Jemena Electricity Networks (Vic) Ltd

2016-20 Electricity Distribution Price Review Regulatory Proposal

Revocation and substitution submission

Attachment 7-12 Addendum to the Sunbury network development strategy

Public

6 January 2016

Jemena Electricity Networks (Vic) Ltd

Sunbury - Diggers Rest Growth Corridor

Network Development Strategy (Addendum)

ELE PL 0030 (A)

Internal

30 December 2015

An appropriate citation for this paper is:

Sunbury - Diggers Rest Growth Corridor

Authorisation

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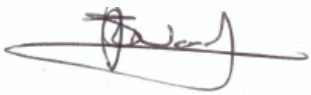
Sean Ward	General Manager Asset Investment and Major Projects	December 2015	

History

Rev No	Date	Description of changes	Author
1	30/12/2015	Initial document	Manoj Ghimire

Owning Functional Area

Business Function Owner:	Network Capacity Planning & Assessment

Review Details

Review Period:	None
NEXT Review Due:	N/A

EXECUTIVE SUMMARY

JEN's Electricity Distribution Price Review 2016-20 (EDPR 2016-20) regulatory proposal submitted on 30 April 2015 included $9.91 million (direct un-escalated $2015) of augmentation capital expenditure (augex) for the Sunbury zone substation upgrade.

This document serves as an addendum to the Sunbury-Diggers Rest Network Development Strategy[1] and seeks to address the AER's concerns with the Sunbury redevelopment included in their preliminary decision (October 2015). It also presents a more detailed options analysis conducted by an independent consultant, but concludes that the preferred option remains unchanged, and that $9.91 million (direct un-escalated $2015) of augex is required to maximise net market benefits to customers.

Augmentation Need

The primary investment drivers for the Sunbury zone substation (SBY) capacity constraint are forecast demand increase and maintaining zone substation supply reliability. The capacity of SBY is provided by two 10/16 MVA 66/22 kV transformers and one 10 MVA 66/22 kV transformer. The overall station transformers' normal rating (i.e. N rating) is effectively 32 MVA, instead of 42 MVA, due to the uneven load sharing of the three transformers. The 10 MVA transformer reaches its limit before the other two transformers are fully utilised.

SBY was originally developed in 1964, and it was built with a basic and cost effective switching arrangement that was appropriate for the small and remotely located load that it originally supplied. The site was designed using outdoor switchgear with transformers in a single switching zone, which is prone to faults within the zone substation (e.g. caused by wildlife contact). Most faults within the zone substation will result in a supply interruption to all customers supplied from SBY.

The justification for the upgrade was provided via the document titled ELE PL 0030 Sunbury-Diggers Rest Growth Corridor Network Development Strategy. That document presented Jemena's long term supply requirements for the Sunbury-Diggers Rest area, and outlined the proposed network development plan that will maximise the net market benefits to customers in the SBY supply area.

Detailed Options Analysis

The AER's preliminary decision (October 2015) allowed only $1.3 million capex to augment SBY by upgrading the 10 MVA transformer. The original document did not include the option of upgrading the 10 MVA transformer and ignoring the station supply reliability issue. This additional option has now been included in the analysis conducted by the independent consultant at an estimated cost of $2.95 million (direct un-escalated $2015).

JEN engaged WSP Parsons Brinckerhoff (WSPPB) to provide an independent technical and economic assessment of the proposal to upgrade SBY. The detailed analysis conducted by WSPPB included 21 different augmentation options, and calculated the net present value (NPV) of the net market benefits, considering:

- Unserved energy (USE) as a result of the capacity constraint with forecast increasing demand;
- USE as a result of faults and asset failures within the zone substation; and
- Whole of asset life cycle costs as a result of future replacements.

[1] ELE PL 0030 Sunbury-Diggers Rest growth corridor network development strategy. Submitted as an augex supporting document with JEN's April 2015 proposal

The four main credible network options identified by WSPPB[2] were:

- Option 2D - Upgrade Transformer No. 2 with protection in situ, 66 and 22kV segmentation
- Option 4A - Upgrade Transformer No. 2 with new protection in new control room
- Option 4D - Upgrade Transformer No. 2 with new protection in new control room, 66 segmentation and 22kV segmentation (partly indoor)
- Option 4E - Upgrade Transformer No. 2 with new protection in new control room, 66kV segmentation and 22kV segmentation (indoor).

