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NSW GOVERNMENT

NSW Network Infrastructure Strategy – Appendices

Appendix B: Network Infrastructure Options

May 2023

The Energy Corporation of NSW (EnergyCo) is part of the **Treasury Cluster**

Contents

This appendix contains the complete list of potential network augmentations, within REZs and within the shared network, that would likely be required in order to practically expand the generation hosting capacity of the REZs across the state.

This includes the potential expansions within the Central-West Orana, New England, South West and Hunter-Central Coast REZs and the downstream augmentations that could be required to deliver this additional generation to the load centres along the east coast.

Limitations

These augmentations are conceptual in nature, and are informed by preliminary power system analysis only. They represent a potential future network configuration based on theoretical maximum generation in the identified REZs. Detailed design, planning and further technical analysis will be required to determine not only the feasibility of each option, but also what the detailed solution would be. All of these options are subject to change, and neither EnergyCo nor the Consumer Trustee are bound to any particular option presented.

Unless otherwise specified, estimates are Class 5b accuracy (i.e. +/- 50%) and for development and construction costs only (excluding finance, generator connection and system strength costs). This provides a comparable basis with estimates for projects under the National Electricity Rules. The total cost for a REZ also includes finance, generator connection and system strength costs at typically an additional 70% to 110% of development and construction costs. Generator and storage proponents that hold access rights will contribute connection and system strength costs. All values are in real 2021 Australian dollars. A detailed description of the method for estimating cost and delivery schedules is in Appendix C of the Draft NIS. Transfer capacities presented represent the increased limit at the time of high summer demand in the importing region. Transfer capacities are for long-term simulations in the generation and transmission expansion model. These vary with generation dispatch, load and weather conditions. Similar to NEMDE, these variabilities are captured in the network constraint equations for simulations in short-term models using time-sequential half-hourly modeling. Transfer capacity increases presented are indicative and will be updated with additional power system studies.

Considerations

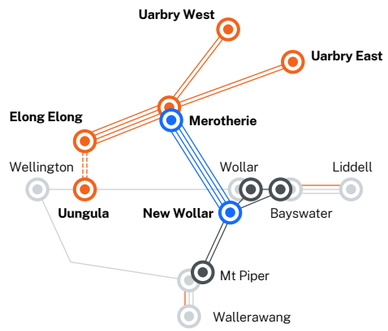
On 9 November 2020, the NSW Government released the NSW Electricity Infrastructure Roadmap to secure cheaper, cleaner and more reliable electricity for NSW households and businesses. The *NSW Electricity Infrastructure Investment Act 2020* defines long duration storage as storage with a registered capacity that can be dispatched for at least eight hours and stipulates a minimum objective of 2 GW (excluding the Snowy 2.0 project) to be constructed by the end of 2029.

In addition to planning for future expansions to the currently identified REZs, the network infrastructure options identified are cognisant of potential opportunities to enable pumped hydro energy storage (PHES) projects with future network expansions. Where potential for enabling PHES projects has been identified, it has been detailed in the Notes column. Whilst each of these network augmentations aren't explicitly required for the project to connect, they have been associated together as in combination, there are opportunities to leverage the synchronous generation to release broader network benefits.

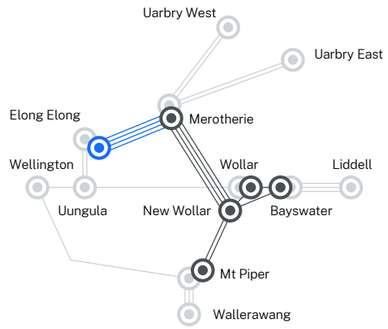
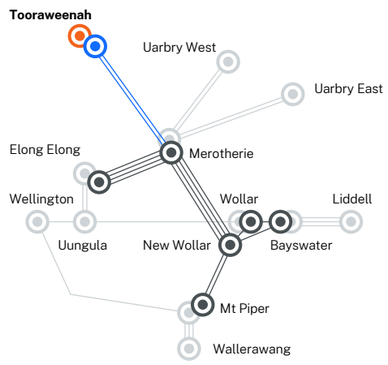
REZ Augmentations

CWO REZ Augmentations (AEMO REZ ID: N3)

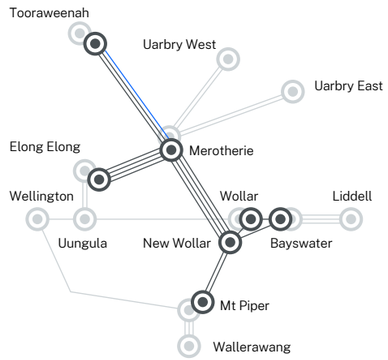
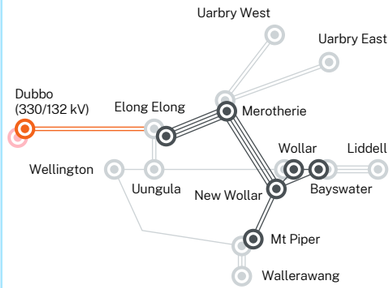
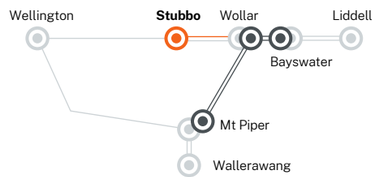
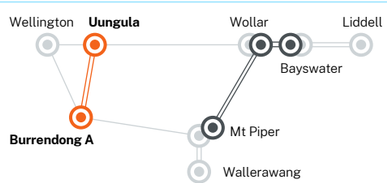
Table 1: Network augmentation options for Central-West Orana REZ

Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
Option 1A (with Uungula Mesh-in)	(Pre-requisite: none) • New Merotherie 500/330 kV substation with 4 x 500/330/33 kV 1,500 MVA transformers • New 330 kV Uarbry East, Uarbry West, Elong Elong switching stations • New 500 kV Wollar switching station • New 330 kV Uungula switching station and cut into Line 79 Wellington – Wollar • 2 x 500 kV DCST line 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 and initially operated at 330 kV from Merotherie to Elong Elong with Quad Orange conductor • 1 x 330 kV DCST from Elong Elong to Uungula with Twin Olive conductor • 5 x 100 MVAr synchronous condensers at Elong Elong switching station • 5 x 100 MVAr synchronous condensers at Merotherie substation • 2 x 100 MVAr synchronous condensers at Uarbry West switching station • 3 x 100 MVAr synchronous condensers at Uarbry East switching station • Provision of switchbays 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	 Subject to further analysis. CWO REZ may be meshed with Line 79 to increase transfer capacity and deliver additional system benefits. Further augmentations to CWO REZ may be revised based on the outcome of this analysis.	4,500	3,186	0.71	September 2027	June 2027	June 2028	Included as part of network build (will be updated based on detailed power system study)	
Option 2A	Not used									

