NEED/OPPORTUNITY STATEMENT (NOS)

Supply to Sydney Inner Metropolitan Area and CBD

NOS- DCN43 revision 3.0

Ellipse project description: Augmentation of supply to the Sydney CBD and inner metropolitan area to relieve network constraints due to asset retirements, asset capability, and load growth in order to meet the present NSW reliability standard.
TRIM file: MF1241

Project reason: Reliability - To meet overall network reliability requirements
Project category: Prescribed - Augmentation

Approvals

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Date submitted for approval	10 January 2017	

1. Existing Arrangement

1.1 Present supply arrangement

The Greater Sydney area is supplied by TransGrid's 500 kV and 330 kV transmission network as shown in Figure 1. The Sydney CBD and inner metropolitan area is fed by an underlying 132kV Ausgrid network supplied by 330/132 kV Bulk Supply Points (BSP) around the perimeter of the Sydney basin (Sydney East, Sydney North, Sydney South, Sydney West via Rookwood Road), as well as two BSP's within the inner metropolitan area (Beaconsfield West and Haymarket). The two inner metropolitan area 330/132 kV BSP's are fed by two underground 330 kV cables from Sydney South substation; Cable 41 to Beaconsfield West and Cable 42 to Haymarket. These 330 kV cables operate in parallel with the Ausgrid 132 kV cable network.

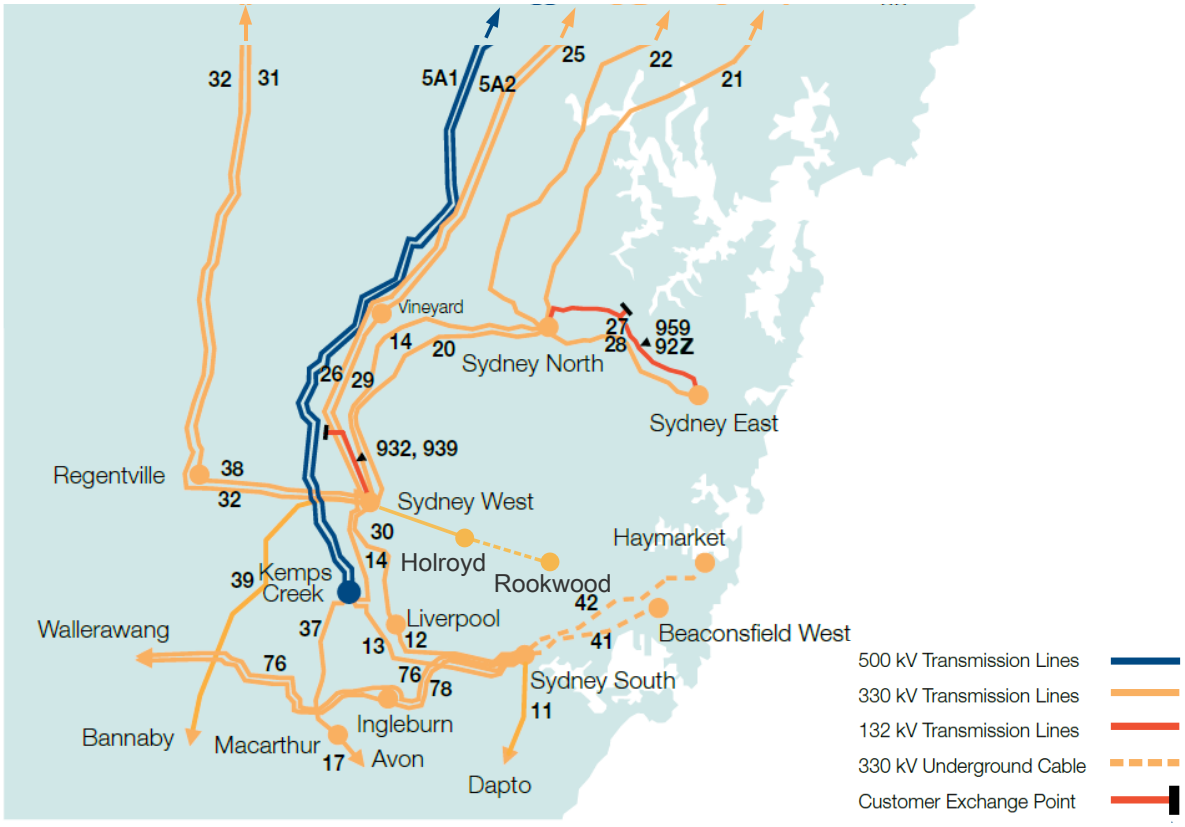


Figure 1 – Supply to Greater Sydney Area

The capability of the inner metropolitan supply network is defined by the combined capacity of the parallel TransGrid 330 kV and Ausgrid 132 kV networks as shown in Figure 2. These networks have been planned to operate as a single electrical system, designed to optimally share the load in proportion to their respective ratings.

