Essential Energy
10.03.10 Augex Jelbart Reactors Investment Case

November 2022

Distribution Major Project

Project:	10.03.10 Augex Jelbart Reactors Investment Case
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Approvals

	Name	Division	Title & Function	Date
1.	[redacted]	Asset & 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	10.03.10 Augex Jelbart Reactors Investment Case
Description	Replace capacitors at the Jelbart Zone Substation with 2 x 6MVAr Reactors
Drivers for Investment	The driver of the investment is to reduce customer voltage levels on the electrical network supplied by the Jelbart 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 Jelbart 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 Jelbart area are as follows: [redacted]
Investment Options	Several options were considered to reduce voltage levels including. - Replacing the 132/22kV power transformer at the 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: - Install 22kV reactors at the Jelbart Zone Substation (NPV $7.9m)
Estimated Expenditure $FY24	2024/25: $0; 2025/26: $0; 2026/27: [redacted]; 2027/28: [redacted]; 2028/29: $0

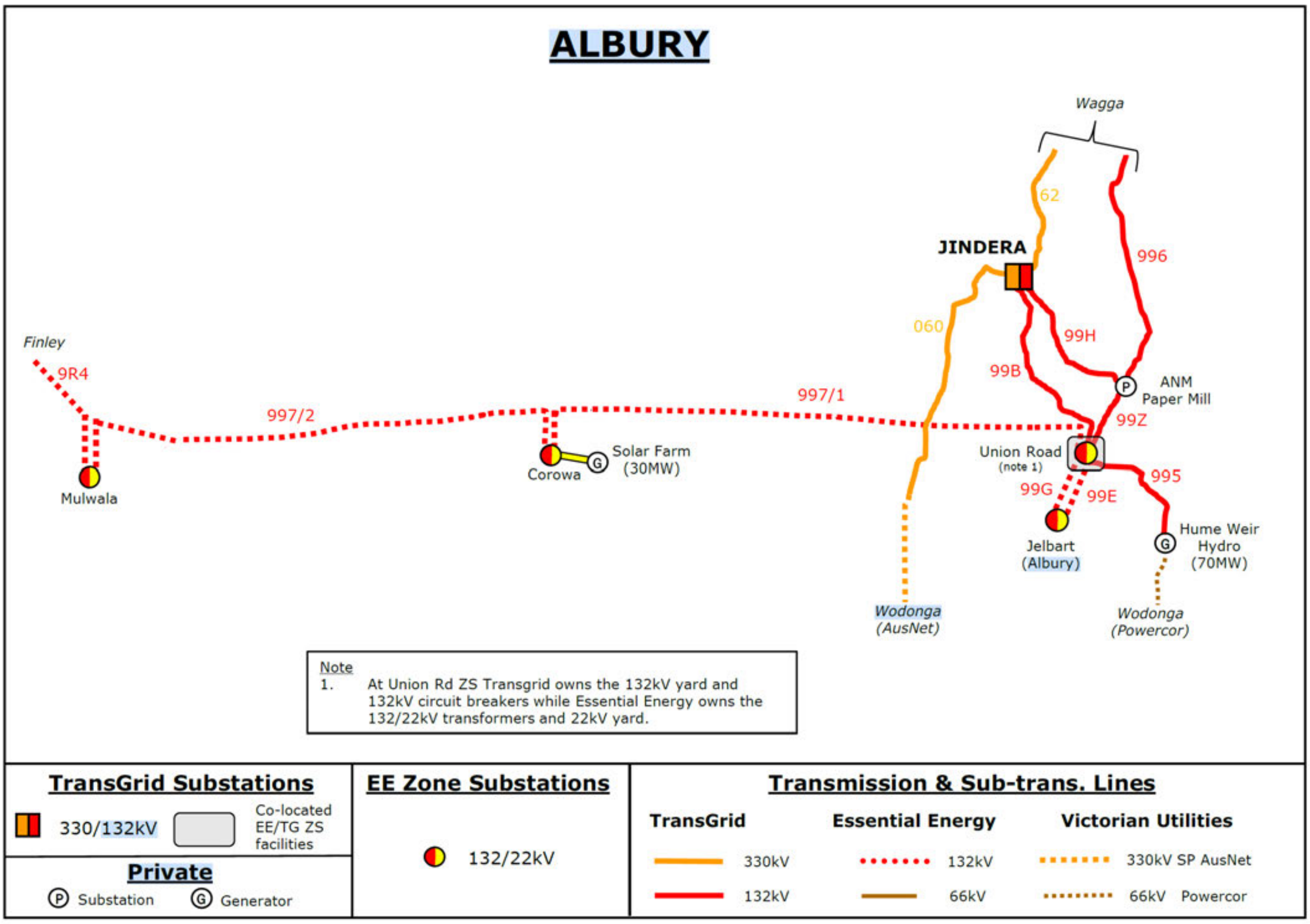
2024/25	2025/26	2026/27	2027/28	2028/29
$0	$0	[redacted]	[redacted]	$0

