



The Liverpool City Centre Distribution Network PR673 Network Consultation Paper

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1 Executive Summary

This consultation paper has been prepared in accordance with the National Electricity Rules (NER) to allow Endeavour Energy to consult with Registered Participants, AEMO and interested parties to examine options to address load growth and delivery of distribution capacity in the Liverpool City Centre/CBD. In accordance with the requirements of the new Rules, the project has been nominated on the list of exempt projects covered by transitional provisions, and hence the current “Regulatory Investment Test for Distribution” (RIT-D) has not been applied to this project. As required by the Rules relating to transitional projects, the old Clause 5.6.2 of the NER has been applied and this requires the former Regulatory Test to be applied instead.

There are existing and emerging capacity constraints on the Liverpool City Centre Distribution Network that have arisen due to ongoing development within the various business precincts of the city centre. This report proposes the augmentation of constrained 11kV feeder underground cables supplying the Liverpool CBD¹ from Liverpool Zone Substation and from Homepride Zone Substation to overcome the identified network constraints.

The system requirement date for the works is summer 2014/15. The works are required to be completed as soon as practically possible to contain increasing load at risk on the Liverpool CBD 11kV distribution network and to provide capacity for new CBD development driven growth. These works will ensure that Endeavour Energy does not compromise supply security and reliability whilst allowing continued network connections and load growth within the Liverpool City Centre.

Demand Management and Local Generation were investigated but it was determined that they are unable to address the constraints identified with the Liverpool CBD network. Two build options to address the identified network constraints were investigated and are listed as follows.

The two build options considered in this report include:

- Option 1 - Augment Liverpool Zone Substation and Homepride Zone Substation and Upgrade the Liverpool CBD 11kV Distribution Network.
- Option 2 – Establish Collimore Park Zone Substation and 11kV CBD feeders

An evaluation of the cost of build options has identified that Option 1 provides the least present value of costs and is the preferred option.

- **The total (*staged*) cost of the preferred solution is \$16.3million plus \$2million contingency**
- **The Present Value of Costs of the project over the asset life is estimated to be \$13.6million**

Option 1 will be implemented in two stages, Stage 1 to commence in 2014/15 and Stage 2 in 2018/19 subject to confirmation of network need. Stage 1 involves minor augmentation of Homepride Zone Substation to extend the 11kV switchboard, development of one new 11kV feeder and augmentation of nine existing 11kV CBD feeders from both Homepride and Liverpool Zone Substations. Stage 1 is estimated to cost \$7.0million plus \$0.9million contingency. Stage 2 involves augmentation of Liverpool Zone Substation to extend the 11kV switchboard, uprate the transformer 11kV cables and develop two

¹ *The use of the abbreviation ‘CBD’ in this consultation paper must not be confused with the CBD classification under the Licence Conditions or AER STPIS applying to the Sydney Central Business District or Sydney CBD. Whilst the Liverpool City Centre essentially has a CBD area, the 11kV feeders supplying it are referred to as CBD feeders but they are not comparable to the Sydney CBD (triplex) feeder network.*

new 11kV CBD feeders whilst redirecting two existing feeders. Stage 2 is estimated to cost \$9.3million plus \$1.1million contingency. Endeavour Energy is carrying out an environmental assessment on the build options in accordance with the Environmental Planning and Assessment Act 1979.

2 Introduction

This consultation paper has been prepared in accordance with the National Electricity Rules (NER) to allow Endeavour Energy to consult with Registered Participants, AEMO and interested parties to examine options to address load growth and delivery of distribution capacity in the Liverpool City Centre/CBD. This consultation is carried out under transitional arrangements relating to the old Clause 5.6.2 of the National Electricity Rules which require the application of the Regulatory Test and consultation in relation to the options assessed. This project has been nominated on the list of projects covered by the transitional provisions of the new Rules and hence is exempt from the current Regulatory Investment Test for Distribution (RIT-D) process but needs to be assessed for the Regulatory Test instead.

The main driver for the capital works is to provide electricity supply capacity into the Liverpool City Centre to enable the connection of new customer load as development occurs and to mitigate the constraints identified on specific parts of the 11kV distribution network. This paper investigates the options available to implement this project. This document includes:

- A description of the identified supply constraints
- A description of the network and non-network options identified to address the constraints

3 Background

3.1 General

The area where network constraints have been identified is The Liverpool City Centre which is shown in Figure 1 and includes the various precinct boundaries and major load centres.

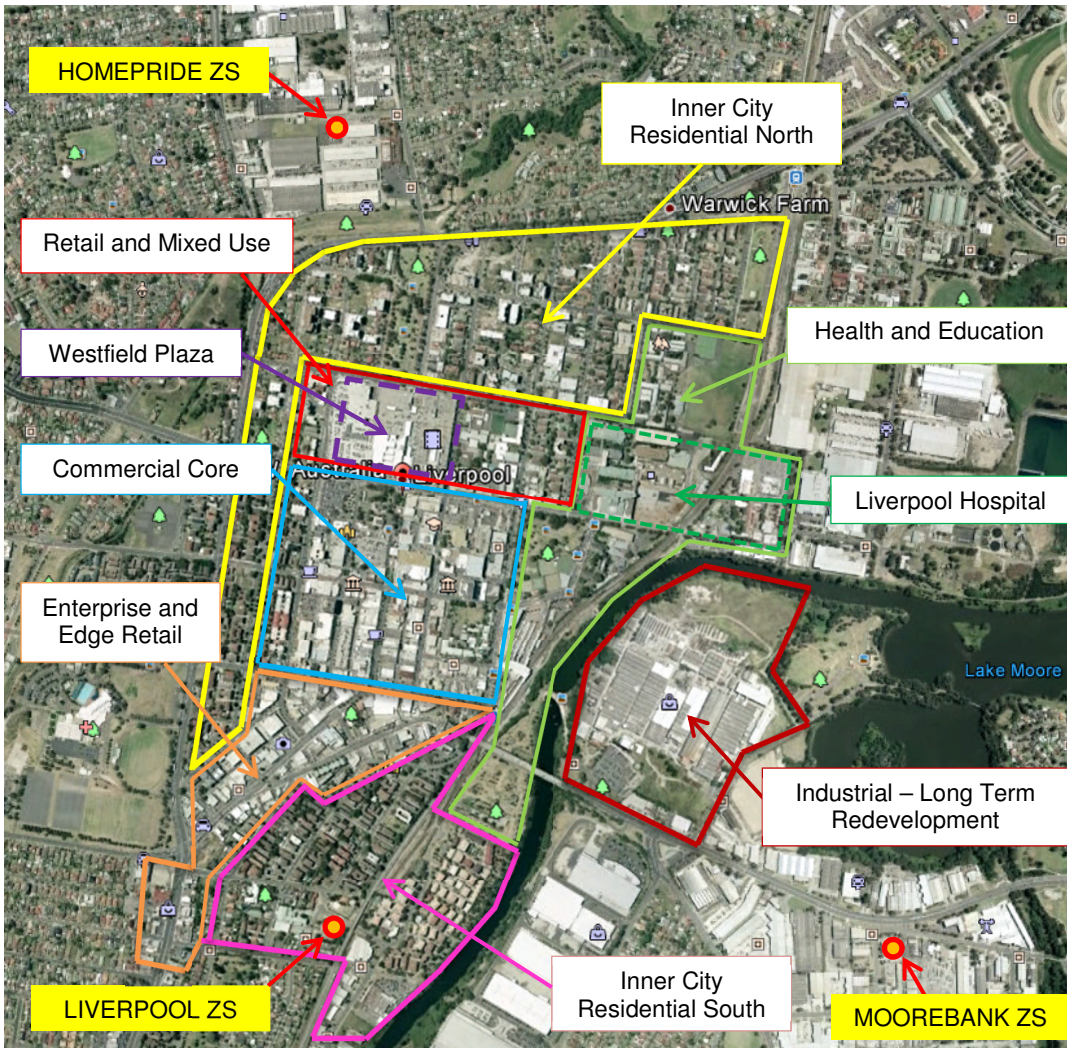


Figure 1: Study Area – Liverpool City Centre

The area under investigation extends from the Georges River in the east to the Hume Highway in the west, and from the Hume Highway in the north to Atkinson St in the south. It includes a CBD, a major shopping centre (Westfield) and a major hospital (Liverpool Hospital). The scale and regional significance of Liverpool Hospital is in the same category as the Royal North Shore (RNS) Hospital, the Royal Prince Alfred (RPA) Hospital and Westmead Hospital.

As the regional city for the south western Sydney metropolitan region, Liverpool is the primary centre for jobs, key regional services, and cultural activities. Reference is made to Liverpool City Council's published documents "Revitalising Liverpool City Centre Plan" covering the Vision, Local Environmental Plan, Development Control Plan and Civic Improvement Plan. These documents indicate that new jobs will be focused on high growth industries and build on the existing strengths within the Liverpool CBD including health, education, retail, business services and commercial activity. The city centre is also transforming into a high rise residential hub.

The city centre is a mix of office, retail, public space, cultural facilities and inner city living. New high density housing is being developed in the Inner City Residential North precinct providing for a range of age and income groups. The city centre will provide new spaces for emerging businesses and mixed development and is being transformed with a vision for a lively atmosphere day and night. New development within the city centre will add interest and vitality at street level attracting a higher population and economic stimulus to the CBD.

The commercial core will be connected to the Liverpool Hospital and Liverpool TAFE focusing on strengthening these assets and their integration into the growth of the city centre with links to recreational facilities along a continuous urban parkland along the west bank of the Georges River.

The city centre will be consolidated through the incorporation of density and height controls in the city centre precincts together with enhancement of the major civic spine of Macquarie Street and adjacent laneways to reinforce these as pedestrian promenades.

Liverpool City is significantly located for economic growth; it is well placed as the gateway to Sydney from the south-west with major motorways (M5 and M7), highways and railway lines all passing through or near the Liverpool City Centre and it is also close to Bankstown Airport and is the only city centre strategically located on the Orbital which enhances its prospects as a business centre.

With the recent announcement of Badgerys Creek Airport, Liverpool City stands as being the closest CBD in the region to the airport and will benefit from increased economic activity as a result.

The above vision which focuses on Liverpool City Centre's economic viability and growth as the major regional centre for South-Western Sydney will place increasing pressures on the electricity supply networks that currently service it. This project will mitigate the increasing risk of Endeavour Energy's network limitations being an impediment to the growth of the Liverpool City Centre.

