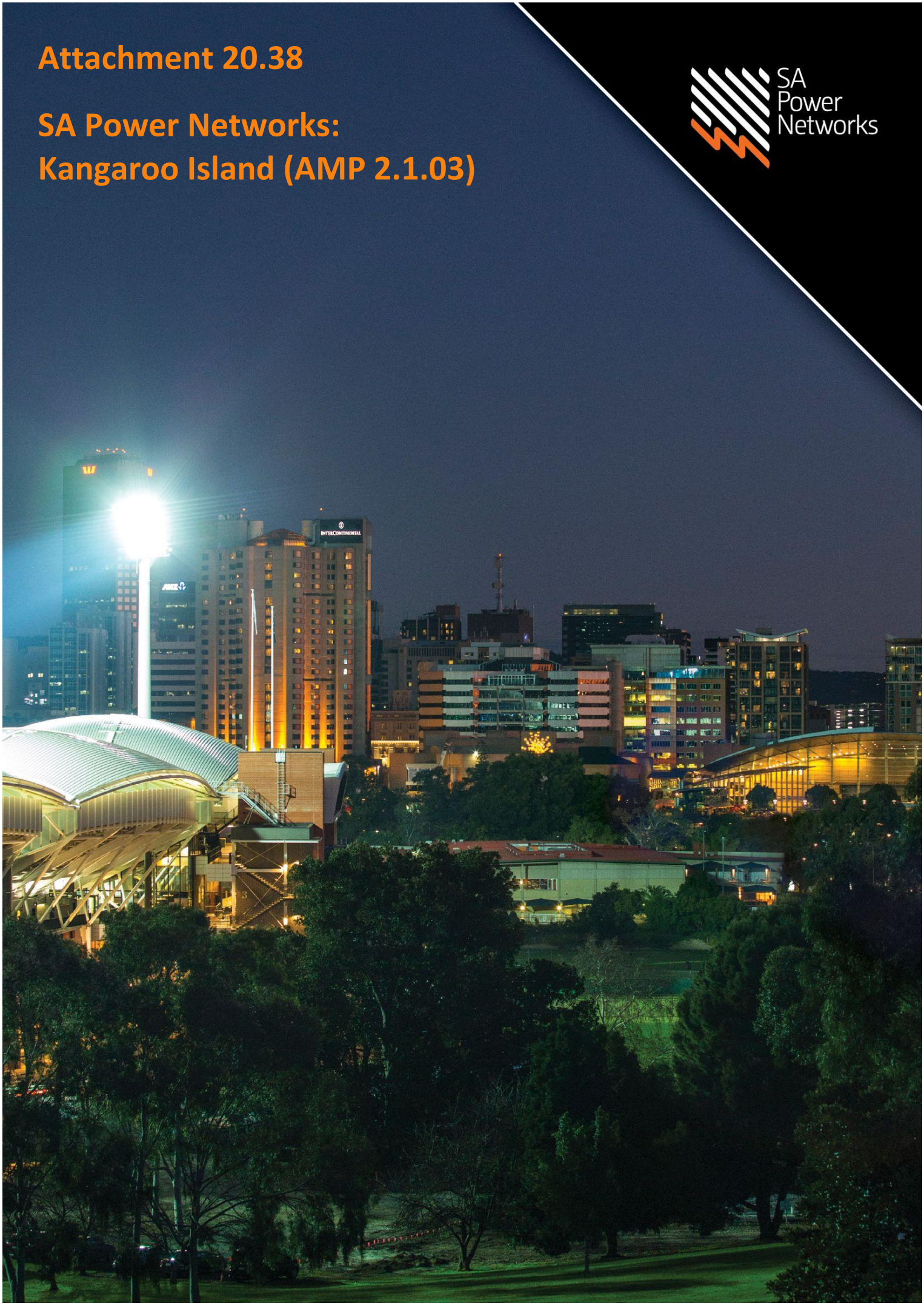
Attachment 20.38

SA Power Networks: Kangaroo Island (AMP 2.1.03)



ASSET MANAGEMENT PLAN 2.1.03
KANGAROO ISLAND – NETWORK SECURITY
SECOND UNDERSEA CABLE
2015 TO 2035

Published: October 2014

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OWNERSHIP OF STANDARD

Procedure 916 Annex B
Issue 2/13

OWNERSHIP OF STANDARD

Name of Standard / Manual: ***AMP 2.1.03 Kangaroo Island – Network Security***

Standard/Manual Owner - Title: ***Manager Network Planning***

Name: ***D Pritchard***

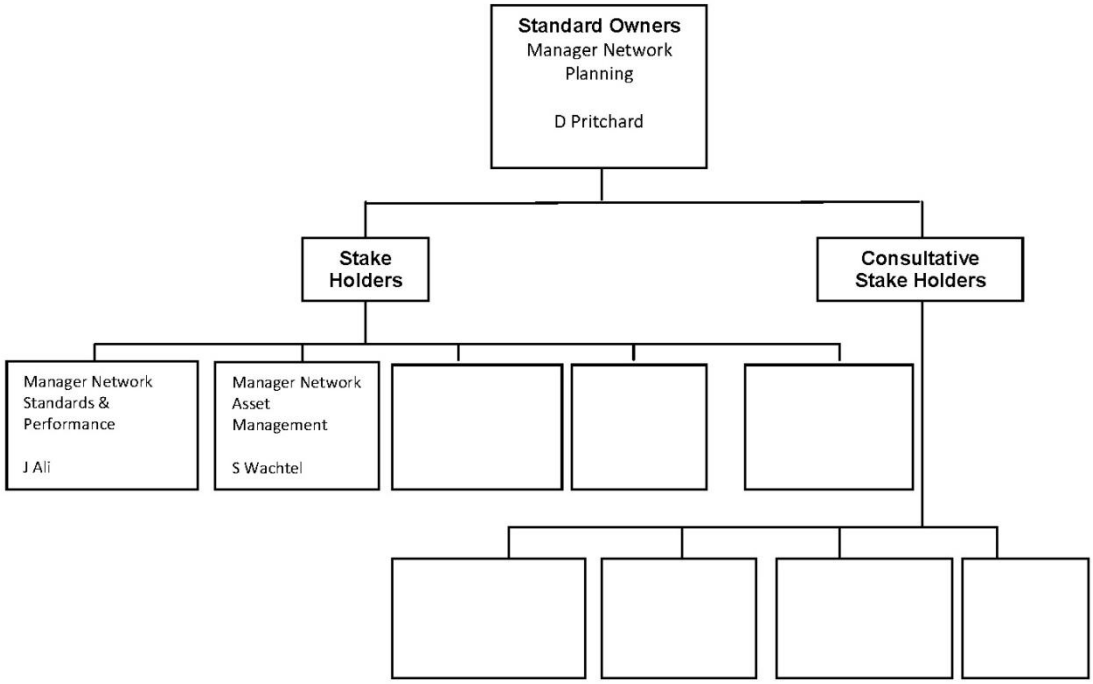
Standard Last Reviewed: June 2014

Standard Last Issued: October 2014

Review Period: 5 years

Next Review Due: October 2019 *(ie. When the next review process is due to commence)*

STANDARD/MANUAL OWNERSHIP STRUCTURE



OTHER RELATED MANUALS

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COMMENTS

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(Asset Management Plan 2.1.03 – Kangaroo Island – Network Security)

DOCUMENT VERSION

Date	Version	Explanation
1/01/2009	0.1	Original AMP
08/10/2014	0.2	Document Review and Update
27/10/2014	1.0	Final

Contents

1. EXECUTIVE SUMMARY

The Kangaroo Island Sub-transmission Electricity Supply Development Plan is developed for the key distribution assets used to supply the Kangaroo Island customers to manage security of supply, reliability, capacity constraints and voltage levels on the network in the most cost effective manner possible.

SA Power Networks recommends the installation of a new submarine cable by 2018 at an estimated cost of $47,500,000 (2013 $). The existing radial 33kV submarine cable is nearing its design life expectancy of 30 years with significant consequences if the cable fails prematurely. A catastrophic cable failure will incur substantial cost to repair and run limited generation over a long period which will in turn impact on tourism, business, community and the economic development of Kangaroo Island.

A cost versus benefit analysis demonstrates the installation of second cable in 2017/18 period rather than running the cable to failure and then installing the new submarine cable delivers lowest cost to our customers unless the existing cable was to last beyond 2034/35 ie more than 11 years past its design life of 30 years. The analysis also considered where the cable may fail as this significantly impacts the cost and repair time; including shallow water (18% of route), deep water (82% of route) and completely buried (95% of route).

Options analysis included

1. Do nothing.
2. Install second submarine cable from Fisheries Creek to Cuttlefish Bay in 2017/18.
3. Run to failure but provide the capital and operating expenditure to provide faster response time (four months).
4. Renewable energy sources (non network solution) with no link to mainland.
5. Install second submarine cable from Fisheries Creek to Cuttlefish Bay before failure and 66/33kV substation and line work upgrade from Cape Jervis to Penneshaw.
6. Install second submarine cable via alternative cable route from Fisheries Creek to Kingscote.

These cases have considered cost of maintaining supply to the 7.5MW of demand on KI for duration of outage, repair of cable and then the subsequent installation of the second submarine cable versus installing the second cable in 2017/18. Sensitivity analysis on three most likely viable options include depth of fault which affects response time and cost of repair, cable cost (+/- 20%), discount rate (6%, 8.5%), generation cost (+/- 20%), cable repair cost (+/- 20%) and value of customer reliability VCR (+/- 20%).

