Supporting Document 12.1.15f
Major Project Detailed Options Report

ESS_4021 Tharbogang to Tabbita Lane 2nd 33kV Feeder (30km)

April 2018

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1. Executive Summary

Major Project	ESS_4021 Tharbogang to Tabbita Lane 2nd 33kV Feeder (30km)
Description	Acquire an easement and construct a new 33kV feeder from the Tharbogang Zone Substation to Tabbita Lane (30km)
Drivers for Investment	Essential Energy has received enquiries for new load associated with the expansion of the poultry industry to the west of Griffith. Applications from multiple proponents have been made for 300 poultry sheds to be constructed over the next three years. This is expected to add 15MVA load to the 79W Googlowi Feeder with the immediate network constraints being addressed by a project to install a 33kV capacitor in the vicinity of the sheds. The remaining constraints include catering for forecast additional load increases and reducing the forecast Value of Unserved Energy.
Investment Options	The most feasible network option is the construction of a second 33kV feeder from the Tharbogang Zone Substation to Tabbita Lane and the least cost DM option is installing solar panels and batteries to reduce peak demand.

Estimated Expenditure Real FY19 $M	2019/20	2020/21	2021/22	2022/23	2023/24
	$3.0	$4.0	$0	$0	$0

2. Overview

Essential Energy has received enquiries for a total of 300 sheds from multiple proponents related to poultry industry expansion to the west of Griffith in the Tabbita / Goolgowi area. The industry is increasing the number of poultry sheds to comply with the RSPCA recommendation on poultry density, in response to the requirement for certification from the major supermarket chains.

There is limited existing 33kV network capacity in the area and a project has been initiated to install a 33kV capacitor on the network to meet the 2019/20 summer forecast demand. This major project report investigates options to cater for future growth and provide reliable supply to this area. The construction of a new 33kV feeder from the Tharbogang ZS to Tabbita Lane is the preferred option to address forecast constraints and improve reliability.

3. Network

The Griffith 33kV network is a hybrid subtransmission / distribution system which supplies a number of 33/11kV Zone Substations (ZS) and 33kV direct connect customers from the TransGrid Griffith 132/33kV supply point. Part of this network services the Griffith west area via the Tharbogang ZS which is normally supplied over the 79R feeder and has an alternate supply over the 79P feeder.

The 79W Goolgowi feeder (Tharbogang – Goolgowi 45kms) is part of a 33kV network between Tharbogang ZS and Hillston 132/33kV substation with a total backbone length of 105kms and normally open at Goolgowi. The majority of load on this network is in the first 30kms between Tharbogang and Tabbita Lane, consisting of numerous 33kV direct connected customers and tee connected Nericon 33/11kV ZS.

The 79W Goolgowi feeder has a 33kV regulator on the outgoing section at Tharbogang ZS and another at the Nericon Tee (Hillston Road Regulator), half way between Tharbogang and Tabbita Lane.

On loss of the 33kV network between Tharbogang and Tabbita Lane there is very limited backup supply provided from Hillston 132/33kV substation.

The network arrangement is illustrated in Figure 1.