Electricity Supply Network for Liverpool City Centre

The city centre is supplied from the southern end by Endeavour Energy's 33/11kV Liverpool Zone Substation equipped with three 35MVA transformers and is also supplied from the northern end by Endeavour Energy's 33/11kV Homepride Zone Substation equipped with three 25MVA transformers. Liverpool Zone Substation has six shared network 11kV feeders and two dedicated 11kV customer feeders into the city centre whilst Homepride Zone Substation has six shared network 11kV feeders and four dedicated 11kV customer feeders into the city centre. Neither Liverpool nor Homepride zone substations have spare 11kV circuit breakers for any future new feeders that may be required for CBD development or dedicated customer feeders.

An overlay of the existing electricity supply network servicing the Liverpool City Centre is shown in Figure 2 including Liverpool Transmission Substation, Liverpool Zone Substation, Homepride Zone Substation, 132kV and 33kV sub-transmission lines (*shown in yellow*) and 11kV distribution feeder underground cables and overhead lines (*shown in red*). CBD serviced from Liverpool Zone Substation is shown in blue and CBD serviced from Homepride Zone Substation is shown in amber.

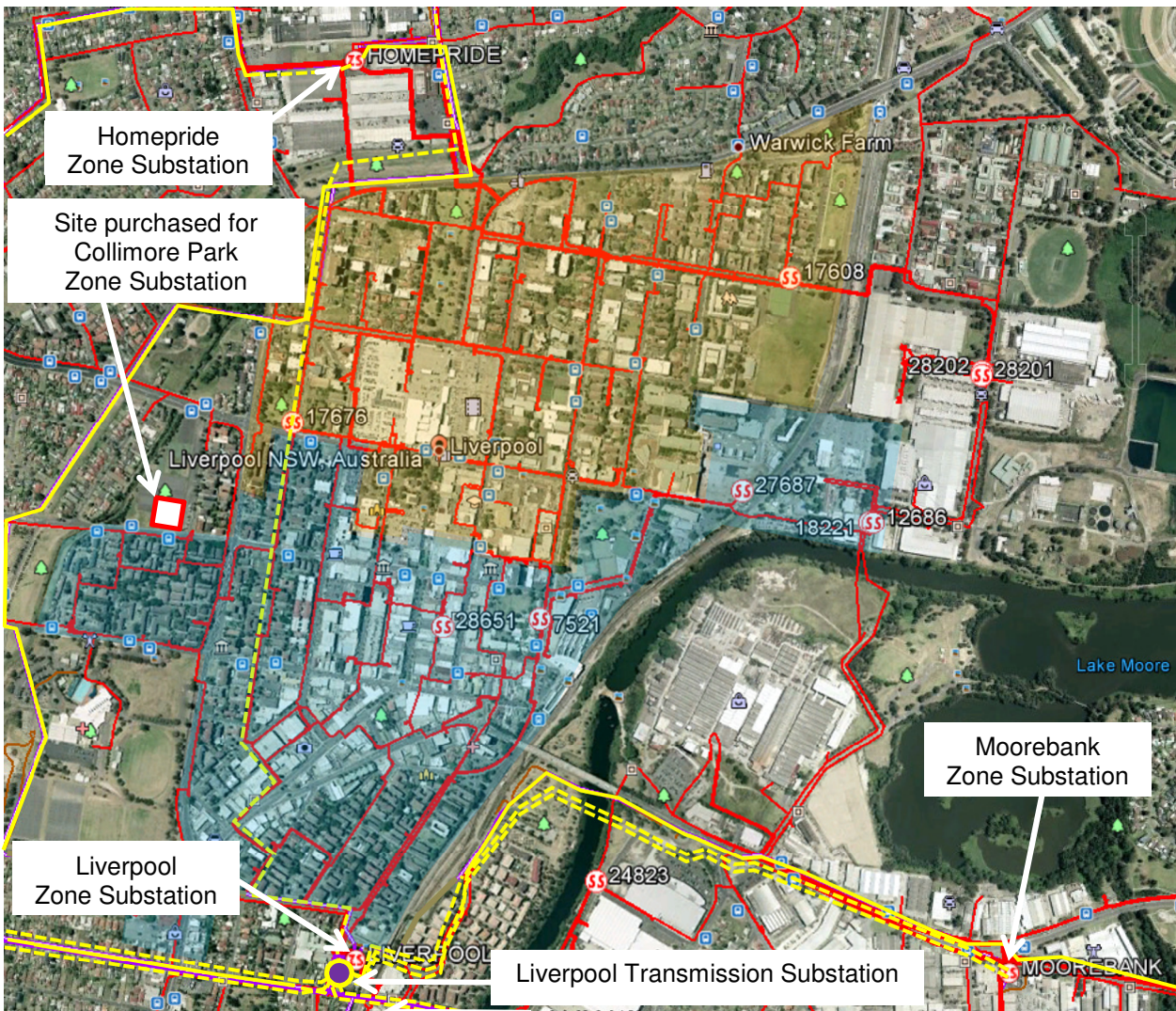


Figure 2: Existing Electricity Supply Network Servicing Liverpool City Centre

3.2 Network Constraints

Liverpool Zone Substation

The firm capacity of Liverpool Zone Substation is 53.8MVA and has capacity constraints on the 11kV CBD distribution network. This is caused by a combination of factors including the following, noting that operational constraints further reduce the station capacity to 43.5MVA:

1. Under-rated older 11kV feeder cables in congested duct banks within the first and second cable sections of CBD feeders. Some feeders will have no spare capacity by summer 2014/15 after new CBD development approved by Liverpool City Council during 2012 and 2013 has connected to the network.
2. Under-capacity transformer 11kV cables rated at 29.6MVA are mismatched to the transformer nameplate rating of 35MVA on T4 and T5 and transformer impedance mismatch of T6 (compared to T4 & T5), together with split bus operation of the standard three-section 11kV switchboard to control fault levels to 13.1kA results in a reduced firm station capacity of 43.5MVA during a sustained outage of T4, T5 or T6.

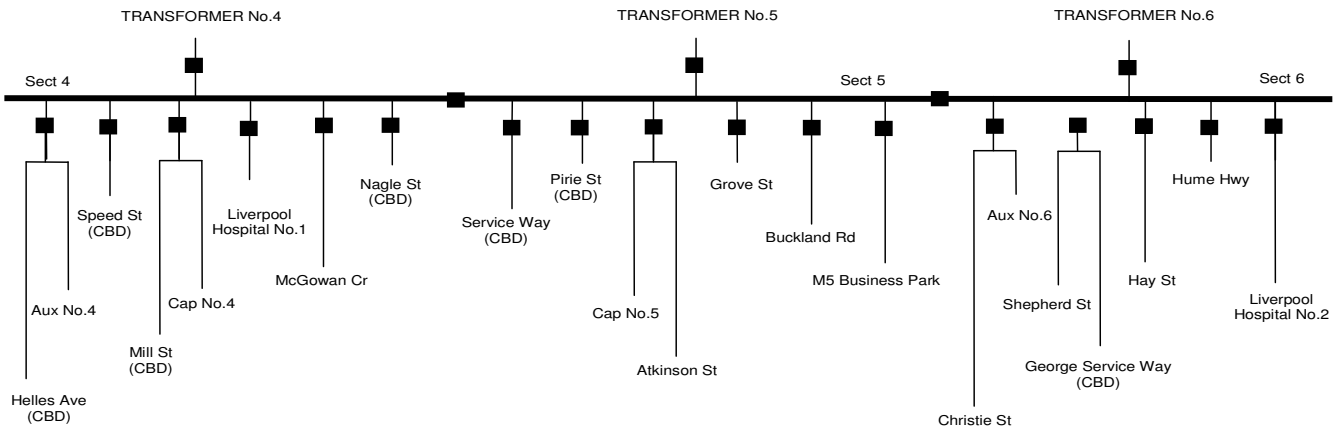


Figure 3: Existing Liverpool Zone Substation 11kV Single Line Diagram

Homepride Zone Substation

Homepride had a 33kV sub-transmission constraint of 46MVA due to the meshed network configuration sharing feeders with Bonnyrigg and Canley Vale Zone Substations which approved SAMP project PR204 addresses. Homepride also has no spare 11kV circuit breakers for future feeders and has several under rated older CBD cables in congested duct banks.

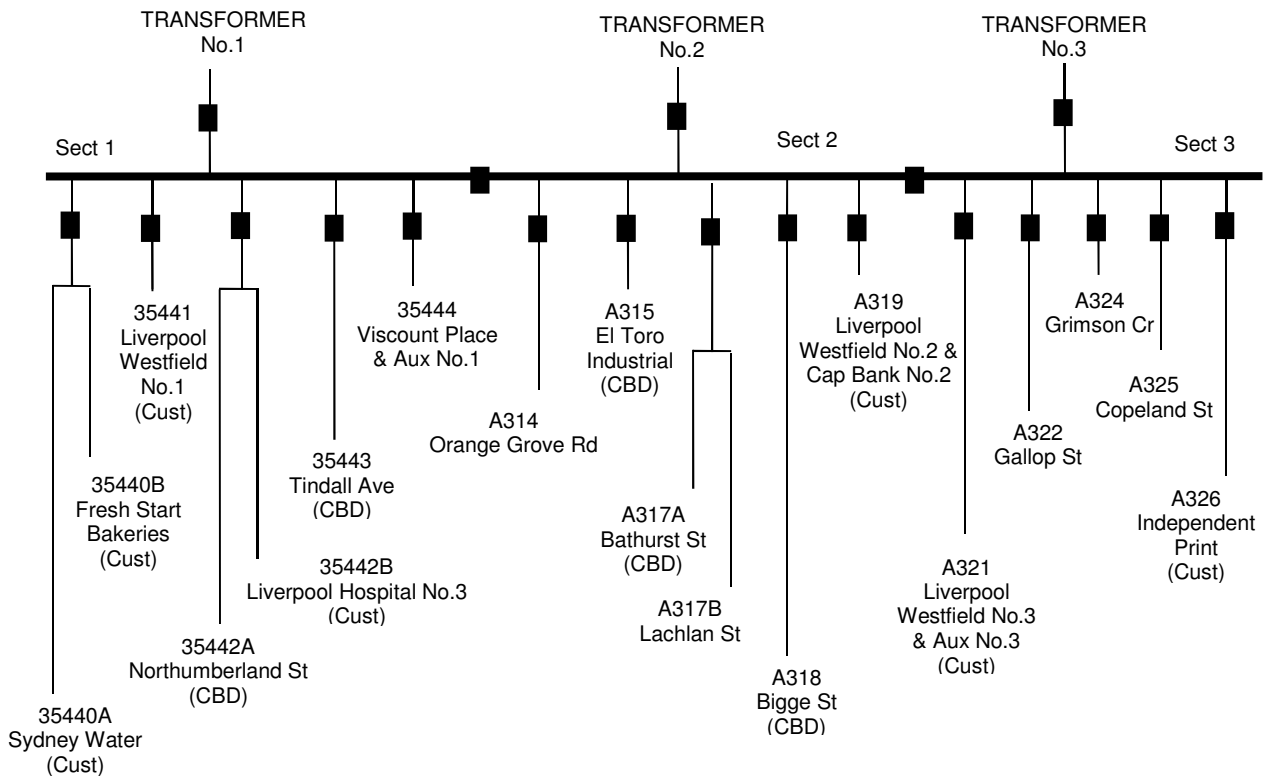


Figure 4: Existing Homepride Zone Substation 11kV Single Line Diagram

Distribution Feeder Constraints

Both zone substations have a blend of old and new 11kV feeder cables but coverage to most CBD streets is not available particularly from Liverpool Zone Substation which has the greater potential to provide additional capacity. Transfer capacity from one zone substation to the other is inherently weak due to both networks suffering from the same constraints. The existing underground distribution network is especially heavily congested in the areas immediately adjacent to and as far as 700m from both zone substations thus constraining the network due to reduced cable thermal ratings. The concern and consequence of these issues is the lack of timely and economical access to distribution capacity for new development within the CBD and the inability to service new customers or effectively back-up existing CBD load during feeder contingencies.

