ATTACHMENT A – TRANSGRID PROJECT ASSESSMENT REPORTS

INDEPENDENT PLANNING REVIEW

Published: **August 2014**

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TABLES

FIGURES

1 – JURISDICTIONAL PLANNING CRITERIA

TransGrid must adhere to jurisdictional licence obligations when making transmission network investment decisions. These are set out in the following documents:

- For New South Wales: Transmission Network Design and Reliability Standard, published by New South Wales Department of Trade and Investment.[1]
- For the Australian Capital Territory: Disallowable Instrument DI2012-267: Utilities Exemption 2012 (No. 3), 2012, published by the ACT Government.[2]

In New South Wales, TransGrid is required to plan and develop its transmission network on an “N-1” basis. There must not be any loss of load following an outage of a single element (line or transformer) during periods of high customer demand unless TransGrid has specifically agreed otherwise with the affected distribution network owner or major directly connected end-use customer. Under this planning criteria, the TransGrid transmission network should be able to withstand:

- A single contingency under all reasonably probable patterns of generation dispatch or interconnection power flow for a 50% POE demand.
- A single contingency under a limited set of patterns of generation dispatch or interconnection power flow for a 10% POE demand.

Additionally, the planning criteria requires that the network in the Sydney metropolitan area should be able to withstand:

- the simultaneous outage of a single 330 kV cable and any 132 kV feeder or 330/132 kV transformer, or
- the outage of any section of 132 kV busbar.

Up to 30 minutes is allowed between the outage of a single 330 kV cable and any 132 kV feeder or 330/132 kV transformer for operational switching to improve network capability. This is referred to as a “modified N-2” requirement.

[1] New South Wales Government. *Transmission Network Design and Reliability Standard for NSW*. Available: http://www.trade.nsw.gov.au/__data/assets/pdf_file/0019/374302/nsw-transmission-network-design-and-reliability-standard.pdf. Viewed 18 July 2014.

[2] ACT Government. Utilities Exemption 2012 (No 3). Available: http://www.legislation.act.gov.au/di/2012-267/current/pdf/2012-267.pdf Viewed: 18 July 2014.

2 – CAPACITY-DRIVEN NETWORK AUGMENTATION PROJECTS

Table 1: TransGrid's proposed network augmentation projects

Project	Proposed commissioning date	AEMO need assessment	Page
Supply to Gunnedah, Narrabri and Moree	2020	Justified network need.	4
Supply to the Inner Sydney Area	2018 (contingent project)	Need contingent on future demand growth, DM levels, cable condition.	11
Snowy to Sydney 330 kV System Upgrade	2019 (contingent project)	Need contingent on market benefit assessment, and following enablement of dynamic ratings as per NCIPAP submission.	17
Development of Southern Supply to the Australian Capital Territory	2020	Justified network need.	21

2.1 Supply to Gunnedah, Narrabri and Moree

The Gunnedah–Narrabri–Moree area is supplied by a 132 kV network that connects to Armidale in the north. Expansion of mining at Boggabri could lead to the network supplying the Gunnedah, Narrabri, and Moree substations exceeding its capacity.

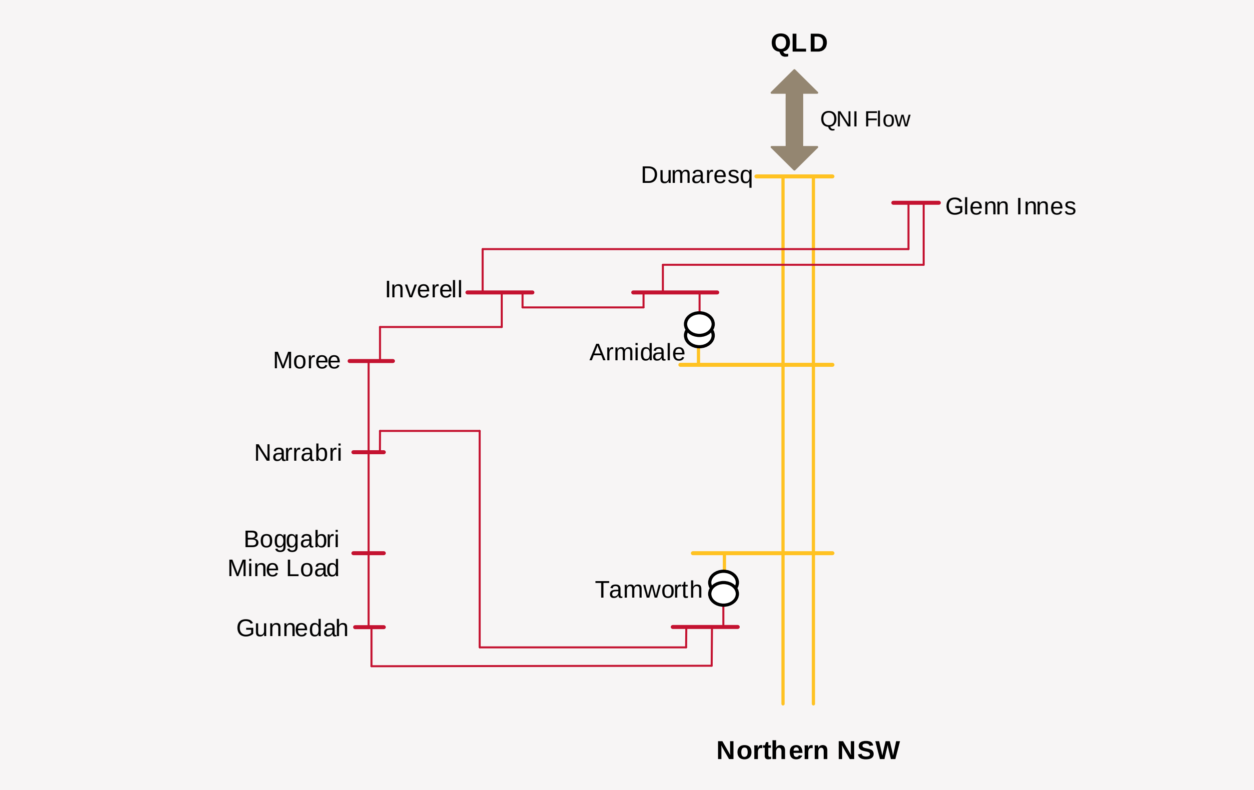
To address this issue, TransGrid propose to install a phase shifting transformer at Tamworth on the Tamworth-Gunnedah line 969.

Background

Figure 1 shows an overview of the study network AEMO has used to assess the network around the Gunnedah area.

For the purposes of this study, the Gunnedah area load consists of load supplied from substations at Gunnedah, Narrabri, and Moree. These loads are fed through five main 132 kV lines: Tamworth–Gunnedah line 969, Gunnedah–Narrabri line 9U3, Moree–Narrabri line 96M, Inverell–Moree line 9U2, and Tamworth–Narrabri line 968.

Figure 1: Gunnedah–Narrabri–Moree area transmission network



AEMO considered both summer day and winter night conditions; although peak demand for the region occurs in winter, the summer peak coincides with conditions that result in lower line thermal ratings.

Key elements and their continuous post contingency ratings are shown in Table 2.

Table 2: Continuous post-contingency of critical network elements in the Gunnedah–Narrabri–Moree area

Network element	Ratings (MVA)	
	Summer day	Winter night
Tamworth–Narrabri line 132 kV 968	122	131
Tamworth–Gunnedah line 132 kV 969	82	91
Gunnedah–Narrabri line 132 kV 9U3	82	91
Moree–Narrabri line 132 kV 96M	110	122
Inverell–Moree line 132 kV 9U2	101	101

New South Wales reliability criteria require that TransGrid plan and develop its transmission network on an “N-1” basis. This means, unless specifically agreed by TransGrid and the affected distribution network owner or major directly connected end-use customer, there must be no loss of load following an outage of a single element (line or transformer) during periods of high customer demand.

The network should be able to withstand a single contingency under all reasonably probable patterns of generation dispatch or interconnection power flow for a 50% POE demand. For a 10% POE demand, the network should be able to withstand a single contingency under a limited set of patterns of generation dispatch or interconnection power flow.

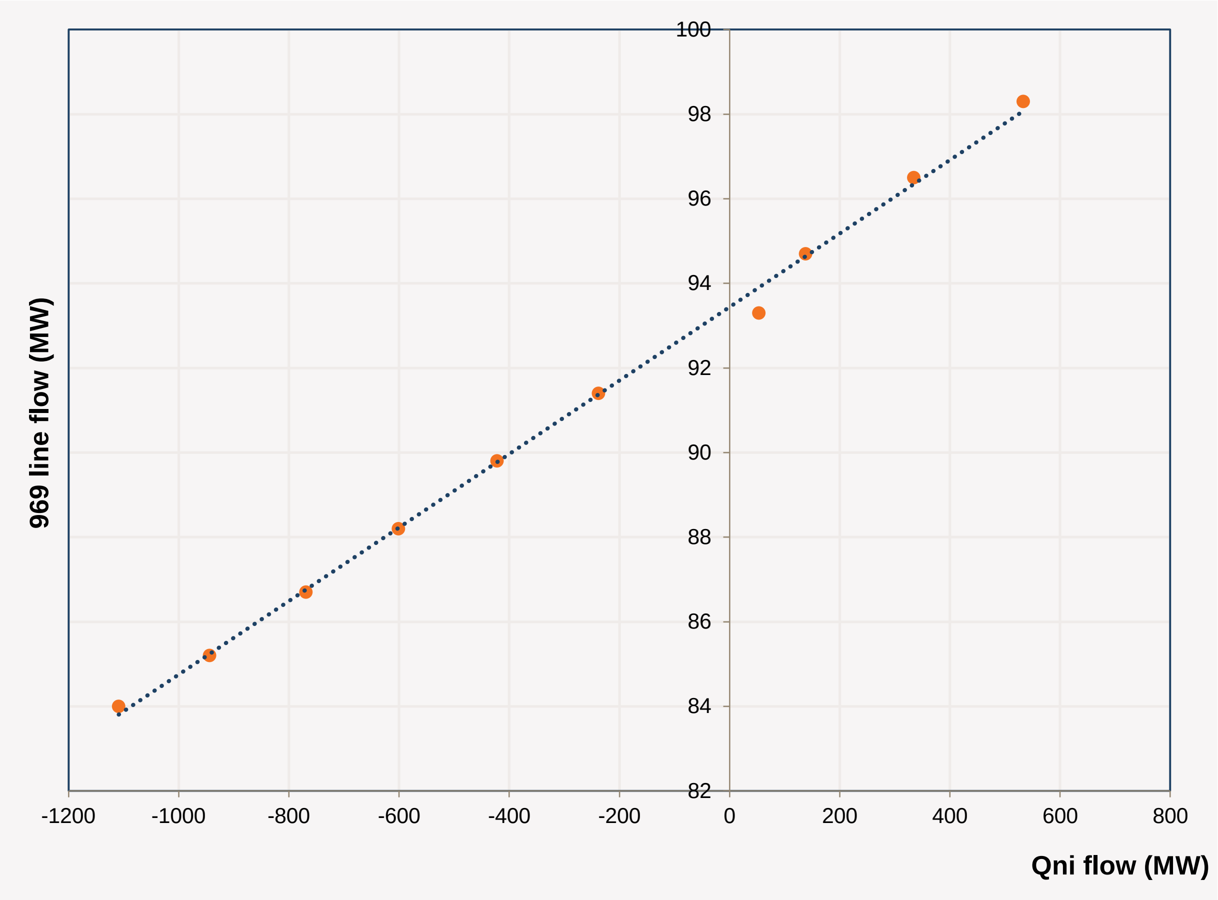
The current flow through all remaining in-service items must remain at, or below, the appropriate continuous post-contingency rating and the voltage at each bulk supply point should be between 90% and 110% of nominal voltage.

Network capability analysis

AEMO performed a study on the 132 kV network supplying the Gunnedah area load to determine the maximum supportable demand given the New South Wales reliability criteria. The most critical contingency identified is the loss of Tamworth–Narrabri 132 kV line 968 causing the overload of Tamworth–Gunnedah 132 kV line 969. This contingency was deemed the most critical as it caused the greatest level of post-contingent loading on the remaining network elements.

The maximum supportable demand that can be supplied in the Gunnedah area is dependent on the Bulli Creek–Dumaresq 330 kV Queensland–New South Wales Interconnector (QNI) flow. If power flow on QNI is from Queensland to New South Wales, then the power flow on line 969 is less than it would be if power were flowing from New South Wales to Queensland. This relationship is demonstrated in Figure 2.

Figure 2: Impact of QNI flow direction on line 969 flow in summer



AEMO also applied a probabilistic study on the 132 kV network to compare future load traces to the maximum supportable demand incorporating the variable of QNI flow and a new solar farm at Moree.

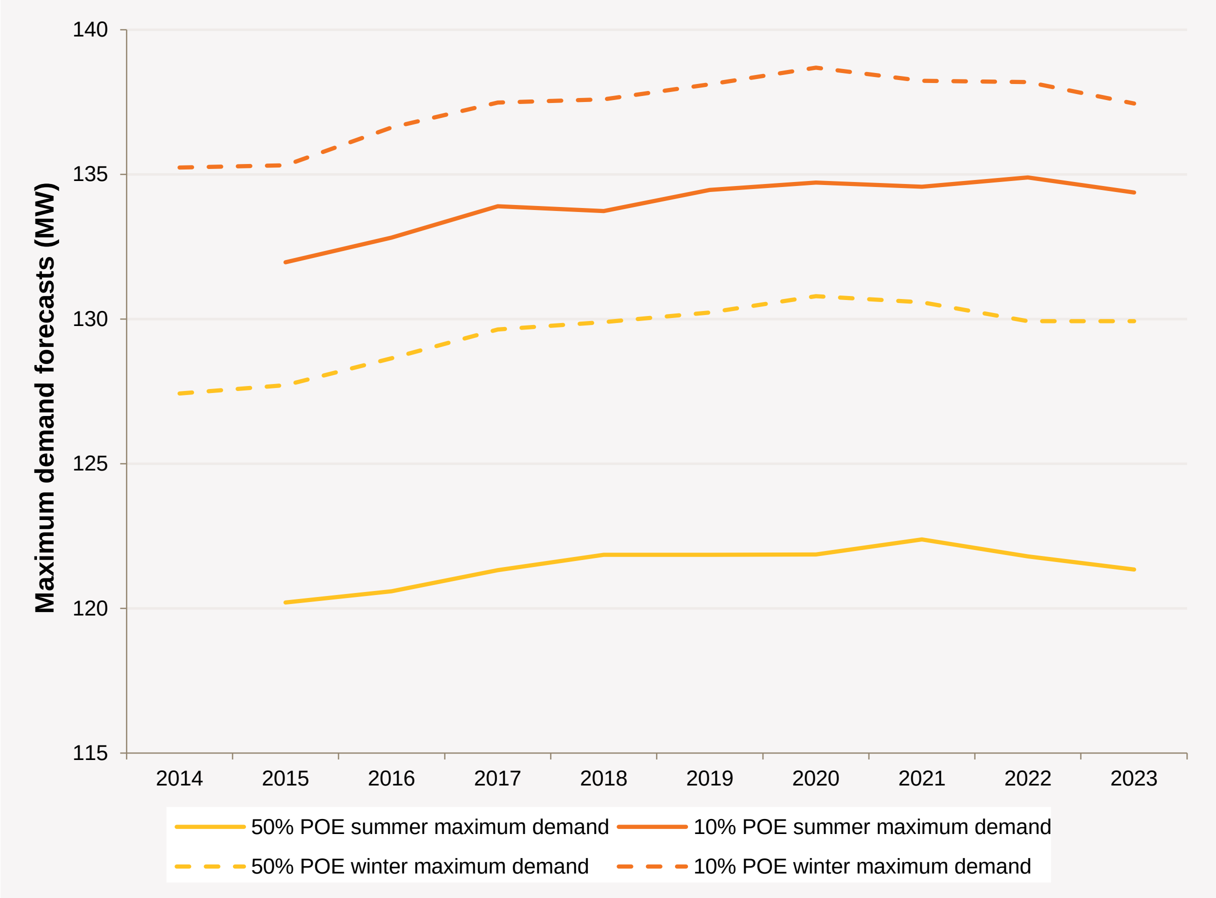
Projected demand

AEMO produces connection point level demand forecasts to accurately assess the timing of any project needed to address supply issues in the Gunnedah area.

For the purposes of this assessment AEMO produced an estimate of the Gunnedah area demand projections.

As demonstrated in Figure 3, AEMO's forecasts show Gunnedah demand to grow until 2020, followed by a period of gradual decline until 2023 for both 50% POE and 10% POE.

Figure 3: Gunnedah area 10-year demand forecast



Network capability with additional reactive support at Narrabri

The tables below show the maximum supportable demand calculated for the Gunnedah area. The calculation of the maximum supportable demand used a value of 20 MW for the Boggabri mining load[3].

Additional reactive support was added to the Narrabri 132 kV substation to maintain and correct network voltage levels. These preliminary studies identify that a maximum of 40 MVAr reactive support at Narrabri is needed to maintain the voltage levels within acceptable operating limits.

[3] TransGrid. Transmission Annual Planning Report 2014. Available http://www.transgrid.com.au/network/np/Documents/Annual%20Planning%20Report%202013.pdf. Viewed 18 July 2014

Table 3: Gunnedah–Narrabri–Moree area summer maximum supportable demand results

Connection Point	Maximum Supportable Demand (300 MW QNI flowing north)	Maximum Supportable Demand (950 MW QNI flowing south)
Gunnedah	22.23	25.72
Narrabri	41.91	48.48
Moree	23.15	26.79
Boggabri Mine Load	20.00	20.00
Total	107.30	121.00

Figure 4: Gunnedah area 10-year summer connection point forecasts (50% POE) for two maximum supportable demand scenarios

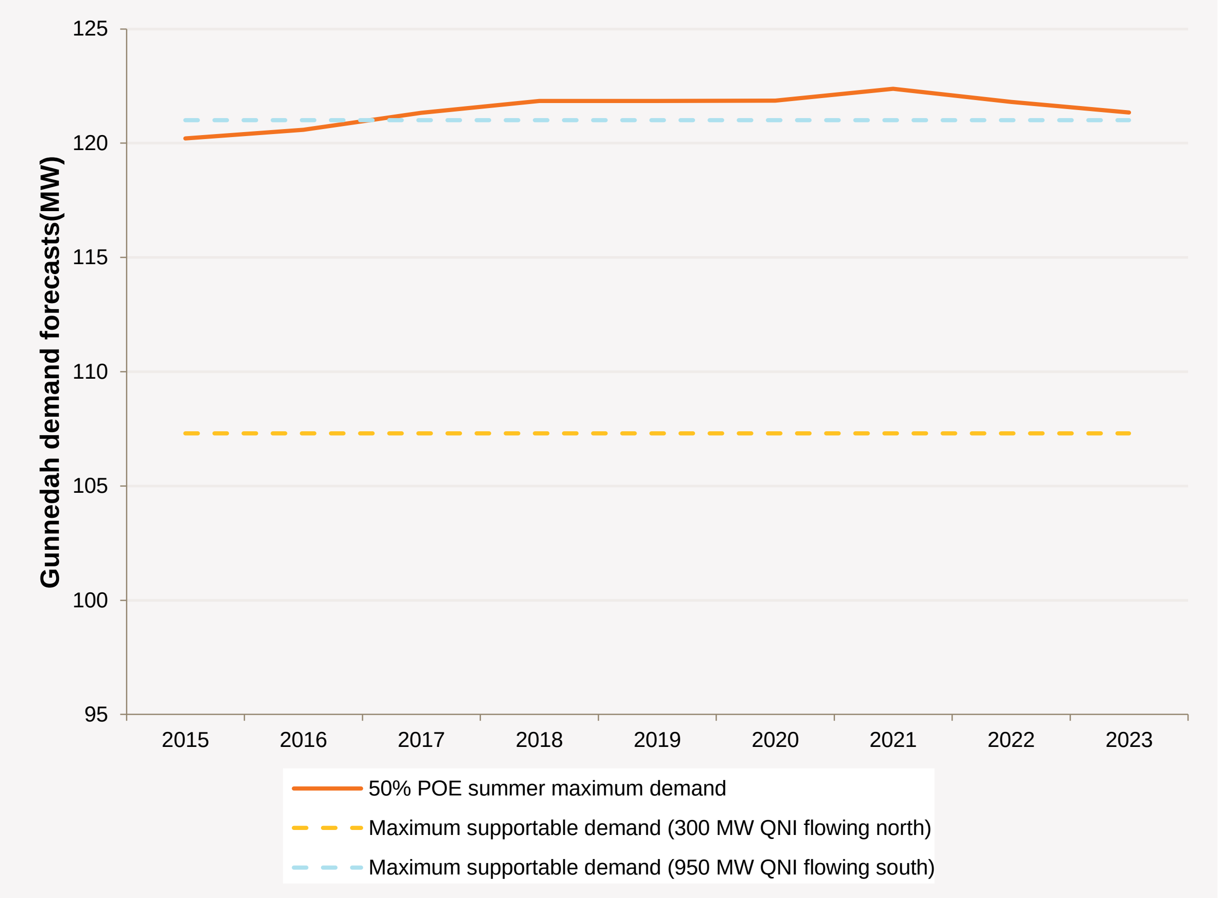
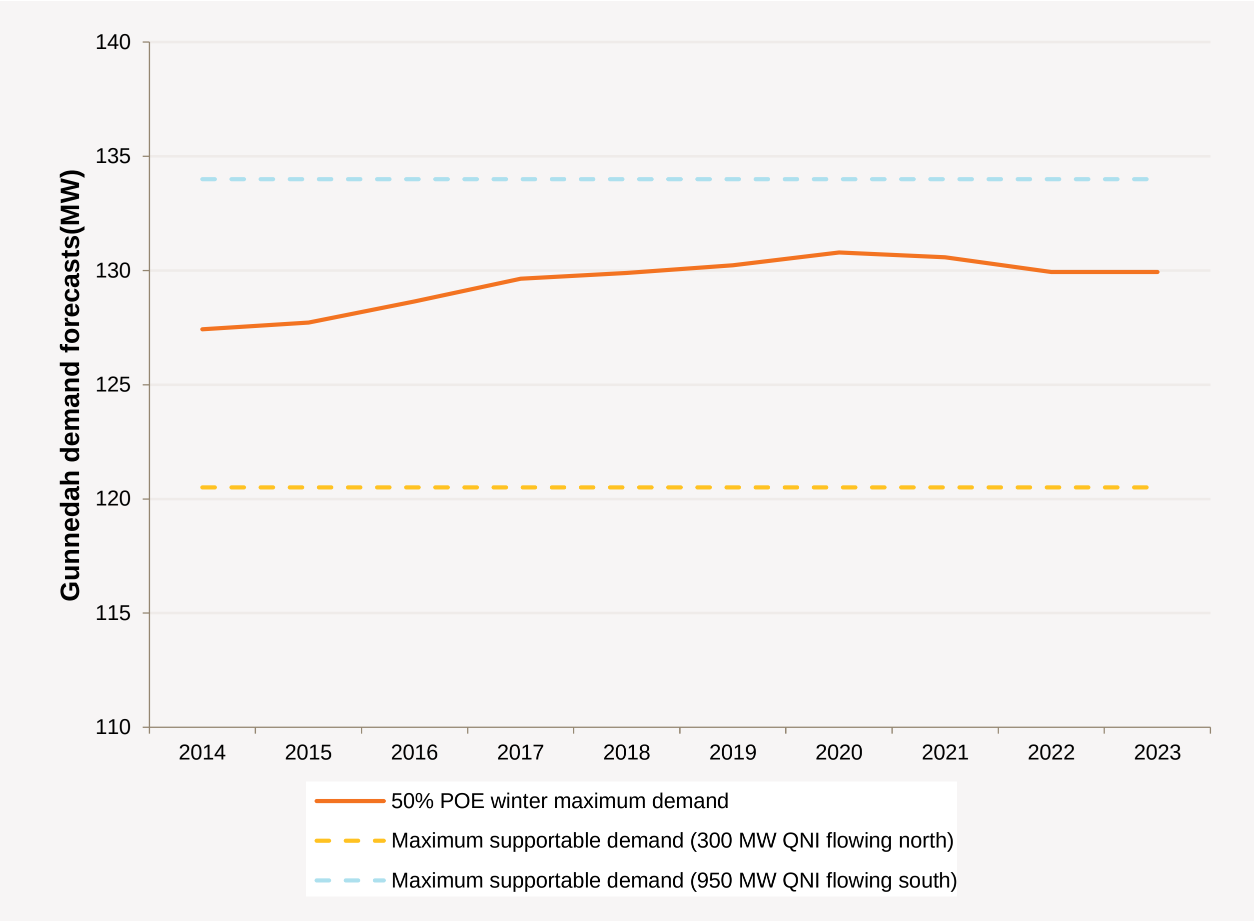