Preferred Option

WSPPB's market benefit analysis of the options clearly shows that the greatest benefit will be realised by replacing the 10 MVA transformer with a new 20/33MVA and undertaking segmentation works on both the 66kV and 22kV (Option 4E). This option has a net present value (NPV) of $589 million, with an augmentation cost of $9.91 million (direct un-escalated $2015). The customer benefit in terms of avoided cost of expected unserved energy greatly exceeds the net cost of the preferred option showing that the works should be undertaken as soon as practical to realise these benefits.

[2] Sunbury Project - WSPPB Independent Assessment (December 2015) P-13

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GLOSSARY

Amperes (A)	Refers to a unit of measurement for the current flowing through an electrical circuit. Also referred to as Amps.
Constraint	Refers to a constraint on network power transfers that affects customer service.
Continuous rating	The permissible maximum demand to which a conductor or cable may be loaded on a continuous basis.
Jemena Electricity Networks (JEN)	One of five licensed electricity distribution networks in Victoria, the JEN is 100% owned by Jemena and services over 320,000 customers via an 11,000 kilometre distribution system covering north-west greater Melbourne.
Maximum demand (MD)	The highest amount of electrical power delivered (or forecast to be delivered) for a particular season (summer and/or winter) and year.
Megavolt ampere (MVA)	Refers to a unit of measurement for the apparent power in an electrical circuit. Also million volt-amperes.
Network	Refers to the physical assets required to transfer electricity to customers.
Network augmentation	An investment that increases network capacity to prudently and efficiently manage customer service levels and power quality requirements. Augmentation usually results from growing customer demand.
Network capacity	Refers to the network's ability to transfer electricity to customers.
Non-network alternative	An alternative solution to growing customer demand, which does not involve augmenting physical network assets.
Planning criteria	The methodologies, inputs and assumptions that must be followed when undertaking technical and economic analysis to predict emerging power transfer limitations.
Probability of exceedance (POE)	The likelihood that a given level of maximum demand forecast will be met or exceeded in any given year:
Regulatory Investment Test for Distribution (RIT-D)	A test established and amended by the Australian Energy Regulator (AER) that establishes consistent, clear and efficient planning processes for distribution network investments over a certain limit ($5m), in the National Electricity Market (NEM).
Reliability of supply	The measure of the ability of the distribution system to provide supply to customers.
10% POE condition (summer)	Refers to an average daily ambient temperature of 32.9ºC derived by NIEIR and adopted by JEN, with a typical maximum ambient temperature of 42ºC and an overnight ambient temperature of 23.8ºC.
50% POE condition (summer)	Refers to an average daily ambient temperature of 29.4ºC derived by NIEIR and adopted by JEN, with a typical maximum ambient temperature of 38.0ºC and an overnight ambient temperature of 20.8ºC.
50% POE and 10% POE condition (winter)	50% POE and 10% POE condition (winter) are treated the same, referring to an average daily ambient temperature of 7ºC, with a typical maximum ambient temperature of 10ºC and an overnight ambient temperature of 4ºC.

ABBREVIATIONS

AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
COO	Coolaroo Zone Substation
DPTS	Deer Park Terminal Station
GSB	Gisborne Zone Substation (Powercor owned)
JEN	Jemena Electricity Network
KTS	Keilor Terminal Station
MD	Maximum Demand
MPA	Metropolitan Planning Authority
MLN	Melton Zone Substation (Powercor owned)
NEM	National Electricity Market
POE	Probability of Exceedance
RIT-D	Regulatory Investment Test for Distribution
SA	St. Albans Zone Substation (Powercor owned)
SBY	Sunbury Zone Substation
SHM	Sydenham Zone Substation
STPIS	Service Target Performance Incentive Scheme
TTS	Thomastown Terminal Station
VCR	Value of Customer Reliability
WND	Woodend Zone Substation (Powercor owned)

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1. INTRODUCTION

This document is an addendum to the document ELE PL 0030 Sunbury-Diggers Rest Growth Corridor Network Development Strategy, dated 23 December 2014, which was submitted as an augex supporting document in JEN's April 2015 proposal. It clarifies the justification of proposed Sunbury zone substation (SBY) upgrade project, and provides JEN's response to the AER's preliminary decision dated 29 October 2015.