The installation of the new 66kV submarine cable will significantly increase the network capacity on Kangaroo Island and remove the requirement to install a 20MVA 33kV Regulator station at Penneshaw to provide voltage support on the 33kV line and additional generation units. The planned rating of the cable would be 20MVA at 33kV (40MVA at 66kV) to provide sufficient forecast capacity for its 30 year life.

The plan to install the second Kangaroo Island submarine cable has received numerous supports from the State Government, Business SA and Kangaroo Island Council with positive customer panel feedback through stakeholder and consumer workshops [1, Pg 25]. Please refer to Attachment 5 for supporting letters from various stakeholders.

2. INTRODUCTION

2.1 Purpose

SA Power Networks is committed to meeting the Regulated Services Standards for all customers. The challenge of meeting this goal for our customers on Kangaroo Island (KI) is particularly difficult, given its submarine supply and radial sub-transmission network.

The purpose of the Kangaroo Island Sub-transmission Electricity Supply Development Plan is to ensure adequate security of supply to meet customer demand in the most cost effective manner possible. The plan is reviewed annually to ensure that actual annual load growth is accounted for and voltage levels are maintained.

2.2 Exclusions

This management plan considers only the sub-transmission system supplying the island (the 66kV and 33kV network) and not the substations and feeder network on the island which are typical of rural SA and are covered in the SA Power Networks 10 year capacity plan (AMP 1.1.01).

Excluded from this plan are the Kangaroo Island substation capacity plans (Kingscote, MacGillivray, Penneshaw and American River), and the 11kV and 19kV feeder network on Kangaroo Island.

3. BACKGROUND

Kangaroo Island is the third largest island off the coast of Australia, situated in the Southern Ocean approximately 15 kilometres off the tip of Fleurieu Peninsula, across the waters of Backstairs Passage. The notoriously treacherous stretch of water across Backstairs Passage has provided isolation to the island, which has enabled much of the island's unique fauna and flora to flourish creating the island's unique environment.

The SA government, recognising the uniqueness of Kangaroo Island, encourages the development of industries like eco-tourism and aquaculture. According to the Kangaroo Island National Landscape Strategic Tourism Plan, Kangaroo Island is visited by more than 190,000 tourists each year and international and local visitor numbers have been increasing over the last 15 years with the exception of 2007/08 when large fires discouraged visitors for an extended period. The development and success of these industries has produced the expectation of a high security of supply comparable to country South Australia. However, the very isolation and sparse population that have made Kangaroo Island so extraordinary also present unique issues regarding the provision of a secure electricity supply to the island.

Kangaroo Island is supplied via a radial (single path) sub-transmission network consisting of approximately 50km of 66kV line between Willunga and Cape Jervis and 90km of 33kV line between Cape Jervis and Kingscote, with a 15km section of 33kV submarine cable installed between Fisheries Creek on the main land and Cuttlefish Bay on Kangaroo Island. The Cape Jervis to Kingscote 33kV Sub-transmission system comprises of six lines. The Cape Jervis to Kingscote Sub-transmission system supplies the 33/11kV distribution substations at Cape Jervis, Penneshaw, American River, MacGillivray and Kingscote as well as 33/19kV SWERs at Island Beach, Baudin Beach, Brown Beach and Nepean Bay. The probability of unplanned outages on the Kangaroo Island radial network is higher than average due to the length of the radial line, terrain in which it traverses and the frequency of storms on the southern Fleurieu Peninsula and Kangaroo Island. Kangaroo Island has an extensive radial distribution network of three phase 11kV and 19kV SWER systems. Radial distribution feeders are used extensively within remote country areas; however they have the

limitation of not providing alternative supply connections. The radial network was initially designed for sparsely populated rural areas of low capacity. The population density within such areas generally cannot support or justify the expenditure of the high cost of supply, installation and maintenance of the infrastructure of a fully interconnected distribution network. Even with a fully integrated network the submarine cable connecting Kangaroo Island to the mainland remains as a potential weak link.

The submarine cable provides unique challenges, as typically with these types of installations the cable is laid direct on the seabed, leaving the cable exposed to possible damage from both shipping and pleasure craft anchors. A catastrophic failure of the Kangaroo Island cable will lead to wide spread outages and could take up to 12 months to repair for a deep sea fault (requires special cable laying ship from overseas to recover, repair and reinstate cable). In the event of damage to the submarine cable, short term electricity demand on Kangaroo Island can be supplied by SA Power Networks' existing 5.4MW of installed back-up diesel generation at Kingscote Substation during non peak periods.

4. SUB-TRANSMISSION SECURITY TO KANGAROO ISLAND (Submarine Cable)

The existing 33kV submarine cable provides a single connection to the mainland. A catastrophic cable failure will incur substantial costs to repair and maintain supply via the diesel power station over a long period.

A cost versus benefit analysis demonstrates the installation of second cable in 2017/18 period rather than running the cable to failure and then installing the new submarine cable delivers lowest cost to our customers unless the existing cable was to last beyond 2034/35 ie more than 11 years past its design life of 30 years. The analysis also considered where the cable may fail as this significantly impacts the cost and repair time; including shallow water (18% of route), deep water (82% of route) and completely buried (95% of route).

After the new cable installation, the Kingscote power station will be kept to maintain its ability to manage failure of the new cable. While the old cable remains in service, it will be used to assist the power station in its maintenance strategy (managing total load). Any availability of the old submarine cable beyond 2018 will allow deferral of the power station capacity upgrade and therefore provide cost advantages to our customers. However, once the old cable fails, the need to upgrade the power station will be necessary to keep pace with the increasing Kangaroo Island load.

Our strategy is linked to the National Electricity Objective as stated in the National Electricity Law, [2] 'to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to – price, quality, safety and security of supply of electricity; and the reliability, safety and security of the national electricity system'. The replacement of the cable provides the least long term cost to customer and does not raise the existing security standard of Kangaroo Island which is presently a hybrid N-1.

4.1 Cable Background

Submarine Cable 1 (abandoned)

The first 33kV submarine cable was installed in 1965 to supply load at Kangaroo Island. The cable route is approximately 15km from Fisheries Creek to Cuttlefish Bay through Backstairs Passage. The first cable had an electrical failure in 1987 after 22 years in service. The cable failure was found and repaired relatively quickly as it was located on the beach. However, the disruption to the customers on Kangaroo Island was significant during this relatively short outage duration. Without any permanent generation installed, emergency generation was employed but some customers had remained without power for nearly three days.

In 1989, an abalone diver reported an apparent damage to the cable. An investigation was performed indicating that corrosion and erosion of the armouring had progressed to the extent that the cable had reached the end of its economic life. The condition of the armour was at a state of deterioration such that any attempt to lift the cable to facilitate repairs would likely to transfer additional stress to the cores and cause future failure. As a temporary measure, the cable was repaired at various locations by binding the broken armour strands and attaching zinc anodes to slow the rate of corrosion.

Following the discovery of the damage to the cable armour, a new cable was installed in May 1993 and the old cable was used as a backup for its remaining limited life. The old cable finally had a mid ocean fatal failure in 2002 (suspected cable joint failure) after 37 years in service. Following a HV test conducted on the three phases of the cable, it was confirmed that the cable was no longer serviceable and was abandoned as it was not financially viable and economical to repair.

Submarine Cable 2 (Existing)

Due to the state of deterioration of the old submarine cable, a contract was awarded to MM Cable Power Division to design and manufacture the existing 33kV submarine cable in New South Wales. The 50 mm^2 Cu submarine cable has 20 cable joints (approximately every 750m) with a rating of 10MVA at 33kV. The submarine cable was installed and energised in May 1993 with a design life expectancy of 30 years.

According to the hydrographical survey that was carried out across Backstairs Passage, approximately 2.6km of the cable is laid on the sea bed with a depth of less than 25m (shallow water). The remaining 12km of cable is laid and buried on the sea bed with a depth of more than 25m (deep sea) with a maximum depth of 61.5m. Approximately 13.9km (95%) of the cable is now completely buried under sandy sea floor.

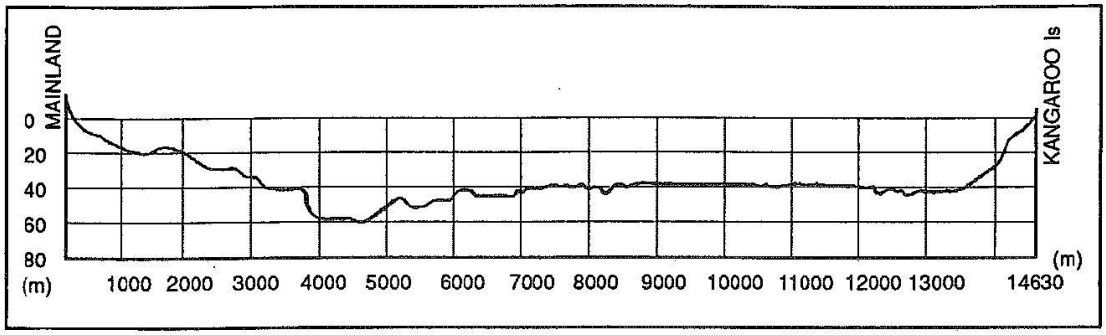


Figure 1: Hydrographical Survey across Backstairs Passage

4.2 Estimated Life Expectancy of the Existing 33kV Cable

The 33kV submarine cable has had an incident free service life to date but the same may not hold true for its secure operation into the future. The major security and supply risk to Kangaroo Island is an outage of the 33kV submarine cable between Cuttlefish Bay and Fisheries Creek. The submarine cable is exposed to possible damage from both shipping and pleasure craft anchors.