Table 4: Gunnedah–Narrabri–Moree area winter maximum supportable demand results

Connection Point	MSD (300MW QNI flowing north)	Maximum Supportable Demand (950 MW QNI flowing south)
Gunnedah	21.06	23.89
Narrabri	43.99	49.90
Moree	35.46	40.22
Boggabri Mine Load	20.00	20.00
Total	120.50	134.00

Figure 5: Gunnedah area 10-year winter connection point forecasts (50% POE) for two maximum supportable demand scenarios

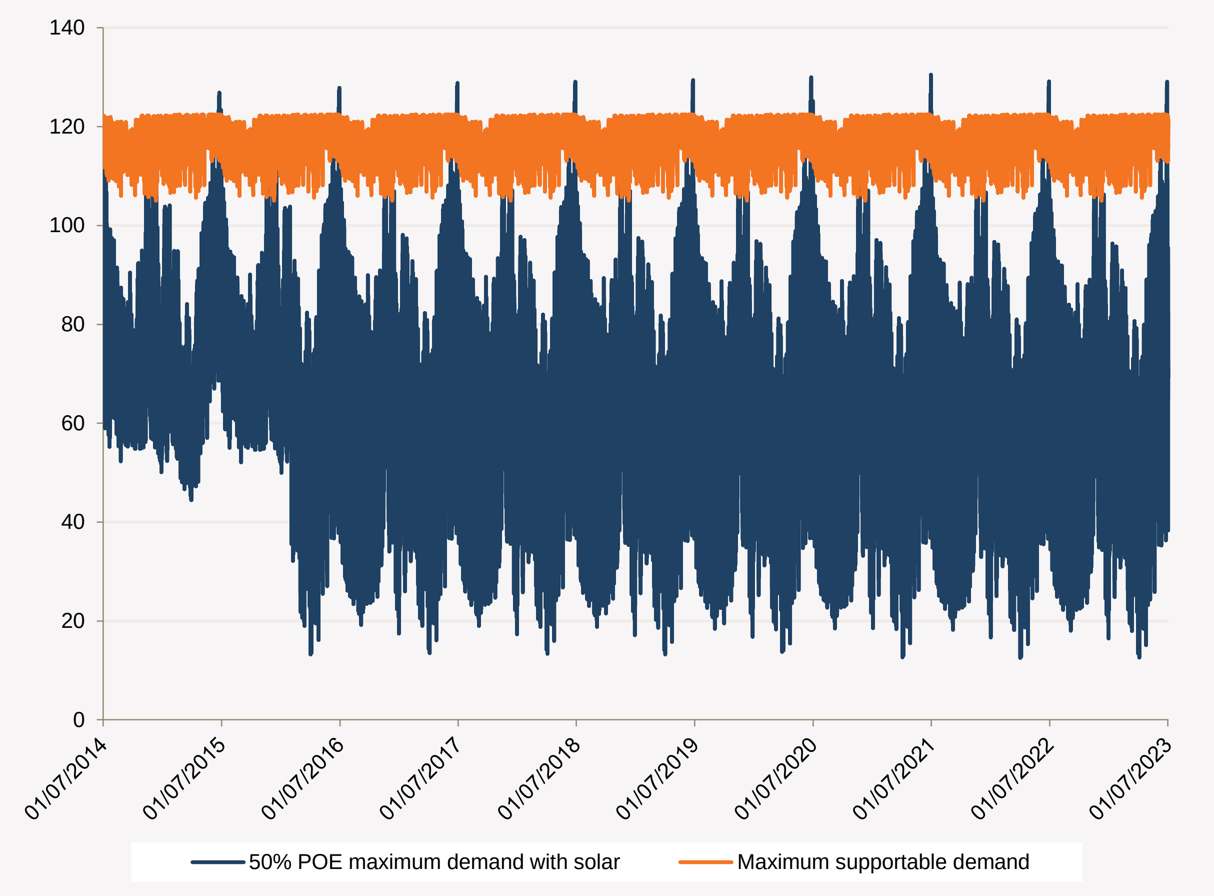


A committed solar generation project connected to the Moree substation is expected to be commissioned in 2016. This additional generation will help reduce the amount of energy at risk in the network around the Gunnedah area.

To capture the potential impact of the solar project, the Gunnedah area maximum supportable demand was calculated as a function of QNI flow. The calculated maximum supportable demand was compared against projected Gunnedah area demand.

The results, in Figure 6, show that although there is a significant reduction in the energy at risk in summer, the energy at risk in winter remains relatively unchanged. Also given the intermittent nature of the generation, in applying the New South Wales reliability standards, the amount of firm capacity (which is the amount of generation capacity that can be relied on at times of peak demand) of the solar farm generator can contribute needs to be considered when determining the best option to address the Gunnedah supply limitation.

Figure 6: Gunnedah area 50% POE forecast and maximum supportable demand



Application of planning criteria

The transmission network planning criteria applying in New South Wales requires that the network should be able to withstand a single contingency under all reasonably probable patterns of generation dispatch or interconnection power flow for a 50% POE demand. The network for a 10% POE demand should be able to withstand a single contingency under a limited set of patterns of generation dispatch or interconnection power flow.[4]

The maximum supportable demand that can be supplied when additional reactive support is provided at Narrabri substation in summer is 107 MW when QNI has maximum flow north and 121 MW when QNI has maximum flow south. For winter, the maximum supportable demand is 120 MW when QNI is flowing north and 134 when QNI is flowing south.

[4] New South Wales Government. *Transmission Network Design and Reliability Standard for NSW*. Available: http://www.trade.nsw.gov.au/__data/assets/pdf_file/0019/374302/nsw-transmission-network-design-and-reliability-standard.pdf. Viewed 18 July 2014.

The results of AEMO's assessment show that under 50% POE conditions, energy is at risk when QNI is flowing north in both summer and winter. Therefore, augmentation options and demand-side management should be considered to alleviate these issues.

Conclusion

AEMO's analysis indicates that augmenting the network by constructing a new 132kV line from Tamworth to Gunnedah will not be required in the medium term due to the relatively small amount of demand at risk over the 10-year forecast period. AEMO considers that this energy at risk may be contracted and resolved through demand side management or other more economic options.

While it has not undertaken detailed studies, AEMO considers:

- TransGrid's proposal to install a phase shifting transformer connecting into 969 line to induce more flow through line 9U2 to supply the Gunnedah area is a credible option.
- Installing reactive power support at key locations, together with Moree solar PV generation dispatch and demand side management may be a credible option.

2.2 Supply to the inner Sydney area

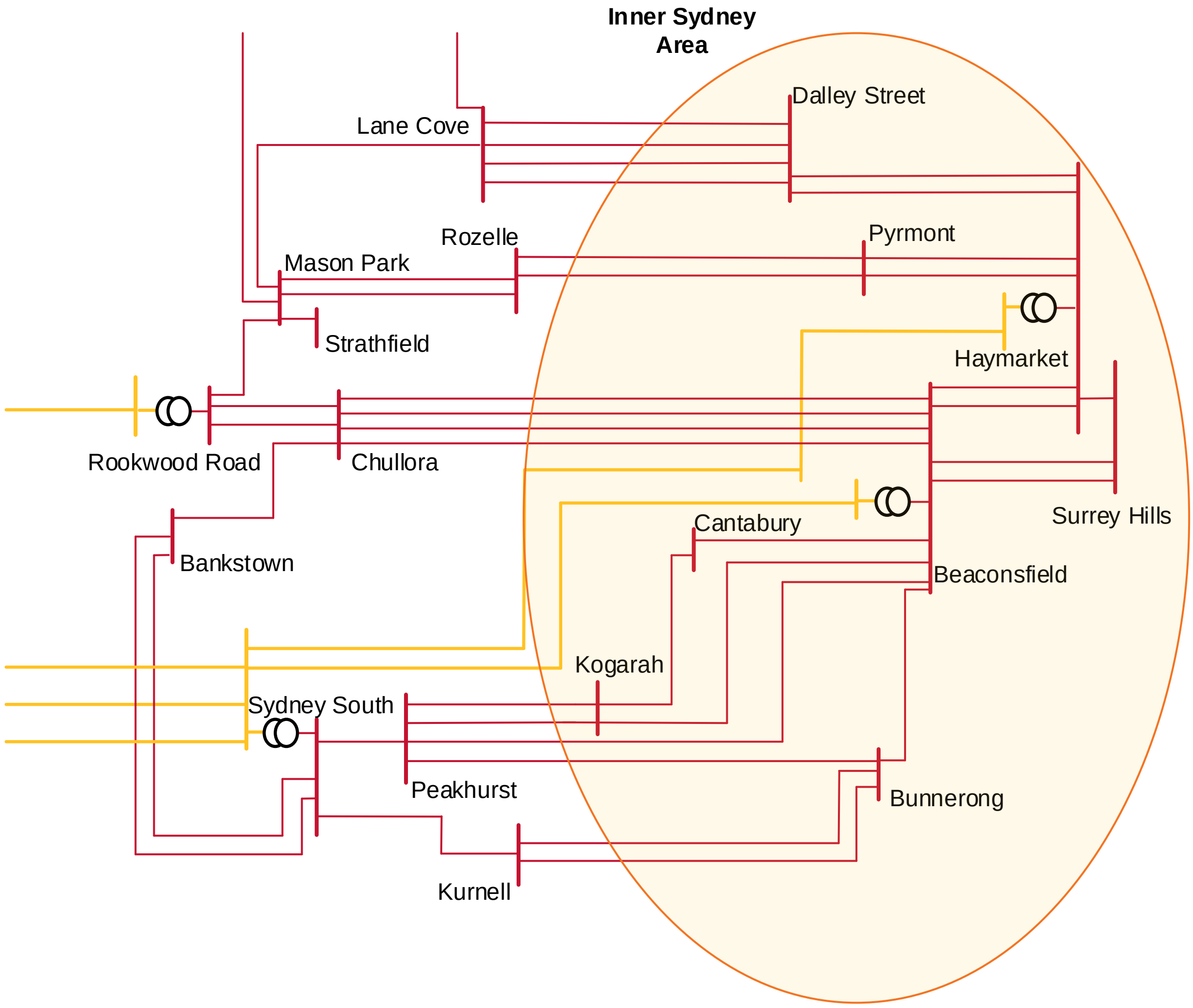
The security of supply to the inner Sydney area could be affected by a number of recent and upcoming events. TransGrid and Ausgrid, the Transmission Network Service Providers (TNSPs) servicing the inner Sydney area, have decreased the rating of the Sydney South-Beaconsfield 330 kV cable and multiple 132 kV cables. In addition, Ausgrid are planning to retire an additional multiple 132 cables feeding the inner Sydney area. These events reduce the capacity of the network to meet growing inner Sydney area demand.

To address these issues TransGrid propose to purchase demand-side responses in the Sydney area, then build a new 330 kV cable from Rookwood Road substation to Beaconsfield substation.

Background

TransGrid and Ausgrid provide transmission supplying the inner Sydney area as shown in Figure 7. Most supply emanates from TransGrid's Sydney South, Beaconsfield, and Haymarket 330/132 kV transformation Bulk Supply Point (BSP) substations, connected by paralleled 330 kV and 132 kV underground cable transmission lines. Figure 7 also highlights key network capability stress points.

Figure 7: Inner Sydney area transmission network



The TNSPs identified emerging constraints due to the following key factors:

- Derating of Sydney South–Beaconsfield 330 kV cable 41.
- Retirement of Ausgrid 132 kV cables approaching the end of their life.
- Degradation of 132 kV cables in the inner Sydney area.
- Inner Sydney area load growth.

Table 5: lists the 132 kV cables in the inner Sydney area facing limitations and requiring retirement, replacement or refurbishment over the next 10-years.

Table 5: Inner Sydney Ausgrid 132 kV cable limitations

Cable name	Source	Destination	Expected limitation date
91M/1	Peakhurst	Beaconsfield	2016-7
928/3	Lane Cove	Dalley St	2018-19
92L/3	Lane Cove	Dalley St	201516
92M/1	Lane Cove	Dalley St	2015-16
929	Lane Cove	Dalley St	2018-19
92C (formerly 91A/2) [5]	St Peter	Chullora	2018-19
90T	Haymarket	Green Square	2021-22
9S2	Beaconsfield	Haymarket	2021-22
92X (formerly 91B/2)	St Peter	Chullora	2022-23
91X	Chullora	Beaconsfield	2022-23
91Y	Chullora	Beaconsfield	2022-23
9SA	Beaconsfield	Campbell St	2023-24
9SB/1	Beaconsfield	Surry Hills Annex	2023-24

The 2014 TransGrid Transmission Annual Planning Report (TAPR)[6], section 7.2.2.2, suggests that higher-than-expected soil temperatures and changes to the condition of the cable bedding and backfill have led to a number of cable rating a reductions. The affected cables include the Sydney South-Beaconsfield 330 kV cable 41, and multiple 132 kV cables.

These ratings are constantly reviewed and, consequently, the cable ratings may be revised if conditions change.

Network capability analysis

The Transmission Network Design and Reliability Standard for New South Wales specifies the inner Sydney area network planning requirements as follows:

A target reliability standard for the inner Sydney metropolitan area shall be jointly developed so that the system will be capable of meeting the peak load under the following contingencies:

a) *The simultaneous outage of a single 330 kV cable and any 132 kV feeder or 330/132 kV transformer; or*

b) *An outage of any section of 132 kV busbar.*

Thus an 'n-1' criterion shall be applied separately to the two networks.

Up to 30 minutes between the two contingencies is allowed for operational switching to improve network capability. This requirement is referred to as a "modified N-2" requirement.

AEMO performed a study on the 330 kV and 132 kV network supplying the inner Sydney area load to determine the maximum supportable demand given the New South Wales reliability criteria. The most critical contingency identified is the loss of South-Haymarket 330 kV cable 42 combined with one of the inner Sydney 132 kV cables. This contingency was deemed the most critical as it caused the greatest level of post-contingent loading on the remaining network elements.

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[5] Cables 91A/2 and 91B/2 have been renamed 92C and 92X respectively.

[6] TransGrid. *Transmission Annual Planning Report 2014*. Available http://www.transgrid.com.au/network/np/Documents/Annual%20Planning%20Report%202013.pdf. Viewed 18 July 2014.

For the purposes of defining maximum supportable demand, AEMO defines the inner Sydney area demand as the sum of the power flow into each of the cables listed in Table 6:

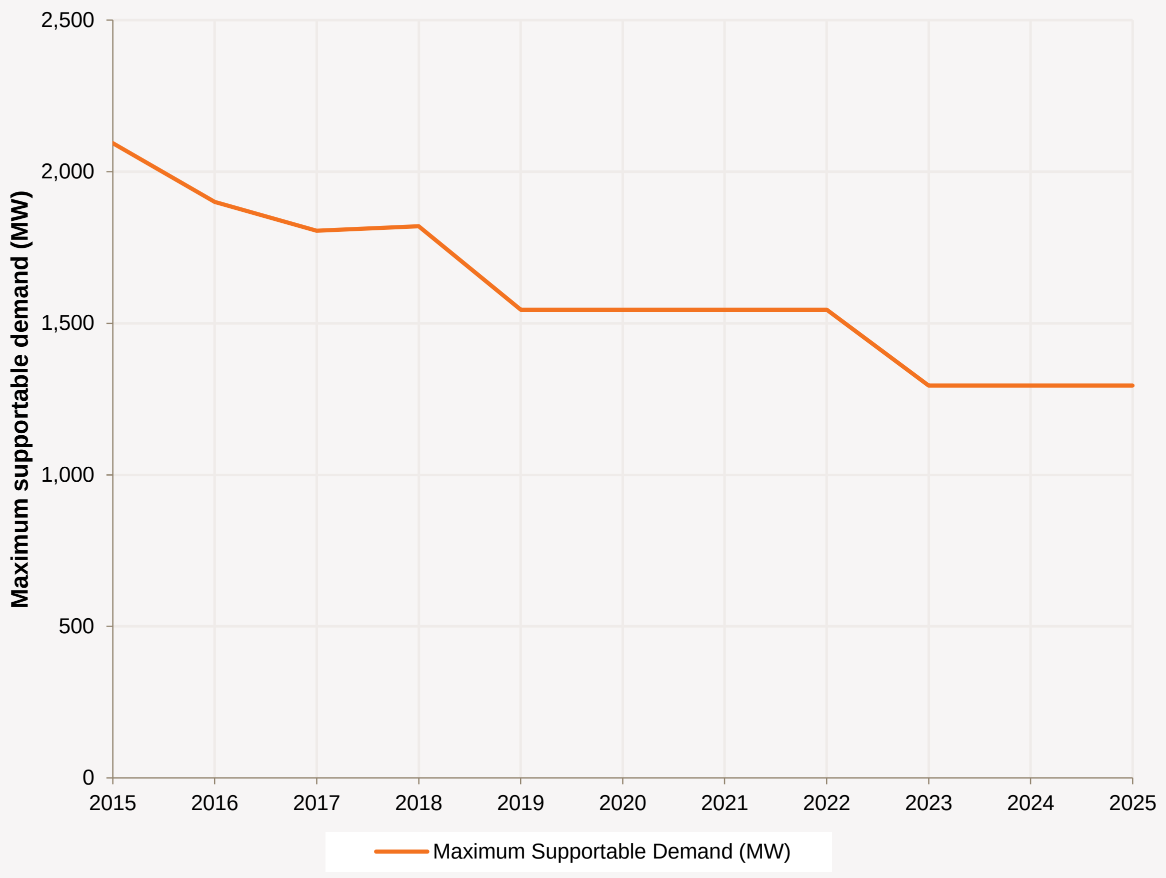
Table 6: Inner Sydney area cables used to define demand

Circuit	From	To	Voltage (kV)
41	Sydney South	Beaconsfield	330
42	Sydney South	Haymarket	330
91M/1	Beaconsfield	Peakurst	132
92C (91A/2)	St Peters	Chullora	132
92X (91B/2)	St Peters	Chullora	132
91X/2	Marrickville	Chullora	132
91Y/2	Marrickville	Chullora	132
910	Sydney South Tee	Canterbury	132
911	Sydney South Tee	Canterbury	132
245	Kurnell	Bunnerong	132
246	Kurnell	Bunnerong	132
91C	Peakhurst	Hurstville North	132
91R	Peakhurst	Hurstville North	132
928/3	Lane Cove	Dalley St	132
929/1	Lane Cove	Dalley St	132
92L	Lane Cove	Dalley St	132
92M	Lane Cove	Dalley St	132
90V/3	Rozelle	City Central	132
90W/4	Rozelle/Pyrmont	City Central	132

Figure 8 shows the maximum supportable demand for the inner Sydney area for each summer from 2015 to 2025. The maximum supportable demand increases following the commissioning of the Rookwood Rd substation in 2014-15, and then it decreases as key 132 kV elements of the network are progressively retired. The large decreases in maximum supportable demand in 2018-19 and 2022-23 are due to multiple cable limitations expected to occur in these years, listed in

Table 5: .

Figure 8: Inner Sydney area network capability, summer 2013-14 to 2024-25



AEMO considered both summer day and winter night conditions; peak demand for the region occurs in summer and the summer peak coincides with conditions that result in lower line thermal ratings. As such, summer peak demand present the most limiting conditions.

TransGrid and Ausgrid have decreased the rating for a number of cables in the inner Sydney area. If the ratings of any of these cables need revised then the maximum supportable demand of the inner Sydney area will change. In particular calculation of maximum supportable demand assumes that the rating of 41 cable is maintained at 575 MVA, any further de-rating would result in a reduction in the maximum supportable demand.