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

2. Network

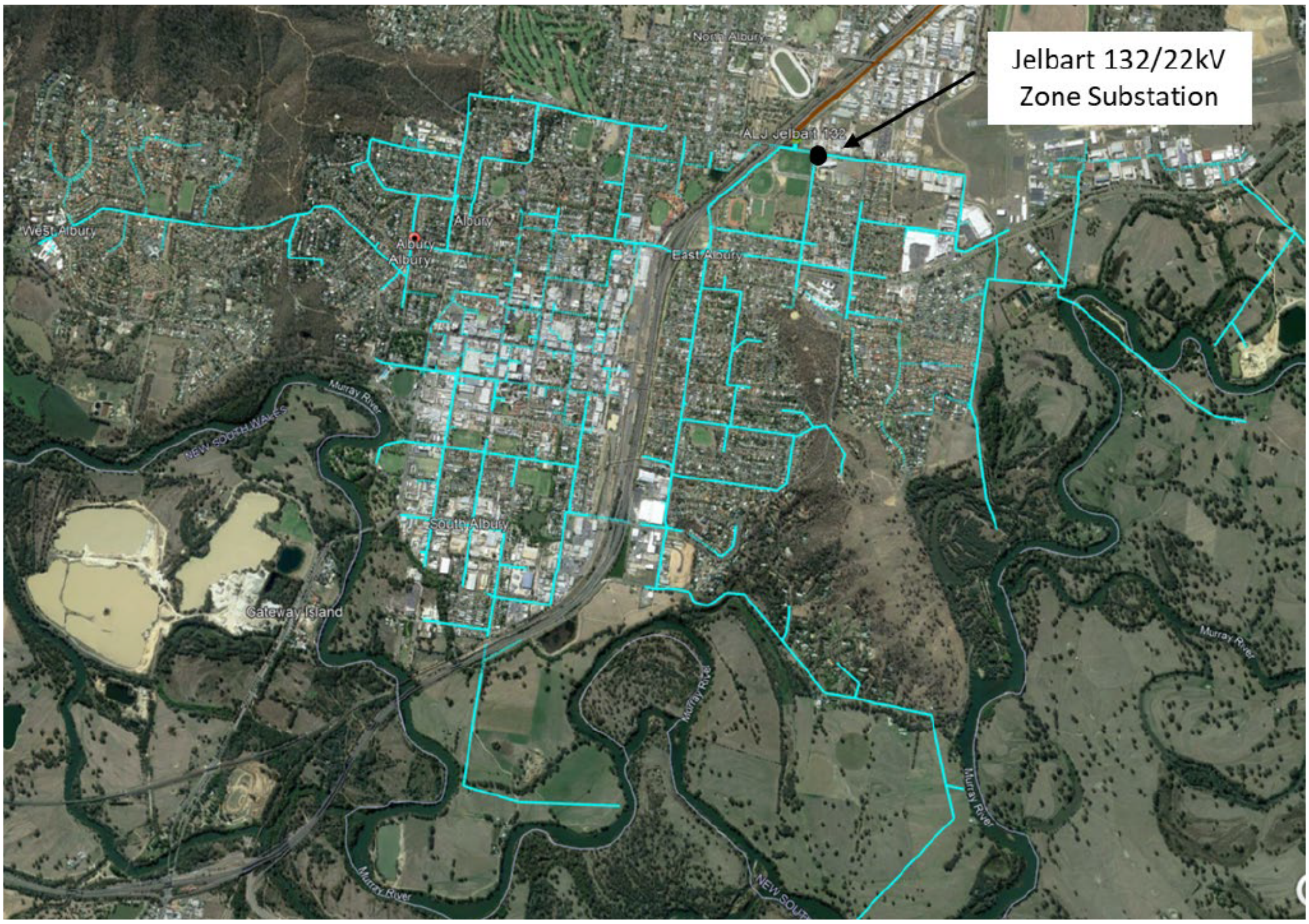
The Jelbart 132/22kV Zone Substation is supplied by two dedicated 132kV feeders from the Union Road Substation. Union Road is primarily supplied by the Jindera 330/132kV substation and provides a normally closed 132kV tie to the Corowa, Mulwala and Finley substations. The Jindera Zone Substation contains two 44MVA rated 132/22kV transformers.