Figure 2 – Network Supplying Sydney CBD and Inner Metropolitan Area

To better describe the key capacity constraints on the inner metro area, two critical network cut-sets have been identified as shown in Figure 3.

The two identified critical cut-sets are described as:

Cut-set 1 - Outer BSP to Inner Metro

This constraint cut-set defines the capability to deliver supply from the bulk supply points on the outer ring of Sydney (Sydney North, Sydney South, and Sydney West via Rookwood) into the inner metropolitan area. This group includes both of the TransGrid 330 kV cable circuits 41 and 42, as well as the Ausgrid 132 kV circuits 90V, 90W, 928, 929, 92L & 92M from Sydney North to CBD, 91A, 91B, 91X and 91Y from Rookwood Road to Beaconsfield West, 245, 246, 910, 911, 91C, 91H/91R, 91L and 91M/1 from Sydney South to Beaconsfield. These circuits operate in parallel, so that the retirement or de-rating of any one of these circuits may affect the supply capability into the study area.

Cut-set 2 - Beaconsfield to CBD & Inner City

During an outage of 42 Cable, the Haymarket BSP load must be supplied by the 132 kV network out of Beaconsfield, with support from Sydney North through Rozelle and Lane Cove. This constraint cut-set includes the TransGrid 330 kV cable 42, as well as the Ausgrid 132 kV circuits 90V, 90W, 928, 929, 92L, 92M, 9S2, 9S4, 9SA, 92P (ex 9SB/1) & 90T.