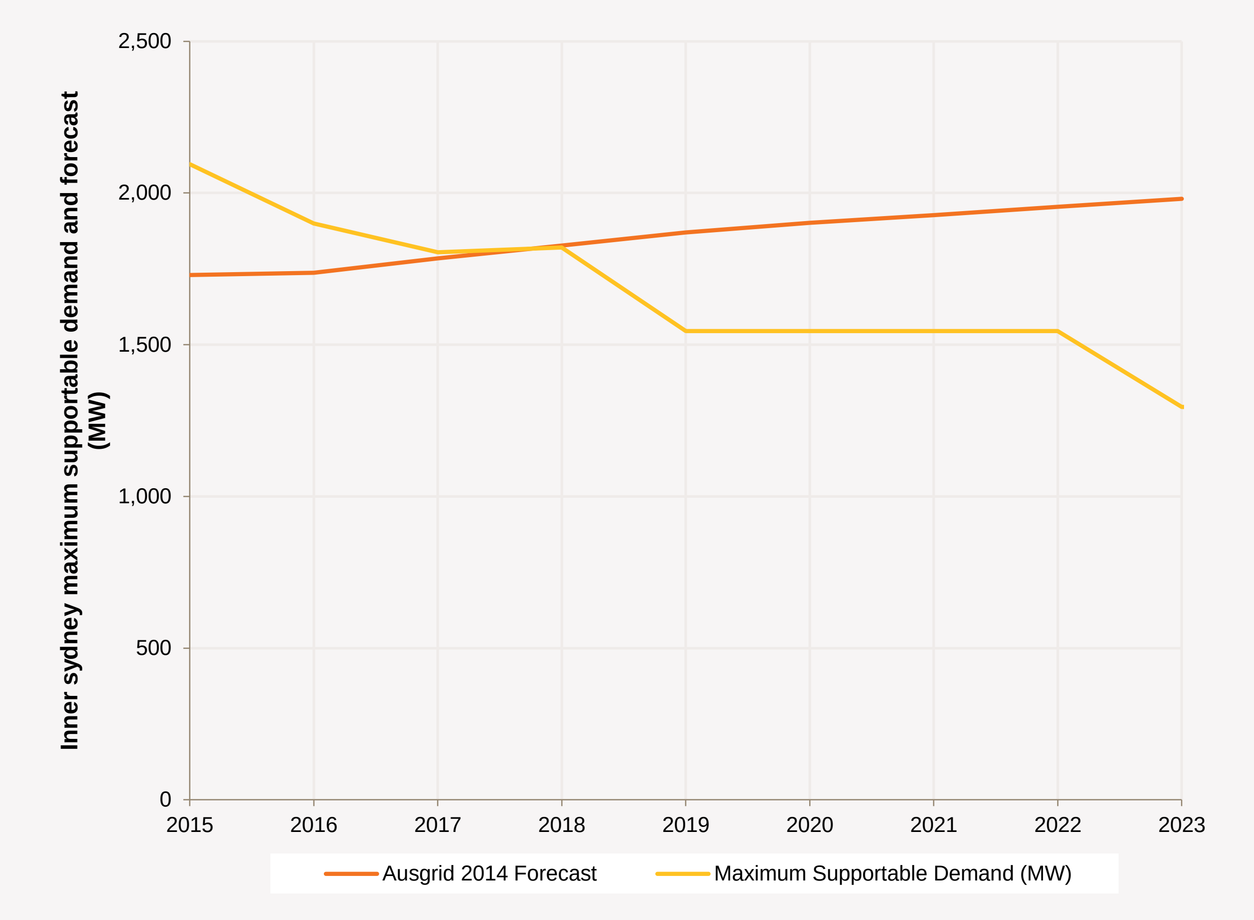
Network capability against projected demand

AEMO produces connection point level demand forecasts. To accurately assess the timing of the any project needed to address supply issues in the inner Sydney area, a lower level (i.e. zone substation) forecast is required. For the purposes of this assessment Ausgrid forecast for the inner Sydney area is used.[7]

Figure 9 shows the maximum supportable demand AEMO calculated for the inner Sydney area against the Ausgrid's 2014 forecast for the inner Sydney area.

[7] TransGrid. *Transmission Annual Planning Report 2014*. Available http://www.transgrid.com.au/network/np/Documents/Annual%20Planning%20Report%202013.pdf. Viewed 18 July 2014.

Figure 9: Inner Sydney area maximum supportable demand and Ausgrid 50% POE forecast loading



Application of planning criteria

The transmission network planning criteria applying in New South Wales for the Sydney metropolitan area requires that network be able to withstand the simultaneous outage of a single 330 kV cable and any 132 kV feeder or 330/132 kV transformer, or the outage of any section of 132 kV busbar.[8]

Assessed against this planning criteria for the inner Sydney area as stated in the Transmission Network Design and Reliability Standard for New South Wales, it is estimated that the capability of the capacity of the network will fall below the in summer 2018-19.

As Figure 10 shows, the low summer peak demand growth rate makes the timing of any project needed to address network security very sensitive to changes in maximum supportable demand. Also, the gradual nature of the changes in maximum supportable demand after 2019 makes the timing of any necessary projects sensitive to any changes in demand forecast. As such, even a relatively small change in maximum supportable demand or demand growth may lead to a material change in timing of an augmentation and so can be bought forward or pushed out by several years.

[8] New South Wales Government. *Transmission Network Design and Reliability Standard for NSW*. Available: http://www.trade.nsw.gov.au/__data/assets/pdf_file/0019/374302/nsw-transmission-network-design-and-reliability-standard.pdf. Viewed 18 July 2014.

Credible options to address the address network security include:

- Demand response within the inner Sydney area.
- Commissioning of new cables into Sydney to the inner Sydney area.
- Piecewise replacement of 132 kV cables.
- Installation of power flow control devices, such as series reactors.
- Rearrangement of existing network assets.

Conclusion

AEMO considers the augmentation of the supply to the inner Sydney area should be contingent on assessment of network security based on revised demand forecasts, and updated maximum supportable demand calculations, showing a need for augmentation within the next four years. This is given:

- Uncertainty about factors determining maximum supportable demand for the inner Sydney area, including: the condition of the de-rated cables, extent of 132 kV cable retirements and the availability of demand management.
- Relatively low forecast demand growth means the required timing of future network augmentation in the area is very sensitive to changes in maximum supportable demand.

2.3 Snowy to Sydney 330 kV network upgrade

The transmission network linking the Snowy Mountains and Sydney may become congested under high summer demand scenarios, with high import from Victoria and high levels of southern New South Wales generation. This congestion could be exacerbated by the commissioning of new generation in southern New South Wales around the Yass–Canberra–Marulan area.

To address this issue TransGrid propose the following augmentations:

- Increasing the ratings of Upper Tumut-Canberra line 01 and 39 Bannaby-Sydney West line 39.
- Increasing the ratings of Yass-Marulan lines 4 and 5.
- Installing phase shifting transformers on Bannaby-Sydney West line 39, Gullen Range-Bannaby line 61and Yass-Marulan line 5.
- Constructing a new 330 kV single circuit line between Yass and Bannaby.
- Replacing equipment at Sydney South, Dapto, Avon, and Macarthur substations.

Background

AEMO's 2013 National Transmission Network Development Plan (NTNDP)[9] identified potential congestion on the transmission network connecting Sydney to the Snowy Mountains area due to the commissioning of new wind farms in Southern New South Wales. Further, this congestion may be exacerbated by changes elsewhere in the NEM, such as:

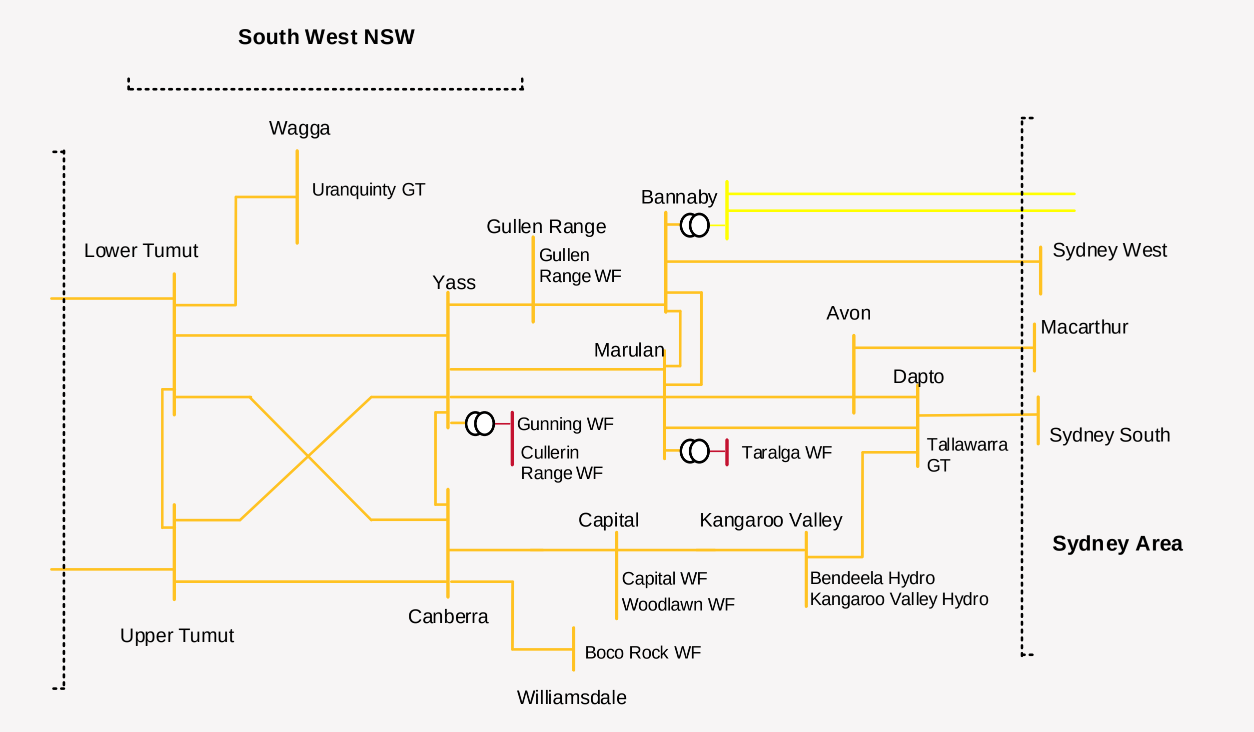
- Increased wind generation in Victoria, South Australia, and Tasmania.
- Declining demand in Victoria, South Australia, and Tasmania.
- Generation retirement in New South Wales or Queensland.
- Increasing demand in New South Wales or Queensland.

There may be significant market benefits in reducing this congestion.

The network connecting the Snowy region through to Sydney is shown in Figure 10 below.

[9] AEMO. *2013 National Transmission Network Development Plan*. Available: http://www.aemo.com.au/Electricity/Planning/~/media/Files/Electricity/Planning/Reports/NTNDP/2013/2013_NTNDP.pdf.ashx Viewed 18 July 2014.

Figure 10: Snowy region to Sydney transmission network



Key elements and their continuous post contingency ratings are shown in Table 7: .

Table 7: Snowy region continuous post-contingency rations of critical network elements

Transmission Line	Summer day rating, post-contingency (MVA)	Winter night rating, post-contingency (MVA)
Upper Tumut–Canberra 330 kV Line 01	995	1080
Upper Tumut–Yass 330 kV Line 02	995	1080
Lower Tumut–Canberra 330 kV Line 07	1143	1143
Lower Tumut–Yass 330 kV Line 3	1145	1200
Canberra–Capital Wind Farm 330 kV Line 6	995	1080
Yass–Marulan 330 kV Line 4	1107	1175
Yass–Marulan 330 kV Line 5	1107	1175
Yass–Gullen Range 330 kV Line 3J	995	1126
Gullen Range–Bannaby 330 kB Line 61	1145	1200
Capital Wind Farm–Kangaroo Valley 330 kV Line 3W	995	1008
Marulan–Dapto 330 kV Line 8	1008	1008
Marulan–Avon 330 kV Line 16	995	1126
Bannaby–Sydney West 330 kV Line 39	995	1008
Dapto–Sydney South 330 kV Line 11	1428	1428
Avon–Macarthur 330 kV Line 17	1428	1560

There are currently three committed generation projects in the southern New South Wales network, with a combined capacity of 385 MW. In addition there are 26 publicly announced projects to build approximately 2,100 MW of generation in southern New South Wales. The committed and publicly announced wind farm projects are listed in Table 8 below.

Table 8: Southern New South Wales committed and publicly announced generation projects

Project	Generation type	Unit status	Nameplate capacity (MW)	Commissioning start date
Boco Rock Wind Farm	Wind - Onshore	Committed	113	March 2015
Gullen Range	Wind - Onshore	Committed	165.5	July 2014
Taralga	Wind - Onshore	Committed	107	October 2014
Dalton	OCGT	Publicly Announced	500	TBA
Capital East Solar Farm P2	PV panels	Publicly Announced	0.4	TBA
Capital Solar Farm	PV panels	Publicly announced	34	TBA
Bango Wind Farm	Wind - Onshore	Publicly announced	140	TBA
Birrema Wind Farm	Wind - Onshore	Publicly announced	75	TBA
Capital 2 Wind Farm	Wind - Onshore	Publicly announced	100	April 2016
Collector	Wind – Onshore	Publicly announced	175	September 2016
Conroys Gap	Wind - Onshore	Publicly announced	30	TBA
Crookwell 2 Wind Farm	Wind - Onshore	Publicly announced	92	TBA
Crookwell 3 Wind Farm	Wind - Onshore	Publically announced	58	TBA
Jupiter Wind Farm	Wind - Onshore	Publicly announced	TBA	TBA
Rugby Wind Farm	Wind - Onshore	Publicly announced	166	TBA
Rye Park Wind Farm	Wind - Onshore	Publicly announced	378	TBA
Yass Valley Wind Farm	Wind - Onshore	Publicly announced	360	TBA

Network capability analysis

Under high summer demand scenarios, with high import from Victoria and high levels southern New South Wales generation, the network between the Snowy generators and Sydney may become congested. Generation from the Tumut and Uranquinty generators, along with power flow from Victoria may need to be constrained to prevent the overload of the Upper Tumut–Canberra 330 kV line 01 following the loss of the Lower Tumut-Canberra 330 kV line 07.

Once the committed projects, 380 MW in aggregate, have been commissioned then there is the potential for lines between Bannaby, Avon and Dapto, and Sydney to become congested. Combined southern New South Wales generation and import from Victoria will need to be constrained to prevent the post contingency power flow on line 39 to exceed rating following the loss of Dapto–Sydney South 330 kV line 11.

If further proposed generation projects were to be commissioned in southern New South Wales, then congestion may occur on the lines between the Yass and Marulan substations. If 150 MW of additional wind generation is installed between Yass and Canberra substations, and the Bannaby and Marulan substations then congestion may occur on the 330 kV transmission lines connecting these substations.

To control the post-contingency flow on the Yass–Marulan 330 kV lines 4 and 5 following the loss of the Gullen Range–Bannaby line 61, combined southern New South Wales generation and import from Victoria then generation may need to be constrained.

Application of planning criteria

As part of their Transitional Revenue Proposal, TransGrid submitted a network capability incentive parameter action plan (NCIPAP).[10] The NCIPAP contains projects to install equipment to enable dynamic line ratings on a number of critical lines in Southern New South Wales. These lines are listed in Table 9.

Table 9: Snowy region potential rating of critical network elements after enablement of dynamic line ratings

Transmission line dynamic line rating projects	Potential rating increase under favourable conditions	
	Summer Day (MVA)	Winter Night (MVA)
Upper Tumut–Canberra 330 kV Line 01	199	216
Upper Tumut–Yass 330 kV Line 02	199	216
Lower Tumut–Canberra 330 kV Line 07	229	229
Lower Tumut–Yass 330 kV Line 3	229	240
Yass–Marulan 330 kV Line 4	221	235
Yass–Marulan 330 kV Line 5	221	235
Yass–Gullen Range 330 kV Line 3J	199	225
Gullen Range–Bannaby 330 kB Line 61	229	240
Bannaby–Sydney West 330 kV Line 39	199	202

Dynamic line ratings enable the thermal rating of a line to be set in real time according to weather conditions. Raring increases of up to 20% at times of favourable conditions, such as low temperatures and high wind speed.

Much of the future congestion in the 330 kV transmission lines between the Snowy region and Sydney is expected to be caused by high levels of wind generation. As such, it is likely that dynamic ratings will assist in reducing potential congestion by allowing higher thermal limits due to high wind speed.

If dynamic line ratings allowed a 10% increase on the Yass-Marulan 330 kV line 4 and 5, and the Bannaby-Sydney West 330 kV line 39, it may be possible to increase power transfer on the 330 kV transmission lines between the Snowy region and Sydney by approximately 400 MW.

The development of new generation projects in the region, and the subsequent need for augmentation, is likely to depend on the Renewable Energy Target (RET). The Federal Government is currently reviewing this and changes

[10] TransGrid. *TransGrid - Revenue Proposal 2014-19 Appendix A NCIPAP.* Available: http://www.aer.gov.au/sites/default/files/TransGrid%20-%20Appendix%20A%20-%20NCIPAP%20-%2031%20January%202014.PDF Viewed: 18 July 2014.

may occur. Although congestion may occur without the entry of projects that are not already committed, the optimal project selection will account for future non-committed generation.

Conclusion

During periods of high summer demand when power is being imported from Victoria, the 330 kV transmission network linking the Snowy region to Sydney operates close to capacity, and may potentially reach its limit.

AEMO considers that TransGrid's proposed augmentation of these transmission lines should be contingent on:

a) Enablement of dynamic ratings as per TransGrid's NCIPAP submission, should it be approved.

b) The 350 MW of committed generation projects in southern New South Wales around Yass–Canberra–Marulan area, or any additional connection points established in this vicinity.

c) Successful completion of the Regulatory Investment Test for Transmission (RIT–T) showing positive market benefits for the augmentation.

This is given:

- Uncertainty over the RET. Wind generation in Southern New South Wales is likely to cause congestion in the 330 kV transmission lines between the Snowy region and Sydney. While there are three committed wind farms projects in the Southern New South Wales area, future wind generation developments will likely depend on the RET.
- The performance and availability of dynamic ratings. Enabling dynamic ratings on critical circuits the 330 kV transmission lines between the Snowy region and Sydney may significantly increase the capacity of these lines during periods of high wind generation.

2.4 Other network augmentation projects

AEMO engaged with TransGrid for this review since they commenced developing their NCIPAP proposals in 2013 including the period over which they developed their transitional and substantive regulatory proposals. Table 10 below lists other network augmentation projects AEMO assessed for this review.

Table 10: Other augmentation projects AEMO assessed for this review

Driver	**Project**	Comment
Distribution capacity	Hallidays Point 132/66 kV Substation	TransGrid excluded this project at the substantive proposal stage.
Market benefit	NSW to Qld Transmission Capacity Upgrade	TransGrid excluded this project at the substantive proposal stage. The 2013 NTNDP did not identify need to upgrade QNI Interconnector.
Regulatory obligation	Development of Southern Supply to the Australian Capital Territory	Justified network need: TransGrid has a statutory obligation to develop a second supply to the ACT.

3 – CONDITION-DRIVEN ASSET REPLACEMENT PROJECTS

3.1 Proposed transformer replacement projects

Table 11: TransGrid's proposed transformer replacement projects

Project	Year	Connection points	Page in this attachment
Forbes No. 1 and No.2 132/66 kV transformer replacement	2018	Forbes	22
Griffith 132/33 kV substation transformer	2015	Griffith	24
Yanco 132/33 kV substation transformer	2015	Yanco	26
Newcastle 330/132 kV substation transformer	2016	Newcastle, Tomago, Waratah West	28
Tamworth 330 kV No.2 Transformer Replacement	2017	Narrabi, Gunnedah, Tamworth	31

3.1.1 Forbes No. 1 and No. 2 132/66 kV transformer replacement

Project	Forbes No. 1 and No. 2 132/66 kV transformer replacement
Year	2018
Credible alternatives	Non network alternatives for transformer capacity.
Assessment objective	Assess the load forecast to see if replacement with lower capacity asset is possible.

