Essential Energy

10.03.08 Augex Bourke Regulator Replacement Investment Case

November 2022

Distribution Major Project

Project:	10.03.08 Augex Bourke Regulator Replacement Investment Case
Date:	Nov 2022
Author:	[redacted]
Version	1
Status:	Approved

Approvals

	Name	Division	Title & Function	Date
1.	[redacted]	Assets & Operations	Manager Network Planning	14/12/22
2.				

Revisions

Issue Number	Section	Details of Changes in this Revision
1.		Initial Issue
2.		
3.		
4.		
5.		

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1. Executive Summary

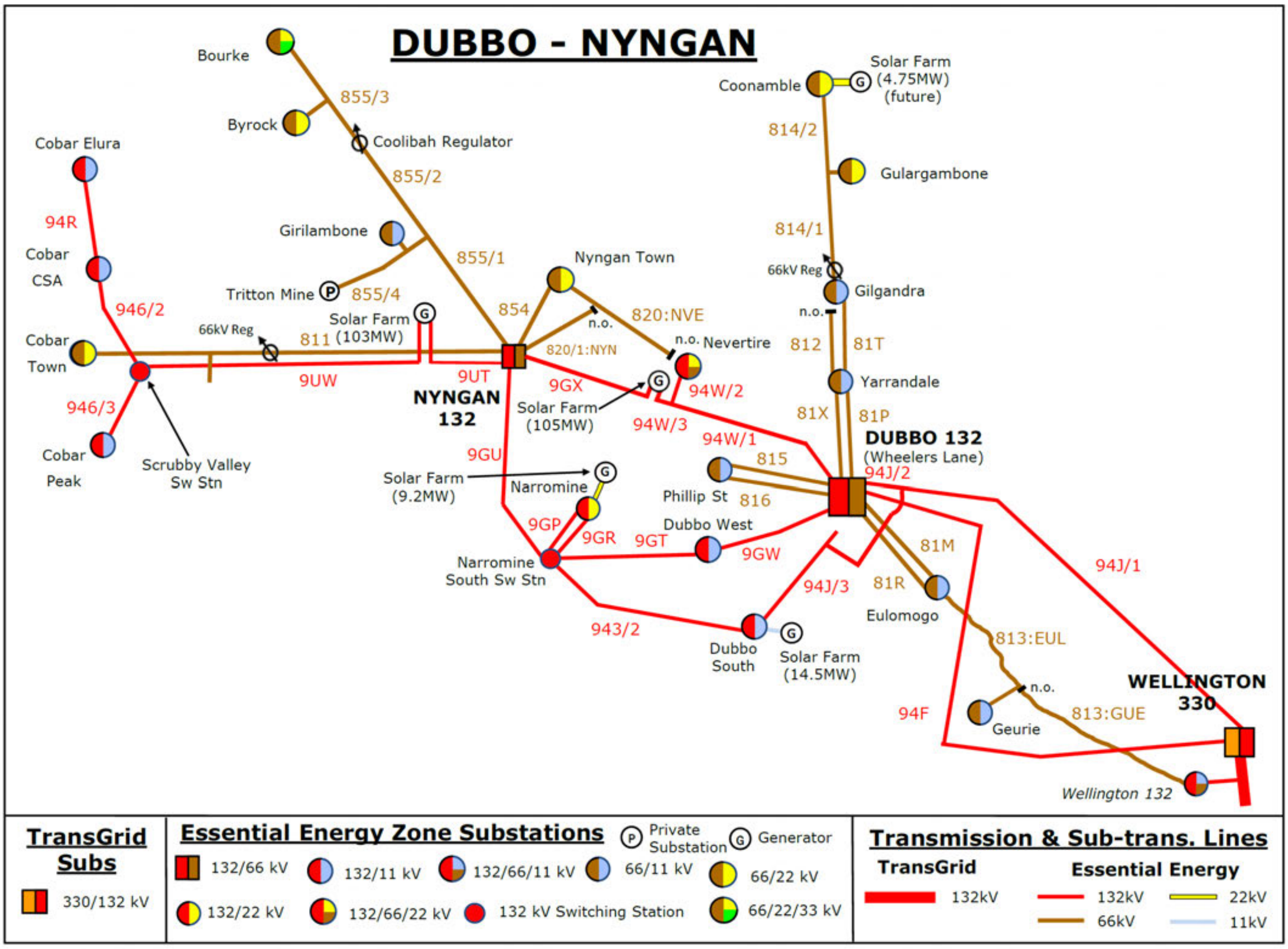
Major Project	10.03.08 Augex Bourke Regulator Replacement Investment Case
Description	Replace 66kV Regulator at Coolabah with unit having 10% buck tap range
Drivers for Investment	The driver of the investment is to reduce customer voltage levels on the electrical network supplied by the Bourke Zone Substation to meet NER 6.5.7 capital objectives. There are periods where high voltages are recorded at premises across the network. **Financial:** Electronic equipment is susceptible to failure and decreased life expectancy when exposed to high voltages. The impact on customer equipment supplied from the Bourke network is estimated to be as follows: [redacted] **Reputation and Compliance:** Essential Energy incurs both compliance and reputational costs when customers complain of high voltage levels. The estimated annual cost incurred by high voltage complaints in the Bourke area are as follows: [redacted]
Investment Options	Several options were considered to reduce voltage levels including. - Installing 22kV and 33kV reactors at the Bourke Zone Substation - Due to the financial cost of this project an Expression of Interest (EOI) for non-network solutions will be advertised prior to project initiation to enable the private sector to submit non-network options for evaluation. The option recommended from the Net Present Value of cost and benefit is as follows: - Replacing the 66kv Coolabah regulator (NPV $4.5m)
Estimated Expenditure $FY24	2024/25: $0; 2025/26: $0; 2026/27: $0; 2027/28: $0; 2028/29: [redacted]