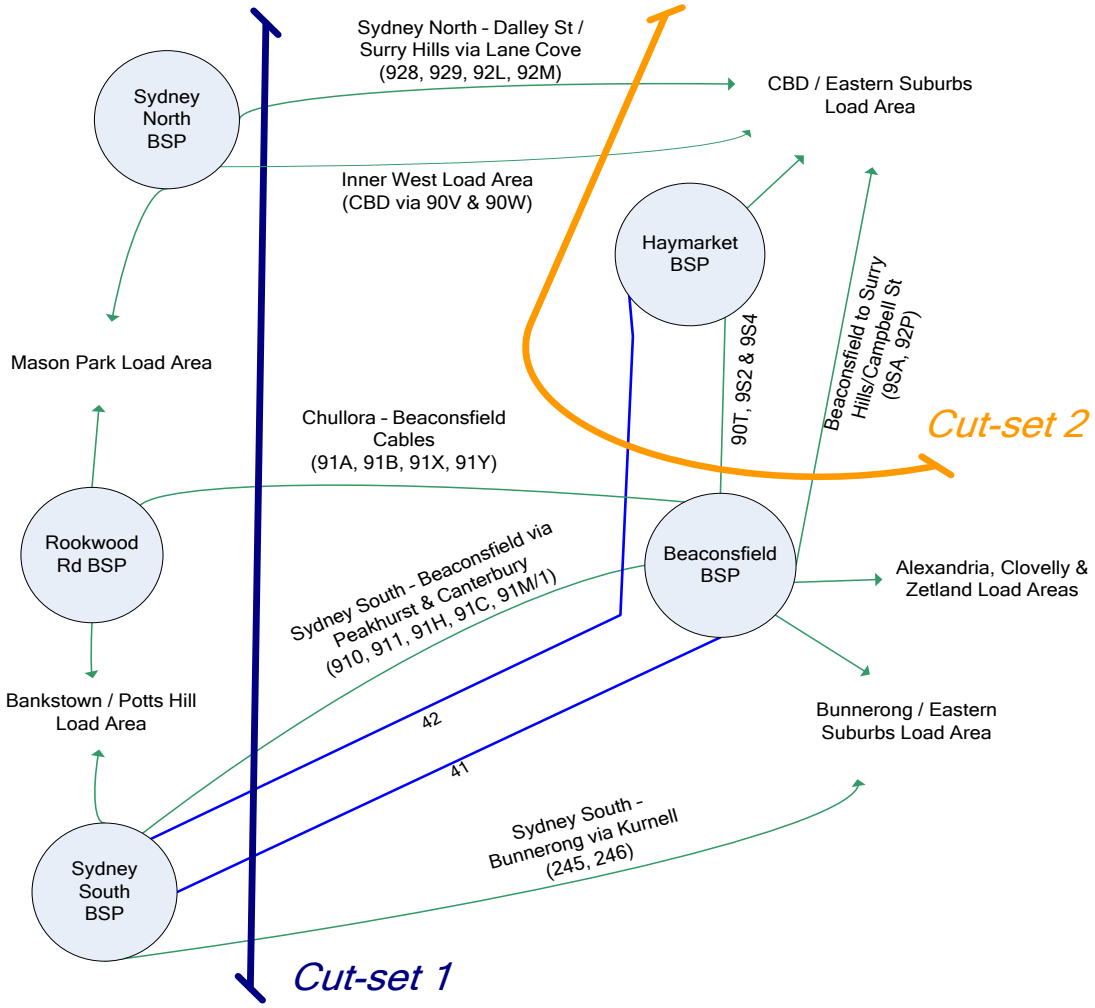


Figure 3 – Constraining cut-sets 1 and 2

1.2 Prescribed planning criteria

The planning criteria applied to the NSW transmission network is defined in the Transmission Network Design and Reliability Standard for NSW, published by the Department of Industry and Investment in December 2010. This standard recognises that supply to high-density urban and central business districts (as shown in Figure 2) shall be given special consideration. The planning criteria applied to the Sydney CBD covers defined credible contingencies that result in the simultaneous outage of two selected elements; one in each of the 330 kV and 132 kV networks ('modified n-2' criteria).

This approach is consistent with supply to other major cities throughout the world.

The planning criteria has been developed after consideration of:

- The importance and commercial sensitivity of the Sydney CBD area load to supply interruptions;
- The high cost of applying a strict 'n-2' criterion to the 330 kV cable network;
- The large number of elements in the 132 kV network supplying the area;
- The past performance of the cable system; and
- The long times to repair cables should they fail.

The standard requires peak load in the CBD to be supplied with no interruption during:

(a) the simultaneous outage of a 330 kV cable and any 132 kV feeder or 330/132 kV transformer; or
(b) an outage of any section of 132 kV busbar.

The reliability standards applying to transmission in New South Wales from 1 July 2018 were recently reviewed by the Independent Pricing and Regulatory Tribunal (IPART). While the reliability standards to apply from 1 July 2018 are not confirmed, a move to a standard that explicitly acknowledges the value of unserved energy to customers is expected[1].

2. Statement of Need

2.1 Forecast growth in the inner metropolitan area and CBD

Peak demand in the inner metropolitan area occurs in the summer season, driven primarily by air conditioning load from residential and commercial customers. The inner metro area demand declined from 2010 to 2014 due to consumer responses to increased electricity prices, the use of energy efficient devices (eg. compact fluorescent lights) and the gradual penetration of embedded renewable generation (eg rooftop solar cell installations). Peak demand has returned to modest growth since 2014 with forecast demand projected to continue growing modestly over the next 10 years[2].

The inner metropolitan supply network is planned using a 50% Probability of Exceedance (PoE) load forecast; that is, a forecast load that is expected to be exceeded once every two years. The updated Ausgrid 2015 forecast (for years 2016 – 2025) of maximum demand (MD) through cut-set 1 under three different scenarios is shown in Figure 4.

Figure 4 – Cut-sets Summer MD Forecast 2016-2025

[1] IPART published a Draft Supplementary Report on 29 September 2016 seeking submissions on the draft recommendations, with the Final Supplementary Report due to the Minister for Industry, Resources and Energy by the end of 2016 for a decision on what standards will apply.

[2] Refer to GHD Report on Ausgrid's 2016 Inner Sydney Demand Forecast available in PDGS Supporting Documents (also available on TransGrid web site)

2.2 Description of need

There is a potential network forecast shortfall to supply the inner metropolitan area load to the standard of reliability required.

In particular, the network has an aging population of Ausgrid 132 kV oil-filled cables, many in poor condition. Ausgrid is devising a program to retire a number of 132 kV cables over the next decade. This program prioritises cables traversing waterways, where the risk of oil leaks has major environmental consequences.

2.2.1 Ausgrid 132 kV cable condition issues and retirement

A major consideration of the inner metropolitan transmission system relates to the performance of Ausgrid's aged oil-filled 132 kV cable network. They are self-contained fluid filled cables ("oil filled cables"), installed during the 1960's and 1970's. Unavailability can be due to both faults and oil leaks. Oil leaks are an environmental hazard requiring lengthy outages to locate the leak and repair. These long repair times cause reduced system availability and reliability as the cables degrade over time.

91L and 91M

91L and 91M are oil filled cables between Peakhurst (to Bunnerong) and Beaconsfield. These cables have suffered from extensive oil leaks historically. 91L has been retired in 2015 and the capacity is replaced by cables 91H, 906 and 907. 91M/1 will be decommissioned by 2017[3].

