



Screening For Non-Network Options

South Leppington Zone Substation - Stage 2

Endeavour Energy

November 2017

CONTACT

If you have any comments or enquiries regarding this report or wish to submit your ideas regarding possible demand reducing initiatives please send to the following email and addressed to Manager Asset Strategy and Planning:

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TABLE OF CONTENTS

1	INTRODUCTION.....	1
2	NETWORK ISSUES	3
2.1	FORECAST	3
2.2	PLANNING LIMITATIONS.....	4
2.2.1	LOAD TRANSFER CAPABILITY	4
2.3	LOAD AT RISK REVIEW.....	5
3	NETWORK OPTIONS	6
4	DEMAND MANAGEMENT PROGRAM DEVELOPMENT	8
4.1	NON-NETWORK OPTION OBJECTIVE	8
4.2	LOAD REDUCTION POTENTIAL.....	9
4.2.1	CHARACTERISTICS OF DEMAND REDUCTION	10
5	FINANCIAL EVALUATION	11
6	CONCLUSION	11
7	CONSULTATION.....	12
7.1	SUBMISSIONS REQUESTED	12
7.2	ENQUIRIES	12
8	RECOMMENDATION	12

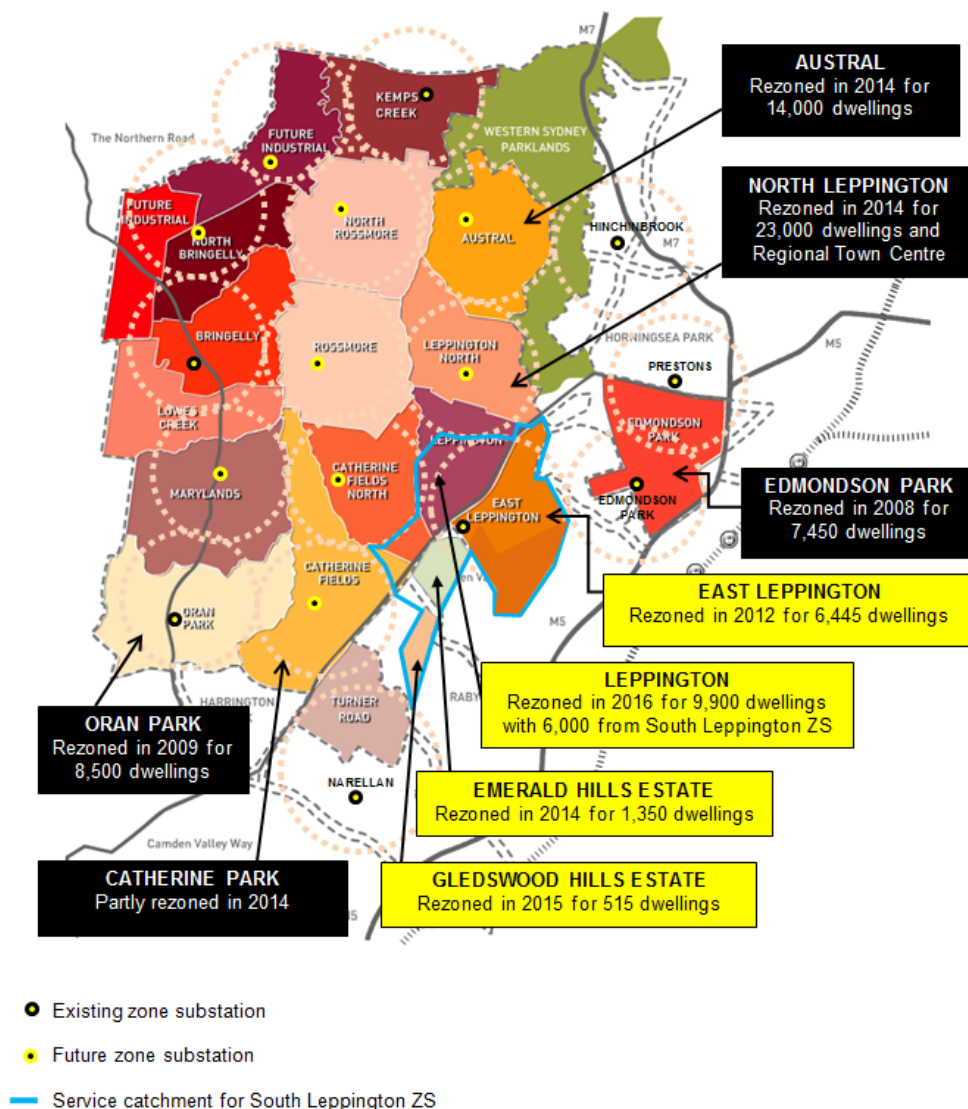
1 INTRODUCTION

This Screening Test Report has been prepared by Endeavour Energy in accordance with the requirements of clauses 5.17.4 of the National Electricity Rules (NER).

The purpose of this report is to explore the feasibility of a non-network option to address the network limitation on the existing interim South Leppington Zone Substation (ZS) and the 11kV network that backs-up the substation. The report provides details of the network limitation resulting from the development in the East Leppington and Leppington precincts including Willowdale and the adjacent developments of Emerald Hills and Gledswood Hills which form part of the South-West Growth Sector.