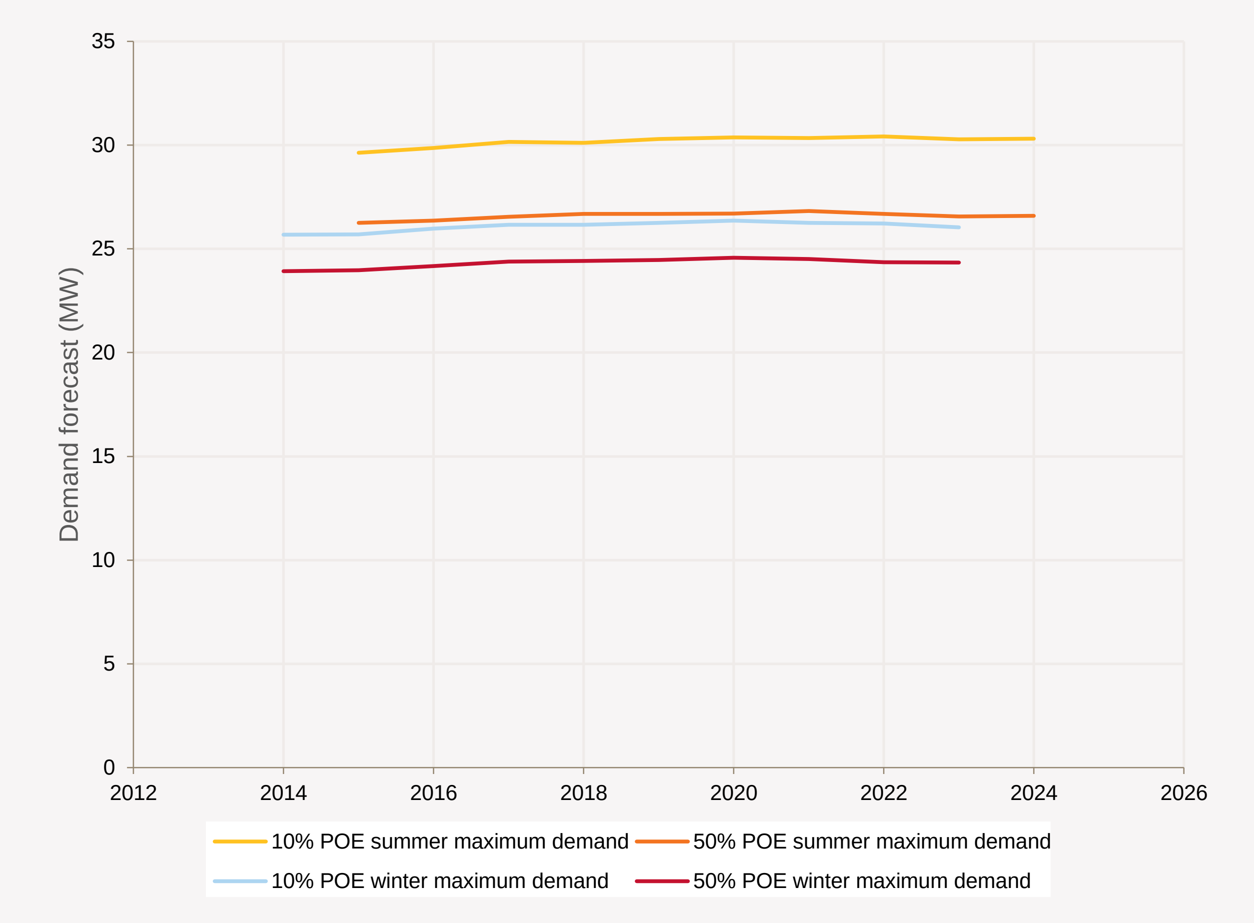
Background

- The Forbes area is supplied by 132 kV connections from 330/132 kV substations at Yass and Wellington. The Forbes 132/66 KV substation feeds local customer load via two transformers.
- TransGrid proposes to replace the existing two 60 MVA 132/66 kV transformers approaching the end of their serviceable lives with two similar 60 MVA 132/66 kV transformers.

Projected demand

- Figure 11 below shows AEMO's 2014 10-year connection point forecasts for Forbes substation.
- AEMO's projects low growth in peak demand at Forbes over the forecast period.

Figure 11: Forbes substation 10-year connection point forecast



AEMO's assessment of the requirement for this project

- The two 132/66 kV 60 MVA transformers at Forbes substation supply local load through Essential Energy's distribution network.
- AEMO's 2014 connection point forecast projects summer peak demand at Forbes to reach 30 MVA (10% POE) by the end of the 10-year forecast period. As this is lower than the firm rating of the substation, AEMO considers no increase in transformer capacity is required.
- AEMO did not identify any other transmission alternatives (e.g. reconfiguration of existing assets) for supplying this local load and therefore considers:
  - There is an ongoing need for the asset.
  - The existing configuration, voltage level, and transformer capacity is justified.
- Like-for-like replacement will result in the same level of reliability at the Forbes substation.

Possible replacement options

- Like for like replacement with new transformers.
- Refurbish or rebuild the existing transformers to extend their serviceable lives if feasible and economic.
- Replacement with two lower capacity 45 MVA transformers if load transfers are feasible.

Conclusion

Assessment criteria	AEMO's assessment
Whether the network configuration could be improved for effective and efficient use of existing assets.	The existing configuration is justified.
Demand growth.	Projected 10-year forecast is lower than the existing substation firm capacity.
Transmission need.	N-1 transformer capacity is required.
Need for a RIT-T capacity increase associated with the asset being replaced.	No step increase or decrease in demand.
Review of voltage level and capacity of replacement transformer.	The existing transformer capacity (two x 60 MVA) is justified based on TransGrid's standard transformer sizes even though replacement with two x 45 MVA transformers is adequate.
TNSP assessment of non-network alternatives for transformer capacity.	Not publically available at time of study.
TNSP assessment of economics of transformer replacement vs transformer refurbishment or rebuild.	Not publically available at time of study.

3.1.2 Griffith 132 kV substation transformer replacement

Project	Griffith No. 1, No. 2 and No. 3 132/33 kV transformer replacement
Year	2015
Credible alternatives	Non network alternatives for transformer capacity
Assessment objective	Assess the load forecast to see if replacement with lower capacity asset is possible.

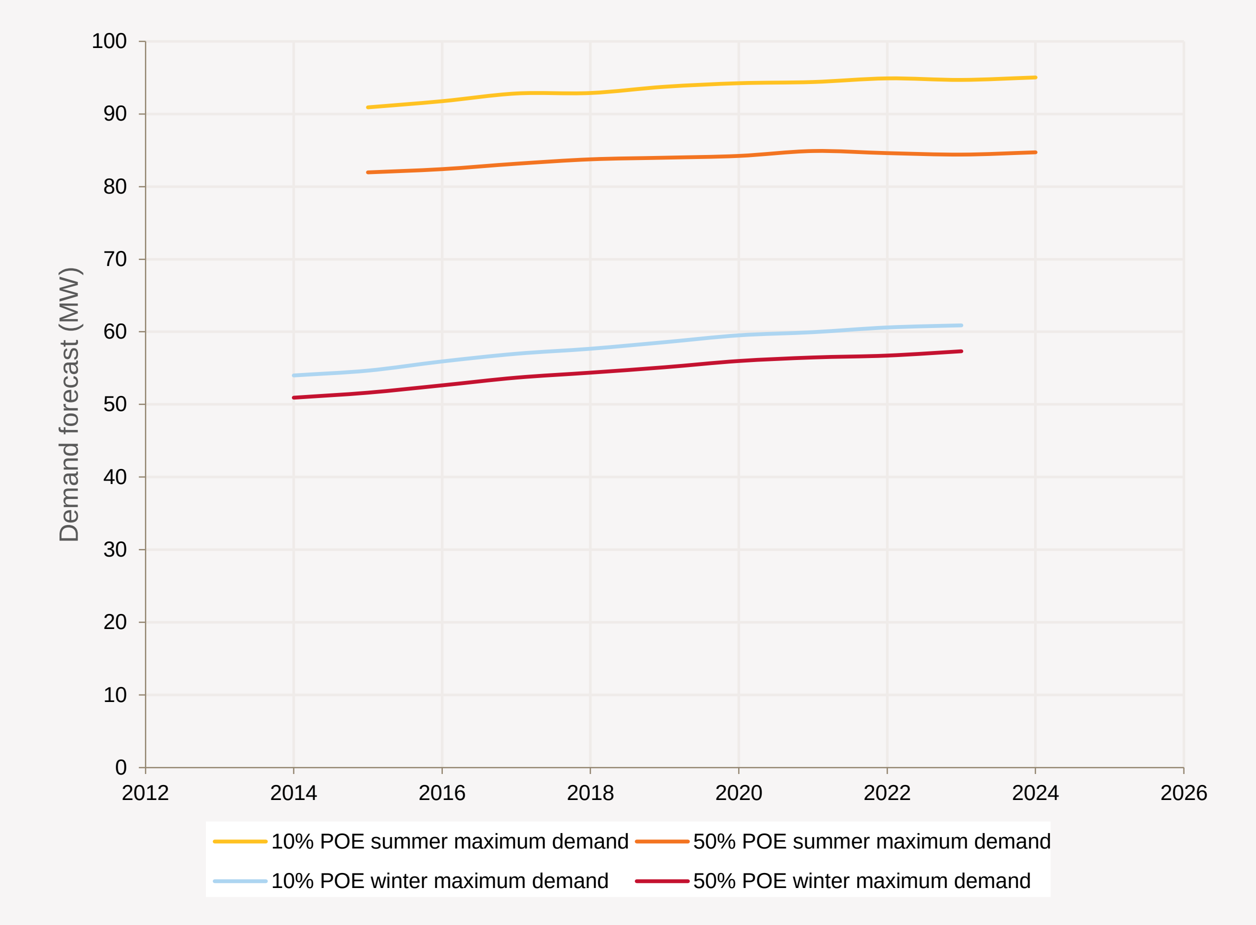
Background

- The Griffith area is supplied by 132 kV connections from the 330/132 kV substation at Darlington and the 132 kV substation at Yanco. The Griffith 132/33 KV substation feeds the local load via three transformers.
- TransGrid propose to replace the existing three 45 MVA 132/33 kV transformers approaching the end of their serviceable lives with three 60 MVA 132/33 kV units.

Projected demand

- Figure 12 below shows AEMO's 2014 10-year connection point forecasts for Griffith substation.
- AEMO's projects low growth in peak demand at Griffith over the forecast period.

Figure 12: Griffith substation 10-year connection point forecast



AEMO's assessment of the requirement for this project

- The existing three 132/33 kV 45 MVA transformers at Griffith substation supply local load through Essential Energy's distribution network.
- AEMO's 2014 connection point forecast projects summer peak demand at Griffith to reach 95 MVA (10% POE) by the end of the 10-year forecast period. As this exceeds the firm capacity of the substation (90 MVA), AEMO considers that increasing transformer capacity by replacing the existing three 45 MVA 132/33 kV transformers with three higher capacity 60 MVA transformers is appropriate.
- AEMO did not identify any other transmission alternatives (e.g. reconfiguration of existing assets) for supplying local load and therefore considers:
  - There is an ongoing need for the asset.
  - The existing configuration, voltage level and transformer capacity is justified.
- Replacement will result in a similar level of reliability at Griffith substation.
- Future forecast maximum demand in excess of firm capacity at Griffith substation may be addressed by operational or minor augmentation strategies such as:
  - Load transfer schemes.
  - DSM initiatives.
  - Reactive compensation for power factor improvement.

Possible replacement options

- Like for like replacement with new transformers
- Replace the existing three transformers with two higher capacity transformers.
- Refurbish or rebuild the existing transformers to extend their serviceable lives if feasible and economic.

Conclusion

Assessment criteria	AEMO's assessment
Whether the network configuration could be improved for effective and efficient use of existing assets.	The existing configuration is justified.
Demand growth.	Projected 10-year forecast is higher than the existing substation firm capacity.
Transmission need.	N-1 transformer capacity is required.
Need for a RIT-T capacity increase associated with the asset being replaced.	No step increase or decrease in demand.
Review of voltage level and capacity of replacement transformer.	Replacement of the existing three 45MVA transformers with three 60MVA transformers is justified.
TNSP assessment of non- network alternatives for transformer capacity	Not publically available at time of study.
TNSP assessment of economics of transformer replacement vs transformer refurbishment or rebuild.	Not publically available at time of study.

3.1.3 Yanco 132 kV substation transformer replacement

Project	Yanco No. 1 and No. 2 132/33 kV transformer replacement
Year	2015
Credible alternatives	Non network alternatives for transformer capacity
Assessment objective	Assess the load forecast to see if replacement with lower capacity asset is possible.

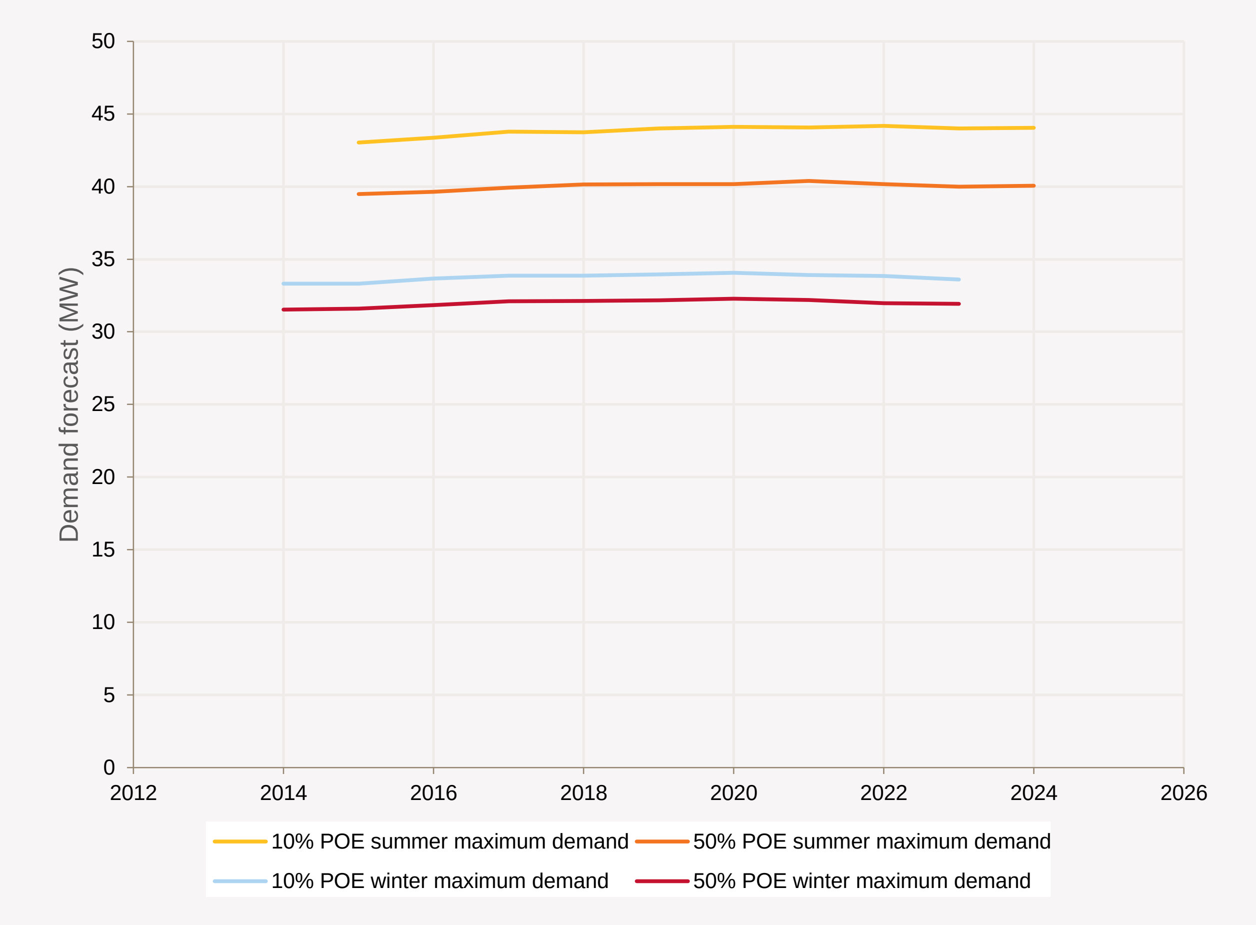
Background

- The Yanco area is supplied by a 132 kV connections from 330/132 kV substations at Darlington and Wagga. The Yanco substation is connected to the Griffith and Uranquinty substations via 132 kV transmission lines. The Yanco 132/33 KV substation feeds the local load via two transformers.
- TransGrid propose to replace the existing two 45 MVA 132/33 kV transformers, approaching the end of their serviceable lives,with two x 60 MVA 132/33 kV units.

Projected demand

- Figure 13 below shows AEMO's 2014 10-year connection point forecasts for Yanco substation.
- AEMO's projects low growth in peak demand at Yanco over the forecast period.

Figure 13: Yanco substation 10 year connection point forecast



AEMO's assessment of the requirement for this project

- The existing two 132/33 kV 45 MVA transformers at Yanco substation supply local load through Essential Energy's distribution network.
- AEMO's 2014 connection point forecast projects summer peak demand at Forbes to reach 46 MVA (10% POE) by the end of the 10-year forecast period. As this exceeds firm capacity of the substation (45 MVA), AEMO considers that increasing transformer capacity by replacing the existing 132/33kV transformers with two higher capacity 60 MVA transformers is appropriate.
- AEMO did not identify any other transmission alternatives (e.g. reconfiguration of existing assets) for supplying local load and therefore considers:
  - There is an ongoing need for the asset.
  - The existing configuration, voltage level and transformer capacity is justified.

Possible replacement options

- Like for like replacement with new transformers
- Refurbish or rebuild the existing transformers to extend their serviceable lives if feasible and economic.

Conclusion

Assessment criteria	AEMO's assessment
Whether the network configuration could be improved for effective and efficient use of existing assets.	The existing configuration is justified.
Demand growth.	Projected 10-year forecast is higher than the existing substation firm capacity.
Transmission need.	N-1 transformer capacity is required.
Need for a RIT-T capacity increase associated with the asset being replaced.	No step increase or decrease in demand.
Review of voltage level and capacity of replacement transformer.	Replacement with two 60 MVA 220/22 kV transformers is justified.
TNSP assessment of non- network alternatives for transformer capacity.	Not publically available at time of study.
TNSP assessment of economics of transformer replacement vs transformer refurbishment or rebuild.	Not publically available at time of study.

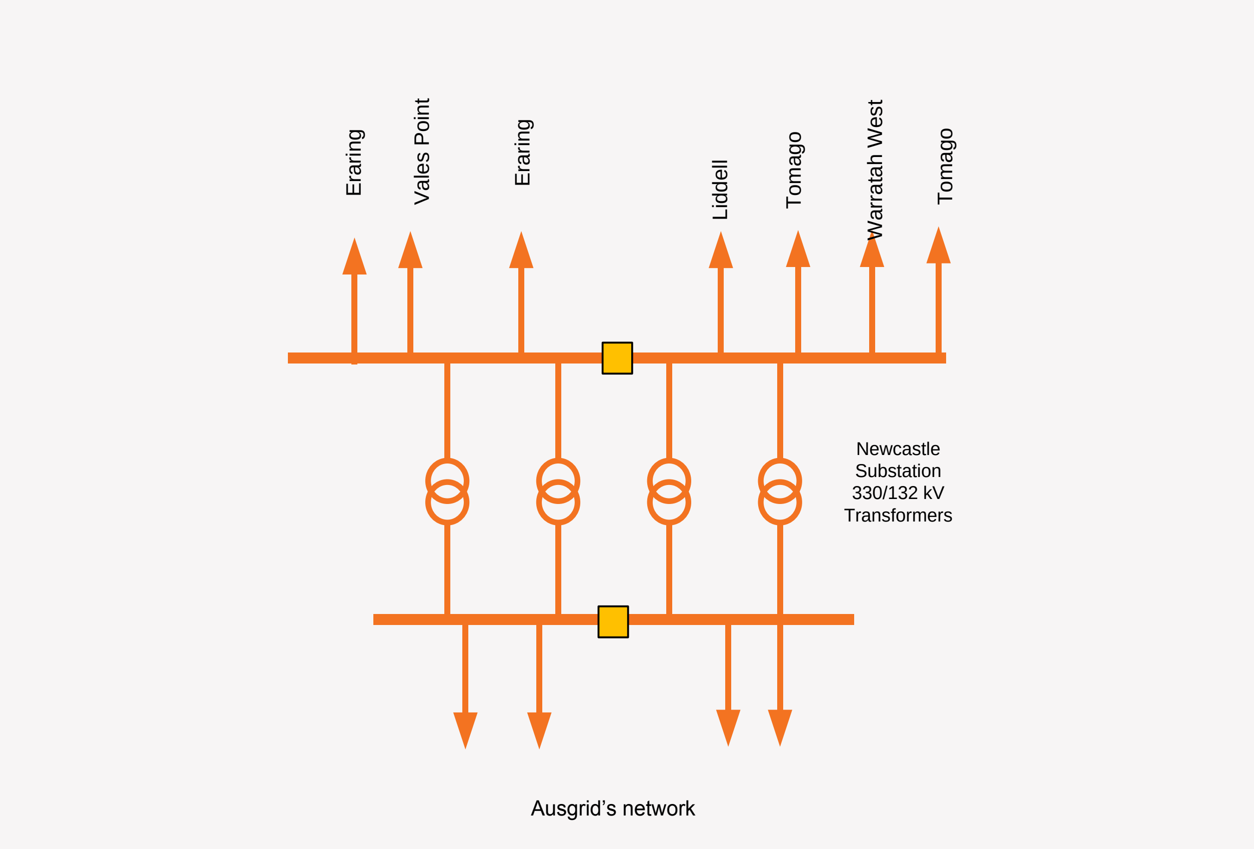
3.1.4 Newcastle 330 kV substation transformer replacement

Project	Newcastle 330/132 kV transformer replacement
Year	2014
Credible alternatives	Non network alternatives for transformer capacity
Assessment objective	Assess the load forecast to see if replacement with lower capacity asset is possible.

Background

- TransGrid's 330/132 kV Newcastle substation is located at Killingworth, approximately 20km west of Newcastle city, and supplies Newcastle and surrounding areas.
- Newcastle substation was commissioned in 1969 with two 375 MVA 330/132 kV transformers and two 400 MVA 330/132 kV transformers banks consisting of single phase units. TransGrid has advised that:
  - The single phase transformer set/bank (T1) was replaced with a 3 phase 375 MVA unit in 2005.
  - The single phase transformer set/bank (T2) was replaced with a 3 phase 375 MVA unit in May 2014.
  - the single phase transformer set/bank (T3) is expected to be replaced with a 3 phase 375 MVA by the end of 2014.
- TransGrid propose to:
  - Replace the single phase transformer set/bank (T3) with a 3 phase 375 MVA by the end of 2014.
  - Retire the single phase transformer set/bank (T4) - originally planned to be replaced by 2016 - due to lower demand in the area following the closure of the Kurri Kurri aluminium smelter.