Note: All values are in middle of the year 2023-24 real dollar terms

2. Network

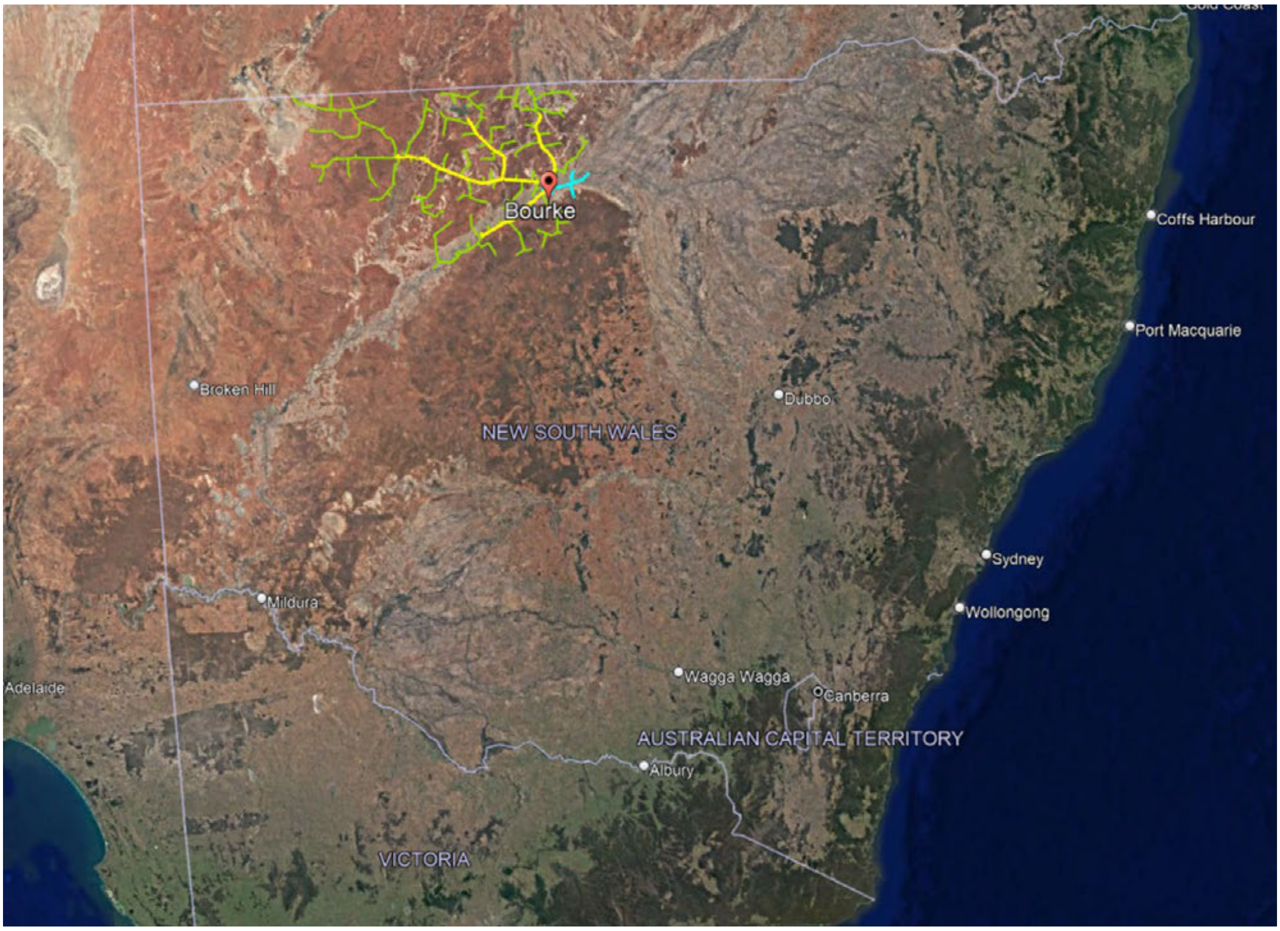
The Bourke 66/33/22kV Zone Substation is supplied via the 66kV line 855 which originates from the Nyngan 132/66kV substation. The Coolabah 66kV regulator maintains voltage levels for the Byrock and Bourke Zone Substations. The subtransmission network supplying Bourke is shown in Figure 1