The South West Growth Sector is within the boundaries of the local government areas of Liverpool, Camden and Campbelltown. The area is forecast to experience significant growth in the residential, commercial and industrial sectors. A total of eighteen precincts which are expected to ultimately yield 102,160 residential dwellings and 23.15 km² of employment land, refer to Figure 1

Figure 1– South West Growth Sector & South Leppington ZS Supply Area



The total load of all the precincts within the South West Growth Sector is estimated to be up to 690 MVA with a development timeframe reaching beyond 2038. The load is based on an average demand per residential lot of 4kVA. This represents a reduction from the previous per-lot demand of 6 to 7kVA due to programs such as BASIX and other energy efficiency measures implemented by State Government policy.

The precincts making up the South West Sector are being released progressively, with some precincts already underway and others rezoned or partly rezoned. The East Leppington precinct otherwise known as the Willowdale estate is progressing at a rapid pace with 3,320 residential lots and a shopping centre processed by Endeavour Energy since 2012. This represents a load of approximately 14 MVA which is expected to appear on South Leppington ZS by summer 2020 as homes are established and occupied. The precinct will ultimately yield up to 6,445 dwellings.

The adjacent residential development of Emerald Hills and Gledswood Hills are concurrently developing with an ultimate yield of 1,350 dwellings and 515 dwellings respectively.

The adjacent Leppington precinct, which was rezoned in 2016 and encompasses the area directly opposite South Leppington ZS along Camden Valley Way, will yield up to 9,900 dwellings of which 6,000 of these would be supplied from South Leppington ZS.

The combined areas within the South Leppington ZS service catchment have a forecast load of 55 MVA supplying approximately 14,310 homes and two shopping centres. South Leppington ZS will need to have a firm capacity of 45 MVA to service ongoing development beyond the current 2,500 dwelling / 10 MVA limitation of the existing “interim” configuration. The summer forecast for South Leppington ZS is shown in Table 2. Table 1 shows the adjacent precincts nominated in Figure 1 together with the number of lots to be supplied from South Leppington ZS.

Table 1 – Ultimate Lot numbers per Precinct supplied by South Leppington Zone Substation

Precinct / Area	Total Lots / Dwellings from South Leppington ZS
East Leppington Precinct	6,445
Leppington Precinct	6,000
Emerald Hills	1,350
Gledswood Hills	515
Total Lots/Dwellings	14,310

The Department of Planning is coordinating development by setting up priority sub-precincts within Austral, North Leppington and Leppington precincts which currently comprise of hundreds of small rural land holdings in fragmented ownership. One of these priority sub-precincts is within the service catchment of South Leppington ZS located south-east of the Leppington Town Centre and railway station.

A review was conducted into the feasibility of implementing a non-network option. The development of this screening report and the investigation of the non-network options are in accordance with the Regulatory Investment Test for Distribution (RIT-D) process.

This screening report includes the following:

- Timing and level of the network load at risk along and other network limitations;
- An overview of the feasible network option(s);
- The potential to remove the load at risk/network limitation by implementing a non-network solution; and
- The objectives for a successful Demand Management (DM) program.

Previously, Endeavour Energy issued a Non-Network Options Report, in the form of a Request for Information (RFI) for non-network options, for a greenfield development area similar to that of South Leppington ZS. Endeavour has determined in the past that, in certain greenfield development areas, demand management is not feasible. The feasibility of a non-network option for the South Leppington ZS augmentation is stated in Section 6 – Conclusion, which also includes an explanation of the determination. This section details the criteria where Endeavour will approach the market for non-network options in greenfield areas. Endeavour will always approach the non-network services market in brownfield areas.

2 NETWORK ISSUES

This section details the constraints faced by the network in terms of available capacity to supply the new development areas. Currently the interim South Leppington ZS supplies six precincts or part precincts.

The South Leppington ZS was established in 2014 as an interim supply solution to meet an urgent capacity need for this part of the South West Growth Sector. The substation was established with a single permanent 132/11kV transformer, a portable control building with four 11kV feeder circuit breakers and a single 132kV sub-transmission feeder. Future augmentation to a permanent substation would be undertaken in a subsequent Stage 2 project.

South Leppington ZS augmentation (Stage 2) will take place when the distribution back-up capacity is exceeded. This is the spare capacity in the 11kV network from adjacent zone substations which would be used to back-up the total load during an outage of the interim South Leppington ZS. This is forecast to occur in 2018 with a forecast load of 11.8 MVA increasing to 18.7 MVA by 2020 and 26.3 MVA by 2022. Endeavour Energy has processed 5,300 lot / dwelling approvals since 2014 representing 21 MVA. About 1,600 dwellings have been connected with the remainder expected to be connected over the next 24 months. The development of the precincts had been accelerated to produce higher numbers in the initial stages. This accelerated development cannot be adequately serviced from the existing interim South Leppington ZS or the 11kV back-up network.

The remainder of the 14,310 lots (approximately 9,010 dwellings) to be supplied by South Leppington ZS is forecast to be developed at an average rate of 550 dwellings per annum which represent a slower yield than production to date.