92L and 92M

92L and 92M are oil-filled cables from Lane Cove to Dalley Street. These cables are some of the worst performing oil-filled circuits within the Ausgrid network, ranked No. 1 and No. 3 respectively due to oil leaks. Furthermore their submarine nature presents an unacceptable risk of environmental damage. It is expected that 92L/3 and 92M/1 will be decommissioned by 2017 in line with the original retirement program.

928 and 929

928 and 929 are oil filled cables from Lane Cove to Dalley St in parallel with 92L and 92M. These cables also traverse environmentally sensitive areas, however oil leakage has historically been lower than 92L and 92M. The retirement timing will be subject to a cost benefit analysis, in consideration of environmental risk, maintenance costs and load growth. It is likely that 928 and 929 will retire by 2019 in accordance with the original plan.

91A & 91B, 91X & 91Y

91A, 91B, 91 X and 91Y were installed in the 1970's. They are oil-filled cables that transfer power from Rookwood Road to Beaconsfield through Chullora and St Peters. These four circuits are a significant contributor to the inner metropolitan network supplying the CBD and Eastern Suburbs. Ausgrid is conducting a cost benefit analysis to find the least cost cable retirement options. The approach is to quantify the annual risk across the key risk areas of Environment, Safety, Reputation, Financial and Reliability, to assess the risk cost reduction benefit compared with the cost of cable retirement and network upgrade options.

2.2.2 Reduced rating of Ausgrid 132 kV cables

Ausgrid has commenced a program of reviewing circuit ratings within its 132 kV underground cable network. Its investigations have discovered a number of locations along cable routes with particularly high natural soil thermal resistivity. This has resulted in a reduction of the rating of several circuits amongst the critical set of cables supplying Sydney's CBD and inner metropolitan area. Table 1 lists the cable de-ratings, as provided in Ausgrid's 'Sydney Inner Metropolitan Transmission Area Plan'.

[3] Joint Planning Report - Inner Metropolitan Area Strategy V4.0 dated 30 Oct 2015

Cable designation	Cable route	Original rating (MVA)	Revised rating (MVA)
90T	Green Square - Haymarket	270	222
91A1/B1	Beaconsfield - St Peters	135	101
91A2/B2	Chullora - St Peters	135	104
91M	Peakhurst - Beaconsfield	210	199
91X1/Y1	Beaconsfield - Marrickville	135	99
91X2/Y2	Chullora - Marrickville	135	101
928/929	Lane Cove - Dalley St	145	121
92M/1	Lane Cove - Dalley St	150	128
92L/3	Lane Cove - Dalley St	150	128
9S2	Beaconsfield - Haymarket	270	225
9SA	Beaconsfield - Campbell St	240	129
9SB	Beaconsfield - Surry Hills Annex	255	129
9SE	Beaconsfield – Green Square	272	227

Table 1 – Schedule of Recently De-rated Ausgrid 132 kV Cables

2.2.3 Reduced rating of 41 cable

In November 2011 TransGrid's 330 kV cable 41 Sydney South to Beaconsfield was de-rated from 663 MVA to 575 MVA following a number of technical investigations. The reasons for this de-rating include.

- Increased ground temperatures. Recent measurements have found that the ground surface temperatures assumed in the original cable rating design are significantly lower than those that exist in the field.
- Degradation of controlled backfill. Recent inspections of the cable have revealed the backfill is not as designed. Therefore it is not able to dissipate heat from the cable in an optimal manner resulting in increased thermal resistivity.
- Variations in natural soil thermal resistivity. The original cable rating design assumes a certain thermal resistivity of the natural soil surrounding the cable installation. Field measurements have shown that this value may have increased above the assumed design value, subject to soil types, along the cable route and ground moisture content.

The backfill along cable 41 has recently been sampled and shown to be of poor condition. This has resulted in a requirement to de-rate the cable 41 to 426 MVA for normal operation and for all future network planning purposes.

The consequence of the de-rating of cable 41, in the absence of other actions, will result in supply reliability of the inner metropolitan area failing to meet the 'modified n-2' criteria to which TransGrid and Ausgrid are required to meet. This reliability risk is managed by the following key actions being implemented as part of the TransGrid – Ausgrid joint planning process in 2014.

- Ausgrid deferring condition-driven cable retirements (91A/2, 91B/2, 91X/2, 91Y/2, 928/3, and 929/1).
- Non-network solutions were identified to manage residual energy at risk where cost effective.
- A joint plan has been developed to determine the most economically efficient solution.

A risk mitigation plan is currently in progress where a sample of the existing cable will be cut out from an area exhibiting poor backfill. Laboratory testing will then be completed and the results used as a proxy to confirm the performance of the remaining cable. If the sample is shown to be of reasonable condition, it might be technically viable to complete cable backfill remediation works along the cable route and then re-rate the cable to 575MVA.

