Addressing reliability requirements in the Maroubra load area

NOTICE ON SCREENING FOR NON-NETWORK OPTIONS

30 APRIL 2020

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1 Introduction

The underground 132kV electricity subtransmission cables ('feeders') commissioned in the 1960s and 1970s, are now reaching, or past, the end of their technical lives. In particular, the self-contained fluid filled (**SCFF**) feeders are now considered an obsolete and outdated technology. They are becoming less reliable and approaching the point at which their replacement maximises the net benefit for the community.

Ausgrid identified the need to replace 132kV Feeder 265 supplying the Maroubra load area and has identified a preferred network solution to mitigate the identified risks.

Capital expenditure for replacement projects are subject to the Regulatory Investment Test for Distribution (RIT-D). No exemptions listed in the NER clause 5.17.3(a) apply and therefore Ausgrid is required to apply the RIT-D to this project. Accordingly, Ausgrid has initiated this RIT-D to replace the 132kV Feeder 265 in order to identify a preferred option that would ensure Ausgrid is able to satisfy its reliability and performance standards in supplying the Maroubra load area.

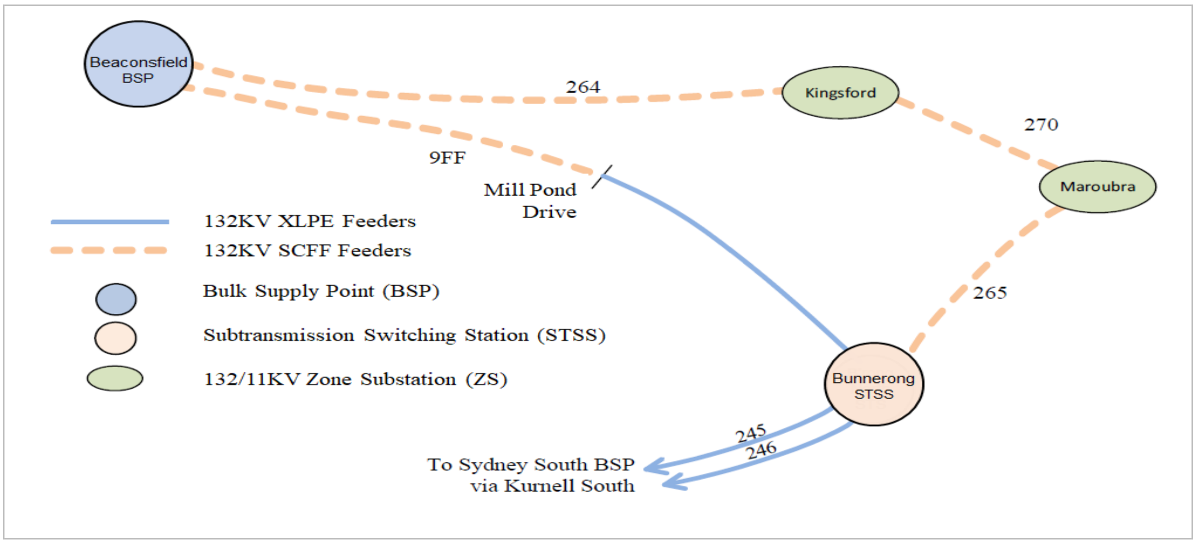
This notice has been prepared under cl. 5.17.4(d) of the NER and summarises Ausgrid's determination that no non-network option is, or forms a significant part of, any potential credible option for this RIT-D. It sets out the reasons for Ausgrid's determination, including the methodologies and assumptions used. A full discussion of asset conditions and the identified need can be found in the Draft Project Assessment Report (DPAR).

2 Electricity demand

2.1 Network configuration

Feeder 265 forms part of a 132kV feeder ring that supplies Kingsford and Maroubra zone substations. Feeder 265 is approximately 3.8km long and connects Maroubra ZS with Bunnerong Subtransmission Switching Station (**STSS**). Its availability is critical to supplying zone substations connected to the ring in the event of an outage of any one of the other cables. While the current design ensures a level of redundancy, any outage on this feeder at the same time as an outage on Feeder 264 would result in the loss of supply to Kingsford ZS and Maroubra ZS, affecting up to 41,600 customers including the University of NSW, the Sydney Children's Hospital and Prince of Wales Hospital, the Sydney Light Rail and the Royal Randwick Racecourse.

