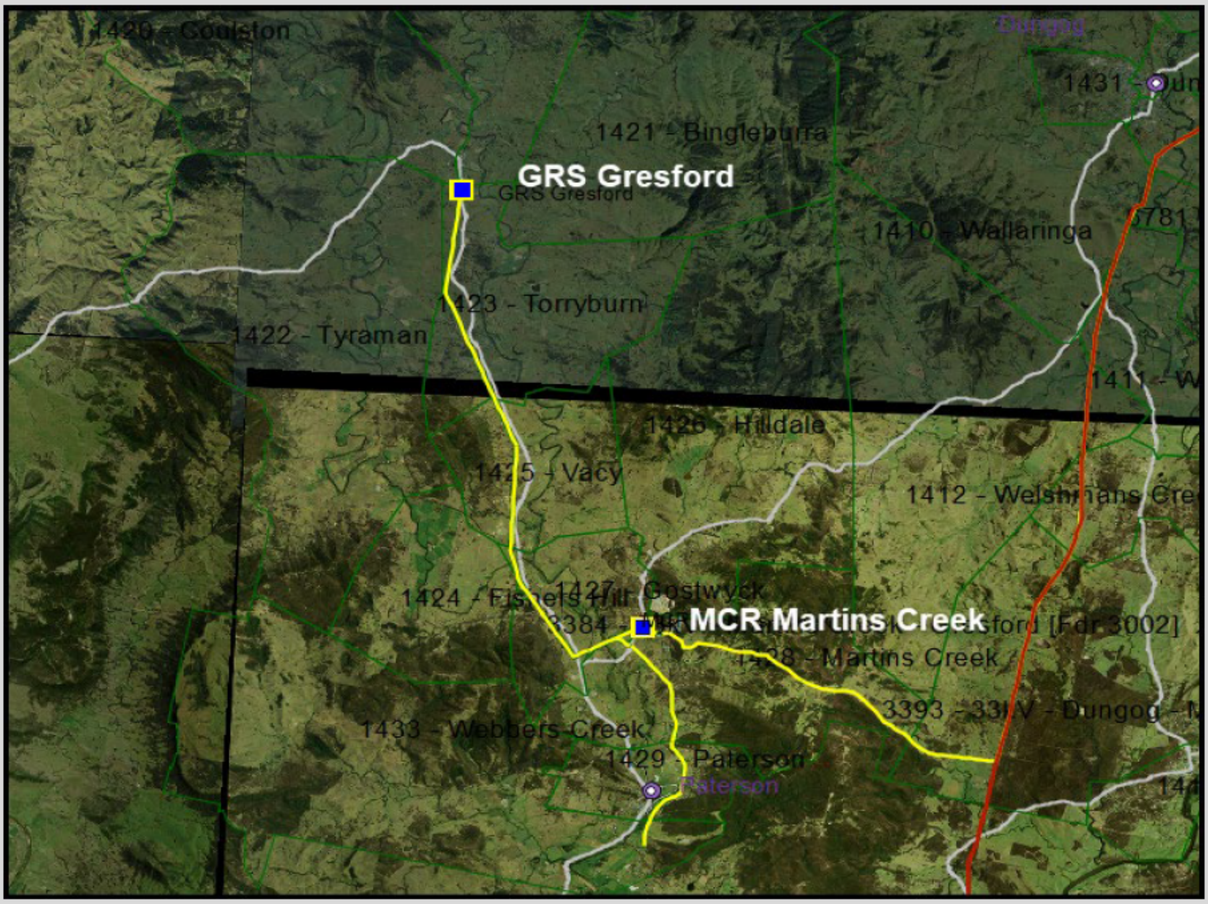
Essential Energy

10.06.06 Resilience Gresford Network Investment Case



October 2022

Network Resilience Project

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Approvals

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

Revisions

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

Table of Contents

1. Executive Summary

Major Project	10.06.06 Resilience Gresford Network Investment Case
Description	Establish back up supply to Gresford ZS
Drivers for Investment	Resilience: To improve the resilience of the network for customer on the Gresford ZS as historical reliability performance is unacceptable and outside applicable standards. Poor reliability performance is primarily caused by lightning and wind, with impact from climate analysis forecasting a significant increase in wind in this area. Following weather events there has been extended periods of power outages, including: 6/03/2019: 25 hours 4/04/2020: 3 hours 27/02/2020: 3 hours Reliability: To improve reliability for those customers in the Gresford ZS. This will also maintain the safety, quality, and security of supply of the network as per NER 6.5.7 capital objectives. Strong customer support for proactive resilience projects including microgrids (refer 4.02 How engagement informed our Proposal).
Investment Options	Options considered to improve customer reliabilty included: > Diesel Generation > Network solution > Battery backup > Market Non-network solution > Lightning protection (excessive capital costs, excluded from further analysis) Due to the scale 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 following option was investigated in detail and evaluated using Net Present Value of cost and benefit: > Diesel Generation (NPV of $7.3M)
Estimated Expenditure FY24$	2024/25: $0; 2025/26: [redacted]; 2026/27: [redacted]; 2027/28: $0; 2028/29: $0

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

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

2. Network

The Stroud 132/33kV sub-transmission substation is owned by Essential Energy, it receives supply via two Transgrid 132kV lines. The sub-transmission supply to Martins Creek and Gresford is taken from Stroud, with the radial 33kV 7J1 from Martins Creek ZS to Gresford ZS being 17km in length. The conductor type on this line is Ferret 6/1/0.118 ACR.

The network at this location is highly susceptible to lightning strikes, with storm/lightning fronts impacting the full length of the line which has no OHEW other than the 1km emanating from each zone substation. The forecasted load for Gresford ZS is 2.6MVA.

A significant constraint on this feeder is its co-existence with the 11kV networks GRS3B3 Gresford Rd and MCR3B4 Vacy. If works, planned or unplanned, are required on the 11kV network, it will often require the 33kV network to be isolated for safety resulting in the loss of all load at Gresford ZS.