Based on CIGRE Technical Brochure 379 WG B1.10 Update of service experience of HV underground and submarine cable systems (2008) [3, Pg 72], relevant analysis of the submarine cable is listed below:

- The main risk for submarine cables is external damage: failure rate = 0.12 to 0.32 failures/100km/year;
- Over 50% of faults occurred on unprotected cables in similar conditions as the Kangaroo Island cable;
- Approximately 50% of reported failures have occurred on installations of age 20 years and more (Kangaroo Island cable will be 25 years in 2018).

Most manufacturers would agree on a 30 – 40 years expected lifetime for a well protected submarine cable [4, Pg 77]. As the Kangaroo Island cable is unprotected, the probability of failure is even higher with a lower life expectancy.

Reasons for higher failure rate of subsea cables:

- Additional mechanical and vibration effects of subsea cables moving with the tides and currents (which lead to mechanical damage at joints and subsea connectors, tracking and then insulation failure from inside of the cable) [5, Pg 5].
- External abrasion of the outer jacket of the cables on the seabed (which leads to sheath faults from outside of the cable) [5, Pg 5].
- Suspension of submarine cables due to irregularities of seabed (which increases risk of external damages) [11, Pg 4].
- Corrosion due to tides and waves [10, Pg 41].

The existing radial 33kV cable is nearing its design life expectancy of 30 years. The Reliability Centred Maintenance (RCM) [5, Pg 5] approach is applied to determine the timing to replace the cable to ensure the continuous performance to support the electricity network on Kangaroo Island. Based on the current asset age of the cable, it has now reached to the final wear out stages identified in the failure probability curve also commonly known as the 'bathtub curve'.

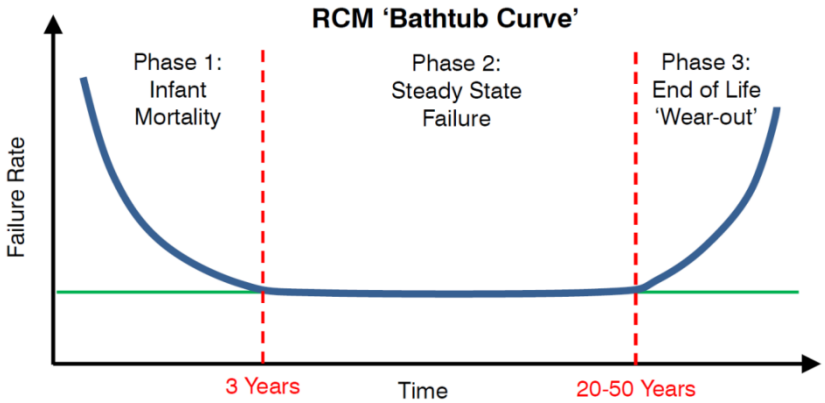


Figure 2: RCM Bathtub Curve

4.3 Underwater Submarine Cable Inspection of the Existing 33kV Cable

An underwater submarine cable inspection of the existing cable was completed in 2012 to assess the condition of the cable. From Fisheries Creek, the current condition of the laid cable seems to support organic marine growth but minor corrosion was evident intermittently with some of the cable's outer sheath fibre being exposed.

Figure 3: Underwater inspection showing minor corrosion on existing submarine cable

At approximately 800 metres from Fisheries Creek to the Cuttlefish Bay shore, the cable is completely buried under the sand. An attempt to located one of the twenty cable straight joints was unsuccessful due to the 'high energy' environment and complete sand burial of the cable. No submarine cable was located during the search at Cuttlefish Bay.

Figure 4: Sand burial of existing submarine cable

In conclusion, only 5% (800 metres) of the cable route length was successfully located and inspected. As most of the 33kV submarine cable route is now buried under the sand, the condition of the cable in the middle of Backstairs Passage is relatively unknown. The layers of organic marine material over buried cables may have the effect of thermal insulation and consequential overheating of the cable [4, Pg 73].

4.4 33kV Cable Repair and Replacement

If the 33kV submarine cable fails, it may or may not be repairable. It will be necessary to locate the fault (if possible), carefully raise the cable from the sea floor using a suitable ship and/or barge with cranes, cut the cable at the fault location, and raise the two sections of cable to the surface then remove water affected sections. A new section of cable is then jointed between the two sections. Care must be taken to avoid bending or stressing the cable, which could result in further damage to the submarine cable.

The ideal reported repair time of submarine cables around the world is approximately two to four months excluding many factors above, the extremes and unknowns [4, Pg 224]. However depending on the location and the limited cable repair vessels in the world, the cable could take more than a year to repair [11, Pg 6].

The duration of an outage of the 33kV submarine cable between Cuttlefish Bay and Fisheries Creek could take up to 12 months to repair for a deep sea fault. The long lead time for repair is influenced by the difficulty in obtaining a replacement cable, limited cable laying and repair ships in Australia, difficulty in locating the fault and adverse weather and sea conditions.

The Backstairs Passage is well known for its challenging sea conditions due to high energy swells penetrating in the St Vincent Gulf from Southern Ocean. Wave heights within Backstairs Passage are typically in the order of 0.9- 1.1m but will increase subject to seasonal variations. The Kangaroo Island 66kV Marine Cable Constructability Assessment Report [13] shows that wave energy within Backstairs Passage increases significantly during winter and early spring compared to during late summer. If the existing cable fails during the period of adverse conditions including unsuitable tidal movements, it could take several months to wait for a suitable weather window to complete the cable repair work successfully.

Based on the hydrographical survey across backstairs passage, approximately 12km (82%) of the cable is laid at a depth of more than 25m (deep sea). 18 out of the 20 of cable joints in the existing cable (known as a common point of cable failure) are located in deep sea, resulting in a high probability of a deep sea cable failure and consequently long repair time.

The cost associated with repair for a mid ocean cable fault is estimated to be in the order of $11,400,000 (2013). See Attachment 4 for breakdown cost summary.

This cost aligns with other utilities [9, Pg 39][11, Pg 6] where a submarine cable repair often cost more than 10 Million EURO dollars (approximately $15 Million Australian dollars) according to CIGRE Technical Brochure 398 WG B1.21 Third-Party Damage to Underground and Submarine Cables (2009) [10, Pg 49].

A number of cable fault scenarios have been explored to determine the likely range of duration of the cable repair. This sensitivity analysis is detailed under Section 5.2.2Fault Location Analysis.

4.5 Generation on Kangaroo Island

In 2005/06 and 2006/07 SA Power Networks installed 5.4MW of remotely controlled backup generation at Kingscote (see photo 1 below) to supply the island in the event of an outage of the sub-transmission connection to Kangaroo Island. However these generators alone would be insufficient to supply Kangaroo Island in the event of a prolonged outage, as would occur for a failure of the submarine cable (up to 1 year for a mid ocean fault).

In the event of a prolonged outage Kingscote's existing 5.4MW of N prime generating capacity would be required to support the island's loads, however with peak loads now

exceeding 7.2MW (January 2014) up to 1.8MW of load would need to be shed until additional generation is installed. To ensure that sufficient generation capacity is available to meet the estimated load growth a fourth generating unit is planned for installation during 2015, increasing N capacity to 7.2MW and N-1 capacity to 6MW.

The Kingscote power station was designed for standby capacity for short durations of operation for either network support or interruptions in supply and hence the generators are only suitable as a short term solution. After 10 days of operation the generating units will need to be progressively taken out of service for maintenance.

In the event of a prolonged outage, at least 2.6MW of mobile generation would need to be installed at Kingscote substation including additional operating and maintenance staff to operate the power station and the additional sets. Considerable logistical and economic issues are also associated with providing an adequate fuel supply and Urea control in the event of a prolonged outage.

The total additional cost to maintain supply to Kangaroo Island for 12 months without the use of the submarine cable is estimated to exceed **$31,800,000 (2013 $)** with fuel costs being the most significant portion. See Appendix 5 for more detailed information on generation cost.

Figure 5: Construction of 6MW of generation at Kingscote

4.6 Interruption of Supply and Value of Customer Reliability

In the event of the catastrophic failure of the 33kV cable, the supply of Kangaroo Island will solely rely on the reliability of supply of the generators at Kingscote. The performance of a generator is measured by its ability to provide secure supply when required. Based on reliability data on remote power stations run by the state government under the Remote Areas Energy Supply Scheme [12 & Attachment 6] (remote towns not connected to the main electricity grid), the availability factor of similar size generators at Umuwa (Central Power House) is estimated to be 99.93%. However, this availability at Umuwa power station was only achieved by the N-1 generator capacity which is presently not available at Kingscote power station. As the best case scenario, the availability factor of Kingscote generators is predicted to be 99.93% which represents 6.1 hours of interruption of supply per year, provided additional generation is installed at Kingscote to provide N-1 connected capability.

