

Essential Energy

10.03.14 Augex Dubbo West Transformer Replacement Investment Case



November 2022

Distribution Major Project

Project: 10.03.14 Augex Dubbo West Transformer Replacement Investment Case

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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

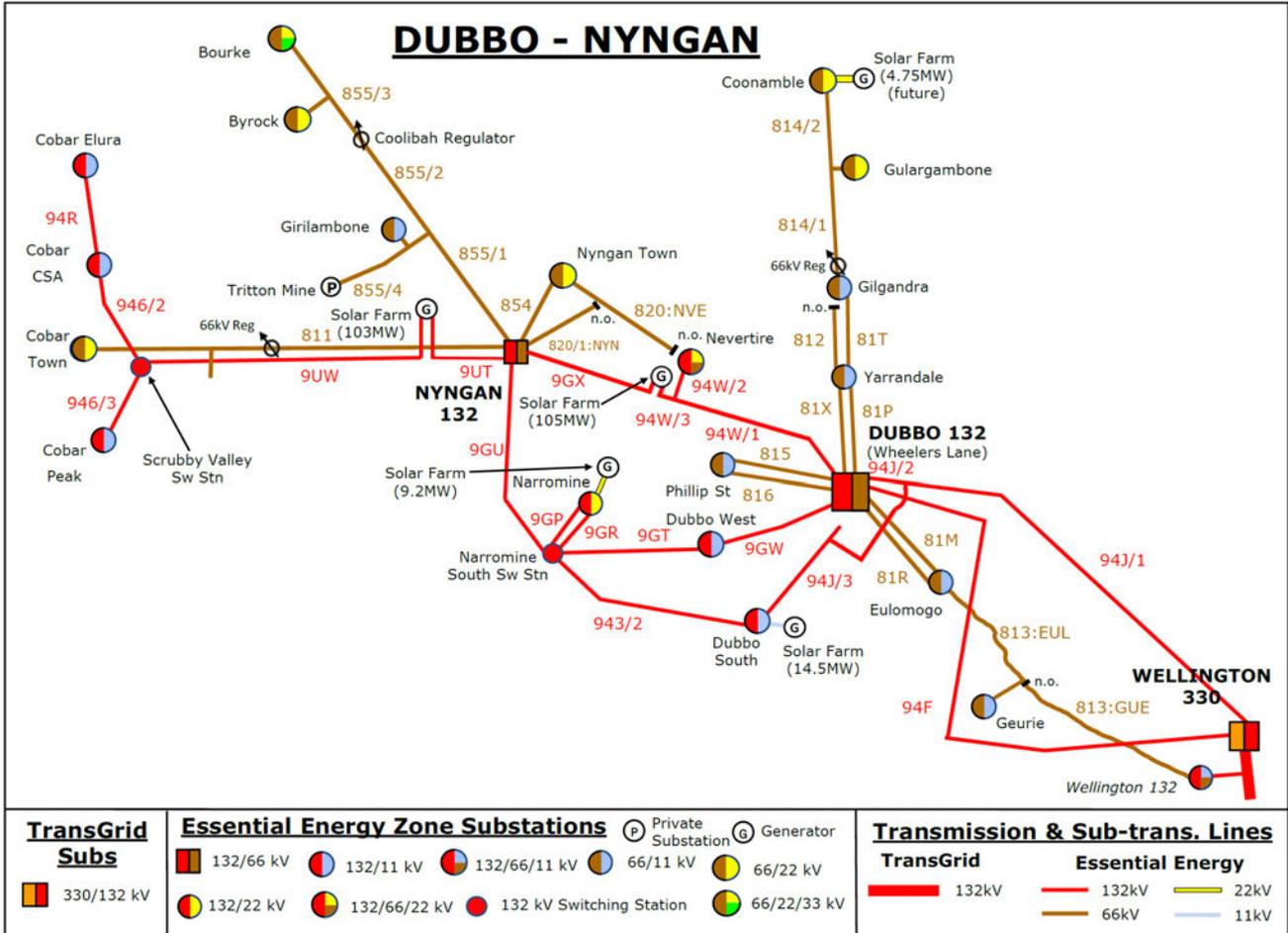
Major Project	10.03.14 Augex Dubbo West Transformer Replacement Investment Case				
Description	Replace 132/11kV Transformer at Dubbo West with higher tap range unit				
Drivers for Investment	<p>The driver of the investment is to reduce customer voltage levels on the electrical network supplied by the Dubbo West Zone Substation to meet NER 6.5.7 capital objectives. There are periods where high voltages are recorded at premises across the network.</p> <p>Financial:</p> <p>Electronic equipment is susceptible to failure and decreased life expectancy when exposed to high voltages. The impact on customer equipment supplied from Dubbo West is estimated to be as follows:</p> <div data-bbox="518 779 1093 920" style="background-color: black; width: 100%; height: 100%;"></div> <p>Reputation and Compliance:</p> <p>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 Dubbo West area are as follows:</p> <div data-bbox="518 1077 1042 1151" style="background-color: black; width: 100%; height: 100%;"></div>				
Investment Options	<p>Several options were considered to reduce voltage levels including.</p> <ul style="list-style-type: none"> - Installing 11kV reactors at the Dubbo West 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. <p>The option recommended from the Net Present Value of cost and benefit is as follows:</p> <ul style="list-style-type: none"> - Replace the 132/11kV power transformer at Dubbo West (NPV \$2.0m) 				
Estimated Expenditure \$FY24	2024/25 \$0	2025/26 \$0	2026/27 \$0	2027/28 \$0	2028/29 █