2.1 FORECAST

The South Leppington ZS load forecast is shown in Table 2 and includes the existing rural area which will reduce as development occurs. The forecast table below shows there is load at risk on South Leppington ZS from 2018. South Leppington ZS is a single transformer and single sub-transmission feeder substation and any loss of either element results in supply being totally dependent on the back-up capacity. Where the zone substation has 'N' supply (no sub-transmission back-up) the load is limited to 10 MVA by the 11kV back-up network.

Table 2 – South Leppington ZS Summer Forecast

Item	Actual			Forecast									
Summer	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Forecast (MVA)	3.7	4.2	6.0	11.8	14.7	18.7	22.7	26.3	29.2	31.2	32.5	33.2	35.0
N - Capacity* (MVA)	10	10	10	9.0	8.0	7.0	6.0	5.5	5.0	4.5	4.0	3.5	3.0
Load at Risk (MVA)	0.0	0.0	0.0	2.8	6.7	11.7	16.7	20.8	24.2	26.7	28.5	29.7	32

* Limit is due to single transmission feeder and transformer and reduces due to increasing normal load on back-up network.

2.2 PLANNING LIMITATIONS

The distribution network is designed, constructed and augmented in accordance with probabilistic planning principles in line with general industry practice. Taken into consideration are the conditions driving network augmentation and construction. Endeavour Energy analyses constraints resulting from the capacity limitations by determining the load at risk and the expected unserved energy over the 10 year forecast period. The trigger for investment is based on a cost benefit analysis in terms of managing the expected load at risk and the value of the expected unserved energy. This is further discussed in section 2.3 Load at Risk Review.

In addition to the zone substation capacity the main requirements driving the augmentation of the network are:

- Security of supply at the zone substation level
- Exceeding 11kV feeder design capacity

As mentioned previously, South Leppington ZS is planned to service approximately 14,310 dwellings and two shopping centres which are proposed to be connected over the next 20 years. The interim South Leppington ZS is limited to 10 MVA due to the limitation of the back-up 11kV capacity. This capacity will progressively reduce over time as new development occurs within other precincts supplied by the same feeders providing the back-up from the adjacent zone substations.

Currently the 11kV back-up consists of one feeder each from Prestons ZS, Edmondson Park ZS, Bow Bowling ZS, Bringelly ZS and two feeders from Narellan ZS. The Prestons and Bringelly feeders will be replaced by the proposed North Leppington ZS network which will then become the partial back-up to South Leppington ZS in lieu of the two feeders from Bringelly and Prestons until capacity is exhausted by the Leppington Town Centre.

2.2.1 LOAD TRANSFER CAPABILITY

There is no opportunity to off-load any substantial customer connected load to adjacent zone substations via the 11kV network due to the capacity already being utilised to supply the ongoing development in other precincts supplied by these zone substations. Some capacity can be provided initially from the North Leppington ZS distribution network but this will progressively decrease as the available spare distribution network capacity is fully consumed.

Assessment of the 11kV back-up feeders shown in Table 3 indicates there would be an unserviceable load of 11,666kVA in 2020 which is when all dwellings are connected and appear on the network. This is equivalent to 2,917 dwellings during a back-up event of South Leppington ZS. The simulation results show four of the six back-up feeders would be overloaded requiring load shedding.

Table 3 – 11kV Back-up Network Capacity in 2020

Feeder Name	Load (kVA) [∞]	Contingency Rating (kVA) [^]	Available Capacity (kVA)	Comments
25744 Gellibrand Rd (Prestons)	10,800	6,000	-4,800	1,200 homes unable to be supplied
W185 Midlothian Rd (Bow Bowling)	8,040	6,000	-2,040	510 homes unable to be supplied
ED1252 Denham Court Rd (Edmondson Park)	9,488	6,000	-3,488	872 homes unable to be supplied
27031 Turner Rd (Narellan)	5,528	6,000	472	Spare capacity for 118 more homes
27038B Devlin Rd (Narellan)	5,144	6,000	856	Spare capacity for 214 more homes
X879 The Northern Rd (Bringelly)	8,669	6,000	-2,669	667 homes unable to be supplied
TOTAL	47,666	36,000	-11,666	2,917 homes unable to be supplied

[∞] Load modelling for total outage on South Leppington ZS, [^] Maximum feeder cable capacity during back-up

2.3 LOAD AT RISK REVIEW

A review was conducted to determine the existing demand on the interim South Leppington ZS and the 11kV network backing-up the zone substation. This is to estimate the load at risk under first level outage conditions which would need to be addressed to defer a network limitation via a demand management program. This is shown in Table 4.