Figure 1: Subtransmission Network supplying Albury



The Jelbart Zone Substation supplies the Albury 22kV network south of the substation including the Albury CBD as shown in Figure 2.

Figure 2: Jelbart Distribution Network



3. Load Growth

Strong growth is forecast by Frontier Economics (**Attachment 11.01**) for both the Jelbart and Union Road Zone Substations supplying Albury, as shown in Table 1.

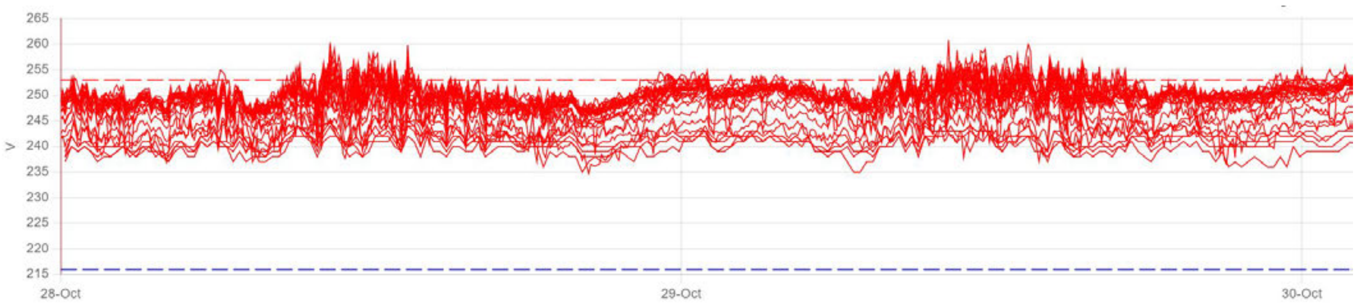
Table 1: Forecast Albury ZS Demand

Financial Year	Jelbart Summer (MVA)	Jelbart Winter (MVA)	Union Road Summer (MVA)	Union Road Winter (MVA)
2022	46.5	35.7	57.7	46.9
2023	46.5	36.0	58.1	48.1
2024	47.0	36.9	59.4	49.8
2025	48.2	38.4	61.6	52.3
2026	49.9	41.0	65.1	56.1
2027	52.4	43.9	69.0	60.7
2028	52.6	44.3	69.8	62.1
2029	52.4	44.7	70.5	63.2

4. Identified Need

High voltage levels have been recorded across the Jelbart network from customer smart meters. Figure 3 shows a voltage trace from 28th to 30th October 2022 for the West Albury feeder suppling residential load to the west of the Albury CBD.