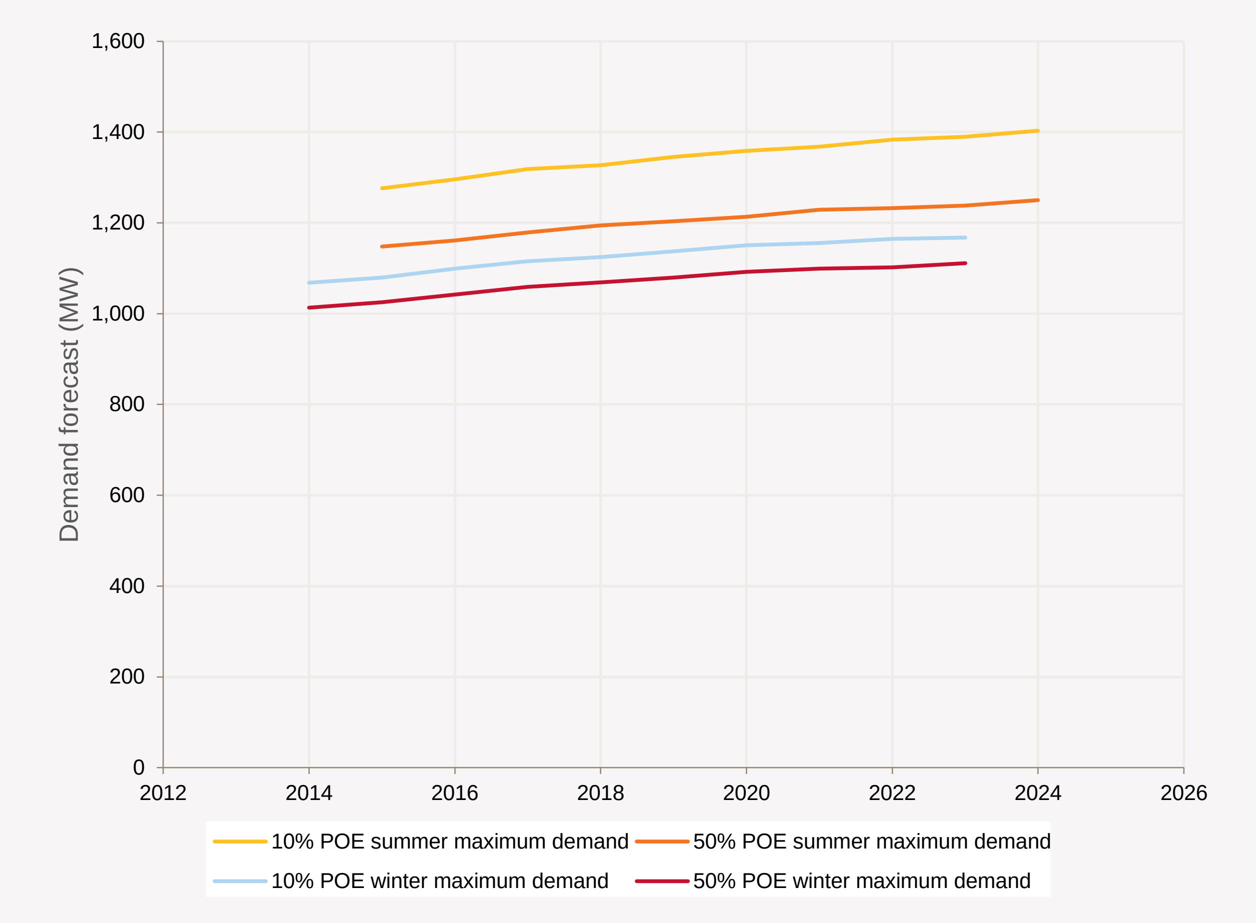
Figure 14: Newcastle substation connection configuration



Projected demand

- The Hunter area is highly interconnected. This means that it is not feasible to correctly account for all load transfers between connection points. To circumvent this issue, AEMO developed a Hunter area aggregate forecast for the Liddell, Munmorah, Muswellbrook, Newcastle, Tomago, Tuggerah, Vales Point, and Waratah West connection points.
- Figure 15 shows AEMO's 2014 10-year connection point forecasts for the Hunter area.

Figure 15: Hunter area 10 year connection point forecast



AEMO's assessment of the requirement for this project

- The existing transformers at Newcastle substation supply local load through Ausgrid's distribution network.
- AEMO's 2014 connection point forecast projects summer peak demand at Newcastle substation to be lower than the current firm capacity of the substation at end of the 10-year forecast period. AEMO therefore considers that no increase in transformer capacity is required at this time.
- AEMO did not identify any other transmission alternatives (e.g. reconfiguration of existing assets) for supplying this local load and therefore considers that the existing configuration and voltage level is justified.
- Future forecast maximum demand in excess of firm capacity at Newcastle substation may be addressed by operational or minor augmentation strategies such as:
  - Installing a 4th transformer in the vacant substation bay.
  - Load transfer schemes.
  - DSM initiatives.
  - Reactive compensation for power factor improvement.

Further reduction of transformer capacity (Network perspective)

There may be potential to further reduce the number of 375 MVA transformers at Newcastle from 3 to 2 by considering the forecast demand requirements for the overall network connecting Newcastle, Tomago and Waratah West, provided there is sufficient transfer capacity exists in the underlying AusGrid network. Detailed studies are required to confirm the viability of this proposal. The available transformer capacity of these substations are listed in Table 12.

Table 12: Transformer capacity in the overall network connecting Newcastle, Tomago and Waratah West substations

Substation	Transformer capacity (MVA)	Minimum Firm Capacity (MVA)
Newcastle	3 x 375	750
Tomago	3 x 375	750
Waratah West	2 x 375	375
Total	3000	1875

AEMO's 2014 forecast demand at these substations is much lower than total transformer capacity and the minimum[11] firm capacity. AEMO therefore considers that there is potential to reduce Newcastle substation to two transformers if load transfers (through Ausgrid's distribution network) from Newcastle to Tomago and/or Waratah West are possible. Detailed studies are required to confirm the viability of this proposal.

Possible replacement options

- Replacement of single phase transformer set/bank (T3) with a new 3 phase transformers
- Replacement of one existing transformer (leaving two transformers in total) if some Newcastle load can be transferred to Tomago and/or Waratah West (subject to study outcomes).
- Refurbish or rebuild existing transformers to extend their serviceable lives if feasible and economic.

Conclusion

Assessment criteria	AEMO's assessment
Whether the network configuration could be improved for effective and efficient use of existing assets.	The existing configuration is justified, but using 3 phase transformers.
Demand growth.	Projected 10 year forecast is lower than the existing substation firm capacity.
Transmission need.	N-1 transformer capacity is required.
Need for a RIT-T capacity increase associated with the asset being replaced.	No step increase or decrease in demand
Review of voltage level and capacity of replacement transformer.	Replacement of existing 2x375MVA transformers is justified on a like-for-like basis. Potential exists to reduce Newcastle transformer capacity if load can be transferred to Waratah West and/or Tomago, but is subject to further analysis.
TNSP assessment of non- network alternatives for transformer capacity.	Not publically available at time of study
TNSP assessment of economics of transformer replacement vs transformer refurbishment or rebuild.	Not publically available at time of study

3.1.5 Tamworth 330 kV substation transformer replacement

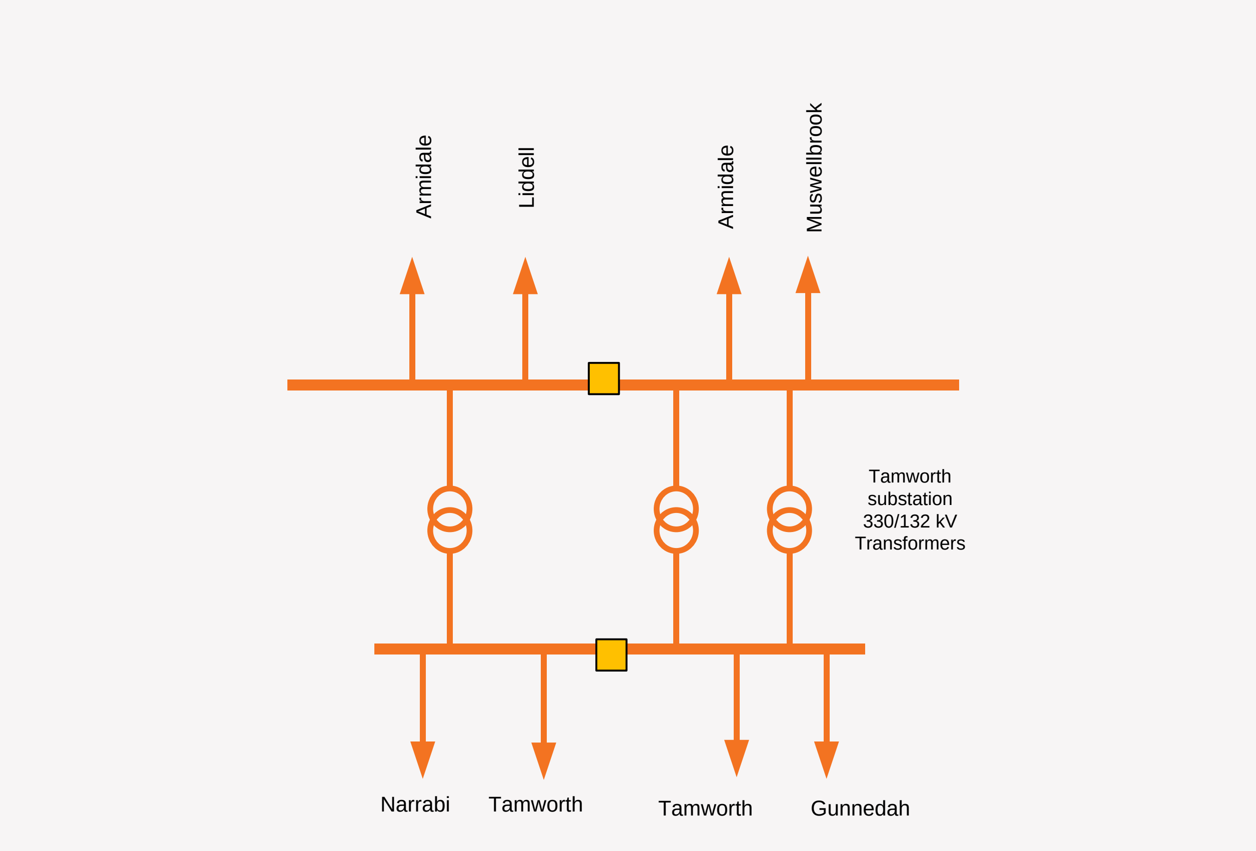
Project	Tamworth 330/132 kV T2 transformer replacement
Year	2017
Credible alternatives	Non network alternatives for transformer capacity
Assessment objective	Assess the load forecast to see if replacement with lower capacity asset is possible.

[11] Estimated using the nominal rating

Background

- The 330/132 kV Tamworth substation supplies the Tamworth, Narrabri and Gunnedah areas and contains three 150 MVA 330/132 kV transformers (T1, T2 and T3).
- TransGrid propose to replace the 150 MVA transformer T2 in 2017 with a 375 MVA unit to allow them to replace the remaining two 150 MVA transformers (T1 and T3) with one 375 MVA transformer when they are due for retirement. No information on the condition or possible replacement date of transformers T1 and T3 was publically available at the time of this assessment.
- Each 330/132 kV 150 MVA transformer has a short term rating of 180 MVA.

Figure 16: Tamworth substation connection configuration

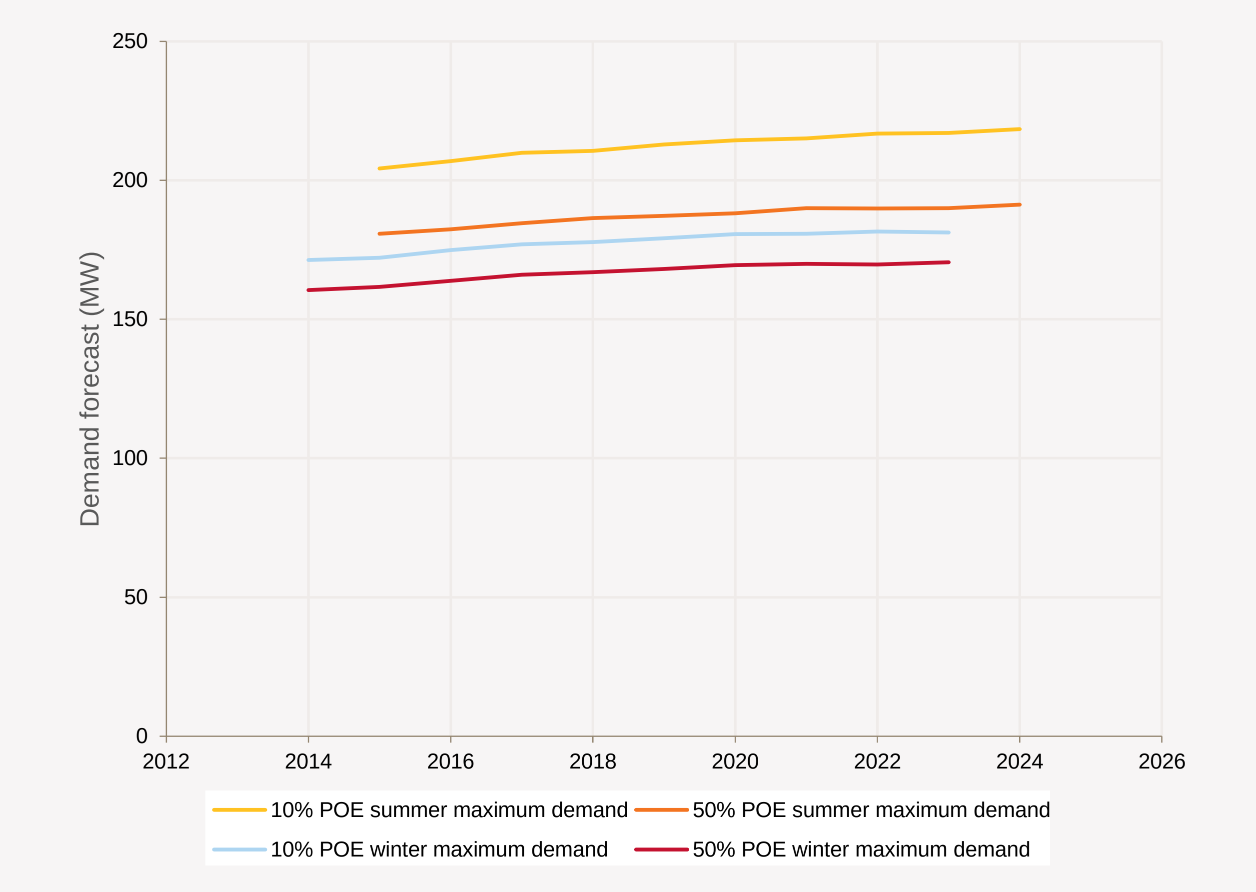


Projected demand

- Figure 17 below compares AEMO's 10-year connection point forecasts for the Tamworth substation (combined load at Tamworth, Narrabi and Gunneda).
- New mining developments in the Boggabri area, between Gunnedah and Narrabri, are expected to add 20 MW of demand[12]. Other than this new development the Tamworth forecast demand shows slow growth.
- As discussed in section 2.1 the demand supplied through the Tamworth transformer is also dependent of QNI flow and demand supplied by other substations connected to the 132 kV network between Narrabri and Armidale.

[12] TransGrid. Transmission Annual Planning Report 2014. Available http://www.transgrid.com.au/network/np/Documents/Annual%20Planning%20Report%202013.pdf. Viewed 18 July 2014

Figure 17: Tamworth substation (combined forecast for Tamworth, Narrabi and Gunnedah) 10-year connection point forecast



AEMO's assessment of the requirement for this project

- The existing transformers at Tamworth substation supply local load at Tamworth, Narrabri and Gunnedah through the Essential Energy's distribution network. The load is also dependent on QNI flow and demand supplied by other substations connected to the 132 kV network between Narrabri and Armidale.
- AEMO's 2014 10% POE demand forecast projects minimal customer demand growth at Tamworth substation is forecast to exceed the short term (24 hour) of a single 330/132 kV transformer (180 MVA)
- AEMO considers that:
  - The replacement of transformer T2 is justified to meet network capacity requirements.
  - There is potential to replace the existing three 150 MVA transformers with two higher capacity transformers, depending on the replacement need for transformers T1 and T3.
- AEMO did not identify any other transmission alternatives (e.g. reconfiguration of existing assets) for supplying local load and therefore considers:
  - There is an ongoing need for the asset.
  - The existing configuration, voltage level and transformer capacity is justified.
- Like for like replacement will result in the same level of reliability at the Tamworth substation.

Possible replacement options

- Like for like replacement with new transformers

- Refurbish or rebuild the existing transformers to extend their serviceable lives if feasible and economic.

Conclusion

Assessment criteria	AEMO's assessment
Whether the network configuration could be improved for effective and efficient use of existing assets.	The existing configuration is justified.
Demand growth.	Projected 10 year forecast is lower than the existing substation firm capacity.
Transmission need.	N-1 transformer capacity is required.
Need for a RIT-T capacity increase associated with the asset being replaced.	No step increase or decrease in demand
Review of voltage level and capacity of replacement transformer.	Replacement of Tamworth 330/132 kV transformer T2 is justified. Depending on the replacement need of the T1 and T3 transformers, potential exists to replace the existing three 150 MVA transformers with two higher capacity transformers.
TNSP assessment of non- network alternatives for transformer capacity.	Not publically available at time of study
TNSP assessment of economics of transformer replacement vs transformer refurbishment or rebuild.	Not publically available at time of study

3.2 Proposed transmission line replacement replacement projects

Table 13: TransGrid's proposed transmission line replacement projects

Project	Year	Connection points	Page in this attachment
Wallerawang – Orange North Transmission line reconstruction	2016	Orange 66 kV, Orange 132kV, Panorama	34
Line 970 Yass to Burrinjuck Pole Replacements	2016	Tumut, Gadara	37
Line 96H Coffs Harbour to Koolkhan Pole Replacements	2016	Koolkhan, Coffs Harbour	39
Line 99J Yanco to Griffith Rebuild	2018	Yanco, Griffith	41
Line 99F Yanco to Uranquinty Pole Replacements	2018	Yanco, Griffith	42

3.2.1 Wallerawang–Orange North line 944 replacement

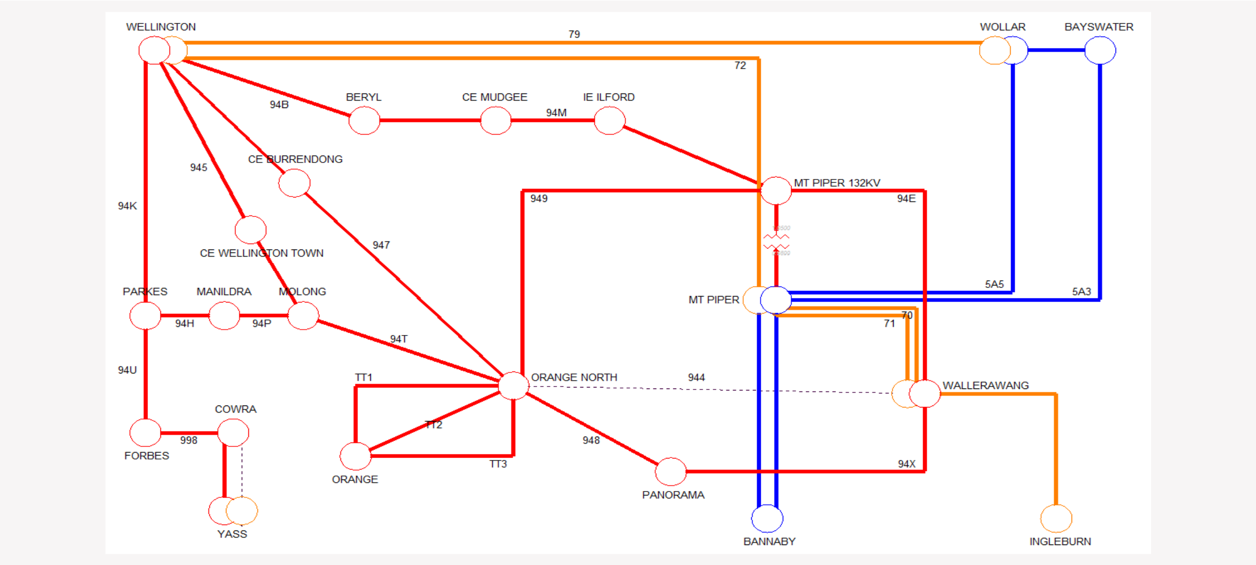
Project	Wallerawang–Orange North line 994 replacement
Year	2019
Credible alternatives	Install series reactors or phase shifting transformers on the Wallerawang-Panorama and Mt Piper-Orange lines, and capacitors at the Orange and Panorama substations. Rebuild line.
Assessment objective	Assess the load forecast and line loadings to see whether there are any growth-related drivers affecting the proposed replacement.

Background

- The Orange North area is supplied by a 132 kV network connecting the Orange, Orange North, and Panorama substations.
- Local load in this area is served by 132kV and 66kV connection points at Orange North substation and a 66 kV connection point at Panorama, supplied by five 132 kV transmission lines:
  - Wallerawang–Orange North 132 kV (944)
  - Mt Piper–Orange North 132 kV (949)
  - Panorama–Orange North 132 kV (948)
  - Wellington–Orange North 132 kV (947)
  - Molong–Orange North (94T).
- The Wallerawang–Orange North 944 line, built in 1959, is due for replacement as it is reaching its economic life span. TransGrid propose to install reactive power plant to maintain network security instead of rebuilding the line.

Connection configuration

Figure 18: Orange area connection configuration



Projected demand

- AEMO's forecasts show Orange area demand (including the Cadia mine load) growing until 2019 followed by a gradual decline until 2023.
- Essential Energy's forecast for demand in the Orange area increases slowly until 2021, then grows more rapidly due to a forecast expansion in mining load.

AEMO's assessment of the requirement for this project

AEMO analysed the 132 kV network supplying the Orange North Area to determine whether the New South Wales reliability standards could be met if the Wallerawang–Orange North 132 kV line (944) was retired.

The study determined the maximum supportable demand in the area for secure operation using an "N-1" contingency analysis if the Wallerawang–Orange North 132 kV line (944) was retired. This involved:

1. Placing the network in a normal operating state after retiring line 944 with all other elements in service, and transformers and capacitors adjusted to maintain correct voltage levels.
2. Modelling the initial load at each connection point using AEMO's 2014 50% POE forecast for the Orange North area connection points.
3. Removing a network element from service.
4. Checking power flow through the remaining in-service network elements against the appropriate ratings.
5. Increasing load in the area and repeating step 4 until the power flow through the remaining in service element reaches its 100% rating or the voltage at a substation is not within operating limits.