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

2. Network

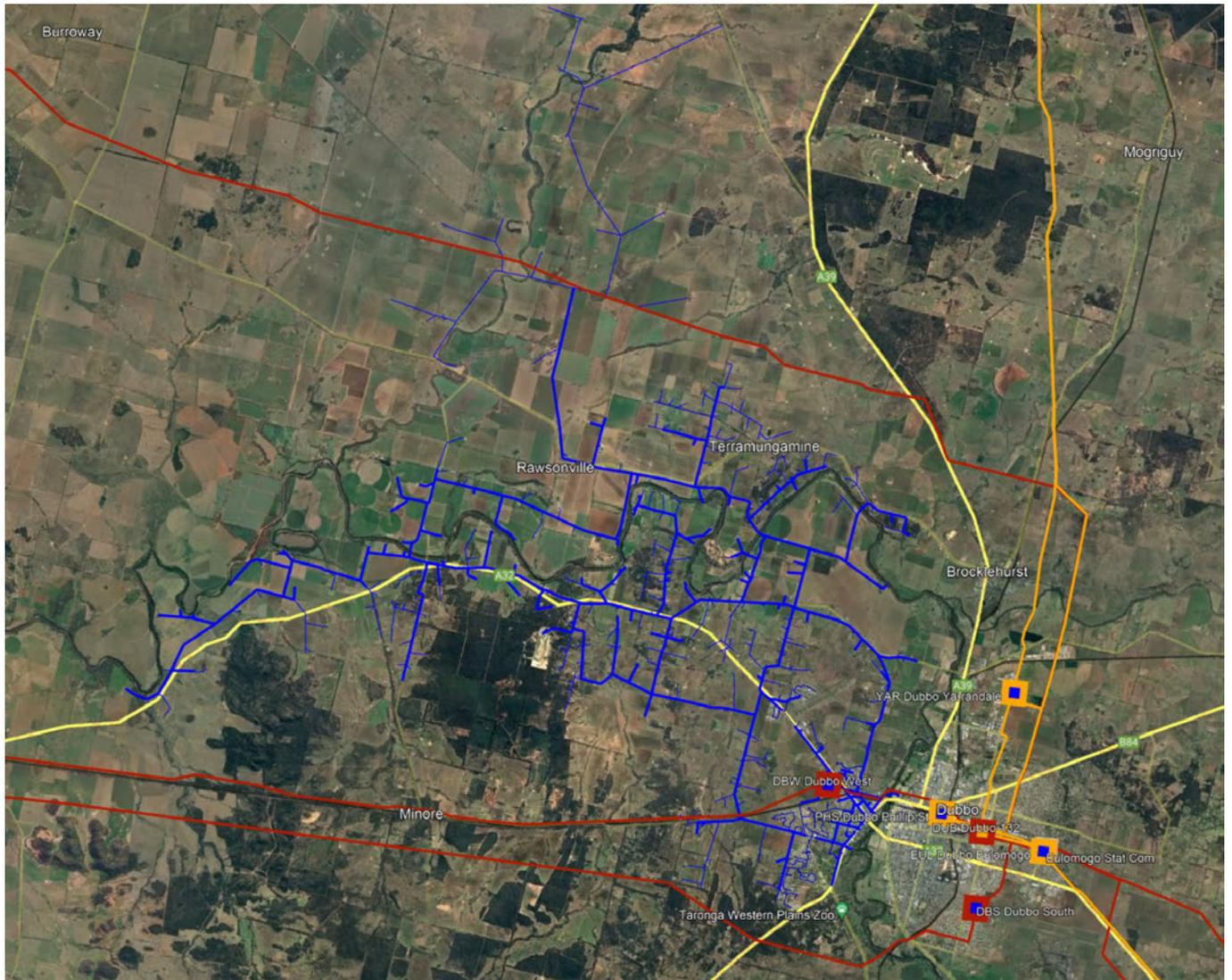
The Dubbo West 132/11kV Zone Substation is supplied by a normally closed 132kV ring network between the Dubbo 132kV Substation and Narromine South Switching Station. The Dubbo West Zone Substation consists of in and out 132kV line circuit breakers and two 30MVA 132/11kV transformers. The network supplying Dubbo West is shown in Figure 1.