The current and short term status of the Liverpool City Centre 11kV 'shared network' feeders is shown in Table 1. Dedicated "customer only" feeders to Westfield and Liverpool Hospital are not shown as any spare capacity on these feeders cannot be used to service other customers.

CBD Feeder Name	Cable Size & Type	Feeder Capacity	Forecast Feeder Load	Spare Capacity	Load at risk	Voltage Reg	Compliance with Planning Standards
		Amps/MVA	Amps/MVA ¹	Amps/MVA	MVA	%	
D819 Speed St ³	0.4Al paper	142 / 2.7	142 / 2.7	0	0	1.8	No
D820 Mill St ³	300Al paper	155 / 3.0	180 / 3.4	-25 / -0.5	0.5	1.2	No
D826 Railway Srvway ³	0.4Al paper	142 / 2.7	160 / 3.0	-18 / -0.3	0.3	0.7	No
D827 Pirie St ³	300Al paper	155 / 3.0	230 / 4.4	-75 / -1.4	1.4	3.3	No
D824 Nagle St	300Al paper	155 / 3.0	60 / 1.1	95 / 1.8	0	1.4	Yes
35570B George Srvway	240Cu XLPE	218 / 4.2	125 / 2.4	93 / 1.8	0	0.5	Yes
35572 Hay St	240Cu XLPE	218 / 4.2	182 / 3.5	36 / 0.7	0	3.2	Yes
Liverpool ZS Total⁴				106 / 2.0	2.2		4
A317a Bathurst St	0.4Al paper	160 / 3.0	96 / 1.8	64 / 1.2	0	0.9	Yes
A317b Lachlan St	300Al paper	178 / 3.4	60 / 1.1	118 / 2.2	0	0.9	Yes
A315 El Toro Industrial ³	300Al paper	178 / 3.4	178 / 3.4	0	0	0.7	No
A318 Bigge St ³	0.4Al paper	160 / 3.0	186 / 3.5	-26 / -0.5	0.5	0.7	No
A325 Copeland St ³	0.4Al paper	140 / 2.7	202 / 3.8	-62 / -1.2	1.2	1.8	No
35443 Tindall Ave ³	240Cu XLPE	240 / 4.7	253 / 4.8	-13 / -0.3	0.3	1.7	No
35442 Northumberland	240Cu XLPE	240 / 4.7	150 / 2.9	90 / 1.7	0	1.0	Yes
Homepride ZS Total⁴				171 / 3.1	2.0		4

1. Forecast feeder load in 2015 - includes all processed load applications and known development applications in 2013
2. Normal urban voltage drop limit is 4.5%, maximum normal feeder load is 240A, 4.6MVA
3. Feeder has no spare capacity or has exceeded feeder capacity
4. Spare capacity on feeders is unable to be directly utilised to mitigate load at risk on other feeders

Table 1 – Condition of the 11kV Liverpool CBD Distribution Network

Demand Forecasts

A load forecast for Liverpool Zone Substation and Homepride Zone Substation is shown in Table 2 and Table 3 respectively. The firm capacity at Liverpool is restricted by 11kV transformer cable capacity and operational restrictions described in Section 3.2.

Year ¹	Actual			Forecast									
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Firm Capacity (MVA)	42.0	42.0	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5
Load Forecast (MVA)	53.3	43.0	50.9	40.3 [^]	40.9	39.8	40.4	41.1	41.8	42.5	43.3	44.2	45.2
Load at Risk (MVA)	11.3	1.0	7.4	0	0	0	0	0	0	0	0.2	0.7	1.7

Notes: 1. Year 2011 refers to summer 2010/11 and is actual recorded network load history data. [^] Load transfer in 2013/14 to Casula ZS.

Table 2 - Summer Demand Forecast and Load at Risk for Liverpool Zone Substation

Year ¹	Actual			Forecast									
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Firm Capacity (MVA)	42.0	42.0	42.0	42.0	50.0 [^]	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Load Forecast (MVA)	36.3	28.1	35.6	35.8	36.2	36.6	37.1	37.7	38.4	39.1	39.9	40.8	41.9
Load at Risk (MVA)	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: 1. Year 2011 refers to summer 2010/11 and is actual recorded (Network Load History) load data. [^] PR204 commissioned.

Table 3 - Summer Demand Forecast and Load at Risk for Homepride Zone Substation

3.3 Potential for Growth

The Liverpool CBD has experienced growth in recent years with construction of several medium and high rise residential apartment buildings, commercial office space, medical and research clinics and expansions to both the Westfield Shopping Plaza and Liverpool Hospital taking place. Liverpool City Council has endorsed a proposal to redevelop older industrial areas into modern high density inner city residential apartments and for the redevelopment of the older CBD core area to accommodate high rise buildings with mixed use office, residential and retail floor space. Liverpool CBD is classified as one of four regional cities within metropolitan Sydney.

The Liverpool CBD is also the nearest established regional city for employment and retail for the South West Growth Sector which is forecast to see an influx of around 78,000 residents in the Liverpool LGA area of the sector over the next 25-30 years. Endeavour Energy has carried out a study of the area shown in Figure 1 and estimated that future redevelopment would ultimately generate up to 180MVA of demand based on floor space ratios determined by Liverpool City Council. This growth is reflected in the demand forecasts of Liverpool and Homepride zone substations shown in Table 2 and Table 3.

Taking the deflated growth trend of recent years and global economic factors into consideration, it is estimated that the 180MVA is likely to take a much longer period of 45-50 years. This will be a major factor in considering additional upstream supply assets for long term provision of bulk capacity in excess of what Liverpool and Homepride can provide. However in the short term and over the next 10 year period, analysis indicates that the existing CBD distribution network has insufficient capacity to support incremental growth with particular feeders failing to meet planning standards. Some city streets do not have any 11kV network making access to available capacity difficult for new developments with added potential connection delays when restrictions are imposed by Endeavour Energy whilst upstream non-contestable feeder works are carried out to provide capacity. Table 1 exposes the weakness in the

network taking into account 2013/14 development applications and load applications indicating the CBD has a spare capacity of 5MVA from six distribution feeders.

3.4 Long Term Network Strategy

The ultimate strategy for the Liverpool City Centre is to establish Collimore Park Zone Substation midway between Liverpool Zone Substation and Homepride Zone Substation to provide a combined capacity of up to 150MVA for the Liverpool City Centre. The CBD load would predominantly be supplied by Collimore Park initially with up to 35MVA firm capacity then ultimately increased to 70MVA together with up to 45MVA from Liverpool and 35MVA from Homepride. Moorebank Zone Substation would be utilised to supply future city centre redevelopment east of the Georges River with potential network extensions into the CBD across the river to make up any shortfall in the ultimate capacity.

When the Liverpool City Centre and surrounding suburbs exceed the capacity of Liverpool and Homepride, the Collimore Park Zone Substation will be needed. The timing of this asset will depend on development rates within the CBD and exhausting spare capacity from both Liverpool and Homepride Zone Substations without impeding CBD progress or adjacent non-CBD areas. On current growth rates this would appear to be well beyond the current forecast period.

3.5 Environmental Issues

Environmental issues that are likely to impact on supply upgrade to the Liverpool City Centre include:

- The management of construction activity
- The management of underground cable works through Liverpool CBD streets

The project will be managed to comply with all aspects of the Environmental Planning and Assessment Act 1979.

Relevant stakeholders will be identified and managed in accordance with corporate stakeholder management and communications policies.

3.6 Asset Age and Condition

Replacement of the Hawker Siddley Brush 11kV circuit breaker trucks on bus-section No.4 and bus-section No.5 at Liverpool Zone Substation is proposed to be carried out as part of this project in lieu of refurbishment program TS007 *“Circuit Breaker Replacement Program.”* This type of circuit breaker was responsible for catastrophic failures at other substations.

3.7 Network Reliability

An investigation into network incidents on 11kV feeders that supply the Liverpool CBD from Liverpool and Homepride between 2007 and 2013 revealed a small number of HV and LV switchgear failures at various distribution installations and limited incidents where 11kV underground cables were fouled by excavation activity.

A concern with the existing network configuration is the increasing occurrence of double feeder terminations onto 11kV circuit breakers at both zone substations with CBD feeders doubled up together with urban feeders or other CBD feeders due to a deficiency in the number of circuit breakers. This can reduce the reliability performance of both feeders and results in two feeders impacted by a single event on one of the two feeders. This is non-standard practice for a CBD and is not permitted in the Endeavour

Energy Network Configuration Policy. Occurrence of this practice is a temporary measure only until a permanent solution is found.

There are currently six feeders double terminated onto three circuit breakers at Homepride Zone Substation and two feeders double terminated on a single circuit breaker in Liverpool Zone Substation not including capacitor banks and auxiliary feeder cables.

4 Project Design Requirements

Based on the previously identified network constraints and the context within which the project is to be carried out, the following factors have been identified as key to meeting the project purpose. All of these factors need to be addressed for each identified option, and the ideal project outcome is intended to satisfy all of these requirements:

- Supply Security – ensuring that customers receive the supply security level detailed in Endeavour Energy planning standards.
- Endeavour Energy Network Configuration Standard SDI 501 & Endeavour Energy Planning Policy 9.2.1 – ensuring that the proposed project meets requirements.
- Financial / Economic Feasibility – ensuring that the requirements of the Regulatory Test are met.
- Demand Growth – ensuring that the preferred solution continues to be appropriate into the future, given forecast levels of demand growth.
- Long Term Network Strategy – the solution must support and be supported by the long-term plan for network development in the area.
- Environmental Feasibility – ensuring that the project does not result in a worse environmental impact than currently exists. Where this is not possible, the project must aim to minimise the additional environmental impact.
- Technical Suitability – all relevant design standards must be met.
- Network Utilisation – the solution proposed makes the best use of the existing capacity of the network.
- Network Safety – the proposed solution does not present any future safety issues for operations and maintenance personnel or members of the public. It addresses any identified current safety concerns.

