Revised Proposal

Attachment 5.23

11KV Network Reinforcement Program

January 2019

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Contents

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Purpose

This document reiterates the approach taken to forecast 11kV network reinforcement requirements for Ausgrid's substantive regulatory proposal (SRP) in April 2018, with additional detail provided to consolidate responses to questions from the AER and stakeholders which arose in response to the SRP.

In their draft determination, the AER stated "*We consider that Ausgrid's methodology to forecast augmentation needs on its 11kV network is reasonable.*"[1] However, the AER raised questions about the application of diversity factors and on this basis discounted the modelled results, substituting their own assessment. This document sets out the sound basis for the diversity applied by Ausgrid to address the AER's concerns, in order to support the AER's acceptance of the model's outputs, given their acceptance that it is reasonable.

Background

The 11kV Network Reinforcement Program addresses capacity shortfalls in Ausgrid's high voltage (HV) distribution network. This program covers over 2,500 HV feeders which consist of 10,038km of overhead (OH) conductors and 8,294km of underground (UG) cables.

This program maintains existing network reliability by addressing the forecast network impacts from load growth. Historically, faults on HV feeders contribute to approximately 70% of outage durations and frequencies on the entire network. Reliability performance is a function of:

- Fault rates;
- Customer numbers per isolation point; and
- Restoration times.

If this program was not undertaken:

- The average HV feeder length will grow as new substations are commissioned increasing the failure rate;
- The number of customers per feeder will increase resulting in more customer interruptions per fault;

[1] Draft Decision Ausgrid Distribution Determination 2019-24, Attachment 5 – Capital expenditure | Draft decision – Ausgrid distribution determination 2019–24, November 2018, p5-38

- The time to restore interrupted customers will increase as the number of switching steps increases due to lack of available capacity on neighbouring feeders, with some parts of the network not being able to have supply restored until the fault is fixed; and
- On some parts of the network, load may need to be “switched off” to prevent assets from being overloaded for safety and asset protection reasons.

The additional capacity funded by this program caters for existing capacity shortfalls and forecast capacity shortfalls from organic load growth. Projects within this program typically include network augmentation and upgrades. They exclude non-network options such as demand management which has been considered separately in terms of its impact on the overall program set out in this document.

This program is for augmentation of the shared network only and does not include extensions required for customer connections. We have assumed that Ausgrid will fund the augmentation costs driven by underlying load growth (basic connections) while larger connecting customers (standard and negotiated) will fund the capacity shortfalls they cause.

We have also assumed that other projects and programs (e.g. switchgear replacement, etc.) do not affect HV capacity.

We have not forecast funding for any CBD 11kV augmentation as the vast majority of CBD capacity shortfalls are caused and therefore funded by connecting customers.

Summary

- The draft capital forecast for the 2019-2024 Regulatory Period was $77.5M (Real direct cost FY17 dollars), but was reduced due to the increase in Demand Management expenditure to $60.2M (Real direct cost FY17 dollars) over 5 years
- Due to changes in the Demand Management assumptions, the final submission capital forecast has changed to $61.1M (Real direct cost FY17 dollars) over 5 years.
- This program addresses expected capacity shortfalls on 188 HV feeders at 67 zone substations
- We forecast that the summated HV feeder peak load increases by approximately 330MVA in summer and 440MVA in winter over the Regulatory Period based on the our POE 50 Spatial Demand Planning Forecast and diversified to HV feeder level.

Methodology

The expenditure forecast for this program is derived from a bottom-up approach that estimates the expected capacity shortfall on each HV feeder and applies a unit rate to arrive at the cost of required augmentation. Spot loads were excluded from this analysis so as to only identify capacity shortfalls driven by underlying growth.

$$Capital\ forecast = Without\ Spots\ capacity\ shortfall \times \$/kVA\ unit\ rate$$

Capacity shortfall

We systematically assessed each feeder for capacity shortfalls through load flow analysis in system normal and credible system abnormal configurations. A credible system abnormal configuration is considered to be the planned or unplanned loss of supply to a single HV feeder trunk or tee section. The capacity shortfall is expressed as the quantity of load that cannot be supplied after four switching steps without exceeding thermal constraints or incurring voltage excursions in line with NIS436 Distribution Network Planning standard.

The expected capacity shortfalls are identified by applying the load of the final year in the Regulatory Period (2023/24) from the POE Spatial Demand Planning Forecast to Ausgrid's existing HV distribution network. This approach intends to identify the constraints that would arise with no network investment. Identification of capacity shortfalls considers:

- the system normal configuration from Ausgrid's corporate Geographical Information System (GIS) as at February 2017;
- the rating of each feeder section;
- the feeder category (Urban or Rural);
- the forecast load of each zone substation at the end of the Regulatory Period (2023/24) from the POE50 Spatial Demand Forecast;
- Expected impacts of Demand Management; and
- Diversity between times of 11kV feeder peaks.