2.3 Forecast network constraints

The forecast network constraints resulting from the above factors are defined by two critical cable cut-sets (refer Figure 3) that become loaded beyond their rating at times of peak demand under outage conditions. The prescribed 'modified n-2' planning criteria was applied to each cable cut-set to define the constraint.

2.3.1 Cut-set 1 constraints

The constraints that arise in cut-set 1 are shown graphically in Figure 5.The forecast load that passes through this cut-set is graphed against the cut-set capacity for each year, inclusive of different cable retirement scenarios. Figure 5 shows that the network does not have adequate capability to meet the modified N-2 requirement with cable 41 de-rated to 426MVA. However the temporary operational measures such as removing one of the Beaconsfield Transformers from service will increase the transfer capacity. The further retirement of any pair of 928&929, 91A&91B and 91X&91Y cables will significantly reduce the network capacity.

Table 2 shows the year cut-set 1 will constrain under different cable retirement schedules. The results show that retirement of 928&929 will lead to a shortage of cut-set 1 capacity in 2026. A shortfall of capacity will occur in cut-set 1 immediately if 928&929 plus any pair of 91A&91B and 91X&91Y retire without network upgrade.

Retirement Schedule Options	Constraints Year
No Further Cable Retirement from 2019	2026
Retire 928, 929 from 2019	2023
Retire 928, 929, 91A/2 and 91B/2 from 2019	2019
Retire 928, 929, 91A/2, 91B/2, 91X/2 and 91Y/2 from 2019	2019

Table 2 – Cut-set 1 Constraints Under different and retirement schedules

2.3.2 Cut-set 2 constraints

The cut-set 2 transfer capability is shown graphically in Figure 6, where the forecast load that passes through the cut-set is graphed against the network capacity under 'modified n-2' conditions for each year associated with various development scenarios.

In 2016, the supply capacity can be seen to be about 150MW higher than the forecast load across cut-set 2 under "modified N-2" outage conditions. Commissioning of cable 90Y Beaconsfield to Belmore Park 132 kV feeder in 2017, the planned rehabilitation of cable 9SA Beaconsfield to Campbell St and 92P (ex 9SB/1) Beaconsfield to Belmore Park 132 kV feeders in 2019 results in an increase in the cut-set capacity. This provides adequate supply capability until 2023 on beyond.