5 Options

5.1 Do Nothing

The 'Do Nothing' option increases the risk profile for supply to the Liverpool City Centre. Endeavour Energy will not be able to secure additional electricity supply to Liverpool City Centre development as growth occurs with just 5MVA of capacity remaining for the next 2 years of forecast growth. A large portion of the upstream sections of the CBD distribution network feeders emanating from Liverpool and Homepride zone substations have inadequate thermal capacity. Connection of larger developments (>650kVA) may need to be deferred until Endeavour Energy has carried out upstream non-contestable "headworks" to establish new feeders or replace existing cables before connection is allowed or may be connected at reduced capacity resulting in delays for customers and impede economic growth for the Liverpool area. Currently there is some spare capacity on the newer 11kV CBD feeders to accommodate moderate incremental CBD growth but on other older feeders there is no spare capacity. Some feeders exceed cable thermal rating due to small conductor size and older type paper insulation. This situation is exacerbated by the congested nature of these feeders. Refer to Table 1 in section 3.2 for the status of 11kV feeders.

In addition to the above, the thermal capacity of the 11kV cables of Transformer No.4 and Transformer No.5 at Liverpool Zone Substation are rated at 29.6MVA falling short of each transformer's nameplate rating of 35MVA by 5.4MVA each. This constraint coupled with the impedance mismatch of Transformer No.6 (resulting in uneven load sharing) and the split-bus configuration and operation of the 11kV busbar, limits the zone substation to a firm capacity of 43.5MVA (14.5MVA per section) thus preventing ultimate access to 23MVA of spare transformer capacity. The split bus configuration is required during periods of high load coincident with the pre-existing high system fault level which prevents all three transformers being operated in parallel on a solid bus as this would exceed the maximum allowed distribution network fault level of 13.1kA

Consequently these conditions do not meet Endeavour Energy Network Planning Policy and Network Configuration Standards.

The 'Do Nothing' option is therefore not appropriate and will not be considered further.

5.2 Demand Management Strategy to Reduce Load

Endeavour Energy investigates non-network options for all major projects in accordance with the National Electricity Rules (NER) 5.17.4. The NER states that all major distribution network capital investment projects must have non-network (demand management) options investigated for all projects above \$5 million and that pass the screening test for non-network options.

The Liverpool CBD experiences capacity constraint issues on the 11kV network during peak periods. Load growth on Liverpool Zone Substation and Homepride Zone Substation predominantly occurs in the Liverpool CBD and surrounding high density residential area and is placing increasing pressure on this network. An investigation has identified two network augmentation options to address these capacity constraints. A non-network option was investigated with the objective to defer or avoid the augmentation of the Liverpool CBD 11kV distribution network.

The investigation into the demand reduction potential found that approximately 1,144kVA of demand reduction is possible on the 11kV feeders from Liverpool Zone Substation and Homepride Zone

Substation that supply the CBD area. This falls short of the required 3,800kVA reduction required to achieve a two year deferral of the preferred network option. A demand management program is not technically feasible as there is insufficient opportunity in the existing customer base to achieve the required level of demand reduction. Details of the investigation are included in Appendix 1.

5.3 Utilising the existing network

The current practice with new load applications within the Liverpool CBD is to utilise spare capacity in the existing network where it can be provided and accessed. This often requires load transfers to adjust feeder loads making it possible for connections to proceed. This practice is becoming more difficult to accomplish, especially for the larger spot loads as opportunities to off-load any CBD customer load onto adjacent parts of the network are diminishing. This is due to the fact that both the Liverpool and Homepride networks which are adjacent to each other and both supply the CBD, have the same constraints. Spare distribution feeder capacity is not readily accessible from all parts of the CBD. It is only available to localised areas along any given feeder route. Spare capacity is unable to be easily and permanently transferred great distances across city blocks because this often includes transferring established loads along the feeder diversion route before reaching the new customer resulting in diminished spare capacity.

Table 1 indicates that up to eight feeders (four from Liverpool Zone Substation and four from Homepride Zone Substation) will have no spare capacity after all 2013 load applications and known development applications have connected onto the network by 2015. Unless action is taken, six of these feeders are expected to exceed thermal capacity. Liverpool Zone Substation has the potential to relieve the Homepride network if it is augmented to overcome the transformer utilisation operational constraint of 43.5MVA which is caused by the combination of a high fault level, the 11kV busbar configuration, mismatched transformer impedances and under rated 11kV transformer cables of Liverpool T4 and T5. Reconfiguration of the CBD networks from both Liverpool and Homepride Zone Substations and redistribution of customers would occur with the establishment of new 11kV feeders and the augmentation and extension of existing 11kV feeders correcting the thermal capacity limitations of the network.

5.4 Build Options

The strategy of this project is to provide spare capacity to the city centre essentially by the augmentation and extension of various parts of the existing distribution network currently servicing the Liverpool CBD. In conjunction with this, a network reconfiguration exercise will be carried out to redistribute customer load on the available feeders from both Homepride and Liverpool zone substations and provide spare capacity to most parts of the CBD for ongoing development. There are two build options for consideration to overcome the identified constraints with one of these options staged over a number of years. The two options have a forecast service period ranging up to 14 years for Option 1 and 16 years for Option 2. These options are detailed as follows.

5.4.1 Option 1 – Augment Liverpool and Homepride Zone Substations and Upgrade the 11kV CBD Distribution Network.

A two stage approach is proposed for this option:

Stage 1 involves the minor augmentation of Homepride Zone Substation to extend the 11kV switchboard development of one new 11kV CBD feeder and augmentation of 9 existing 11kV CBD feeders from Homepride and Liverpool.

Stage 2 augments Liverpool Zone Substation by extending the 11kV switchboard to four sections, uprating transformer 11kV cables, developing 2 new 11kV CBD feeders and redirecting 2 existing feeders.

Other variations of the 11kV switchboard were considered with the original proposal using the standard 6 section ringed configuration. Consideration in the elimination of pre-existing operational constraints by adopting the proposed configuration has allowed the move away from the standard configuration and reduced the option cost by \$2.0 million. The total capital outlay for Option 1 is \$16.3 million before contingency allowances. This expenditure will occur in two stages and over a number of years.

This option involves the replacement of thermally constrained CBD feeder cables emanating from Liverpool and Homepride Zone Substations to a point where thermal capacity is no longer a constraint. The augmentation of these cables will provide capacity for ongoing growth on the majority of feeders. It is proposed to replace existing 0.4sq inch aluminium paper cable and 300mm² aluminium paper cable with 300mm² copper XLPE cable where applicable. Table 4 and Table 5 show post feeder upgrade capacity. With a combined spare capacity of 20.3MVA on 14 shared network feeders and an undiversified annual load growth rate of 2.4MVA averaged across feeders, Endeavour Energy can supply up to 8.5 years of CBD development. Take up of capacity will vary and busier feeders could be fully utilised within 4 years. Load will be connected to the nearest appropriate feeder but is location dependent on new development whilst not imposing excessive connection cost.

Feeder Name	Existing Network Load with 2013/14 DA & Load Applications Amps / MVA	Existing Spare Capacity Amps / MVA	Augmented Network Load with 2013/14 DA & Load Applications Amps / MVA	Proposed Spare Capacity Amps / MVA	Replaced Cable km
35570B - George S/way	125 / 2.4	93 / 1.8	125 / 2.4	93 / 1.8	
D819 Speed St	142 / 2.7	0	142 / 2.7	98 / 1.9	0.95
D820 Mill St	180 / 3.4	- 25 / - 0.5	180 / 3.4	60 / 1.1	0.06
D826 Railway S/way	160 / 3.0	- 18 / - 0.3	160 / 3.0	80 / 1.5	0.78
D827 Pirie St	230 / 4.4	- 75 / - 1.4	230 / 4.4	10 / 0.2	0.77
35572 Hay St	182 / 3.5	36 / 0.7	153 / 2.9	65 / 1.2	
D824 Nagle St	60 / 1.1	95 / 1.8	89 / 1.7	151 / 2.9	0.39
D822 Liverpool Hosp 1 ¹	245 / 4.7	28 / 0.5	245 / 4.7	28 / 0.5	
35573 Liverpool Hosp 2 ¹	100 / 1.9	173 / 3.3	100 / 1.9	173 / 3.3	
TOTALS	1424 / 27.1	106 / 2.0²	1424 / 27.1	557 / 10.6²	2.95

Table 4 – Option 1 (Stage 1) Post Upgrade of Liverpool 11kV CBD Feeders

Feeder Name	Existing Network Load with 2013/14 DA & Load Applications Amps / MVA	Existing Spare Capacity Amps / MVA	Augmented Network Load with 2013/14 DA & Load Applications Amps / MVA	Proposed Spare Capacity Amps / MVA	Replaced Cable km
A315 El Toro Industrial	178 / 3.4	0	178 / 3.4	64 / 1.2	0.7
A318 Bigge St	186 / 3.5	- 26 / - 0.5	186 / 3.5	54 / 1.0	0.3
A325 Copeland St	202 / 3.8	- 62 / - 1.2	202 / 3.8	38 / 0.7	0.1
35443 Tindall Ave	253 / 4.8	- 13 / - 0.3	253 / 4.8	0	
35442a Northumberland	150 / 2.9	90 / 1.7	150 / 2.9	90 / 1.7	
A317a Bathurst St	96 / 1.8	64 / 1.2	96 / 1.8	144 / 2.7	0.6
A317b Lachlan St	60 / 1.1	118 / 2.2	60 / 1.1	118 / 2.2	
35441 Westfield 1 ¹	190 / 3.6	83 / 1.6	190 / 3.6	83 / 1.6	
A319 Westfield 2 ¹	150 / 2.9	45 / 0.9	150 / 2.9	45 / 0.9	
A321 Westfield 3 ¹	152 / 2.9	24 / 0.5	152 / 2.9	24 / 0.5	
35442b Liverpool Hosp 3 ¹	100 / 1.9	173 / 3.3	100 / 1.9	173 / 3.3	
TOTALS	1717 / 32.7	171 / 3.1²	1717 / 32.7	508 / 9.7²	1.7

1. Customer only feeders 2. Excludes Westfield & Liverpool Hospital feeders

Table 5 – Option 1 (Stage 1) Post Upgrade of Homepride 11kV CBD Feeders

At Homepride Zone Substation, the 11kV switchboard would be extended with two additional circuit breakers and the development of one new 11kV feeder to supply high rise residential housing in the Inner City Residential North precinct which is undergoing widespread development with multiple buildings under construction. These works will increase spare distribution network capacity *from Homepride Zone Substation* to 15.4MVA (refer Table 6).