Figure 1: Subtransmission Network supplying Dubbo West



The Dubbo West Zone Substation supplies residential Dubbo load and rural load to the west of Dubbo as shown in Figure 2.

Figure 2: Dubbo West Distribution Network



3. Load Growth

Moderate growth in peak demand is forecast by Frontier Economics (Attachment 11.01) for Dubbo West, as shown in Table 1.

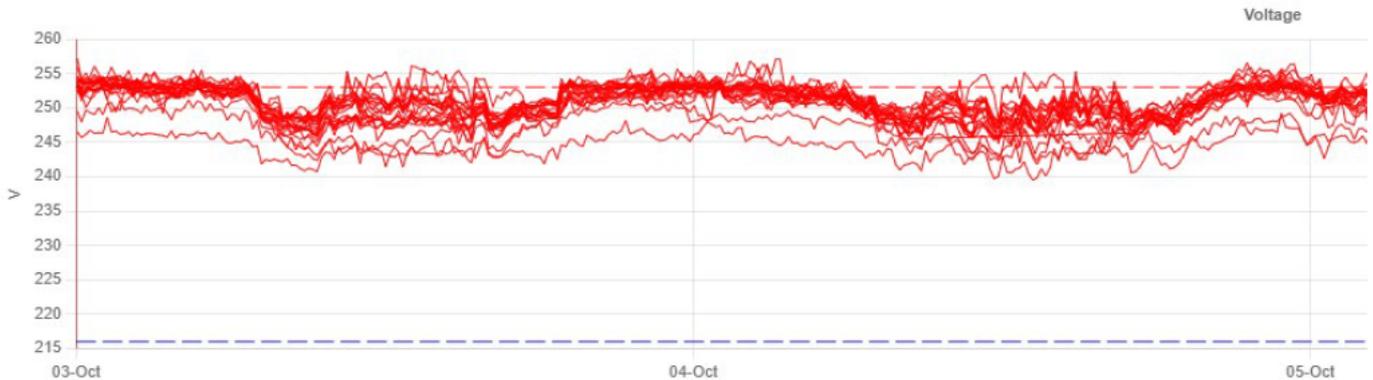
Table 1: Forecast Dubbo West ZS Demand

Financial Year	Dubbo West Summer (MVA)	Dubbo West Winter (MVA)
