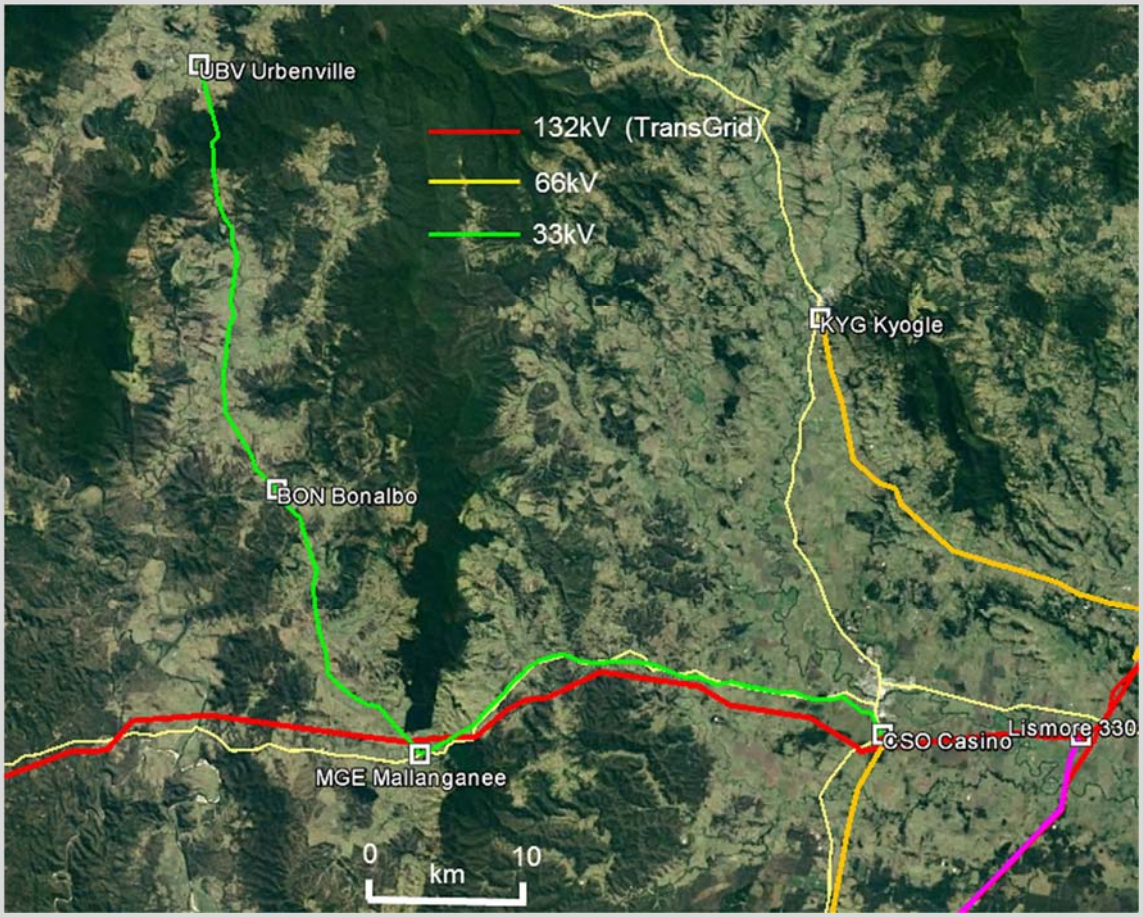
Supporting Document 12.1.15d
Major Project Report
Detailed Options

ESS_4022 Casino – Augment supply to Urbenville



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1. Executive Summary

Major Project	ESS_4022 Casino – Augment supply to Urbenville
Description	Replace aged copper conductor that has reached end of serveciable life
Drivers for Investment	Poor asset condition Providing and maintaining a reliable and safe 33kV network
Investment Options	The investment options considered include: Staged Reconductor (Stage 1 - 15km Stage 2 - 21km) Full Reconductor (36km) Backup Diesel Generation
Estimated Expenditure $million (Real FY19)	2019/20: $0 2020/21: $0 2021/22: $1.6 2022/23: $0 2023/24: $0
	The timing of this project is contingent on the progress of the development

2. Overview

The Casino to Mallanganee 33kV feeder (36km) is the first section of a radial 33kV network that supplies three 33/11kV zone substations (Bonalbo, Mallanganee and Urbenville) as shown below in Figure 1.