The total capacity shortfall is based on the assumption that 100% of the Urban network and 50% of the Rural network should be able to be restored by network switching. It was deemed appropriate to fund only 50% of the Rural feeder load at risk, as Rural feeders have not historically been planned to the same level of redundancy as Urban feeders. Not all rural feeders have existing interconnectivity, and adding interconnectivity for these feeders is likely to be cost prohibitive due to the distance required to connect to a neighbouring feeder.

$$Total\ capacity\ shortfall = 100\% \times Urban\ shortfall + 50\% \times Rural\ shortfall$$

Diversity Factor

In the draft determination, the AER noted that "*Ausgrid's methodology to forecast augmentation needs on its 11kV network is reasonable."* However, the AER commented that "*the 1.1 factor that Ausgrid has applied appears to be arbitrary*" and that there is an "*absence of any evidence to justify Ausgrid's proposed diversity factor.*"

Ausgrid does not believe that a diversity factor of 1.1 is either arbitrary or abnormal. However, to provide data to address the AER's concern's , Ausgrid analysed actual 15-minute interval load data from SCADA on every 11kV feeder for Winter 2017 and Summer 17/18, identifying both the feeder peaks and the zone substation peak.

Every feeder and zone was checked for abnormal network switching that could have caused double counting and thus affected the diversity factor calculation. Data resulting from abnormal switching was removed from the data set. No weather correction or other scaling factors were applied to the raw data to prevent the introduction of possible sources of distortion to the final results. These empirically derived diversity factors are illustrated in Figure 1 in the next page.

Only two area plans out of 24 had a diversity factor of less than 1.1. For reference, a higher diversity factor applied in allocating ZS loads to feeders would tend to increase feeder loadings and hence tend to increase the need for investment, while a lower diversity factor would tend to decrease feeder loading and the corresponding need for investment.

The areas with diversity factors of less than 1.1 (Upper North Shore and Terrey Hills / Pittwater) only contribute $0.2M (0.4%) of the capital forecast. It is therefore reasonable that a diversity factor of 1.1 is not overstating the load at risk on the 11kV network.