Figure 1: Subtransmission network supplying Bourke



Both 22kV and 33kV supplies are provided from the Bourke Zone Substation, with the 22kV network mainly servicing the town and the 33kv network servicing the rural areas where 19.1kV SWER is predominantly used to supply rural properties. The area of the state serviced by the Bourke network is shown in Figure 2.

Figure 2: Bourke Distribution Network



3. Load Growth

Limited growth in peak demand is forecast by Frontier Economics (**Attachment 11.01**) for Bourke, as shown in Table 1.

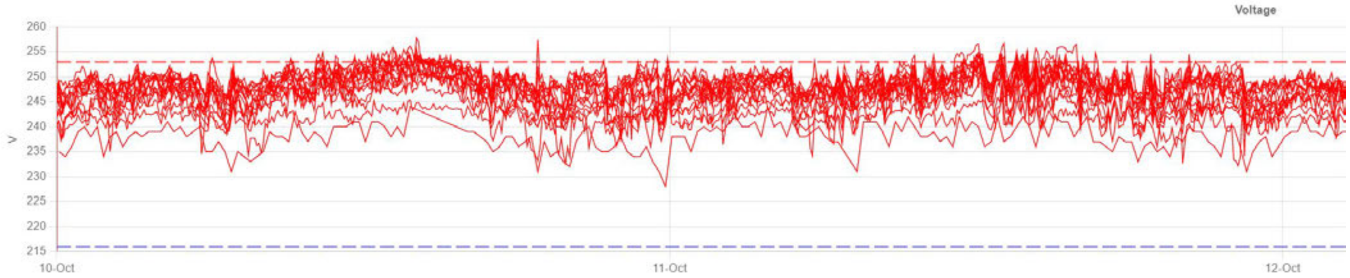
Table 1: Forecast Bourke Demand

Financial Year	Bourke 22kV Summer (MVA)	Bourke 22kV Winter (MVA)	Bourke 33kV Summer (MVA)	Bourke 33kV Winter (MVA)
2022	5.8	5.5	2.1	1.6
2023	5.8	5.5	2.1	1.6
2024	5.8	5.5	2.2	1.6
2025	5.8	5.5	2.2	1.7
2026	5.8	5.5	2.2	1.7
2027	5.8	5.5	2.2	1.7
2028	5.9	5.6	2.3	1.7
2029	5.8	5.5	2.3	1.8