The copper conductor on this feeder has reached end of serviceable life and is subject to regular failure, resulting in poor reliability for customers and an increasing public safety risk.

This Major Project report investigates options to alleviate the risks associated with conductor failure; loss of supply (poor reliability), injury/fatality, bush fire ignition and damage to public property.

The preferred option to alleviate risk is to reconductor the 15km section of the line which traverses the higher areas towards Mallanganee as Stage 1. The remaining 21km section towards Casino would be reconductored in a second stage in year 2021/22.

3. Network / Asset Condition

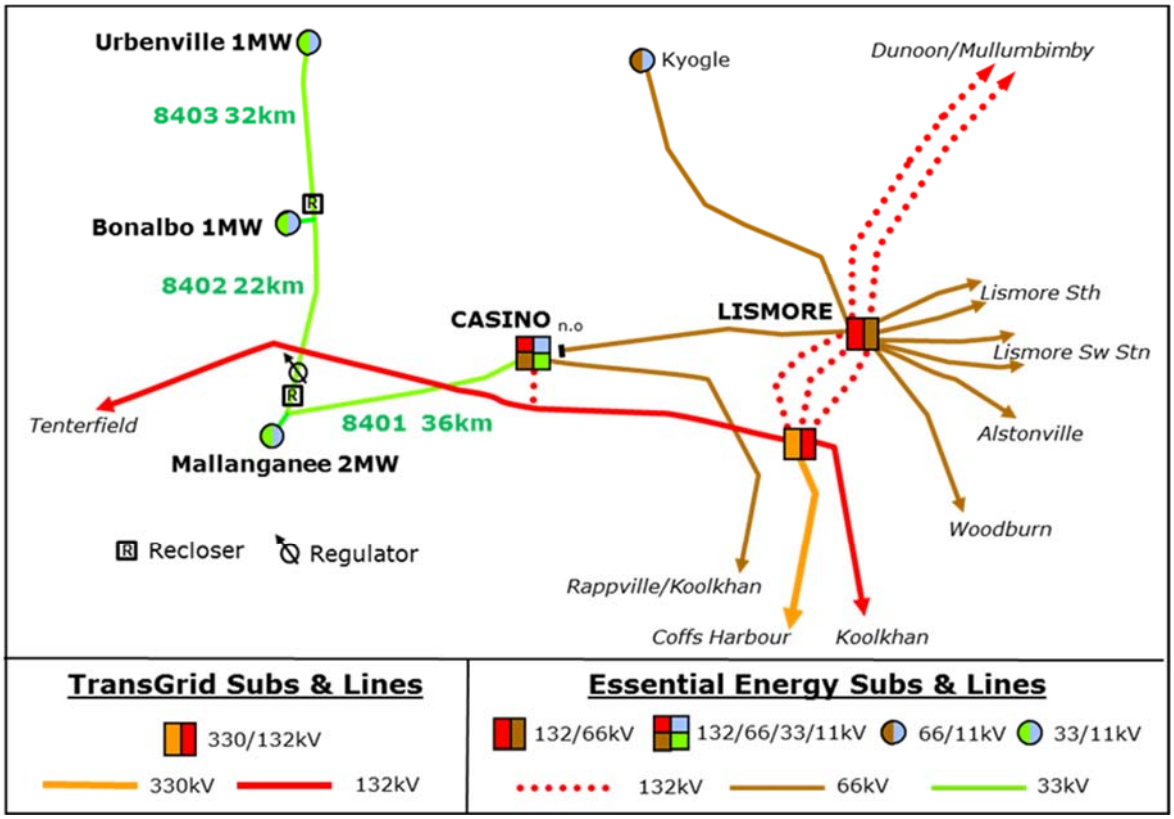


Figure 1 Casino – Urbenville 33kV network

The Casino – Mallanganee 33kV feeder was constructed in 1950, consisting of 239 spans with single pole, predominantly delta pin pole top construction and 7/.080 copper conductor. It has 11kV underslung for the entire length, except for a short section near Casino, the underslung 11kV is also mostly copper conductor of the same era. The average pole age is 37 years, with 80 of the 239 poles over 50 years old.