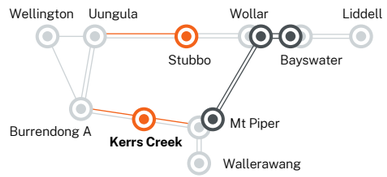
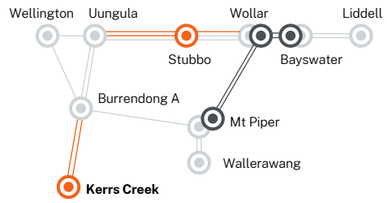
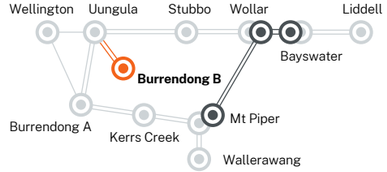
CWO REZ Augmentations (AEMO REZ ID: N3) *continued*

Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
Option 2B (Elong Elong expansion)	(Pre-requisite: CWO REZ Option 1A) • Expand Elong Elong substation with 3 x 500/330/33 kV 1,500 MVA transformers • Operate 4 circuits between Elong Elong and Merotherie to 500 kV *Note: Hunter Transmission Project will be required when the total network capacity is greater than 3 GW as pre-requisite. Cost is not included.*		3,000	324	0.11	March 2031	December 2030	March 2032	Included as part of network build (will be updated based on detailed power system study)	
Option 3A (Tooraweenah expansion)	(Pre-requisite: CWO REZ Option 2B) • New Tooraweenah 500/330 kV substation with 3 x 500/330/33 kV 1,500 MVA transformers • New 500 kV DCST line from Tooraweenah to Merotherie with Quad Orange conductor • Augment Merotherie substations • Provision of switchbays for future generator connections (cost estimation is not required)		3,000	924	0.31	March 2031	December 2030	March 2032		

CWO REZ Augmentations (AEMO REZ ID: N3) *continued*

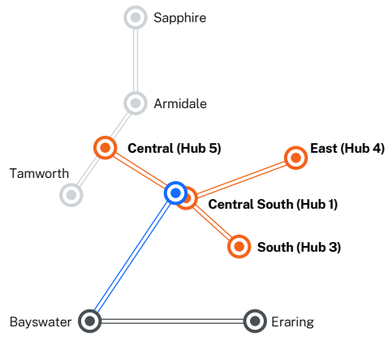
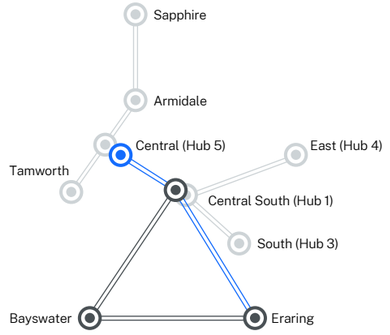
Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
Option 3B (Tooraweenah further expansion)	(Pre-requisite: CWO REZ Option 3A) • Expand Tooraweenah 500/330 kV substation with 1 x 500/330/33 kV 1,500 MVA transformer • An additional 500 kV SCST line from Tooraweenah to Merotherie with Quad Orange conductor • Augment Merotherie substations • Provision of switchbays for future generator connections (cost estimation is not required)		1,500	944	0.63	March 2035	December 2034	March 2036	Included as part of network build (will be updated based on detailed power system study)	
Option 3C (Dubbo expansion) *Note: Hunter Transmission Project will be required when the total network capacity is greater than 3 GW as pre-requisite. Cost is not included.*	(Pre-requisite: CWO REZ Option 2B) • Expand Dubbo as 330/132 kV substation with 3 x 330/132 kV 375 MVA transformers • An additional 330 kV DCST line from Dubbo to Elong Elong with Twin Mango conductor • Provision of switchbays for future generator connections (cost estimation is not required) An additional 500/330 kV 1500 MVA transformer at Elong Elong		500	419	0.84	March 2035	December 2034	March 2036		
Option 4 (Stubbo expansion)	(Pre-requisite: none) • New 330 kV Stubbo switching station and cuts into Line 79 Wellington – Wollar • New 330 kV SCST line between Wollar and Stubbo with Twin Olive conductor • Expand Wollar substation with 330 kV busbar and 1 x 500/300/33 kV 1,500 MVA transformer • Provision of switchbays for future generator connections (cost estimation is not required)		500	350	0.70	March 2027	December 2026	March 2028		
Option 5A (Burrendong expansion 1)	(Pre-requisite: none) • New 330 kV Burrendong switching station and cuts into Line 72 Wellington – Mt Piper • New Uungula switching station and cuts into Line 79 Wollar – Wellington • New 330 kV DCST line from Burrendong switching station to Uungula with Twin Mango conductor		500	350	0.70	March 2027	December 2026	March 2028		With this augmentation, up to 500 MW of additional PHES could connect

