliver net market benefits to consumers but are not needed until later in the horizon.

[1] The outcomes presented in this appendix are based on the ODP, which is CDP11 described in Appendix 6. Cost benefit analysis.

[2] The ISP may identify projects as "Actionable New South Wales" or "Actionable Queensland" rather than "Actionable ISP" projects. These projects are expected to progress under the *Electricity Infrastructure Investment Act 2020* (NSW) or the proposed *Energy (Renewable Transformation and Jobs) Bill 2023* (QLD) rather than the ISP framework.

Key changes from the 2022 ISP

AEMO notes the following key changes between the 2022 ISP and this Draft 2024 ISP Appendix 5.

- **Higher costs for transmission, generation and storage were observed since the 2022 ISP** due to global supply chain issues and workforce shortages, including around 30% increases for transmission projects. AEMO expects that transmission project costs will continue to increase beyond the rate of inflation while the sector adapts to market pressures. Both observed and forecast transmission cost increases are included in the Draft 2024 ISP.
- **The transmission build is consistent with the 2022 ISP over the next decade**. Beyond 2040 the forecast is more uncertain and shows a reduction in total network build over the ISP horizon compared to previous reports. The *Step Change* and *Progressive Change* scenarios have similar needs for new transmission as the 2022 ISP until the early 2040s, although delivered marginally slower in *Progressive Change*. This supports the need for the first 5,000 km of transmission lines to be delivered by 2033, with many of the projects either committed or anticipated, and already well underway for delivery.
- **The ISP transmission projects are progressing**, as previously actionable projects are now committed or complete and **several 2022 ISP future ISP projects move to actionable status** in the Draft 2024 ISP. All other actionable projects from the 2022 ISP remain actionable. The Gladstone Grid Reinforcement and Queensland SuperGrid South projects are now likely to be actionable Queensland projects. The New England REZ Extension and further augmentation of that REZ are now included as parts of the actionable New South Wales project New England REZ Transmission Link rather than as a future ISP project.

A5.1 Transmission development overview

The development path identified by AEMO as the ODP in the ISP includes a set of network investments which are coordinated and integrated with the projected development of new generation, storage, and consumer energy resources (CER), to deliver the best outcomes for consumers across a range of scenarios and sensitivities. These network investments are categorised as:

- **Flow path augmentations** – upgrades to the portion of the transmission network used to transport significant amounts of electricity across the backbone of the interconnected network to load centres.
- **REZ expansions** – expansion of the network required to connect renewable generation in areas where clusters of large-scale renewable energy can be developed using economies of scale.

Depending on the individual circumstances of each transmission project, each project is be classified as:

- **Committed and anticipated ISP projects**. Transmission augmentation projects being developed and delivered by transmission network service providers (TNSPs) or relevant NEM jurisdictional bodies are categorised as committed or anticipated after meeting a certain threshold[3]:
  - Committed projects meet five criteria relating to planning, construction, land, contracts and financing.
  - Anticipated projects are in the process of meeting at least three of the criteria for committed projects.
- **Actionable ISP projects** address an identified need specified in an ISP and which forms part of an optimal development path[4]. The Actionable ISP projects deliver positive net market benefits to consumers in the ODP if progressed before the next ISP, and so are already underway or should progress via the relevant regulatory frameworks.
- **Actionable New South Wales projects** that proceed through the *Electricity Infrastructure Investment Act 2020* (NSW)[5] for the actionable New South Wales projects
- **Actionable Queensland projects** which may proceed through the *Energy (Renewable Transformation and Jobs) Bill 2023 (QLD)*[6].
- **Future ISP projects** are forecast in the ISP to be an actionable ISP project in the future. Future projects will deliver net market benefits to consumers but are not needed until later in the horizon.

The seven actionable projects (including actionable ISP projects and actionable projects under jurisdictional frameworks) and the 13 future ISP projects are required in the ODP in all scenarios. Future ISP projects, including those that are required in some but not all scenarios, are listed in Section A5.4.14.

In preparing the ISP, AEMO has consulted with network planners through joint planning and given due regard to the transmission annual planning reports. AEMO includes consultation on non-network options as part of the annual Inputs, Assumptions and Scenarios consultation process.

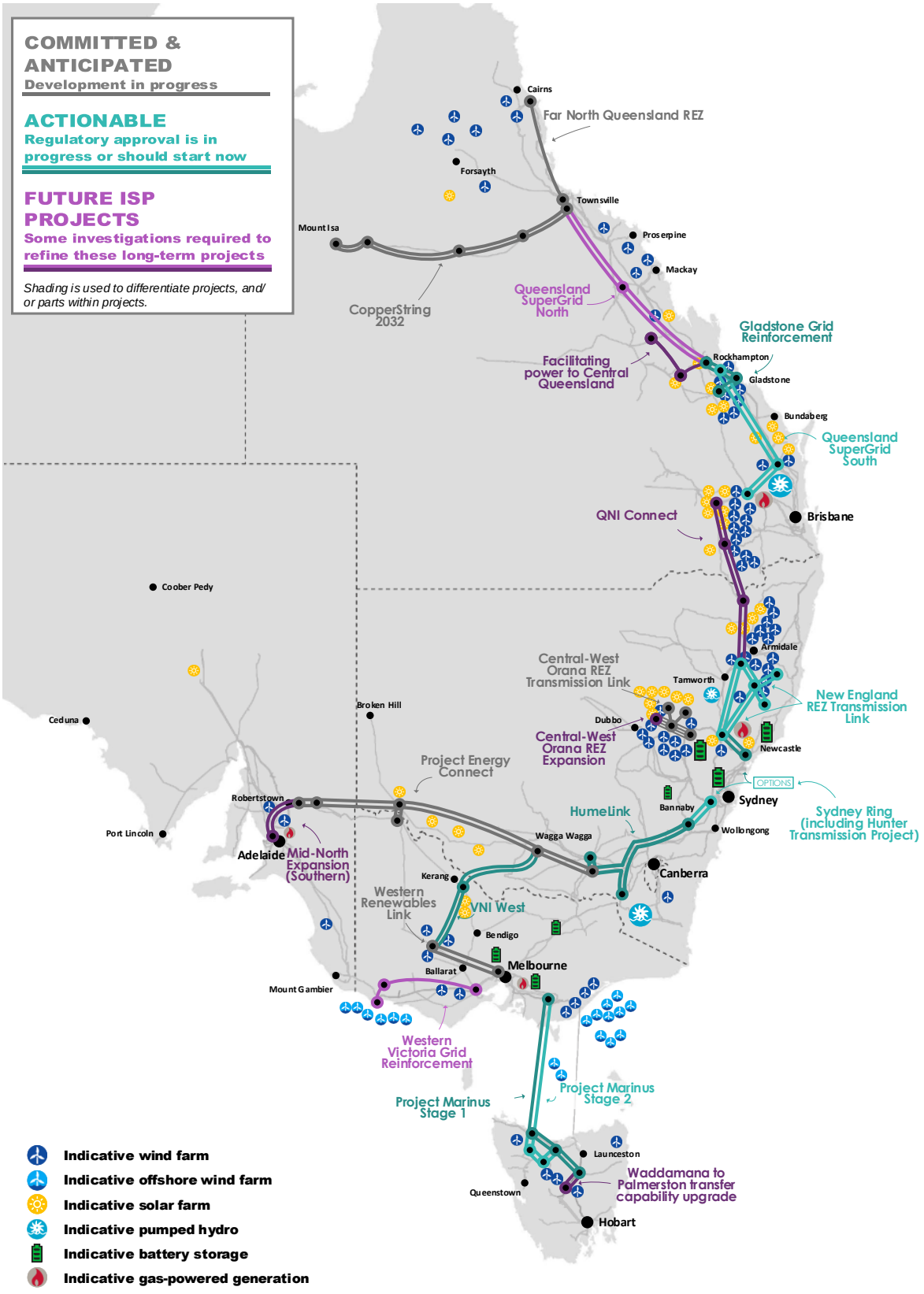
[3] Further details about the criteria for committed and anticipated project status are in the AER's Regulatory investment test for transmission publication, and are also summarised in AEMO's Transmission Augmentation Information page. The AER publication is at https://www.aer.gov.au/system/files/AER%20-%20Regulatory%20investment%20test%20for%20transmission%20-%2025%20August%202020.pdf and AEMO's Transmission Augmentation Information page is at https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/transmission-augmentation-information.

[4] NER Chapter 10.

[5] See https://legislation.nsw.gov.au/view/html/inforce/current/act-2020-044#statusinformation.

[6] At https://www.legislation.qld.gov.au/view/html/bill.first/bill-2022-053.

Figure 1 Summary of the ISP optimal development path



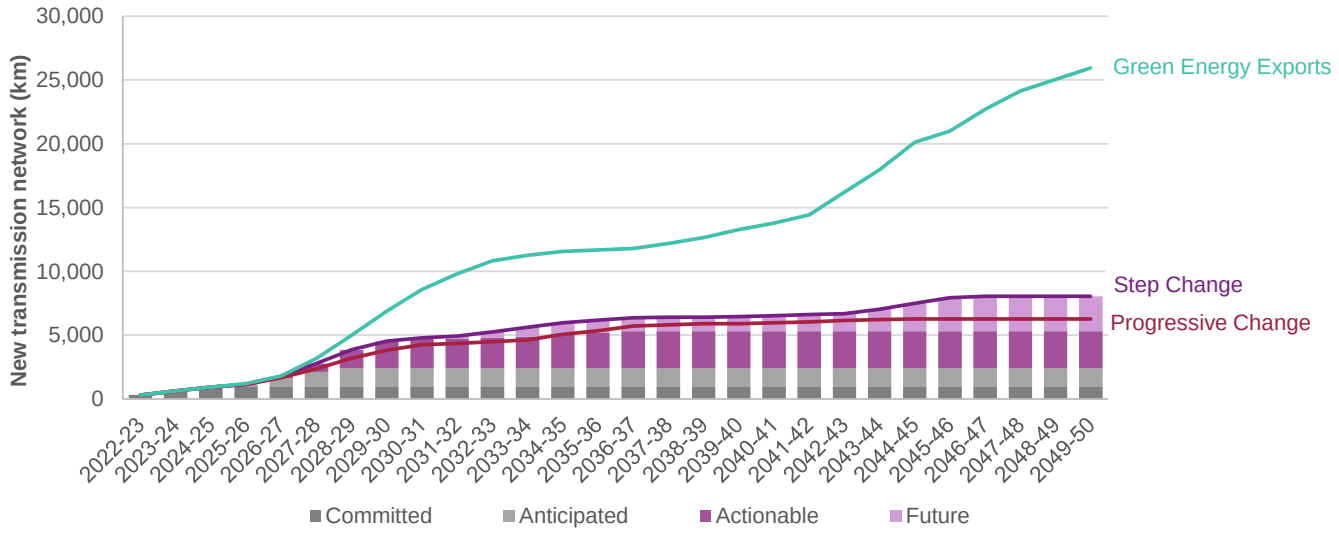
This map shows indicative new generation and storage in 2040, and transmission projects that include new transmission lines, increase capacity by 1,000 MW or more, and are required in all scenarios by 2050.

A5.1.1 Transmission development

The ISP identifies that between 6,000 km and 26,000 km of new transmission network investment is required to connect new generation and storage opportunities to demand centres through REZ and Flow Path transmission assets. Figure 2 highlights the new network investments required per year across all scenarios. Under the *Step Change* scenario, approximately 8,000 km of transmission is required over the full ISP horizon.

Step Change transmission build shows a reduction in total network build over the ISP horizon compared to previous reports. However, echoing the outcome of the 2022 ISP, the Draft 2024 ISP recommends approximately 5,000 km of transmission build in the next decade before tapering off in the latter stages of the horizon. This greatly depends on whether distributed PV is passive or orchestrated, technical change in storage options, and a range of other factors.

Figure 2 New transmission network investments required in the least cost development path

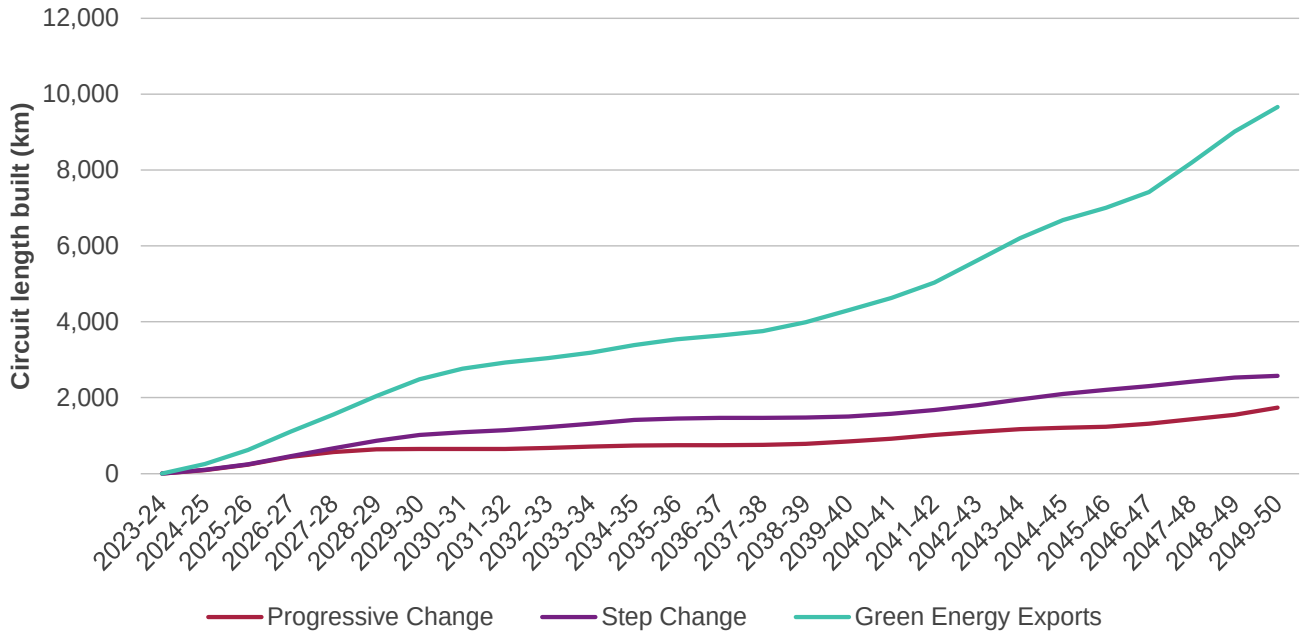


In addition to the transmission network required, between 2,000 km and 10,000 km of connection assets are required to connect the generation identified in this ISP to the transmission network. Generator connection assets account for the transmission infrastructure required to connect a generator within a REZ to a REZ network and the wider NEM, and for connection of other generators and storage. More information on generator connection assets can be found in Section 5 of the 2023 *Transmission Expansion Options Report*[7].

Figure 3 highlights the length of connection assets required per year across all scenarios. Approximately 3,000 km of connection assets are required under the *Step Change* scenario by 2049-50, bringing the total network investment required under this scenario to approximately 11,000 km.

[7] At https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-transmission-expansion-options-report.pdf?la=en.

Figure 3 New network required to connect generation to the main transmission network



A5.1.2 Preparatory activities

In the final ISP, AEMO may trigger preparatory activities, which include activities to design and to investigate the costs and benefits of actionable ISP projects, future ISP projects and REZ stages (as applicable)[8] in addition to the cost-benefit analysis of the ISP. Preparatory activities may include:

(a) detailed engineering design

(b) route selection and easement assessment work

(c) cost estimation based on engineering design and route selection

(d) preliminary assessment of environmental and planning approvals, and

(e) council and stakeholder engagement, including local environmental groups as well as traditional owners of nearby land and waters that may be affected are required to better inform future ISPs[9].