Figure 1: 132kV network relevant to feeder 265



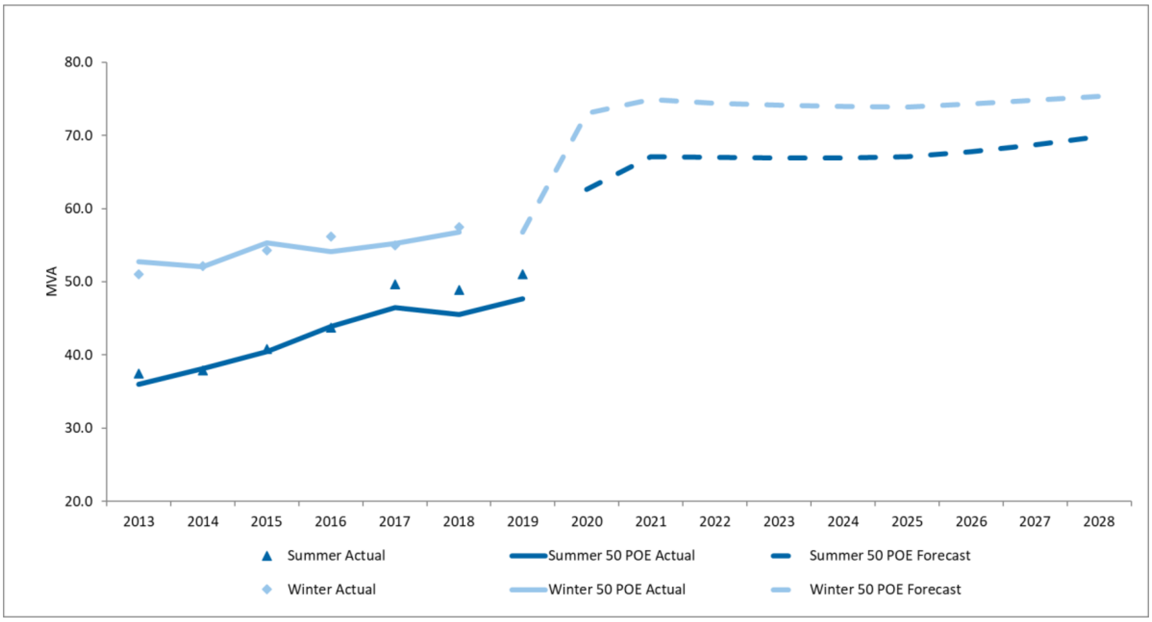
2.2 Demand forecast

While the identified need is associated with aged asset issues, a sufficiently large demand reduction may potentially defer the proposed preferred network solution. Due to the ring configuration of the network, the relevant areas where demand reductions could contribute towards a deferral are served from Kingsford and Maroubra zone substations. Figures 2 and 3 below show the summer and winter maximum demand forecasts for Kingsford ZS and Maroubra ZS from Ausgrid's published 2019 forecast, which include the historical actual demand, the 50% probability of exceedance level (50 POE) weather corrected historical demand and the 50 POE forecast demand.

2.2.1 Demand forecast – Kingsford

Kingsford zone substation has a total capacity of 125 MVA and a firm capacity of 62 MVA in summer and 65 MVA in winter. From Ausgrid's published 2019 forecast, the maximum demand on the zone substation was 57.5 MVA which occurred during winter 2018 at 7:00pm AEDT on 18 June 2018. The weather corrected demand at the 50 POE level was 56.7 MVA. The power factor at the time of summer maximum demand was 0.998. Maximum demand has typically occurred in winter in past years with time of peak ranging between 18:45pm and 19:30pm AEDT. The step change in demand in the near term is due to forecast block loads and load transfers from nearby Clovelly zone substation.

Figure 2: Demand forecast at Kingsford zone substation

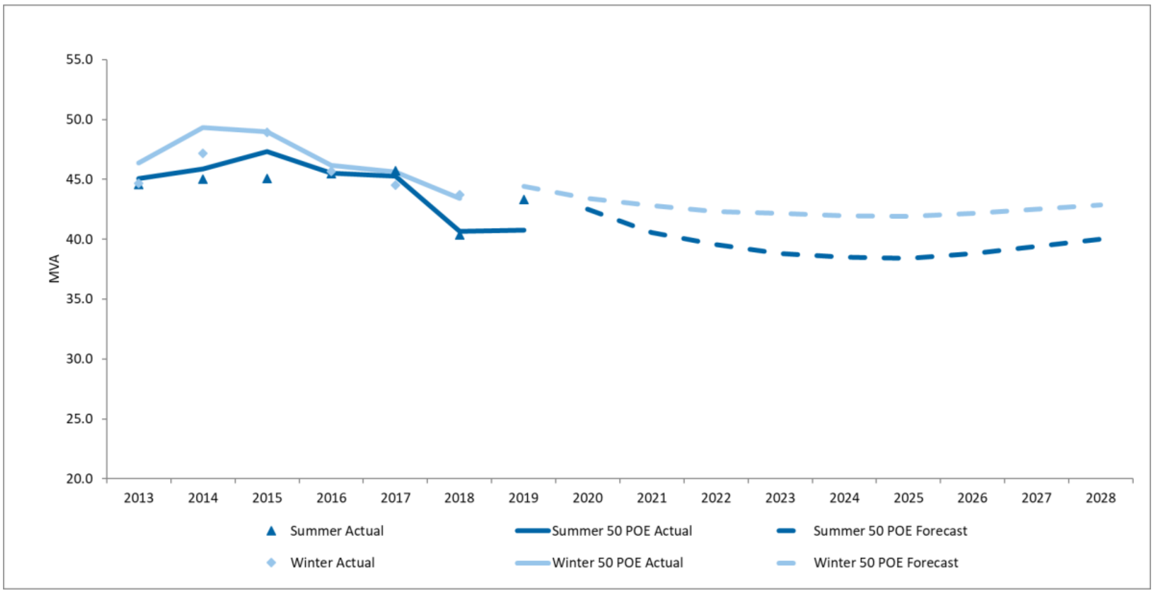


2.2.2 Demand forecast – Maroubra

Maroubra zone substation has a total capacity of 148 MVA and a firm capacity of 102.8 MVA. From Ausgrid's published 2019 forecast, the maximum demand on the zone substation was 43.7 MVA which occurred at 7:00pm AEDT on 18 June 2018. The weather corrected demand at the 50 POE level was 43.4 MVA. The power factor at the time of summer maximum demand was 0.983.

Maximum demand has typically occurred in winter in past years, In the winter season, the maximum demand has recently occurred between 18:30pm and 19:30pm AEDT.