1.1 BACKGROUND

JEN's April 2015 proposal included $9.91 million (direct un-escalated $2015) of augmentation capital expenditure (augex) for the Sunbury zone substation (SBY) upgrade.

The Sunbury and Diggers Rest area is located within the Victorian Government's urban growth boundary, and the Metropolitan Planning Authority is currently preparing five Precinct Structure Plans for development of the areas surrounding the Sunbury CBD. In August 2010, changes to the Urban Growth Boundary (UGB) released 2,270 hectares for potential development around Sunbury. This could result in a total population in Sunbury of approximately 100,000 over the next 30 years. The number of dwellings in the area is expected to increase from the present number of approximately 14,500 to up to 35,000 by the year 2030[3].

As part of this development, Sunbury and Diggers Rest would join to become one settlement, with Sunbury to the north east and the smaller Diggers Rest to the south-west. With these developments expected to lead to population growth in the area, maximum demand is expected to grow at a rate of 3% over the next 10 years. Appendix A contains the 2015 load demand forecasts for the Sunbury supply area.

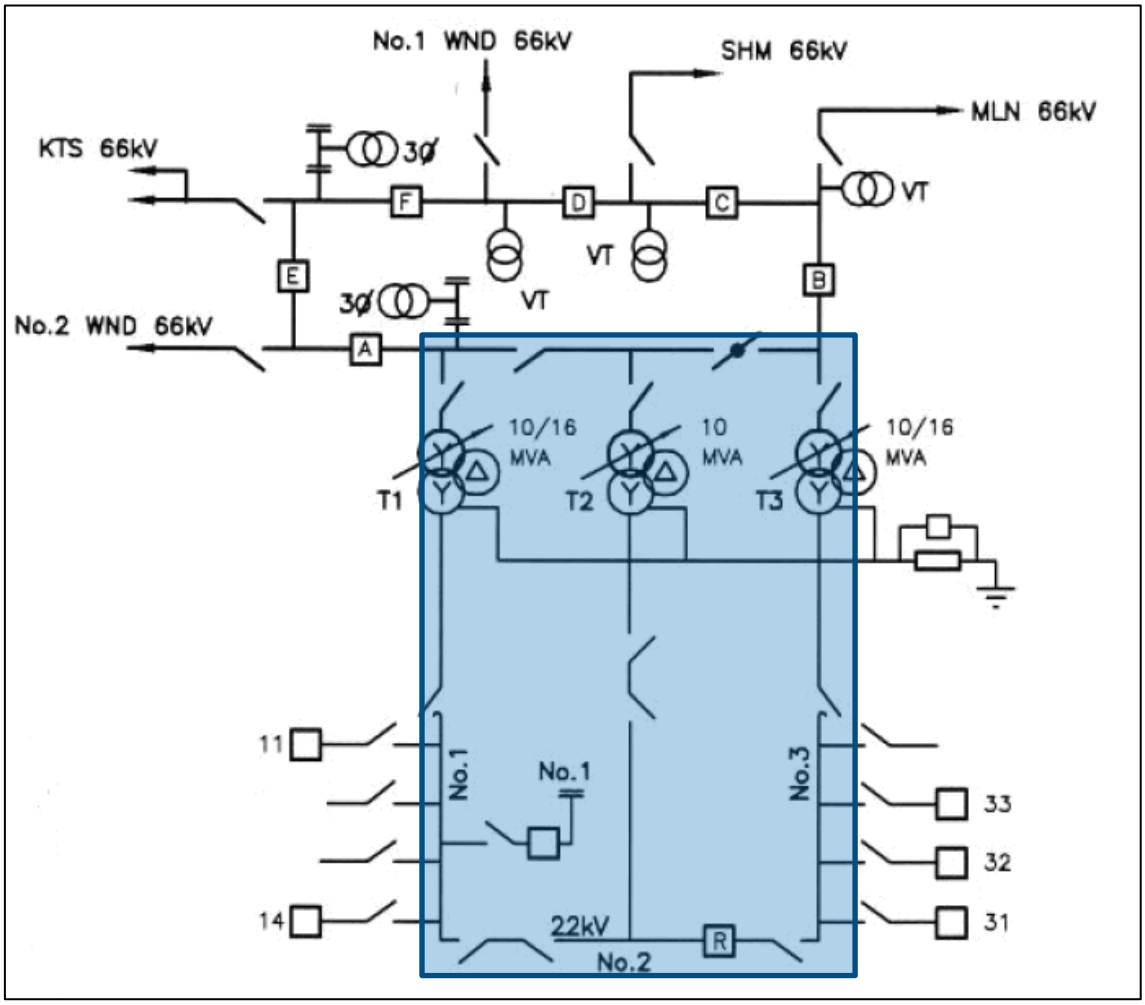
Currently the Sunbury zone substation (SBY) supplies over 15,100 customers with two 10/16 MVA 66/22 kV transformers and one 10 MVA 66/22 kV transformer. The overall station transformers' normal rating (i.e. N rating) is effectively 32 MVA, instead of 42 MVA, due to the uneven load sharing of the three transformers. The 10 MVA transformer reaches its limit first before the other two transformers are fully utilised.