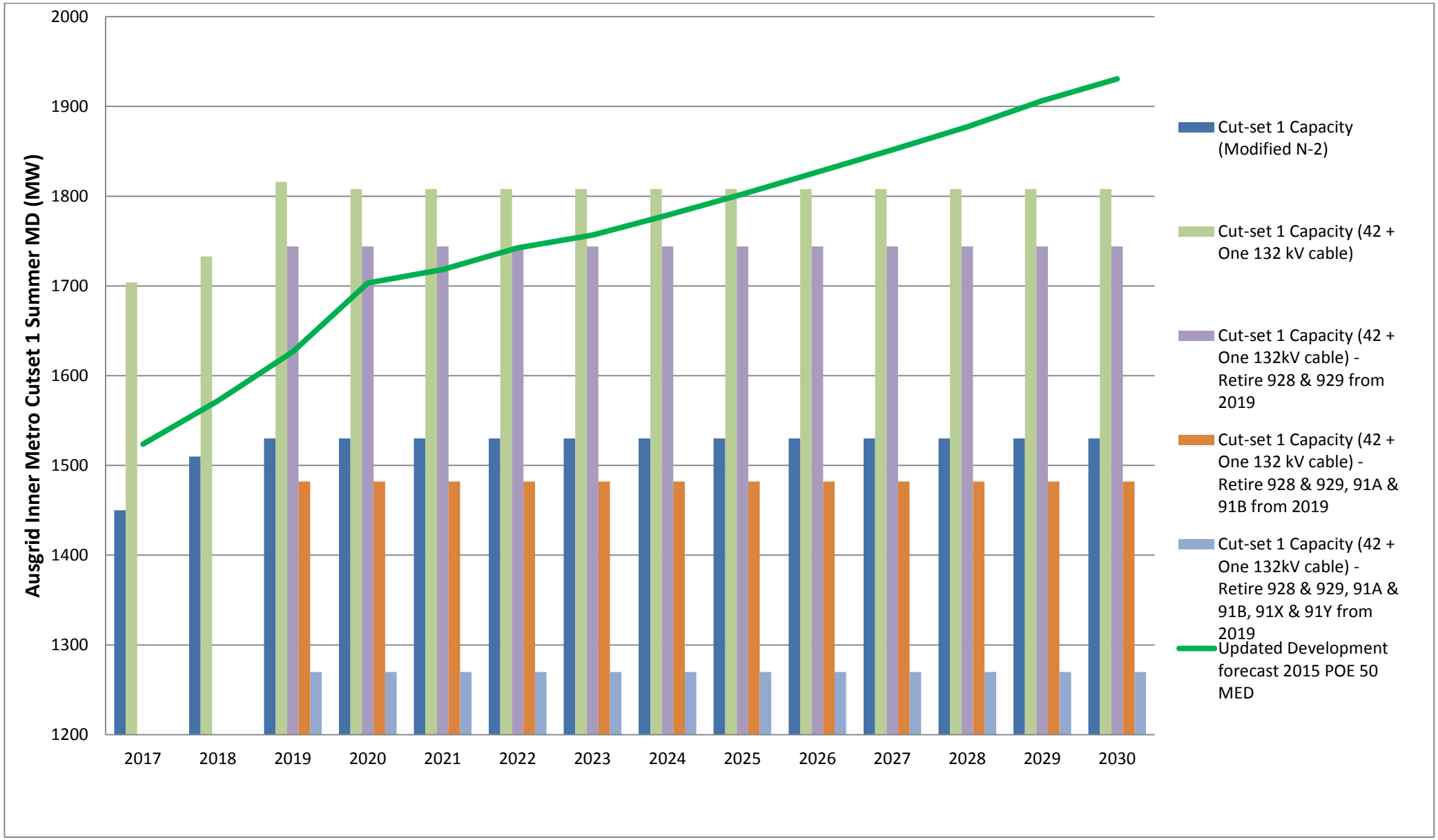


Figure 5 – Cut-set 1 network capacity vs forecast load

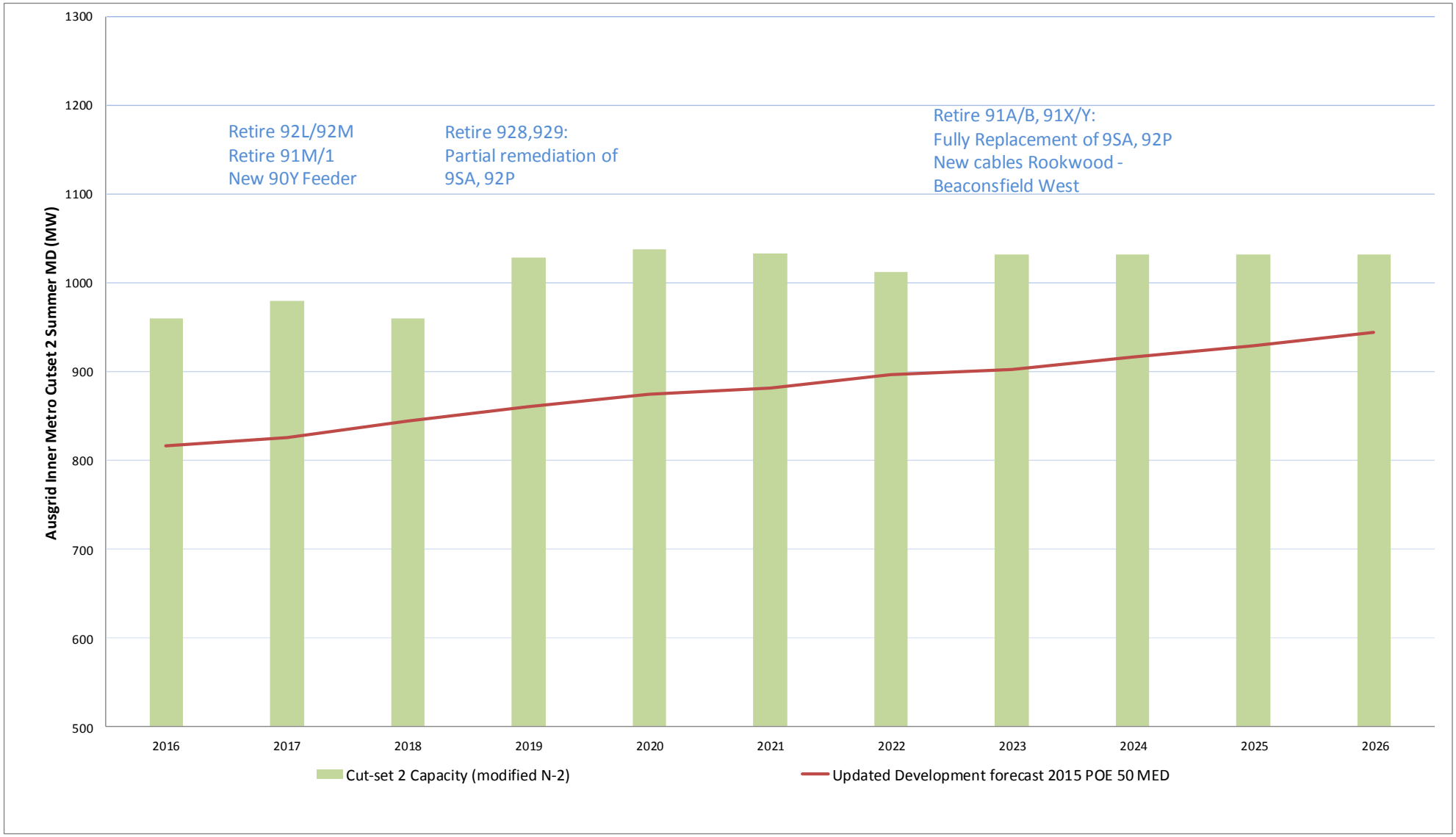


Figure 6 – Cut-set 2 network capacity vs forecast load

2.4 Need date

2.4.1 Cost Benefit Analysis jointly conducted by Ausgrid and TransGrid

Ausgrid and TransGrid are jointly conducting a risk cost & benefit analysis to evaluate strategies for cable retirements, assuming a gradual degradation of cable conditions and consequential increase in cable unavailability rate as time elapses. The methodology is to quantify the annual risks across the key areas of Safety, Reputation, Environmental, Financial and Reliability (value of unserved energy). The NPV analysis of risk reduction benefits is then compared to the cost of implementation for each network upgrade strategy.

The outcome of the cost benefit analysis will be the cable retirement strategy including the cable retirement date and associated preferred network upgrade option[4].

2.4.2 Indicative date to address need

The graphs and discussion in Section 2.3 show the shortfall in supply capacity to the Sydney CBD and inner metropolitan (which will lead to increased Expected Unserved Energy over time) if:

A. Some of Ausgrid 132 kV oil-filled cables are retired
B. The transfer capability supplying the inner metropolitan area is reduced due to A (above), or any further derating of 132 kV or 330 kV cables.
C. The inner metro area forecast load exceeds the supply capability from cut-set 1.

The lead time for addressing the need (extra supply capability provided by new cables) is at least five years. Based on the current demand forecast and presently assumed Ausgrid cable retirement program, the Need will be addressed in the revenue period 2018 – 2023[5,6].

2.4.3 Cable failure or other potential evidence for early cable retirement

While the project need date is determined by the Ausgrid cable retirement program and inner metro area load growth, an unplanned cable failure or new information may bring forward the need date.

2.5 Type of Service