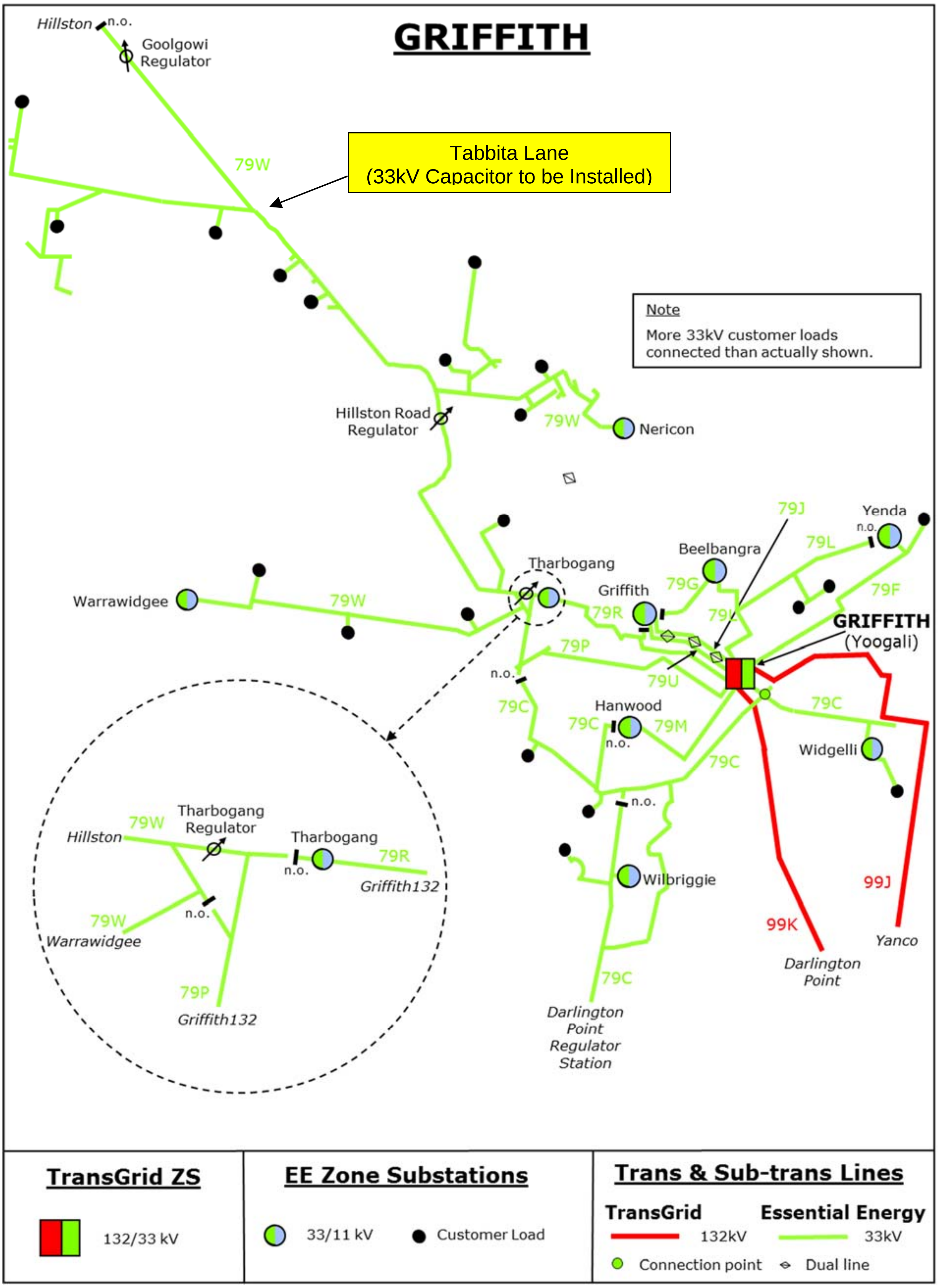

Figure 1 Griffith – Goolgowi – Hillston 33kV Supply Network

4. Load Forecast

Essential Energy has received multiple enquiries totalling approximately 300 new poultry sheds in the vicinity of Tabbita Lane, with the average demand per shed typically being around 50kVA, giving a total forecast load increase of 15MVA. The poultry industry is rapidly increasing shed numbers to comply with recent RSPCA recommendations on poultry density and certification requirements from major supermarket chains. These loads are estimated to diversify with the existing load on the feeder with a diversity factor of 80%. The load forecast including the proposed poultry development and an agricultural pumping connection at Nericon are shown in Table 1.

Development	Demand MVA	Sheds	Progress	Connection Point
Sidal and Morton	1.0	20	Connected	96-81016 Tx
Tabbita Poultry 1 and 2	2.0	40	Connected	96-L14534 Link
Rombola Nericon	2.2	Pumping	Connected	96-L17246 Link
Scolexia Voag	0.4	8	Connected	CE173892 Pole
Tabbita Poultry 3,4,5	3.0	60	1819	96-L14534 Link
Scolexia Voag	3.6	72	1920	CE173892 Pole
McRaes Road	5.0	100	1920	New Feeder
Summated Total	**17.2**			
Diversified Total	**13.7**			

Table 1 Griffith Poultry Load Applications

Background growth on the 79W feeder is around 300kVA/annum, with multiple agricultural industries in the Nericon and Tabbita Lane areas looking to expand. Combining the poultry spot load with the background growth gives the following load forecast for the 79W feeder.