AEMO will not declare preparatory activities in the Draft ISP. AEMO may consult with responsible TNSPs with the intention of requiring in the final ISP that TNSPs carry out preparatory activities, including publishing a report on the outcome of these activities by the time(s) specified in the final ISP.

[8] These terms are defined in NER 5.10.2 and Chapter 10. At https://www.aemc.gov.au/regulation/energy-rules/national-electricity-rules.

[9] Defined in NER 5.10.2 and expanded upon in the AER's final determination on Enhancing Community Engagement in Transmission Building, at https://www.aemc.gov.au/sites/default/files/2023-11/final_determination_-_enhancing_community_engagement_in_transmission_building.pdf.

A5.1.3 Transmission costs

Since the previous ISP, AEMO has updated its Transmission Cost Database, to ensure that transmission project costs reflect the recent supply change issues and the impact of inflation (both economic wide as well transmission asset specific). Consequently, AEMO has modelled transmission costs more accurately than ever before.

These updates improve the alignment of the Transmission Cost Database with TNSPs' best practice in conceptual cost estimates for transmission infrastructure and improve the accuracy of the tool through review of the project attribute and risk factors. Significant TNSP engagement was necessary to update the Transmission Cost Database, as many transmission projects have progressed through the RIT-T process since the original development of the database.

An important result of this update is that project cost estimates produced using the updated Transmission Cost Database are, dependent on scope, approximately 30% higher (in real terms). These real cost increases reflect cost pressures that are specific to the transmission industry and represent an increase beyond economy-wide inflation. The nominal increase in project costs reflected in the updated Transmission Cost Database would additionally include cumulative inflation from December 2020 to June 2022; this was 7.6%[10] (rounded).

AEMO has prepared a new transmission cost forecasting approach for the 2024 ISP in response to these unprecedented cost increases observed across the sector in recent years. In previous ISPs, AEMO assumed that transmission network augmentation costs would increase in line with economy-wide inflation. Now, AEMO will apply additional escalation factors for individual cost components based on specialist advice and following stakeholder consultation. This incorporates forecasts such as commodity prices (oil, aluminium, copper and steel) and land cost.

AEMO expects that transmission project costs will continue to increase beyond economic inflation while the sector adapts to markets pressures driven by the global race to net zero. For more information, refer to the 2023 *Transmission Expansion Options Report*.

The updated Transmission Cost Database is available for download from AEMO's website[11].

A5.1.4 Undergrounding transmission lines

Overhead lines are often an economic, flexible, and responsive design choice for augmenting the high-voltage transmission network. Overhead lines represent the vast majority of the Australian transmission network, and have reliably served the community for many years.

In the 2023 *Transmission Expansion Options Report*[12], AEMO found that the costs of underground cables are approximately four to 20 times higher than overhead lines – depending on a range of design factors such as voltage, capacity and whether the cables can be direct buried or require tunnels. AEMO publishes a Transmission

[10] Reserve Bank of Australia. *Statement on Monetary Policy – August 2021.* At https://www.rba.gov.au/publications/smp/2021/aug/inflation.html.

[11] Registration for the Transmission Cost Database tool is available at https://forms.office.com/r/YbmiGc24TP.

[12] At https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-transmission-expansion-options-report.pdf?la=en.

Cost Database[13] that allows stakeholders to explore cost estimates for overhead transmission lines and underground cables.

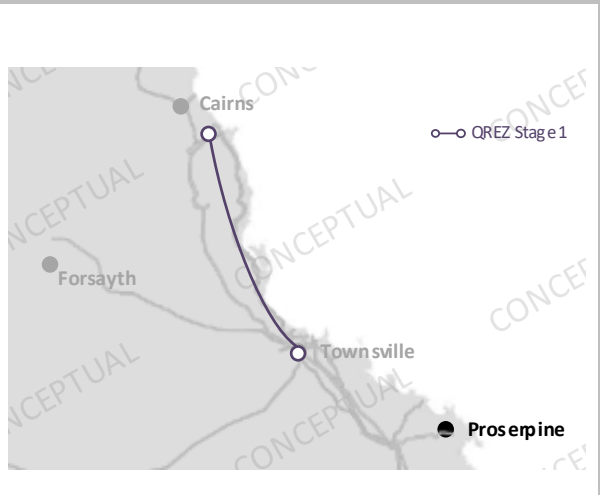
In contrast to transmission projects in countries that have high population and energy density, Australian transmission projects tend to stretch very long distances. Implementing underground transmission network over these long distances will often be cost-prohibitive, and should only be considered on a case-by-case basis. Opportunities for undergrounding network may be feasible for generator connection assets, where distances are shorter, and the investment cost is largely dictated by the capital cost of generation (for example, wind or solar farms).

[13] Registration for the Transmission Cost Database tool is available at https://forms.office.com/r/YbmiGc24TP.

A5.2 Committed and anticipated projects

AEMO includes all committed and anticipated transmission projects in all scenarios. The projects are modelled as being completed at the time advised by the proponent and this does not vary across scenarios. The 2023 *ISP Methodology* states that AEMO includes all committed and anticipated generation and transmission projects in all future states of the world, in accordance with the AER's *CBA Guidelines*[14]. This means these projects are assumed to proceed and are not considered in the ISP cost benefit analysis. Currently, AEMO has modelled two committed transmission projects and three anticipated projects[15]. The details of these projects are discussed below.

A5.2.1 Far North Queensland REZ

Summary	
In August 2020, the Queensland Government committed $145 million to establish three REZs in Queensland. It was further announced in May 2021 that the northern zone (which includes the Far North Queensland region) would be directed $40 million of this committed funding in transmission infrastructure to establish the Far North Queensland REZ[16]. The scope of the network upgrades is to establish a third 275 kV connection into the Woree Substation, with all associated works to be completed by April 2024[17]. Works associated fall outside the bounds of the RIT-T due to the external nature of the funding provided which will facilitate non-regulated opportunities and developments in Far North Queensland.	
Existing network capability	
While there is thermal capacity for additional generation within this zone, without the coastal 275 kV circuit upgrade, future VRE generators need additional investment. The upgrade also improves reliability to the Cairns area and provides greater resilience to Far North Queensland.	

[14] At https://www.aer.gov.au/system/files/AER%20-%20Cost%20benefit%20analysis%20guidelines%20-%2025%20August%202020.pdf.

[15] Status of the projects is informed by the August 2023 Transmission Augmentation Information page, at https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/transmission-augmentation-information.

[16] See https://www.powerlink.com.au/sites/default/files/2021-09/Powerlink%20Queensland%20-%20Developing%20the%20Northern%20QREZ%20-%20Final%20Report.pdf.

[17] See section 9.3 of Powerlink's Transmission Annual Planning Report. Available at: https://www.powerlink.com.au/sites/default/files/2023-11/2023%20Transmission%20Annual%20Planning%20Report%20-%20Whole%20Document.pdf.

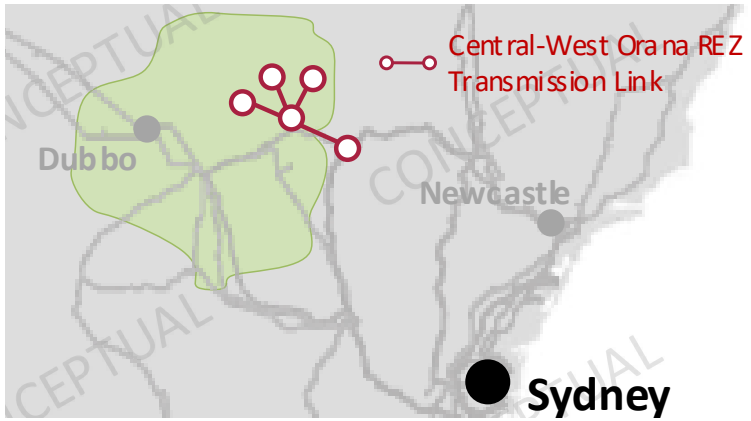
ISP candidate options						
Description	**Status**	**Additional network capacity (MW)**	**Expected cost ($ million)**	***Progressive Change***	***Step Change***	***Green Energy Exports***
• Conversion of one side of the coastal 132 kV double-circuit transmission line to permanently operate at 275 kV, as the third transmission line between Ross and Woree substations. • Associated line reactor at the Woree Substation end. • Establishment of a 275 kV bus at Woree Substation. • Construction of a 275 kV bay at Ross Substation. • Installation of a 275/132 kV transformer at Tully Substation	Committed	Allow for up to 500 MW of new generation.	Committed project.	November 2023 *		

* The Far North Queensland REZ project is modelled as commissioned by November 2023 as per the 2023 IASR. However, latest information from Powerlink note the new date of commissioning is April 2024. Please refer to the Transmission Augmentation Information page for more information, at https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/transmission-augmentation-information.

A5.2.2 Central-West Orana REZ Transmission Link

Summary

Central-West Orana REZ has been identified by the New South Wales Government as the state's first pilot REZ. The Central-West Orana REZ was declared on 5 November 2021[18] under the *NSW Electricity Infrastructure Investment Act 2020* (NSW) with a minimum of 3,000 MW of additional transmission network capacity within the Central West NSW region of the state. REZ design and community engagement is currently progressing, with an initial 4,500 MW of additional transmission network capacity being planned. The Central-West Orana REZ Access Scheme was declared under the Act on 19 December 2022[19].



Existing network capability

The project to establish the Central-West Orana REZ is considered anticipated. The existing network capability is approximately 900 MW, which will increase by 4,500 MW once Central-West Orana REZ is established.

Hunter Transmission Project 1.0 (CNSW-SNW Option 1) is required to address network constraints between CNSW and SNW to enable the increase in network capacity from 3,000 MW to 4,500 MW for Central-West Orana REZ Transmission Project.

ISP candidate options

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
• New Merotherie 500/330 kV substation with 4 x 500/330/33 kV 1,500 MVA transformers. • New 330 kV Uarbry East, Uarbry West and Elong Elong switching stations. • New 500 kV Wollar switching station.	Anticipated	4,500	Anticipated project	September 2027 *		

[18] See https://www.energyco.nsw.gov.au/cwo-rez#declaration.

[19] See https://www.energyco.nsw.gov.au/central-west-orana-rez-access-scheme-declaration.

• 2 x 500 kV DCST lines from Wollar to Merotherie with Quad Orange conductor. • 1 x 330 kV DCST from Merotherie to Uarbry East with Twin Olive conductor. • 1 x 330 kV DCST from Merotherie to Uarbry West with Twin Olive conductor • 2 x 500 kV DCST operated at 330 kV from Merotherie to Elong Elong with Quad Orange conductor. • 3 x 250 MVAr synchronous condensers at Elong Elong switching station. • 4 x 250 MVAr synchronous condensers at Merotherie substation. • Provision of switch bays for future generator connections (cost estimation is not required) • An additional 330 kV SCST line from Bayswater to Liddell. • An additional 330 kV SCST line from Mt Piper to Wallerawang.				

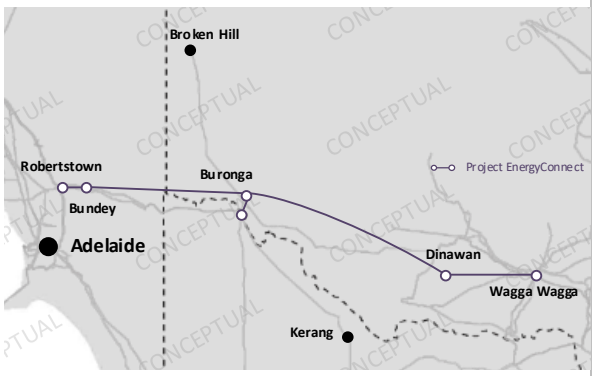
* The Central West Orana REZ Transmission link is modelled as commissioned by September 2027 as per the 2023 IASR. However, latest information from Transgrid and EnergyCo note the new date of commissioning is August 2028. Please refer to the Transmission Augmentation Information page for more information, at https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/transmission-augmentation-information.

A5.2.3 Project EnergyConnect

Summary

Project EnergyConnect is a new 330 kV interconnector between New South Wales and South Australia. The interconnector runs from Robertstown in South Australia to Wagga Wagga in New South Wales, via the northernmost section of the transmission network in Victoria. It traverses between east and west, linking the REZs of Riverland, Murray River, and South West New South Wales, providing additional hosting capacity in these REZs.

ElectraNet and Transgrid gained regulatory approval from the AER in May 2021*. Project EnergyConnect is expected to be completed, including inter-network testing and the release of full capacity, by July 2026‡.



Existing network capability

Presently no interconnection between South Australia and New South Wales.

ISP candidate options

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
Stage 1: • A new Robertstown to Bundey 275 kV double-circuit line. • A new Bundey to Buronga 330 kV double-circuit line strung one circuit initially. • A new 330/275 kV substation and 3x400 MVA 330/275 kV transformers at Bundey. • A new 330/220 kV substation, 1x200 MVA 330/220 kV transformer and 1x200 MVA 330 kV phase shifting transformer at Buronga. • Static and dynamic reactive plant at Bundey and Buronga. • An inter-trip protection scheme to trip the PEC interconnector if South Australia becomes separated from Victoria via the Heywood Interconnector. **Stage 2:** • Second 330 kV circuit strung on the Bundey–Buronga 330 kV double-circuit line.	Committed	**Stage 1:** 150 MW In both directions. **Stage 2:** 800 MW In both directions of NSW-SA 100 MW In both directions of VIC-SA REZ network limit increase: 800 MW in S2, 800 MW in N5	Committed project	**Stage 1**: July 2024 **Stage 2**: July-2026‡		

• A new Buronga to Red Cliffs 220 kV double-circuit line. • A new 330 kV double-circuit line from Buronga to Dinawan. • A new 500 kV double-circuit line from Dinawan to Wagga Wagga operating at 330 kV†. • A new 330 kV switching station at Dinawan. • Additional 4x200 MVA 330 kV phase shifting transformers at Buronga. • Additional 2x200 MVA 330/220 kV transformers at Buronga. • Turning the existing 275 kV line between Para and Robertstown into Tungkillo. • Static or dynamic reactive plant at Bundey, Robertstown, Buronga and Dinawan. • A special protection scheme to detect and manage the loss of either of the AC interconnectors connecting to South Australia. *Scope of works provided by ElectraNet and Transgrid.*				

* AER. *Transgrid and ElectraNet – Project EnergyConnect contingent project*, at https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/contingent-projects/transgrid-and-electranet-%E2%80%93-project-energyconnect-contingent-project.
† See https://www.minister.industry.gov.au/ministers/taylor/media-releases/government-supporting-delivery-critical-transmission-infrastructure-southwest-nsw.
‡ This service date refers to capacity available following completion of inter-network testing, timing is updated according to the latest advice provided by the relevant TNSPs. The capacity release and timing are conditional on availability of suitable market conditions and good test results. The ISP modelling, using information available at the time, modelled the service date as July 2026 with full capacity release.

A5.2.4 Western Renewables Link

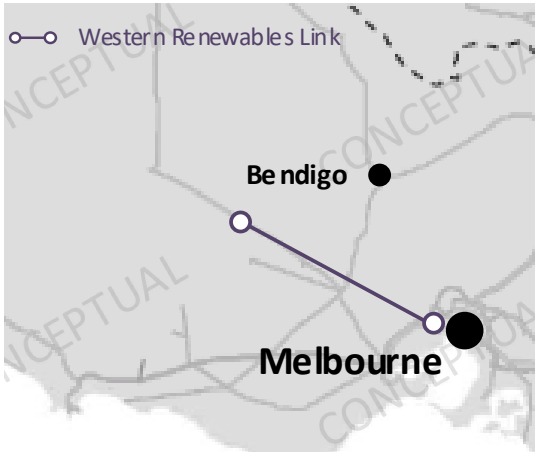
Summary

The Western Renewables Link (WRL, formerly named "Western Victoria Transmission Network Project") is a planned 500 kV double circuit overhead electricity transmission line from Bulgana in western Victoria to Sydenham in Melbourne's north-west. The augmentation will alleviate constraints identified on the 220 kV network in Western Victoria. Addressing these network constraints from existing and committed large-scale renewable generation within the area, additional REZ capacity & future VRE development will be unlocked.