Prior to the installation of Kingscote generators in 2006, Kangaroo Island relied entirely on supply from the mainland via the submarine cable and the radial 33kV sub-transmission line. Maintaining security of supply on the 33kV sub-transmission had been a difficult task due to the frequent stormy conditions of Kangaroo Island. These were reflected on the 2002–2006 System Average Interruption Duration Index (SAIDI) value of approximately 726 min. The SAIDI value has improved significantly since the installation of the backup generators with a recent 2008–2012 average SAIDI value of 36 mins. In an event of a cable failure, Kangaroo Island will experience poor 33kV sub-transmission reliability of supply similar to the period prior to 2006 which represents an additional 11.5 hours of interrupted supply.

The National Value of Customer Reliability (VCR) is used to reflect how much customers are willing to pay to have secure supply. The VCR value being used is $50,000/MWh. The VCR cost incurred for not having secure supply at Kangaroo Island based on one year of generation with the average Kangaroo Island load at 3.8MW is estimated to be $3,400,000 (2013 $).

The general impact on the community in Kangaroo Island must also be considered. The island is promoted as one of South Australia's premier tourist icons and as an eco-tourism destination. The development and success of these industries has produced the expectation of a high security of supply comparable to metropolitan Adelaide. The loss of security of supply to Kangaroo Island portrays a negative image to potential investors and tourists intending to visit. The economic development from tourism and local businesses will be significantly impacted. In addition, SA Power Networks' strong corporate, public and community reputation will be greatly affected in the event of a cable failure [10, Pg 50].

4.7 New 66kV Submarine Cable

Ultimately, any submarine cable that is laid to improve the long-term security performance of Kangaroo Island should be rated at 66kV to allow for long term capacity upgrades. The new submarine cable is proposed to be rated at 66kV but energised at 33kV initially. The planned rating of the cable would be 40MVA at 66kV and 20MVA at 33kV to provide sufficient capacity for its 30 year life. The existing 33kV cable will be used to assist the power station in its backup strategy (managing total load) until it fails.

GHD was engaged by SA Power Networks to obtain a detailed specification for the turn-key design, supply, delivery, installation and commissioning of the proposed 66kV submarine cable across the Backstairs Passage, to determine project feasibility and risks. GHD has also provided a Cable Route Study report [14] and Constructability Assessment report [13] to understand potential issues and manage them effectively. The specification was subsequently provided to the recommended cable suppliers and installers to enable an estimated cost to be determined. GHD engaged five potential manufacturers [6] to offer budget prices for the turn-key design, supply, delivery, installation and commissioning of a 40MVA 66kV submarine cable, initially energising at 33kV with a capacity limit of 20MVA.

Based on the manufacturers' feedback, the total estimated cost of installing the cable along with associated modifications to the existing 33kV network is **$47,500,000 (2013 $)**. See Attachment 4 for breakdown cost summary.

The required environmental assessment by GHD and approvals to allow the cable project to be implemented has been underway and is expected to be approved by the end of 2015.

In the event of a cable failure and the immediate requirement to replace the cable, SA Power Networks will have the necessary approved specification and required approvals to

implement the cable replacement process within approximately two years of decision to proceed.

As a risk control measure, the KI Emergency Response Plan has been developed to manage the loss of supply on Kangaroo Island due to a faulted submarine cable. SA Power Networks is also in the process of setting up annual retainers with specialist contractors associated with repairing the cable. The cable risk assessment captured in the 2013 Risk Profiling exercise has been identified as high risk with effective controls and provided to the SA Power networks Risk and Compliance Committee.

Risk control measures such as insurance have not been implemented due to the market being unable to identify any viable insurance options. Upon consultation with Aon (insurance broker), SA Power Networks concluded that property and business interruption insurance is not available for the KI cable on reasonable terms. A pass through arrangement in relation to the cable is considered part of financing approach by SA Power Networks.

The plan to install the second Kangaroo Island submarine cable has received numerous supports from the State Government, Business SA and Kangaroo Island Council with positive customer panel feedback through stakeholder and consumer workshops [1]. Please refer to Attachment 5 for supporting letters from various stakeholders.

5. POTENTIAL SOLUTIONS AND NET PRESENT VALUE ANALYSIS

5.1 Options Considered

Options considered for the replacement of the existing submarine cable:

1. Do nothing.
2. Install second submarine cable from Fisheries Creek to Cuttlefish Bay in 2017/18.
3. Run to failure but provide the capital and operating expenditure to provide faster response time (four months).
4. Renewable energy sources (non network solution) with no link to mainland.
5. Install second submarine cable from Fisheries Creek to Cuttlefish Bay before failure with 66kV cable and 66/33kV substation and line work upgrade from Cape Jervis to Penneshaw.
6. Install second submarine cable via alternative cable route from Fisheries Creek to Kingscote.

Option 1: Do nothing

This is not a recommended option.

Advantages

1. Capital expenditure ranges from $4.1M to $94.3M in the 2015-2020 regulatory period depending when the cable fails. Cable is expected to fail by 2023/24 but likelihood of failure increases each year as it approaches cable life expectancy of 30 years.

Disadvantages

1. This is not a prudent option as the probability and likelihood of cable failure is high with major consequences (cable is 27 years old in 2020).
2. If left unattended in the 2015-2020 reset period, the cable is likely to fail, resulting in Kangaroo Island load being interrupted for prolonged period.

3. A catastrophic failure of this cable could take up to 12 months to identify and repair or up to 24 months if the cable had to be replaced.
4. Higher Net Present Cost (NPC) option, refer NPV attachment if cable fails before 2034/35.
5. Poor customer service – reflected in value of lost load in NPV.

Option 2: Replace submarine cable from Fisheries Creek to Cuttlefish Bay in 2017/18 ($47.5M)

Recommended option

The proposed solution is to install second submarine cable (approximately 15km) with a new 66kV cable (initially energised at 33kV) in 2017/18.

Advantages

1. Maintaining security of supply to Kangaroo Island by mitigating the risk of failure of the old cable.
2. Increases supply capacity to Kangaroo Island and solve the voltage constraint by providing adequate voltage levels along the Penneshaw to American River 33kV Line for 33/19kV SWER Isolating transformers.
3. Impact on customers is significantly reduced based on value of lost load.
4. Route is within the Special Purpose Area 7 (SPA-7) which provides an overlay to the zoning that allows ongoing operation of submarine cables with minimal impact on sensitive cultural heritage and flora/fauna areas.
5. Lowest Net Present Cost (NPC) option, refer NPC attachment if cable fails before 2034/35.
6. Supporting SA government strategic plans.

Disadvantages

1. Capital expenditure in 2015-20 regulatory period

Option 3: Run to failure but provide the capital and operating expenditure to provide faster response time (4 months).

This is not a recommended option.

The solution is to run submarine cable to failure but provide the capital and operating expenditure (total of $11.8M in 2015/20 period) to provide faster response time (four months) and ensure back up power station is capable of supplying all customer loads on Kangaroo Island at similar levels of reliability.

A number of pre-planning activities have to be put in place to enable a four months repair time:

- Purchase of new spare cable and cable joints in 2016 (3km of spare cable, one set of spare joints and one set of termination joints)
- Submarine cable storage (warehouse purchase with security system) including annual cable testing.

- Annual retainers with Locator Company, Repair Company, Barge Company and power station operating company for their commitments to have their services available if they become needed to meet the response time.
- New all weather safe track to Cuttlefish Bay for small truck and bi-annual maintenance to allow fast access on Cuttlefish Bay.
- Purchase of additional generation to provide high availability (N-1) of power station.
- Replacement of existing short lived power station assets including protection and control.

Advantages

1. Capital expenditure ranges from $11.8M to $69.4M in the 2015-2020 regulatory periods, depending when the cable fails.

Disadvantages

1. This is not a prudent option as the probability and likelihood of cable failure is high with major consequences (cable is 27 years old in 2020).
2. If left unattended in the 2015-2020 reset period the cable is likely to fail, resulting in Kangaroo Island load being interrupted for prolonged period.
3. A catastrophic failure of this cable could take up to four months to repair with pre-planning activities in place.
4. Higher Net Present Cost (NPC) option, refer NPV attachment if cable fails before 2036/37.
5. Poor customer service – reflected in value of lost load in NPV.

Option 4: Renewable energy sources (non network solution) with no link to mainland ($92M plus $14M per year)

This is not a recommended option.

Advantages

1. Uses renewable energy.

Disadvantages

1. Capital expenditure to construct and maintain renewable energy supplies (integrated wind/bio diesel/solar power generation plant) to support the existing Kangaroo Island load is high and not viable. This renewable energy integration setup is more viable for smaller scale islands with lower peak demand ie King Island.

   Example: King Island [8] with a peak load of 3.4MW (50% of Kangaroo Island's current peak load) has seen an investment of $46M [7] to provide 6MW of diesel, 3.2MW of wind energy and 0.1MW of solar energy with an operating cost of approximately $7m per annum.

   At double of King Island's cost to implement a similar integrated renewable solution on Kangaroo Island's existing load of 7.2MW, this option is uneconomical and not viable.

   Capital and Operating expenditure would need to reduce to $15M and $5M per annum respectively to be comparable to Option 2 without considering the additional disadvantage of reliability reduction. Such cost reductions are not feasible at this time.

2. Reliability/security of supply has reduced compared to the proposed network solution (reliability similar to option 1 when running as power station).

Option 5: Install second submarine cable from Fisheries Creek to Cuttlefish Bay before failure with 66kV cable and 66/33kV substation and line work upgrade from Cape Jervis to Penneshaw ($61.7M)

This is not a recommended option.

The solution is to replace the existing submarine cable (approximately 15km) with a new 66kV cable in 2018 including 66kV line overhead extension from Cape Jervis to Penneshaw and associated substation upgrade.