Load	17/18	18/19	19/20	20/21	21/22
Feeder 79W	9.8	12.2	19.1	19.4	19.7

Table 2 Griffith West Area Load Forecast (MVA)

5. Constraint

The immediate voltage and thermal constraints caused by the poultry load will be addressed by the project to install a 33kV capacitor at Tabbita Lane. This will support an estimated 19.1MVA load on the 79W feeder. Constraints associated with the forecast load beyond this level from 2020/21 onward include:

- Voltage on the incoming side of the Hillston Road regulator is below the accepted lower voltage level of 93% for direct connect customers
- Voltage levels on the extremity of the 79W feeder would fall below 93%
- The load would exceed the rating of the Hillston Road regulator
- For loss of load north of the Hillston Road regulator the voltage at Nericon would rise to 115% until the fast tap change on the regulator returned voltage to normal
- Significant load would be lost for a fault on the 33kV feeder from Tharbogang to Tabbita Lane

6. Value of Unserved Energy

The amount of energy not supplied can be equated to an annual value, being Value of Unserved Energy (VUE) based on a Value of Customer Reliability (VCR[1]). In the case of the 79W feeder this value is expected to be particularly high due to the length and loading of the feeder. The following assumptions have been used to calculate the VUE.

The feeder from Tharbogang to Tabbita Lane is 30km in length and is unshielded 33V construction with an estimated outage rate of 2 outages / 100km / year. Given the length and rural setting of the feeder is expected a fault would take 4 hours to find and repair. The load on the Tabbita feeder is very seasonal in nature and is forecast to have a capacity factor of 0.3 based on existing poultry demand.

7. Options

7.1.1 Option

Option 1. Do Nothing

Future load levels will be beyond the thermal and voltage regulation capacity of the feeder would require load to be shed in rolling outages that would affect all customers connected to the 79W feeder. The VUE for faults on the 33kV feeder from Tharbogang to Tabbita Lane is $17.6M over a 40-year timeframe.

Option 2. Construct a Second 33kV Feeder from Tharbogang to Tabbita Lane

This option would involve the establishment of a second 33kV feeder from the Tharbogang ZS to Tabbita Lane. The feeder would be connected to the outgoing side of the 33kV regulator at the Tharbogang ZS through a recloser. Reclosers would also be installed to create a switching station at the Hillston Road regulator. The feeder would then continue to Tabbita Lane to separate the Tabbita Lane load from the existing 79W Goolgowi feeder. This would require the acquisition of an easement, it may be possible to utilise the Kidman Way road reserve but for this option the full cost of easement acquisition has been assumed. The new 33kV overhead construction would be single circuit, timber, rural construction. The estimated direct capital cost of this option is $7.0M.

8. Option 3. Non-Network Option

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

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.

In this case the most cost-effective option would be to incentivise the poultry farms to install solar panels on the sheds and Essential Energy could provide batteries to match the demand of the sheds to the solar output profile, thereby reducing peak demand on the feeder. It is estimated that 300kW of batteries would be required per year to meet the 300kVA per annum forecast increase in load, with an estimated cost of $300k/annum at the present market rate of $1M/MW. Installed batteries would also have a benefit for faults on the 33kV network between Griffith TransGrid and Tabbita Lane which have been included as a benefit in the NPV. Installing batteries in the Tabbita area has been investigated as Option 3. The estimated cost of this option is $11.7M over 40 years.

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[1] VCR – $/MWH rates from 'AEMO Value of Customer Reliability – Application Guide Dec 14' CPI escalated to present day value

9. Risk Analysis

9.1.1 Safety

The option investigated for this project will not reduce the chance that a customer experiences an outage so will not have a material impact on safety.

9.1.2 Network (Reliability)

It has been assumed that a fault on the 33kV feeders to the west of Griffith would have an average 4-hour restoration time from supply interruption.