Figure 3: Demand forecast at Maroubra zone substation

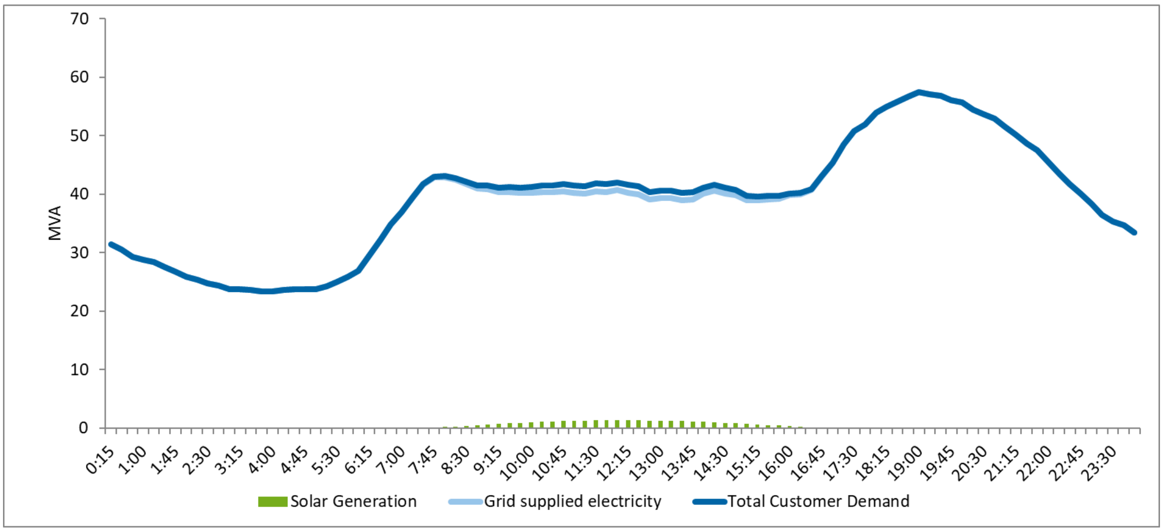


2.3 Pattern of use

2.3.1 Pattern of use – Kingsford

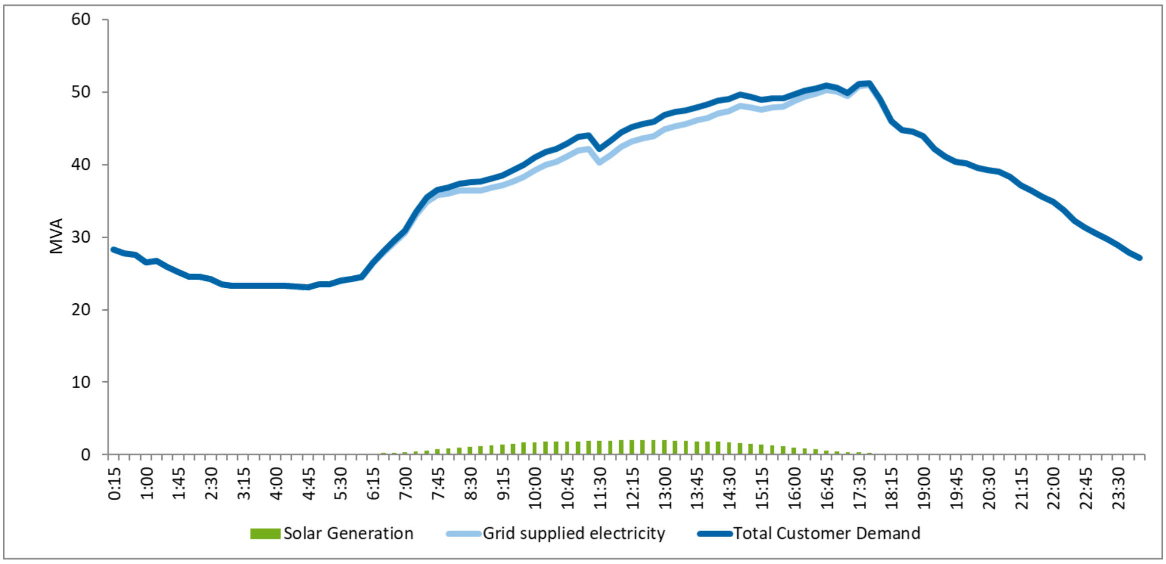
Over the past 7 years, annual maximum demand at Kingsford ZS has mostly occurred in winter, with a time of peak typically between 18:45pm and 19:30pm AEDT. Across winter 2018 and summer 2018/19, maximum demand at Kingsford occurred at 7:00pm AEDT on 18 June 2018. There is a total connected Solar PV capacity of 3.0 MW for customers supplied from Kingsford ZS. During the winter 2018 peak day and time, these PV systems are estimated to generate 0 MW at time of peak. Figure 4 below shows the demand profile on this day, including the estimated contribution from customer solar power systems.

Figure 4 – Winter peak day demand profile and PV contribution at Kingsford ZS on 18 June 2018



During summer 2018/19, Kingsford ZS experienced its summer peak demand at 5:45pm AEDT on 31 January 2019. Figure 5 below shows the demand profile on this day including the contribution from customer solar power systems.

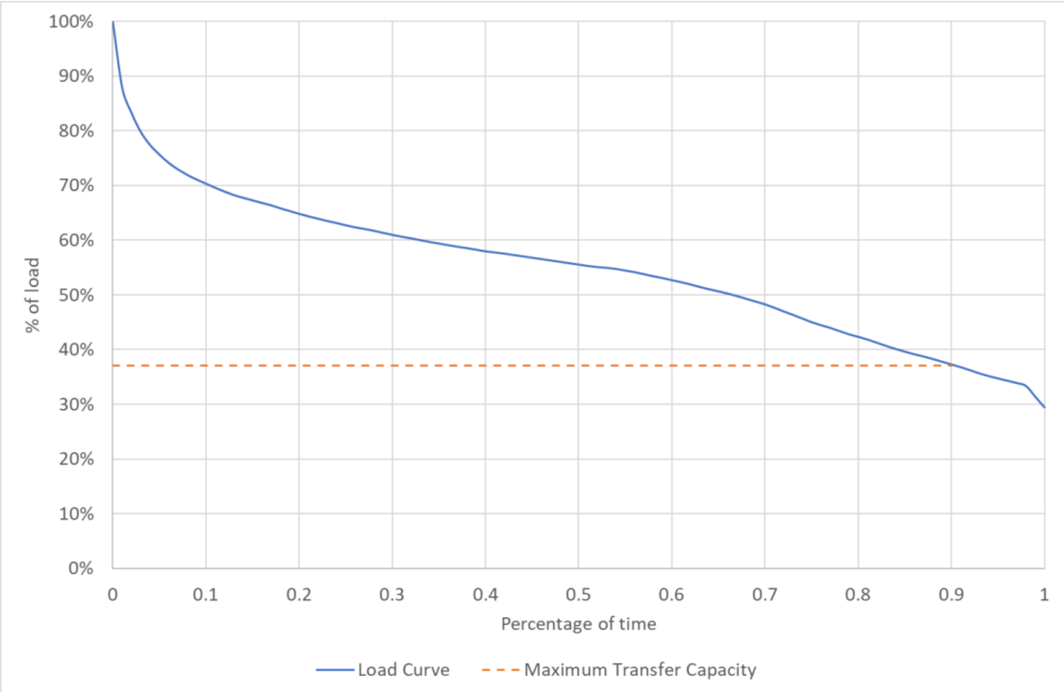
Figure 5 – Summer peak day demand profile and PV contribution at Kingsford ZS on 31 January 2019



Currently, the emergency load transfer capacity for Kingsford ZS is about 21 MVA or about 37% and 42% of the winter 2018 and summer 2018/19 maximum demand. Maximum demand exceeds the load transfer capacity for around 90% of the year. The load duration curve, including the load transfer capacity excluding transfers to Maroubra ZS, is shown in Figure 6 below.