Table 4 – Modified Forecast & Network Load at Risk

Growth	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Existing Rural	3.6	3.6	3.6	3.6	3.6	3.1	2.3	1.3	1	0.8
East Leppington	6.2	7.4	9.1	11.2	12.8	14.3	15.4	16.2	17	17.8
Emerald Hills	1	1.5	2.3	2.8	3.5	3.8	4	4.2	4.4	4.6
Leppington	0.9	1.8	3	4.1	5.3	6.4	7.6	8.7	9.9	11
Gledswood Hills	0.1	0.4	0.7	1	1.3	1.6	1.9	2.1	2.1	2.1
Total Load	11.8	14.7	18.7	22.7	26.5	29.2	31.2	32.5	34.4	36.3
Available 11kV back-up capacity[∞]	9.0	8.0	7.0	6.0	5.5	5.0	4.5	4.0	3.5	3.0
LAR	2.8	6.7	11.7	16.7	20.8	24.2	26.7	28.5	30.9	33.3

[∞] Available capacity will diminish over time as the 11kV feeders from Prestons, Edmondson Park, Bow Bowling and Narellan.

The above analysis shows there are network constraints on both South Leppington ZS and the 11kV network backing-up South Leppington ZS. An investigation into options needs to address this network constraint.

Exceeding the firm capacity of a zone substation or its back-up supply does not necessarily trigger network investment alone. This is dependent on the load at risk, probability of failure and the consequence in the event of failure including the expected outage duration, the level of expected unserved energy, and 11kV feeder design capacity. These factors form the basis of probabilistic planning and network investment.

The base case (do nothing option) results in a significant amount of unserved energy, as shown in Table 5. The figures represent the 50% expected unserved energy figures. The energy at risk below the installed capacity is multiplied by the probability of failure. The energy at risk above the installed capacity does not consider the probability of failure as that load cannot be supplied at all.

Table 5 – Base Case Risk Exposure

Year	Energy at Risk (MWh) Annual	Hours at Risk 50% POE	Expected Unserved Energy (MWh)	Cost of Expected Unserved Energy (\$'000)
2017/18	24.0	25	24.0	2.9
2018/19	175.1	107	175.1	21.2
2019/20	589.9	248	591.5	109.3
2020/21	1,126.3	512	1,210.6	2,074.0
2021/22	1,659.0	940	2,015.0	8,395.0

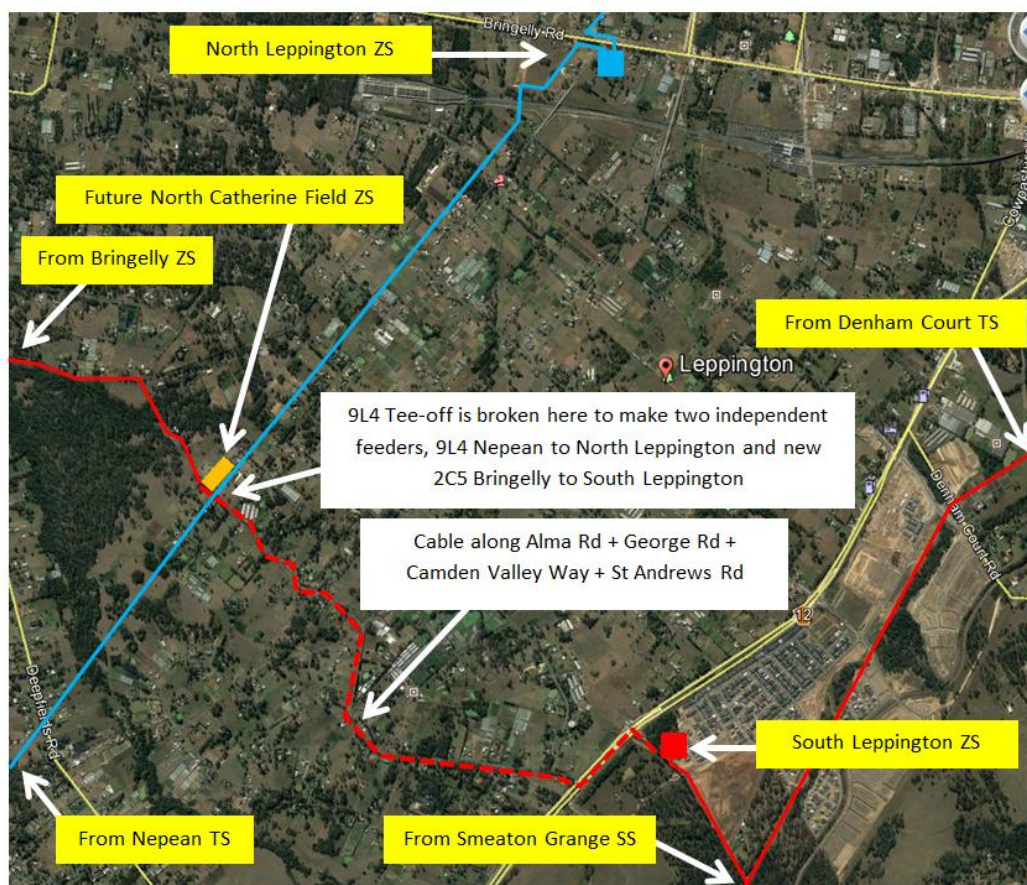
3 NETWORK OPTIONS

The proposed and preferred network option being considered is to augment the interim South Leppington ZS to a 45 MVA firm capacity substation. This project will:

- establish a permanent control building;
- install four 11kV switchboard sections;
- install an indoor 132kV switchboard;
- install a second 132/11kV 45MVA transformer;
- install a second 132kV feeder; and
- remove the existing portable control room and temporary 132kV outdoor switchgear.