The feeder transverses from the relatively flat areas at Casino rising into the hills and into the Great Dividing Range near Mallanganee. Located in a small area of NSW that has the highest average lightning ground flash density (see Attachment A), the feeder is susceptible to thunder storms and lightning strikes, particularly in the higher area near Mallanganee. Having delta pin pole top construction, the feeder has no overhead earthwire protection, other than small sections (<1km) at the exit of Casino and entry to Mallanganee zone substations.

Being in an area susceptible to lightning strikes, the conductor is struck excessively, producing fault currents that overheat the conductor, leading to annealing of the copper strands. The copper hardens over time, and combined with pitting the strands begin to fracture and the conductor breaks.

A tensile strength test undertaken on a sample of the conductor indicated it has 48% of the recommended strength as per Australian Standard AS 1746 - 1991 Conductors - Bare Overhead - Hard Drawn Copper - Western Australia. The same test undertaken on a sample of same era 7/.080 copper conductor from the Quirindi – Murrurundi 33kV feeder (circa 1948) showed 98% of recommended tensile strength.

The 67-year-old 7/.080 copper conductor on the Casino - Mallanganee feeder has reached end of serviceable life and is subject to regular failure, resulting in poor reliability for customers. The conductor has failed three times in the last 18 months, with a recent conductor failure caused by a bird flying into the feeder during a calm early morning.

Beyond poor reliability, fallen conductors also pose significant safety risks including:

- Injury/fatality – electrocution of people and stock/wildlife
- Bushfire ignition
- Damage to public property
- The Casino – Mallanganee 33kV feeder has issues that need to be addressed to improve reliability and decrease public safety risk. Network augmentation options investigated to alleviate the issues are detailed in Section 4.

4. Network Options

When comparing network augmentation options Net Present Value (NPV) analysis is used to show which option has the greater NPV benefit.

A key consideration, beyond capital cost, in NPV calculations is the annual Value of Unserved Energy (VUE - $/MWH). VUE is applied as a benefit and represents the variation of improved customer reliability within each option.

VUE analysis assumes annual unplanned outage rates based on historical data. For each option, estimated outage rates are combined with average restoration times, energy lost during outage and Value of Customer Reliability[1] (VCR) to give an annualised VUE.

4.1.1 Options

Option 1 - Do Nothing

A do-nothing option does not address the network issues, will not improve customer reliability and will increase the public safety risk.

There is no capital cost associated with this option, only ongoing maintenance costs. Presently there are maintenance defects (aged pole tops, poles etc, not conductor) on this feeder. These defects will be rectified in year 1 and there will be ongoing annual maintenance costs based on historic defect rates.

Although the conductor failure rate will increase over time as the conductor deteriorates, the increased conductor failure rate has not been considered relevant, as the overall implications of a do-nothing option are apparent without an assumed increase in conductor failure.

Option 1 has estimated capital cost $0.0M and 40-year NPV of -$1.41M

Option 2 – Staged Reconductor (Stage 1 - 15km Stage 2 - 21km)

This option would require the more critical 15km section of the line which traverses the higher areas towards Mallanganee to be reconductored as Stage 1. The area towards Mallanganee has experienced more recent conductor fails (13 of 18 failures).

The first stage will be reconductored in the current regulatory period (2014/15-2018/19) in 2018/19. The remaining 21km section towards Casino would be reconductored in a second stage future year (2021/22).