Advantages

1. Maintaining security of supply to Kangaroo Island by mitigating the risk of failure of the old cable.
2. Increases supply capacity to Kangaroo Island and solve the voltage constraint by providing adequate voltage levels along the Penneshaw to American River 33kV Line for 33/19kV SWER Isolating transformers.
3. Impact on customers is significantly reduced based on value of lost load.
4. Route is within the Special Purpose Area 7 (SPA-7) which provides an overlay to the zoning that allows ongoing operation of submarine cables with minimal impact on sensitive cultural heritage and flora/fauna areas.
5. Supporting SA government strategic plans.

Disadvantages

1. Large capital expenditure. The additional cost of $14,300,000 for 66kV line and substation work can be delayed based on the forecast voltage constraint on the island when a new submarine cable is installed in the 2015-2020 reset period.

Option 6: Install second submarine cable via alternative cable route from Fisheries Creek to Kingscote ($111M)

This is not a recommended option.

Advantages

1. Maintaining security of supply to Kangaroo Island by mitigating the risk of failure of the old cable.
2. Increases supply capacity to Kangaroo Island.
3. Impact on customers is significantly reduced based on value of lost load.

Disadvantages

1. Capital expenditure is more than double compared to Option 2 due to the long distance (> 40km) and significant additional infrastructure upgrade to connect to Kingscote Substation.
2. Alternative route is not within the Special Purpose Area 7 (SPA-7) which provides an overlay to the zoning that allows ongoing operation of submarine cables. Deviating from the Special Purposes area will greatly affect and delay the cable approval process.

5.2 Net Present Value (NPV) Analysis

5.2.1 Option Analysis Table

Net Present Value (NPV) analysis was completed to demonstrate the optimum management strategy. A number of relevant scenarios have been considered including the assessment of the sensitivity of the NPV result due to cost changes to generation, repair work and Value of Customer Reliability (VCR).

The following inputs have been considered in the NPV business case:

- Cost of new submarine cable
- Cost of repairing the existing submarine cable
- Cost of running the Kingscote generators
- Cost of Value of Customer Reliability (VCR) when supplied by the Kingscote generators
- Generation availability at Kingscote (Reliability data)
- Installation of generation units to maintain N-1 load at risk and meet demand gap
- Operational cost due to generation peak load lopping
- Cost of 33kV Regulator Station at Penneshaw to provide voltage support

The Net Present Value (NPV) analysis was performed on the three most likely viable options by comparing Option 1 (Do nothing), Option 2 (cable replacement in 2017/18) and Option 3 (run to failure).

The table below shows a summary of NPV cost based on year of failure [24-25].

Description	NPV Cost ($M)*
Option 1a: Cable failure in 2018/19 and replace cable in 2019/20	$75.07
Option 1b: Cable failure in 2023/24 and replace cable in 2024/25	$58.37
Option 1c: Cable failure in 2033/34 and replace cable in 2034/35	$40.09
Option 1d: Cable failure in 2034/35 and replace cable in 2035/36	$38.51
Option 2: Replace cable in 2017/18	**$39.14**
Option 3a: Cable failure in 2018/19 and replace cable in 2019/20	$61.76
Option 3b: Cable failure in 2023/24 and replace cable in 2024/25	$51.52
Option 3c: Cable failure in 2034/35 and replace cable in 2035/36	$40.56
Option 3d: Cable failure in 2036/37 and replace cable in 2037/38	$38.77

Table 1: NPV Table

Based on the Net Present Value (NPV), it is better for all SA customers to replace the submarine cable before it fails nominally in 2017/18.

The existing cable would need to last beyond 2034/35 (41 yrs old cable) to be more economical and cost effective than adding a second submarine cable in 2017/18 (similar NPV value). It is unlikely that the existing cable will last 11 years past its design life and 19 years longer than the original cable.

Under Option 3 where up front capital and operating expenditures (total of $11.8M in 2015/20 period) are provided in the 2015-20 regulatory period to ensure faster response time (four months), the existing cable would need to last beyond 2036/37 (43 yrs old cable) to be more economical and cost effective than adding a second submarine cable in 2017/18 (similar NPV value). It is unlikely that the existing cable will last 13 years past its design life and 21 years longer than the original cable.

By comparing Option 3 (run to failure) and Option 1 (do nothing), Option 3 provides a lower NPV value to Option 1 before 2031/32. Therefore, the existing cable would need to last beyond 2031/32 (38 years) to be more economical than running cable to failure with up front capital and operating expenditures.

Therefore, installing a new submarine cable to Kangaroo Island in 2017/18 has shown to be the most economical and lowest long term cost to customer to manage risk compared to replacing the existing cable when it fails. Costs versus benefit economic cases have been produced to support and justify the replacement of the cable in the 2015-2020 period versus running the cable to failure and then installing the new submarine cable.

5.2.2 Fault Location Analysis

Failure of the 33kV submarine cable is the single greatest risk to the security of the Kangaroo Island network. The Kangaroo Island Emergency Response Plan has been developed and structured to portray the activities that are to be under taken to successfully repair the cable and can be divided into three scenarios. Please refer to Attachment 4 for breakdown cost summary.

1. **Shallow water cable fault (2 months)**
   This scenario applies if the cable fault occurs within the depth of 25m which only covers 18% (2.6km) of the cable route. This unlikely 'best case' scenario assumes that the cable fault can be found and seen on sea bed with adequate spare cable to repair and associated repair facilities available during calm weather conditions. Generation on Kangaroo Island to operate for at least two months until cable fault is repaired.

   The probability of this scenario occurring is low (10%) based on the number of cable joints (2 out of 20 joints) as a common point of failure within the depth of 25m (short length of cable).

2. **Deep ocean cable fault (12 months)**
   This scenario applies if the cable fault occurs in deep sea with a depth of more than 25m which covers the majority 82% (12km) of the cable route. This scenario where the cable fault is difficult to identify and repair due to the cable buried in deep water and repair work performed during rough weather conditions is likely to occur across Backstairs Passage.

   Associated repair facilities or potential service providers have to be sourced internationally. Procurement of new spare cable can delay the repair operation

by many months. The requirement to source and organise service providers for the repair work and have a portion of adequate spare cable manufactured and shipped to Australia would take at least 8 months. Due to limited periods of suitable tidal movement for accessing the cable to repair and the location of the fault, it would take four months to repair the cable. Generation will be required to operate for at least 12 months until SA Power Networks is satisfied with the cable's integrity.

The probability of this scenario occurring is very high (90%) based on the number of cable joints (18 out of 20 joints) as a common point of failure within the depth of 25m – 61.5m (majority length of cable).

3. **Unsuccessful in locating cable fault hence initiating the replacement of a new cable (24 months) – Deeply buried**
   Worst case scenario where the cable repair work was unsuccessful and the cable was unable to be found due to the conditions of tidal and stormy weather in particular if the fault is located near Cuttlefish Bay and buried deep in the sand.

   This scenario also applies if the armour of the cable has damaged and corroded as any attempt to lift the cable without cable armour to facilitate repairs would likely to transfer additional stress to the cores and damage other sections of the cable. This was one of the main reasons why the old submarine cable was abandoned.

   Existing cable is abandoned to initiate the order and replacement of a new submarine cable. General delivery time of a new cable is approximately 24 months after order according to cable manufacturer. Therefore, generation on Kangaroo Island will operate for approximately 24 months to cover cable order, delivery and installation time.

   The probability of this scenario occurring is low due to the likelihood of finding the cable within Backstairs Passage.

   The table below shows a sensitivity based NPV table ($M) based on the above [24-25].

Description	Shallow Water Fault (2 months)	Deep Ocean Fault (Option 1 - 12 months, Option 3 - 4months)	Unsuccessful Cable Repair (Fault Not Found) (24 months)
Option 1a: Cable failure in 2018/19	$47.75	$75.07	$90.82
Option 1b: Cable failure in 2023/24	$37.50	$58.37	$70.64
Option 1c: Cable failure in 2033/34	$27.60	$40.09	$47.88
Option 1d: Cable failure in 2034/35	$26.63	$38.51	$45.95
Option 2: Replace cable in 2017/18	**$39.14**	**$39.14**	**$39.14**
Option 3a: Cable failure in 2018/19	$53.24	$61.76	$96.31
Option 3b: Cable failure in 2023/24	$45.05	$51.52	$78.20
Option 3c: Cable failure in 2035/36	$36.93	$40.56	$56.25
Option 3d: Cable failure in 2037/38	$35.51	$38.77	$53.02

Table 2: Cable Failure NPV Table

The NPV table shows evident that Option 2 (Replacing the cable in 2017/18 before failure) has a lower NPV score during a deep ocean fault or an unsuccessful cable repair event within its design life of 30 years.

Under shallow water fault conditions, the existing cable would need to last beyond 2023/2024 to provide a lower NPV value to Option 2. In the event of an unsuccessful cable repair hence initiating the replacement of a new cable, the cable needs to last beyond 2048/49 to provide a lower NPV value to Option 2. However, the probability of a shallow water fault or unsuccessful cable repair event is low due the majority length of the submarine cable in deep sea (depth of 25m–61.5m) covering 90% of existing cable joints.

5.2.3 Sensitivity Analysis

The table below shows a sensitivity based NPV table ($M) based on a deep ocean cable fault event (12 months) due to the likelihood of it occurring on Backstairs Passage[24-25].