At Liverpool Zone Substation the 11kV cables on Transformer No.4 and Transformer No.5 would be upgraded to achieve nameplate rating and the 11kV switchboard extended from a three section busbar to a four section busbar. These works will result in the increase of substation firm capacity from 43.5MVA to 66.8MVA and increase spare distribution network capacity *from Liverpool Zone Substation* to 17.4MVA (refer Table 7) less any capacity take-up by CBD development between the two stages.

Table 6 and Table 7 show the resultant feeder loads and network capacity at the completion of Option 1 after all constrained feeder cables have been upgraded, additional feeders have been installed, and Liverpool transformers T4 and T5 cables replaced.

It can be seen from these tables that an increase of almost 15.5MVA in spare distribution capacity can be provided from Liverpool Zone Substation and an increase of just over 12MVA from Homepride Zone Substation making a combined total increase of 27.5MVA for the Liverpool City Centre/CBD. This option makes the best use of existing network assets and maximises utilisation of installed transformer capacity whilst addressing network constraints. This project will involve augmentation of the underground network and extension of 11kV switchboards while customers remain connected to the network. This will present challenges and these will need to be managed during the course of the project.

Feeder Name	Existing Network Load with 2013/14 DA & Load Applications Amps / MVA	Existing Spare Capacity Amps / MVA	Augmented Network Load with 2013/14 DA & Load Applications Amps / MVA	Proposed Spare Capacity Amps / MVA	New Cable km	Replaced Cable km
New Hanwell Serviceway ¹	0	0	100 / 1.9	140 / 2.7	0.54	
A315 El Toro Industrial ²	178 / 3.4	0	178 / 3.4	62 / 1.2		0.73
A318 Bigge St ²	186 / 3.5	- 26 / - 0.5	108 / 2.0	132 / 2.5		0.3
A325 Copeland St ⁶	202 / 3.8	- 62 / - 1.2	202 / 3.8	38 / 0.7		0.1
35443 Tindall Ave ⁴	253 / 4.8	- 13 / - 0.3	156 / 3.0	84 / 1.6		
35442a Northumberland ⁴	150 / 2.9	90 / 1.7	150 / 2.9	90 / 1.7		
A317a Bathurst St ²	96 / 1.8	64 / 1.2	96 / 1.8	144 / 2.7		0.6
A317b Lachlan St ⁶	60 / 1.1	118 / 2.2	60 / 1.1	118 / 2.2		
35441 Westfield 1 ⁷	190 / 3.6	83 / 1.6	190 / 3.6	83 / 1.6		
A319 Westfield 2 ⁷	150 / 2.9	45 / 0.9	150 / 2.9	45 / 0.9		
A321 Westfield 3 ⁷	152 / 2.9	24 / 0.5	152 / 2.9	24 / 0.5		
35442b Liverpool Hosp 3 ⁷	100 / 1.9	173 / 3.3	100 / 1.9	173 / 3.3		
TOTALS	1717 / 32.7	171 / 3.1⁸	1642 / 31.2	808 / 15.4⁸	0.54	1.7

1. New 300_{mm}² Cu XLPE cable 2. Augment to 300_{mm}² Cu XLPE cable 3. Augment to 240_{mm}² Cu XLPE cable
4. Existing 240_{mm}² Cu XLPE cable 5. Existing 300Al paper cable 6. Partially supplies CBD 7. Customer feeder
8. Excludes Westfield & Liverpool Hospital feeders

Table 6 – Post Augment of Homepride Zone Substation with One Additional 11kV CBD Feeder

Feeder Name	Existing Network Load with 2013/14 DA & Load Applications Amps / MVA	Existing Spare Capacity Amps / MVA	Augmented Network Load with 2013/14 DA & Load Applications Amps / MVA	Proposed Spare Capacity Amps / MVA	New Cable km	Replaced Cable km
35570B - George S/way ⁴	125 / 2.4	93 / 1.8	125 / 2.4	93 / 1.8		
New - Crawford S/way ²	0	0	157 / 3.0	83 / 1.6	1.40	
New - Carey St ²	0	0	57 / 1.1	183 / 3.5	0.75	
D819 Speed St ¹	142 / 2.7	0	110 / 2.1	130 / 2.5		Stage 1
D820 Mill St ⁵	180 / 3.4	- 25 / - 0.5	180 / 3.4	60 / 1.1		Stage 1
D826 Railway S/way ¹	160 / 3.0	- 18 / - 0.3	160 / 2.5	80 / 1.5		Stage 1
D827 Pirie St ¹	230 / 4.4	- 75 / - 1.4	73 / 1.4	167 / 3.2	0.35	Stage 1
35572 Hay St ³	182 / 3.5	36 / 0.7	183 / 3.5	35 / 0.7	0.03	
D824 Nagle St ³	60 / 1.1	95 / 1.8	158 / 3.0	82 / 1.6	1.12	Stage 1
D822 Liverpool Hosp 1 ⁷	245 / 4.7	28 / 0.5	245 / 4.7	28 / 0.5		
35573 Liverpool Hosp 2 ⁷	100 / 1.9	173 / 3.3	100 / 1.9	173 / 3.3		
TOTALS	1424 / 27.1	106 / 2.0⁶	1548 / 29.5	913 / 17.4⁶	3.65	

1. Augment to 300_{mm}² Cu XLPE cable 2. New 300_{mm}² Cu XLPE cable 3. Extend with 240_{mm}² Cu XLPE cable 4. Existing 240_{mm}² Cu XLPE cable 5. Partially supplies CBD 6. Excludes Liverpool Hospital feeders 7. Customer feeder

Table 7 – Post Augment of Liverpool Zone Substation with Two Additional 11kV CBD Feeders

With a combined spare capacity of 32.8MVA over all 17 CBD shared network feeders and an undiversified load growth rate of 2.4MVA per year averaged across all feeders, Endeavour Energy would secure a minimum of 13.5 years of growth capacity for the Liverpool City Centre.

5.4.2 Option 2 – Establish Collimore Park Zone Substation

- Establish Collimore Park Zone Substation
- Establish 10 x new 11kV feeders

The total capital outlay for this option is \$27.1 million plus a contingency amount of \$2.0 million.

This option establishes Collimore Park Zone Substation on the Endeavour Energy owned site at the corner of Collimore St and Moore St Liverpool. Refer to Figure 3 for location and proposed supply catchment area. The Collimore St site was acquired for its suitability to accommodate a future CBD zone substation to ensure Endeavour Energy's ability to provide long term supply security for the Liverpool City Centre. The option would develop ten (10) 11kV feeders including two (2) dedicated "hub" feeders into the CBD and surrounding fringe areas and reconfigure the existing distribution network. A "hub" feeder is a dedicated cable solely for back-up use within the CBD running from the zone substation to a specially located switching station having common coupling to three shared network feeders. The hub feeder is capable of supplying the entire load of one shared network feeder.

Collimore Park Zone Substation would off-load the Liverpool and Homepride zone substation distribution networks to reduce feeder loads to within thermal capacity and increases spare capacity to supply new development nearer to the zone substations. This option would establish more effective cross-zone support between the three zone substations than currently exists between Liverpool and Homepride. No works would be carried out at Liverpool or Homepride zone substations as part of this option. The augmentation of any existing 11kV feeder cables from these zone substations would be carried out as part of the annual Distribution Works Program if subsequently identified as constrained after taking into account any potential off-load to new CBD feeders from Collimore Park Zone Substation. Sub-transmission supply for Collimore Park would be at 33kV from Liverpool Transmission Substation.

Implementation of Option 2 would result in a spare capacity of 18.6MVA at Collimore Park, 11.4MVA at Liverpool and 9.3MVA at Homepride (refer to Tables 8a, 8b and 8c). The Liverpool City Centre would have a growth capacity of 39.3MVA provided by the three zone substations. With an undiversified CBD load growth rate of 2.4MVA per year, Endeavour Energy would secure a minimum of 16.5 years of growth capacity for the Liverpool City Centre. Endeavour Energy would be in a position to further increase capacity at Collimore Park at a later network need date (as required) by providing an additional 35MVA of firm capacity to secure a further 14.5 years of CBD growth.