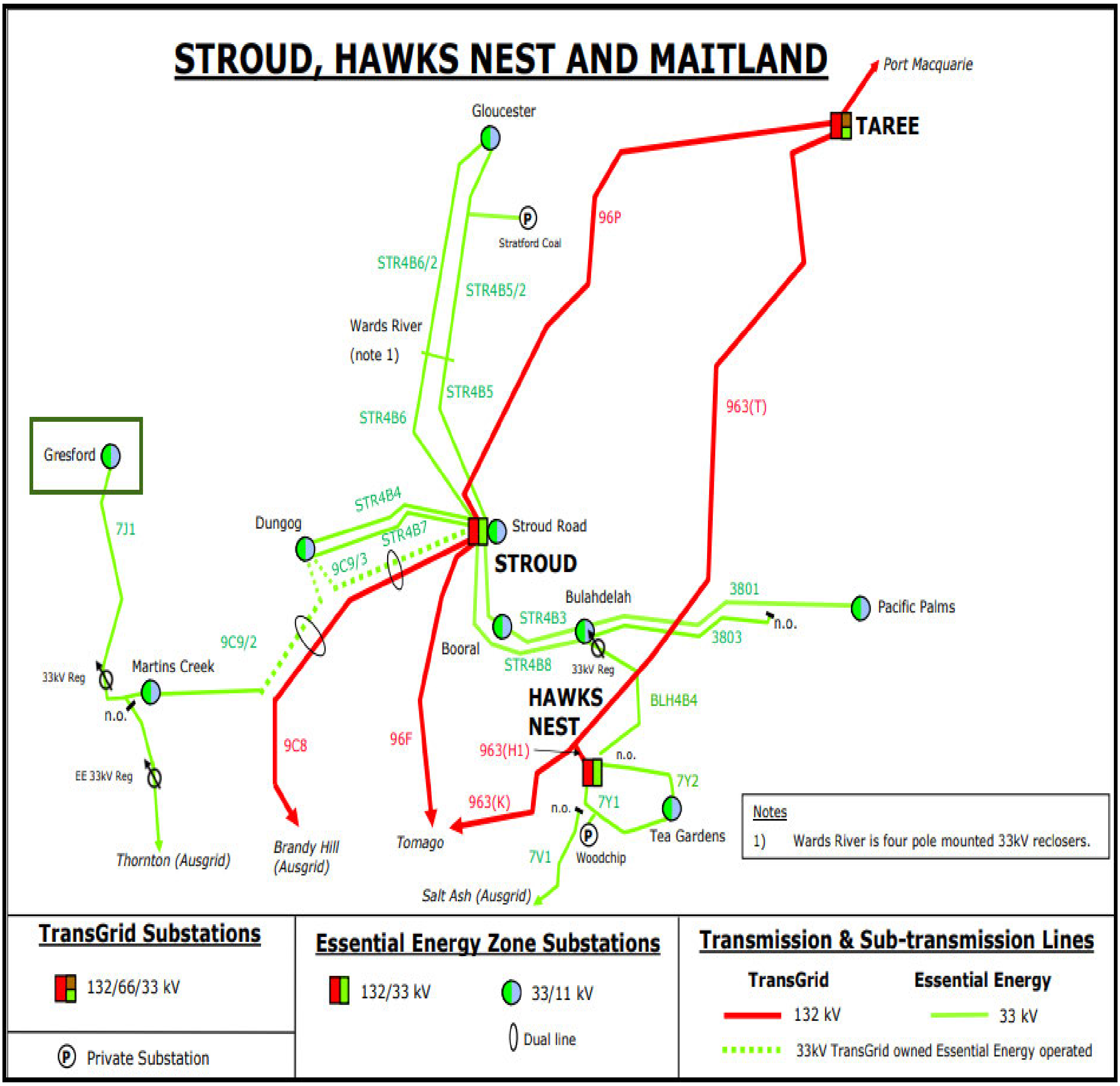

Figure 1 - Simplified Subtransmission Network

Asset inspection cycles include a ground inspection every five years and aerial photo inspections (drone), also every five years. To minimise planned customer outages, the feeders are mostly maintained live line.

3. Reliability

Based on historical performance data the reliability of the 33kV Subtransmission at this location network is mainly affected by weather and equipment fatigue.

For faults on this feeder, resources patrol the feeder visually via adjacent public roads and other access tracks. Depending on weather and night/daytime, patrols may take several hours. Once the fault is found, emergency repairs are usually completed straight away.

Typical storm/lightning faults impact overhead assets including the pole top; crossarm or insulators. Conductor or pole faults are less common however, this failure mode has contributed to long duration outages due to access conditions and mobilisation of plant.

Historical outage data indicates there is an average of 2.7 unplanned outages per annum, slightly above typical rates for an unshielded 33kV feeder which on average is 2.5 outages/100km/annum. Due to the conditions and patrol requirements the average outage timeframe is approximately 5 hours.

Maintaining a reliable supply is a key investment driver in determining network augmentation expenditure.