CWO REZ Augmentations (AEMO REZ ID: N3) *continued*

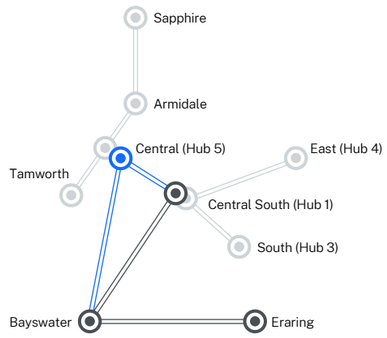
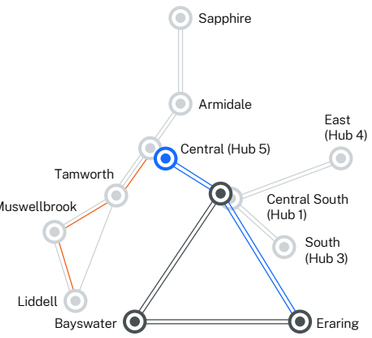
Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
Option 5B (Kerrs Creek expansion 1)	(Pre-requisite: Option 4 and 5A) • New 330 kV Kerrs Creek switching station and cuts into Line 72 and new parallel section between Mt Piper – Burrendong A • New 330 kV SCST line between Burrendong A and Mt Piper with Twin Olive conductor • New 330 kV SCST line between Uungula and Stubbo with Twin Olive conductor • New 2 x 330 kV 60 MVAr line shunt reactors at Burrendong A and 2 x 330 kV 60 MVAr line shunt reactors at Mt Piper		800	1,061	1.33	March 2031	December 2030	March 2032	Included as part of network build (will be updated based on detailed power system study)	With this augmentation, up to 310 MW of additional PHES could connect (alternative to option 5C)
Option 5C (Kerrs Creek expansion 2)	(Pre-requisite: Option 4 and 5A) • New 330 kV Kerrs Creek switching station • New 330 kV DCST line from Kerrs Creek to Burrendong switching station with Twin Mango conductor • New 330 kV DCST line between Uungula and Stubbo with Twin Olive conductor • New 330 kV SCST line between Stubbo and Wollar with Twin Olive conductor		800	746	0.93	March 2031	December 2030	March 2032		With this augmentation, up to 310 MW of additional PHES could connect (alternative to option 5B)
Option 5D (Burrendong B expansion 1)	(Pre-requisite: Option 5B or 5C) • New 330 kV Burrendong B switching station • New 330 kV DCST line from Burrendong B switching station to Uungula switching station with Twin Mango conductor		500	223	0.45	March 2035	December 2034	March 2036		

NE REZ Augmentations (AEMO REZ ID: N2)

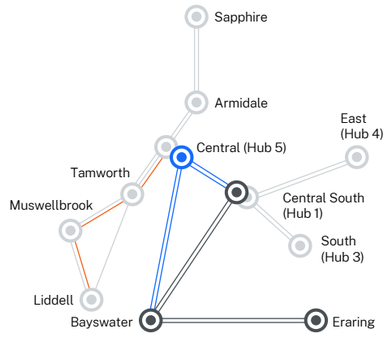
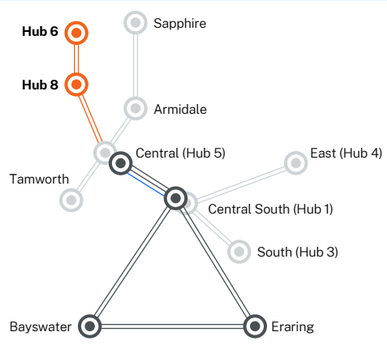
Table 2: Network augmentation options for New England REZ

Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delayed* Scenario		
Option 1	(Pre-requisite: none) • New Central South (Hub 1) 500/330 kV substation with 3 x 500/330/33 kV 1,500 MVA transformers • New 330 kV South (Hub 3) and East (Hub 4) switching stations • New 330 kV Central (Hub 5) switching station and cut into the existing lines between Tamworth and Armidale • New 500 kV built and initially 330 kV operated DCST line from Central (Hub 5) to Central South (Hub 1) with Quad Orange conductor • New 330 kV DCST line between Central South (Hub 1) and South (Hub 3) with Twin Olive conductor • New 500 kV DCST line between Central South (Hub 1) and Bayswater with Quad Orange conductor • New 330 kV DCST line between Central South (Hub 1) and East (Hub 4) with Twin Olive conductor • 4 x 500 kV 150 MVAr line shunt reactors (in total) are required for 500 kV DCST line between Hub 3 and Bayswater • New 6 x 330 kV 200 MVA phase shifting transformers at Central (Hub 5)		2,400	2,205	0.74	September 2028	June 2028	September 2029		This option will increase the NNSW – CNSW and/or NNSW – SNW Cut set limit. Please refer to Table 6 for details.
Option 2A	(Pre-requisite: NE REZ Option 1) • Expand Central (Hub 5) switching station to 500/330 kV substation with 3 x 500/330/33 kV 1,500 MVA transformers • Operate line between Central (Hub 5) and Central South (Hub 1) to 500 kV • New 500 kV DCST from Central South (Hub 1) to Eraring with Quad Orange conductor • 4 x 500 kV 150 MVAr line shunt reactors (in total) are required for 500 kV DCST line between Central South (Hub 1) and Eraring • Augment Central South (Hub 1) and Eraring to accommodate additional lines		3,600	2,097	0.70	September 2032	June 2032	September 2033		This option will increase the NNSW – CNSW and/or NNSW – SNW Cut set limit. Please refer to Table 6 for details.

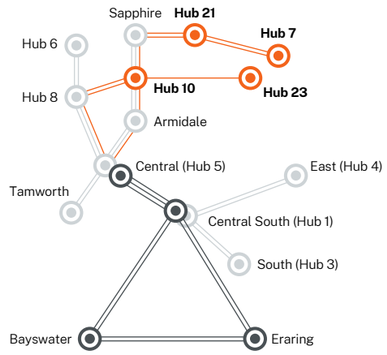
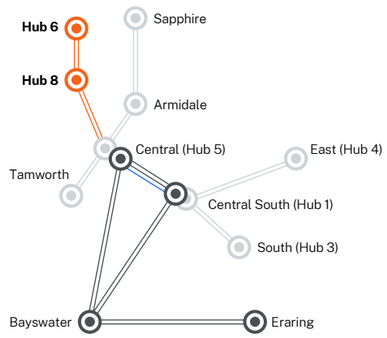
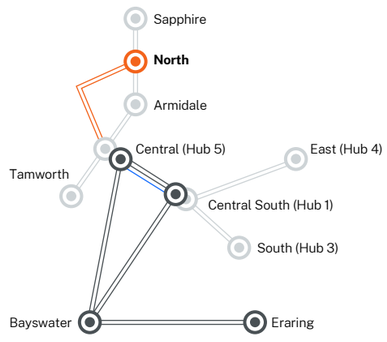
NE REZ Augmentations (AEMO REZ ID: N2) *continued*

Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delayed* Scenario		
Option 2B	(Pre-requisite: NE REZ Option 1) • Expand Central (Hub 5) switching station to 500/330 kV substation with 3 x 500/330/33 kV 1,500 MVA transformers • Operate line between Central (Hub 5) and Central South (Hub 1) to 500 kV • New 500 kV DCST from Central (Hub 5) to Bayswater with Quad Orange conductor • 4 x 500 kV 150 MVAr line shunt reactors (in total) are required for 500 kV DCST line between Central (Hub 5) and Bayswater		3,000 (with 3 Tx at Hub 5) 3,600 (with 3 Tx at Hub 5 + additional 1 Tx at Hub 1) subject to build limit and external network capacity	1,946	0.43	September 2032	June 2032	September 2033		This option will increase the NNSW – CNSW and/or NNSW – SNW Cut set limit. Please refer to Table 6 for details.
Option 2C	(Pre-requisite: NE REZ Option 1) • Expand Central (Hub 5) switching station to 500/330 kV substation with 3 x 500/330/33 kV 1,500 MVA transformers • Operate line between Central (Hub 5) and Central South (Hub 1) to 500 kV • New 500 kV DCST from Central South (Hub 1) to Eraring with Quad Orange conductor • 4 x 500 kV 150 MVAr line shunt reactors (in total) are required for 500 kV DCST line between Central South (Hub 1) and Eraring • Augment Central South (Hub 1) and Eraring to accommodate additional lines • Rebuild portion of Line 86 from Central (Hub 5) to Tamworth as 330 kV double circuit line • Rebuild Line 88 Tamworth – Muswellbrook and Line 83 Liddell – Muswellbrook as 330 kV double circuit line • Augment Central (Hub 5), Central South (Hub 1), Bayswater, Tamworth, Muswellbrook and Liddell to accommodate additional lines		3,500	2,780	0.79	September 2032	June 2032	September 2033		This option will increase the NNSW – CNSW and/or NNSW – SNW Cut set limit. Please refer to Table 6 for details.

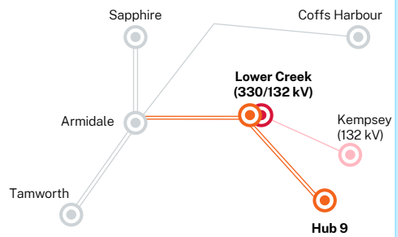
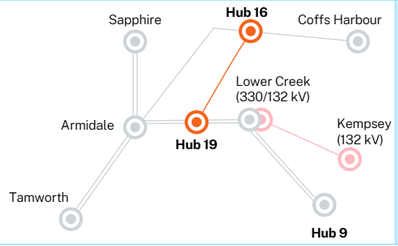
NE REZ Augmentations (AEMO REZ ID: N2) *continued*

Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delayed* Scenario		
Option 2D	(Pre-requisite: NE REZ Option 1) • Expand Central (Hub 5) switching station to 500/330 kV substation with 3 x 500/330/33 kV 1,500 MVA transformers • Operate line between Central (Hub 5) and Central South (Hub 1) to 500 kV • New 500 kV DCST from Central (Hub 5) to Bayswater with Quad Orange conductor • 4 x 500 kV 150 MVAr line shunt reactors (in total) are required for 500 kV DCST line between Central (Hub 5) and Bayswater • Rebuild portion of Line 86 from Central (Hub 5) to Tamworth as 330 kV double circuit line • Rebuild Line 88 Tamworth – Muswellbrook and Line 83 Liddell – Muswellbrook as 330 kV double circuit line • Augment Central (Hub 5), Central South (Hub 1), Bayswater, Tamworth, Muswellbrook and Liddell to accommodate additional lines		3,500 (with 3 Tx at Hub 5) 5,000 (with 3 Tx at Hub 5 + additional 1 Tx at Hub 1) subject to build limit and external network capacity	2,686	0.54	September 2032	June 2032	September 2033		This option will increase the NNSW – CNSW and/or NNSW – SNW Cut set limit. Please refer to Table 6 for details.
Option 3A	Not used									
Option 3B	Not used									
Option 3C	Not used									
Option 3D	Not used									
Option 4A	(Pre-requisite: NE REZ Option 2A) • New Hub 6 and Hub 8 330 kV switching station • New 330 kV DCST line from Hub 6 to Hub 8 with Twin Olive conductor • New 330 kV DCST line from Hub 8 to Hub 5 with Twin Olive conductor • New 500 kV DCST and strung on one side line from Hub 5 to Hub 1 with Quad Orange conductor • Augment Hub 5 to accommodate additional lines and 1 x 500/330/33 kV 1,500 MVA transformers		1,400	870	0.62	September 2036	June 2036	September 2037		

NE REZ Augmentations (AEMO REZ ID: N2) *continued*

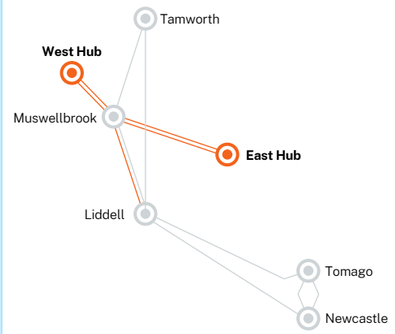
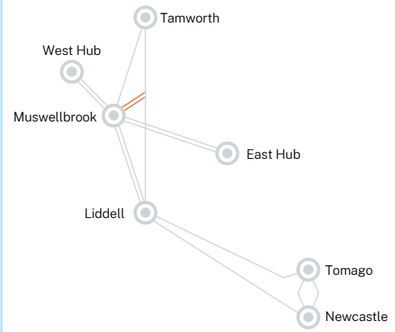
Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delayed* Scenario		
Option 4B	(Pre-requisite: NE REZ Option 4A) • New Hub 7, Hub 21 and Hub 23 330 kV switching stations • New Hub 10 switching station which cuts into existing 330 kV lines between Sapphire and Armidale • New 330 kV DCST line from Hub 7 to Hub 21 with Twin Olive conductor • New 330 kV DCST line from Hub 21 to Sapphire with Twin Olive conductor • New 330 kV SCST line from Hub 23 to Hub 10 with Twin Mango conductor • New 330 kV SCST line from Sapphire to Armidale via Hub 10 with Twin Olive conductor • New 330 kV DCST line from Hub 10 to Hub 8 with Twin Olive conductor • New 330 kV SCST line from Hub 8 to Hub 5 with Twin Olive conductor • New 330 kV SCST line from Armidale to Hub 5 with Twin Olive conductor • Augment Hub 5 to accommodate additional lines and 1 x 500/330/33 kV 1,500 MVA transformers		1,600	1,690	1.06	September 2040	June 2040	September 2041		
Option 4C	(Pre-requisite: NE REZ Option 2B) • New Hub 6 and Hub 8 330 kV switching stations • New 330 kV DCST line from Hub 6 to Hub 8 with Twin Olive conductor • New 330 kV DCST line from Hub 8 to Hub 5 with Twin Olive conductor • New 500 kV DCST and strung on one side from Hub 5 to Hub 1 with Quad Orange conductor • Augment Hub 5 to accommodate additional lines and 1 x 500/330/33 kV 1,500 MVA transformers		1,400	880	0.63	September 2036	June 2036	September 2037		
Option 4D	(Pre-requisite: NE REZ Option 2B) • New North switching station which cuts into Sapphire – Armidale and Dumaresq – Armidale line • New 500kV built and initially 330 kV operated DCST line from North switching station to Central (Hub 5) with Quad Orange conductor • Augment Central (Hub 5) with one additional 500/330kV transformer • New 500kV DCST line strung on one side between Central (Hub 5) to Central South (Hub 1)		1,500	786	0.52	September 2036	June 2036	September 2037		