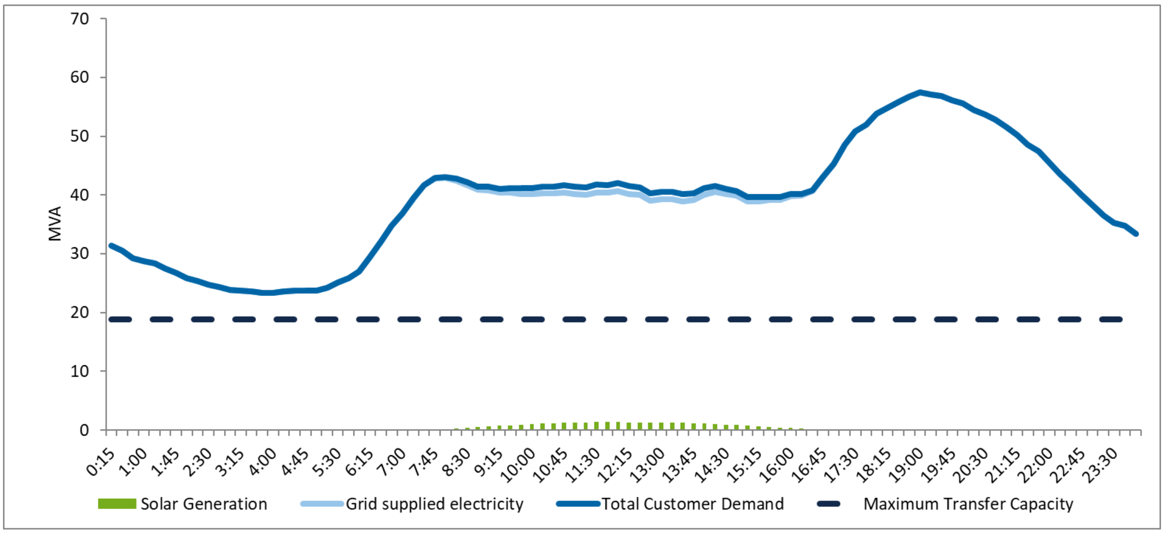
It is assumed that the load types supplied by this substation will not change substantially into the future and therefore the load duration curve will maintain its characteristic shape. The load duration curve is used to determine the energy at risk and/or the amount of load curtailment required at certain load levels. It is a direct input into the modelling of the Expected Unserved Energy (EUE), which is the probability weighted amount of load that would be unmet due to network capacity limitations.

Figure 6: Kingsford ZS load duration curve



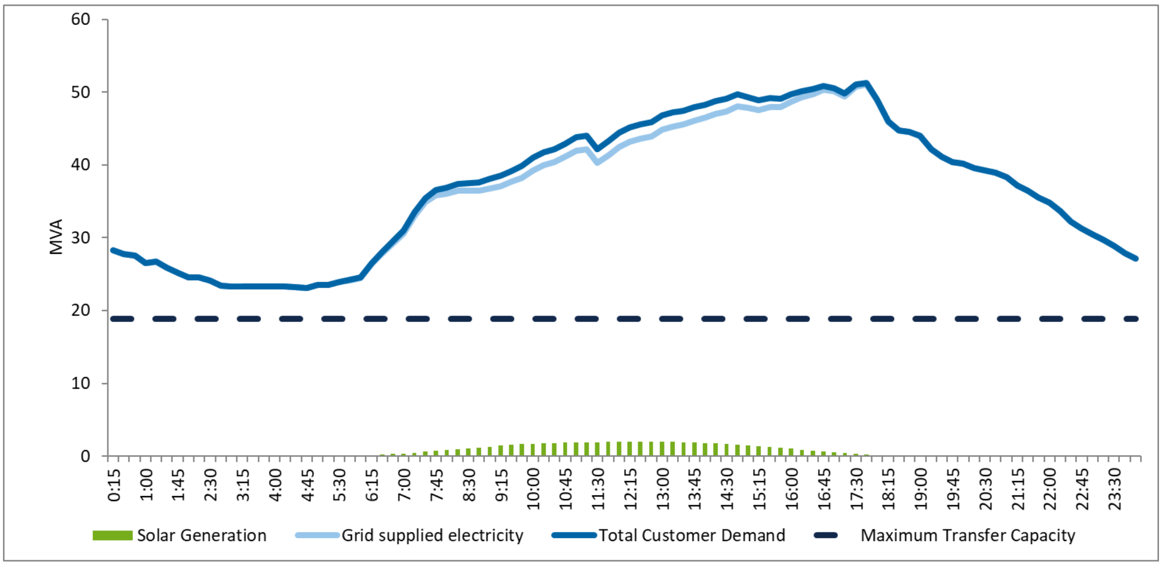
In the event of a network outage on a winter peak demand day, the shortfall in network supply would be for the entire day after realising the maximum load transfer capacity. The maximum shortfall would be around 36 MVA on 18 June 2018 as shown in Figure 8 below.

Figure 8: Winter peak day profile at Kingsford ZS showing maximum load transfer on 18 June 2018



Similarly, for a summer maximum demand day and following realisation of the maximum transfer capacity through network switching, there is a shortfall of supply of up to 30 MVA which would occur for the entire day, using 31 January 2019 as an example. See Figure 7 below.