Examples of some of the longer outages that have occurred are detailed below:

6/03/2019: 25 hours; Due to lightning and storm multiple faults reported as vegetation fallen from outside the corridor. Multiple spans wires down from pole to pole.

Figure 2 – Vegetations fallen across the wire INCD-2095253-a

4/04/2020: 3 hours; Due to wind contributed to the equipment fatigue. The main cause was a broken insulator pin Pole 97069077.

27/02/2020: 3 hours; Burnt out blades on ABS on the 33kV.

Figure 3 – Broken insulator INCD-20100-r

Further historical reliability data for this feeder can be found in Appendix A which shows the vast majority of outage causes attributed to adverse weather conditions. The SAIDI and SAIFI of the 3 feeders is as shown in Figure 4. The longest feeder is 126km in length with 486 customers.

The breach of Licence Conditions reliability standards has occurred primarily due to SAIDI thresholds being exceeded. The feeder GRS3B1 is currently compliant but was non-compliant in June 2020 quarter.

Figure 4 - SAIDI/SAIFI Performance of the GRS3B1 feeder

3.1 Climate Impact Assessment

This project forms part of our Resilience Plan (**Attachment 6.02**) and strengthening the network. As shown in Figure 5 below, the line is located in an area forecast to have increased asset damage of approximately 30% combined impact from bushfire, flood, and windstorm by RCP4.5 in 2070, as informed by the findings ot our climate change impact assessment.