2022	17.8	13.3
2023	17.9	13.4
2024	18.0	13.5
2025	17.7	13.5
2026	17.9	13.7
2027	18.1	14.0
2028	18.2	14.2
2029	18.2	14.1

4. Identified Need

High voltage levels have been recorded across the Dubbo West network from customer smart meters. Figure 3 shows a voltage trace from 3rd to 5th October 2022 for the West/South feeder supplying residential load in Dubbo City

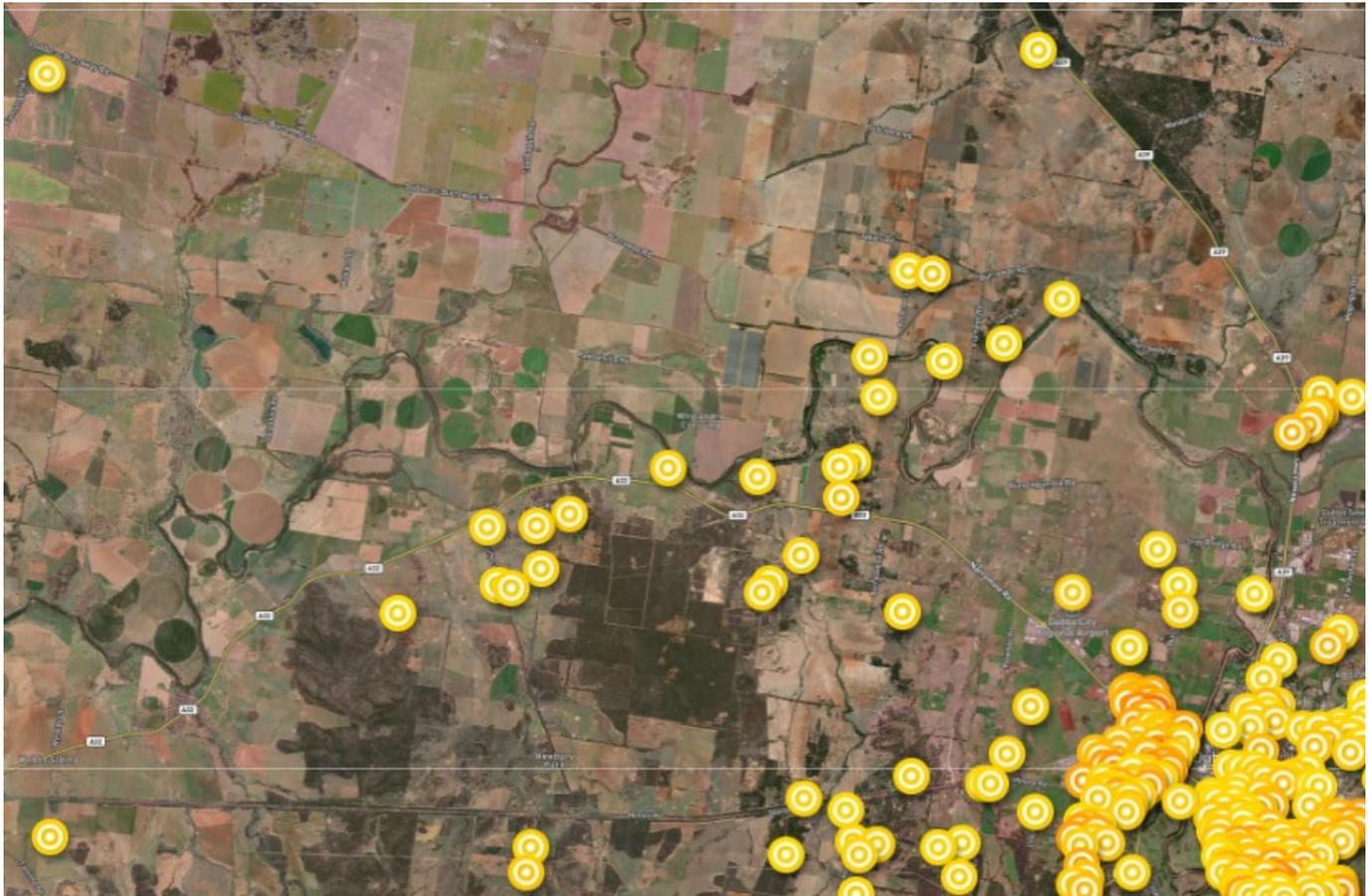
Figure 3: Smart meter Voltage Trace for West/South (Residential) Feeder in October 2022