The estimated cost of these works is \$26.1 million. It is proposed to commission the substation prior to summer 2020/2021. The geographic, schematic and single line diagrams of the network works are shown in Figures 3 to 5.

Figure 3: Proposed South Leppington ZS Network Geographic



OPTION 1 – Cable extension from existing OH

Figure 4: Proposed South Leppington ZS Single Line Diagram

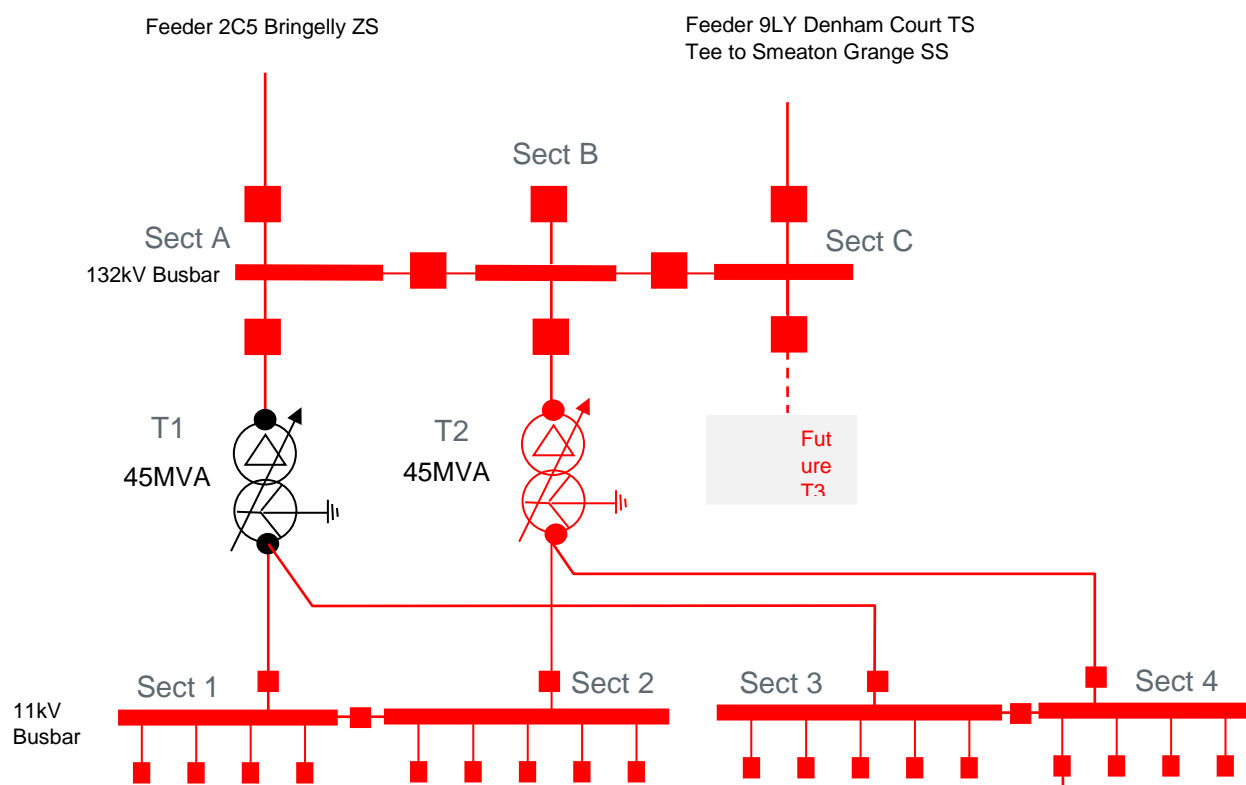
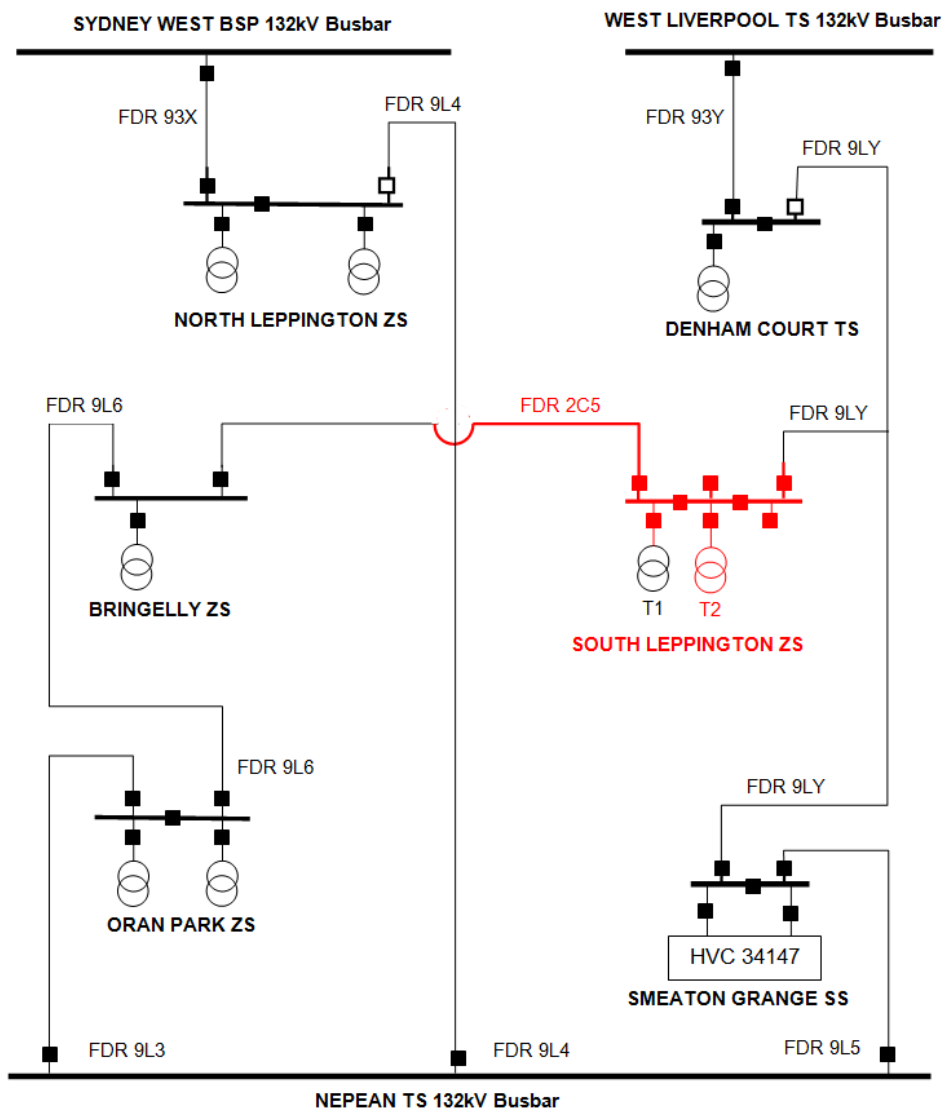