4. Identified Need

High voltage levels have been recorded across the Bourke network from customer Smart meters. Figure 3 shows a voltage trace from 10th to 12th October 2022 for the Bourke No.2 feeder suppling residential load in the Bourke Township.

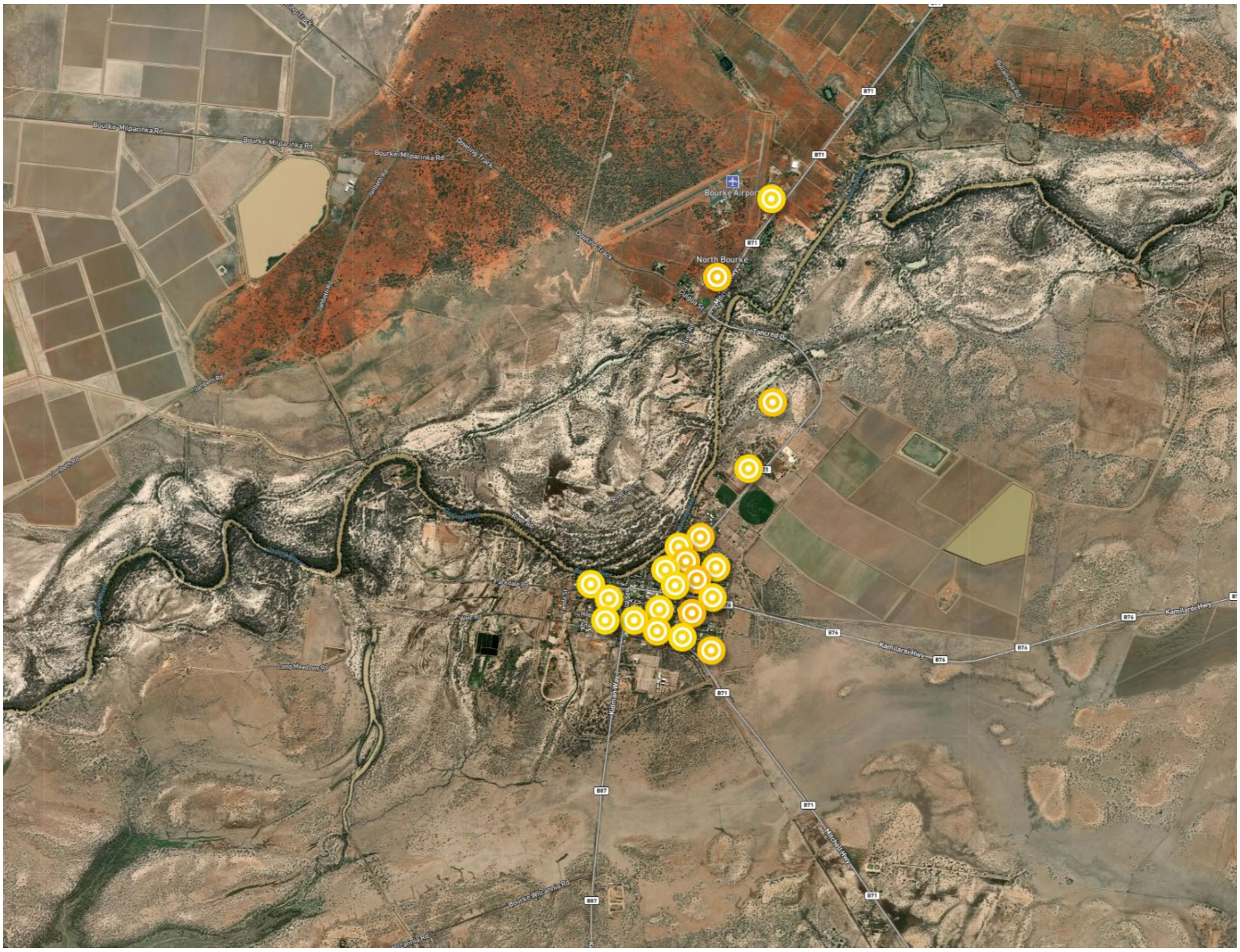
Figure 3: Smart meter Voltage Trace for Bourke No.2 Feeder in October 2022