Since summer 2012/13, load transfers to nearby Sydenham zone substation (SHM) and Coolaroo zone substation (COO) have occurred to manage the imminent overload under system normal condition. Load transfer under system normal conditions is only used as a temporary relief rather than a permanent solution, as this places additional risks on the adjacent zone substations and feeders where the transfer was made. From 2018 onwards, there will be insufficient capacity at SBY, including load transfers to SHM and COO, to supply the forecast summer maximum demand.

When the station was originally developed, in 1964, it was built with a basic and cost effective switching arrangement that was appropriate for the small and remotely located load that it originally supplied. The site was designed using 22kV outdoor switchgear which is prone to faults caused by wildlife contact, lightning, or other external influences. All three transformers are in a single switching zone, meaning there are no 66kV and 22kV transformer circuit breakers to switch within substation faults. Any fault within the station will result in a supply interruption to all customers supplied from SBY. The present arrangement at SBY is shown in the single line diagram below, Figure 1-1, with the single switching zone for the transformers highlighted.

[3] "Growth Corridor Plans – Managing Melbourne's Growth" Growth Area Authority, November 2011

Figure 1–1: Existing Sunbury Zone Substation (SBY) Single Line Diagram



1.2 PROPOSED PREFERRED OPTION (APRIL 2015)

Options to alleviate emerging constraints at SBY are analysed in the document ELE PL 0030 Sunbury-Diggers Rest Growth Corridor Network Development Strategy, with the focus on the long term development plans for the area.

The preferred and recommended option identified was to redevelop and augment SBY by November 2018 which maximizes the net market benefit compared to other options. This option has net market benefits of $364 million, with an augmentation cost of $9.91 million (direct un-escalated $2015). The market benefits forecast to be delivered by the preferred solution are predominately driven by a reduction in the amount of expected unserved energy over the assessment period.

2. RESPONSE TO AER PRELIMINARY DECISION

This section provides JEN's response to the AER's preliminary decision (October 2015) statements on the Sunbury zone substation upgrade project (Attachment 6-Capital expenditure | Jemena Preliminary decision 2016-20, P.6-46 to P.6-49).

AER Statement 1 - We have included $1.3 million capex for a new transformer in our alternative estimate which reflects the prudent and efficient amount for Jemena to meet expected demand growth in the Sunbury-Diggers Rest area of Jemena's network. We have not included the remaining capex to rebuild the substation in our alternative augex estimate because it is primarily driven by age condition of some assets and reliability concerns. Based on our review of Jemena's supporting information, we are not satisfied that this capex is necessary to maintain network reliability, security or safety in accordance with the capex objectives of the NER.

In the AER's preliminary determination, it has broadly accepted JEN's proposal to augment the Sunbury zone substation to meet expected demand growth in the Sunbury-Diggers Rest area. However, the AER has only included $1.3 million of capex for a new transformer in its alternative estimate. JEN is concerned that the AER selected $1.3 million as the quantum of required augex based on JEN's response to an AER query[4] which included a cost breakdown of preferred option.

JEN takes this opportunity to clarify that the cost allocated to each of the eight items in Table 2.2 of its response are not the stand-alone project cost to implement each component, as they appear to have been perceived to be. The cost provided for the component 'Replace 10 MVA transformer with a new 20/33MVA transformer' does not include any labour, design, construction management and other costs to fully install a new transformer at SBY. The full cost of this stand-alone project option is estimated as $2.95 million (direct un-escalated $2015), with component breakdown outlined in Table 2-1.