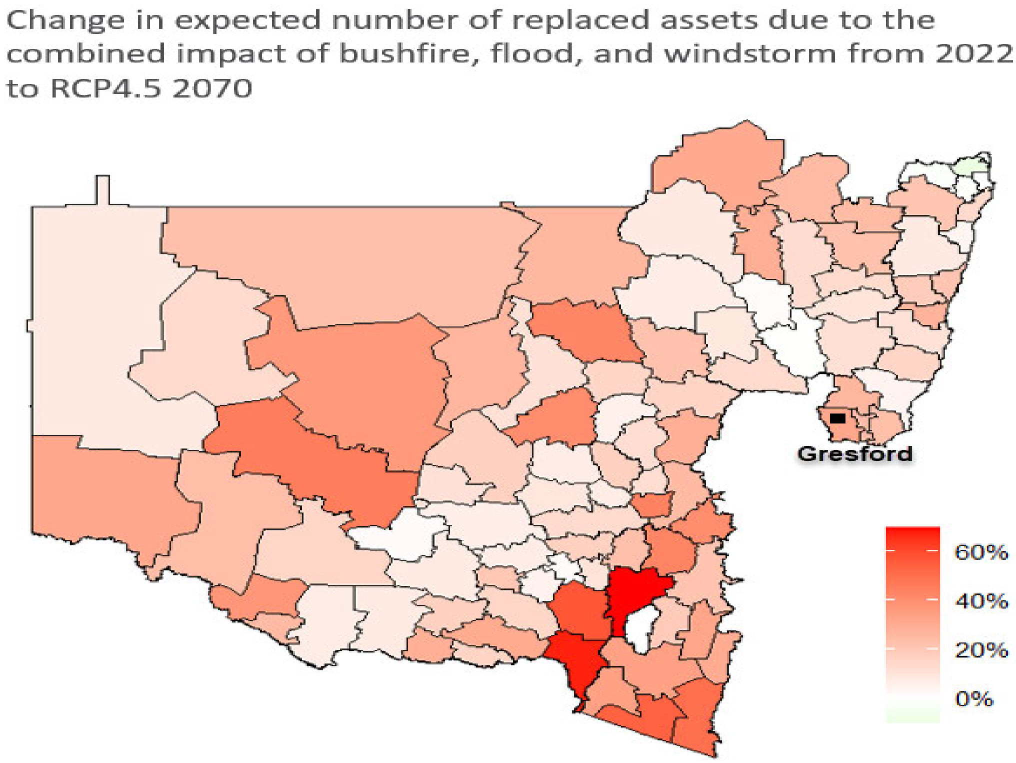

Figure 5 – Expected increase in asset replacement due of climate impact (**Attachment 6.01 Climate Impact Assessment)**

Based on the climate modelling analysis, climate is predicted to have an increasing impact on the network in this area as shown in Figure 6, thus increasing the criticality of the electrical supply for at risk customers.