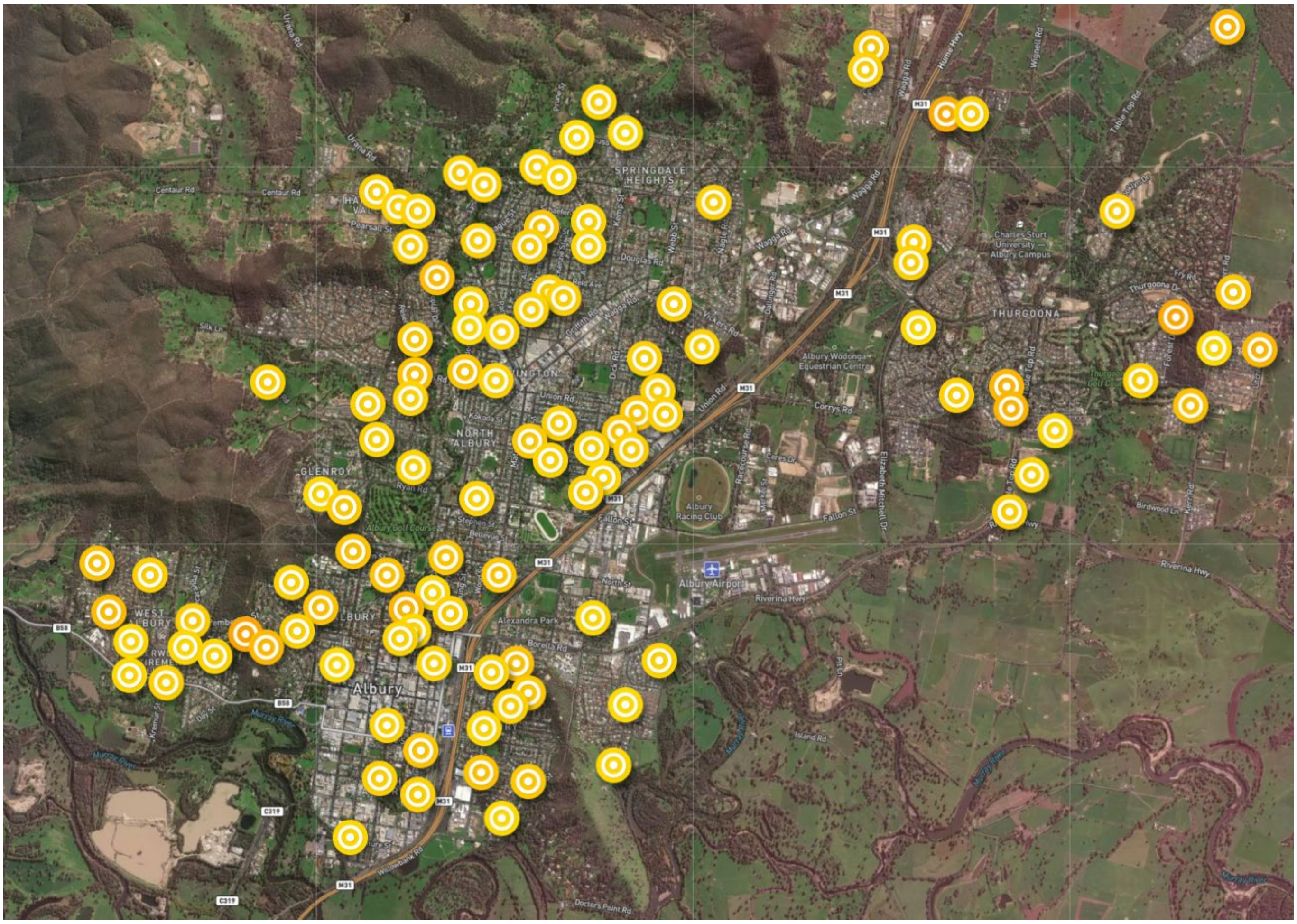
Figure 3: Smart meter Voltage Trace for West Albury (Urban) Feeder in October 2022



This trace show voltages above the 253V upper limit in the Australian standard at all times of day, but especially exacerbated by rooftop solar generation in daylight hours.

High voltage issues are not confined to a single area in Albury, widespread high voltage issues are demonstrated in Figure 4, which highlights transformers that have experienced a high voltage issue between August and November 2022.