9.1.3 Environmental

The feeder route for the second 33kV feeder outlined in Option 2 would be chosen to minimise environmental impacts which are expected to be minor.

9.1.4 Financial

Following an extended outage there would be the possibility for claims of compensation from customers. This is expected to be limited in scale and of low value, so these costs have not been included in this evaluation.

9.1.5 Compliance

Compliance risk is assessed for issues that may arise as a result of not complying to relevant standards, acts or guideline. It is up to Essential Energy to determine the standard of alternate supply required using a Value of Customer Reliability approach.

9.1.6 Reputation

Reputational risks are categorised as those risks associated with the tarnishing of the company's reputation as the result of an overhead conductor failure, not including that incurred by the resultant outage.

It is anticipated that the risk to corporate reputation as a result of a power outage is minor under the corporate risk matrix. That is, the outage may result in attention from media and or heightened concern from local community / external stakeholders, or, criticism from multiple sources for one or two days.

10. Cost Evaluation

The capital cost for each option is summarised in Table 3.

Option	2018/19	2019/20	2020/21	2021/22	2022/23
Option 1 - Do Nothing	$0.00	$0.00	$0.00	$0.00	$0.00
Option 2 - 33kV Feeder	$0.00	$3.00	$4.00	$0.00	$0.00
Option 3 - Non Network	$0.00	$0.00	$0.30	$0.30	$0.30

Table 3 CAPEX cost per option ($M)

As noted in Section 6, the annual VUE has been estimated outage rate of 2 outages / 100km / year. Given the length and rural setting of the feeder is expected a fault would take 4 hours to find and repair. The load on the Tabbita feeder is very seasonal in nature and is forecast to have a capacity factor of 0.3 based on existing poultry demand.

The annual VUE has been calculated considering the following assumptions and an indexed VCR value of $41,210/MWH. The annual value of unserved energy for each option is shown in Table 4.

Option	2018/19	2019/20	2020/21	2021/22	2022/23
Option 1 - Do Nothing	$-	$-	$-	$-	$-
Option 2 - 33kV Feeder	$-	$448,866	$459,145	$490,881	$540,142
Option 3 – Non Network	$-	$1,295	$13,204	$46,578	$97,487

Table 4 Value of Unserved Energy Saving for Each Option

The Present value of cost for each option has been calculated combining the capital and operational costs and the annual VUE with results of base and sensitivity cases shown in Table 5. Further summarised detail of the NPV analysis is shown in Appendix A.

	Base Dis. Rate	Discount Rate Sensitivity		Capital Sensitivity		VUE Sensitivity	
Option	3.45%	1.45%	5.45%	+25%	-25%	+25%	-25%
1	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2	**$20.24**	**$32.81**	**$12.66**	**$18.73**	**$19.57**	**$26.81**	**$13.67**
3	$11.36	$17.92	$7.44	$9.98	$12.74	$15.58	$7.14

Table 5 Net Present Value Results

11. Recommended Option

Given the annual ongoing VUE, Option 1 Do Nothing is not a viable option to address the forecast constraints on the Goolgowi feeder. Option 2 is technically feasible and has the highest NPV benefit, making it the recommended option. Adding battery storage to defer the network expenditure is technically feasible but has a lower NPV benefit that Option 2 due to the VUE for loss of upstream network elements.

12. References

Doc No.	Document Name	Relevance
1	Tharbogang to Tabbita 2nd 33kV Feeder NPV.xlsx	Net Present Value Analysis calculations

13. Key Terms and Definitions

Term	Definition
FY	Financial Year
NPV	Net Present Value
VCR	Value of Customer Reliability
VUE	Value of Unserved Energy

Appendix A – Net Present Value Analysis (Base)

(Do Nothing not shown)

Project:	**Tharbogang to Tabbita Lane**					
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**	**50 Yr NPV**	**60 Yr NPV**
OPTION 1: Do Nothing	-	-	-	-	-	-	-
OPTION 2: 33kV Feeder Tharbogang to Tabbita	-	128,876	9,190,637	15,645,806	**20,244,163**	20,244,163	20,244,163
OPTION 3: Generation	-	743,772	5,421,553	8,848,978	**11,358,325**	11,530,602	11,619,311