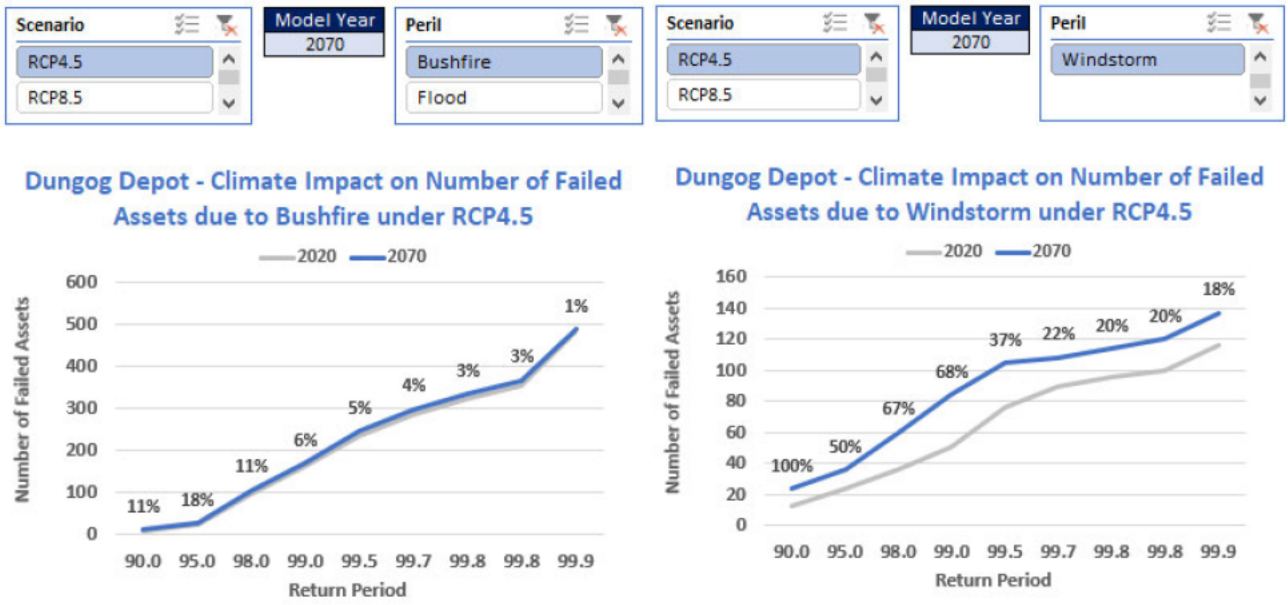

Figure 6 - Forecasted analysis of climate impact (Source 6.01.01 Climate Summary Line Graph)

Climate impact modelling been included in the NPV analysis for this project but does offer additional qualitative benefits.

4. Options Analysis

Several options were investigated to improve reliability in the Gresford ZS. The option for lightning protection was ruled out of further analysis due to excessive capital costs due to the length of exposed network. A further three options were identified and compared via Net Present Value (NPV) analysis. NPV analysis considers both costs and benefits over typical life of asset (40 years). Costs include both capital and operating. The key benefit in this case is the Value of Customer Reliability (VCR).

Beyond reliability benefit other risk value benefits were considered as per Appraisal Value Framework (**Attachment 6.03.03**). The benefit of alleviating specific network risks such as safety, environment (bushfire), financial, reputation and compliance were also considered. A summary of the risk framework assessment is detailed below in Section 5

Table 1 includes the primary variable assumptions to calculate the Baseline risk of the overhead network supplying the Gresford ZS.

Table 1 - Variables for Baseline Risk

Variable	Value	Source
Discount Rate	3.54%	Current internal rate for standard control CAPEX
Failure Rate of OH Line	2.7	Historical performance over the past seven years
Load Impacted	2.4MVA	Average customer load in Gresford ZS
Outage Timeframe	5hrs	Historical performance over the past ten years
NPV Period	40yrs	Current internal common modelling window

4.1 Option 1 - Diesel Generation- Gresford ZS

This option has a capital cost of [redacted] and would require a diesel powered generator unit to be installed at the Gresford ZS. The unit would be semi containerised standard 415V output and connect to the 11kV busbars at the local zone substation via a 415V/11kV step-up transformer. Considering peak demand, optimised generator protection and operation, two 1.5MVA units would be installed at the secondary busbar of Gresford ZS. The units would have fuel storage for at least eight hours of running.

The NPV analysis assumes the life of the generators to be 20 years, thus for the 40-year NPV analysis the cost of a replacement of the generator at 20 years has been considered. For the purpose of residual risk, a conservative assumed failure rate of 1 in 10 years has been included for the diesel generator in the event that the generator fails to supply the ZS.

Qualitative benefits exist for this option that have not been quantified in the NPV analysis. In particular generation will allow field staff to perform construction activities for both unplanned and planned outages. This benefits field staff in reducing time constraints on outage timeframes and the requirement to perform live-line work. Planned outages for customers will also reduce as the generator can be utilised during activities that can't be performed live. Fault and emergency response can be better planned (i.e. resources, materials etc) improving efficiencies.

On loss of the 33kV supply, the 11kV transformer circuit breakers would open, and generator start-up would occur within minutes.

Option 1 has estimated capital cost of [redacted] and a Net Present Value of $7.3M and an impact to STPIS targets included in Service Target Performance Incentive Scheme (STPIS) Approach (Attachment 8.04).

4.2 Option 2 – Line Duplication

Historically the main components that resulted in the highest Customer Minutes Lost (CML) were pole top failure and conductor damage caused by vegetation contact that occurred during storm activity. The network solution would be to construct a second 33kV feeder to Gresford ZS thereby creating an alternate supply. This solution will reduce outage times but is restricted by the time taken to validate the fault and ensure the alternate supply can be safely and practically utilised.