AEMO considered both summer day and winter night conditions; peak demand for the region occurs in summer and the summer peak coincides with conditions that result in lower line thermal ratings.

AEMO's analysis indicated that the replacement of line 944 may be postponed for up to 10-years if additional reactive support is installed at the Panorama and Orange substations:

- With 50 MVAr of shunt capacitance installed at the Panorama substation, after beneficial network reconfiguration, maximum supportable demand in summer is approximately 255 MW and 290 MW in winter. This is below the AEMO's forecast peak demands for summer and winter.
- However, with 50 MVAr of shunt capacitance installed at both the Panorama and Orange substations and installation of series reactors on the transformers on the Wallerawang-Panorama and Mt Piper-Orange lines, it may be possible to increase the capacity of the network beyond peak summer and winter demand. The maximum capability of the network will then depend on the level of installed reactive support.
- Minimal growth in customer demand is expected once new industrial load is connected.
- Replacing the Wallerawang–Orange North 132 kV transmission line may not be the least-cost development alternative - installing a shunt reactive compensation at Orange and Panorama, along with series reactors on the Wallerawang-Panorama and Mt Piper-Orange lines may represent a more economical alternative in the short term and reduce transmission line loading and improve voltage regulation.

Conclusion

Assessment criteria	AEMO's assessment
Whether the network configuration could be improved for effective and efficient use of existing assets.	Installing series reactors on the Wallerawang-Panorama and Mt Piper-Orange North line transformers would increase the capability of the existing transmission lines.
Assessment of the ongoing need for transmission line.	It may be possible to defer construction of a new transmission line with the installation of appropriate reactive support.
Review of voltage level and capacity of line.	Existing levels are justified.
Review of drivers for augmentation if the voltage and capacity are higher than the existing levels.	Not applicable.
Comment on the TNSP assessment of non-network alternatives for transmission line or capacity.	Not applicable.
Comment on the TNSP assessment of economics of replacement vs line rebuild.	TNSP assessment or relevant technical information. Not publically available at time of study.

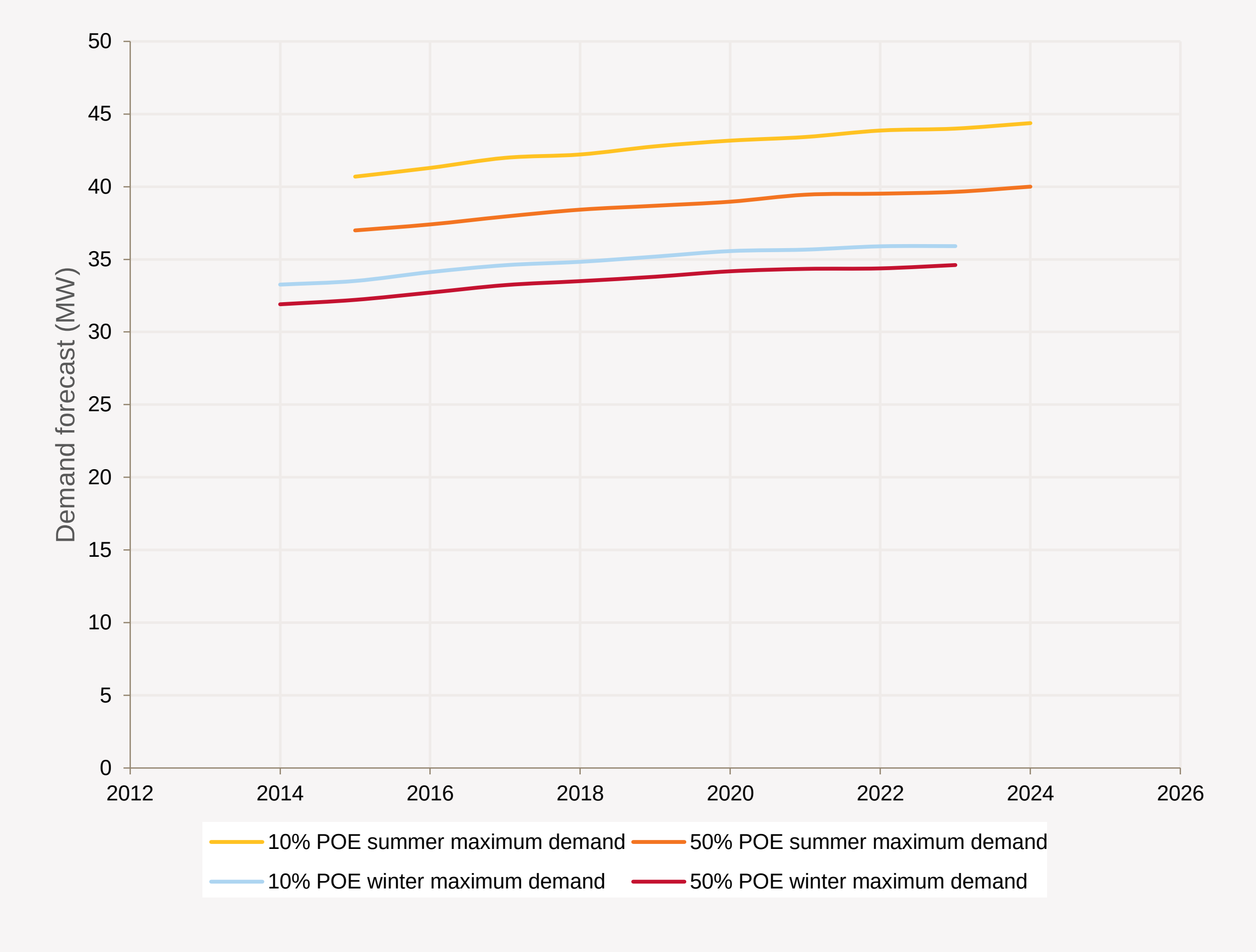
3.2.2 Yass–Burrinjuck transmission line pole replacement

Project	Line No 997 Yass – Burrinjuck transmission line pole replacement
Year	2016
Credible alternatives	Rebuild line
Assessment objective	Assess the load forecast and line loadings to see whether there are any growth related drivers affecting the replacement.

Background

- Gadara, Tumut and Burrinjuck are supplied via a 132 kV connection between Yass and Wagga 330/132 kV Substations.
- The recent expansion of the Visy mill at Gadara will influence capacity requirements for the area.
- TransGrid propose to rebuild the Yass–Burrinjuck line to address asset condition and ensure adequate thermal rating. The present thermal rating of the line is 91 MVA.
- Projected demand
- Figure 19 below shows AEMO's 10-year connection point forecasts for Tumut substation

Figure 19: Tumut substation 10-year connection point forecast



AEMO's assessment of the requirement for this project

- The Yass–Burrinjuck 132kV transmission line provides supply security for load at Tumut and Gadara and transmits power from generating stations at Burrinjuck and Blowering to the area.
- AEMO's 2014 connection point forecast projects summer peak demand at Tumut and Gadara (10% POE) at the end of the 10-year forecast period to be less than the current thermal capacity of the Yass–Burrinjuck 132kV transmission line. AEMO therefore considers that the existing thermal capacity is appropriate.
- AEMO undertook power flow studies for the local network using the 10-year (10% POE) peak demand forecast. This indicated that Yass–Burrinjuck 132kV transmission line is highly loaded during peak periods for certain dispatch scenarios and contingencies.

Conclusion

Assessment criteria	AEMO's assessment
Whether the network configuration could be improved for effective and efficient use of existing assets	No
Assessment of the ongoing need for transmission line	Line provides security (N-1) for Tumut and Gadara load and Burrinjuck, and Blowering power stations
Review of voltage level and capacity of line	Existing levels are justified.
Review of drivers for augmentation if the voltage and capacity are higher than the existing levels	Not applicable
Comment on the TNSP assessment of non-network alternatives for transmission line or capacity	Not applicable
Comment on the TNSP assessment of economics of pole replacement vs line rebuild	TNSP assessment or relevant technical information not publically available at time of study

3.2.3 Coffs Harbour–Koolkhan transmission line pole replacement

Project	Line No 96H Coffs Harbour – Koolkhan transmission line pole replacement
Year	2016
Credible alternatives	Rebuild line
Assessment objective	Assess the load forecast and line loadings to see whether there are any growth related drivers affecting the replacement.

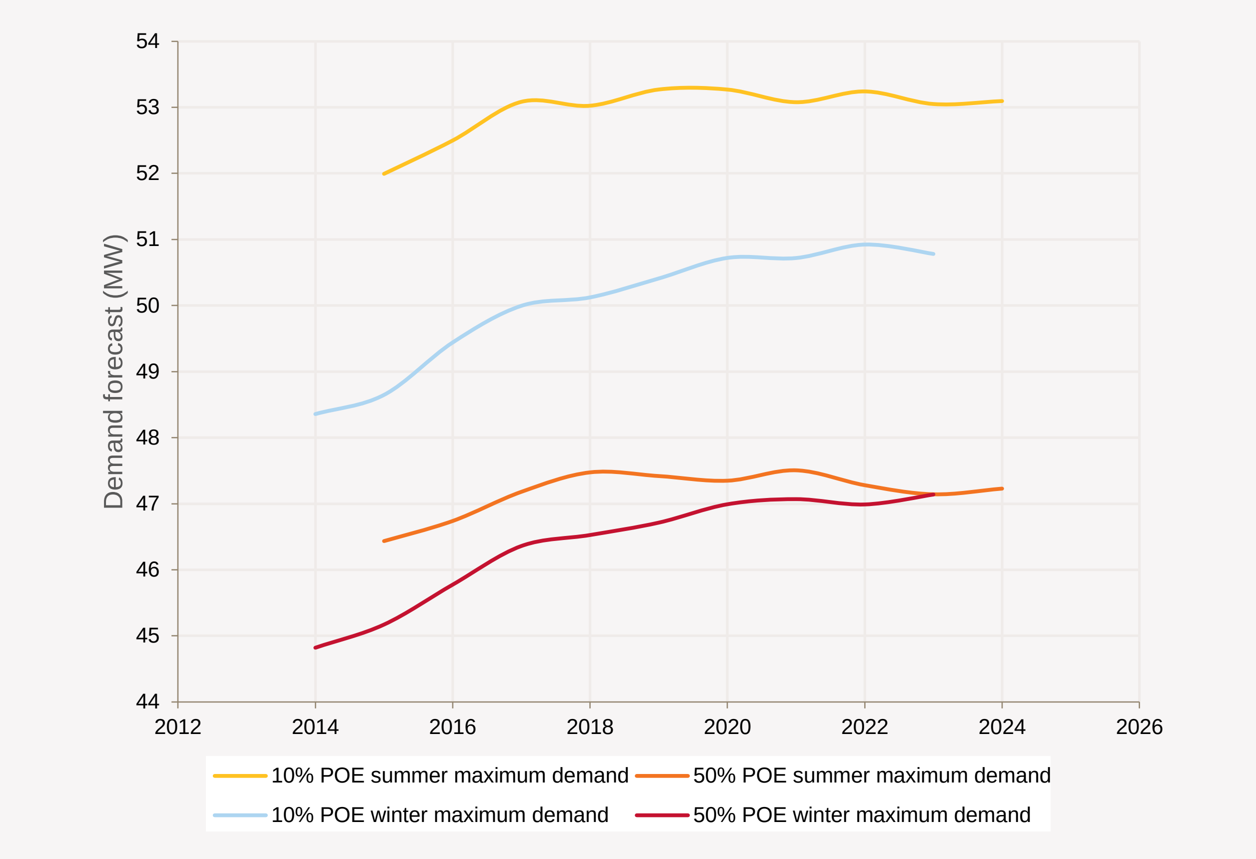
Background

- The Koolkhan area is supplied via a 132 kV connection between Coffs Harbour and Lismore 330/132 kV Substations.
- TransGrid propose to rebuild the Coffs Harbour – Koolkhan line to address asset condition and ensure adequate thermal rating. The present thermal rating of the is 132 MVA.

Projected demand

- Figure 20 below shows AEMO's 2014 10-year connection point forecasts for Koolkhan substation
- The 2014 AEMO forecast also shows minimal growth in peak summer demand.

Figure 20: Koolkhan substation 10-year connection point forecast



AEMO's assessment of the requirement for this project

- The Coffs Harbour–Koolkhan 132kV transmission line provides N-1 supply security for customer load in the Koolkhan area.
- AEMO's 2014 connection point forecast projects peak demand at Koolkhan (10% POE) at the end of the 10-year forecast period to be less than the current thermal capacity of the Coffs Harbour–Koolkhan transmission line. AEMO therefore considers that the existing thermal capacity is appropriate.
- AEMO undertook power flow studies for the local network using the 10-year (10% POE) peak demand forecast. This indicated that Coffs Harbour–Koolkhan 132kV transmission line is highly loaded during peak periods for certain dispatch scenarios and contingencies.

Conclusion

Assessment criteria	AEMO's assessment
Whether the network configuration could be improved for effective and efficient use of existing assets	No
Assessment of the ongoing need for transmission line	Line provides security of supply for Koolkhan customers.
Review of voltage level and capacity of line	Existing levels are justified.
Review of drivers for augmentation if the voltage and capacity are higher than the existing levels	Not applicable
Comment on the TNSP assessment of non-network alternatives for transmission line or capacity	Not applicable

Comment on the TNSP assessment of economics of pole replacement vs line rebuild	TNSP assessment or relevant technical information publically available at time of study

3.2.4 Yanco–Griffith transmission line rebuild

Project	Line No 99J Yanco – Griffith transmission line pole replacement
Year	2018
Credible alternatives	
Assessment objective	Assess the load forecast and line loadings to see whether there are any growth related drivers affecting the replacement.

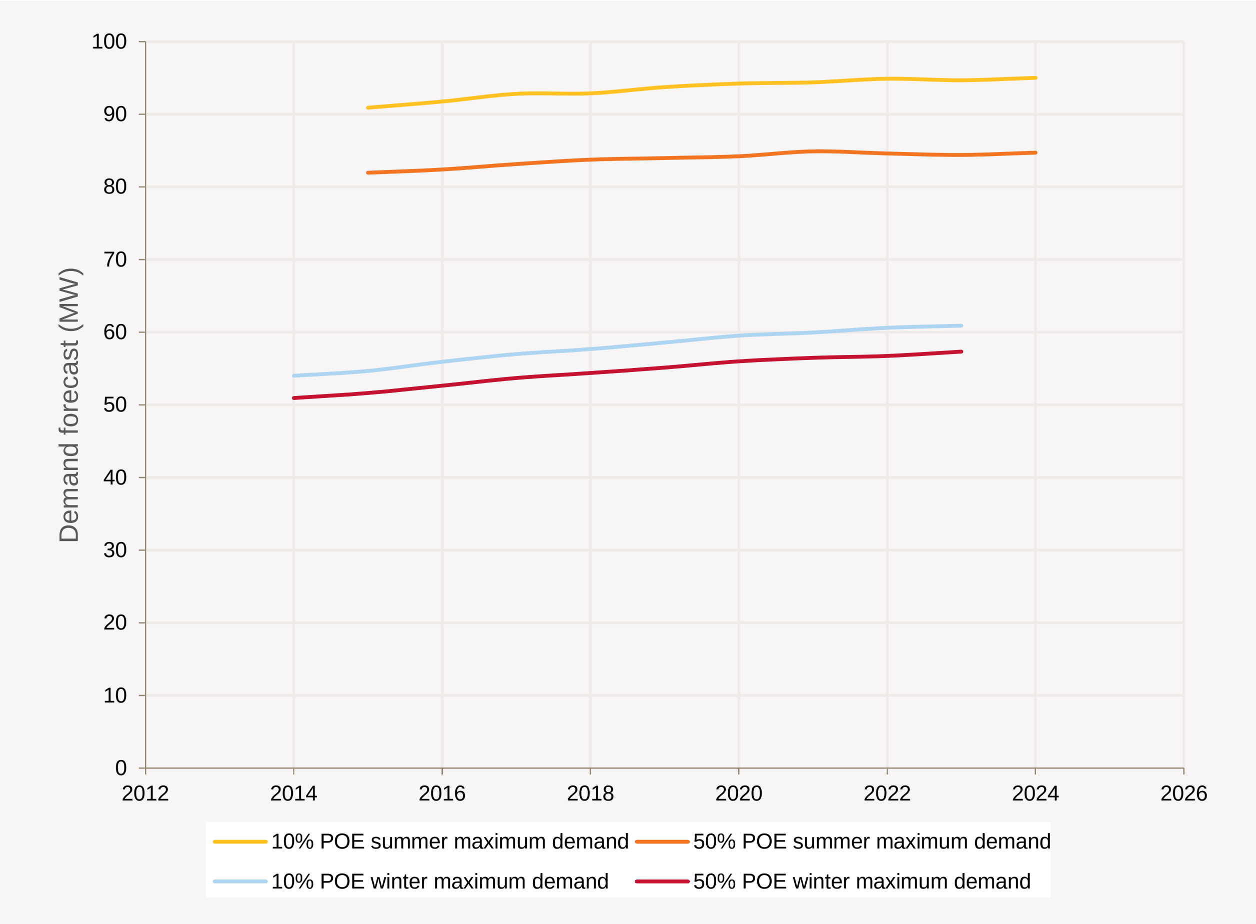
Background

- The Griffith area is supplied via a 132 kV connection from Yanco and Darlington Point 132 kV substations.
- TransGrid propose to rebuild the Yanco–Griffith line to address asset condition and ensure adequate thermal rating. The present thermal rating of the line is 132 MVA.

Projected demand

- Figure 21 below shows AEMO's 10-year connection point forecasts for the Griffith substation.

Figure 21: Griffith substation 10-year connection point forecast



AEMO's assessment of the requirement for this project

- The Yanco–Griffith 132kV transmission line provides security of supply to customer load in the Griffith area.
- AEMO's 2014 connection point forecast projects summer peak demand at Griffith (10% POE) at the end of the 10-year forecast period to be less than the current thermal capacity of the Yanco–Griffith 132kV transmission line. AEMO therefore considers that the existing thermal capacity is appropriate.
- AEMO undertook power flow studies for the local network using the 10-year (10% POE) peak demand forecast. This indicated that Yanco–Griffith 132kV transmission line is highly loaded during peak periods for certain dispatch scenarios and contingencies.

Conclusion

Assessment criteria	AEMO's assessment
Whether the network configuration could be improved for effective and efficient use of existing assets	No
Assessment of the ongoing need for transmission line	Line provides security of supply for the customers of the Griffith area.
Review of voltage level and capacity of line	Existing levels are justified.
Review of drivers for augmentation if the voltage and capacity are higher than the existing levels	Not applicable
Comment on the TNSP assessment of non-network alternatives for transmission line or capacity	Not applicable
Comment on the TNSP assessment of economics of pole replacement vs line rebuild	TNSP assessment or relevant technical information publically available at time of study

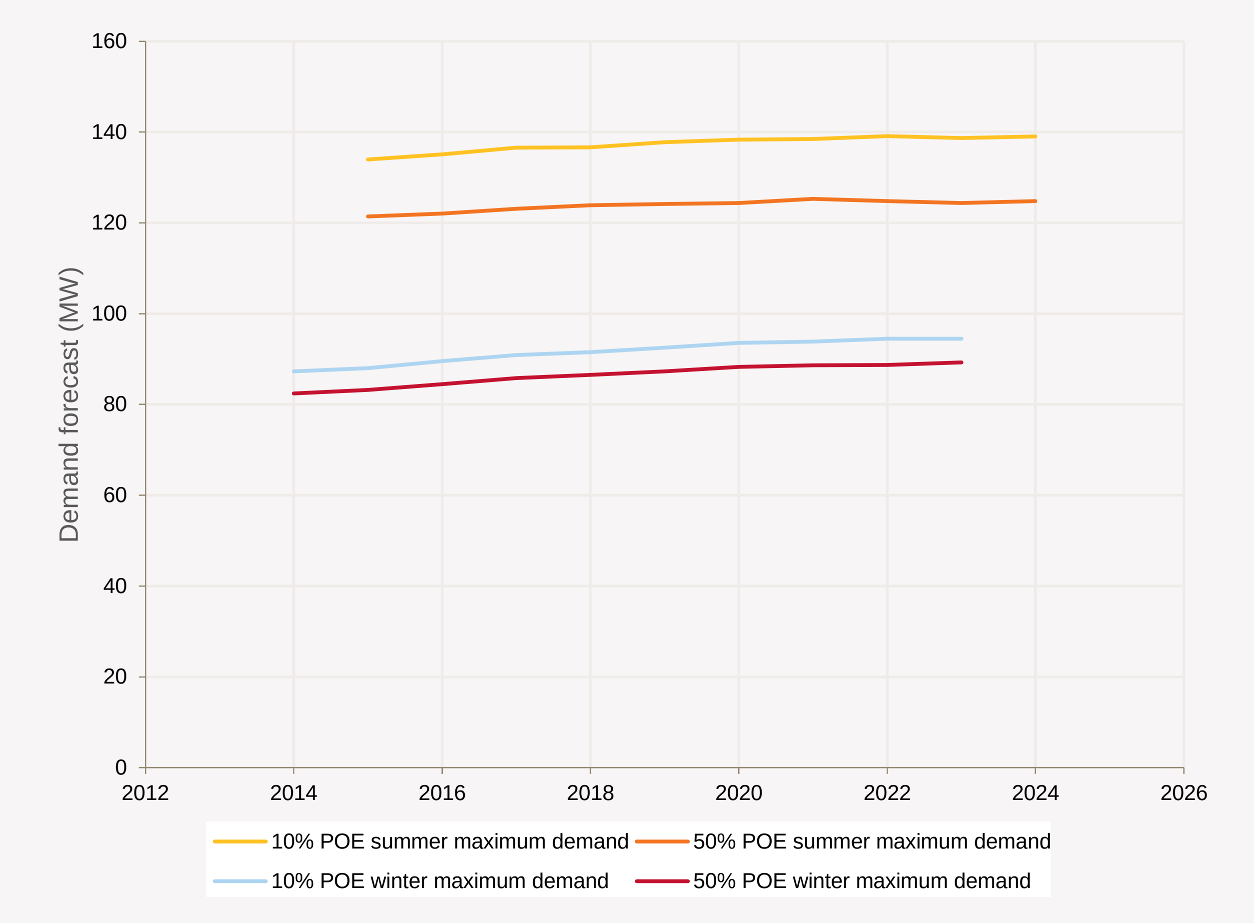
3.2.5 Yanco–Uranquinty transmission line pole replacement

Project	Line No 99F Yanco – Uranquinty transmission line pole replacement
Year	2018
Credible alternatives	
Assessment objective	Assess the load forecast and line loadings to see whether there are any growth related drivers affecting the replacement.