Figure 5: Proposed South Leppington ZS Single Line Diagram



4 DEMAND MANAGEMENT PROGRAM DEVELOPMENT

4.1 NON-NETWORK OPTION OBJECTIVE

The objective of a Non-Network Option is to reduce sufficient demand to allow existing capacity to supply the new release areas and in turn defer the augmentation of the interim South Leppington ZS. To achieve this, the demand reduction must target the South Leppington ZS and the 11kV back-up network supply areas. It is expected that the majority of demand reduction will be via the existing customer base as the newly connected customers need to meet strict energy efficiency standards. The demand reduction from these energy efficient homes is already built into the demand forecast.

A demand reduction of 11.7 MVA needs to be obtained by 2020 on the interim South Leppington ZS for a one year deferral and 16.7 MVA by 2021 for a two year deferral of the substation augmentation. This is to ensure sufficient capacity is available to supply the new residential release areas, refer to Table 4.

4.2 LOAD REDUCTION POTENTIAL

There are currently 2,117 residential customers supplied by the interim South Leppington ZS with a total peak load in the order of 5.1 MVA. There are also 101 business customers with a total peak load of about 0.9 MVA. There are currently about 2,800 residential and 360 business customers connected to the 11kV feeders providing back-up supply to the interim South Leppington ZS. These figures are increasing as these 11kV feeders supply new development precincts within their individual supply areas. The loading on these feeders, during back-up loading conditions, are shown in Table 3. If sufficient demand reduction is available from this customer base then a non-network option will be considered feasible to defer the proposed substation augmentation.

Previous industrial/commercial area demand management programs have delivered demand reductions from customers following an energy audit from between 10% to 20%. The demand from the interim South Leppington ZS business sector is 0.9 MVA. It is estimated that the industrial/commercial load on the 11kV feeders providing back-up is about 3.2 MVA. Using an average figure of 15% it is estimated that the potential demand reduction available from the industrial/commercial sector is about 623kVA, refer Table 6.

Previous *PeakSaver* and *CoolSaver* residential demand management programs implemented by Endeavour achieved a take-up rate of 4% with an average reduction level of 1.7kVA per customer. It is believed that with improved marketing techniques and using external aggregation services an improved take-up rate of 8% may be achievable. Table 6 below shows the calculated demand reduction from these initiatives.

Endeavour is currently trialling a residential Battery Energy Storage System (BESS) program for potential demand management as part of a Demand Response (DR) program. These systems, coupled with Solar PV, have the potential to deliver effective demand reduction. Currently, there are about 475 Solar PV's connected within the network supplied by the interim South Leppington ZS and the back-up 11kV feeders. This represents 9.7% of the residential customer base. The demand reduction figure shown in Table 6 is based on taking an optimistic view of increasing the penetration to 13% with the vast majority of PV owners adopting the BESS offer. The estimated demand reduction is based on an average BESS peak output of 2kVA for 4 hours covering the majority of the peak period.