Unplanned outages due to weather and subtransmission failures will still be an ongoing issue. Therefore, this option was deemed economically unfeasible.

Option 2 has a capital cost estimated in excess of [redacted] and is deemed uneconomical.

4.3 Option 3 Battery Back-up Storage for Gresford ZS

A battery storage option would require installation of containerised battery banks at Gresford ZS.

The battery banks would be connected directly to the to the 11kV busbars. On loss of the 33kV supply, auto-changeover to the battery banks would occur. With a peak demand of 2.4MVA, the battery banks would need significant capacity to provide backup supply over the extended unplanned outage periods, which is anticipated to be at least 24 hours.
The advantages of battery storage are they are fast acting sources of supply, they are relatively quick to install, can be extended readily and have low running cost. They can provide benefits beyond backup supply: stabilise the grid in frequency events and sale of spare capacity into the grid at high wholesale price points. Neither of these benefits can be considered as Essential Energy is not in a regulated position to do so. Disadvantages of batteries are they are relatively costly, and at this stage the battery life is expected to be less than 20 years. In comparison to other network options with typical asset life of 40 years, it is assumed the battery would be replaced after 20 years.
It is estimated that the average power consumption is 2.4MVA, for 24 hours requires a battery bank of 62.4MWh. This option has been ruled out of further analysis due to an estimated capital cost of [redacted], with an expected cost of [redacted] per MWh based on energy storage costs received from Essential Energy network battery trial project in 2022.

Option 3 has a capital cost estimated in excess of [redacted] and is deemed not economical without subsidies or grants.

4.4 Option 4 Market led Non-Network Solution

The requirements to improve resilience and reliability of the Gresford ZS may be advertised 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 and backup power solutions under any business model and operational 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.

Option 4 does not have NPV analysis at this stage but will be considered as part of the project development.

4.5 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 improved reliability.

Option 2 has a capital cost estimated in excess of [redacted] and is deemed not economical.

Option 3 has been evaluated as not being economically viable solution due to the high initial and cyclical capex cost.

Option 4 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 diesel generation is currently the recommended option due to lower capital cost, and positive NPV benefit over a 40 year period.

5. 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.

5.1 Safety

Safety consequence considers the risk to both public and Essential Energy personnel. The existing risk in this case is live conductor dropping to the ground mostly from storm activity or possible vehicular contact with pole, leading to possible injury or fatality. The protection equipment which opens the feeder when conductor drops to the ground is fast acting and reinforced by secondary backup equipment if primary equipment fails. Although the consequence is severe, the probability of failure and likelihood of consequence deems the risk to public and personnel safety to be acceptable. Options 1 and 3 offer reliability and resilience to the network and will allow repair/maintenances work to be done as best as possible as without a negative impact on the customers in the ZS. Option 2 solution will reduce the outage for the ZS caused by equipment failure only. Unplanned outages due to weather and subtransmission failures will still be an ongoing issue, hence, the network solution may not be the ideal solution. Due to the low probability and likelihood of consequence a value for Safety has been deemed negligible and excluded from the NPV for all options.

5.2 Network (Reliability)

Network risk captures the consequences associated with loss of supply. As noted above in Section 3 Reliability, the existing reliability to customers supplied by Gresford ZS is the main risk that is addressed in this network investment evaluation. The probability of failure and the consequence associated with loss of supply are relatively straight forward and readily valued, via average unplanned outages rates and VCR. Loss of supply is assessed utilising the historic failure rate and length projected forward utilising the AERs Value of Customer Reliability (VCR) and 6.03.03 Appraisal Value Framework.

5.3 Environmental

The prevalent environmental risk is bushfire. As a pole top/conductor fails and live conductor touches the ground, it may, dependant on conditions and environment ignite fire, causing property damage. Essential Energy uses the Phoenix Rapid Fire system and internal modelling to determine a fire risk per pole. The area between Martins Creek ZS to Gresford ZS is deemed to be a low bushfire risk. All three proposed augmentation options have the existing feeder remain in service. Although the consequence is moderate, the probability of failure and likelihood of consequence deems the risk to be acceptable. Other environmental risks would be transformer oil and diesel fuel spillage. Essential Energy complies to all relevant standards with oil containment and fuel storage. The risk and consequences associated with transformer oil and diesel fuel is negligible and acceptable. Due to a lack of difference between baseline and residual risks environmental risk has been excluded from the NPV.