A RIT-T was completed in July 2019†. Minor transmission line augmentations, including wind monitoring and upgrading station limiting transmission plant, on the Red Cliffs to Wemen to Kerang to Bendigo, and Moorabool to Terang to Ballarat, 220 kV transmission lines, were completed in 2021 through AusNet Services' Network Capability Incentive Project Action Plan (NCIPAP).

In May 2023, WRL's scope & timing was augmented as part of the VNI West PACR^. Updated scope includes relocation of the North Ballarat terminal station to Bulgana and upgrade of the transmission line from north of Ballarat to Bulgana from 220 kV to 500 kV.

This project is classified as an anticipated project and is expected to be completed in mid-2027.



Existing network capability

The existing network capability does not allow full dispatch of existing and committed renewable generation in Western Victoria and Murray REZ at times of high generation output.

ISP candidate options

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
• A new 500 kV double-circuit transmission line from Sydenham to Bulgana with switched shunt line reactors at the end of each circuit (approximately 70 MVAr). • A new 500 kV switchyard with two new 1,000 MVA 500/220 kV transformers at the existing Bulgana terminal station. • Extension and augmentation of the 500 kV Sydenham Terminal Station. • Additional 100 MVAr 500 kV switched bus reactor at Sydenham Terminal Station. • Cut-in of the existing Ballarat to Moorabool No.2 220 kV transmission line at Elaine Terminal Station.	Anticipated	V3: 1460	Anticipated project.	July 2027*		

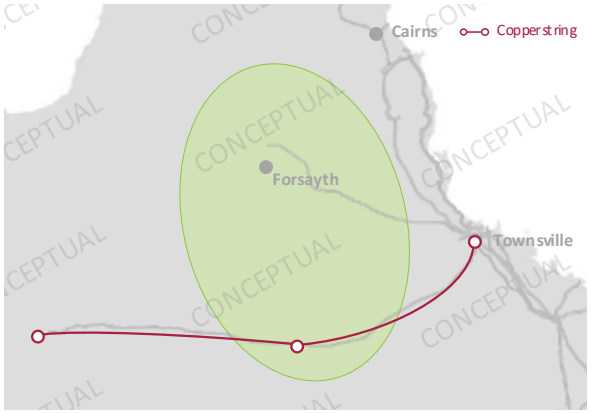
† AEMO. Western Victoria Renewable Integration, at https://www.aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/victorian_transmission/2019/pacr/western-victoria-rit-t-pacr.pdf.
* This service date refers to full capacity available following completion of all testing.
^AEMO. VNI West PACR Volume 1. At https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/victorian_transmission/vni-west-rit-t/reports-and-updates/vni-west-pacr-volume-1.pdf?la=en.

A5.2.5 CopperString 2032 (QEJP Stage 4)

Summary

The Queensland Government has announced that it will deliver the roughly 840 km CopperString 2032 project. CopperString 2032 will connect the North-West Minerals Province of Queensland to the National Electricity Market near Townsville[20]. The project scope includes 500 kV transmission capacity between Townsville and Hughenden to unlock the renewable energy potential of the region.

AEMO is now considering the CopperString 2032 project as an Anticipated Project after outcomes from joint planning with Powerlink and the Queensland Government. CopperString 2032 incorporates the 500kV section of the Queensland Energy and Jobs Plan (QEJP) SuperGrid Stage 4.



Existing network capability

The project to establish CopperString 2032 is considered anticipated. As such the existing network capability is assumed to be approximately 2,200 MW, incorporating the CopperString 2032 project (1,500 MW) as well as existing network capability (700 MW) for peak demand, summer typical and winter reference conditions. For the 2024 ISP, only the 500 kV section of CopperString 2032 is modelled.

The existing network at the North-West Mineral Province is islanded from the NEM. The NEM only extends as far west as Julia Creek and is mainly energised at 66 kV in that area. The existing network for this REZ was designed to support North-West Queensland load, rather than building for future generation projects. The REZ can potentially support much more generation with more transmission infrastructure.

ISP candidate options

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
• Establish a new 500 kV substation south of Townsville (near Townsville) • Install 2x500/275 kV, 1500 MVA transformers at near Townsville 500 kV substation • Establish a new 275 kV substation near Townsville • Cut-in the Strathmore to Ross 275kV DCST and SCST lines to the 275kV substation near Townsville. • Establish a new 500 kV substation at Hughenden with associated switchgear and bays. As well as required 500/330kV transformers.	Anticipated	This option accommodates at least 1,500 MW of new generation in Q2.	Anticipated project.	June 2029*		

[20] See section 2.3.1 of Powerlink's Transmission Annual Planning Report. Available at: https://www.powerlink.com.au/sites/default/files/2023-10/TAPR%202023%20Full%20Report_0.pdf

• Establish a new 500kV substation (mid-point between NQ 500 kV and Hughenden substations) with associated switchgear and bays. • A new 500 kV transmission line from near Townsville to mid-point to Hughenden • A new 330 kV transmission line from Hughenden to Cloncurry • A new 220 kV transmission line from Cloncurry to Mount Isa • Up to six new substation sites with required switchgear and relevant transformers.				

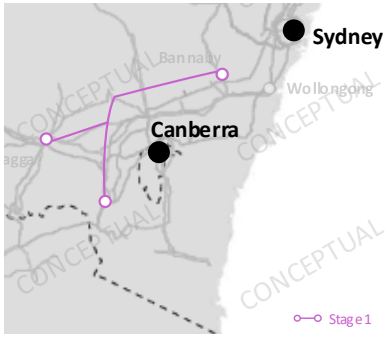
* This service date refers to earliest practical full capacity available following completion of all testing.

A5.3 Actionable ISP projects

Seven actionable projects are identified:

- Three actionable ISP projects – where the relevant TNSP is currently assessing or has already assessed the project under the RIT-T framework by considering the ISP candidate option as one of the RIT-T credible options..
- Two actionable New South Wales projects – where augmentations will be assessed under the *Electricity Infrastructure Investment Act 2020 (NSW)* rather than through the RIT-T.
- Two actionable Queensland projects where augmentations may progress under the Queensland *Energy (Renewable Transformation and Jobs) 2023 Bill (QLD)* rather than the RIT-T framework.

A5.3.1 HumeLink

Summary	
HumeLink is a proposed 500 kV line to reinforce the southern New South Wales network for connecting the Snowy Mountains Hydroelectric Scheme and Project EnergyConnect to Bannaby. This will provide access to increased generation and storage from Snowy Hydroeletric and renewable generation in Southern and Southwest New South Wales. HumeLink was identified as an actionable ISP project in the 2020 and 2022 ISPs, and is confirmed to be an actionable ISP project in this ISP. Transgrid has completed the RIT-T process for this project and early works funding has been approved by the AER. HumeLink is a pre-requisite for the actionable VNI West project. Delivery of HumeLink beyond its optimal timing will impact the timing of VNI West.	
Existing network capability	
The maximum transfer capability from SNSW to CNSW is 2,700 MW at peak demand and summer typical and 2,950 MW at winter reference periods. The maximum transfer capability is limited by thermal capacity of Yass–Marulan or Crookwell–Bannaby 330 kV lines following a credible contingency and, voltage and transient stability limits. The Warratah Super Battery project (including battery, SIPS, minor network augmentations, paired generation) is expected to increase the transfer capability by 250 MW from SNSW to CNSW. The maximum transfer capability from CNSW to SNSW is 2,320 MW at peak demand and summer typical and 2,590 MW at winter reference periods. The maximum transfer capability is limited by thermal capacity of Yass–Canberra or Marulan–Yass[21] or Gullen Range–Bannaby 330 kV lines following a credible contingency.	

[21] Uprating of Marulan – Yass and Marulan – Collector – Yass 330 kV transmission lines were included in limit assessment.

Identified need

The identified need for HumeLink has not changed since the 2020 ISP or the 2022 ISP:

- increase the transfer capacity and stability limits between the Snowy Mountains and major load centres of Sydney, Newcastle and Wollongong
- enable greater access to lower cost generation to meet demand in these major load centres, and
- facilitate the development of renewable generation in high quality resource areas in southern New South Wales, which will further lower the overall investment and dispatch costs in meeting New South Wales demand while ensuring emissions targets are met at the lowest overall cost to consumers.

Progress and next steps

- Transgrid has completed the Project Assessment Conclusions Report for HumeLink, which was published with an addendum in December 2021.
- AEMO will evaluate the entire project through another feedback loop assessment as part of the Actionable ISP process.
- Transgrid estimates completion of early works by 2024, with implementation by December 2026. This timeline is ahead of optimal delivery (2029-30 in *Step Change* and *Green Energy Exports*, 2030-31 in *Progressive Change*).

ISP candidate option(s)

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	Timing
• New Gugaa 500/330 kV substation and 330 kV double-circuit connection to the existing Wagga Wagga 330 kV substation. • Three 500 kV transmission circuits between: – Maragle and Bannaby 500 kV substations. – Maragle and Gugaa 500 kV substations. – Gugaa and Bannaby 500 kV substations. These circuits will be built on double circuit transmission structures. • Three 500/330 kV 1,500 MVA transformers at Maragle substation. • Two 500/330 kV 1,500 MVA transformers at new Gugaa substation. • 500 kV Line shunt reactors at the ends of Maragle – Bannaby, Maragle – Gugaa and Gugaa – Bannaby 500 kV lines. • Augmenting the substations at Maragle, Wagga Wagga and Bannaby to accommodate the additional transmission lines and transformers.	Actionable ISP Project	2,200 MW in both directions. Access to Snowy 2.0 generation and storage of 2,200 MW. REZ network limit increase: 1,500 MW in N6, 2,200 MW in N6+N7, 800 MW in N5.	4,892 (June 2023 dollars) Class 3 (-5% to +12%)	**Implementation**: **Timing advised by proponent:** Northern Circuit (Gugaa to Bannaby): July 2026 Southern Circuit (Gugaa to Maragle to Bannaby): December 2026 **ISP optimal timing:** *Progressive Change*: July 2030 *Step Change*: July 2029 *Green Energy Export*: July 2029

A5.3.2 Sydney Ring (Reinforcing Sydney, Newcastle, and Wollongong Supply)

Summary

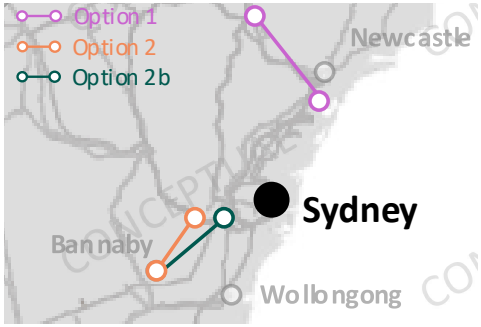
The transmission network in the Sydney, Newcastle, and Wollongong (SNW) area was originally designed to connect large coal-fired generators in the Hunter Valley to supply the SNW load centres. When these coal-fired generators retire, the network has insufficient capability to supply SNW load centres from generators located outside of the Hunter Valley. The Sydney Ring Project increases transfer capacity into the SNW load centres.

The northern part of this project is named the Hunter Transmission Project (Option 1) and may include the Waratah Super Battery and related upgrades. This option increases the transfer capacity by up to 5,000 MW, and allows additional power to be exported from Central-West Orana REZ and the Hunter Coast REZ to SNW load centres. The Hunter Transmission Project is classified as a *priority transmission infrastructure project* under the NSW Government Electricity Infrastructure Investment Act 2020[22]. This project was identified as an actionable project in the 2022 ISP, now it is proceeding as an actionable NSW project rather than through the ISP framework. It is scheduled to be completed by 2027-28.

The Waratah Super Battery (WSB) project is a priority transmission project in NSW[23]. WSB with a System Integrity Protection Scheme (SIPS) is proposed to increase transfer capacity from Central NSW (CNSW) to SNW. This project also includes minor network augmentation to increase thermal capacity of Bannaby–Sydney West, Yass–Marulan and Yass–Collector–Marulan 330 kV lines. Network transfer capacity increase resulting from WSB with SIPS and minor network augmentation are included in ISP modelling.

For the Draft 2024 ISP, Transgrid provided an updated scope of works for Sydney Ring Southern 500 kV loop (Option 2b). Timing for an augmentation to increase network capacity in Sydney Ring south depends on load distribution within SNW and power transfer from Southern NSW to CNSW, Northern NSW to CNSW and CNSW to SNW and, other benefits. Direction and amount of power transfer on 500 kV lines between Bannaby and Mt Piper would highly influence timing of Sydney Ring Southern augmentation.

AEMO recommends that a combination of solutions be considered to address the identified need with detailed market modelling studies – including a northern network option, a southern network option, and other network upgrades as part of the work associated with this Actionable Project.



Existing network capability

The existing transfer capability varies depending on load and generation distribution within SNW area, as well as the generation within CNSW and power transfer from northern and southern NSW subregions to SNW. The existing transfer capability from the north and the south are separately identified to better define these limitations. CNSW-SNW South flow path is assumed as sum of flows on Bannaby – Sydney West, Marulan – Dapto, Marulan – Avon and Kangaroo Valley – Dapto 330 kV lines. CNSW-SNW North flow path is assumed as CNSW-SNW flow paths less CNSW-SNW South flow paths.

[22] For further details on the Australian government's Rewiring the Nation program, see: https://www.dcceew.gov.au/energy/renewable/rewiring-the-nation.

[23] New South Wales Government, October 2022, "Government Gazette". At https://gazette.legislation.nsw.gov.au/so/download.w3p?id=Gazette_2022_2022-473.pdf.

The maximum transfer capability of the northern side of CNSW-SNW flow path is 4,490 MW at peak demand and summer typical periods, and 4,730 at winter reference periods. The maximum transfer capability from the southern side of CNSW-SNW flow path is 2,540 MW at peak demand and summer typical, and 2,720 at winter reference periods.

The WSB project (including battery, system integrity protection scheme (SIPS) minor network augmentations, paired generation) is expected to increase the transfer capability by 660 MW and 250 MW for CNSW-SNW North and CNSW-NSW South flow paths respectively.

The maximum northern transfer capability is limited by several 330 kV lines and the most limiting elements are Liddell-Newcastle and Liddell-Tomago 330 kV lines. The maximum southern transfer capability is limited by several 330 kV lines and the most limiting element is Bannaby-Sydney West 330 kV line.

Identified need

The identified need for Sydney Ring project has not changed since the 2022 ISP. The identified need for the Sydney Ring project is: to deliver net market benefits for consumers by increasing the power system's capability to supply the Sydney, Newcastle and Wollongong load centres, replacing supply capacity that will be removed on the closure of coal-fired power stations in the Newcastle area.

Progress and next steps

The Hunter Transmission Project will progress as an actionable NSW project and will proceed through the *Electricity Infrastructure Investment Act 2020 (NSW)* rather than the ISP framework. To inform the design process, AEMO recommends that a combination of solutions be considered with detailed market modelling studies:

- A northern network option – 500 kV link between the Eraring and Bayswater substations, also known as the Hunter Transmission Project.
- A southern network option – 500 kV link between Bannaby and a new substation in the locality of South Creek
- Virtual transmission – a System Integrity Protection Scheme (SIPS) as part of a staged delivery (for example, the Waratah Super Battery).
- Other minor network upgrades – including, but not limited to, the uprating of relevant existing 330 kV lines (such as Bannaby – Sydney West 330 kV line).