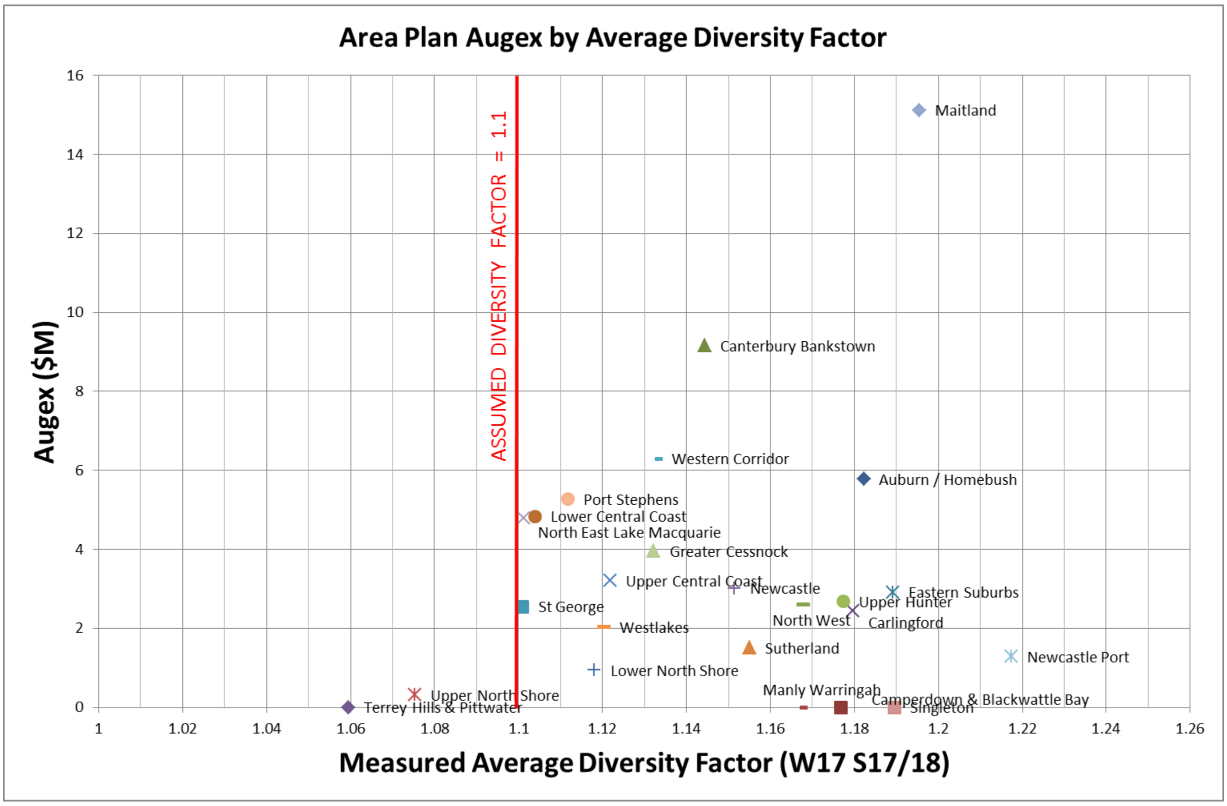

Figure 1 - Ausgrid Zone Substation Diversity Factors

$/kVA unit rate

We applied a unit rate of $250/kVA to the capacity shortfall to determine the forecast capex. HV planning use this unit rate as a cost benefit assessment to determine if proposed augmentation projects are prudent. This value is lower than the historical average of $404/kVA for projects that were initiated under the now revoked deterministic Schedule 1 of the Distribution Network Service Provider Licence Conditions. The lower threshold ensures that future projects will provide a better cost benefit outcome than the historical average.

As an example, if load flow modelling identified a capacity shortfall of 1MVA, project options less than $250,000 would meet the threshold for investment and a project would be issued to address the capacity shortfall. If all available options to address the capacity shortfall exceeded $250,000 then a project would not be issued.

Further Cost Benefit Analysis

This program addresses 281.0 MVA of load at risk across 188 HV feeders on the distribution network.

The benefit to cost ratio (BCR) of this program is:

$$BCR = \frac{Benefit}{Cost}$$

The benefit of this program can be expressed by the reduction in the Value of Lost Load (ΔVoLL).

$$\Delta VoLL = \Delta EUE \times VCR$$

$$\Delta EUE = Load\ at\ risk \times Load\ Factor \times pf \times SAIFI \times \Delta CAIDI$$

Assumptions:

- Load at risk of 281.0 MVA;
- Load Factor of 0.65 (average load / peak load);
- power factor of 0.9;
- Ausgrid's historical SAIFI for urban feeders of 0.6 applies across the load at risk;
- an average of 2 hour CAIDI improvement; and
- VCR of $40,000 / MWh.

$$\Delta EUE = 197.2\ MWh$$

$$\Delta VoLL = \$7.9M$$

$$Benefit = NPV\ (\text{discount rate, period}, \Delta VoLL)$$

Assumptions:

- Discount rate of 3.86%
- Period of 40 years.

$$Benefit = \$165.6M$$

$$Cost = \$61.1M$$

$$BCR = 2.7$$

As the BCR is materially larger than 1, this program provides more benefit than it costs and should be approved.

This equates to the following benefit $ / kVA

$$Benefit\ \$/kVA = \frac{Benefit}{Load\ at\ risk}$$

$$= \frac{\$165.6M}{281{,}000\ kVA}$$

$$= \$589/\ kVA$$

Results (by Area Plan region)

Area Plan region	Number of Zones requiring augmentation	Capacity Shortfall (MVA)	Capital Expenditure ($M real FY17 direct)
Auburn / Homebush	6	17.5	4.4
Camperdown & Blackwattle Bay	0	0.0	0.0
Canterbury Bankstown	7	29.2	6.9
Carlingford	3	7.4	1.9
Eastern Suburbs	4	8.8	2.2
Greater Cessnock	2	18.7	3.0
Lower Central Coast	6	15.6	3.7
Lower North Shore	2	2.8	0.7
Maitland	6	57.7	11.5
Manly Warringah	0	0.0	0.0
Newcastle Inner City	3	9.1	2.3
Newcastle Port	1	4.3	1.0
Newcastle Western Corridor	4	21.1	4.8
North East Lake Macquarie	5	14.5	3.6
North West	2	8.5	2.0
Port Stephens	5	21.2	4.0
Singleton	0	0.0	0.0
St George	1	7.7	1.9
Sutherland	2	4.6	1.1
Sydney CBD	0	0.0	0.0
Terrey Hills & Pittwater	0	0.0	0.0
Upper Central Coast	3	13.7	2.4
Upper Hunter	3	10.3	2.0
Upper North Shore	1	0.9	0.2
West Lake Macquarie	1	7.3	1.5
Grand Total	**67**	**281.0 MVA**	**$61.1M**