Description	NPV Cost	Cable cost -20% / +20%	Discount rate 6% / 8.5%	Generation cost -20% / +20%	Cable Repair cost -20% / +20%	VCR Cost -20% / +20%
Option 1a: Cable failure in 2018/19	$75.07	$68.38	$75.07	$70.32	$73.37	$74.56
		$81.77	$66.36	$79.83	$76.78	$75.59
Option 1b: Cable failure in 2023/24	$58.37	$53.36	$58.37	$54.72	$57.10	$57.96
		$63.37	$46.67	$62.02	$59.64	$58.77
Option 1c: Cable failure in 2033/34	$40.09	$37.30	$40.09	$37.87	$39.38	$39.85
		$42.89	$27.02	$42.32	$40.80	$40.34
Option 1d: Cable failure in 2034/35	$38.51	$35.87	$38.51	$36.39	$37.84	$38.27
		$41.14	$25.63	$40.63	$39.18	$38.74
Option 2: Replace cable in 2017/18 before failure	**$39.14**	**$32.04**	**$39.14**	**$39.14**	**$39.14**	**$39.14**
		$46.24	**$35.07**	**$39.14**	**$39.14**	**$39.14**

Table 3: Sensitivity Based NPV Table

The sensitivity based NPV table shows evident that Option 2 (Replacing the cable in 2017/18 before failure) has a lower NPV score prior to 2034/35. It is unlikely that the existing cable will last for 41 years and 19 years longer than the original cable.

In conclusion, Net Present Cost (NPC) analysis has demonstrated that the replacement of the existing cable before failure (2018) has the least NPC of all the viable and feasible options.

6. CAPACITY REVIEW

6.1 Forecast Load Growth

The behaviour of the system was assessed for system normal (n) using 10% Probability of Exceedance (POE) load forecast for each of the four substations assuming all equipment in service on the island. Forecasted demand growth is low based on the recent measured changes in demand (refer to AMP 1.1.01 for demand growth calculations). The following table shows the total Kangaroo Island 20 year load forecast.

Year	10% PoE Forecast (MVA)	Year	10% PoE Forecast (MVA)
2014/15	7.8	2024/25	8.9
2015/16	7.9	2025/26	9.0
2016/17	8.0	2026/27	9.1
2017/18	8.1	2027/28	9.3
2018/19	8.2	2028/29	9.4
2019/20	8.3	2029/30	9.6
2020/21	8.4	2030/31	9.7
2021/22	8.5	2031/32	9.9
2022/23	8.6	2032/33	10.0 **Cable Capacity Limit**
2023/24	8.8	2033/34	10.2

Table 4: 20 Year Load Forecast for Kangaroo Island

The loads stated above represent the forecast load leaving Cape Jervis substation and take into account diversity between substation loads, sub-transmission losses and an adjustment due to the presence of any embedded generation (including Photovoltaics - PV). Time of peak is now 19:30 hours hence additional PV will have negligible impact on forecast peak demand (Solar PV output near zero at 20:00 hours).

However, the forecast does not include potential large spot loads, which will advance the cable constraint date which is presently forecast for 2032/33. Several major developments have been proposed but not committed on Kangaroo Island. These developments are not included in the above forecast.

6.2 Sub-transmission Capacity Constraints and Solutions

6.2.1 Capacity Constraints

There are three major capacity constraints on the existing sub-transmission supply network on Kangaroo Island in the next 20 years, as summarised in the table below.

The installation of a new submarine cable in 2018, initially energized at 33kV will provide a significant improvement to voltage levels on Kangaroo Island, primarily through a reduction in losses on the sub-transmission network.

Constraint Number	Capacity Constraint	Capacity Limit (MVA)
1	Voltage Level (before new submarine cable)	9.6MVA
2	Existing 33kV Submarine Cable Capacity	10.0MVA
3	American River to Macgillivray 33kV Line	6.2MVA

Table 5: Sub-transmission Capacity Constraints

The following work is proposed to maintain adequate voltage levels across the network using current planning criteria.

- Substation 11kV bus voltages must remain above 98% of nominal
- The primary side of 33/19kV SWER isolating transformers must remain above 88% of nominal

The predominant voltage constraint for Kangaroo Island is the 33kV line voltage from Penneshaw to American River due to SWER isolating transformers located near Island Beach.

Note: Additional generators at Kingscote will also be added when business case shows Kangaroo Island load at risk is too high or too long in terms of customer impact ($ per KVA).

6.2.2 Solutions for Capacity Constraints

All costs are indicative only, and are in 2013 cost values.

Constraint Number	Constraint Type	Year	MVA Limit	Constraint	Work Required	Estimated Cost (2013 $)
1	N	2030/ 2031	9.6	Unable to supply adequate voltage levels along the Penneshaw to American River 33kV Line for 33/19kV SWER Isolating transformers	Install a 20MVA 33kV Regulator station at Penneshaw to provide voltage support on the 33kV line between Penneshaw and American River to ensure adequate voltage on the 19kV Island Beach SWER. **(Not required if new submarine cable is installed)**	$3,900,000
2	N	2033/ 2034	10	Overloaded submarine cable	Install a 14.8km 66kV submarine cable from Fisheries Creek to Cuttlefish Bay. Cable to be initially energized at 33kV with remote controlled load switches at both ends allowing for fast restoration upon failure.	$47,400,000
3	N	2032/ 2033	6.2	American River to Macgillivray 33kV Line Overload	Uprate 17.1km of American River to Macgillivray 33kV Line from T50 to T60	$1,500,000

Table 6: Solutions for Sub-transmission Capacity Constraints

7. SUB-TRANSMISSION EXTENSION

The existing 33kV sub-transmission network on Kangaroo Island only extends westward as far as MacGillivray and Kingscote. Most customers at the far end are supplied by 19kV SWER feeders via extended 11kV network or by stand-alone generation (off-grid).

Any extension of the 33kV sub-transmission network is likely to enable the connection of loads that have hitherto remained unserved, or been served only by local stand-alone generation, with the construction of the additional 11kV network to reach the customers.

Timing of these sub-transmission extension projects is dependant on major customers committing to connection.

Apart from Parndana, Smith Bay and Emu Bay, there are also several other locations on Kangaroo Island that would be well served by extension of the 33kV network, such as Vivonne Bay and Flinders Chase.

7.1 Supply to Parndana

Parndana 11kV feeder (KI-42) extends westward from MacGillivray substation for approximately 50km, to supply the township of Parndana and beyond. It currently has two separate midline 11kV voltage regulator stations and is currently encroaching on its maximum load limit due to customer voltage constraints. Large customers along this 50km long feeder may also utilise stand-alone generation due to the weak nature of the network that passes them.

The proposed stages for the West End are listed below:

Stage 1: 2015-2020

It is proposed to install additional 11kV voltage regulation on the Parndana 11kV feeder (KI-42). This will increase the load limit to 400kVA of new load at Parndana Township or 140kVA at the end of the feeder. The total estimated cost of installing additional 11kV voltage regulation is $600,000 (2013 $).

Stage 2: Beyond 2020

It is proposed to extend the 33kV sub-transmission network from MacGillivray Substation to Parndana for approximately 24km and establish a new 33/11kV 3MVA Modular 3 substation at Parndana.

The proposed new substation at Parndana will solve the Stage 1 voltage constraint and provide additional network capacity which in turn rejuvenates the West End and Parndana areas to promote new growth and attract more potential developers and visitors to the region.

The total estimated cost of extending the 33kV sub-transmission network from MacGillivray Substation to Parndana for approximately 24km and establish a new 33/11kV 3MVA Modular 3 substation at Parndana is $6,200,000 (2013 $).

Note: The capacity increase at Parndana Substation to provide additional supply to potential customers located at the end of the feeder would be limited prior to the installation of the new submarine cable.

7.2 Supply to Emu Bay and Smith Bay

Customers at Emu Bay and Smith Bay are currently being supplied by Kingscote 11kV feeder (KI-31) and associated Emu Bay 19kV SWER feeder (KI-57) or by stand-alone generation (off-grid). Kingscote 11kV feeder (KI-31) currently has a midline 11kV voltage regulator and is currently encroaching on its maximum load limit due to customer voltage constraints.

The proposed stages for Emu Bay and Smith Bay are listed below:

Stage 1: 2015 - 2020

It is proposed to relocate existing voltage regulator and install additional 11kV voltage regulator on the Kingscote 11kV feeder (KI-31). This will increase the load limit to approximately 1000kVA at the end of the feeder. The total estimated cost of relocating existing voltage regulator and install additional 11kV voltage regulator is $700,000 (2013 $).

Stage 2: Beyond 2020

It is proposed to extend the 33kV sub-transmission network from Kingscote Substation to Emu Bay for approximately 13km and establish a new 33/11kV 3MVA Modular 3 substation near Emu Bay.

The proposed new substation at Parndana will solve the Stage 1 voltage constraint and provide additional network capacity which in turn promote new growth and attract more potential developers and visitors to the bay area.

The total estimated cost of extending the 33kV sub-transmission network from Kingscote Substation to Emu Bay for approximately 13km and establish a new 33/11kV 3MVA Modular 3 substation near Emu Bay is $4,700,000 (2013 $).

Note: The capacity increase at future Emu Bay Substation would be limited prior to the installation of the new submarine cable.