[1] AEMO Value of Customer Reliability – Application Guide Dec14 , pg 5 NSW rate (added 2.5% CPI to 2017) = $41,299/MWH

The feeder will undergo refurbishment beyond just the conductor being replaced with aging poles and pole top constructions to be replaced as required based on condition assessments. For both stages the 11kV conductor, which is mostly copper and is underslung the 33kV conductor for most of the 36km length, will also be replaced.

With replacement of the 33kV conductor, customer reliability is significantly improved and VUE is applied as a benefit. In this option, with a staged approach, there will be an initial VUE benefit with Stage 1 which is less than that of the full reconductoring. This lesser value is applied until Stage 2 is complete in three years when the full VUE benefit is realised.

Option 2 has estimated capital cost $2.65M and a 40-year NPV of $19.52M

Option 3 – Full Reconductor (36km)

This option would require 36km of the copper conductor to be replaced in one year. As with option 2 the feeder will undergo refurbishment beyond just the conductor being replaced with aging poles and pole top constructions to be replaced as required based on condition assessments. The 11kV conductor which is mostly copper and is underslung the 33kV conductor for most of the 36km length will also be replaced.

With conductor replacement on the whole feeder, the improved customer reliability is realised in the first year and the full VUE benefit is applied.

Option 3 has estimated capital cost $2.60M and a 40-year NPV of $19.93M

Option 4 – Backup Diesel Generation

This option would require diesel generators to be permanently installed onto the 11kV busbars at the three zone substations. Two 1MW generators at Mallanganee and one 1MW generator each at Bonalbo and Urbenville.

The backup diesel could allow for deferral of the conductor replacement for a medium term. The diesel generation improves customer reliability but does not decrease the public safety risk. Generation could not be installed as a permanent solution as the conductor will get to a point where it fails excessively.

For any outage on the 33kV feeder section, the generation backup would require auto-changeover (less than 1 minute) to avoid customer supply loss and STPIS[2] penalties and be comparable to that as achieved with conductor replacement.

The generation has ongoing operation and maintenance costs. Once the conductor is replaced the main equipment (generators and step up transformers) would be recovered at a cost benefit.

All present defects on the feeder would be rectified and there will be ongoing annual maintenance costs based on historic defect rates.

The added advantage of generation at all zone substations is improved customer reliability at Bonalbo and Urbenville zone substations with outages on the 33kV feeder sections between Mallanganee – Bonalbo and Bonalbo - Urbenville. This gives a greater overall annual VUE benefit.

A five-year deferral of conductor replacement was used in the base case NPV analysis.

Option 4 has estimated capital cost $4.68M and a 40-year NPV of $18.69M

Other Options

Additional network augmentation options other than the above four were also considered but ruled out of NPV analysis as they were deemed too costly and/or technically difficult. Further detail of these options are shown in Appendix B.

[2] STPIS – AER Service Target Performance Incentive Scheme

4.1.2 NPV Analysis

Net Present Value Result

The NPV analysis for each option comprised only the capital, VUE, operating and maintenance costs of the 33kV network. Reconductoring of the aged 11kV underslung copper conductor will occur in the resourcing of this project. The additional cost to reconductor the 11kV has not been included in the NPV analysis as the costs / benefits only relate to the 33kV network.

A summary of the Net Present Value analysis results is shown below in Table 1. Further detail of the NPV analysis is shown in Appendix C.

	Base Dis. Rate	Discount Rate Sensitivity		Capital Sensitivity		VUE Sensitivity	
Option	3.45%	1.45%	5.45%	25%	-25%	25%	-25%
1	-$1.41	-$2.15	-$0.98	-$1.41	-$1.41	-$1.41	-$1.41
2	$19.52	$28.08	$14.24	$18.99	$20.05	$24.98	$14.06
3	$19.93	$28.59	$14.57	$19.39	$20.48	$25.51	$14.36
4	$18.69	$27.42	$13.30	$17.74	$19.64	$24.49	$12.88

Table 1 Net Present Value Analysis ($M)

Preferred Option Consideration

As shown above in Table 1, the NPV results for options 2 and 3 are relatively close.

In selecting the preferred option, factors such as resourcing, feasibility and project risk that cannot be readily costed in an NPV analysis are also considered.