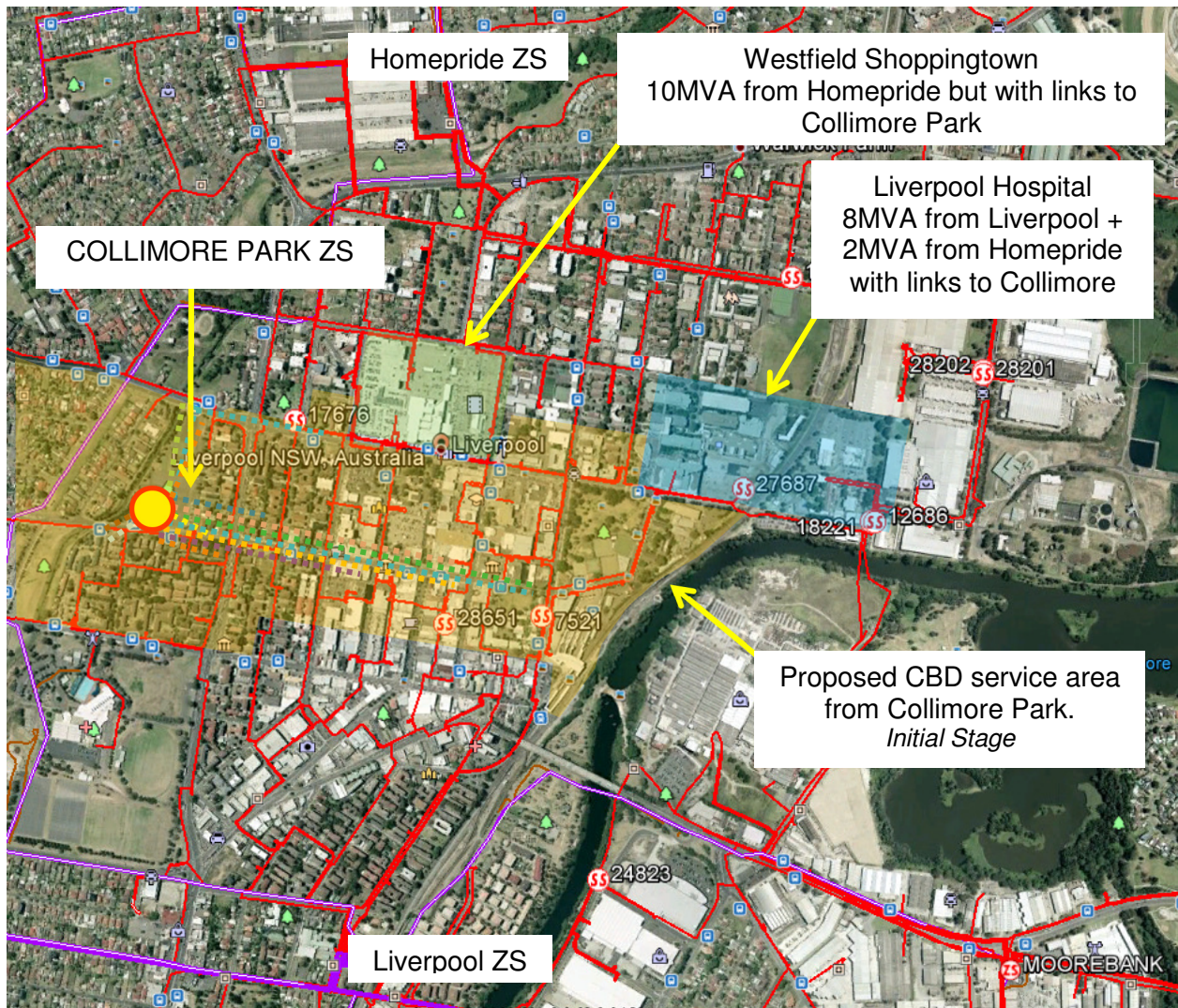


Figure 5: Proposed Collimore Park ZS Service Area of the Liverpool CBD

Figure 5 shows the indicative service catchment area for the proposed Collimore Park Zone Substation. The CBD would be supplied from three sources including Homepride and Liverpool with cross-zone ties for contingency switching. Tables 8a, 8b and 8c show the proposed 11kV CBD feeder loads and spare capacity from Collimore Park, Homepride and Liverpool Zone Substations as a result of implementing Option 2 – *Establish Collimore Park Zone Substation*.

Figure 6 outlines the proposed sub transmission works required to connect the new substation at 33kV.

Feeder Name	Existing Network Load with 2013/14 DA & Load Applications Amps / MVA	Augmented Network Load with 2013/14 DA & Load Applications Amps / MVA	Proposed Spare Capacity Amps / MVA	New Cable km	Replace Cable km
New - CBD Feeder No.1 ¹	0	137 / 2.6	103 / 1.9	0.58	
New - CBD Feeder No.2 ¹	0	147 / 2.8	93 / 1.8	0.76	
New - CBD Feeder No.3 ¹	0	152 / 2.9	88 / 1.7	0.88	
New - CBD Feeder No.4 ¹	0	48 / 0.9	192 / 3.6	0.4	
New - CBD Feeder No.5 ¹	0	64 / 1.2	176 / 3.4	0.27	
New - CBD Feeder No.6 ¹	0	90 / 1.7	150 / 2.8	0.49	
New - Elizabeth Dr ¹	0	183 / 3.5	57 / 1.1	0.1	
New - Memorial Ave ¹	0	120 / 2.3	120 / 2.3	0.08	
New - HUB No.1 ²	0	0	360 / 6.8	0.9	
New - HUB No.2 ²	0	0	360 / 6.8	0.6	
TOTALS	0	941 / 17.9	979 / 18.6³	5.1	Nil

Table 8a – Collimore Park Zone Substation 11kV Feeders

Feeder Name	Existing Network Load with 2013/14 DA & Load Applications Amps / MVA	Augmented Network Load with 2013/14 DA & Load Applications Amps / MVA	Proposed Spare Capacity Amps / MVA	New Cable km	Replace Cable km
35570B George Srvceway	125 / 2.4	92 / 1.8	126 / 2.4		
D826 Railway Srvceway	160 / 3.0	132 / 2.5	10 / 0.2		
D819 Speed St	142 / 2.7	88 / 1.7	54 / 1.0		
D827 Pirie St	230 / 4.4	86 / 1.6	69 / 1.3		
35572 Hay St	182 / 3.5	26 / 0.5	192 / 3.6		
D824 Nagle St	60 / 1.1	60 / 1.1	95 / 1.8		
D820 Mill St	180 / 3.4	103 / 2.0	52 / 1.0		
D822 Liverpool Hosp 1	245 / 4.7	245 / 4.7	28 / 0.5		
35573 Liverpool Hosp 2	100 / 1.9	100 / 1.9	173 / 3.3		
TOTALS	1424 / 27.1	932 / 17.7	598 / 11.4³	Nil	Nil

Table 8b - Liverpool Zone Substation 11kV CBD Feeders

Feeder Name	Existing Network Load with 2013/14 DA & Load Applications Amps / MVA	Augmented Network Load with 2013/14 DA & Load Applications Amps / MVA	Proposed Spare Capacity Amps / MVA	New Cable km	Replace Cable km
A318 Bigge St	186 / 3.5	108 / 2.0	52 / 1.0		
A315 El Toro Industrial	178 / 3.4	158 / 3.0	18 / 0.3		
35443 Tindall Ave	253 / 4.8	134 / 2.5	106 / 2.0		
35442 Northumberland St	150 / 2.9	150 / 2.8	90 / 1.7		
A317a Bathurst St	96 / 1.8	96 / 1.8	64 / 1.2		
A317b Lachlan St	60 / 1.1	60 / 1.1	118 / 2.2		
A325 Copeland St	202 / 3.8	100 / 1.9	40 / 0.7		
35441 Westfield 1	190 / 3.6	190 / 3.6	83 / 1.6		
A319 Westfield 2	150 / 2.9	150 / 2.9	45 / 0.9		
A321 Westfield 3	152 / 2.9	152 / 2.9	24 / 0.5		
35442b Liverpool Hosp 3	100 / 1.9	100 / 1.9	173 / 3.3		
TOTALS	1717 / 32.7	1398 / 26.6	488 / 9.3³	Nil	Nil

Table 8c - Homepride Zone Substation 11kV CBD Feeders

1. New 300_{mm}² Cu XLPE cable
2. Standby CBD back-up feeder only and does not count as spare capacity
2. Excludes Liverpool Hospital feeders, Westfield feeders and HUB feeders

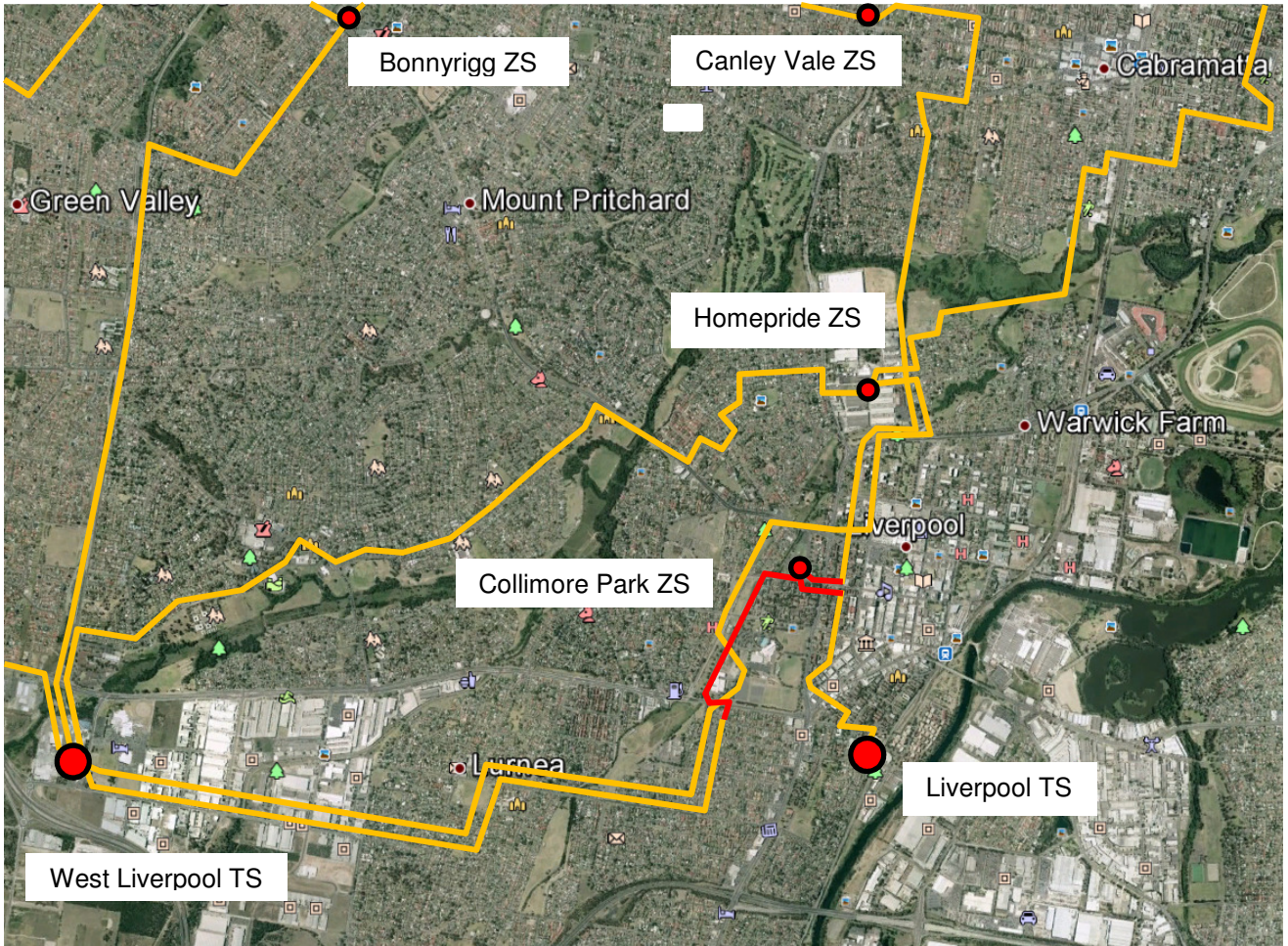


Figure 6 - Proposed 33kV Sub-transmission Supply for Collimore Park Zone Substation

6 Option Comparison

The build solutions were assessed against the project design requirements discussed in Section 4.

The two build options were investigated and assessed based on technical suitability and ability to meet long term network and customer requirements as well as total project cost. The comparative costs of the two options considered including contingency are as follows:

Option 1	Augmentation of the Liverpool CBD Network	\$18.2 million
Option 2	Establishment of Collimore Park Zone Substation	\$29.1 million

Both of the considered options meet the project requirements however the staging of the construction proposed in Option 1 offers a number of advantages including:

- (i) Best use of existing installed transformer capacity
- (ii) The ability to respond more quickly to development
- (iii) The opportunity to defer capital expenditure

6.1 Technical Considerations

A number of technical factors were considered for each build option.