ISP candidate options

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	Timing
Option 1: Sydney Ring Northern 500 kV loop: † • New switching stations near the existing Bayswater and Eraring substations. • A new 500 kV double-circuit line between near Eraring substation and near Bayswater substation. • Two 500/330 kV 1,500 MVA transformers at near Eraring substation. • Line reactors on 500 kV transmission lines between near Eraring and near Bayswater[24].	Actionable NSW Project‡	5,000 (This capacity increase for accommodation of additional new generation from North of Bayswater and 2/3 generation from Central West NSW)	926 (±50%)	**Implementation:** Timing advised by proponent: December 2027 **ISP optimal timing**: *Progressive Change*: July 2028 *Step Change*: July 2028

[24] The need for line reactors is a subject of ongoing joint planning with EnergyCo and Transgrid.

Note: when Central West Orana REZ exceeds 3 GW this option should be considered to transfer this additional generation to SNW.				*Green Energy Export*: July 2027
Option 2: Sydney Ring Southern 500 kV loop:* • Establish a new substation in the locality of South Creek with 2 x 500/330/33 kV, 1,500 MVA transformers. • Connect the new substation in the locality of South Creek into Eraring – Kemps Creek 500 kV lines and Bayswater – Sydney West and Regentville – Sydney West 330 kV lines. • A new 500 kV double-circuit lines from Bannaby to the new substation in the locality of South Creek. • Rebuild the section of existing Bannaby – Sydney West 330 kV line from locality of South Creek to Sydney West to double-circuit line. • Augment the existing Bannaby and Sydney West substations. • Line reactors on 500 kV transmission lines between Bannaby and locality of South Creek. Refer to the 2023 *Transmission Expansion Options Report* for additional alternative options.	Alternative option	4,500 (This capacity increase is for accommodation of additional new generation from south of Bannaby and 1/3 generation from Central-West NSW.)	1,550 (-30% to +40%)	Alternative option
Option 2b: Sydney Southern 220 kV* • Rebuild line 39 from Bannaby to Sydney West as double-circuit line. • Augment the existing Bannaby and Sydney West substations.	Alternative option	1,200 (This capacity increase is for accommodation of additional new generation from south of Bannaby)	553 Class 5b (±50%)	Alternative option

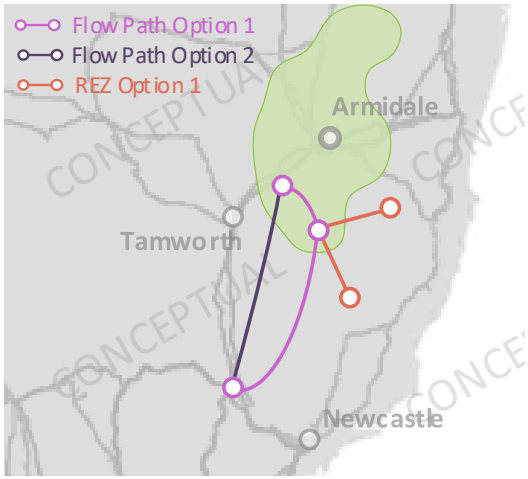
† The northern part of the project is named the Hunter Transmission Project and may include the Waratah Super Battery and related upgrades.
‡ Sydney Ring project is an actionable NSW project rather than an actionable ISP project. This project will progress under the Electricity Infrastructure Investment Act 2020 (NSW) rather than the ISP framework.
* New South Wales Government. *Waratah Super Battery*, at https://www.energyco.nsw.gov.au/projects/waratah-super-battery The southern Sydney Ring network option may subsequently proceed through the New South Wales, ISP or RIT-T framework.

A5.3.3 New England REZ Transmission Link

Summary

The NSW *Electricity Infrastructure Investment Act 2020* requires that the New England REZ be declared with an intended 8,000 MW of additional transmission network capacity[25]. The New England REZ Transmission Link is a proposed 500 kV line between central and northern NSW to access increased renewable generation in northern NSW as well as a 330kV REZ extension.

In the 2022 ISP, major augmentation of CNSW-NNSW flow path was identified as an actionable New South Wales project (New England REZ Transmission Link) rather than an actionable ISP project. This project will progress under the *Electricity Infrastructure Investment Act 2020* (NSW). It is scheduled to be completed by 2028-29.



Existing network capability

The QNI Minor project, which increases the transfer capacity of the existing QNI, has been commissioned and considered in service from June 2023.

CNSW to NNSW maximum transfer capability is 910 MW at peak demand, summer typical and winter reference periods. The maximum transfer capability is limited by voltage stability for loss of Kogan Creek generator.

NNSW to CNSW maximum transfer capability is 930 MW at peak demand and summer typical periods and 1,025 MW at winter reference period. The maximum transfer capability is limited by thermal capacity of Armidale–Tamworth 330 kV lines following a credible contingency†.

Identified need

The identified need for this project is to increase the capability of the transmission network to enable the connection of expected generation in the New England REZ by:

- increasing the transfer capacity between expected generation in the New England REZ and the existing transmission network in the Hunter region, and
- ensuring sufficient resilience to avoid material reductions in transfer capacity during an outage of a transmission element

or as otherwise consistent with the New South Wales Government's Electricity Infrastructure Roadmap.

Progress and next steps

On 17 December 2021, the New England REZ was formally declared to progress under the NSW Electricity Infrastructure Roadmap rather than through the ISP framework. This declaration identifies that EnergyCo NSW will be the infrastructure planner responsible for coordinating the development of the REZ. More information about the delivery of the New England REZ is available on the New South Wales Government website.

[25] See https://legislation.nsw.gov.au/view/html/inforce/current/act-2020-044#sec.23.

ISP candidate options				
Description	**Status**	**Additional network capacity (MW)**	**Expected cost ($ million)**	**Timing**
Flow path (CNSW-NNSW Option 1): • New Central South (Hub 1) 500/330 kV substation in New England with 3 x 500/330/33 kV 1,500 MVA transformers. New 330 kV Central (Hub5) switching station in New England and cut into the existing lines between Tamworth and Armidale. • New 500 kV built and initially 330 kV operated double-circuit line from Hub 5 to Hub 1. • New 500 kV double-circuit line between Hub 1 and Bayswater with Quad Orange conductor. • 4 x 500 kV 150 MVAr line shunt reactors (in total) are required for 500 kV double-circuit line between Hub 1 and Bayswater. • New 6 x 330 kV 200 MVA power flow control at Hub 5.	Actionable NSW Project‡	3,000 (both directions of CNSW to NNSW) REZ N2: 2,000 *This transfer capacity may be investigated further for the Final 2024 ISP.*	1,834 (±50%)	**Implementation:** Timing advised by proponent: September 2028 **ISP optimal timing**: *Progressive Change*: July 2031 *Step Change*: July 2028 *Green Energy Export*: July 2028
REZ (N2 Option 1): • New 330 kV South (Hub3) and East (Hub 4) switching stations. • New 330 kV double-circuit line between Hub 1 and Hub 3. • New 330 kV double-circuit line between Hub 1 and Hub 4.	Actionable NSW Project‡	REZ N2: 1,000	370 Class 5b (±50%)	**ISP optimal timing**: *Progressive Change*: July 2031 *Step Change*: July 2030 *Green Energy Export*: July 2030
Flow path (CNSW-NNSW Option 2): • Expand Hub 5 switching station to 500/330 kV substation with 3 x 500/330/33 kV 1,500 MVA transformers. • Operate line between Hub 5 and Hub 1 from 330 kV to 500 kV. • New 500 kV double-circuit from Hub 5 to Bayswater with Quad Orange conductor. • 4 x 500 kV 150 MVAr line shunt reactors (in total) are required for 500 kV double-circuit line between Hub 5 and Bayswater. *Prerequisite: CNSW-NNSW Option 1*	Actionable NSW Project‡	3,000 (both directions of CNSW to NNSW) (assuming downstream limitations addressed by Hunter Transmission Project/CNSW-SNW Option 1). REZ N2: 3,000	1,493 Class 5b (± 50%)	**ISP optimal timing**: *Progressive Change*: July 2042 *Step Change*: July 2034 *Green Energy Export*: July 2032

† Transgrid published a Project Assessment Draft Report (PADR) for managing risk on Tamworth – Armidale 330 kV line (Line 86) on 30 May 2022. Options include transfer capability improvement between Tamworth and Armidale. AEMO will consult with Transgrid on these options and their impact on transfer capability. Available at https://www.transgrid.com.au/projects-innovation/managing-risk-on-line-86-tamworth-armidale.
‡ New England REZ Transmission Link project is an actionable New South Wales project rather than an actionable ISP project. This project will progress under the *Electricity Infrastructure Investment Act 2020* (NSW) rather than the ISP framework.

A5.3.4 Gladstone Grid Reinforcement

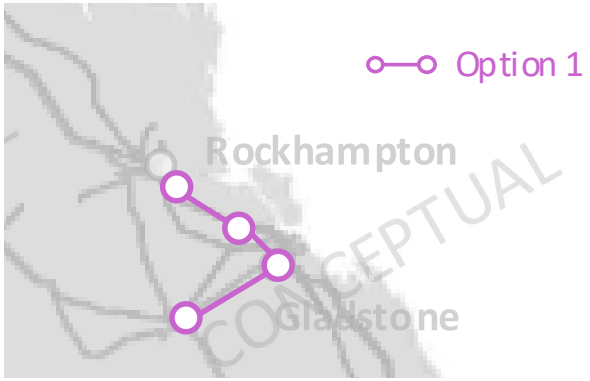
Summary

Following the retirement or reduced generation from Gladstone Power Station and increased generation in North Queensland, transmission network which supplies the Gladstone area will be constrained. As a result, forecast demand at Boyne Island, Calliope River, Larcom Creek and Raglan substations cannot be supplied. If major industrial loads are electrified, or if large Hydrogen projects progress, there is a potential for a material shift in the supply-demand balance in the Gladstone area.

The Gladstone Grid Reinforcement project greatly increases transfer from Central Queensland into the Gladstone area. The Gladstone Grid section is a bottle neck between generation in Central and Northern Queensland and the load centres in South Queensland. This project also facilitates much more transfer capacity from Central and Northern Queensland to Southern Queensland.

For the 2022 ISP, Powerlink provided preparatory activities report for reinforcements of CQ and GG section as it was identified as a Future ISP project. For the 2023 Transmission Expansion Options Report, Powerlink provided an updated scope and cost associated with the project.

The Gladstone Grid Reinforcement project is an actionable Queensland project in the Draft 2024 ISP. If the bill is passed, this project is expected to progress under the Energy (Renewable Transformation and Jobs) Bill 2023 rather than the ISP framework.



Existing network capability

The maximum power transfer capability is influenced by the amount of generation dispatch within northern and central Queensland, particularly at Gladstone. This limit is influenced by the thermal capacity of the Calvale–Wurdong, Bouldercombe–Calliope River, Bouldercombe–Raglan, Larcom Creek–Calliope River or Calliope River–Wurdong 275 kV circuits.

- With typical generation output from Stanwell and Callide, CNQ to GG maximum transfer capability is 700 MW at peak demand and summer typical levels, and 1,050 MW at winter reference condition.
- In the reverse direction, GG to CNQ maximum transfer capability is 750 MW at peak demand and summer typical levels and approximately 1,100 MW at winter reference periods.

Identified need

The identified need for Gladstone Grid Reinforcement is to increase power transfer capability of the transmission network to:

- support the growing major industrial load in the Gladstone region once the Gladstone power station retires,
- facilitate more power transfer between Central and Northern Queensland and Southern Queensland, and
- enable Queensland SuperGrid South,

or as otherwise consistent with the Queensland Government's objectives of Queensland Energy and Jobs Plan.

Progress and next steps

The Queensland Government is progressing the *Energy (Renewable Transformation and Jobs) Bill 2023* (the Bill). If the Bill passes, the Gladstone Grid Reinforcement may proceed through the priority transmission investment framework under the Bill rather than the ISP framework.

Powerlink may then make a submission to the Queensland Government to prescribe how the Gladstone Grid Reinforcement may become an *eligible priority transmission investment* under the Bill. The submission is to include:

- when construction of Gladstone Grid Reinforcement must commence, and
- the identified need Powerlink proposes that the Gladstone Grid Reinforcement will address while maximising net economic benefits.

The Queensland Government may then declare Gladstone Grid Reinforcement a *priority transmission investment* and direct Powerlink to construct it. AEMO will continue extensive joint planning with Powerlink to facilitate this process.

ISP candidate option

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	Timing
Option 1: • New 275 kV high-capacity double-circuit line between Calvale and Calliope River. • Rebuild Calliope River to Larcom Creek 275 kV high-capacity double-circuit line. • Rebuild Larcom Creek to Bouldercombe 275 kV high-capacity double-circuit line. • A new (third) 275/132 kV transformer at Calliope River.	Actionable QLD Project‡	CQ to GG: 2,600 MW GG to CQ: 500 MW	1,300 Class 5b (±50%)	**Implementation**: Timing advised by proponent: September 2029 (Earliest practical date) **ISP optimal timing**: *Progressive Change*: July 2030 *Step Change*: July 2030 *Green Energy Export*: July 2030

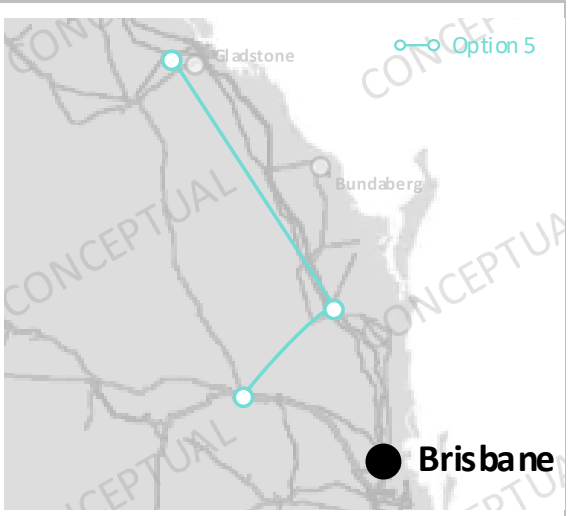
‡ Gladstone Grid Reinforcement is likely to be an actionable Queensland project rather than an actionable ISP project. This project may progress under the proposed framework to be established by the *Energy (Renewable Transformation and Jobs) Bill 2023* rather than the ISP framework.

A5.3.5 Queensland SuperGrid South (QEJP Stage 2)

Summary

Queensland SuperGrid South project is Stage 2 of the Queensland Energy and Jobs Plan in line with Queensland SuperGrid Infrastructure Blueprint. This project involves new 500 kV transmission lines to connect Borumba pumped hydro energy storage into Central Queensland†. This is likely to be an Actionable Queensland project.

In the 2020 ISP, AEMO required Powerlink to complete preparatory activities to increase transfer capability from CQ to SQ. In 2022 ISP, this project was referred as 'Central to Southern Queensland' as a future ISP project. Since the 2022 ISP, the Queensland Energy and Jobs Plan was unveiled, and a new option for connecting CQ and SQ was proposed for the 2024 ISP called the Queensland SuperGrid South. This option has been selected in the optimal development path. The SuperGrid South also provides the required transmission capacity to allow the Anticipated Borumba pumped hydro project to connect into the NEM (QEJP Stage 1).



Existing network capability

From CQ to SQ maximum transfer capability is approximately 2,100 MW. This capability is applicable in peak demand, summer typical, and winter reference periods.

The maximum power transfer from CQ to SQ grid section is limited by transient or voltage stability following a Calvale to Halys 275 kV circuit contingency.