Table 2–1: Cost to replace 10 MVA transformer

Item	Cost (direct un-escalated real $2015)
Replace existing 10 MVA transformer with new 20/33MVA	$1,307,401
Uprate 66kV Bus	$787,166
Installation and civil works	$229,035
Protection, SCADA and Comms in existing panel	$266,685
Control building asbestos control	$200,000
Design and PM	$163,499
Total	**$2,953,785**

In addition, JEN reaffirms that the following network constraints will not be alleviated by implementing the AER's recommendation of just replacing the 10 MVA transformer in SBY.

1. Reliability will not be maintained: Currently all three transformers are in a single switching zone, meaning there are no 66kV and 22kV circuit breakers (CBs) to isolate fault zones. Any fault within the station will result in a supply interruption to all customers supplied from SBY. There have been 17 times in past 20 years when all customer load at the substation has been lost due to faults within the station. For the standard switching arrangement, typical at other JEN substations, single contingency events do

[4] JEN response to AER information request AER IR#016.1 P-5 Table 2.2 dated 19 August 2015

not result in loss the entire station. The reliability impacts of a station outage at SBY will increase in proportion to the forecast demand increaseand corresponding higher utilisation of network assets.

2. Unsustainable health and safety risk: In order to de-energise and re-energise the transformers and/or associated 66 kV and 22 kV buses, the gang operated isolating switches need to be physically operated on site because there are no 66 kV bus ties CBs, transformer 22 kV CBs or 22 kV bus tie CBs. This poses an unsustainable safety risk to field operators because they operate the isolating switches manually in a live switchyard. This is inconsistent with JEN's standards and good engineering industry practice. In typical standard JEN zone substations there are always 66 kV bus-tie CBs, transformer 22 kV CBs and 22 kV bus-tie CBs to make and break the load currents. Also, the existing control building is asbestos clad and has no room for new cubicles.

3. Unsustainable Environmental risk: To capture small oil leaks through the transformer bunding, JEN standards require the installation of an oil and water separation pit called Humeceptor pit. Currently SBY zone substation does not have any Humeceptor pit which poses safety risks to JEN personnel working in contaminated soil as well as environmental risk to the zone substation surrounding area.

4. Inadequate 66kV and 22kV bus rating: The existing 66 kV bus is rated at only 56 MVA and is a strung bus made with flexible conductors. With increased customer load and a higher capacity transformer installation, the 66 kV bus needs to be uprated. The current Jemena standard for 66 kV bus is 142.8 MVA with tubular bus arrangement. Also, part of the 22 kV bus is rated at only 16 MVA. With the increased customer load and higher capacity transformer installation, the 22KV bus rating is insufficient. The current Jemena standard 22 kV bus rating is 47.6 MVA.

5. Unacceptable load at risk during construction: To only replace the 10 MVA transformer as per the AER's recommendation, the existing 10 MVA transformer would need to be removed, before the start of the work. Given the high load on the substation, there would be unacceptably high load at risk once the 10 MVA transformer is taken out of service until the new transformer is installed. Managing the load at risk during the construction period would be difficult as there is insufficient load transfer available and the construction time window without the risk of load shedding would be much shorter.

Collectively, the risks above identify that the alternative technical solution implied within the preliminary decision (to replace the 10 MVA transformer only) will not address the reliability risks and therefore does not satisfy the capex objectives. This is further supported in WSPPB's independent review of the Sunbury development strategy at Attachment 7-11 of JEN's submission.

AER Statement 2 - Unlike its augmentation assessments, Jemena did not present details of the impact on customers from further outages in terms of the value of expected unserved energy. Rather, Jemena's analysis appears to be qualitative in nature and places no probability of the likelihood of further outages and the cost to consumers. This makes it difficult to determine whether the proposed cost to rebuild the substation is less than the cost to consumers from not proceeding.

JEN did not present details of the impact on customers from within station outages because the present value of expected unserved energy due to insufficient station capacity is so high that it overshadows the expected unserved energy due to station faults.