NE REZ Augmentations (AEMO REZ ID: N2) *continued*

Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delayed* Scenario		
Option 5A	(Pre-requisite: none) • New Hub 9 switching station • Establish a new Lower Creek 330/132 kV substation with 1 x 330/132 kV 375 MVA transformer • Rebuild part of Line 965 as 330 kV DCST from Armidale to Lower Creek with Twin Olive conductor • Relocate existing 132 kV 200 MVA phase shift transformer on Line 965 from Armidale to Lower Creek • New 330 kV DCST from Lower Creek to Hub 9 with Twin Mango conductor		800	647	0.81	September 2028	June 2028	September 2029		With this augmentation, up to 900 MW of additional PHES could connect
Option 5B	(Pre-requisite: NE REZ Option 5A) • New Hub 16 switching station which cuts into existing Line 87 from Armidale to Coffs Harbour • New Hub 19 switching station and cuts into the line from Armidale to Lower Creek • New 330 kV SCST line from Hub 16 to Hub 19 with Twin Mango conductor		300	218	0.73	September 2033	June 2033	September 2034		

HCC REZ Augmentations (AEMO REZ ID: N/A)

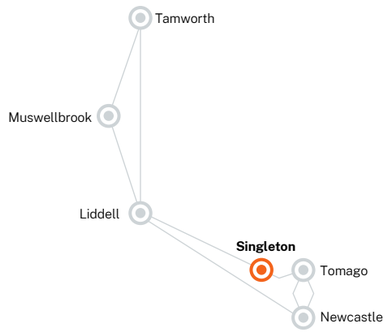
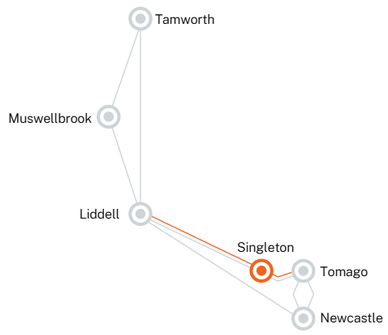
Table 4: Network augmentation options for Hunter-Central Coast REZ

Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
Option 1 (reference scope)	(Pre-requisite: None) • 1 x new 330 kV circuit from Liddell to Muswellbrook with Twin Olive conductor (17.68 km) • 1 x 330 kV DCST from East Hub to Muswellbrook • 1 x 330 kV DCST from West Hub to Muswellbrook		950*	425	0.44	December 2026	June 2026	December 2027	Included as part of network build (will be updated based on detailed power system study)	With this augmentation, up to 250 MW of additional PHES could connect
Option 2	(Pre-requisite: HCC REZ Option 1) • Cut Muswellbrook into parallel Line 84 Liddell – Tamworth (1 x 330 KV DCST around 4 km from Muswellbrook to Line 84)		700*	31	0.04	December 2030	September 2030	December 2031		

* Note that the total available downstream capacity for this and CWO REZ combined is approximately 3,000 MW until Hunter Transmission Project is commissioned. The Waratah Super Battery could provide approximately 300 MW additional capacity if paired with new generation near Muswellbrook, before Hunter Transmission Project is commissioned. Post Hunter Transmission Project, the proposed indicative transfer improvement will be achieved

** Note that the total available downstream capacity for this, Upper Hunter connection and CWO REZ combined is approximately 3,000 MW until Hunter Transmission Project is commissioned.
Post Hunter Transmission Project, the proposed indicative transfer improvement will be achieve.
Post Hunter Transmission Project+NEREZ, the total downstream capacity for this, Upper Hunter connection, CWO REZ and NE REZ combined is approximately 7,400MW

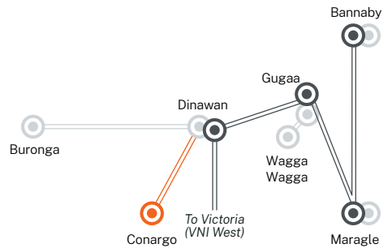
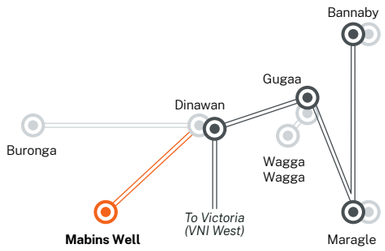
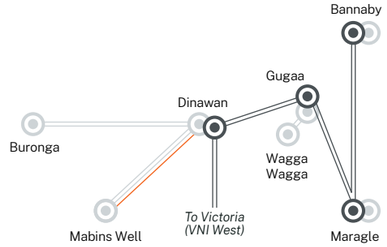
HCC REZ Augmentations (AEMO REZ ID: N/A) *continued*

Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
Option 3	(Pre-requisite: None) • New 330 kV Singleton switching station and cuts into line 82 Liddell – Tomago		500**	52	0.10	December 2026	June 2026	December 2027	Included as part of network build (will be updated based on detailed power system study)	
Option 4	(Pre-requisite: HCC REZ Option 3) • Rebuild Line 82 Liddell – Tomago via Singleton as 330 kV double circuit line		800**	945	1.18	December 2030	September 2030	December 2031		