Option 3 requires significant resources to complete 36km of reconductoring, vulnerable to delays and cost blowouts due to weather and other constraints over the construction period. Option 3 is considered a less achievable project and locks resources into a considerable/lengthy program of work.

Option 2, staging the reconductoring, is considered an achievable project utilising a 'segment-based delivery' resource plan.

There are a number of other distribution capital and operational projects proposed for the network in and around Bonalbo in 2018/19. To maximise resource and delivery efficiency and minimise customer outages it is planned to undertake both the Stage 1 33kV Casino – Mallanganee Subtransmission project and the Bonalbo distribution capital and operational projects at the same time in a 'segment based' program of work.

5. Non-Network Options

With all network augmentation investigations Essential Energy examines opportunities to alleviate network constraints with non-network solutions. Non-network options generally consist of either demand management or embedded generation providing alternate supply.

Demand management requires the peak demand to be reduced to a level which removes or defers the network constraint. The reduction in demand can be achieved by a number of methods, mainly load curtailment or fuel substitution. Demand reduction in this case will not alleviate the public safety risk and does not significantly reduce the energy lost during unplanned outages to a point where it would defer or negate the network need.

Generation in the form of backup diesel capability has been considered in this case as per option 4 and other embedded generation was considered in 'Other Options' (see Appendix B).

6. Recommendation

Option 2 is the preferred and recommended option. The proposed staged reconductoring of the Casino - Mallanganee 33kV feeder has a positive NPV benefit and will maximise the efficiency of delivery and resources whilst also minimising outages throughout the duration of both subtransmission and distribution works.