		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 2: 33kV Feeder Tharbogang to Tabbita												
Capital Expenditure:												
Easement Inland Low Cost (30km x $50k/km)	40		(1,500,000)									
33kV Overhead Line Timber Rural Neon (30km x $178,500/k	40		(1,500,000)	(3,800,000)	-		-	-	-			-
Cash Outflows - Risk												
O&M		-	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)
		-	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)	(15,000)
Operating Profit:		-	**(30,000)**	**(30,000)**	**(30,000)**	**(30,000)**	**(30,000)**	**(30,000)**	**(30,000)**	**(30,000)**	**(30,000)**	**(30,000)**
Depreciation Capital Investment 2			-	(37,500)	(132,500)	(132,500)	(132,500)	(132,500)	(132,500)	(132,500)	(132,500)	(132,500)
Depreciation Capital Investment 3			-	-	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)	(5,000)
Net Profit After tax		-	**(21,000)**	**(73,500)**	**(143,500)**	**(143,500)**	**(143,500)**	**(143,500)**	**(143,500)**	**(143,500)**	**(143,500)**	**(143,500)**
VUE Saving		-	448,866	459,145	490,881	540,142	609,349	716,448	878,971	1,111,193	1,494,225	1,494,225
Undiscounted Cashflow:		-	(2,572,134)	(3,539,355)	522,381	571,642	640,849	747,948	910,471	1,142,693	1,525,725	1,525,725
Discounted Cash Flow		-	(2,486,355)	(3,307,220)	471,841	499,117	540,883	610,223	718,046	871,135	1,124,351	1,086,854
Cumulative Discounted Cash Flow (Option 2)		-	(2,486,355)	(5,793,575)	(5,321,734)	(4,822,617)	(4,281,734)	(3,671,511)	(2,953,464)	(2,082,329)	(957,978)	128,876
		10 Yr NPV	**20 Yr NPV**	**30 Yr NPV**	**40 Yr NPV**	**50 Yr NPV**	**60 Yr NPV**					
NPV (Option 2):		**128,876**	**9,190,637**	**15,645,806**	**20,244,163**	**20,244,163**	**20,244,163**					
OPTION 3: Generation												
Capital Expenditure:												
Cost of battery storage / annum	40	-	-	(300,000)	(300,000)	(300,000)	(300,000)	(300,000)	(300,000)	(300,000)	(300,000)	(300,000)
Capital Investment 2	40											
Cash Outflows - Risk												
O&M		-	-	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)
			-	-	-	-	-	-	-	-	-	-
Operating Profit:		-	-	**(3,000)**	**(3,000)**	**(3,000)**	**(3,000)**	**(3,000)**	**(3,000)**	**(3,000)**	**(3,000)**	**(3,000)**
Depreciation Capital Investment 2			-	-	-	-	-	-	-	-	-	-
Net Profit After tax		-	-	**(2,100)**	**(7,350)**	**(12,600)**	**(17,850)**	**(23,100)**	**(28,350)**	**(33,600)**	**(38,850)**	**(44,100)**
VUE Saving		-	1,295	13,204	46,578	97,487	168,353	277,121	441,321	675,230	1,059,949	1,059,949
Undiscounted Cashflow:		-	1,295	(288,896)	(253,272)	(200,113)	(126,997)	(15,979)	150,471	386,630	773,599	775,849
Discounted Cash Flow		-	1,252	(269,948)	(228,769)	(174,724)	(107,186)	(13,037)	118,669	294,749	570,088	552,678
Cumulative Discounted Cash Flow (Option 3)		-	1,252	(268,696)	(497,465)	(672,189)	(779,375)	(792,412)	(673,743)	(378,994)	191,094	743,772
		10 Yr NPV	**20 Yr NPV**	**30 Yr NPV**	**40 Yr NPV**	**50 Yr NPV**	**60 Yr NPV**					
NPV(Option 3):		**743,772**	**5,421,553**	**8,848,978**	**11,358,325**	**11,530,602**	**11,619,311**					