From SQ to CQ maximum transfer capability is 1,100 MW at peak demand, summer typical levels and at winter reference periods. This assumes Powerlink establishes a new double circuit line from Blackwall to Karana Downs allowing dedicated double circuit connections from Blackwall to Rocklea and Blackwall to South Pine. Following these works the maximum transfer capability from SQ to CQ is limited by thermal capacity of the Palmwoods – South Pine 275 kV line following a credible contingency.

Identified need

The identified need for Queensland SuperGrid South is to increase power transfer capability of the transmission network to:

- support the expected increase in renewable generation in Central and Northern Queensland to support growing demand in Southern Queensland,
- supply the large industrial loads in Central Queensland with renewable energy especially after significant amounts of coal generation in Central Queensland are decommitted or withdrawn, and
- provide the necessary infrastructure required to adequately host the large Borumba pumped hydro project. Without this transmission infrastructure, Borumba output will be significantly constrained, and the project could become unviable,

or as otherwise consistent with the Queensland Government's objectives of Queensland Energy and Jobs Plan.

Progress and next steps

The Queensland Government is progressing the Energy (Renewable Transformation and Jobs) Bill 2023 (the Bill). If the Bill passes, the Queensland SuperGrid South may proceed through the priority transmission investment framework under the Bill rather than the ISP framework.

Powerlink may then make a submission to the Queensland Government to prescribe how the Queensland SuperGrid South may become an *eligible priority transmission investment* under the Energy Bill. The submission should include:

- when construction of Queensland SuperGrid South must commence, and

- the identified need Powerlink proposes that the Queensland SuperGrid South will address while maximising net economic benefits.

The Queensland Government may then declare Queensland SuperGrid South a priority transmission investment and direct Powerlink to construct it. AEMO will continue extensive joint planning with Powerlink to facilitate this process.

ISP candidate option

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	Timing
Option 5: • Establish 500 kV Halys substation (with 3 x 500/275 kV 1,500 MVA transformers). • Establish 500 kV substations west of Gladstone (CQ 500 kV substation) and Woolooga West (each with 2x500/275 kV 1,500 MVA transformers). • Establish CQ 275 kV substation. • Install dynamic reactive support at CQ substation. • Establish a 500 kV double-circuit line between Halys and Woolooga West substations. • Establish a 500 kV double-circuit line between Woolooga West to CQ substations. • Establish a 275 kV double-circuit line from Woolooga West to existing Woolooga Substation. • Cut the Calliope River to Calvale circuits into the CQ 275 kV substation. • Cut the Bouldercombe to Larcom Creek circuits into the CQ 275 kV substation. • Install 2x 275 kV power flow control at existing Woolooga substation on existing 275 kV eastern corridor to South Pine • Special protection scheme for transfer limit increase (similar to Virtual transmission line). Cost of this NSA excluded. *Prerequisite: CQ-GG Option 1 (GGR)*	Actionable QLD Project‡	CQ to SQ: 3,150 MW SQ to CQ: 3,150 MW	3,287 Class 5b (±50%)	**Implementation**: Timing advised by proponent: June 2031 (Earliest practical date) **ISP optimal timing**: *Progressive Change*: July 2030 *Step Change*: July 2030 *Green Energy Export*: July 2030

† https://www.epw.qld.gov.au/__data/assets/pdf_file/0030/32988/queensland-supergrid-infrastructure-blueprint.pdf.
‡ Queensland SuperGrid South is likely to be an actionable Queensland project rather than an actionable ISP project. This project may progress under the proposed framework to be established by the *Energy (Renewable Transformation and Jobs) Bill 2023* rather than the ISP framework.

A5.3.6 Project Marinus

Summary
Project Marinus is a proposed 1,500 MW capacity undersea and underground electricity interconnection between Tasmania and Victoria delivered by Marinus Link Pty Ltd, which will be operating in parallel with the existing Basslink interconnector. It is proposed to be delivered as two 750 MW high voltage direct current (HVDC) developments between Burnie area in Tasmania and Latrobe Valley in Victoria. This project also includes alternating current (AC) transmission network developments within the North West Tasmanian electricity network which will be delivered by TasNetworks. TasNetworks has completed a RIT-T for this network augmentation. The Project Assessment Conclusions Report (PACR), the third report of the RIT-T, was published in June 2021[26]. As it was for the 2022 ISP, the project is confirmed in this ISP as an actionable project for delivery in 2029-30.
Existing network capability
The transfer capacity between Tasmania and Victoria is limited by the thermal capability of Basslink (HVDC system between Tasmania and Victoria). Transfer capacity between Tasmania and Victoria is limited to 462 MW (as measured at the receiving end) in both directions at times of peak demand, summer typical and winter reference periods. Additional network upgrades may also be required for the Central Highlands REZ for new generation connecting in the south of the REZ in order to access the network upgrades associated with Project Marinus. In particular incremental upgrades associated with the Waddamana to Palmerston network sections are expected.
Identified need
The identified need for Project Marinus has not changed since the 2022 ISP: • The characteristics of customer demand, generation and storage resources vary significantly between Tasmania and the rest of the NEM. Increased interconnection capacity between Tasmania the other NEM regions has the potential to realise a net economic benefit by capitalising on this diversity.
Progress and next steps
TasNetworks has completed a RIT-T Project Assessment Conclusions Report to determine the preferred option for Project Marinus, published in June 2021. Marinus Link Pty Ltd has submitted a RIT-T update to the AER in November 2023. AEMO will evaluate the entire project through another feedback loop assessment in accordance with the NER process for actionable ISP projects[27].

[26] TasNetworks. Project Marinus PACR, at https://www.marinuslink.com.au/wp-content/uploads/2021/06/Project-Marinus-RIT-T-PACR.pdf.

[27] NER 5.16A.5(b).

ISP candidate options				
Description	**Status**	**Additional network capacity (MW)**	**Expected cost ($ million)[28]**	**Timing**
Option 1 (Project Marinus Stage 1)† • A 750 MW monopole HVDC link between Burnie area in Tasmania and Hazelwood area in Victoria. • A new 750 MW HVDC monopole converter station in Burnie area. • A new 750 MW HVDC monopole converter station in Hazelwood area. • A new 220 kV switching station at Heybridge adjacent to the converter station. • A new double-circuit 220 kV transmission line between Sheffield, Heybridge and Burnie. • A new 220 kV double-circuit line from Palmerston to Sheffield with decommissioning of existing the single-circuit line. • A new 500 kV connection from converter station in Hazelwood area. • Decommission existing Sheffield – Burnie 220 kV line. *(Scope of works provided by TasNetworks and MarinusLink)*	Actionable ISP Project	Project Marinus: 750 MW in both directions. Basslink and Project Marinus VIC to TAS 962 MW TAS to VIC 1,212 MW	2,890 (HVDC) Class 4 (±30%) 950 (HVAC) Class 4 (+30%,-15%)	**Implementation**: Timing advised by proponent: December 2030[29] (full capacity release) **ISP optimal timing**: *Progressive Change*: July 2029 *Step Change*: July 2029 *Green Energy Export*: July 2029
Option 2 (Project Marinus Stage 2) • An additional 750 MW monopole HVDC link between Burnie area in Tasmania and Hazelwood area in Victoria. • An additional new 750 MW HVDC monopole converter station in Burnie area. • An additional new 750 MW HVDC monopole converter station in Hazelwood area. • A new 220 kV switching station at Staverton. • A new double-circuit 220 kV transmission line from Staverton to Burnie via Hampshire • Cut-in both Sheffield-Mersey Forth double-circuit 220 kV lines at Staverton. • Capacity increase of the four Sheffield–Staverton 220 kV transmission circuits • A new 500 kV connection from converter station in Hazelwood area. *Pre-requisite: TAS-VIC Option 1 (Project Marinus – Stage 1)* *(Scope of works provided by TasNetworks and Marinus Link)*	Actionable ISP Project	Project Marinus: 750 MW in both directions. Basslink and Project Marinus Stage 1 and Stage 2 VIC to TAS 1,712 MW TAS to VIC 1,962 MW	2,210 (HVDC) Class 4 (±30%) 525 (HVAC) Class 4 (+30%,-15%) *Note: This part is estimated to cost an additional $235 million if completed more than 2 years after Stage 1.*	**Implementation:** Timing advised by proponent: December 2032[28] (full capacity release) **ISP optimal timing:** *Progressive Change*: July 2036 *Step Change*: July 2036 *Green Energy Export*: July 2031

[28] Cost estimates for the ISP modelling were updated as advised by Marinus Link Pty Ltd for the HVDC scope and from TasNetworks for the HVAC scope.

[29] Proponents have advised that these dates are still under negotiation but can be used for modelling purposes.

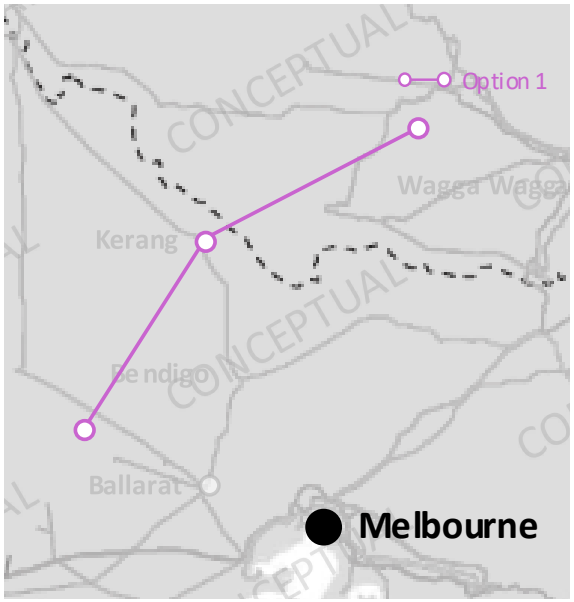
A5.3.7 VNI West

Summary

VNI West is a proposed 500 kV interconnector from Bulgana substation in Victoria to a new substation named Dinawan in southwest New South Wales. The 2022 ISP identified VNI West (via Kerang) as the ISP candidate option in the ODP. Since publication of the 2022 ISP, AEMO Victoria Planning (AVP) and Transgrid jointly released the VNI West Consultation Report – Options Assessment, which proposes Option 5A as the preferred option. This option connects Bulgana and Dinawan via a new terminal station near Kerang. This option includes relocation of the Western Renewable Link (WRL) proposed terminal station from north of Ballarat to Bulgana and the uprate of the proposed WRL transmission line from north of Ballarat to Bulgana from 220 kV to 500 kV[30].

AEMO has based its analysis on Option 5A. This option was presented as the preferred option in AVP's Project Assessment Conclusions Report (PACR) published in May 2023.

VNI West remains as an actionable ISP project as it was in the 2022 ISP.



Existing network capability

Transfer capability of future options have been modelled with committed projects of VNI Minor upgrade and Victoria System Integrity Protection Scheme (SIPS) with battery storage for increased transfer capability from Southern New South Wales to Victoria.

Victoria to SNSW maximum transfer capability is 870 MW at peak demand and 1,000 MW at summer typical and winter reference periods. The maximum transfer capability is limited by voltage stability or transient stability limit.

The maximum transfer capability from SNSW to Victoria is 400 MW at peak demand, summer typical and winter reference periods. This is limited by a voltage stability limit. When available, Victoria's SIPS allows the 330 kV lines between South Morang and Murray to operate at a higher thermal capacity for a short period following a critical contingency.

Identified need

The identified need for the VNI West project has not changed since the previous ISPs. VNI West will increase transfer capacity between New South Wales and Victoria to realise net market benefits by:

- efficiently maintaining supply reliability in Victoria following the closure of further coal-fired generation and the decline in aging generator reliability – including mitigation of the risk of existing plant closing earlier than expected,
- facilitating efficient development and dispatch of generation in areas with high quality renewable resources in Victoria and southern New South Wales through improved network capacity and access to demand centres, and
- enabling more efficient sharing of resources between NEM regions.

[30] See https://www.aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/victorian_transmission/vni-west-rit-t/reports-and-updates/vni-west-pacr-volume-1.pdf?la=en.

Progress and next steps				
VNI West was determined to be an actionable ISP project in the 2020 and 2022 ISP. The RIT-T proponents for this project are Transgrid and AVP. The RIT-T for this project is nearing completion with the preferred option identified in the PACR. The capacity release date identified in the PACR is December 2029. Early works and community engagement and consultation are being undertaken by Transgrid and Transmission Company Victoria (TCV).				
ISP candidate option				
Description	**Status**	**Additional network capacity (MW)**	**Expected cost ($ million)**	**Timing**
Option 1 (VNI West): • A new 500 kV double-circuit overhead line from Bulgana to near Kerang to Dinawan. • Series compensation on both 500 kV lines between Bulgana to near Kerang. • Upgrade Dinawan – Gugaa double-circuit line from 330 kV to 500 kV operation (lines build at 500 kV as part of PEC). • Establish Dinawan 500 kV switchyard with two 500/330 kV 1,500 MVA transformers. • New terminal station near Kerang with two 500/220 kV 1,000 MVA transformers. • 220 kV connections from the new terminal station near Kerang to the existing 220 kV lines near Kerang. • Modular power flow controllers to prevent overloading on 330 kV lines between Upper/Lower Tumut and South Morang and 220 kV lines between Dederang and Thomastown. • 500 kV line shunt reactors at both ends of the three following 500 kV circuits: (i) Bulgana – near Kerang, (ii) near Kerang – Dinawan and (iii) Dinawan – Gugaa. • Two new 500 kV bays and line exits with a total of two 500 kV line shunt reactors at the Bulgana Terminal Station. • Up to +/- 400 MVAr dynamic reactive compensation at the new 220 kV terminal station near Kerang. • Approximately 100 MVAr 500 kV switched bus connected reactor at Sydenham. *Pre-requisite: HumeLink*	Actionable ISP Project	North: 1,935 MW South: 1,669 MW V2: 1,580 MW V3 (WRL timing): 1,460 MW V3 (WRL and VNI timing): 200 MW N5: 900 MW	3,499 * (2020-21 dollars) (Cost is inclusive of $315m WRL project) Class 4 (± 30%)	**Implementation:** Timing advised by proponent: December 2029, or earlier with additional support. **ISP optimal timing:** *Progressive Change*: July 2034 *Step Change*: July 2029 *Green Energy Export*: July 2031

* For ISP modelling, AEMO has applied a cost of $3,614 million for VNI West. This is determined by subtracting the cost of WRL from the quoted project cost in 2020-21 dollars and converting to real 2023 dollars.

A5.4 Future ISP projects

Future ISP projects deliver net market benefits to consumers but are not needed until later in the horizon. The optimal timing for the least cost candidate development path is shown in this section. There are 13 future ISP projects that are developed in all scenarios by 2050. Future ISP projects that are developed in some but not all scenarios are listed in section A5.4.14.

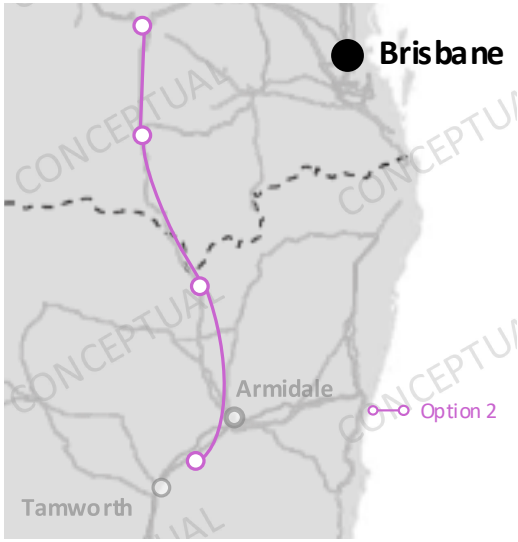
A5.4.1 QNI Connect

Summary

The Northern New South Wales (NNSW) and Southern Queensland (SQ) corridor represents a portion of the network which forms part of the QNI. Development options on this corridor include the northern sections of proposed QNI Augmentations.