Background

- Yanco is supplied via 132 kV connections from 330/132 kV substations at Darlington and Wagga. The 132kV Yanco–Uranquinty transmission line transmits power from Uranquinty power station to supply load at Griffith and Yanco substations.
- TransGrid propose to rebuild the Yanco–Uranquinty line to address asset condition and ensure adequate thermal rating. The present thermal rating of the line is 114 MVA.
- Projected demand
- Figure 22 below shows AEMO's 10-year connection point forecasts for the Griffith and Yanco substations

Figure 22: Combined Griffith and Yanco substations 10-year connection point forecast



AEMO's assessment of the requirement for this project

- The Yanco – Uranquinty 132kV transmission line provides security of supply to customer load in the Griffith and Yanco areas.
- AEMO's 2014 connection point forecast projects summer peak demand at Griffith and Yanco (10% POE) at the end of the 10-year forecast period to be less than the current thermal capacity of the Yanco – Uranquinty 132kV transmission line. AEMO therefore considers that the existing thermal capacity is appropriate.
- AEMO undertook power flow studies for the local network using the 10-year (10% POE) peak demand forecast. This indicated that Yanco – Uranquinty 132kV transmission line is highly loaded during peak periods for certain dispatch scenarios and contingencies.

Conclusion

Assessment criteria	AEMO's assessment
Whether the network configuration could be improved for effective and efficient use of existing assets	No
Assessment of the ongoing need for transmission line	Line provides security of supply for the customers of the Yanco area.
Review of voltage level and capacity of line	Existing levels are justified.
Review of drivers for augmentation if the voltage and capacity are higher than the existing levels	Not applicable

Assessment criteria	AEMO's assessment
Comment on the TNSP assessment of non-network alternatives for transmission line or capacity	Not applicable
Comment on the TNSP assessment of economics of pole replacement vs line rebuild	TNSP assessment or relevant technical information publically available at time of study

3.3 Proposed reactive plant replacement projects

Table 14: TransGrid's proposed reactive plant replacement projects

Project	Year	Connection points	Page in this attachment
Canberra 330/132 kV Substation Capacitors	2017	Canberra, Yass, Queanbeyan, Williamsdale	44
Broken Hill No. 3 and No. 4 Capacitor Replacement	2020	Broken Hill	46
Buronga 275/220 kV Substation line No.X2 220 kV reactor replacement	2016	None (light load study)	48
Broken Hill 220 kV No. 1 and No.2 Reactor Replacement	2017	Broken Hill	48

3.3.1 Canberra 330/132 kV substation capacitor bank replacement

Project	Canberra 330/132 kV substation capacitor bank replacement
Year	2017
Credible alternatives	Non-network alternative for reactive capacity.
Assessment objective	Assess the load forecast to see whether there are any growth related drivers affecting the replacement.

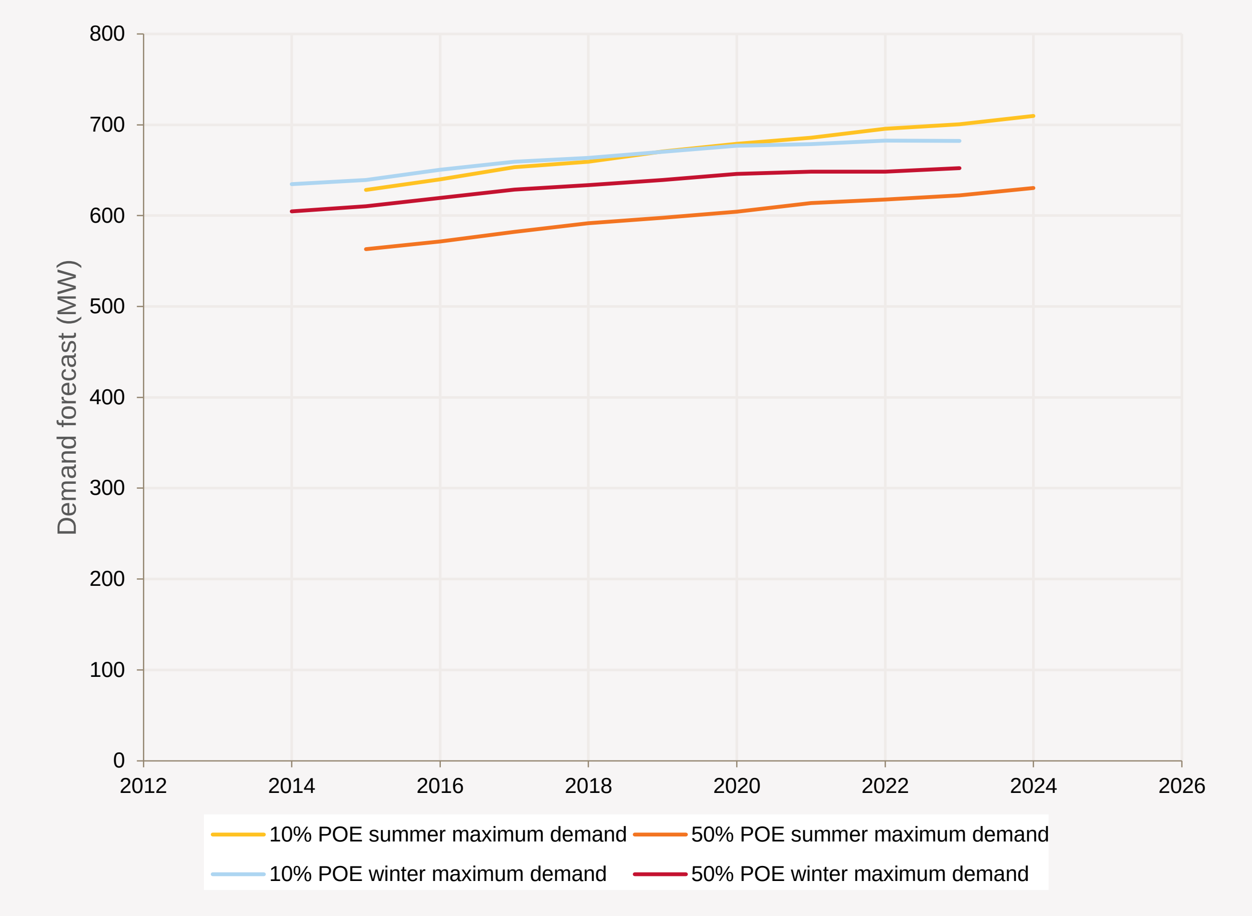
Background

- The Canberra 330/132 kV substation supplies Queanbeyan substation and ActewAGL's distribution network. Canberra is also connected to the new Williamsdale substation via a 330 kV line.
- TransGrid advise that an existing 80 MVAr capacitor bank (C1) is approaching the end of its serviceable life.
- TransGrid is considering to increase the transfer capacity of the Snowy to Yass/Canberra 330 kV network. Additional shunt reactive compensation is required to support this.
- TransGrid propose to refurbish and expand the C1 capacitor bank from 80 MVAr to 120 MVAr.

Projected demand

- The Canberra and Williamsdale areas are highly interconnected. This means that it is not feasible to correctly account for all load transfers between connection points. To circumvent this issue, AEMO developed a Canberra area aggregate forecast for the Canberra and Williamsdale connection points.
- Figure 23 below shows AEMO's 2014 10-year connection point forecasts for the Canberra and Williamsdale substations.

Figure 23: Combined Canberra and Williamsdale substations 10-year connection point forecast



AEMO's assessment of the requirement for this project

- The Canberra substation 132 kV capacitor banks provide:
- Reactive support for the interconnected transmission network under high transfer conditions – New South Wales import capability from the Snowy transmission network is determined to an extent by voltage support at Canberra.
- Reactive compensation for growing customer load in the Canberra and Yass area.
- AEMO's 2014 connection point forecast projects steady load growth in Canberra and Williamsdale show over the next 10 years.
- AEMO therefore considers – based on forecast load growth, voltage support requirements and the need for high levels of reactive support under high power transfer conditions – replacing the existing 80 MVAr capacitor bank C1 at Canberra substation with a higher capacity 120 MVAr capacitor bank is appropriate.
- AEMO also notes that the cost of increasing the capacitor bank capacity from 120 MVAr to 80 MVAr is marginal compared to the incremental gain in reactive output.

Possible replacement options

1. Install a new capacitor bank with a high capacity.
2. Refurbish the existing capacitor bank.
3. Non-network alternatives.
4. Like-for-like replacement of the existing capacitor bank.

Conclusion

Assessment criteria	AEMO's assessment
Review of load forecast to identify any transmission need without the aged asset.	Assessed – need exists for a replacement asset.
TNSP assessment of non-network alternatives for reactive capacity.	Not publically available at time of study
TNSP assessment of economics of replacement vs refurbishment or rebuild.	Not publically available at time of study

3.3.2 Broken Hill substation capacitor bank replacement

Project	Broken Hill substation No.3 and No. 4 capacitor bank replacement
Year	2020
Credible alternatives	Non-network alternative for reactive capacity
Assessment objective	Assess the load forecast to see whether there are any growth related drivers affecting the replacement.

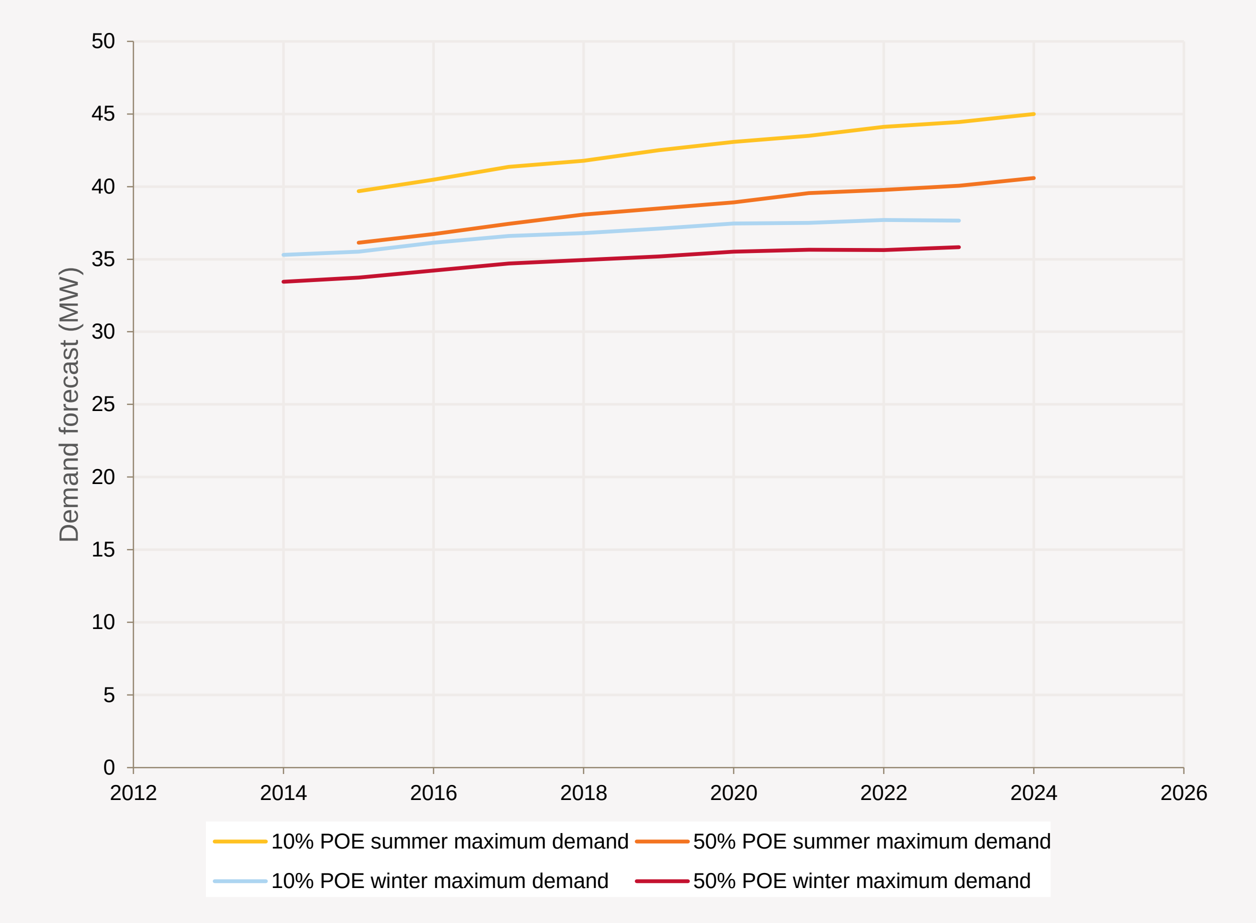
Background

- Broken Hill substation is supplied via a single 220 kV transmission line from Buronga. Two generator-transfomers are connected to the 22 kV bus at Broken Hill substation, and provide security of supply during an outage of the 220 kV line from Buronga. Reactive compensation is required to restore network voltages under high demand operating conditions.
- TransGrid propose to replace the existing 8 MVAr capacitor banks on a like for like basis approaching the end of their serviceable lives.

Projected demand

- Figure 24 below shows AEMO's 2014 10-year connection point forecasts for the Broken Hill substation

Figure 24: Broken Hill substation 10-year connection point forecast



AEMO's assessment of the requirement for this project

- The Broken Hill substation 220 kV capacitor banks provide reactive compensation for the 220kV transmission line from Buronga to restore voltage levels at Broken Hill during high demand periods.
- AEMO's 2014 connection point forecast projects gradual growth in customer demand at Broken Hill over the next 10 years.
- AEMO considers there will be an ongoing need for voltage support at Broken Hill and therefore, like for like replacement of the existing 8 MVA capacitor banks is appropriate.

Possible replacement options

1. Install new capacitor banks with high capacity.
2. Refurbish the existing capacitor banks.
3. Non-network alternatives.
4. Like-for-like replacement of the existing capacitor banks.

Conclusion

Assessment criteria	AEMOs assessment
Review of load forecast to identify any transmission need without the aged asset	Assessed – need exists for a replacement asset
TNSP assessment of non-network alternatives for reactive capacity	Not publically available at time of study

Assessment criteria	AEMOs assessment
TNSP assessment of economics of replacement vs refurbishment or rebuild	Not publically available at time of study

3.3.3 Buronga substation reactor replacement

Project	Buronga 275/220 kV substation line No. X2 220 kV reactor replacement
Year	2016
Credible alternatives	None identified
Assessment objective	Review the voltage profile during light load conditions to justify the need for a replacement asset.

Background

- Buronga is supplied by a 220 kV connection from the 330/220 kV substation at Darlington Point, via Balranald. The Broken Hill and Red Cliffs substations are also connected to Buronga at 220 kV.
- TransGrid propose to replace the existing Buronga–Broken Hill line 33 MVAr X2 220 kV reactor on a like for like basis as it approaches the end of its serviceable life.

AEMO's assessment of the requirement for this project

- The reactors at Buronga are critical to maintaining network voltages within required limits and ensuring security of supply to customers at Broken Hill:
  - The 220 kV Buronga–Broken Hill transmission line is relatively long and the capacitive effect of the line is pronounced during periods of low transfer capacity.
  - Substation reactors reduce potential for high-voltages during low demand situations and provide compensation for the capacitive effect of lightly loaded long transmission lines.
- AEMO considers – based on voltage control requirements at Buronga and Broken Hill – like for like replacement of the Buronga 220 kV X2 reactor is appropriate.

Possible replacement options

1. Install a new reactor
2. Refurbish the existing reactor

Conclusion

Assessment criteria	AEMO's assessment
Review of load forecast to identify any transmission need without the aged asset	Assessed – need exists for a replacement asset
TNSP assessment of economics of replacement vs refurbishment or rebuild	Not publically available at time of study

3.3.4 Broken Hill substation reactor replacement

Project	Broken Hill 220 kV No.1 and No. 2 reactor replacement
Year	2017
Credible alternatives	None identified
Assessment objective	Review the voltage profile during light load conditions to justify the need for a replacement asset.

Background

- Broken Hill is supplied by a 220 kV connection from the Darlington Point 330/220 kV substation, via Balranald and Buronga. The Broken Hill 220/22 KV substation feeds the local load via two transformers. There are two generator-transformers connected to the Broken Hill 22 kV bus providing backup supply.
- TransGrid propose to replace the existing Buronga–Broken Hill line No. 1 and No. 2 220 kV 25 MVAr reactors on a like for like basis as they are approaching the end of their serviceable life.

AEMO's assessment of the requirement for this project

- The reactors at Buronga are critical to maintain network voltages within required limits and ensuring security of supply to customers at Broken Hill:
  - The 220 kV Buronga–Broken Hill transmission line is relatively long and the capacitive effect of the line is pronounced during periods of low transfer capacity.
  - Substation reactors reduce potential for high-voltages during low demand situations and provide compensation for the capacitive effect of lightly loaded long transmission lines.
- AEMO considers – based on voltage control requirements at Broken Hill – like for like replacement of the Broken Hill No1 and No 2 reactors is appropriate.

Possible replacement options

1. Install new reactors
2. Refurbish the existing reactors

Conclusion

Assessment criteria	AEMO's assessment
Review of load forecast to identify any transmission need without the aged asset	Assessed – need exists for a replacement asset
TNSP assessment of economics of replacement vs refurbishment or rebuild	Not publically available at time of study

3.4 Proposed substation replacement projects

Table 15: TransGrid's proposed substation projects

Project	Year	Connection points	Page of this attachment
Canberra 330 kV substation	2019	Canberra and surrounding area	49
Cooma substation	2016	Cooma, Bega and Munyang	52
Munmorah 330 kV substation	2020	Central Coast and Colongra Power Station	54
Vales Point 330 kV substation	2018	Central Coast and surrounding area	56

3.4.1 Canberra 330/132 kV substation rebuild

Project	Canberra 330/132 kV substation rebuild
Year	2017
Credible alternative	Refurbish existing site

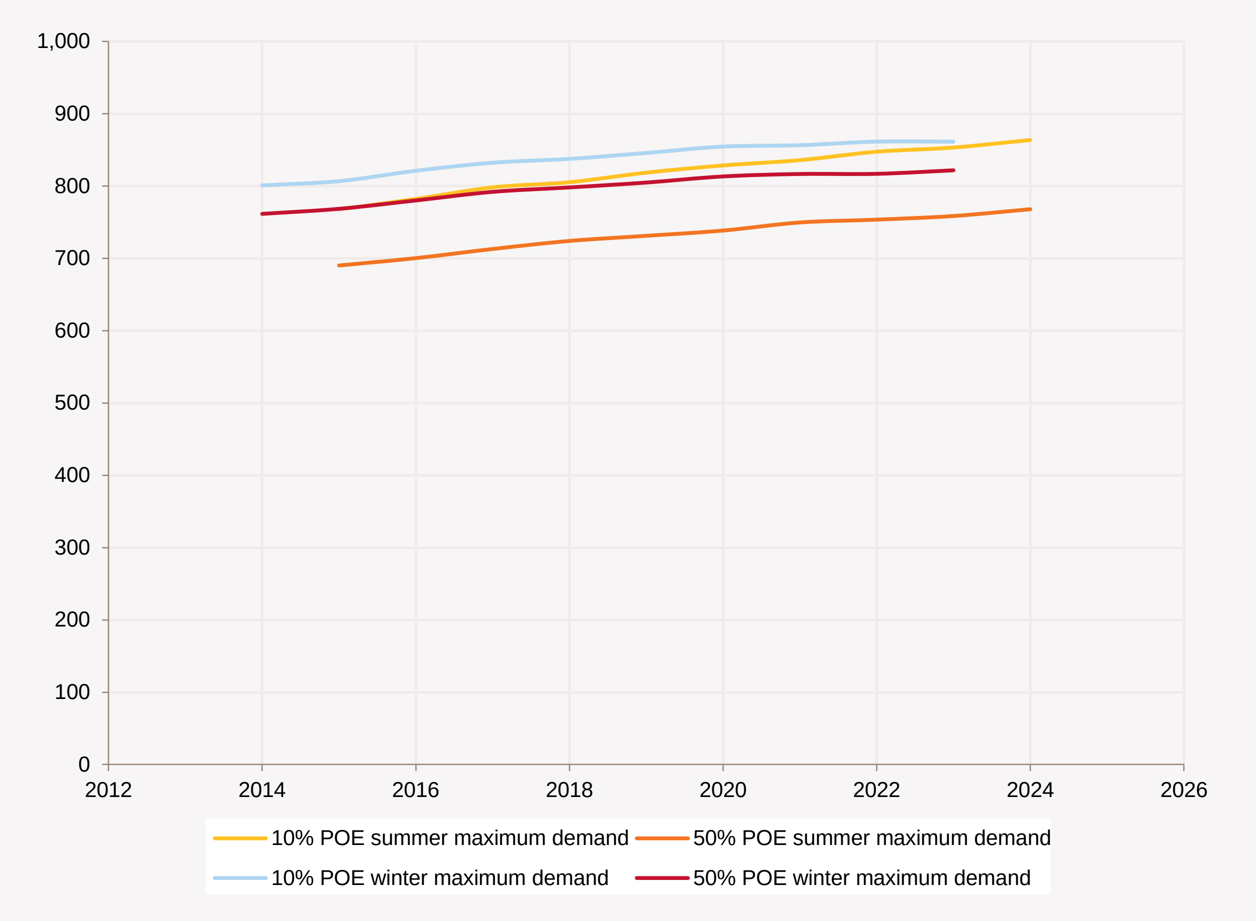
Background

- Canberra substation is a critical part of the New South Wales transmission network. It forms part of the interconnected network with Victoria and provides supply capacity to Canberra and surrounding area, including Williamsdale, Queanbeyan, and Cooma substations.
- In addition the Canberra substations supplies the 132 kV network between Cooma and the Murray hydro power station.
- The New South Wales import capability from the Snowy transmission network is determined to an extent by voltage support at Canberra. The Canberra 132 kV section capacitor banks have the duel function of providing reactive power support for the interconnected transmission network under high transfer conditions; and providing reactive power compensation to growing demand in the Canberra and Yass area.
- Canberra 330/132 kV substation is equipped with two 375 MVA 330/132 kV transformers and two 400 MVA 330/132 kV transformers that provide supply to the ActewAGL sub-transmission and distribution network. TransGrid propose three 375 MVA 330/132 kV transformers at the new Canberra substation.
- Additional 132 kV supply capacity is provided by Williamsdale substation located to the south of Canberra substation. While Williamsdale Substation is presently connected to the Canberra substation via a single 330 kV transmission circuit, this connection configuration will change following the establishment of Wallaroo Substation (north–west of Canberra) and associated reconfiguration of 330 kV lines.
- The Williamsdale and Canberra 330/132 kV transformers are effectively connected in parallel, via the ActewAGL underpinning 132 kV network, and share Canberra and surrounding area load.
- The Canberra 330 kV section is configured for “breaker and a half” operation while the 132 kV section is constructed for “double bus” operation.
- TransGrid advise that Canberra substation and its equipment is now approaching the end of its serviceable life and requires replacement.