Table 6 – Potential Demand Reduction – All Sectors

Area	Customers / Loads	Take-up Rate / Conversion Rate	Potential Demand Reduction (kVA)
Residential	4,886 customers	8% @ 1.7kVA	665
Residential (PV)	4,886 customers	13% @ 2kVA	1,270
Industrial / Commercial	4.1 MVA	15%	623
Total			2,558

There exists an estimated potential of 2.6 MVA demand reduction from the existing customer base supplied from the interim South Leppington ZS and the back-up 11kV feeders. This falls short of the required 11.7 MVA demand reduction target by summer 2019/20 for a one year deferral and 16.7 MVA for a two year deferral.

Other demand management initiatives not considered in this study may be feasible. For example, a large embedded generation facility with sufficient capacity may be able to defer the substation

augmentation but would still need the 11kV distribution network development to supply power to the newly constructed housing. Previous experience has shown that large embedded generation close to residential development areas is subject to noise and other environmental restrictions which is challenging. A feasibility analysis into embedded generation options will need to be carried out by embedded generation proponents with the necessary approvals from the local council and other regulatory bodies.

4.2.1 CHARACTERISTICS OF DEMAND REDUCTION

Currently the South Leppington supply area is predominantly rural residential in nature. The load profiles of the interim South Leppington ZS for two peak days are shown in Figure 6 and 7. These load profiles will not change to any great extent once the development in the precinct has been completed as the load profile shown below is typically residential in its shape.

Figure 6 –South Leppington Zone Substation Load Profile – Friday 10 February 2017

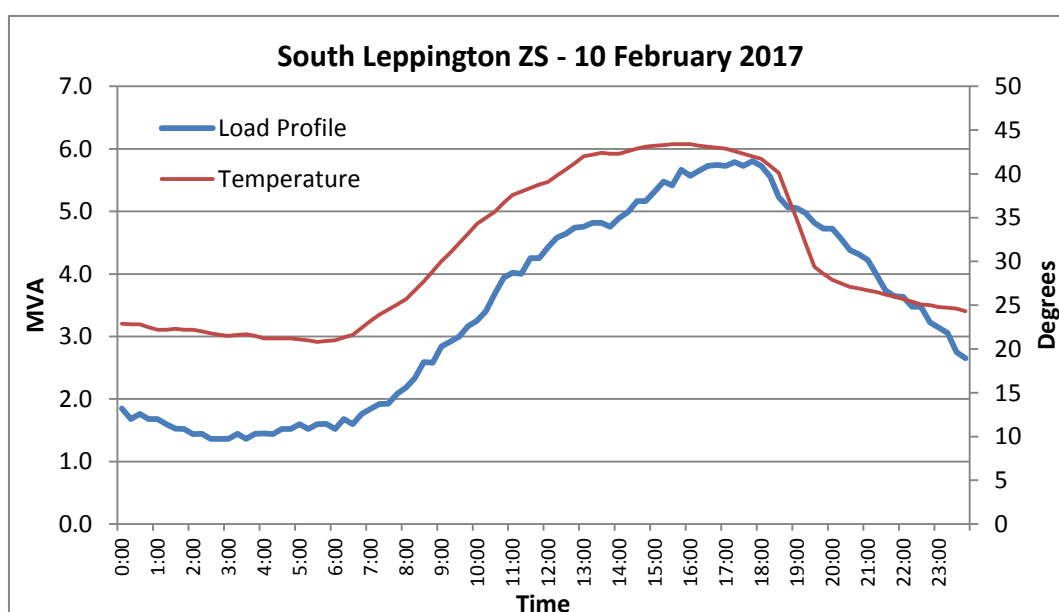
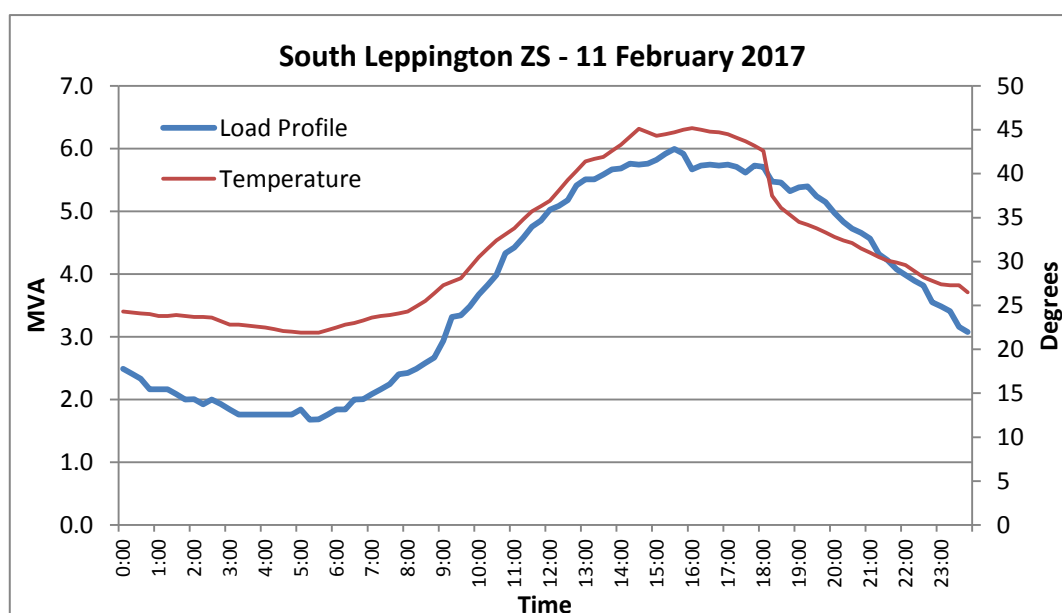


Figure 7 –South Leppington Zone Substation Load Profile – Saturday 11 February 2017



The two load profiles above show slightly different profiles from a working day to a non-working day. This highlights the natural variation to customer usage patterns from day to day. A demand management program will need to provide sufficient demand reduction to cover the relevant period. As demand increases and the duration the demand that exceeds capacity also increases.