The cost of unserved energy under the 'do nothing' scenario resulting from capacity constraints and within station faults is presented in Table 2-2. It should be noted that the impact on customers, cost of unserved energy due to faults within the station, will not be alleviated by the AER's recommended option of just replacing the 10MVA transformer.

Table 2–2: Cost of unserved energy under do nothing scenario

Year	Cost of unserved energy – station capacity related ($k)	Cost of unserved energy – station fault related ($k)	Total cost of unserved energy ($k)
2015	$6	$476	$482
2016	$604	$503	$1,107
2017	$1,191	$513	$1,704
2018	$2,825	$529	$3,354
2019	$6,202	$545	$6,747
2020	$13,240	$565	$13,805
2021	$30,815	$583	$31,398
2022	$57,027	$597	$57,624
2023	$101,732	$618	$102,350
2024	$141,985	$640	$142,625
2025	$188,890	$661	$189,551

Assumptions:

- VCR - $38,950 / MWh
- To evaluate the cost of unserved energy due to faults within station,
  - the probability of loss of the whole station due to real faults is 0.0097%, based on one fault every 1.17 years (historical records show 17 faults in past 20 years) and an average supply restoration time of 1 hour;
  - load factor of 0.39 (2014 actual);
  - 50POE maximum demand forecasts.

As can be seen in Table 2.2 that the cost of unserved energy posed by the faults within the station and an increasing demand on Sunbury zone substation means that it is prudent to augment and redevelop the station as per the proposed preferred option.

In WSPPB's net present value (NPV) analysis of the options, it has included the cost of unserved energy posed by the station faults within the station.

AER Statement 3 - Similarly, while several of the assets may be aging, Jemena has not provided evidence that the assets need to be immediately replaced in the 2016–20 period (including in addition to the capex that is proposed within its repex forecast). This is because Jemena has not established that replacing these assets is necessary to maintain network reliability, security, safety or quality to satisfy the capex objectives.

There is need to replace some of the aged circuit breakers, particularly two 66kV CBs and two 22kV CBs which are no longer supported by the manufacture[5]. The details of these CBs are presented in Table 2-3.

Table 2–3: Aged Circuit Breakers detail at SBY

Circuit Breaker (CB) type	No. of CBs	Age (years)	CB Health Index forecast (derived from CBRM)		
			Now	2021	2025
ASEA HLE 66kV outdoor	2	51	5.5	7.36	8.38
AEI type JB424, 22kV outdoor	1	46	6.05	7.51	8.68
Reyrolle type OMT, 22kV outdoor	1	46	6.05	7.51	8.68

As can be seen from Table 2-3, all four CBs are beyond their regulatory life of 45 years and the forecast high value health index (>7) in 2021 represents serious deterioration; i.e advanced degradation process reaching the point that they actually threaten failure. In this condition the probability of failure is significantly raised and the rate of further degradation will be relatively rapid[6].

JEN confirms that these replacement works are not included in the business as usual repex in our April 2015 proposal. JEN has planned to advance these replacements to coincide with the major capital project at SBY with the view that the synergies in design and construction for the major capital project and renewal of these aging assets provide cost savings compared to doing the work in piecemeal manner. These efficiencies are considered in WSPPB's net market benefit assessments

AER Statement 4 - Most of the outdoor 22 kV circuit breakers that Jemena proposed to replace were replaced in 2000 and are not reaching the end of their life.

JEN agrees with the AER's statement that the four existing outdoor 22kV circuit breakers (4 Crompton Greaves – 30-SFGP-25A 22kV CBs) that JEN proposed to replace were replaced in 2000 and are not reaching the end of their life.

However, there have been ongoing issues with these CBs installed at zone substations Airport West (AW), Coburg North (CN), Sunbury (SBY) and Yarraville (YVE). Gas leaks were found in one CB at SBY and one CB at YVE; both of these CBs had all three poles replaced with refurbished poles. In March 2014, while doing corrective maintenance on the AW No. 4 22kV transformer CB, the shock absorber was found to have been dislodged. Further investigation found a gas leak from one of the poles of the CB. All three poles were replaced with refurbished poles and the CB was put back in service.

In WSPPB's net present value analysis of the options it has included the terminal values of these CBs with the assumption of their two-thirds life will be left if they are replaced in 2018.