This trace show voltages above the 253V upper limit in the Australian standard during the day, being increased by rooftop solar generation.

High voltage issues recorded for Bourke mainly appear in town where a majority of smart meters are located. Figure 4 highlights transformers that have experienced a high voltage issue between November 2021 and November 2022.

Figure 4: High Voltage Issues Detected by Smart Meters on Bourke Network



Customer smart meter data has been used to estimate the cost to customers from overvoltage, with a full breakdown of the assumptions given in Appendix 1.

Table 2: Cost due to Overvoltage / Annum

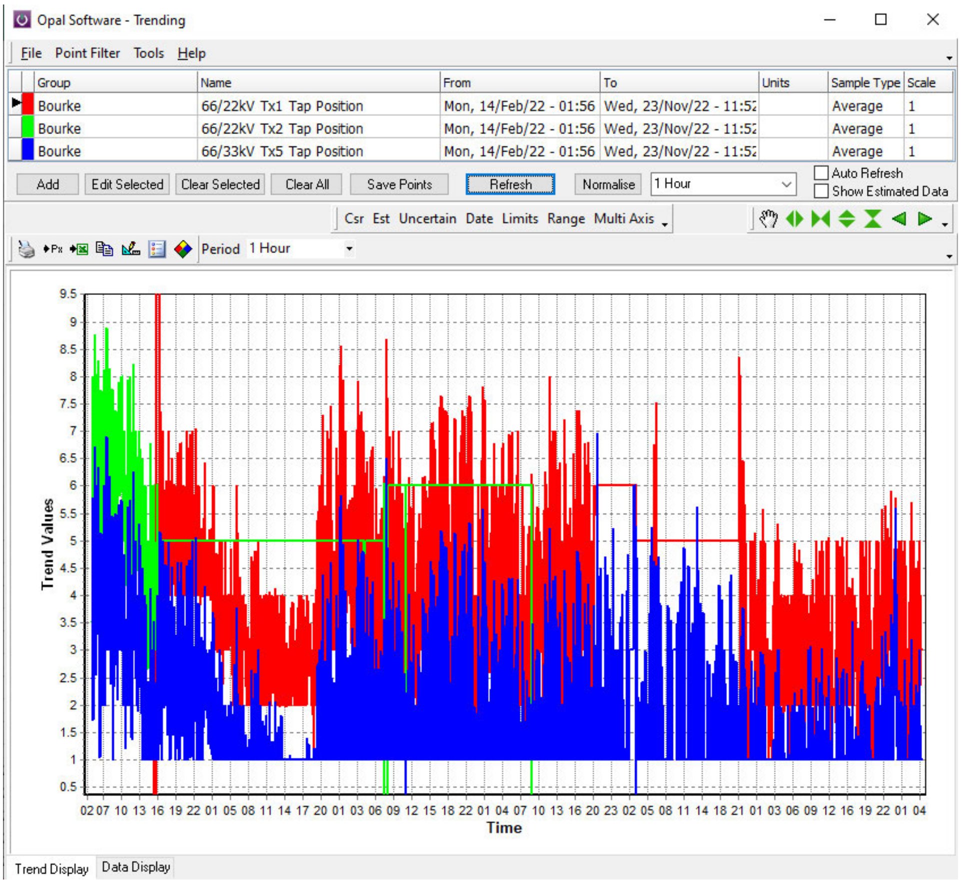
Reduced Life	Lost Equipment	Curtailment	Reputation	Compliance	Annual Cost
[redacted]					

The identified need is high voltage levels measured at customer premises which need to be lowered to meet Essential Energy's obligation in relation to quality of supply, as required by AS 60038 Standard Voltages.