Fault Levels

The calculated fault level for Homepride Zone Substation is within the maximum fault level recommended in Network Configuration Standard SDI 501. However the 11kV fault level at Liverpool Zone Substation remains higher than 13.1kA and requires the continued practice of the one-third/two-thirds split operation of the 11kV busbar with one transformer plus one transformer respectively and a third transformer on standby. The operational risks with this configuration will be mitigated by the proposed new configuration of four bus sections with one transformer output split over two sections. Refer to the proposed Single Line Diagram in Figure 9 of Section 5.4.1

Fault level on the Liverpool 11kV busbar and the Homepride 11kV busbar are shown in Table 9.

	3 Phase-Earth Fault Level		1 Phase-Earth Fault Level	
	kA	MVA	kA	MVA
Liverpool Zone Substation Two transformers in service	18.9 [^]	360 [^]	17.3 [^]	330 [^]
Homepride Zone Substation Two transformers in service	11.5	218	12.74	243

Table 9 - Details of System Fault Levels

[^] Endeavour Energy is currently implementing a solution to reduce the fault levels at Liverpool Zone Substation.

The fault level on the Homepride 11kV busbar is within the maximum fault levels recommended in Special Report No.67 Network Parameters of 13.1kA, 250MVA.

Step and Touch Potential

Where concrete poles are required, any hazardous step and touch potentials that may exist on the poles under fault conditions shall be managed to safe levels (Refer AS/NZS 7000) by adequately earthing affecting poles.

This report does not recommend implementation of Option 2 which would require new 33kV sub-transmission concrete poles and therefore does not apply and is not investigated further.

6.2 Environmental Consideration

An environmental assessment of the build options will be carried out in accordance with statutory requirements outlined in Section 3.3 of this report.

A Preliminary Environmental Assessment has been prepared for the proposed network option. The study did not identify any major constraints that would prohibit the distribution works within the Liverpool City Centre but highlighted the potential impacts and precautions required relating to traffic and pedestrian management, noise, spoil management, archaeology and heritage, street landscape and restoration as well as electromagnetic fields. Based on preliminary inspections of the work area and similar ongoing projects within the Parramatta CBD, the substation augmentation and cable replacement works proposed in Option 1 is considered feasible from an environmental perspective.

6.2.1 Electromagnetic Fields

This section will generally only be applicable when considering the augmentation or construction of new transmission lines. Values of EMF surrounding lines for the various options need to be calculated. Graphs showing the EMFs produced for the various options should be included. This report does not recommend the implementation of Option 2 at this point in time which would have required new 33kV sub-transmission feeders and therefore EMF considerations are not applicable. Installation of new 11kV underground feeder cables will increase EMF levels but the impact will be low and an assessment is not required as the levels will likely be less than the 1000mG allowable. Prudent avoidance should still be used to minimise risks.

6.2.2 Stakeholder Management

There are a number of stakeholders that may be affected by this project. Their needs and issues need to be managed such that the project will not be adversely affected. A preliminary stakeholder management plan will be prepared during the design and project management phase of the project. The plan will recommend that detailed consultation takes place with residents and businesses in the immediate vicinity of the proposed distribution work within the Liverpool City Centre as well as those in the vicinity of Liverpool and Homepride Zone Substations where internal works will also take place.

6.3 Financial Evaluation and Regulatory Test

A financial evaluation was carried out for each option. The Present Value of Costs was calculated for the two build options outlined. Table 10 below outlines the results of the calculations and includes sensitivity analysis as required by the Regulatory Test.

		OPTION 1 Augment Liverpool ZS & Homepride ZS & Upgrade the 11kV CBD Distribution Network		OPTION 2 Establish Collimore Park ZS
		Stage 1	Stage 2	
Total Capital Outlay (nominal \$m)		6.65	8.84	27.1
Variability of capital outlay (+/- percent)		10		10
Scenario		PV of Costs (\$ million)		
		Option 1 (Stage 1 + Stage 2)		Option 2
Base Case		13.57		25.49
High Capital		14.74		27.73
Low Capital		12.41		23.26
High Operating & Maintenance	120%	13.95		26.11
Low Operating & Maintenance	80%	13.19		24.87
High Discount Rate	10.2%	12.24		23.88
Low Discount Rate	6.2%	15.44		27.88
Early commissioning	2021	13.80		26.65
Late commissioning	2023	12.79		24.83

Table 10: Results of Present Value of Costs Calculations

6.3.1 Regulatory Test Outcome

Option 1 (*Stage 1 + Stage 2*) “Augment Liverpool ZS and Homepride ZS and Upgrade the 11kV CBD Distribution Network” minimises the Present Value of Costs and therefore meets the requirements of the Regulatory Test.

6.4 Option Comparison Table

An assessment of the various build options considered against the project requirements is shown in Table 11.

Requirement	Option 1 Augment Liverpool ZS & Homepride ZS & Upgrade the 11kV CBD Distribution Network		Option 2 Establish Collimore Park ZS
	Stage 1	Stage 2	
Supply Security provides short term supply security for Liverpool City Centre residences and businesses	Yes	Yes	Yes
Licence Condition Compliance 11kV distribution feeders controlled to planning limits for normal load current and voltage regulation.	Yes	Yes	Yes
Financial / Economic Feasibility satisfies the regulatory test	Yes	Yes	No
Capital Cost	\$6.65m	\$8.84m	\$27.1m
Present Value of Costs	\$13.57m		\$25.5m
Demand Growth – provides long term (greater than 10 years) capacity needs for targeted area	No Next constraint 2018	Yes	Yes
Long Term Network Strategy solution will support long term strategy for Liverpool CBD	Yes	Yes	Yes
Technical Suitability design standards met	Yes	Yes	Yes
Environmental Feasibility	Yes	Yes	Yes
Network Utilisation best use of existing network capacity	Yes Limited use of existing spare transformer capacity	Yes Maximises use of existing spare transformer capacity	No Inadequate use of existing spare transformer capacity
Network Safety – does not present future safety issues for operations and maintenance personnel or members of public	No Safety Issues	No Safety Issues	No Safety Issues

Table 11: Comparison of Options

6.5 Preferred Option

Option 1 - *Augment Liverpool and Homepride Zone Substations and Upgrade the 11kV CBD Distribution Network* will rectify immediate network constraints and will meet network and customer requirements for growth capacity for up to 13.5 years. Option 2 – *Establish Collimore Park Zone Substation* will rectify immediate network constraints and meet network customer requirements for growth capacity for up to 16.5 years. *Option 2* provides the foundation for the ultimate long term CBD solution for a CBD zone substation that would initially be established as a partial of the ultimate asset. Whilst this option does not make best use of existing installed transformer capacity at Liverpool Zone Substation or Homepride Zone Substation, it avoids the difficult augmentation process that is required in Option 1 to upgrade the distribution network to acceptable service standards and avoids the associated disruption to the general public, residences and businesses in and around the City Centre.

A comparison of the two options investigated in this report leads to the conclusion that whilst Option 2 ultimately provides the greatest potential increase in spare capacity to meet longer term CBD growth, Option 1 is the lowest cost solution at \$16.3 million and provides long term capacity for CBD growth. .

Emerging constraints thereafter would need to be addressed by either demand management and/or better utilisation of the existing asset(s) or by implementing another project such as Option 2 – *Collimore Park Zone Substation*.

Therefore Option 1 has been assessed to be the most appropriate solution to mitigate immediate network constraints and cater for short to medium term CBD growth requirements and is recommended as the preferred option.

All works associated with the preferred option will generally be in accordance with Substation Design Instruction SDI 501 “Network Configuration” which adopted elements of the System Development Special Report 067 “Network Parameters”. The proposed build option does slightly vary from SDI 501 to deliver a tailored solution for Liverpool. The move away from the originally proposed standard 6 section ringed switchboard configuration for a 70MVA substation has reduced the cost of this option by \$2.0 million.

7 Conclusion and Recommendation

Significant immediate and long-term network constraints have been identified for the Liverpool City Centre 11kV distribution network. Two build options to address this network constraint have been investigated, compared and evaluated. Load transfers, demand management and local generation were found to be unable to address the constraints identified due to the magnitude of existing constraints and forecast load growth on the CBD distribution feeder network.

A financial evaluation of the cost of build options has identified that Option 1 “*Augment Liverpool and Homepride Zone Substations and Upgrade the 11kV CBD Distribution Network*”, satisfies the Regulatory Test.

This Network Investment Report recommends the following:

1. Implementation of Build Option 1 – Stage 1 works commencing in 2014/15 at a cost of \$7.0 million plus contingency of \$0.9million to address immediate constraints on the CBD distribution network and provide growth capacity for the Liverpool City Centre.
2. Implementation of Build Option 1 – Stage 2 works (~2018) at nominal cost of \$9.3 million plus contingency of \$1.1 million. This stage will be subject to confirmation of network need by Asset & Network Planning Branch after the completion of Stage 1 and prior to Gate 3 approval.

The total capital expenditure for the staged approach of Build Option 1 (*Stage 1 + Stage 2*) is \$16.3 million plus a contingency amount of \$2.0 million and will provide capacity for long term growth in the Liverpool City Centre.

Screening For Non-Network Options

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Liverpool CBD Distribution Network

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Endeavour Energy

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May 2014

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 and Network Planning:

consultation@endeavourenergy.com.au

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1.0 INTRODUCTION

A review was conducted into the feasibility of a non-network option to reduce the peak summer demand on the Endeavour Energy Liverpool Central Business District (CBD) Distribution network. This network experiences capacity constraint issues on the 11 KV network during peak periods in summer, and an investigation has identified credible network options to address the constraint. In accordance with the National Electricity Rule 5.17.4, screening for non-network options was conducted.

The objective of a non-network option is to defer or avoid the augmentation of the Liverpool CBD 11 kV network required to address the capacity constraint during peak summer periods.

The screening test is to determine if a non-network option is feasible. If found to be feasible, a non-network options report will be issued to obtain submissions from non-network service providers and other interested parties as part of the consultation process.

2.0 NETWORK ISSUES

This section details the capacity constraints faced by the Liverpool CBD 11 kV network, the network options that have been identified to address the constraint and the demand reduction required from a non-network option to defer or avoid the network augmentation.

The Liverpool CBD distribution network supplied by the Liverpool Zone Substation and Homepride Zone Substation (ZS) has diminishing spare capacity across the various feeders of the Liverpool CBD. Liverpool ZS has 18 feeders, out of which 8 feeders supply the Liverpool CBD, and likewise, Homepride ZS has 18 feeders, out of which 10 feeders supply the Liverpool CBD. There are currently four feeders from Liverpool ZS, and four feeders from Homepride ZS that are overloaded or have no capacity. Load switching between feeders has already been attempted to its maximum level, and no further load switching can be performed between the existing feeders to relieve constrained 11kV feeders.