Figure 7: Summer peak day profile at Kingsford ZS showing maximum load transfer on 31 January 2019

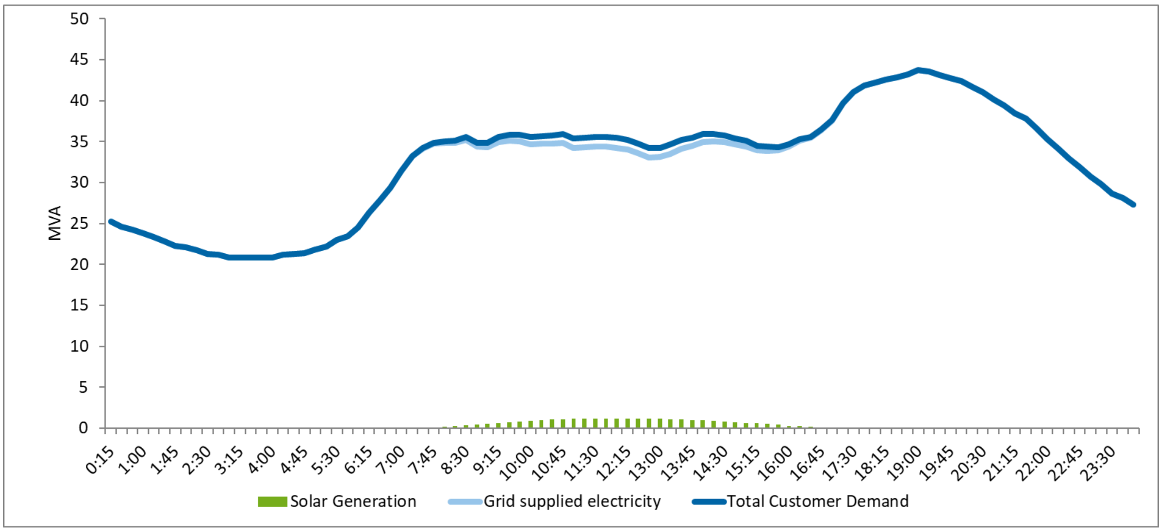


2.3.2 Pattern of use – Maroubra ZS

Over the past 7 years, annual maximum demand at Maroubra ZS has occurred in winter, with a time of peak typically between 18:30pm and 19:30pm AEDT.

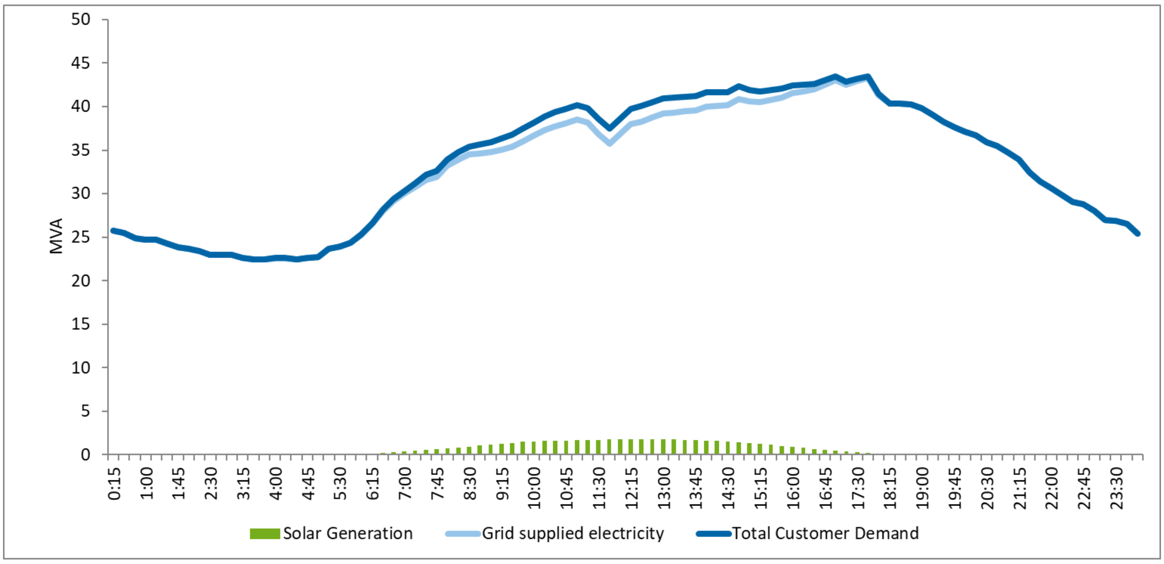
There is a total Solar PV capacity of 2.7 MW connected to Maroubra ZS. At the peak time of 7:00pm AEDT on 18 June 2018, these PV systems are estimated to generate 0 MW at time of peak. Figure 9 below shows the load trace on this day including the contribution from customer solar power systems.

Figure 9: Winter peak day demand profile and PV contribution at Maroubra on 18 June 2018



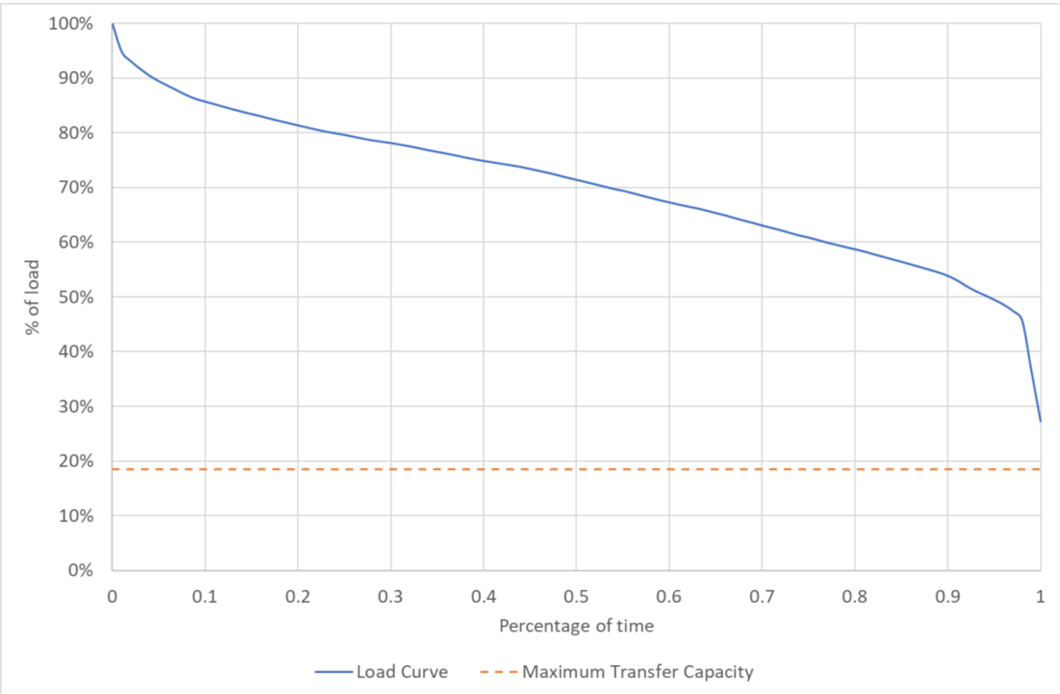
Summer peak electricity demand at Maroubra ZS typically occurs in the afternoon. Over the past 7 years, the time of summer peak has occurred between 11:30am and 17:45pm AEDT. Figure 10 below shows the load trace for the highest summer load day 31 January 2019 including the estimated contribution from customer solar power systems on this day.