5.4 Compliance

Compliance risk is assessed for issues that may arise because of not complying to relevant Standards, Acts or Guidelines. Essential Energy complies to all relevant Standards and Acts. There is no compliance risk that needs to be addressed.

5.5 Reputation

Reputational consequences are categorised as those risks associated with the tarnishing of the company's reputation as the result of mostly, in this case, ongoing loss of supply due to overhead asset failure. This investment will address some of the risk associated with Gresford ZS having long outage durations.

5.6 Financial

Financial consequences, in this case, are generally those costs associated with fault and emergency work, over-and-above typical planned maintenance costs. Ongoing asset failure has a consequence of ongoing fault and emergency work, which could be costly if the annual probability of failure was significant and increasing exponentially. The existing 33kV network will remain in service. The addition of new assets (Diesel Generator, switchgear, control, and communication devices) will require maintenance. The generator will require regular maintenance to ensure that it will be able to perform as expected. The life of the generator is expected to be 20 years.

References

Doc No.	Document Name	Relevance
1	Gresford Generator NPV.xlsx	NPV Option Analysis
2	4.02 How engagement informed our Proposal	Reference material, justification
3	6.01 Climate impact assessment	Reference material
4	6.01.01 Climate summary line graph	Reference material
5	6.02 Resilience Plan	Reference material
6	6.03.01 Corporate Risk Management Procedure	Reference material
7	6.03.02 Network Risk Management Manual	Reference material
8	6.03.03 Appraisal Value Framework	Reference material, risk evaluation
9	8.04 Service Target Performance Incentive Scheme (STPIS) Approach	STPIS target adjustment

Key Terms and Definitions

Term	Definition
$M	Dollars expressed in millions
CML	Customer Minutes Lost
DNSP	Distribution Network Service Provider
FY	Financial Year
MW	MegaWatt
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 – Historic unplanned outages for the Gresford ZS