The predominant load type in the CBD is a mixture of small and large commercial customers, medium sized industrial customers along with residential sectors. The Industrial customers are primarily based to the east of Copeland Street,

2.1 FORECAST

Table 1 and 2 shows the demand forecast for Liverpool ZS and Homepride ZS. The forecast verifies that there is spare capacity at the zone substations level. The main issue is the 11kV feeder capacity to supply the future load connections. Liverpool ZS has a firm rating of 53.8 MVA, and Homepride ZS has a firm rating of 42 MVA

Table 1– Liverpool ZS Forecast

Summer	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Liverpool ZS	44.4	45.0	^43.9	44.6	45.2	45.9	46.6	47.5	48.4	49.3
Firm	53.8	53.8	53.8	53.8	53.8	53.8	53.8	53.8	53.8	53.8
Load Increase	0	0.6	~0.5	0.7	0.6	0.7	0.7	0.9	0.9	0.9

^ Includes load transfer to Anzac Village ZS
 ~excludes load transfer to Anzac Village ZS

Table 2 – Homepride ZS Forecast

Summer	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Homepride ZS	35.2	35.5	36.0	36.4	37.0	37.6	38.3	39.1	40.0	40.9
Firm	42	42	42	42	42	42	42	42	42	42
Load Increase	0	0.3	0.5	0.4	0.6	0.6	0.7	0.8	0.9	0.9

2.2 PLANNING LIMITATIONS

The distribution network is designed, constructed and augmented in accordance with company policies 9.2.1 Network Planning and 9.2.5 Network Design. These policies detail the conditions that drive network augmentation and construction. The main requirements that drive network augmentation is when:

- The 'Load at Risk' is to exist for more than 1% of the calendar year;
- The peak demand is greater than 120% of equipment thermal rating;
- 11kV feeder voltage regulation exceeding 3.5% in residential, industrial and commercial areas; and/or
- Voltage regulation on the secondary of the ZS and TS transformers to exceed tapping limits.
- Voltage drop on the 132kV network exceeds the 10% limit.
- 11KV Feeder design capacity not to be exceeded

Currently four feeders from the Liverpool ZS and four feeders from Homepride ZS, which supply the Liverpool CBD, are either at capacity, or have exceeded their load capacity. The majority of the growth load on both these substations are concentrated on these feeders, and further growth on these feeders are limited due to the capacity constraint.

2.3 NETWORK OPTIONS

The preferred network options include a variety of upgrade and augmentation work, as shown in

Table 3 – Network Options

Options	Project	Cost
Option 1 Stage 1	Upgrade affected Liverpool and Homepride feeders to provide spare capacity for up to 4 years	\$7.9m
Option 1 Stage 2	Augment Liverpool ZS and Homepride ZS, and Install additional 11kV CBD feeder network to provide spare capacity for up to 10 years.	\$10.4m
Option 2	Establish Collimore Park ZS, providing spare capacity for up to 16 years	\$29.1m

As the most expensive credible option is greater than \$5m a RIT-D screening for non-network options is to be conducted.

Asbestos Cement (AC) ducts may be encountered with Option 1-Stage 1 and Option 1-Stage 2, in which case the costs may increase. The preferred network option in the first stage is Option 1A followed by Option 1B in the second stage, after 4 years, as it provides security of supply to the Liverpool CBD for 14 years.

3.0 DEMAND MANAGEMENT PROGRAM DEVELOPMENT

3.1 DEMAND MANAGEMENT OBJECTIVE

The load growth is concentrated primarily in the Liverpool CBD area, which is mostly supplied by four Liverpool ZS feeders and four Homepride ZS feeder. The objective of a demand management program would be to reduce the peak demand on the over loaded feeders on both the Liverpool ZS and Homepride ZS, thus deferring the augmentation of the Feeders and Zone substations.

To be successful, a demand reduction of 2,100 kVA on the four constrained Liverpool feeders and 1,700 KVA on the four constrained Homepride Feeders is required to remove the current 11kV feeder capacity limitation. The demand reduction required includes the load applications received for CBD development.

Table 4 – Demand Reduction Required

Feeder Circuit Breaker / Name	Design Capacity Amps / KVA	Current Feeder Load Amps / KVA	*Forecast Feeder Load Amps / kVA	Immediate load reduction required KVA	~Load Reduction For Forecast	^Required Demand reduction KVA	Major Customers load on feeder	Total Major customer load/feeder KVA	#Percentage reduction required
Liverpool Zone Sub									
D819 Speed St^	142 / 2,700	70 / 1,300	142 / 2,700	0	0	0	1	125	0%
D820 Mill St	155 / 3,000	180 / 3,400	180 / 3,400	400	0	400	2	574	69.7%
D826 Serviceway^	142 / 2,700	116 / 2,200	160 / 3,000	0	300	300	4	1,069	28%
D827 Pirie St^	155 / 3,000	206 / 3,900	230 / 4,400	900	500	1,400	5	1,403	99.7%
Total	11,400 KVA	10,800 KVA	13,500 KVA	1,300 KVA	800 KVA	2,100 KVA	12	3,171 KVA	66%
Homepride Zone Sub									
A318 Bigge St^	160 / 3,000	110 / 2,100	186 / 3,500	0	500	500	5	802	62.5%
A315 El Toro Industrial^	176 / 3,400	150 / 2,900	176 / 3,400	0	0	0	4	829	0%
A325 Copeland St^	140 / 2,700	130 / 2,500	202 / 3,800	0	1,100	1,100	2	212	>100%
35443 Tindall Ave^	240 / 4,700	220 / 4,200	253 / 4,800	0	100	100	1	465	21.5%
Total	13,800 KVA	11,700 KVA	16,100 KVA	0 KVA	1,700 KVA	1,700 KVA	12	2,308 KVA	73.6%

* Forecast feeder load includes load applications which will be processed in two years (by 2016)

~ The load reduction for Forecast takes into account the applications received, which take 18 to 24 months to process.

^ Feeders experiencing majority of CBD development, and the required demand reduction is based on feeder limitations and growth capacity for each of the constraint feeders, to achieve a two year deferral. This does not take into account the load applications which may be received in the future.

Percentage is based on dividing the Required Demand reduction by the Major Customer load, to achieve a two year deferral.

3.2 CUSTOMER REVIEW

There are 12 large business customers in the Liverpool ZS area, with a total demand in the order of 3,171 KVA, and further 12 large business customers in the Homepride ZS area, with a total demand in the order of 2,308 KVA. The remaining customer base is made up of small commercial businesses and high density residential load.

The high density residential sector has many newly constructed multi story units which contains mainly gas water heating. Energy Efficiency standards have been incorporated into the design of the building.

The small commercial business sector is predominantly street lined shops. Implementing demand reducing initiatives in this sector is challenging and has not delivered significant demand reduction in the past. These customers are predominantly on general supply energy only tariffs and have little incentive to reduce demand.

3.3 LOAD REDUCTION POTENTIAL

Previous demand management programs have delivered demand reductions of between 10% to 20% from large industrial / commercial customers that have received an energy audit. The large customer load in the Liverpool ZS area is 3,171 KVA. Using an average figure of 15%, a demand reduction of about 476 KVA can be expected in the Liverpool ZS area from the industrial/commercial customer sector.

The large customer load in the Homepride ZS area is 2,308 KVA and using an average figure of 15% a demand reduction of about 346 KVA can be expected in the Homepride ZS area from the Industrial/commercial customer sector.

The residential sector contains approximately 4,813 customers on the affected 11kV feeders in the Liverpool ZS and Homepride ZS areas. This consists of around 1,878 customers who are connected to the affected Liverpool ZS feeders, and a further 2,935 customers connected to the affected Homepride ZS feeders. Statistics from the *PeakSaver* and *CoolSaver* programs from the Rooty Hill DM Program indicate that a take-up rate of 4% can be expected with an average reduction level of 1.7 kVA per customer. Table 5 below shows the total expected demand reduction within the affected Liverpool and Homepride ZS supply area.

Table 5 – Potential Demand Reduction – All Sectors

Area	Customers / Loads	Take-up Rate / Conversion Rate	Demand Reduction (kVA)
Residential	4,813 customers	4% @ 1.7 kVA	327
Industrial / Commercial (Liverpool ZS)	3,171 KVA	15%	471
Industrial / Commercial (Homepride ZS)	2,308 KVA	15%	346
Total			1,144

An estimated potential demand reduction of 1,144 KVA exists in the Liverpool ZS and Homepride ZS areas. This falls short of the 3,800 KVA required (2,100 KVA required from the affected Liverpool ZS feeders and 1,700 KVA from the affected Homepride ZS feeders).

The load profiles of all the feeders are flat, with the peak starting at around 10am and lasting till 5pm, and any demand reduction would need to occur during this time, to be effective. The demand reduction does not consider any embedded generation options however, considering the level of demand reduction required it would be difficult to achieve this, as demand reduction needs to be spread over eight 11KV feeders.

The low demand reduction available is due to the fact that the load constraint is confined to specific feeders of the Liverpool and Homepride Zone Substations. This reduces the number of potential customers who can be approached for load reduction.

A demand management program in the Liverpool CBD was operated from June 2006 to March 2011. A total of 6.2 MVA demand reduction was implemented, all of which was permanent (no temporary load curtailment). This program covered a much larger supply area and included the industrial sector. Many cost effective demand reducing initiatives have already been identified and implemented. Hence, further cost effective demand reducing initiatives would be harder to implement.

4.0 FINANCIAL EVALUATION

The process for screening for non-network options involves three distinct evaluation phases:

- Technical feasibility: To determine if the demand reduction required to defer the network option for at least one year is achievable within the load type being supplied;
- Financial feasibility: To determine if the savings obtained by deferring the network project (Avoided Distribution Cost) is sufficient to incentivise the customer base to participate in demand reducing initiatives that is, the non-network option can be implemented at a lower cost than the network option; and
- Timeliness: The non-network option can be implemented in sufficient time.

As the screening identified that a demand management option is not technically feasible the financial evaluation for the program was not conducted.

5.0 CONCLUSION

The investigation into the demand reduction potential found that approximately 1,144 KVA demand reduction is possible in the Liverpool ZS and Homepride ZS areas. This falls far short of the required 3,800 KVA reduction to achieve a two year deferral. In the case of a one year deferral, a demand reduction of 2,550 kVA would be required (1,300 kVA from Liverpool feeders to overcome immediate constraints and half of the forecast load, which is 400kVA and 850kVA for Liverpool and Homepride feeders respectively).

A demand management program is not technically feasible as there is insufficient opportunity in the existing customer base to achieve the required level of demand reduction. No further investigations were conducted.

6.0 RECOMMENDATION

It is recommended not to proceed with further investigations of a non-network option to overcome the Liverpool ZS and Homepride ZS feeder constraint as there is insufficient available demand reduction to defer the preferred network option.