Figure 10: Summer peak day demand profile and PV contribution at Maroubra ZS on 31 Jan 2019



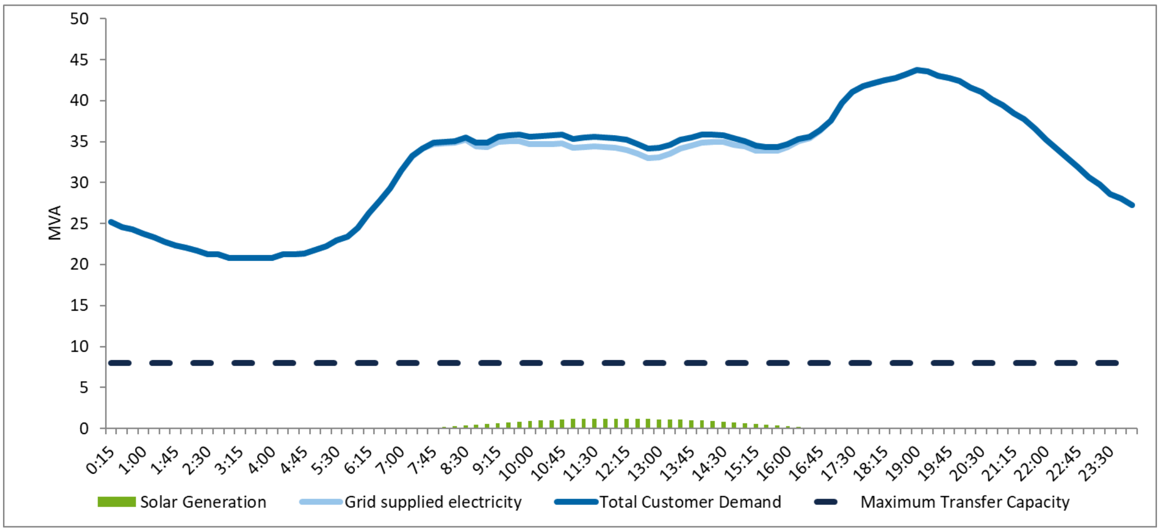
Maroubra ZS currently has a load transfer capacity of 8 MVA or about 18% of both the winter 2018 and summer 2018/19 maximum demands. Electricity demand exceeds the transfer capacity for 100% of the year. The load duration curve, including the load transfer capacity excluding Kingsford, is shown in Figure 11 below. It is assumed that the load types supplied by this substation will not change substantially into the future and therefore the load duration curve will maintain its characteristic shape.

Figure 11: Maroubra ZS load duration curve



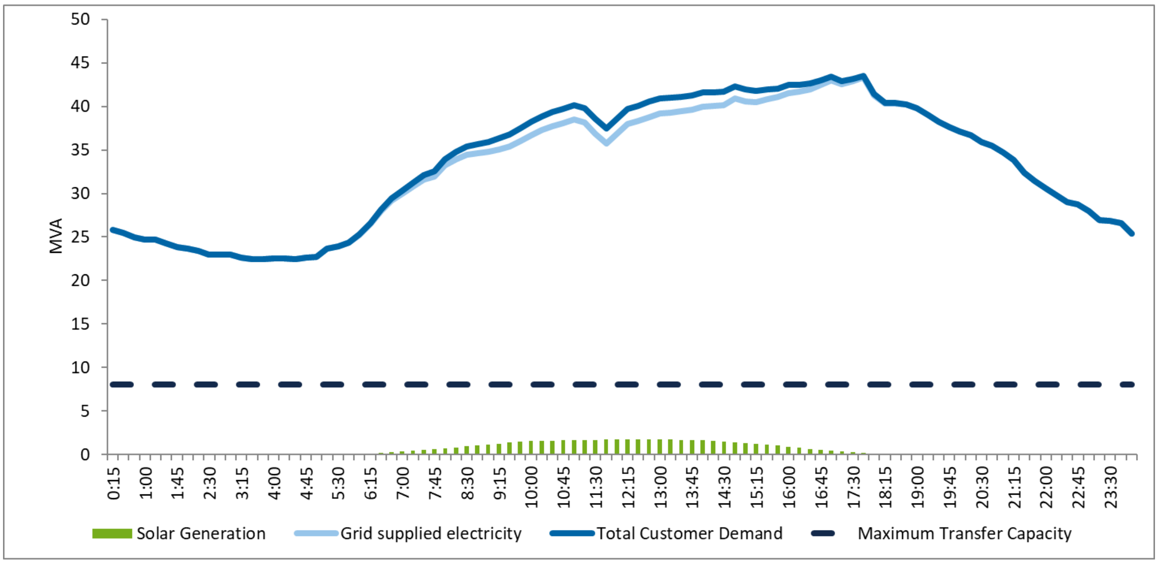
In the event of a network outage on a winter maximum demand day and following realisation of the maximum transfer capacity through network switching, there is a maximum shortfall of around 35 MVA which would occur for the entire day. See Figure 12 below.

Figure 12: Winter peak day profile at Maroubra ZS showing maximum load transfer 18 June 2018



Similarly, for a summer peak demand day, the shortfall in network supply would be for the entire day after realising the maximum load transfer capacity. The maximum shortfall would be around 36 MVA. See Figure 13 below.