A project to increase the transfer capacity of the existing QNI (referred as 'QNI Minor') has been completed. The QNI Minor project which increases the transfer capacity of the existing QNI has been commissioned and inter-network testing considered complete from June 2024.

An additional new interconnection between Queensland and New South Wales (QNI Connect) would increase transfer capacity between Queensland and New South Wales to share renewable energy and firming services between regions. In the 2022 ISP, AEMO required that Powerlink and Transgrid complete preparatory activities for QNI Connect 500 kV and 330kV options.



Existing network capability

Transfer capability with future options are modelled with QNI Minor upgrade in service.

- NNSW to SQ maximum transfer capability is 685 MW at peak demand and 745 MW at summer typical and winter reference periods. The maximum transfer capability is limited by voltage or transient stability for loss of the Kogan Creek generator.
- In the reverse direction, SQ to NNSW maximum transfer capability is 1,205 MW, 1,165 MW and 1,170 MW at peak, summer typical and winter reference periods respectively. The maximum transfer capability is limited by thermal capacity of Armidale – Sapphire and Armidale – Dumaresq 330 kV lines following a credible contingency and dispatch of generation at Sapphire.

ISP candidate options						
Description	**Status**	**Additional network capacity (MW)**	**Expected cost ($ million)**	***Progressive Change***	***Step Change***	***Green Energy Exports***
Option 2: • A new 330 kV double-circuit line from locality of New England Hub 5 to Dumaresq to Bulli Creek to Braemar. • New 330/275 kV transformers at Braemar. • 330 kV Line shunt reactors at New England Hub 5, Dumaresq, Bulli Creek, and Braemar, for the 330 kV lines between New England Hub 5 and Braemar (via Dumaresq and Bulli Creek). (Pre-requisite: Cut-in both Tamworth–Armidale 330 kV lines to a new substation in locality of New England Hub 5). **Earliest feasible delivery date:** 2030-31 *Provided by Powerlink and Transgrid*	Future	North: 1,260 South: 1,700	2,518[31] Class 5 (±50%)	2036-37	2033-34	2030-31

[31] See Preparatory Activities page, at https://aemo.com.au/consultations/current-and-closed-consultations/2023-transmission-expansion-options-report-consultation.

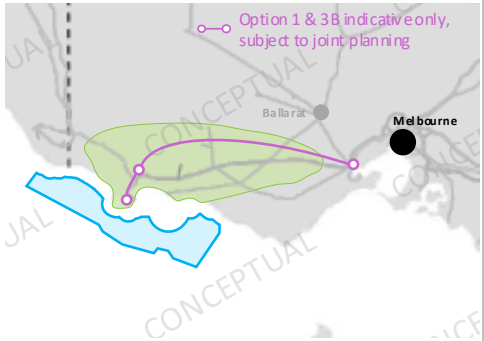
A5.4.2 Western Victoria grid reinforcement

Summary

The South West Victoria REZ has moderate to good quality wind resources in close proximity to the 500 kV and 220 kV networks in the area. The total committed and in-service wind generation in the area exceeds 2 GW. The Victorian Government has outlined its vision for offshore wind and has set targets for 2 GW of offshore wind capacity by 2032, 4 GW by 2035 and 9 GW by 2040.

The Victorian Government has announced that VicGrid will provide a coordinated transmission connection point near Portland[32]. VicGrid is currently undertaking consultation on the development of this infrastructure and AEMO will continue to co-ordinate with VicGrid on this matter. Due to the large amount of onshore and offshore generation flagged for connection in this REZ, and outcomes highlighting potential need for network upgrades in the 2030s, co-ordination of new generation and network expansion may be required.

South West Victoria REZ expansion is required in the early 2030s in the *Green Energy Exports* scenario, and mid-2030s in *Step Change*, to facilitate the connection of generation within this REZ. AEMO Victorian Planning completed preparatory activities in July 2023 for South West Victoria REZ expansion, outlining option combinations to uplift the network capacity to allow for onshore and offshore VRE development.



Existing network capability

The current REZ transmission limits for existing and new VRE before any network upgrade in South West Victoria are limited by voltage stability, and modelled with the SWV1 group constraint. This limit is approximately 1,700 MW for peak demand, summer typical and winter reference conditions, prior to commissioning of the Victorian Government RDP: Mortlake turn in project[33].

ISP candidate options[34]

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
Option 1: • Moorabool – Geelong 220 kV line upratings via terminal station augmentations. **Earliest feasible delivery date:** 2032-33.	Future	Nil.	58 Class 5a (± 30%)	2038-39	2034-35	2033-34
Option 3B: • New Heywood – Bulgana 500 kV double-circuit • New Alcoa Portland – Heywood 500 kV single circuit. **Earliest feasible delivery date:** 2032-33. *Pre-requisite: Option 1*	Future	2,800	1,239 Class 5a (± 30%)	2038-39	2034-35	2033-34

[32] See https://engage.vic.gov.au/project/offshore-wind-transmission-in-gippsland-and-portland/page/development-and-engagement-roadmap.

[33] AEMO. *RDP Stage 1: Mortlake turn-in* alleviates existing voltage constraint between Moorabool and Mortlake 500 kV Terminal Stations enabling up to 1,500 MW of additional generation output. At https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/vapr/2023/2023-victorian-annual-planning-report.pdf?la=en and http://www.gazette.vic.gov.au/gazette/Gazettes2022/GG2022S547.pdf.

[34] Augmentation options for the Western Victoria grid reinforcement were provided as part of preparatory activities completed for South-West Victoria as inputs to the 2024 ISP. AEMO is collaborating with AEMO Victorian Planning and VicGrid to further investigate options that support onshore and offshore VRE development, and will incorporate these into the Final 2024 ISP.

A5.4.3 Eastern Victoria grid reinforcement

Summary

The Gippsland Coast REZ has been identified for offshore wind resource potential in relatively shallow waters, with a connection point close to existing 500 kV networks at Loy Yang or Hazelwood. There is currently significant interest in this area from a number of offshore wind farms, but projects have not developed sufficiently at this stage for AEMO to identify any as anticipated or committed projects. Augmentation options below could provide capacity for onshore and offshore connection.

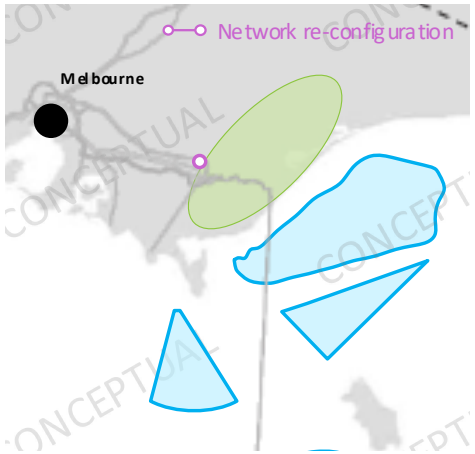
The Victorian Government has outlined its vision for offshore wind and has set targets for at least 2 GW of offshore wind capacity by 2032, 4 GW by 2035 and 9 GW by 2040[35]. The government has announced that VicGrid will provide a coordinated transmission connection point near the Gippsland Coast. New transmission lines will also be developed where needed to link the common connection points with the existing electricity grid.

AEMO understands that potential transmission augmentation projects for Gippsland REZ are likely to be delivered as a dedicated asset of some kind. This has been treated similar to a generation connection asset in the ISP model, rather than a network augmentation. VicGrid is currently undertaking consultation on the development of this infrastructure and AEMO will continue to co-ordinate with VicGrid on this matter.

Due to the large amount of generation flagged for onshore & offshore connection in this REZ, and outcomes highlighting potential need for network upgrades near 2035, co-ordination of new generation and network expansion may be required.

Following the Yallourn Power Station retirement, changes in the network configuration in Latrobe Valley 220 kV would be required for increased utilisation of Latrobe Valley to Melbourne 220 kV lines. AEMO Victorian Planning has explored options to increase the utilisation and recently identified a preferred switching arrangement at Hazelwood 220 kV switchyard[36]. AEMO Victorian Planning is investigating to address emerging Melbourne Eastern Metro network constraints. This would allow an increase in transfer capacity of the existing 500 kV lines between Latrobe Valley and Melbourne. For the final ISP, AEMO National Transmission Planner will work with AEMO Victorian Planning for inclusion of a 220 kV switching arrangement at Hazelwood, as well as options to increase the utilisation of the existing 500 kV lines between Latrobe Valley and Melbourne, or any options that may require additional transmission.

AEMO National Transmission Planner may, in the 2024 ISP, request preparatory activities be undertaken to explore the potential need to increase the transmission capacity between the Latrobe Valley and Melbourne, including increasing the network capability of existing transmission lines or any augmentations. AEMO National Transmission Planner will work with AEMO Victoria Planning on what those preparatory activities might be and potential timeframes in which the activities will be required to be undertaken.



Existing network capability

Due to the high capacity of the network in this REZ (with four 500 kV and six 220 kV lines from Latrobe Valley to Melbourne designed to transport energy from major Victorian brown coal power station), significant generation can be accommodated. The network capacity of the existing 220 kV lines between Latrobe Valley and Melbourne is currently utilised by the Yallourn coal generation. The transfer capacity of 500 kV lines between Hazelwood and Melbourne major load centres can be restricted by the capacity of 500/220 kV transformers in the Eastern Metropolitan Melbourne area.

[35] See https://www.energy.vic.gov.au/renewable-energy/offshore-wind-energy#:~:text=Victoria%27s%20offshore%20wind%20targets%20are,9%20GW%20by%202040.

[36] See https://www.aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/vapr/2023/2023-victorian-annual-planning-report.pdf?la=en.

The transmission limit of the Latrobe Valley to Melbourne 500 kV lines is represented by the 'SEVIC1' group constraint and has a 6,000 MW limit modelled. The SEVIC1 constraint includes VRE generation from V5 (Gippsland) and V7 (Gippsland Coast) and existing generation at Loy Yang and Hazelwood 500 kV substations, as well as import from Tasmania to Victoria. The SEVIC1 limit does not include the potential for connection of new generation at the Yallourn 220 kV substation.					
ISP candidate options					
Description	**Status**		***Progressive Change***	***Step Change***	***Green Energy Exports***
ISP modelling indicates a potential need for up to 3 GW of additional transmission capacity from the Latrobe Valley area to Melbourne to facilitate onshore and offshore VRE development. This need will depend on the timing and location of a market response to Victoria's offshore wind targets. The Draft 2024 ISP modelled network uplift for the eastern Victoria area using capacities and costs as per Option 1 and 2 in the 2023 Transmission Expansion Options Report. AEMO Victorian Planning has identified a potential switching configuration at Hazelwood 220 kV switchyard and investigating option to address emerging Melbourne Eastern Metro network constraints as identified in the Victorian Annual Planning Report (2023). Augmentation of the network from Latrobe Valley to Melbourne could allow increased onshore and offshore wind development in Gippsland. Through joint planning, AEMO National Transmission Planner, AEMO Victorian Planning and VicGrid will continue to explore options to address emerging limitations and maximise utilisation of the existing network. **Earliest feasible delivery date:** 2030-31.		Future	Option 1: 2036-37 Option 2: 2044-45	Option 1: 2035--36 Option 2: 2037-38	Option 1: 2031-32 Option 22: 2033-34

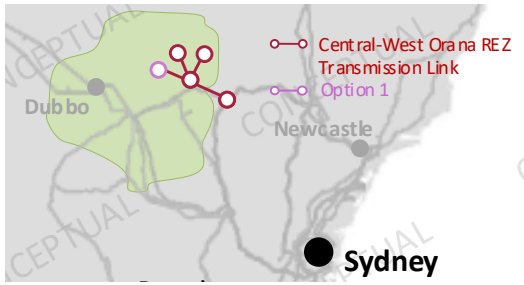
A5.4.4 Central West Orana REZ Extension

Summary

The project to establish the Central-West Orana REZ transmission link is considered an anticipated project as identified in Section A5.2.

Central-West Orana REZ has been identified by the New South Wales Government as the state's first pilot REZ. The Central-West Orana REZ was declared on 5 November 202137 under the Electricity Infrastructure Investment Act 2020 (NSW) with a minimum of 3,000 MW of additional transmission network capacity within the Central West NSW region of the state. REZ design and community engagement is currently progressing, with an initial 4,500 MW of additional transmission network capacity being planned. The Central-West Orana REZ Access Scheme was declared under the Act on 23 December 202238.

This identifies the Central West Orana REZ expansion as a future project.



Existing network capability

With the anticipated ISP project for Central West Orana REZ transmission link as identified in Section A5.2.2, the Central West Orana REZ transfer capacity increases by 4,500 MW, subject to the downstream Hunter Transmission project augmentation.

ISP candidate options

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
Option 1: • Expand Elong Elong substation with 3 x 500/330/33 kV 1,500 MVA transformers. **Earliest feasible delivery date:** 2030-31.	Future	Increase of Central West Orana REZ network limit by 1,500 MW	243 Class 5b (±50%)	2034-35	2040-41	2030-31

[37] See https://www.energyco.nsw.gov.au/cwo-rez#declaration.

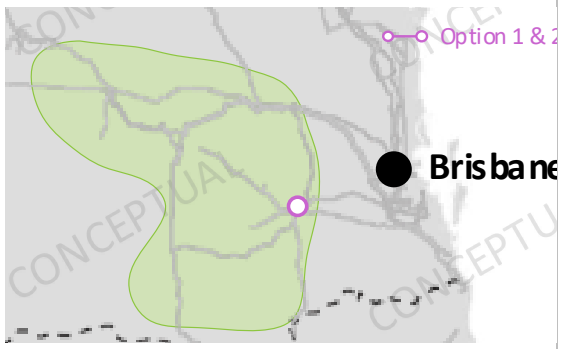
[38] See https://www.energyco.nsw.gov.au/central-west-orana-rez-access-scheme-declaration.

A5.4.5 Darling Downs REZ expansion

Summary

Upgrade options associated with the transmission limit constraint SWQLD1 (the Darling Downs) may be built to improve the generation capacity in southwest Queensland. These augmentations will facilitate transmission of this generation to load centres in the locality of Brisbane.

The optimal development path requires at least 200 MW of expansion in the Darling Downs in 2034-35. This development card shows either transmission augmentation option could be developed for this REZ. Which of Option 1 or Option 2 is chosen as the future ISP option will be informed by joint planning between AEMO and Powerlink over which option produces the largest net benefit.



Existing network capability

The existing network facilitates power transfer from south west Queensland to the load centre in Brisbane. This transmission can support up to approximately 5,300 MW of generation into Brisbane during summer peak, summer typical and winter reference conditions. However, this capability is significantly reduced depending on the output of existing coal and gas generation in the REZ, the flow of power from New South Wales, and the flow of power from central Queensland.

ISP candidate options

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
Option 1: • Replace existing 1,300 MVA 330/275 kV transformer at Middle Ridge with 1,500 MVA 330/275 kV transformer. **Earliest feasible delivery date:** 2027-28. *Scope provided by Powerlink.*	Future	500	28[39] Class 5 (±50%)	2036-37*	2034-35*	2041-42*
Option 2 (alternative): • Implement a limit extension special protection scheme – run-back of generation in SWQ with 300 MW BESS response in SEQ (similar to a virtual transmission line)[40].	Future	200-300	Non-network projects not costed	-	-	-

*Either option 1 or option 2 gives the required transmission limit uplift and could be implemented. The decision of option chosen will be as a result of discussions with Powerlink.