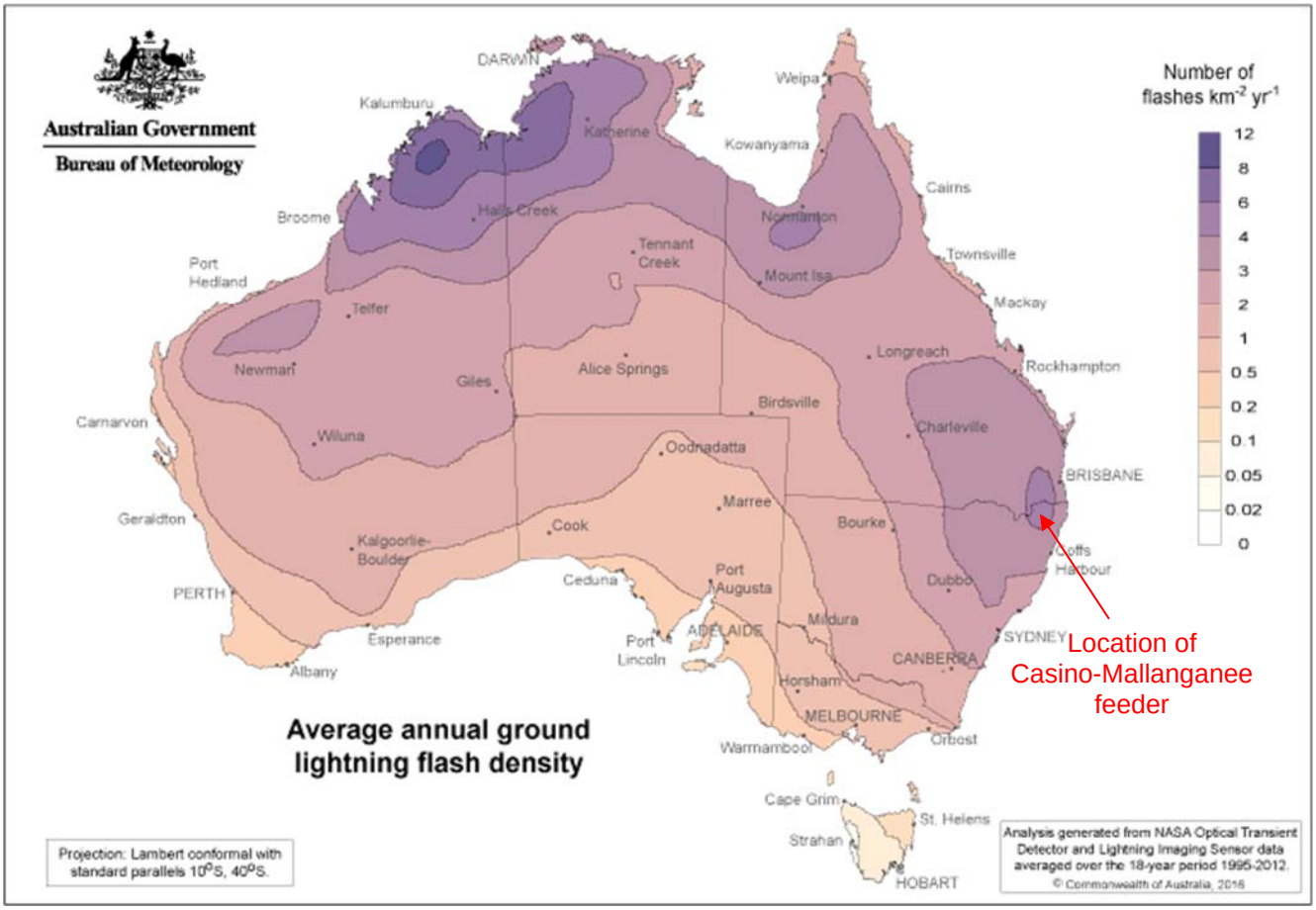
7. References

Doc No.	Document Name	Relevance
1	NPV Casino-Mallanganee V1.xlsx	Net Present Value Analysis calculations

8. Key Terms and Definitions

Term	Definition
AER	Australian Energy Regulator
NER	National Electricity Rules
NPV	Net Present Value
STPIS	Service Target Performance Incentive Scheme
VUE	Value of Unserved Energy
VCR	Value of Customer Reliability

Appendix A – BOM Average Annual Ground Lightning Flash Density



Appendix B – Other Network Options (Not included in NPV)

a) Establish 132/33kV transformation at Mallanganee

Mallanganee ZS site is small with an adjacent hillside, limiting expansion. The connection would require a 132kV busbar with 132kV loop in/out as TransGrid would not allow a second tee connection (already Casino 132/66kV ZS) on their Tenterfield-Lismore 132kV line.
The 33kV copper conductor on the Casino – Mallanganee feeder could be removed but the 11kV underslung would still require to be maintained.

This option was deemed problematic and costly at over $5M

b) 33kV supply from Kyogle zone substation

A new 33kV supply from Kyogle would require 40+km of new 33kV or rebuilding of 11kV feeders out of Kyogle and Bonalbo zone substations to 33kV.
This option was deemed problematic and costly at over $15M

c) Battery Backup

This option would require installation of 16MWH of battery bank backup. For any outage on the Casino – Mallanganee feeder, the battery backup would automatically restore supply within one minute to avoid STIPIS penalty and depending of load times would supply peak load for at least four hours. It is assumed the 33kV feeder would be fully reconductored in ten years.

This option was deemed costly at over $10M

d) Full Supply Generation

This option would require install of renewable energy generation and battery bank backup. The network would be supplied by either the renewable energy source or battery backup. This would require acquisition of significant land parcels.
The 11kV underslung on the Casino – Mallanganee would still require to be maintained, the 33kV conductor could be removed.

This option was deemed problematic and too costly at over $15M

e) Install Embedded Customer Generation

This option would require installation of renewable energy generation and battery bank backup and a customer or combined customer level. Individual customers or small customer groups would be supplied by a hybrid renewable, diesel or battery source.