Supply to the Sydney CBD and inner metropolitan area is entirely a prescribed service. The need to address the shortfall in supply capacity to the Sydney CBD and inner metropolitan area is part of the capital expenditure objectives in the NER Clause 6A.6.7(a), in particular:

1. meet the expected demand for *prescribed transmission services* over that period;
2. comply with all applicable *regulatory obligations or requirements* associated with the provision of *prescribed transmission services*; and
3. maintain the quality, reliability and security of supply of prescribed transmission services.

[4] Non-network options will also be considered in the analysis, in particular, their contribution in deferring the network upgrades.

[5] The exact need date will be determined by the cost/benefit analysis which will consider the value of Expected Unserved Energy and cost of network/non-network solutions.

[6] Due to the upturn in demand from 2013, continuing deteriorating condition of a number of Ausgrid 132 kV cables and retirement of a number of Ausgrid cables, and further de-rating of TransGrid Cable 41 in 2016 due to improved information on the condition of the backfill, TransGrid and Ausgrid consider that the assumptions and inputs used in the cost benefit analysis are more firm now and the need should be addressed in the regulatory period 2018-23.

3. Risk Assessment

The primary risks of not providing a new supply to the Sydney CBD and inner metropolitan area:

- Increased exposure to the loss of critical loads;
- Failure to meet the prescribed network reliability criteria.
- Environmental risk due to oil leak from Ausgrid aged oil-filled cables.

The risk assessment results are shown in Attachment 1.

4. Assumptions

This Need Statement assumes the following:

- Cable 41 remains serviceable for the period of this study with a firm continuous summer cyclic rating of 426 MVA;
- Loadflow analysis is based on the updated Ausgrid 2015 (years 2016 – 2025) metropolitan development load forecast;
- Ausgrid cable de-ratings are summarised in Table 1;
- Reliability criteria for the Sydney Inner Metropolitan Area and CBD remains at a 'modified n-2'.

5. Recommendation

There is an augmentation Need to upgrade the supply capacity of the inner metropolitan network to meet the reliability requirements.