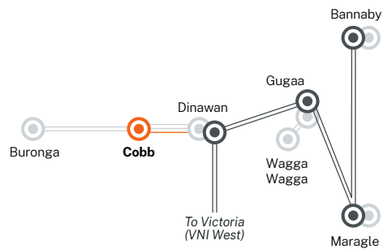
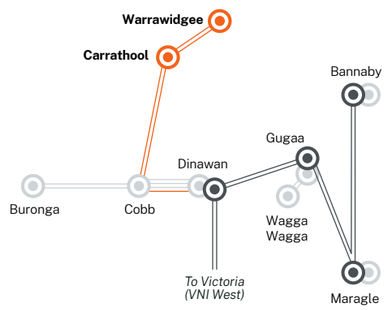
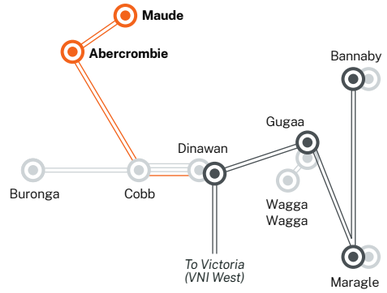
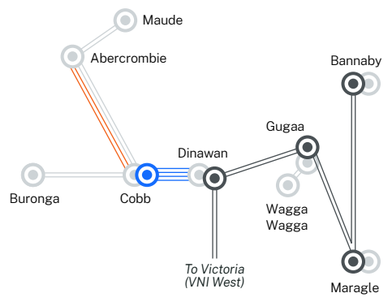
** Note that the total available downstream capacity for this, Upper Hunter connection and CWO REZ combined is approximately 3,000 MW until Hunter Transmission Project is commissioned.
Post Hunter Transmission Project, the proposed indicative transfer improvement will be achieve.
Post Hunter Transmission Project+NEREZ, the total downstream capacity for this, Upper Hunter connection, CWO REZ and NE REZ combined is approximately 7,400MW

SW REZ Augmentations (AEMO REZ ID: N5)

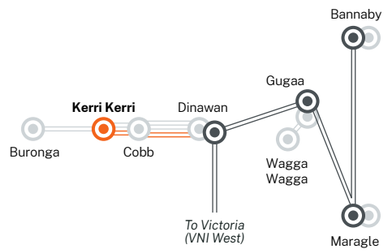
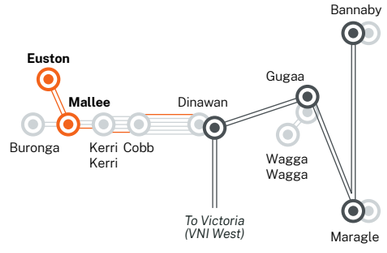
Table 3: Network augmentation options for South-West REZ

Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength Remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
Option 1	*Not used*								Included as part of network build (will be updated based on detailed power system study)	
Option 2	(Pre-requisite: Dinawan – Wagga 500 kV upgrade) • New Conargo 330 kV switching station • New 330 kV DCST line from Conargo to Dinawan with Twin Mango conductor		800	349	0.44	June 2031	March 2031	June 2032		
Option 3A	(Pre-requisite: Dinawan – Wagga 500 kV upgrade) • New Mabins Well 330 kV switching station • New 330 kV DCST line from Mabins Well to Dinawan with Twin Olive conductor		1,400	292	0.21	June 2031	March 2031	June 2032		
Option 3B	(Pre-requisite: SW REZ Option 3A) • New 330 kV SCST line from Mabins Well to Dinawan with Twin Olive conductor		1,400	241	0.17	June 2031	March 2031	June 2032		

SW REZ Augmentations (AEMO REZ ID: N5) *continued*

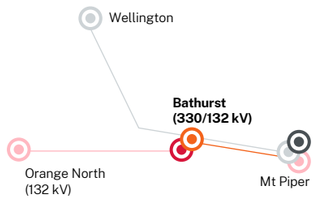
Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength Remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
Option 4	(Pre-requisite: SW REZ Option 1) • New Cobb 330 kV switching station which cuts into lines between Buronga and Dinawan • New 330 kV DCST line strung on one side from Cobb to Dinawan with Twin Olive conductor		1,400	516	0.37	June 2031	March 2031	June 2032	Included as part of network build (will be updated based on detailed power system study)	
Option 5	(Pre-requisite: SW REZ Option 4) • New Carrathool 330 kV switching station • New Warrawidgee 330 kV switching station • New 330 kV DCST line from Warrawidgee to Carrathool with Twin Mango conductor • New 330 kV DCST line from Carrathool to Cobb with Twin Olive conductor • String the other side of 330 kV line from Cobb to Dinawan		1,400	986	0.70	June 2035	March 2035	June 2036		
Option 6A	(Pre-requisite: SW REZ Option 4) • New Maude 330 kV switching station • New Abercrombie 330 kV switching station • New 330 kV DCST line from Maude to Abercrombie with Twin Mango conductor • New 330 kV DCST line from Abercrombie to Cobb with Twin Olive conductor • String the other side of 330 kV line from Cobb to Dinawan		1,400	1,043	0.74	June 2035	March 2035	June 2036		
Option 6B	(Pre-requisite: SW REZ Option 6A) • New 330 kV DCST line from Abercrombie to Cobb with Twin Olive conductor • Rebuild 4 x 330 kV lines between Cobb and Dinawan to 500 kV with Quad Orange Conductor • New 4 x 500/330/33 kV 1,500 MVA transformers at Cobb		2,800	2,519	0.90	June 2039	March 2039	June 2040		

SW REZ Augmentations (AEMO REZ ID: N5) *continued*

Option	Description	Network configuration diagrams	Additional network capacity (MW)	Total cost ($ million)	$/MW	Earliest delivery			System strength Remediation	Notes
						Central Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
Option 7A	(Pre-requisite: SW REZ Option 4) • New Kerri Kerri switching station which cuts into lines between Buronga and Cobb • New 330 kV DCST line from Kerri Kerri to Cobb with Twin Olive conductor • New 330 kV DCST line from Cobb to Dinawan with Twin Olive conductor • 4 x 330 kV 60 MVAr line shunt reactors (in total) are required for 330 kV DCST line between Kerri Kerri and Cobb		2,000	1,101	0.55	June 2035	March 2035	June 2036	Included as part of network build (will be updated based on detailed power system study)	
Option 7B	(Pre-requisite: SW REZ Option 7A) • New Euston switching station • New Mallee switching station which cuts into lines between Buronga and Kerri Kerri switching station • New 330 kV DCST line from Euston to Mallee with Twin Mango conductor • New 330 kV SCST line from Mallee to Kerri Kerri with Twin Olive conductor • New 330 kV SCST line from Kerri Kerri to Cobb with Twin Olive conductor • New 330 kV SCST line from Cobb to Dinawan with Twin Olive conductor		1,400	1,397	1.00	June 2039	March 2039	June 2040		

Shared Network Augmentations to Leverage System Benefits from Long Duration Storage