5. Options Analysis

Smart meter recordings show that a vast majority of the issues on the Bourke network are caused by high voltages, with very few low voltage issues being recorded. Moving the voltage setpoint on both the 22kV and 33kV regulated buses at the zone substation would be a very low cost way to minimise high voltages recorded on the network. The issue with this solution is the high 66kV voltages coming into the Bourke Zone Substation, with both the 66/22kV and 66/33kV power transformers at their maximum buck ratio of 10%. This issue also limits the effectiveness of future network options, such as closed loop voltage control to improve the voltage levels at Bourke, as this relies on the ability to adjust voltage levels at the zone substation. Figure 5 shows the tap position of the 66/33kV and 66/22kV transformers from February to November 2022 which is the range of the available smart meter data.

Figure 5: Bourke 132/22kV Transformer Tap Position Nov 2021 to Nov 2022



The incoming 66kV voltage will limit any change to the 22kV bus voltage at the Bourke Zone Substation.

Below are the feasible options that were considered to address the high voltage issue.

5.1 Option 1 – Replace 66kV Coolabah Regulator

Reducing the 66kV voltage level at the Bourke Zone substation could be accomplished by replacing the 66kV Coolabah regulator with a unit that has buck tap capability. The Coolabah regulator was installed to increase 66kV voltage levels to Bourke under peak load, but at the time there was no requirement to buck the voltage, so the regulator does not include buck capability. Replacing the regulator would allow the unit to be replaced with Essential Energy's new specification requiring a 10% buck range. This additional range would allow the 66kV voltage to be lowered, which in turn allows the zone substation 33kV and 22kV voltages to be lowered, alleviating a vast majority of the high voltage complaints. As this is the replacement of an existing unit, maintenance costs for this option are considered to remain the same.

Option 1 has estimated capital cost of [redacted] and a Net Present Value of $4.5M.

5.2 Option 2 - Install 33kV and 22kV Reactors at the Zone Substation

Installing switched reactors at the Bourke Zone substation would allow inductive reactive power to be switched in when the 66kV voltage exceeded the tap range of the power transformers. Inductive reactive power flowing through the reactive impedance of the power transformer would produce a voltage drop, allowing the secondary voltage to be reduced. Based on the impedance of the existing transformers it is calculated that a 2MVAr reactor on both the 22kV and 33kV bus would be required at the Bourke Zone Substation. There is spare space in the fenced perimeter of the Bourke Zone substation that could be used to install the 22kV reactors. The reactors have a 25 year life so allowance has been made to replace the reactors in 25 years' time

Option 2 has estimated capital cost of [redacted] and a Net Present Value of $3.0M.

5.3 Option 3 - Market led Non-Network Solution

The requirements to improve voltage levels on the Bourke network may be advertised to the market via an EOI process to enable the market to respond with alternative non network solutions. The response from the market could include another option not previously investigated by Essential Energy and could include other market benefits driven from 3rd party owned solutions. The basis of the EOI will be to request alternative energy storage or devices that can provide voltage reduction under any business model and operation conditions to ensure all new solutions can be assessed. Because of this approach, submissions may need to be reviewed against any applicable regulatory rules and if a solution is deemed to be economically viable, engagement with regulators may be required. Solutions from this market exercise will then be assessed against network solutions.

As such Option 3 does not have NPV analysis at this stage but will be considered as part of the project development.

5.4 Recommended Option

In recommending a preferred option, the initial capital costs are considered along with the NPV analysis of overall 40-year benefit, which is primarily based on increased life of customers' electronic equipment.

Option 2 to install 22kV reactors has a higher capital cost to replacing the 66kv regulator so does not provide the most value in this case.

Option 3 will be evaluated prior to Essential Energy commencing the project to ensure up to date market pricing and solutions are used in the final evaluation.

Option 1 to replace the 66kV Coolabah regulator to allow a larger buck tap range is lower cost than the alternative and provides the same benefit, giving more value and making this the recommended option.