8. RECOMMENDED SOLUTION

8.1 Recommended Solution for 2015-2020

To eliminate the risk of a prolonged outage associated with the radial submarine cable, it is recommended to install a second submarine cable between Fisheries Creek and Cuttlefish Bay in 2018. Additional voltage regulation at Parndana and Emu Bay are proposed to address forecast voltage constraints on the 11kV feeders.

The table below shows recommended projects for the 2015-2020 reset period:

Project Year	Project Description	Estimated Cost (2013 $)
2018	New 66kV Submarine Cable	$47,500,000
2019/20	New Voltage Regulation on Parndana 11kV feeder (KI-42)	$600,000
2019/20	New Voltage Regulation on Kingscote 11kV feeder (KI-31)	$700,000
	TOTAL	**$48,800,000**

Table 7: Project Timing for Recommended Solution

Note: The installation of an additional 1.8MW generation unit ($4.1M) in 2018 has been excluded as constraints will be solved by the installation of the new submarine cable.

8.2 Recommended Solution Beyond 2020

Based on the line capacity constraint on the island, the American River to Macgillivray 33kV Line Uprate project is proposed in 2032. Construction of future Parndana and Emu Bay substations will be dependant on future customer growth in the area. In order to improve supply security and increase sub-transmission capacity on Kangaroo Island, it is proposed that the 66kV sub-transmission network be constructed between Cape Jervis, Penneshaw and Kingscote along with 66/33kV transformers at Penneshaw and Kingscote beyond 2035 based on the current growth forecast.

The table below shows recommended future projects between 2020-2035:

Project Year	Project Description	Estimated Cost (2013 $)
2032/33	American River to Macgillivray 33kV Line Uprate	$1,500,000
2033/34*	Construct a new 24km 33kV line from MacGillivray to Parndana, and build a new (modular 3) 3MVA 33/11kV substation at Parndana	$6,200,000
2035/36*	Construct a new 13km 33kV line from Kingscote to Emu Bay, and build a new (modular 3) 3MVA 33/11kV substation at Emu Bay	$4,700,000
	TOTAL	**$12,400,000**

Table 8: Project Timing for Recommended Solution

*Construction pending on customer growth in the area.

9. APPENDICES

9.1 Appendix 1: Sub-Transmission Security on Kangaroo Island

As previously identified Kangaroo Island is supplied via a radial sub-transmission network originating at Willunga. The radial line traverses large distances over remote and rough terrain. The southern Fleurieu Peninsula and Kangaroo Island are identified as high bush fire zones and both are subjected to frequent storms, which have a significant impact on maintaining security of supply. Faults on the 33kV radial overhead system on Kangaroo Island can take longer to locate and repair than faults on the mainland, due to the remote conditions.

The proposed addition of the second submarine cable will increase security of supply to Kangaroo Island, but not on Kangaroo Island itself. The 33kV sub-transmission network on the island will remain radial and this radial sub-transmission network is a key supply security weakness on Kangaroo Island.

Kangaroo Island Performance Summary 2001/02 -2012/13:

Unplanned SAIDI	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
Island Distribution	507	128	431	395	170	264
Island Sub-transmission	721	556	212	1256	788	820
Total (mins.)	1228	684	643	1651	958	1084

Unplanned SAIDI	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Island Distribution	334	193	229	158	247	412
Island Sub-transmission	330	22	99	40	21	0
Total (mins.)	664	215	328	198	268	412

Table 9: Kangaroo Island Performance Summary 2001/2 - 2012/13

The average annual contribution to Kangaroo Island SAIDI by sub-transmission faults was approximately 36 minutes between 2009 and 2013. This compares with an island total of approximately 284 minutes. As the above mentioned statistics indicate, there has been a significant improvement to the sub-transmission security over the last five years with the installation of Kingscote generators, to the point where Kangaroo Island's reliability is comparable to other areas of the Fleurieu Peninsula. Therefore additional investment can not be justified based on historical reliability figures. However with the existing sub-transmission network approaching the end of useful life, sub-transmission security can be expected to worsen in the coming years.

The majority of Kangaroo Island's 33kV sub-transmission network was constructed in the mid 1960s. The lines transverse rough terrain with the majority of the island classified as a high corrosion zone, this has an adverse effect on the expected lifetime of the overhead conductor.

An overview of the different conductor sections is shown below.

Conductor Section (33kV)	Length (km)	Conductor Size & Type	Year of Commissioning	Expected End of Useful Life
Cape Jervis – Fisheries Creek	5.1	0.1 ACSR	1965	2025
Cuttlefish Bay – Penneshaw	6.1	0.1 ACSR	1965	2025
Penneshaw – American River	31.2	0.1 ACSR	1966	2026
American River – MacGillivray	17.1	0.1 ACSR	1966	2026
MacGillivray – Kingscote	18	0.06 ACSR	1985	2035

Table 10: Conductor Information on Kangaroo Island

Note: Average life of 0.1 ACSR and 0.06 ACSR conductors is 60 and 50 years respectfully.

As per the above table the majority of the sub-transmission network will require replacement in the future. In order to improve supply security and increase sub-transmission capacity on Kangaroo Island without the need for lengthy outages, it is proposed that a 66kV sub-transmission network be constructed between Cape Jervis, Penneshaw and Kingscote.

The new 66kV sub-transmission network between Cape Jervis, Penneshaw and Kingscote will be a high security 66kV overhead line with an overhead earth wire for lightning resistance. This arrangement will provide a 66kV and 33kV sub-transmission network on the island capable of supplying all substations during an n-1 event (ie no longer radial). This solution will avoid the need for lengthy periods of generation while the existing 33kV lines are being replaced and will also provide ample capacity for future load growth in the region beyond 2035. Maintenance operations will also be simplified, with the ability to utilise the existing 33kV network.

In order to extend the 66kV sub-transmission network to Kingscote the following work will be required

- Expand Cape Jervis substation with one 66kV circuit breaker and one 66kV voltage transformer and construct 11.2km of 66kV line from Cape Jervis to Penneshaw;
- Expand Penneshaw substation with two 66kV circuit breakers, one 33kV circuit breaker, one 66kV voltage transformer and one 12.5MVA 66/33kV transformer and construct 51.7km of 66kV line from Penneshaw to Kingscote;
- Expand Kingscote substation with one 66kV circuit breaker and one 12.5MVA 66/33kV transformer.

This project would be completed in stages beyond 2025 depending on the condition of the 33kV network on Kangaroo Island.

9.2 Appendix 2: Recent Developments

Each year, SA Power Networks includes projects in its capital budget to manage the network capacity versus customer demand balance and network security of supply in its SA electricity distribution network. Several projects have been implemented to upgrade the capacity of the sub-transmission network that supplies Kangaroo Island and to maintain adequate levels of quality of supply to customers on Kangaroo Island. The major projects completed since 2009:

2013

Kangaroo Island J Tariff Peak Load Shift

A large number of meters on Kangaroo Island were programmed with revised hot water switching times to spread the J tariff peak which was adversely impacting the ability to run the Kingscote Power Station. This has reduced the time that the load on the island exceeds the generation capacity, by load shifting the manageable hot water load.

2012

Kingscote Power Station Upgrade to prepare for additional generation capacity

The Kangaroo Island Contingency plan identified several issues with the ability of the existing Kingscote Power Station to operate continuously for prolonged periods in the event of a cable failure. To facilitate the installation of additional emergency generation capacity, a section of the site was cleared. Extra fuel tank connections, step up transformers and generator concrete pads were installed. The site is now suitable for connection of up to three additional generators, which will be required if the power station has to operate for a prolonged period (in excess of two weeks).

2010

Kingscote Substation Upgrade

The Kingscote Substation upgrade was undertaken to solve the forecasted overload of the Kingscote region and surrounding areas. Kingscote Substation was upgraded with a new 33/11kV 6.25MVA transformer and 33kV transformer circuit breaker.

American River Substation Upgrade

To provide sufficient substation capacity in the American River area, the existing American River Substation was upgraded with a new 3.0MVA 33/11kV transformer, 33kV recloser and 11kV switching cubicle.

2009

Yankalilla to Cape Jervis 66kV Line

In early 2009, the 66kV network was extended from Yankalilla to Cape Jervis by the purchase of the existing 26km private 66kV line (Starfish Windfarm) allowing the voltage capacity of Kangaroo Island to be increased to 9.8MVA.

9.3 Appendix 3: Potential Customers

Customers with load over 90kVA contribute to the cost of augmentation in accordance with the South Australian Electricity Supply Industry Distribution Code. Customers who have enquired but not proceeded in the last two years are shown in the following table.

Customer Type	Requested Demand (kVA)
Supply from Kingscote Substation to a community titled development (30 allotments)	234
Supply from Kingscote Substation to an agriculture business	390
Supply from Kingscote Substation to an aquaculture business	500
Total	1,124

Table 11: Customer Enquiries that have not proceeded

The table below shows potential customers with existing off-grid generation who may want to be supplied via SA Power Networks distribution network in the last two years.

Customer Type	Requested Demand (kVA)
Supply from Kingscote Substation to an aquaculture business	287
Total	287

Table 12: Off-grid customers who may want to connect to the distribution network

The table below shows a customer who has enquired but not yet committed in 2014.

Customer Type	Requested Demand (kVA)
Major development near American River	500
Total	500

Table 13: Customer Enquiries (not yet committed)

The existing load forecast for Kangaroo Island does not include these potential customer loads which would bring forward infrastructure upgrades to the network if connected.