[5] JEN PL 0039 Zone Substation Circuit Breaker Asset class strategy P.18, P.19

[6] JEN PL 0039 Zone Substation Circuit Breaker Asset class strategy P.17

3. OPTIONS ANALYSIS

JEN engaged WSP Parsons Brinckerhoff (WSPPB) to provide an independent assessment of JEN's proposal to upgrade the Sunbury zone substation (SBY).

WSPPB developed 21 augmentation options in its independent review. Out of these options WSPPB identified four credible options ('do-nothing' option is the base case) to alleviate emerging network constraints at SBY. The summary of the net market benefit analysis of the four options is reproduced in Table 3.1.

Table 3–1: Summary of WSPPB identified viable options and economic analysis

OPTION	NP CAPEX COST ($M, 2015)	NPC ($M, 2015 DIRECT)	NPV ($M, 2015)	RANK
Option 1 - Do-Nothing	$(0.65)	$(605.22)	$-	-
Option 2D - Upgrade Transformer No.2 with protection in situ, 66 and 22kV segmentation	$(3.56)	$(19.65)	$585.57	3
Option 4A - Upgrade Transformer No.2 with new protection in new control room	$(4.00)	$(20.71)	$584.51	4
Option 4D - Upgrade Transformer No.2 with new protection in new control room, 66 segmentation and 22kV segmentation (partly indoor)	$(7.93)	$(19.31)	$585.91	2
Option 4E - Upgrade Transformer No.2 with new protection in new control room, 66 segmentation and 22kV segmentation (indoor)	$(8.43)	$(16.16)	$589.06	1

WSPPB's market benefit analysis of the options clearly shows that the greatest benefit will be realised by replacing the 10MVA transformer with a new 20/33MVA and undertaking segmentation works on both the 66kV and 22kV (Option 4E). This option has a net present value (NPV) of $589.06 million consisting of $8.43 million of present value of costs.

This option is consistent with the preferred option in JEN's original proposal submitted in April 2015.

4. PREFERRED OPTION AND CONCLUSION

In line with WSPPB's independent review outcome, JEN's preferred and recommended strategy is to augment and redevelop the Sunbury Zone Substation (SBY). This option has a net present value (NPV) of $589 million, with an augmentation cost of $9.91 million (direct un-escalated $2015).

The customer benefit in terms of avoided cost of expected unserved energy greatly exceeds the net cost of the preferred option showing that the works should be undertaken as soon as practical to realise these benefits.

This analysis has reaffirmed that JEN's proposal presented in the Sunbury - Diggers Rest Network Development Strategy to augment and redevelop the station is the most prudent and efficient option. By implementing this option by 2018, JEN will be able to maintain network reliability, security, safety and quality of the supply in SBY supply area to satisfy the capex objectives.

APPENDIX A: LOAD DEMAND FORECAST FOR SUNBURY

SBY Zone Substation is a summer critical station. It has system normal N rating of 32 MVA and summer N-1 cyclic rating of 26.4 MVA

Table APP A-1 presents SBY Zone Substations actual maximum demand for summer 2015, and the summer and winter 50% POE and 10%POE maximum demand forecast from winter 2015 through to 2025.

Table APP A–1: SBY load demand forecast

Name	S/W	Actual (Summer 2015) & Forecast (from Winter 2015) Maximum Demand (MVA)										
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
SBY	Summer (50% POE)	36.5	38.9	39.6	40.9	42.2	43.7	45.2	46.2	48.0	49.7	51.3
	Winter (50%POE)	33.1	33.7	34.7	36.0	37.4	38.9	40.4	41.5	43.2	45.0	46.9
	Summer (10% POE)	36.5	42.8	43.7	45.1	46.7	48.2	50.0	51.3	53.0	55.2	56.9
	Winter (10%POE)	33.9	34.5	35.5	36.7	38.3	39.7	41.3	42.4	44.2	46.1	48.1

Figure APP A-1 presents 2014 and 2015 summer demand forecasts for SBY compared to the station's capacity. It shows that, under 50% POE and 10% POE summer maximum demand conditions, the substation loading already exceeds its system normal rating, and its N-1 cyclic rating. In addition, 2015 maximum demand forecasts are higher than 2014 forecast numbers showing the zone substation upgrade works should be undertaken as soon as practical.

Figure APP A–1: SBY summer load demand forecast