This option was deemed problematic and too costly at over $20M

Appendix C – Net Present Value Analysis (Base)

Showing only first 10 years of analysis. Full analysis as per reference document 'NPV Casino-Mallanganee V1.xlsx'

Project:	Casino - Urbenville
Company Tax Rate	30%
Discount Rate after Tax:	3.45%

NPV Summary	Total Capital Costs	10 Yr NPV	20 Yr NPV	30 Yr NPV	40 Yr NPV
OPTION 1: Do Nothing	-	(381,439)	(742,218)	(1,038,432)	**(1,406,663)**
OPTION 2: Staged Reconductor	**(2,648,334)**	6,347,228	12,302,192	16,519,685	**19,517,952**
OPTION 3: Full Reconductor	**(2,598,334)**	6,768,991	12,721,728	16,937,634	**19,934,771**
OPTION 4: Backup Generation	**(4,678,334)**	5,298,692	11,344,042	15,645,586	**18,689,699**

		FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29
Timeline (Year)	Book Life Yrs	0	1	2	3	4	5	6	7	8	9	10
OPTION 1: Do Nothing												
Capital Expenditure:	Depreciation Age											
No Capital Investment	40	-	-	-	-	-	-	-	-	-	-	-
Cash Outflows - O&M / Risk												
Annual feeder maintenance		(129,500)	(36,260)	(11,000)	(11,000)	(148,925)	(12,650)	(41,699)	(12,650)	(171,264)	(14,548)	(47,954)
Net Profit After tax		**(90,650)**	**(25,382)**	**(7,700)**	**(7,700)**	**(104,248)**	**(8,855)**	**(29,189)**	**(8,855)**	**(119,885)**	**(10,183)**	**(33,568)**
VUE Saved		-	-	-	-	-	-	-	-	-	-	-
OPTION 2: Staged Reconductor												
Capital Expenditure:												
Reconductor 15km east of Mallanganee	40	(1,194,087)										
Reconductor 21km west of Casino	40	-	-	-	(1,454,247)		-	-	-			-
Cash Outflows - O&M / Risk												
Annual feeder maintenance		(4,664)	(4,664)	(4,664)	(5,893)	(1,788)	(24,204)	(2,056)	(6,777)	(2,056)	(27,835)	(2,364)
Net Profit After tax		**(3,265)**	**(24,161)**	**(24,161)**	**(25,022)**	**(47,597)**	**(63,289)**	**(47,785)**	**(51,090)**	**(47,785)**	**(65,830)**	**(48,001)**
VUE Saved		825,417	825,417	825,417	990,501	990,501	990,501	990,501	990,501	990,501	990,501	990,501
OPTION 3: Full Reconductor												
Capital Expenditure:												
Reconductor all 36km	40	(2,598,334)										
Cash Outflows - O&M / Risk												
Annual feeder maintenance		(1,555)	(1,671)	(1,788)	(5,893)	(1,788)	(24,204)	(2,056)	(6,777)	(2,056)	(27,835)	(2,364)
Cash Inflows - Benefits												
Net Profit After tax		**(1,088)**	**(46,641)**	**(46,722)**	**(49,596)**	**(46,722)**	**(62,414)**	**(46,910)**	**(50,215)**	**(46,910)**	**(64,955)**	**(47,126)**
VUE Saved		990,501	990,501	990,501	990,501	990,501	990,501	990,501	990,501	990,501	990,501	990,501
OPTION 4: Backup Generation												
Capital Expenditure:												
Install backup gen then reconductor	40	(3,400,000)					(2,598,334)					-
Recovered diesel generators & txs (benefit)	40							1,320,000				
Cash Outflows - O&M / Risk												
Annual generation O&M		(95,200)	(95,200)	(95,200)	(95,200)	(95,200)	(95,200)					
Annual feeder maintenance		(129,500)	(36,260)	(11,000)	(11,000)	(148,925)	(12,650)	(1,555)	(1,671)	(1,788)	(5,893)	(1,788)
Cash Inflows - Benefits												
Net Profit After tax		**(157,290)**	**(151,522)**	**(133,840)**	**(133,840)**	**(230,388)**	**(134,995)**	**(106,059)**	**(83,041)**	**(83,122)**	**(85,996)**	**(83,122)**
VUE Saved		1,155,507	1,155,507	1,155,507	1,155,507	1,155,507	1,155,507	990,501	990,501	990,501	990,501	990,501