6. Risk Framework

Essential Energy's Corporate Risk Management Procedure (6.03.01) and Network Risk Management Manual (6.03.02) underpins network investments in line with the risk Appraisal Value Framework (6.03.03) and provide a consistent approach to network asset risk management and augmentation evaluation. The purpose of the procedures is to estimate the level of risk via probability of failure, likelihood of consequence and evaluate cost of consequence for network investments. The framework looks at overall network risk across six key areas: Safety, Network (Reliability), Environment, Compliance, Reputation and Financial.

6.1 Safety

Safety consequence considers the risk to both public and Essential Energy personnel. Safety is not likely to be a major contributing factor to this investment as the level of overvoltage is minimal and not likely to cause a safety risk.

6.2 Environmental

All businesses must manage the risks their activities may pose to human health and the environment from pollution or waste. There is no environmental risk that needs to be addressed with this constraint.

6.3 Compliance

Compliance risk is assessed for issues that may arise because of not complying to relevant Standards, Acts or Guidelines. Essential Energy is exceeding the upper voltage threshold in the Australian Standard in this case, so there is the risk of compliance related costs which this project will aim to minimise.

6.4 Reputation

Reputational consequences are categorised as those risks associated with the tarnishing of the company's reputation. This investment will address a majority of the risk associated with solar PV tripping offline due to high voltage levels which is where most complaints are generated. This project will address a vast majority of these complaints

6.5 Financial

No Financial costs to Essential Energy in this instance as costs are borne by customers who have to replace their electronic equipment sooner and have their rooftop PV curtailed by high voltage levels.

References

Doc No.	Document Name	Relevance
1	Bourke High Voltage Options Comparison NPV.xlsx	NPV Option Analysis
2	ESS_1_Voltage_ValueCalc	Calculation method to value high voltages
3	6.03.01 Corporate Risk Management Procedure	Reference material
4	6.03.02 Network Risk Management Manual	Reference material
5	6.03.03 Appraisal Value Framework	Reference material, risk evaluation
6	11.01 Forecasts of Customer numbers, energy consumption and demand	Reference material

Key Terms and Definitions

Term	Definition
$M	Dollars expressed in millions
FY	Financial Year
MW	Megawatt
NER	National Electricity Rules
NPB	Net Present Benefit (Benefits over 40-year expressed in present value)
NPC	Net Present Cost (Capital and operation costs over 40-year expressed in present value)
NPV	Net Present Value
NPVM	Net Present Value to Market (NPB subtract NPC)
RIT-D	Regulatory Investment Test – Distribution
VCR	Value of Customer Reliability
VUE	Value of Unserved Energy

Appendix A – Value of high voltages

All figures are based on the ESS1 Value Calculator being applied to 12 months of smart meter data and scaled by the number of customers on the zone substation unless otherwise indicated. Cost outcome shown in Table 3.

Table 3: Cost due to Overvoltage / Annum

Reduced Life	Lost Equipment	Curtailment	Reputation	Compliance	Annual Cost
[redacted]					

Reduced Life

Electronic equipment is sensitive to high voltage, with the mean time to fail reduced as voltage increases. This measure is applied directly from the PIP1 value calculator.

Lost Equipment

If the voltage exceeds the supply standard there is a chance of electronic equipment failure, this measure is applied directly from the PIP1 value calculator.

Curtailment

Based on rooftop solar curtailment for voltages above the supply standard. The value of lost generation is 30c/kWh in the PIP1 value calculator which has been scaled down to 5c/kWh for this assessment to allow for the reduction in feed in tariffs since the PIP1 calculator was released.

Reputation

Cost to Essential Energy from reputational damage due to complaints of high voltages. This value has been scaled back by a factor of 30 from the PIP1 value calculator in line with the compliance cost below as we're considering every premise, not just the ones that complain and initiate a PIP1 value calculation.

Compliance

Cost to Essential Energy of compliance related activities from high voltages levels. The total compliance costs for all sites have been scaled back to the actual costs incurred on high voltage complaints, which results in a scaling of 1/30 from the PIP1 calculator.