DATE	ZONE	REGION	EQUIPMENT	CAUSE	Sub	IR	Min	LCM	Comment (New Field)
Sun 16/03/14	GRESFORD	North Coast	Conductor - HV	Environ - Weather - High Wi	N	INCD-498916-a	1421	1405765	++ FAULT CAT - WIRES DOWN COMMENTS - HV AND LV WIRES DOWN
Thu 13/09/12	GRESFORD	North Coast	Pole - HV	Environ - Weather - Lightnin	N	INCD-91611-V	1391	1264510	2 faults: 11kV Conductor down near Sub 50358 tripping R42055. Lightning hit pole in Ausgrid
Wed 06/03/19	GRESFORD	Mid North C	Conductor - HV Failed	Veg - Trees Blown into Con	N	INCD-2095253-a	1031	1187443	Multi reports: multiple spans wires down, wires in tree, tree over 33kV and 11kV conductors, s
Thu 14/01/16	GRESFORD	North Coast	Conductor - HV Failed	Environ - Weather - High Wi	N	INCD-1063311-a	1161	933444	11kV conductors down over the Paterson river near Spooners Bridge next to Caravan park. On
Tue 21/04/15	GRESFORD	North Coast	Conductor - HV Failed	Environ - Weather - Heavy F	N	INCD-98325-c	411	430973	++Multiple Fault Reports See F-36485-c
Wed 06/03/19	GRESFORD	Mid North C	Conductor - HV Failed	Veg - Trees Blown into Con	N	INCD-2095252-a	452	420626	Multi reports: multiple spans wires down, wires in tree, tree over 33kV and 11kV conductors, s
Sat 14/04/18	GRESFORD	North Coast	Conductor - HV Failed	Environ - Weather - Lightnin	Y	INCD-1802064-a	433	406154	Conductor Down - Gresford Road
Sat 04/02/17	GRESFORD	North Coast	Insulator Failed	Environ - Weather - Lightnin	Y	INCD-1400211-a	356	331220	Blown 33kV insulators due to lightning strike near L30194.
Sat 12/01/13	GRESFORD	North Coast	Conductor - HV	Environ - Weather - Lightnin	N	INCD-9814-c	262	237372	AUSGRID PROTECTION OPERATED AT RECLOSER 33175 - PATROL ALL CLEAR SUPPL
Mon 14/03/16	GRESFORD	North Coast	Conductor - HV	Environ - Weather - Lightnin	N	INCD-1118836-a	249	229068	132kV circuit breaker has tripped off. Likely cause due to close lightning strike near line.
Mon 20/01/20	GRESFORD	Mid North C	Pole - HV Failed	Equip - Vibration Damage	N	INCD-12511-q	180	169764	MAIN OFF PIN, TOP 1/3 WAY DOWN BURNT, APPROX BURNT HALF WAY THROUGH POI
Thu 27/02/20	GRESFORD	Mid North C	ABS Failed	Equip - Contacts	N	INCD-18702-r	180	169379	BURNT OUT BLADES ON ABS FAULT CAT - Other COMMENTS - Sparking 33kV ABS, sta
Sun 16/03/14	GRESFORD	North Coast	Conductor - HV	Environ - Weather - High Wi	N	INCD-498684-a	158	156278	++ FAULT CAT - WIRES DOWN COMMENTS - HV AND LV WIRES DOWN
Sat 04/04/20	GRESFORD	Mid North C	Insulator	Equip - Fatigue	Y	INCD-20100-r	164	154438	Broken insulator pin Pole 97069077
Mon 10/04/17	GRESFORD	North Coast	Insulator Failed	Equip - Fatigue	N	INCD-1465476-a	151	140879	Broken Insulator
Wed 22/01/20	GRESFORD	Mid North C	Pole - HV Failed	Environ - Weather - Lightnin	N	INCD-16345-r	120	113091	See F-23819-r
Thu 26/09/13	GRESFORD	North Coast	Conductor - HV	Veg - Trees Blown into Con	Y	INCD-346484-a	119	109211	CONDUCTOR BLOWN INTO TREE AT POLE 97068803
Tue 30/07/19	GRESFORD	Mid North C	Sectionaliser / Recloser	Animal - Bird	N	INCD-2125040-a	115	107760	Found Dead Magpie on top of Recloser ++ FAULT CAT - Other COMMENTS - Found Dead M
Thu 04/10/18	GRESFORD	North Coast	Sectionaliser / Recloser	Animal - Bird	Y	INCD-1956095-a	101	94370	BIRD NEST ON R30228 HAS CAUSED DAMAGE TO HV BUSHING
Tue 14/02/17	GRESFORD	North Coast	Insulator Failed	Environ - Weather - Lightnin	N	INCD-82570-d	58	54262	Broken Insulator 5 span outside Gresford Zn
Wed 06/01/16	GRESFORD	North Coast	Joint / Connection - HV	Environ - Weather - Lightnin	N	INCD-1055550-a	53	46746	Blown 33KV pothead at Dugong Zone sub on the Martins creek Fdr - DUG4B3.
Tue 14/02/17	GRESFORD	North Coast	Insulator Failed	Environ - Weather - Lightnin	Y	INCD-1411570-a	47	43633	BROKEN INSULATOR AND LOW 33KV MAIN AT POLE 97064655 ++ FAULT CAT - Equipme
Mon 08/12/14	GRESFORD	North Coast	CB	Environ - Weather - Lightnin	Y	INCD-82823-c	24	43513	
Wed 04/05/16	GRESFORD	North Coast	CB Failed	Animal - Bird	N	INCD-1159772-a	41	30025	BIRD ON 33KV BUS STROUD 132, PROT OPERATED AS NORMAL BUT 132KV CB 7K1 HA
Thu 01/11/12	GRESFORD	North Coast	Transmission System Fault	NF - Likely Weather - Lightr	Y	INCD-95826-V	19	16880	
Mon 13/03/17	GRESFORD	North Coast	Current or Voltage Trans Failed	Other - Switching Error	N	INCD-1437464-a	14	13251	SUB FITTERS LEFT CT LINKS OPEN
Sun 07/12/14	GRESFORD	North Coast	Transmission System Fault	Environ - Weather - Lightnin	N	INCD-82798-c	5	8005	