[39] See Preparatory Activities page, at https://aemo.com.au/consultations/current-and-closed-consultations/2023-transmission-expansion-options-report-consultation.

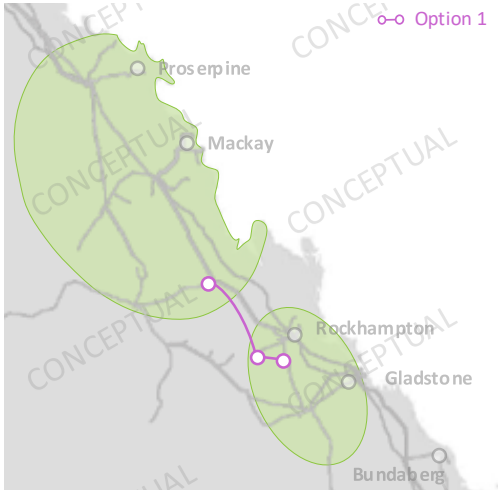
[40] In addition to this scheme, Powerlink's preparatory activities note a special protection system splitting scheme. This has not been included as it is an operational scheme that may later be considered as part of a RIT-T.

A5.4.6 Facilitating power to Central Queensland

Summary

Upgrade options associated with the Group Constraint NQ2 may be built to improve the generation capacity in Northern Queensland, Q1 to Q5. These augmentations will facilitate transmission of this generation to load centres in the south.

The Queensland Government has announced that, subject to final investment decisions, it will build a 5,000 MW / 24-hour Pioneer-Burdekin pumped hydro energy storage project in this area near the Burdekin shire, as part of the Queensland SuperGrid.



Existing network capability

The current network was designed to facilitate the transmission of power from Central Queensland to support the load in Northern Queensland. Thus, its capacity was designed around North Queensland load, rather than building for future generation projects.

The network has the ability to support up to 2,500 MW of generation during summer peak and summer typical conditions and 2,750 MW during winter reference conditions.

ISP candidate options

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
Option 1: • Construct additional 275 kV circuit from Bouldercombe to Stanwell. • String and energise the second Broadsound-Stanwell 275 kV circuit (on existing DCST). **Earliest feasible delivery date:** 2030-31.	Future	400	173 Class 5b (±50%)	-	2035-36	-

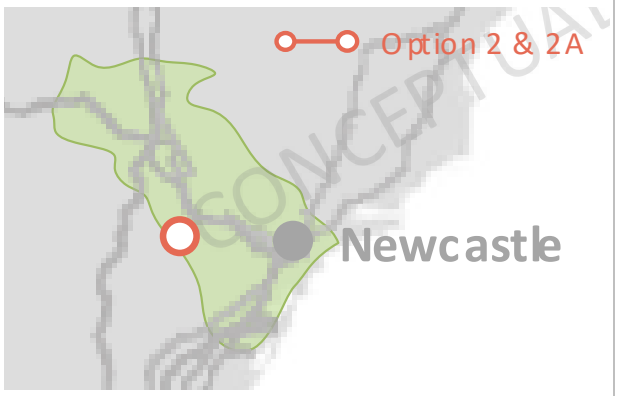
A5.4.7 Hunter – Central Coast REZ Extension

Summary

The Hunter-Central Coast (HCC) REZ has been identified to assist industries to decarbonise and access renewable energy with a mix of solar, onshore and offshore wind energy projects.

The REZ has been declared with 1,000 MW of intended network capacity and EnergyCo has been appointed the Infrastructure Planner under the Electricity Infrastructure Investment Act 2020 (NSW).

The capacity of the Hunter-Central Coast REZ is likely to increase over time with the retirement of coal-fired power stations, re-purposing of mining land and the growth of offshore wind.



Existing network capability

This REZ is intended to supply the Sydney, Newcastle and Wollongong load centre (SNW) and it is assumed that supply to SNW would also include high southbound flows from NNSW to CNSW. The REZ limit is at 400 MW to reflect the limit for supplying SNW.

ISP candidate options

Description[41]	**Status**	**Additional network capacity (MW)**	**Expected cost ($ million)**	***Progressive Change***	***Step Change***	***Green Energy Exports***
Option 2: • New 330 kV Singleton switching station and cuts into line 82 Liddell–Tomago. **Earliest feasible delivery date:** 2027-28.	Future	Increase of N9 REZ network limit by 500 MW	59 Class 5b (±50%)	2027-28	2029-30	-
Option 2A:	Future	375	106 Class 5b (±50%)	2028-29	2044-45	-

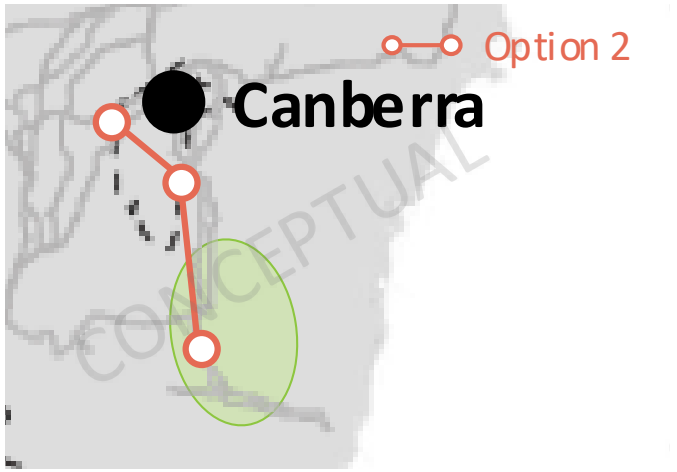
[41] The following options for this REZ are mutually exclusive and cannot both be selected by the ISP model. Further joint planning is required to clarify whether the capacity for this future ISP project can be achieved. This project may change for the final 2024 ISP.

• New 330/132 kV 375 MVA Singleton two transformer substation and cuts into line 82 Liddell–Tomago and connected to Ausgrid's Singleton 132 kV substation switching station. **Earliest feasible delivery date:** 2030-31.						

A5.4.8 Cooma-Monaro REZ Extension

Summary

The Cooma-Monaro REZ has been identified for its pumped hydro potential. This REZ has moderate to good quality wind resources that require increased transmission capacity to unlock.



Existing network capability

The existing 132 kV network connecting Cooma-Monaro REZ to Canberra, Williamsdale and Munyang can accommodate approximately 200 MW of additional generation.

ISP candidate options

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
Option 2: • 330 kV line Cooma–Williamsdale–Stockdill. • Two 330/132 kV transformers at Cooma. **Earliest feasible delivery date:** 2030-31.	Future	500	512 Class 5b (±50%)	-	2045-46	2030-31

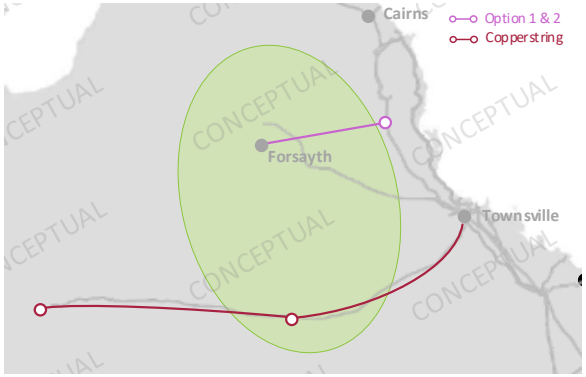
A5.4.9 North Queensland Clean Energy Hub expansion

Summary

The Clean Energy Hub REZ is at the north-western section of Powerlink's network, and has excellent wind and solar resources.

The Queensland Government has announced that it will deliver the approximately 840 km CopperString 2032 project. CopperString 2032 will connect the North-West Minerals Province of Queensland to the National Electricity Market via Mulgrave near Townsville. The project scope includes 500 kV transmission capacity between Townsville and Hughenden to unlock the renewable energy potential of the region.

AEMO is now considering the CopperString 2032 project as an anticipated project after outcomes from joint planning with Powerlink and the Queensland Government. This project expands upon this network to unlock more renewable generation in the Clean Energy Hub REZ.



Existing network capability

The project to establish CopperString 2032 is considered anticipated. As such, the existing network capability is assumed to be approximately 2,200 MW, incorporating the CopperString 2032 project (1,500 MW) as well as existing network capability (700 MW) for peak demand, summer typical and winter reference conditions. For the 2024 ISP, only the 500 kV section of CopperString 2032 is modelled.

The existing network at the North-West Mineral Province is islanded from the NEM. The NEM only extends as far west as Julia Creek and is mainly energised at 66 kV in that area. The existing network for this REZ was designed to support North-West Queensland load, rather than building for future generation projects. The REZ can potentially support much more generation.

ISP candidate options

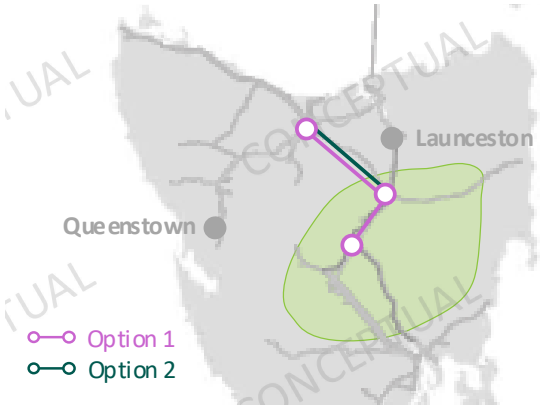
Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
Option 1 & 2: • Establish a 275 kV yard at Kidston substation near Forsayth. • Build a 275 kV double-circuit line from Kidston to Guybal Munjan substation (energise only a single line until generation in the REZ develops, then energise the second line). **Earliest feasible delivery date:** 2030-31.	Future	1000	651 Class 5a (±30%)	-	2042-43	2030-31

† At https://aemo.com.au/consultations/current-and-closed-consultations/2022-draft-isp-consultation.
‡ At https://aemo.com.au/-/media/files/major-publications/isp/2021/transmission-cost-report.pdf?la=en.

A5.4.10 Waddamana to Palmerston transfer capability upgrade

Summary

This REZ has excellent quality wind resources and has good pumped hydro resources. It is located close to major load centres at Hobart. The Tasmania Central Highlands augmentation options are influenced by the Project Marinus augmentations.



Existing network capability

The current total REZ transmission limit for existing (144 MW Wild Cattle Hill wind farm) and new VRE before any network upgrade in the Central Highlands is approximately 527 MW for peak demand and summer typical conditions and 668 MW for winter reference condition. VRE development opportunities are anticipated around the Waddamana substation.

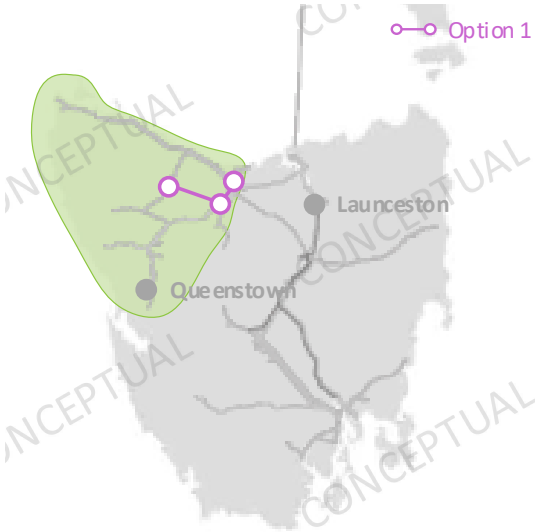
ISP candidate options

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
Option 1: • Build a Palmerston-Waddamana 220 kV double-circuit line. • Build 2 x power flow controllers on the 2 x 220 kV transmission lines from Palmerston-Sheffield. **Earliest feasible delivery date:** 2027-28.	Future	690	201 Class 5a (± 30%)	2029-30	2029-30	2029-30
Option 2: • Build a second Palmerston-Sheffield 220 kV double-circuit line. Pre-requisite: TAS-VIC Option 2, T3 Option 1. **Earliest feasible delivery date:** 2032-33.	Future	675	274 Class 5a (± 30%)	-	2041-42	-

A5.4.11 North West Tasmania REZ Extension

Summary

This REZ has excellent quality wind resources and good pumped hydro resources. The North West Tasmania augmentation options are highly dependent on Project Marinus.



Existing network capability

The current total REZ transmission limit for existing (112 MW Granville Harbour wind farm) and new VRE before any network upgrade in North West Tasmania is approximately 277 MW for peak demand and summer typical conditions and 112 MW for winter reference condition.

Note this REZ is affected by voltage stability constraints for VRE connection at Farrell 220 kV substation. Future REZ generators are assumed to have a runback scheme in place to reduce generation output post contingency to within network capacity for lines currently covered by the Network Control System Protection Scheme (NCSPS), but not for new transmission lines.

ISP candidate options

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
Option 1: • Build a new Hampshire Hills wind collector station. **Earliest feasible delivery date:** 2027-28.	Future[42]	800	28[43] Class 5a (± 30%)	2029-30	2029-30	2028-29

[42] TasNetworks may wish to investigate the need for this project as part of finalising the contingent project application for the Project Marinus RIT-T.

[43] This cost estimate covers only section of the scope which is not already covered by Project Marinus Stage 2. As the optimal timing of this REZ extension is before Project Marinus Stage 2, the 220 kV Staverton switching station, cut-in of Sheffield-Mersey Forth 220 kV lines and new double-circuit Staverton-Hampshire Hills 220 kV line are expected to be built before Project Marinus Stage 2. Any expected cost for advancement of these line works not included in this estimate.

A5.4.12 Mid North REZ expansion

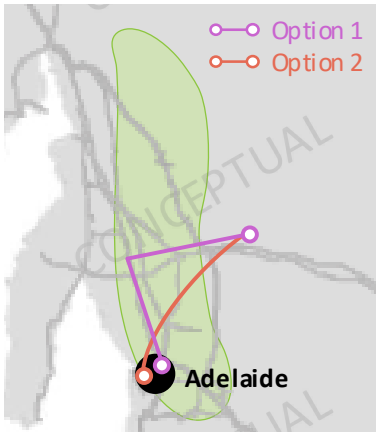
Summary

The Mid-North SA REZ has moderate quality wind and solar resources. There are several major wind farms in service in this REZ, totalling over 1,700 MW installed capacity.

The Mid North limit represents the generation build limit applied to S3, S4, S5, S6, S7, S8, and S9 REZs. This constraint is necessary because these REZs all must export any additional power generation south towards Adelaide primarily along the existing four 275 kV parallel circuits from Davenport to near Adelaide (Para). This corridor of the network forms a bottleneck for these REZ.

The application of this group constraint is not considered for the *Green Energy Exports* scenario.

Option 1 and 2 of the Mid North SA REZ expansion are required in the late 2020s in the *Green Energy Exports* scenario, and late 2040s in the *Step Change* scenario to facilitate the connection of generation within these REZs.



Existing network capability

The individual REZs which form this group constraint each have their own individual existing network capabilities. The collective generation build from S3 to S9 cannot exceed an additional 2,400 MW without network augmentation between Davenport and Adelaide being required.

ISP candidate options

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
Option 1: • Build a 275 kV double-circuit line between Bundey and Para. • Build a 275 kV double-circuit line from Brinkworth to cut into Bungama-Blyth West 275 kV circuit. • Disconnect existing Waterloo-Templers 132 kV line at each end. • Build a 132 kV single-circuit line from Templers West to Templers. • 1 x 160 MVA, 275/132 kV transformer at Templers West. **Earliest feasible delivery date:** 2027-28.	Future	900	416 Class 5b (±50%)	-	2045-46	2029-30
Option 2: • Build a 330 kV double-circuit line from Bundey to Globe Derby. **Earliest feasible delivery date**: 2027-28.	Future	1,150	740 Class 5b (±50%)	2050-51	2045-46	2029-30

A5.4.13 Queensland SuperGrid North (QEJP Stage 3)

Summary

To improve the modelling of network losses, the Central-Northern sub-region from the 2022 ISP was further divided into North Queensland (NQ) and Central Queensland (CQ) sub-regions. Upgrade options associated with this new CQ – NQ flow path may be built when generation in REZs Q1 to Q5 (Northern Queensland) exceeds 2,500 MW. These augmentations facilitate transfer of generation in northern Queensland to load centres further south.