Table 5: Network augmentation options that could leverage system benefits from long duration storage

Option	Description	Network Configuration Diagrams	Additional network capacity (MW)	Total Cost ($ million)	Estimate source	Cost estimate class	$/MW	Earliest Delivery			System Strength Remediation	Notes
								Central Scenario	Early Coal Exit Scenario	Transmission Delayed Scenario		
Pumped hydro near Bathurst	• Establish a new Bathurst 330/132 kV substation with 1 x 330/132 kV 375 MVA transformer • Rebuild part of Line 949 as 330 kV circuit from Mt Piper to Bathurst with Twin Olive conductor on the same tower as portion of Line 72 Mt Piper – Wellington		325	90	AEMO TCD	Class 5b	0.28	December 2026	September 2026	December 2027	N/A	With this augmentation, up to 325 MW of additional PHES could connect

Downstream Augmentations

CNSW – NNSW

Table 6: Improvements to the CNSW – NNSW cut set are encompassed by the augmentations within the NE REZ

	Transfer Increase NNSW – CNSW (MW)	Transfer Increase NNSW – SNW (MW)
Option 1	3,000	-
Option 2A	-	3,000
Option 2B	3,000	-
Option 2C	500	3,000
Option 2D	3,500	-

CNSW – NNSW *continued*

Table 7: Downstream network augmentations that impact the CNSW – SNW flow path

Flow path	Development path	Development driver	Option name	Augmentation description	Forward direction power flow	Notional transfer level increase (MW)*		Indicative cost estimate ($ million)	Earliest delivery			Additional REZ hosting capacity provided (MW)	Notes
						Forward direction	Reverse direction		*Central* Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
CNSW-SNW	Northern side of Sydney	Retirement of coal-powered generation in New South Wales.	CNSW-SNW Option 1	SNW Northern 500 kV loop: • A new 500 kV substation near Eraring • A new 500 kV double circuit line between substation near Eraring and Bayswater substation. • Two 500/330 kV 1,500 MVA transformers either at Eraring substation or new substation near Eraring	CNSW to SNW	5,000 (This capacity increase for accommodation of additional new generation from North of Bayswater and 2/3 generation from Central West NSW)	NA	993	December 2027	September 2027	December 2028	-	With no augmentations in the SNW area, up to 235 MW of additional PHES could connect
	Northern side of Sydney	CWO REZ Development	CNSW-SNW Option 4	(Pre-requisite: CNSW-SNW Option1) • A new 500 kV Wollar South substation • Divert 3 lines from Merotherie to Wollar, to Wollar South • A new 500 kV double circuit line between Wollar South and Eraring substation with Quad Orange conductor • Two 500/330 kV 1,500 MVA transformers either at Kemps Creek • 1 x 330 kV SCST line between Vales Pt and Eraring • 1 x 330 kV SCST line between Vales Pt and Munmorah • Thermal upgrade for Line 24 Vales Pt – Eraring and 92 Newcastle – Vales Point • 1 x 330 kV SCST line between Liddell – Newcastle • 1 x 330 kV SCST line between Eraring – Newcastle	CNSW to SNW	6,000	NA	2,232	March 2031	December 2030	March 2032	N3: 6,000	

* Same increase applies to all transfer limit conditions (Peak demand, Summer typical and Winter reference)

CNSW – NNSW *continued*

Flow path	Development path	Development driver	Option name	Augmentation description	Forward direction power flow	Notional transfer level increase (MW)*		Indicative cost estimate ($ million)	Earliest delivery			Additional REZ hosting capacity provided (MW)	Notes
						Forward direction	Reverse direction		*Central* Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
CNSW-SNW	Northern side of Sydney	Retirement of coal-powered generation in New South Wales + NE REZ + CWO REZ development.	CNSW-SNW Option 6	(Pre-requisite: CNSW-SNW Option 1) • A new 500 kV double circuit line between substation near Eraring and Bayswater substation. • Two 500/330 kV 1,500 MVA transformers either at Eraring substation or new substation near Eraring • Two 500/330 kV 1,500 MVA transformers either at Kemps Creek • 1 x 330 kV SCST line between Vales Pt and Eraring • 1 x 330 kV SCST line between Vales Pt and Munmorah • Thermal upgrade for Line 24 Vales Pt – Eraring and 92 Newcastle – Vales Point • 1 x 330 kV SCST line between Liddell – Newcastle • 1 x 330 kV SCST line between Eraring – Newcastle	CNSW to SNW	6,000	NA	1,766	March 2031	December 2030	March 2032	N2: 6,000	With no augmentations in the SNW area, up to 235 MW of additional PHES could connect

* Same increase applies to all transfer limit conditions (Peak demand, Summer typical and Winter reference)

CNSW – NNSW *continued*

Flow path	Development path	Development driver	Option name	Augmentation description	Forward direction power flow	Notional transfer level increase (MW)*		Indicative cost estimate ($ million)	Earliest delivery			Additional REZ hosting capacity provided (MW)	Notes
						Forward direction	Reverse direction		*Central* Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
CNSW-SNW	Southern side of Sydney	Retirement of coal-powered generation in New South Wales.	CNSW-SNW Option 2	SNW Southern 500 kV loop: • A new 500 kV double circuit line from the Bannaby substation to a new Overhead/Underground Transition site. • 8 km of tunnel installed underground 500 kV cables from Transition site to new substation in the locality of South Creek. • Establish 500/330 kV substation in the locality of South Creek. • Cut-in both Eraring – Kemps Creek 500 kV circuits at the new substation in the locality of South Creek. • Two new 500/330 kV 1,500 MVA transformers at the new substation in the locality of South Creek. • Replace a section of existing Bannaby-Sydney West 330 kV to double circuit line between the locality of South Creek and Sydney West. • Uprate the existing line between Bannaby and the locality of South Creek from 85 degrees to 100 degrees operating temperature. • Cut-in Bayswater – Sydney West 330 kV line at South Creek. • Cut-in Regentville – Sydney West 330 kV line at South Creek.	CNSW to SNW	4,500 (This capacity increase for accommodation of additional new generation from South of Bannaby and 1/3 generation from Central West NSW	NA	1,843	March 2031	December 2030	March 2032	-	With no augmentations in the SNW area, up to 235 MW of additional PHES could connect
	Northern and Southern sides of Sydney	Retirement of coal-powered generation in New South Wales.	CNSW-SNW Option 3	Both SNW Northern 500 kV loop and SNW Southern 500 kV loop: • CNSW-SNW Option 1. • CNSW-SNW Option 2.	CNSW to SNW	5,600 (No restriction to generation dispatch from north, south and west of SNW)	NA	2,827	March 2031	December 2030	March 2032	-	