Figure 13: Summer peak day profile at Maroubra ZS showing maximum load transfer 31 January 2019



2.4 Customer characteristics

Kingsford and Maroubra zone substations serve a mixture of residential and non-residential customers. A breakdown of the customer characteristics for the 2018/19 period is as follows:

Table 1: Customer characteristics – Kingsford ZS

Item	Residential	Small Non-Residential	Large Non-Residential	Total
Number of Customers	22,964	1,389	72	24,425
% of Customers	94%	5.7%	0.3%	
Annual Consumption (MWh)	95,294	25,095	122,260	242,648
% of Annual Consumption	39.3%	10.3%	50.4%	
Number of Solar Customers	709	64	0	782
% of Solar Customers	91%	8.2%	1.2%	
Average Annual Consumption(MWh)	4.1	18	1698	

About 28% of residential customers live in detached homes with an average usage of about 6.4 MWh per year. Households living in apartments, townhouses and flats have an average usage of about 3.2 MWh per year.

Table 2: Customer characteristics – Maroubra ZS

Item	Residential	Small Non-Residential	Large Non-Residential	Total
Number of Customers	15,083	1,568	115	16,766
% of Customers	90.0%	9.4%	0.7%	
Annual Consumption (MWh)	59,935	26,018	118,475	204,428
% of Annual Consumption	29.3%	12.7%	58.0%	
Number of Solar Customers	622	39	4	665
% of Solar Customers	94%	5.9%	0.6%	
Average Annual Consumption(MWh)	4.0	17	1,030	

About 36% of residential customers live in detached homes with an average usage of about 5.8 MWh per year. Households living in apartments, townhouses and flats have an average usage of about 2.9 MWh per year.

3 Aged asset issues

Feeder 265 is a SCFF cable commissioned in 1979. It is approximately 3.8km long and connects Maroubra ZS with Bunnerong Subtransmission Switching Station (**STSS**). Its availability is critical to supplying zone substations connected to the ring in the event of an outage of any one of the other cables, as shown in Figure 1 on page 3.

A critical assumption underpinning the identified need is that retaining the SCFF 132kV Feeder 265 is expected to increase the risk of involuntary load shedding. The major factor contributing to the risk of involuntary load shedding is the age of the feeder which is reaching the end of its technical life. SCFF cable technology is obsolete and requires specialist skills to repair and maintain. Outage times can be lengthy and spares are not readily available.

The performance of this feeder has been poor with the occurrence of oil leaks over the past 15 years, affecting the reliability of supply to the Kingsford-Maroubra area. Tests conducted in 2013 and 2017 confirmed degradation in the insulation of the feeder. This could lead to further fluid leaks and affect the reliability of the feeder.

To minimise the environmental risks of fluid leaks in SCFF feeders, Ausgrid has a program to replace all SCFF on its network with known leaks, including Feeder 265.

4 Proposed preferred network option

This section provides details of the options that Ausgrid identified in the network planning process and identification of the proposed preferred option. Ausgrid has identified two network options that either replace the existing 132kV feeder between Bunnerong STSS and Maroubra ZS by undertaking a like-for-like replacement of the existing feeder or installing one new 132kV feeder, coupled with a spare conduit for a future feeder. The two credible options are summarised below. All costs in this section are in real $2019/20, unless otherwise stated.

Table 3: Summary of the credible options considered

Overview	Key components	Length of new feeders	Estimated capital cost
Option 1 – Replacement of existing Feeder 265 Bunnerong STSS to Maroubra ZS like-for-like.	Replacement of existing Feeder 265 like-for-like using modern equivalent technology - Cross Linked Polyethylene (**XLPE**) cable.	3.7km	$13.9 million
Option 2 – Replacement of Feeder 265 with spare ductline to enable installation of future feeder Bunnerong – Kingsford.	Installation of one new 132kV feeder using modern XLPE cable to replace existing Feeder 265 and spare conduits (for a future feeder) connecting Maroubra ZS to Bunnerong STSS.	3.7km	$15.0 million

Ausgrid also considered one additional network option involving the decommissioning of the existing Feeder 265 and no works considered to replace the subtransmission feeder. However, this option was ruled out and not progressed further as it leaves Kingsford and Maroubra zone substations with only one source of supply.

Ausgrid has elected to assess three alternative future scenarios – namely:

- low benefit scenario – Ausgrid has adopted a number of assumptions that give rise to a lower bound NPV estimate for each credible option, in order to represent a conservative future state of the world with respect to potential market benefits that could be realised under each credible option;
- baseline scenario – the baseline scenario consists of assumptions that reflect Ausgrid's central set of variable estimates which, in Ausgrid's opinion, provides the most likely scenario; and
- high benefit scenario – this scenario reflects an optimistic set of assumptions, which have been selected to investigate an upper bound on reasonably expected market benefits.

A summary of the key variables in each scenario is provided in the table below.

Table 4: Summary of the three scenarios investigated

Variable	Scenario 1 – baseline	Scenario 2 – low benefits	Scenario 3 – high benefits
Demand	POE50	POE90	POE10
VCR	$42.12/kWh (Derived from the AER VCR 2019 estimates)	$29.48/kWh (30 per cent lower than the central, AER-derived estimate)	$54.76/kWh (30 per cent higher than the central, AER-derived estimate)
Capital Costs (including future capital costs)	100 per cent of capital cost estimate	125 per cent of capital cost estimate	75 per cent of capital cost estimate
Timing of Future Capital Costs	Target completion in 2031 (11 years from now)	Target completion in 2033 (13 years from now)	Target completion in 2029 (9 years from now)

Refer to the Draft Project Assessment Report for this project for further details about the options assessment methodology and scenario analysis.

Preferred option at this draft stage

Option 2 has been found to be the preferred option, which satisfies the RIT-D. It involves the replacement of the existing SCFF Feeder from Bunnerong STSS ZS to Maroubra ZS with a new 132kV feeder 3.7km long and includes a spare ductline to facilitate the installation of a future feeder. Once installed, the existing SCFF feeder will be decommissioned.

The estimated capital cost of this option is $15.0 million. Ausgrid assumes that the necessary construction to install the new feeders would commence in 2020/21 and end in 2021/22. Once the new installation is complete, operating costs are expected to be approximately $75,000 per annum (around 0.5 per cent of capital expenditure).

Refer to the Draft Project Assessment Report for this project for further details about the options assessment.