In September 2022, the Queensland Government released Queensland Energy and Jobs Plan and Queensland SuperGrid Infrastructure Blueprint which calls for the large-scale pumped hydro for firming - Pioneer-Burdekin (west of Mackay). Inclusion of Pioneer-Burdekin would affect the ultimate build out of the SuperGrid North timing and will be considered in the context of Queensland Government policy decisions. Pioneer-Burdekin is currently progressing through Queensland Government assessment and decision-making processes and AEMO is yet to consider Pioneer-Burdekin an anticipated project (based on AEMO's criteria). AEMO does recognise Queensland Government's commitment to build the project however, the Queensland SuperGrid North project is listed as a future ISP project with the possibility of progressing as a Queensland actionable project.

Existing network capability

The current network was designed to facilitate the transmission of power from Central Queensland to support the load in Northern Queensland. As a result, the Central and North Queensland sub-regions can only support up to 2,500 MW of generation across the five REZs in Northern Queensland, depending on the level of storage in the sub-region.

From CQ to NQ maximum transfer capability is 1,200 MW at peak demand, summer typical levels and 1,400 MW at winter reference periods. The maximum transfer capability is limited by thermal ratings and voltage stability for the loss of CQ or NQ transmission network elements.

From NQ to CQ maximum transfer capability is 1,200 MW at peak demand and summer typical levels and 1,400 MW at winter reference periods, assuming Powerlink upgrades limiting 8 km of line into Ross from Strathmore 275 kV.

ISP candidate options

Description	Status	Additional network capacity (MW)	Expected cost ($ million)	*Progressive Change*	*Step Change*	*Green Energy Exports*
Option 2: Stage 3 of the QEJP • Establish 500 kV substations at locality of northern part of CQ. • Substation works at Townsville 500kV (established as part of CopperString 2032 project) • 2 x 1,500 MVA 500 / 275 kV transformers at northern CQ substation	Future project may progress under the *Energy (Renewable Transformation and Jobs) 2023 Bill*	CQ to NQ: 3,000 NQ to CQ: 3,000 REZ Q3: 3,000 REZ Q2: 800 NQ2: 3,000	4,184 Class 5b (±50%)	-	Timing will be considered in the context of Queensland Government policy decisions[44]	July 2044

[44] See the Queensland SuperGrid Blueprint for more details. Available at: https://www.epw.qld.gov.au/__data/assets/pdf_file/0030/32988/queensland-supergrid-infrastructure-blueprint.pdf.

• Establish a 500 kV double-circuit steel tower (DCST) line from CQ to northern CQ substations. • Establish a 500 kV DCST line from northern CQ to NQ substations. • Special protection scheme for transfer limit increase (similar to Virtual transmission line). Cost of this Network Service Agreement (NSA) excluded. **Earliest feasible delivery date:** 2032-33. *Prerequisite: CQ-SQ Option 5 (QEJP)*						

A5.4.14 Other future ISP Projects

In addition to the projects identified earlier in Section A5.4, Table 1 identifies indicative projects only selected in single scenarios or required towards the end of the modelling horizon which are expected to evolve from one ISP to the next. These projects are conceptual and vary significantly between scenarios in relation to size of network augmentation and the timing.

The augmentation projects listed in Table 1 refer to projects outlined in the 2023 *Transmission Expansion Options Report*. AEMO welcomes feedback on these projects.

Table 1 Indicative transmission and REZ augmentations required later in the horizon

REZ / flow path upgrade	Augmentation option[45] (REZ network limit increase)	*Progressive Change*	*Step Change*	*Green Energy Exports*
N1 – North West New South Wales	N1 Option 1 (1,660 MW)	-	-	2039-40
	500 kV expansion (3,000 MW)	-	-	2042-43
N2 – New England	N2 Option 3 (900 MW)	-	-	2044-45
N3 – Central West Orana	N3 Option 2	-	-	2042-43
N8 – Cooma-Monaro	500 kV expansion (3,000 MW)	-	-	2031-32
N9 – Hunter-Central Coast	N9 Option 1A (950 MW)	-	-	2027-28
	500 kV expansion (12,000 MW)	-	-	2043-44
Q1 – Far North Queensland	Q1 Option 1	-	-	2036-37
	Q1 Option 2	-	-	2042-43
	500 kV expansion (3,000 MW)	-	-	2032-33
	500 kV expansion (3,000 MW)	-	-	2033-34
	500 kV expansion (12,000 MW)	-	-	2044-45

[45] For an outline of each project's scope, see the 2023 *Transmission Expansion Options Report*, at https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-transmission-expansion-options-report.pdf?la=en

REZ / flow path upgrade	Augmentation option[45] (REZ network limit increase)	*Progressive Change*	*Step Change*	*Green Energy Exports*
	500 kV expansion (6,000 MW)	-	-	2048-49
	500 kV expansion (9,000 MW)	-	-	2049-50
Q2 – North Queensland Clean Energy Hub	500 kV expansion (3,000 MW)	-	-	2033-34
	500 kV expansion (6,000 MW)	-	-	2043-44
	500 kV expansion (15,000 MW)	-	-	2046-47
	500 kV expansion (21,000 MW)	-	-	2048-49
Q5 – Barcaldine	Q5 Option 1 (500 MW)	-	-	2034-35
	Q5 Option 2 (350 MW)	-	-	2044-45
	500 kV expansion (3,000 MW)	-	-	2044-45
Q6 – Fitzroy	500 kV expansion (3,000 MW)	-	-	2040-41
	500 kV expansion (3,000 MW)	-	-	2048-49
Q9 – Banana	500 kV expansion (6,000 MW)	-	-	2046-47
South QLD to Central QLD (Flow Path)	SQ-CQ Option 1 (900 MW)	-	-	2030-31
S2 – Riverland	500 kV expansion (3,000 MW)	-	-	2045-46
S4 – Yorke Peninsula	S4 Option 1 (450 MW)	-	-	2031-32
	S4 Option 2 (450 MW)	-	-	2041-42
	500 kV expansion (3,000 MW)	-	-	2044-45
S6 – Leigh Creek	S6 Option 1 (950 MW)	-	-	2044-45
	500 kV expansion (3,000 MW)	-	-	2029-30
S8 – Eastern Eyre Peninsula	S8 Option 1 (300 MW)	-	-	2027-28
Mid-North SA (Group Constraint)	500 kV expansion (3000 MW)	-	-	2031-32
	500 kV expansion (3000 MW)	-	-	2044-45
North SA (Group Constraint)	NSA Option 2 (300 MW)	-	-	2027-28
	NSA Option 1 (1,200 MW)	-	-	2040-41
	275kV expansion (1,000 MW)	-	-	2040-41

REZ / flow path upgrade	Augmentation option[45] (REZ network limit increase)	*Progressive Change*	*Step Change*	*Green Energy Exports*
T1 – North East Tasmania	T1 Option 1 (800 MW)	-	-	2045-46
T2 – North West Tasmania	500 kV expansion (3,000 MW)	-	-	2029-30
	T2 Option 2 (500 MW)	-	-	2029-30
	T2 Option 3 (800 MW)	-	-	2029-30
	220kV expansion (900 MW)	-	-	2044-45
T3 – Central Highlands	T3 Option 2 (690 MW)	-	-	2031-32
	500 kV expansion (3,000 MW)	-	-	2031-32
	500 kV expansion (3,000 MW)	-	-	2039-40
V2 – Murray River	V2 Option 1 (800 MW)	-	-	2030-31
V6 – Central North Victoria	V6 Option 3 (1,500 MW)	-	-	2033-34
V8 – Portland Coast	V8 Option 3A (1,800 MW)	2038-39	-	-
South West Victoria (Group constraint)	500 kV expansion (3,000 MW)	-	-	2037-38
South East Victoria (Group Constraint)	500 kV expansion (2,000 MW)	-	-	2039-40

Glossary

This glossary has been prepared as a quick guide to help readers understand some of the terms used in the ISP. Words and phrases defined in the National Electricity Rules (NER) have the meaning given to them in the NER. This glossary is not a substitute for consulting the NER, the Australian Energy Regulator's (AER's) Cost Benefit Analysis Guidelines, or AEMO's *ISP Methodology*.

Term	Acronym	Explanation
Actionable ISP project	-	Actionable ISP projects optimise benefits for consumers if progressed before the next ISP. A transmission project (or non-network option) identified as part of the ODP and having a delivery date within an actionable window. For newly actionable ISP projects, the actionable window is two years, meaning it is within the window if the project is needed within two years of its earliest in-service date. The window is longer for projects that have previously been actionable. Project proponents are required to begin newly actionable ISP projects with the release of a final ISP, including commencing a RIT-T.
Actionable New South Wales project and actionable Queensland project	-	A transmission project (or non-network option) that optimises benefits for consumers if progressed before the next ISP, is identified as part of the ODP, and is supported by or committed to in New South Wales Government or Queensland Government policy and/or prospective or current legislation.
Anticipated project	-	A generation, storage or transmission project that is in the process of meeting at least three of the five commitment criteria (planning, construction, land, contracts, finance), in accordance with the AER's Cost Benefit Analysis Guidelines. Anticipated projects are included in all ISP scenarios.
Candidate development path	CDP	A collection of development paths which share a set of potential actionable projects. Within the collection, potential future ISP projects are allowed to vary across scenarios between the development paths. Candidate development paths have been shortlisted for selection as the ODP and are evaluated in detail to determine the ODP, in accordance with the ISP Methodology.
Capacity	-	The maximum rating of a generating or storage unit (or set of generating units), or transmission line, typically expressed in megawatts (MW). For example, a solar farm may have a nominal capacity of 400 MW.
Committed project	-	A generation, storage or transmission project that has fully met all five commitment criteria (planning, construction, land, contracts, finance), in accordance with the AER's Cost Benefit Analysis Guidelines. Committed projects are included in all ISP scenarios.
Consumer energy resources	CER	Generation or storage assets owned by consumers and installed behind-the-meter. These can include rooftop solar, batteries and electric vehicles. CER may include demand flexibility.
Consumption	-	The electrical energy used over a period of time (for example a day or year). This quantity is typically expressed in megawatt-hours (MWh) or its multiples. Various definitions for consumption apply, depending on where it is measured. For example, underlying consumption means consumption being supplied by both CER and the electricity grid.
Cost-benefit analysis	CBA	A comparison of the quantified costs and benefits of a particular project (or suite of projects) in monetary terms. For the ISP, a cost-benefit analysis is conducted in accordance with the AER's Cost Benefit Analysis Guidelines.
Counterfactual development path	-	The counterfactual development path represents a future without major transmission augmentation. AEMO compares candidate development paths against the counterfactual to calculate the economic benefits of transmission.
Demand	-	The amount of electrical power consumed at a point in time. This quantity is typically expressed in megawatts (MW) or its multiples. Various definitions for demand, depending on

Term	Acronym	Explanation
		where it is measured. For example, underlying demand means demand supplied by both CER and the electricity grid.
Demand-side participation	DSP	The capability of consumers to reduce their demand during periods of high wholesale electricity prices or when reliability issues emerge. This can occur through voluntarily reducing demand, or generating electricity.
Development path	DP	A set of projects (actionable projects, future projects and ISP development opportunities) in an ISP that together address power system needs.
Dispatchable capacity	-	The total amount of generation that can be turned on or off, without being dependent on the weather. Dispatchable capacity is required to provide firming during periods of low variable renewable energy output in the NEM.
Distributed solar / distributed PV	-	Solar photovoltaic (PV) generation assets that are not centrally controlled by AEMO dispatch. Examples include residential and business rooftop PV as well as larger commercial or industrial "non-scheduled" PV systems.
Firming	-	Grid-connected assets that can provide dispatchable capacity when variable renewable energy generation is limited by weather, for example storage (pumped-hydro and batteries) and gas-powered generation.
Future ISP project	-	A transmission project (or non-network option) that addresses an identified need in the ISP, that is part of the ODP, and is forecast to be actionable in the future.
Identified need	-	The objective a TNSP seeks to achieve by investing in the network in accordance with the NER or an ISP. In the context of the ISP, the identified need is the reason an investment in the network is required, and may be met by either a network or a non-network option.
ISP development opportunity	-	A development identified in the ISP that does not relate to a transmission project (or non-network option) and may include generation, storage, demand-side participation, or other developments such as distribution network projects.
Net market benefits	-	The present value of total market benefits associated with a project (or a group of projects), less its total cost, calculated in accordance with the AER's Cost Benefit Analysis Guidelines.
Non-network option	-	A means by which an identified need can be fully or partly addressed, that is not a network option. A network option means a solution such as transmission lines or substations which are undertaken by a Network Service Provider using regulated expenditure.
Optimal development path	ODP	The development path identified in the ISP as optimal and robust to future states of the world. The ODP contains actionable projects, future ISP projects and ISP development opportunities, and optimises costs and benefits of various options across a range of future ISP scenarios.
Regulatory Investment Test for Transmission	RIT-T	The RIT-T is a cost benefit analysis test that TNSPs must apply to prescribed regulated investments in their network. The purpose of the RIT-T is to identify the credible network or non-network options to address the identified network need that maximise net market benefits to the NEM. RIT-Ts are required for some but not all transmission investments.
Reliable (power system)	-	The ability of the power system to supply adequate power to satisfy consumer demand, allowing for credible generation and transmission network contingencies.
Renewable energy	-	For the purposes of the ISP, the following technologies are referred to under the grouping of renewable energy: "solar, wind, biomass, hydro, and hydrogen turbines". Variable renewable energy is a subset of this group, explained below.
Renewable energy zone	REZ	An area identified in the ISP as high-quality resource areas where clusters of large-scale renewable energy projects can be developed using economies of scale.

Term	Acronym	Explanation
Renewable drought	-	A prolonged period of very low levels of variable renewable output, typically associated with dark and still conditions that limit production from both solar and wind generators.
Scenario	-	A possible future of how the NEM may develop to meet a set of conditions that influence consumer demand, economic activity, decarbonisation, and other parameters. For the 2024 ISP, AEMO has considered three scenarios: *Progressive Change*, *Step Change* and *Green Energy Exports*.
Secure (power system)	-	The system is secure if it is operating within defined technical limits and is able to be returned to within those limits after a major power system element is disconnected (such as a generator or a major transmission network element).
Sensitivity analysis	-	Analysis undertaken to determine how modelling outcomes change if an input assumption (or a collection of related input assumptions) is changed.
Spilled energy	-	Energy from variable renewable energy resources that could be generated but is unable to be delivered. Transmission curtailment results in spilled energy when generation is constrained due to operational limits, and economic spill occurs when generation reduces output due to market price.
Transmission network service provider	TNSP	A business responsible for owning, controlling or operating a transmission network.
Utility-scale or utility	-	For the purposes of the ISP, 'utility-scale' and 'utility' refers to technologies connected to the high-voltage power system rather than behind the meter at a business or residence.
Virtual power plant	VPP	An aggregation of resources coordinated to deliver services for power system operations and electricity markets. For the ISP, VPPs enable coordinated control of CER, including batteries and electric vehicles.
Variable renewable energy	VRE	Renewable resources whose generation output can vary greatly in short time periods due to changing weather conditions, such as solar and wind.