This trace is unusual in that average voltages are higher during the night than the day at Dubbo West. This is caused by the voltage control setting of the Nevertire solar farm reducing 132kV voltages during the day that then rise on the lightly loaded 132kV network at night. The voltage trace shows voltages above the 253V upper limit in the Australian standard during both the day and night, being impacted by both high voltages on the lightly loaded 132kV network at night and rooftop solar generation during the day.

High voltage issues can be seen in Dubbo city where and in the rural area to the northwest of Dubbo. 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 the Dubbo West 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

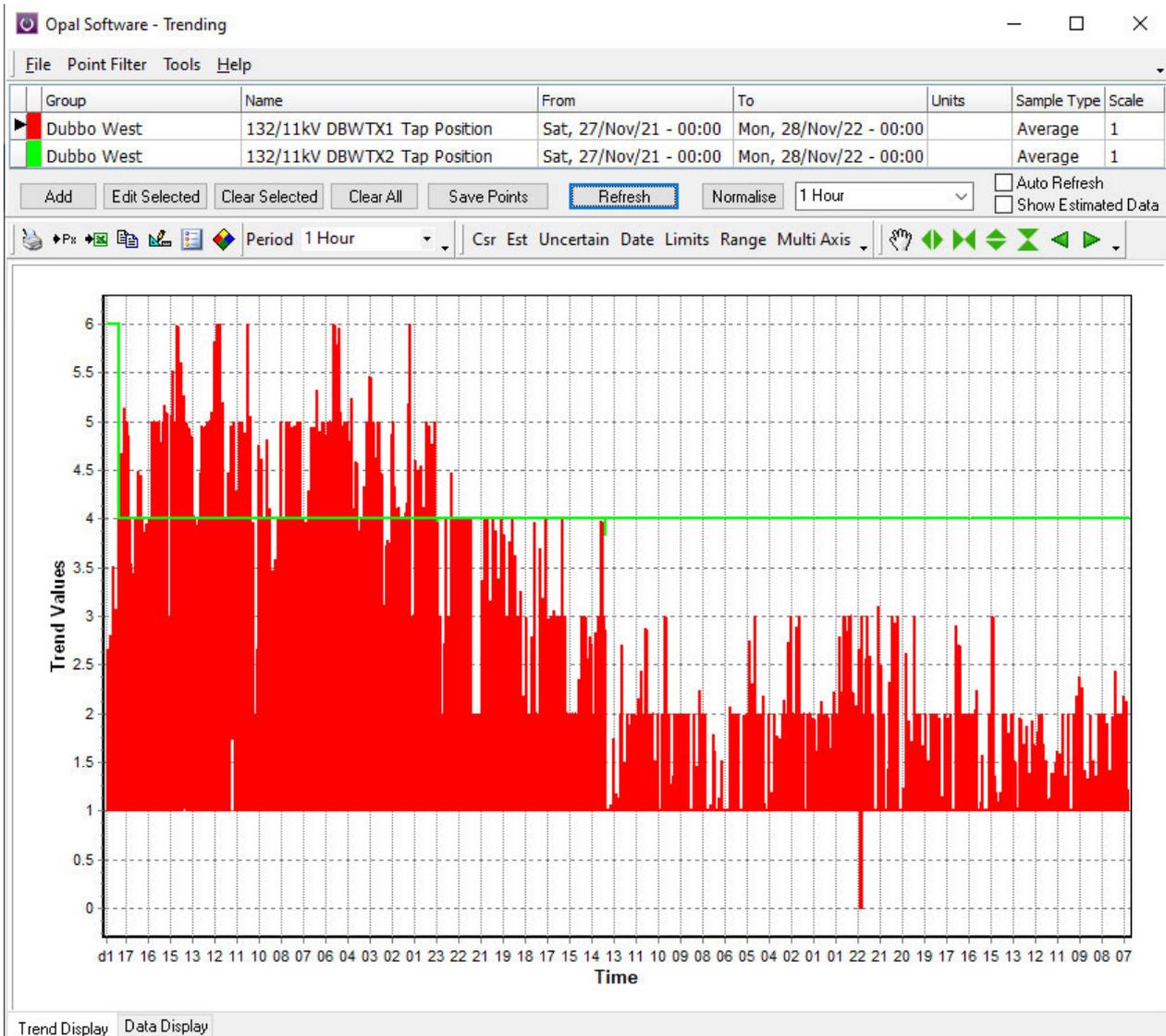
Reduced Life	Lost Equipment	Curtailement	Reputation	Compliance	Annual Cost