Figure 4: High Voltage Issues Detected in Spring 2022



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]					

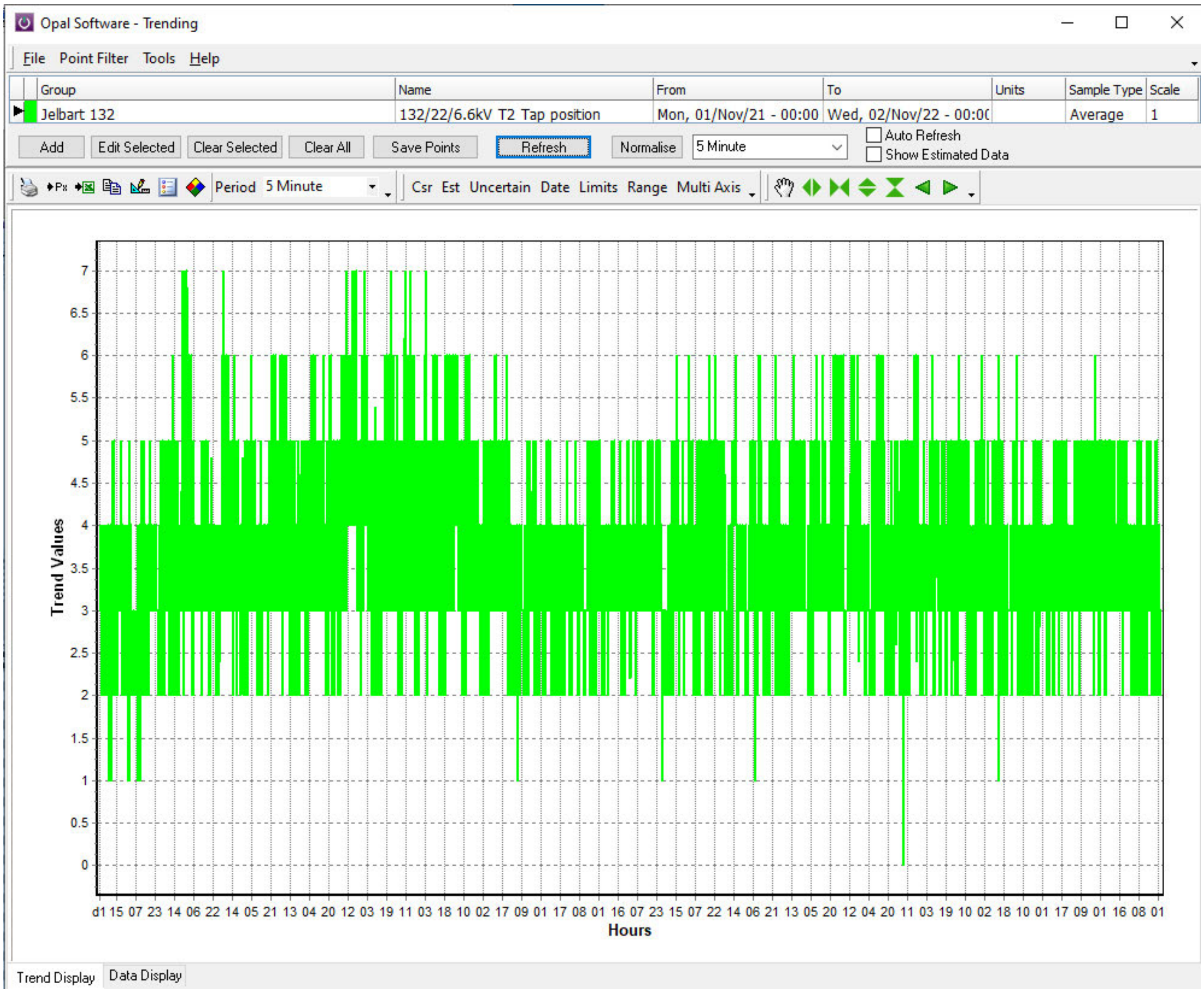
The Jelbart Zone substation contains two 44MVA rated transformers which have overload capability, but the cyclic rating of the substation is limited to 1200A by the rating of the 22kV switchboard that caps overload to a maximum of 46MVA. Demand on the Jelbart Road substation is forecast to exceed the cyclic rating of the substation in 2022, with limited options to upgrade the substation due to the undersized ducts for 22kV transformer cables and lack of spare ducts to install additional cables. Albury has an interconnected 22kV network between the Union Road and Jelbart Zone Substations, with the only feasible option to move load to the Union Road zone substation over the 22kV network.