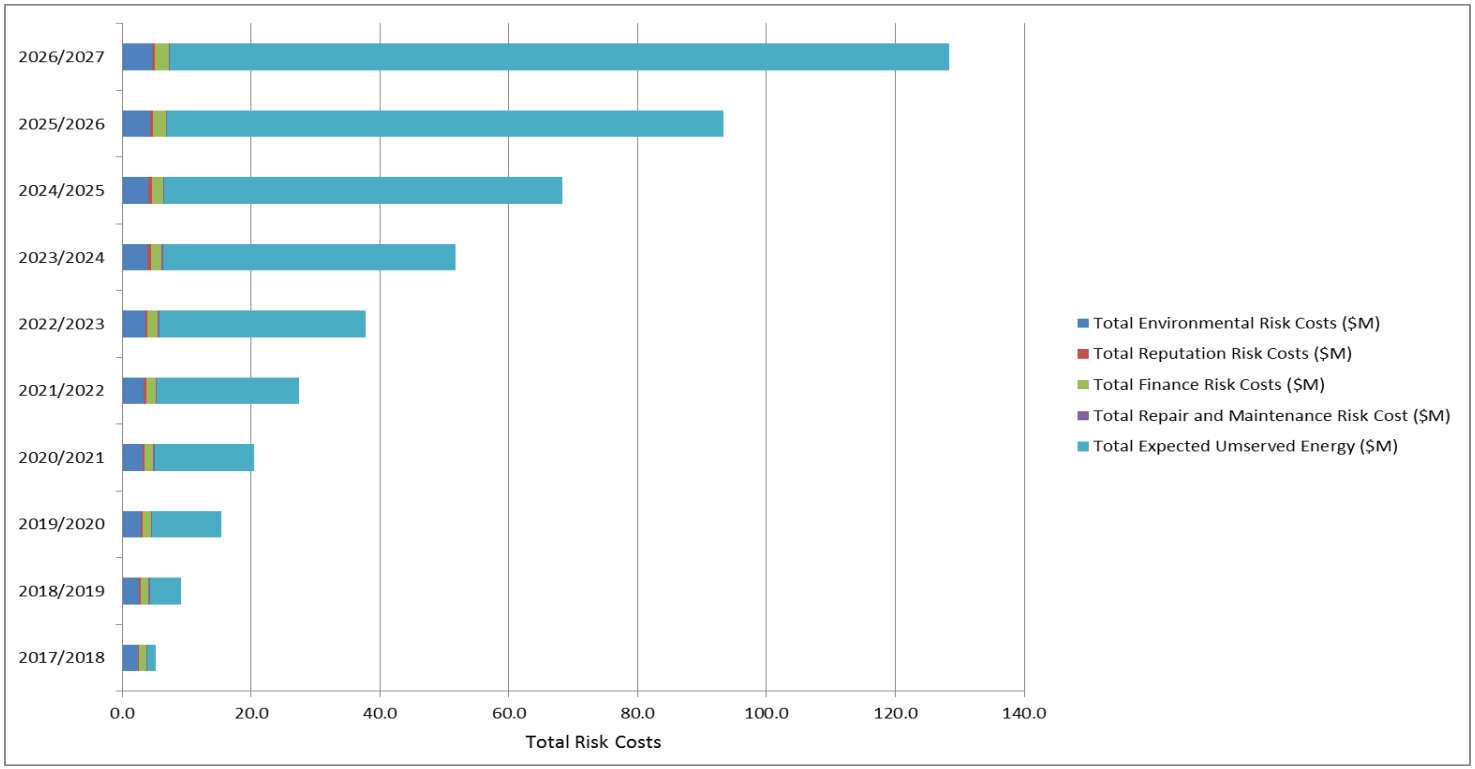
The long lead time to implement a solution also needs to be considered.

It is recommended that option evaluation for all feasible network and non-network options to address the identified need be initiated. Options should consider the interaction and timing of other supply related needs in the greater Sydney area and should consider staged implementation over a number of years.

Attachment 1 Risk costs summary

The risk costs expected due to base case (Do nothing) for the next 10 years are as given below.

	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025	2025/2026	2026/2027
Total Environmental Risk Costs ($M)	2.3	2.6	2.8	3.1	3.3	3.6	3.8	4.1	4.3	4.6
Total Reputation Risk Costs ($M)	0.23	0.26	0.28	0.31	0.33	0.35	0.56	0.45	0.49	0.54
Total Finance Risk Costs ($M)	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
Total Repair and Maintenance Risk Cost ($M)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Total Expected Unserved Energy ($M)	1.3	4.8	10.7	15.5	22.0	32.0	45.4	61.8	86.4	121.0
Total Risk Costs ($M)	5.2	9.1	15.4	20.5	27.4	37.7	51.6	68.4	93.4	128.3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