* Same increase applies to all transfer limit conditions (Peak demand, Summer typical and Winter reference)

CNSW – NNSW *continued*

Flow path	Development path	Development driver	Option name	Augmentation description	Forward direction power flow	Notional transfer level increase (MW)*		Indicative cost estimate ($ million)	Earliest delivery			Additional REZ hosting capacity provided (MW)	Notes
						Forward direction	Reverse direction		*Central* Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
CNSW-SNW	Southern side of Sydney	SW REZ Development	CNSW-SNW Option 5B	(Pre-requisite: CNSW-SNW Option 2) • A new 500 kV DCST from the Bannaby substation to the substation in the locality of South Creek. • Expand Kemps Creek substation with 4 additional 500/330 kV transformers • A new 500 kV DCST from the South Creek substation to Kemps Creek • A new 330 kV DCST between Kemps Creek and Sydney South • A new 330 kV DCST between Kemps Creek and Sydney North • A new 330 kV DCST between South Creek and Sydney West	CNSW to SNW	6,000	NA	1,733	March 2035	December 2034	March 2036	N5: 6,000	With no augmentations in the SNW area, up to 235 MW of additional PHES could connect
	Bayswater to Newcastle	Hydrogen scenario – To provide access to port near Newcastle.	H-Newcastle (This is not an alternative option to supply SNW)	Three new 500 kV lines from Bayswater to Newcastle. Four new 500/330 kV transformers at Newcastle. Line shunt reactors at each of the new 500 kV lines.	CNSW to SNW	5,000	5,000	1,561	March 2031	December 2030	March 2032		
	Bannaby to Dapto	Hydrogen scenario – To provide access to port near Dapto.	H-Dapto (This is not an alternative option to supply SNW)	Three new 500 kV lines from Bannaby to Dapto. Four new 500/330 kV transformers at Dapto. Line shunt reactors at each of the new 500 kV lines.	CNSW to SNW	5,000	5,000	1,229	March 2031	December 2030	March 2032		

* Same increase applies to all transfer limit conditions (Peak demand, Summer typical and Winter reference)

SNSW – SNW

Table 8: Downstream network augmentations that impact the CNSW – SNW flow path

Flow path	Development path	Development driver	Option name	Augmentation description	Forward direction power flow	Notional transfer level increase (MW)*		Indicative cost estimate ($ million)	Earliest delivery			Additional REZ hosting capacity provided (MW)	Notes
						Forward direction	Reverse direction		*Central* Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
SNSW-CNSW	HumeLink	To provide access to Snowy 2.0 generation to load centres in SNW.	SNSW-CNSW Option 1 (HumeLink)	• New Gugaa 500/330 kV substation and 330 kV double circuit connection to the existing Wagga Wagga 330 kV substation. • Three new 500 kV transmission lines: – Between Maragle and Bannaby 500 kV substations; – Between Maragle and Gugaa 500 kV substations; and – Between Gugaa and Bannaby 500 kV substations. • Three 500/330 kV 1,500 MVA transformers at Maragle. • Two 500/330 kV 1,500 MVA transformers at Gugaa. • 500 kV Line shunt reactors at the ends of Maragle – Bannaby, Maragle – Gugaa and Gugaa – Bannaby 500 kV lines	SNSW to CNSW	2,200	2,200	3,324**	June 2027	June 2026	June 2028	N6+N7: 2,200 (N6: 1,500)	
	Wagga Wagga to Bannaby	Increased import from Victoria and South Australia with high existing and Snowy 2.0 hydro generation	SNSW-CNSW Option 2	• An additional new 500 kV line from Gugaa to Bannaby. *(Pre-requisite: HumeLink)*	SNSW to CNSW	2,000	2,000	962	June 2031	March 2031	June 2032	N6: 1,500	
			SNSW-CNSW Option 4A	(Pre-requisite: HumeLink) • An additional new 500 kV DCST line from Dinawan to Gugaa • An additional new 500 kV DCST line from Gugaa to Bannaby • 4 additional new 500/330/33 kV 1500 MVA transformers at Dinawan	SNSW to CNSW	6,000	6,000	3,711	June 2031	March 2031	June 2032	N5: 6,000	

* Same increase applies to all transfer limit conditions (Peak demand, Summer typical and Winter reference)

** Cost estimate sourced from Transgrid, of unknown cost estimate class

SNSW – SNW *continued*

Flow path	Development path	Development driver	Option name	Augmentation description	Forward direction power flow	Notional transfer level increase (MW)*		Indicative cost estimate ($ million)	Earliest delivery			Additional REZ hosting capacity provided (MW)	Notes
						Forward direction	Reverse direction		*Central* Scenario	*Coal Exit by 2030 and Strong Electrification* Scenario	*Transmission Delay* Scenario		
SNSW-CNSW	Wagga Wagga to Bannaby	Increased import from Victoria and South Australia with high existing and Snowy 2.0 hydro generation	SNSW-CNSW Option 4B	(Pre-requisite: HumeLink) • An additional new 500 kV SCST line from Dinawan to Gugaa • An additional new 500 kV SCST line from Gugaa to Bannaby • 2 additional new 500/330/33 kV 1500 MVA transformers at Dinawan	SNSW to CNSW	3,000	3,000	2,065	June 2031	March 2031	June 2032	N5: 3,000	
			SNSW-CNSW Option 3	• HVDC between Wagga Wagga and Bannaby: • A 2000 MW bi-pole overhead transmission line from locality of Bannaby to locality of Wagga Wagga. • A new 2,000 MW bipole converter station in locality of Bannaby. • A new 2,000 MW bipole converter station in locality of Wagga Wagga. • AC network connection between new HVDC converter station in the locality of Bannaby and the existing Bannaby 500 kV substation. • AC network connection between HVDC converter station in the locality of Wagga Wagga and Gugaa 500 kV substation. (Assumption: This option comes after HumeLink)	SNSW to CNSW	2,000	2,000	2,490	June 2031	March 2031	June 2032	N6: 2,000	

* Same increase applies to all transfer limit conditions (Peak demand, Summer typical and Winter reference)

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Cover image courtesy of GettyImages. Wind turbines silhouetted on a ridgeline at sunset.

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