Projected demand

- Figure 25 below shows AEMO’s 2014 10-year connection point forecasts for the Canberra, Williamsdale, Queanbeyan, and Cooma substations.

Figure 25: Combined Canberra, Williamsdale, Queanbeyan and Cooma substations 10-year connection point forecast



AEMO's assessment of the requirement for this project

- The existing function and services provided by Canberra Substation cannot be transferred or performed by any other substation or generation facilities in proximity of the existing substation.
- As noted in 3.3.1, AEMO considers the replacement and upgrade of the existing capacitor banks at Canberra substation is justified, based on forecast load growth and the need for high levels of reactive support under high transfer conditions.
- AEMO considers:
  - Replacing the existing switchyard assets at Canberra substation based on a "breaker and a half" (330 kV) and "double bus" (132 kV) is appropriate.
  - Rebuilding the substation immediately adjacent to the existing Canberra substation will reduce the need for material re-alignment of 330/132 kV overhead line connections.

Possible replacement options

1. Establishing a new 330/132 kV substation in close proximity to the existing substation site.
2. An in-situ replacement and rebuilding of the existing Canberra Substation.

Conclusion

Assessment criteria	AEMOs assessment
Whether the network configuration could be improved for effective and efficient use of existing assets	None identified.
Comment on options for replacement (in-situ replacement vs establishment of a new substation)	Cost comparison is required, but construction of a new substation may confer worker safety benefits.

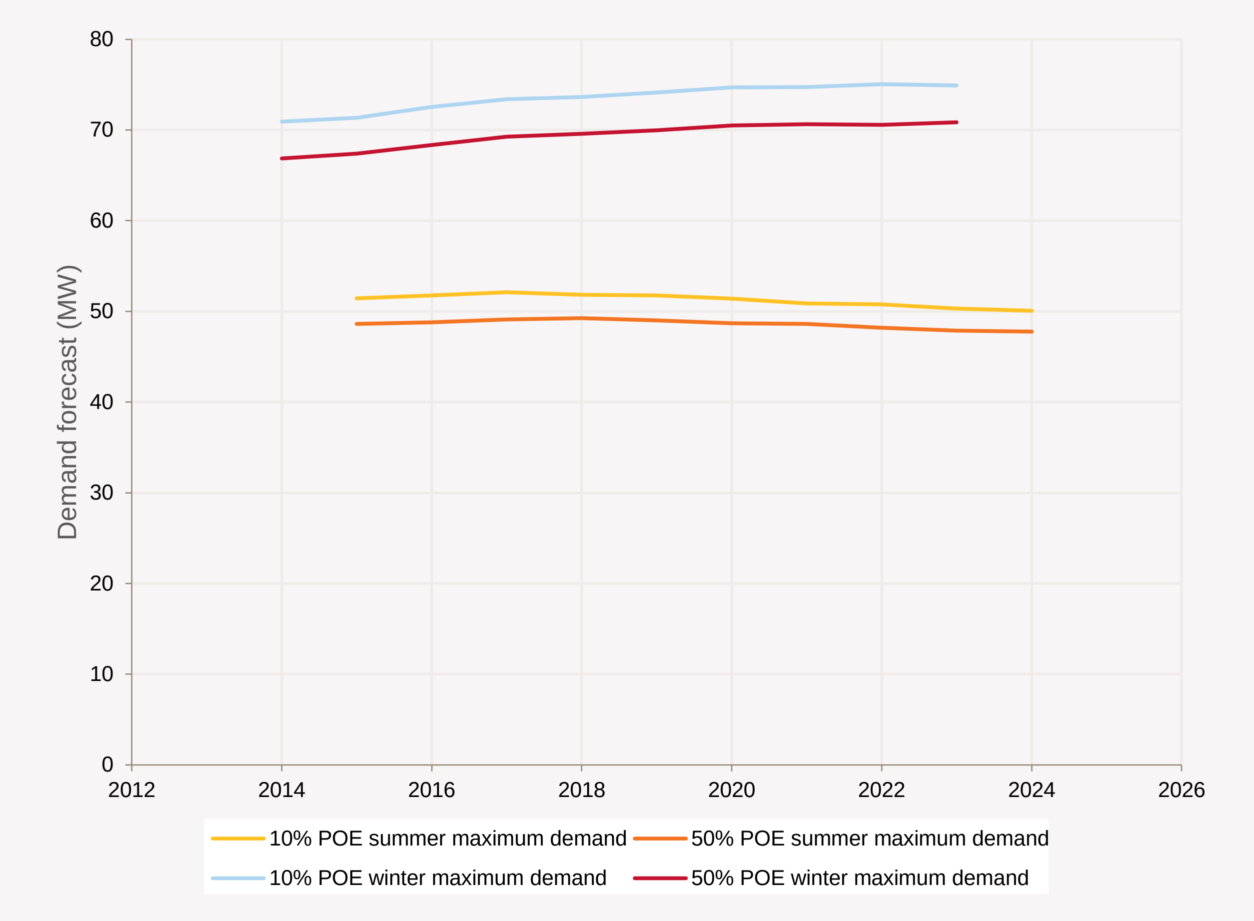
3.4.2 Cooma substation replacement

Project	Cooma substation replacement
Year	2016
Credible alternative	Refurbish on existing site

Background

- Cooma substation is supplied via two 132 kV transmission lines from Canberra/Williamsdale. It supplies adjoining substations and customer load at voltage levels of 132/66/11 kV. Radial 132 kV lines from Cooma substation supply remote customer loads at Bega and Munyang.
- Cooma Substation was established in 1954. TransGrid have advised that the substation and its equipment are now approaching the end of their serviceable lines and is in need of replacement.
- TransGrid propose to replicate the functionality of the existing substation by constructing a new substation immediately adjacent the existing facility by installing the following equipment at Cooma:
  - 2 x 132/66 kV 60 MVA transformers
  - 1 x 132 kV double busbar
  - 1 x 132 kV 12 MVAr capacitor bank
  - 5 x 132 kV line switch bays
  - Control, protection and metering panels and cabling for all switchgear
  - Projected demand
- Figure 26 shows AEMO's 2014 10-year connection point forecasts for the Cooma substation.

Figure 26: Cooma substation 10-year connection point forecast



AEMO's assessment of the requirement for this project

- The existing function and services provided by Cooma Substation cannot be transferred or performed by any other substation or generation facilities in proximity to the existing substation.
- TransGrid propose a like for like replacement of substation assets, with additional shunt reactive compensation and provision for the connection of future services.
- AEMO's power flow studies for the local network using the 10-year (10% POE) peak demand forecast indicated:
  - The two existing 132 kV lines from Williamsdale/Canberra are required to provide N-1 supply reliability.
  - The inclusion of shunt reactive power compensation on the Cooma 132kV bus section will ensure adequate voltage levels under contingency operating conditions as the existing 132 kV lines supplying Cooma from Williamsdale/Canberra are relatively long.
- AEMO also considers:
  - Inclusion of a spare line switch bay (not populated) would provide opportunity to connect future customer services at Cooma.
  - Rebuilding the substation immediately adjacent the existing Cooma Substation will reduce the need for material re-alignment of the connecting 132/66/11 kV overhead lines. However AEMO has been informed that the land adjacent to the Cooma substation is unavailable.

Possible replacement options

- Establish a new 132 kV substation in close proximity to the existing substation site.
- Conclusion

Assessment criteria	AEMO's assessment
Whether the network configuration could be improved for effective and efficient use of existing assets	None identified
Comment on options for replacement (in-situ replacement vs establishment of a new substation)	Land unavailable for establishment of new substation.

-

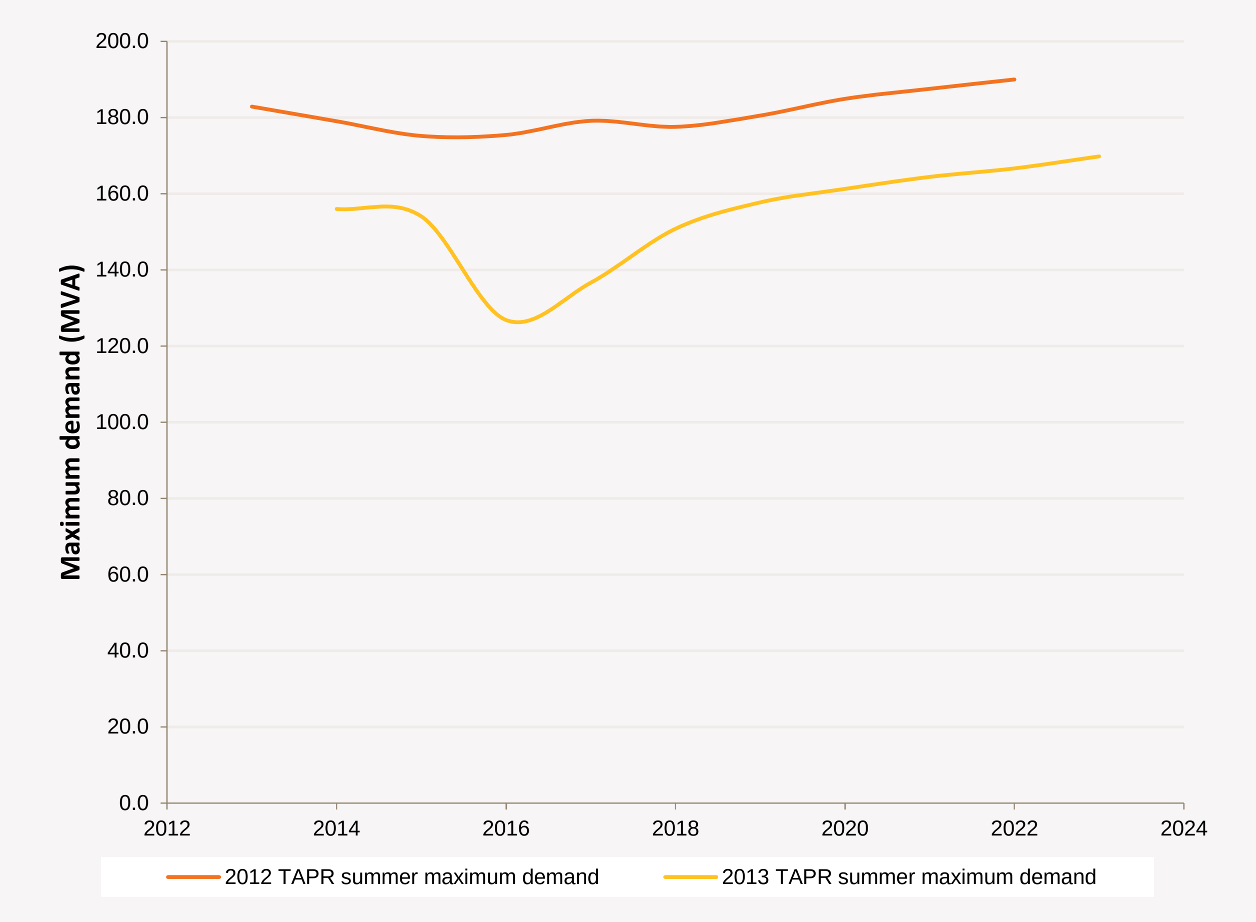
3.4.3 Munmorah 330 kV substation rebuild

Project	Munmorah 330 kV substation rebuild
Year	2019
Credible Alternative	Refurbish on existing site.

Background

- Munmorah 330 kV substation forms a critical part of the Central Coast transmission network. It contributes to interconnected network operation, supports the connection of Colongra Power Station and supplies local customer load through Ausgrid's distribution network.
- TransGrid have advised that:
  - Munmorah substation and its equipment are now approaching the end of their serviceable lives and is in need of replacement.
  - There is need to install a new series reactor on the 330 kV bus section at Munmorah substation to control power flows in New South Wales central coast network. The reactor would prevent uneconomic restrictions on base-load power station operation in the area.
- TransGrid's propose to rebuild of the Munmorah 330 kV substation without replacing equipment connected to the retired Munmorah generators or the power station transformers, with a new series reactor.
- A series reactor was previously originally installed at Munmorah, but was de-commissioned due to its physical condition, and was not replaced following the retirement of Munmorah Power Station.
- As an alternative to installing the reactor at Munmorah, TransGrid have advised that the new series reactor may be installed at Vales Point Power Station, but further studies are required to confirm this.
- Munmorah has a single 330/132 kV 375 MVA transformer supplying to the 132 kV network. The 330 kV bus section is configured for "breaker and a half" operation.
- Projected demand
- The Hunter area is highly interconnected. This means that it is not feasible to correctly account for all load transfers between connection points. To circumvent this issue, AEMO developed a Hunter area aggregate forecast for the Liddell, Munmorah, Muswellbrook, Newcastle, Tomago, Tuggerah, Vales Point, and Waratah West connection points.
- As the Munmorah substation lies outside the major Newcastle-Tomago-Waratah West load centre of the Hunter area, AEMO has applied TransGrid's TAPR forecast in this assessment of TransGrid's proposed Munmorah substation rebuild.
- Figure 27 compares TransGrid's 2012 and 2013 TAPR 10-year connection point forecasts for the Munmorah substation.

Figure 27: Munmorah substation 10-year connection point forecast



AEMO's assessment of the requirement for this project

- The existing function and services provided by Munmorah Substation cannot be readily transferred to or performed by another substation or generation facilities in proximity of the existing substation.
- Munmorah 330 kV substation is configured for operation with a single 366 MVA 330/132 kV transformer to supply to Ausgrid's distribution network.
- AEMO's power flow studies indicate that installation of a series reactor may be required to balancef power flows and ensure efficient utilisation of the 330 kV Central Coast transmission network. Site assessment is required to confirm the optimal location for the new reactor.
- AEMO considers that, given the space limitations around the existing site, rebuilding on the existing site may represent the only viable development option.

Possible replacement options

1. Establish a new 330 kV substation in close proximity to the existing substation site. However, this may be difficult due to site and environmental considerations.
2. An in–situ replacement and rebuilding of the existing Munmorah substation

Conclusion

Assessment criteria	AEMO's assessment
Whether the system configuration could be improved for effective and efficient use of existing assets	Potential to retain Colongra network connection assets and use a smaller substation footprint.

Comment on options for replacement (in-situ replacement vs establishment of a new substation)	Detailed cost comparison is required.

3.4.4 Vales Point 330 kV substation rebuild

Project	**Vales Point 330 kV substation rebuild**
Year	2017
Credible alternative	Refurbish on existing site.

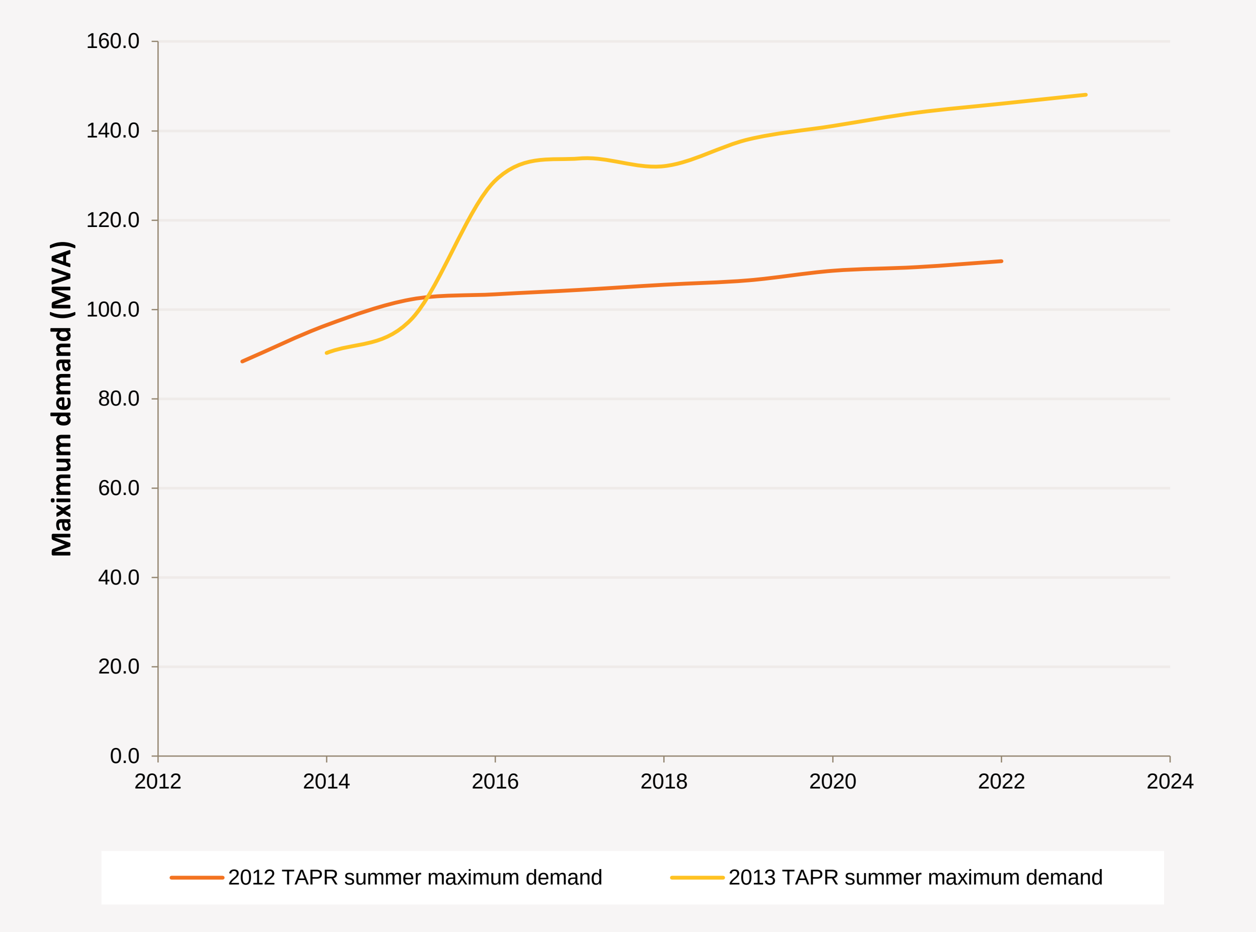
Background

- Vales Point substation forms a critical part of the Central Coast transmission network. It contributes to interconnected network operation, supports the connection of Vales Point Power Station and supplies local customer load through Ausgrid's distribution network.
- TransGrid have advised that
  - Vales Point substation and its equipment are now approaching the end of their serviceable lives and is in need of replacement.
  - There is a need to install a new series reactor on 330 kV bus section at Vales Point substation to control power flows in New South Wales central coast network. The reactor would prevent uneconomic restrictions on base-load power station operation in the area.
- A series reactor was previously originally installed at Munmorah, but was de-commissioned due to its physical condition, and was not replaced following the retirement of Munmorah Power Station.
- TransGrid have advised that the new series reactor may be installed at Vales Point Power Station, as an alternative to Munmorah switchyard but further studies are required to confirm this.
- Vales Point has two 330/132 kV 200 MVA transformers supplying to the 132 kV network. The 330 kV bus section is configured for "breaker and a half" operation.

Projected demand

- The Hunter area is highly interconnected. This means that it is not feasible to correctly account for all load transfers between connection points. To circumvent this issue, AEMO developed a Hunter area aggregate forecast for the Liddell, Munmorah, Muswellbrook, Newcastle, Tomago, Tuggerah, Vales Point, and Waratah West connection points.
- As the Vales Point substation lies outside the major Newcastle-Tomago-Waratah West load centre of the Hunter area, AEMO has applied TransGrid's TAPR forecast in this assessment of TransGrid's proposed Vales Point substation rebuild.
- Figure 28 compares TransGrid's 2012 and 2013 TAPR 10-year connection point forecasts for the Vales Point substation.

Figure 28: Vales Point substation 10-year connection point forecast



AEMO's assessment of the requirement for this project

- The existing function and services provided by Vales Point Substation cannot be readily transferred to or performed by another substation or generation facilities in proximity to the existing substation.
- Vales Point 330 kV substation is configured for operation with 2 x 200 MVA 330/132 kV transformers to supply to Ausgrid's distribution network.
- AEMO's power flow studies indicate that installation of a series reactor may be required to balance power flows and ensure efficient utilisation of the 330 kV Central Coast transmission network. Site assessment is required to confirm the optimal location for the new reactor.
- AEMO considers, given the space limitations around the existing site, rebuilding on the existing site may represent the only viable development option.

Possible replacement options

1. Establish a new 330 kV substation in close proximity to the existing substation site. However, this option may be difficult due to site and environmental considerations.
2. An in-situ replacement and rebuilding of the existing Vales Point substation

Conclusion

Assessment criteria	AEMO's assessment
Whether the network configuration could be improved for effective and efficient use of existing assets	None identified
Comment on options for replacement (in-situ replacement vs establishment of a new substation)	Detailed cost comparison is required.