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 Dubbo West 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 132/11kV power transformer, which is limited to a ratio of 1.05 p.u between the HV and LV sides of the transformer. This issue also limits the effectiveness of future network options, such as closed loop voltage control to improve the voltage levels at Dubbo West, as this relies on the ability to adjust voltage levels at the zone substation. Figure 5 shows the tap position of the 132/11kV transformers from November 2021 to November 2022, which shows no scope to adjust voltage down.

Figure 5: Dubbo West 132/11kV Transformer Tap Position Nov 2021 to Nov 2022



The 132/11kV transformer tap changers will limit any change to the 11kV bus voltage at the Dubbo West Zone Substation.

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

5.1 Option 1 – Replace 132/11kV Power Transformer at Zone Substation

Replacing the 132/11kV Power Transformer at the Dubbo West Zone Substation would allow for a greater buck tap range to be specified for the new transformer. The existing Dubbo West 132/11kV transformers have a 5% buck range, where Essential Energy's new specification requires a 10% buck range. This additional range would allow the zone substation 11kV 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 11kV 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 \$2.0m.

5.2 Option 2 - Install 11kV Reactors at Zone Sub

Installing switched reactors at the Dubbo West 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 11kV voltage to be reduced. Based on the impedance of the existing transformers it is calculated that three 4MVAR reactors would be required at the Dubbo West Zone Substation. There is limited space in the existing fenced yard at Dubbo West so allowance to extend the zone substation yard and fence has been included in the estimated upfront and maintenance cost of this option. The reactors have a 25 year life, so allowance has also been made to replace the reactors in 25 years' time

Option 2 has estimated capital cost of [REDACTED] and a Net Present Value of -\$0.4m.

5.3 Option 3 - Market Led Non-Network Solution

The requirements to improve voltage levels on the Dubbo 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 11kV reactors provides the most benefit, as the solution will reduce voltages when the substation is supplied by both transformers, but with a much higher capital cost due to the need to extend the Dubbo West substation this option has less value than the alternative.

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 a 132/11kV power transformer to allow a larger buck tap range is the preferred option in this case as the capital cost is lower for this option, producing better value overall.

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	Dubbo West 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	Curtailement	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.

Curtailement

Based on rooftop solar curtailement 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.