The required demand reduction of 11.7 MVA will need to target the 2pm to 6pm peak demand on working and non-working peak days on the 11kV network. This demand reduction will need to be initiated up to 5 to 6 times a year on a pre-emptive basis, based on the 2018 summer. The number of DR events will quickly increase to 16 events in 2019 and 53 events in 2020. The duration of the demand reduction will also increase from a four hour to a six hour period during the same time. This indicates that temporary demand reduction initiatives may not be capable of providing the number of events and duration required. Endeavour believes that only permanent demand reduction initiatives are capable of meeting this demand reduction characteristic and the demand management program objectives.

5 FINANCIAL EVALUATION

Endeavour Energy is required to ensure investments in the distribution network are prudent and the preferred option is the one that represents the best net economic value that achieves the desired outcome. Endeavour Energy's financial incentive payments for the implementation of demand management initiatives are based on the cost saving from deferring capital expenditure (Avoided Distribution Cost) and addressing the expected load and energy at risk.

A financial evaluation of the preferred network option indicates deferring \$26.1 million for one year results in an Avoided Distribution Cost (ADC) of \$1.8 million. The expenditure to implement a non-network option will occur over three years from 2017/18 to 2019/20 to achieve a one-year deferral. This provides a maximum financial incentive payment of \$125 per kVA as a one-off payment based on targeting 11.7 MVA of demand reduction. This represents the maximum amount that would be available for permanent demand reduction and is dependent on the reliability of demand reduction. Load curtailment payment will need to be structured differently and potentially on a kWh basis.

Previous demand management programs have shown that payments in the order of \$100 per kVA to \$120 per kVA are generally required to incentivise customers to implement demand reducing initiatives. Hence, the maximum financial incentive payment of \$125 per kVA is considered sufficient to implement an effective demand management program to achieve the required demand reduction.

6 CONCLUSION

The investigation into the demand reduction found that potentially 2.6 MVA is attainable on the 11kV network supplying the South Leppington ZS supply area and the 11kV back-up feeders. However, this falls far short of the required demand reduction of 11.7 MVA for a one year deferral and 16.7 MVA for a two year deferral. The required demand reduction will need to target the 2pm to 6pm peak demand initially and increasing to 1pm to 7pm within a two year period. The number of events will also increase from 5 to 6 per year on a pre-emptive basis to 16 events in 2019 and 53 events in 2020. This indicates that temporary demand reduction initiatives may not be capable of providing the number of events and duration of the required reduction and only permanent demand reduction initiatives are capable of meeting these objectives.

The financial analysis indicates that a non-network option is financially feasible with a maximum incentive payment of up to \$125 per kVA however there is insufficient opportunity in the existing customer base to successfully achieve the required level of demand reduction. The increase in demand

resulting from lot releases and housing construction makes it challenging to obtain the necessary level of demand reduction to defer the augmentation of the interim South Leppington ZS. It is expected that the majority of demand reduction may be obtained via the existing customer base as the newly connected housing are constructed to strict energy efficiency standards.

As a result of the Demand Management Feasibility Study Endeavour Energy has concluded that there is insufficient opportunity to obtain the required demand reduction to defer the augmentation of the interim South Leppington ZS.

This particular greenfield development area contains the following characteristics:

1. Low base load and customer base to obtain demand reduction;
2. High demand growth rate and accelerated lot release plans;
3. Low firm network capacity in comparison to the peak demand to service the growth;
4. Low back-up electricity supply capacity to support the growth; and
5. High government and community expectation of developments receiving the utility services to enable development.

When a greenfield development area contains these characteristics Endeavour is unlikely to proceed with market consultation for non-network investigations as it is beyond the scope of obtaining sufficient demand reduction and deferring network upgrades. Where the greenfield development does not contain all of these characteristics, particularly items 1 to 3, Endeavour may approach the market and request submissions for non-network options.

7 CONSULTATION

7.1 SUBMISSIONS REQUESTED

Endeavour Energy seeks written submissions from market participants and interested parties in relation to the conclusion and recommendation outlined in this document or any other comments or enquiries regarding this report.

7.2 ENQUIRIES

All submissions and enquiries regarding this document should be directed to Endeavour Energy's Manager Asset Strategy and Planning at consultation@endeavourenergy.com.au.

8 RECOMMENDATION

It is recommended not to proceed with further investigations of non-network options to overcome the network constraints on the existing interim South Leppington ZS as there is insufficient demand reduction opportunity available to defer the augmentation of this substation. It is recommended to proceed with the preferred network option.