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

Smart meter recordings show that a vast majority of the issues on the Jelbart network are caused by high voltages, with very few low voltage issues being recorded. Moving the voltage setpoint 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 lack of buck tap on the 132/22kV power transformer, which is limited to a ratio of 1.05 p.u between the HV and LV sides of the transformer. Figure 5 shows the tap position of the 132/22kV transformer from November 2021 to November 2022, which shows limited scope to adjust voltage down. This issue also limits the effectiveness of future network options, such as closed loop voltage control to improve the voltage levels, as this relies on the ability to adjust voltage levels at the zone substation.

Figure 5: Jelbart 132/222kV Transformer Tap Position Nov 2021 to Nov 2022



The 132/22kV transformer tap changers will limit any change to the 22kV bus voltage at the Jelbart Zone Substation.

In August 2021, Transgrid adjusted the 132kV AVR setpoint down at Jindera following a request from Essential Energy to help move the Albury transformers off tap 1. This change helped the issue of the transformers hitting tap 1 and calling for lower, but the scope for Transgrid to lower the voltage further is limited by high load N-1 constraints on the 132kV network.

5.1 Option 1 – Replace 132/22kV Power Transformer at Zone Substation

Replacing the 132/22kV Power Transformer at the Jelbart Zone Substation would allow for a greater buck tap range to be specified for the new transformer. The existing Jelbart 132/122kV transformer has a 5% buck range, where Essential Energy's new specification requires a 10% buck range. This additional range would allow the zone substation 22kV voltage level 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. Essential Energy's maintenance policy dictates that the spare transformer must be put into service for a one month period every year for condition monitoring, which would require the 22kV voltage to be raised to accommodate the lower tap range of the standby unit. This reduction in benefit has been allowed for in the calculated benefit.

Option 1 has estimated capital cost of [redacted] and a Net Present Value of $7.5M.

5.2 Option 2 - Install 22kV reactors At Jelbart Zone Sub

Installing switched reactors at the Jelbart Zone substation would allow inductive reactive power to be switched in when the 132kV voltage exceeded the tap range of the power transformer. Inductive reactive power flowing through the reactive impedance of the power transformer would produce a voltage drop, allowing the 22kV voltage to be reduced. Based on the impedance of the existing transformers it is calculated that two 6MVAr reactors would be required at the Jelbart Zone Substation. There are two 22kV capacitors at the Jelbart Zone substation that are no longer required as the reactive power at Jelbart has fallen substantially over the last 10 years, presenting the opportunity to replace the capacitors with reactors at an estimated cost of [redacted]. As the reactors would be replacing existing capacitors the maintenance cost at the substation is not expected to increase. 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 $7.9.

5.3 Option 3 - Market led Non-Network Solution

The requirements to improve voltage levels on the Jelbart 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 1 to replace a 132/22kV power transformer to allow a larger buck tap range is a feasible option to address the high voltage issue, but the value of this option is limited by the requirement to have the non-duty transformer in service for 1 month per year, giving this option less value than the alternatives.

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 2 to install 22kV reactors has a similar capital cost to replacing a transformer but will provide a year round solution to the voltage issue, providing the best value in this case.

6. Risk Framework

Essential Energy's Corporate Risk Management Procedure (**Attachment 6.03.01**) and Network Risk Management Manual (**Attachment 6.03.02**) underpins network investments in line with the risk Appraisal Value Framework (**Attachment 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

Financial costs in this instance 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	Jelbart 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.

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.