5 Assessment of non-network solutions

5.1 Required demand management characteristics

As noted in Section 2, a concurrent outage on Feeder 265 and Feeder 264 would result in loss of supply to Kingsford and Maroubra zone substations, affecting up to 41,600 customers. In 2021/22, the expected completion date of the proposed preferred network option, up to 89 MVA of customer demand supplied by Kingsford and Maroubra would be lost, after realising available transfer capability.

To be considered a feasible option, any demand management solution must be technically feasible, commercially feasible; and able to be implemented in sufficient time by 2021/22 for deferral of the network investment.

5.2 Available demand management funds

To identify the available funds for a possible demand management solution, the net NPV benefit for the network option is compared against the net NPV benefit of a deferral of the preferred network option.

Table 5 below shows the available funds for a deferral of the network investment for 1, 2 and 3 years.

Table 5 – Required combined demand reductions at Kingsford and Maroubra zones

Required peak demand reduction	Available funds		
	1 Yr deferral	2 Yr deferral	3 Yr deferral
30 MVA	$37,000	NIL	NIL

Demand management funds are very limited:

- For a 1-year deferral, due to the low load transfer capacity and very high unserved energy that must be met across both Kingsford and Maroubra zones, the available funds are about $37,000 for a peak demand reduction of 30 MVA. This is equivalent to $1.23/kVA, which is extremely low; and
- For 2 and 3-year deferrals the NPV is lower than the NPV of the proposed preferred network option, hence zero budget is available for these deferral scenarios.

The above figures already account for the 29 MVA of load transfer capacity out of the Kingsford-Maroubra load areas and assumes this capacity can be fully realised. This is also the case for determining the feasibility of demand management solutions as outlined in section 5.3 below.

5.3 Demand management options considered

Ausgrid has considered a number of demand management solutions to determine their commercial and technical feasibility to assist with the identified need for Feeder 265. Each of the demand management solutions considered is summarised below.

5.3.1 Customer power factor correction

As a mature and proven demand management solution, customer power factor correction is both technically feasible and offers reliable permanent reductions sufficient at a low cost. Analysis of customer interval data indicates a commercial potential of around 1.5 MVA across both Kingsford and Maroubra zones. At a projected demand management cost of about $25-50 per kVA, the estimated cost to achieve commercial potential is about $38k – $75k.

This solution would contribute less than 5% of the required 30 MW demand reduction at a cost that is, at minimum, the entire available funds.Consequently, we consider there is insufficient funds available for this solution to be considered part of a cost-effective alternative.

5.3.2 Customer solar power systems

A possible demand management solution might be to provide a financial incentive to customers to invest in new solar power systems such that an accelerated take-up of solar reduces the forecast demand and energy overload conditions. Analysis of interval data for Kingsford and Maroubra zones shows that while solar generation is partially coincident with the energy shortfall, it offers no reduction in load during non-solar hours, including at times of winter peak demand. As the shortfall is across all hours in the year (base load of around 29 MVA), a non-dispatchable solar power system would offer no support outside of daylight hours.

To assess the viability of this solution, we estimated the potential cost and impact from a hypothetical incentive program to encourage customer investment in solar power. If we assumed that incentives of about 25% of customer investment might encourage additional customer take-up of solar that would otherwise not occur, an incentive of about $250 per kVA would, for example, incentivise an additional 1 MW of customer solar power systems requiring a total customer incentive payment of about $250k, which is significantly higher than the available funds for a 1-year deferral. As solar power system generation is subject to hourly, seasonal and cloud cover variation, an example 1 MW solar array is estimated to generate up to 1.4GWh annually, equivalent to only 0.3% of the present annual net energy consumption from customers connected to Kingsford and Maroubra zones.

This indicates that customer solar power system would address an insignificant component of the energy shortfall. Consequently, we consider there is insufficient funds available for this solution to be considered part of a cost-effective alternative.

5.3.3 Customer energy efficiency

Customer energy efficiency improvements as a demand management solution provides a financial incentive to customers to accelerate take-up of energy efficiency improvements with the aim of reducing their forecast energy consumption and the impact of overload conditions.

To assess the viability of this solution, we estimated the potential cost and impact from a hypothetical incentive program to encourage customer investment in energy efficiency improvements. If we assumed that incentives of about 20-40% of customer investment might encourage additional customer take-up of energy efficiency improvements than would otherwise occur, an incentive of about $200-500 per kVA incentive might achieve up to 0.1-0.2 MVA and 0.1-0.3 GWh in annual energy efficiency savings using 100% of the available funds for a 1-year deferral. This would address only a small component of the energy shortfall. Consequently, we consider there is insufficient funds available for this solution to be considered part of a cost-effective alternative.

5.3.4 Demand response

Demand response is a common demand management option and offers a relatively mature solution for standard network overload needs. Demand response can involve either or both a temporary reduction in customer load and the use of embedded generation to either replace grid supplied electricity to the customer or export to the local grid.

To assess the viability of this solution, we estimated the potential cost and impact from a hypothetical demand response program that reduced peak demand for the top 100-200 hours. Past practice shows that costs for traditional demand response from commercial and industrial (C&I) customers is in the range of $50-150 per kW for 40-100 hours of dispatch and 3-5 months availability. If it was assumed that demand response could be acquired for an estimated $75-125 per kVA per year for 12 months availability, the available funds would fund less than 1 MW of demand response. As this solution would only address a very small component of the energy and demand shortfall, we consider there is insufficient funds available for this solution to be considered part of a cost-effective alternative.

5.3.5 Large customer energy storage

While this option is technically feasible and offers a viable form of demand response, current and near-term pricing indicates that the solution would not be economic in comparison with demand response. At an estimated cost of over $1m per MWh, a peak lopping storage solution to address the top 100-200 hours would need to leverage significant other market benefits to be viable and yet would only address a very small component of the energy shortfall. We therefore consider there is insufficient funds available for this solution to be considered part of a cost-effective alternative.

6 Conclusion

Based on the demand management options considered in Section 5, it is not considered possible that sufficient demand management measures could be feasibly implemented to achieve the required demand reduction to make project deferral technically and economically viable. Consequently, a Non-Network Options Report has not been prepared in accordance with rule 5.17.4(c) of the National Electricity Rules.

Ausgrid