9.4 Appendix 4: Private End User Generation

According to the Report for the Kangaroo Island Development Board, *'An Investigation into the Utilisation of End User Generation on Kangaroo Island'*, the four existing sites with the largest generation capacity are:

Customer Type	Location	Distance from Backbone (km*)	Generation Capacity (kVA)
Accommodation business	Hanson Bay	**70km**	460
Aquaculture business	Wisanger	**20km**	632
Aquaculture business	Wisanger	**20km**	2,250
Agriculture business	Parndana	**17km**	1,620

Table 14: Sites with Largest on-site Generation Capacity

* Straight line distance of company location from existing SA Power Networks' backbone network (Kingscote or MacGillivray).

The Kangaroo Island Development Board has identified approximately 6.4MVA of total private generation on Kangaroo Island. Large customers who remain in isolation are not connected to our backbone network and use prime generators as their main source of power. Supply could be made available to these customers however this would require major upgrade and extension to the backbone network due to their isolated location away from the network. Therefore, these generators are unable to be utilised to support other customers on the island.

This information supports the case for investment in a new submarine cable as it highlights a number of sizable demands currently unserved by the existing network. Peak demand will increase significantly if these customers decide to be entirely supplied by the network.

The Kangaroo Island network also has limits as to how much embedded generation or load that can be connected at any point due to the resulting impact that it will have on the network voltage. Therefore, there is little scope for connecting relatively large embedded generators other than at major substations due to the impact that it will have on the dynamic network voltages.

According to the Stage 2 Stakeholder and Consumer Workshop Report by Deloitte Dec 2013 [1, Pg 26], for typically small customers that are already connected to the network, self-generation was limited to emergency backup, typically works for short durations and will not supply electricity 24/7 during peak demand periods. These generators will run to more frequent breakdowns and malfunction if being operated for longer than the prescribed number of continuous operation hours. This indicates the need for an efficient secure solution should the existing submarine cable experience a failure.

9.5 Appendix 5: Generation Cost in the Event of a Cable Failure

The Kingscote power station was designed as a standby power station with the balance of plant infrastructure installed to suit its standby rating. The design more than adequately meets this criterion, provided the duration necessary to meet the demands in providing the alternative electricity supply for KI is limited to a maximum of a few days.

The power station design allows for an automatic start and load supplying Kingscote substation and associated loads in the event of a network fault resulting in the loss of supply at the substation. In the event the interruption is to the 33kV network, the distribution network controller at Keswick will assess the situation and via the remote control facilities using a contingency switching program energise the 33kV network on Kangaroo Island to resupply the customers on KI from the Kingscote power station.

The existing average load on KI is in the order of 3.8MW with peak demand (summer and winter) often exceeding the 6MW standby rating of the Kingscote generation. With the predicted load growth, within this reset period, the capacity of the Kingscote power station will be exceeded during peak times more often. To ensure that sufficient generation capacity is available to meet the estimated load growth a fourth generating unit is planned for installation during 2015, increasing N capacity to 7.2MW and N-1 capacity to 6MW.

In the event that the Kingscote power station is called upon to operate for any extended period, ie greater and a few days, the 8MW standby generation rating, which includes the additional fourth generating unit is reduced to its prime power rating 7.2MW (ie 90% of the standby rating). In addition, every 10 days of continuous operation each of the generating units will need to be taken out of service for between 5 and 22 hours, dependant on the service interval, to undertake the manufacture's recommended programmed maintenance inspections. Thus resulting in the loss of generation capacity of at least one generating unit providing a maximum of 5.4MW (prime power), which is below the existing 2014 peak demand regardless of any predicted load increases.

To maintain the required 8MW of generation capacity the capacity must be increased to at least 10MW to provide a 9MW prime power rating for continuous operation. This additional 2.0MW of generation capacity will permit a maximum of 1 existing 1.8MW (prime power) generating unit being out of service for routine maintenance or repair, whilst still maintaining sufficient generation capacity for continuity of supply.

The operational costs estimate for the ongoing operation of the Kingscote standby 8MW power station hence are much higher than would be expected for a similar base (prime power) power station.

The costs provided at KI Generation Cost ERP spreadsheet reflect the extraordinary additional requirement that would not be associated with a base load power station, which include:

1. Leasing of additional 2.6MW (prime power rating) of generation
2. Leasing of additional fuel storage capacity of 182k litres providing approximately 7 days fuel storage capacity with existing tank
3. Lease / purchase of bulk lube oil tanks for storage of new and waste oil for servicing of the generating units on site
4. Mobilisation, installation and commissioning of:
    a. additional 2.6MW (prime power rating) of generation
    b. additional fuel storage capacity
    c. bulk lube oil tanks

5. Additional freight cost of fuel and oil to KI, which includes the additional ferry costs
6. Additional costs associated with manning the Kingscote site 24/7 to monitor the operation, dispatch generation capacity to meet cyclic load of the network and routine programmed preventative maintenance services, as this is not SA Power Networks core business
7. Additional expenses in providing accommodation and living expenses for operating crews, whilst on KI
8. Additional fares and travel time expenses between Adelaide and Kingscote
9. Demobilisation and clean up of site after cable repair
10. Contingency budget:
    a. Inevitable repairs and/or replacement of failed equipment, eg water pumps, radiator fans, fuel / oil pumps, electrical equipment, fan belts, radiators, etc
    b. Replacement generating unit

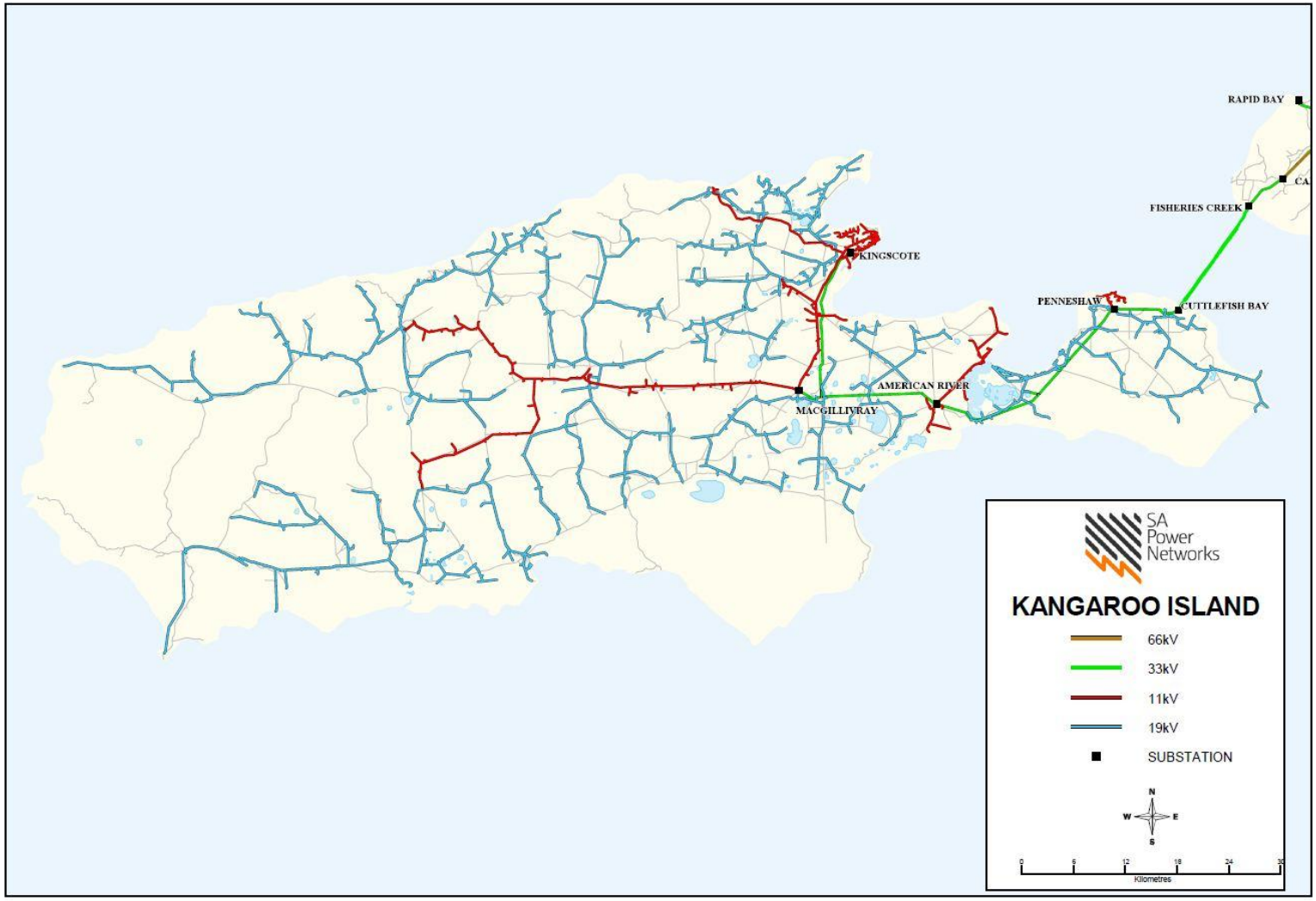
Based on these extraordinary additional costs it is irrelevant to draw any such comparison between the operating costs of a similar rated prime power station and the Kingscote 8MW standby power station.

The estimate for operating the Kingscote power station to maintain continuity of electricity supply on KI for 12 months in the event of a submarine cable failure is broken into the following major items:

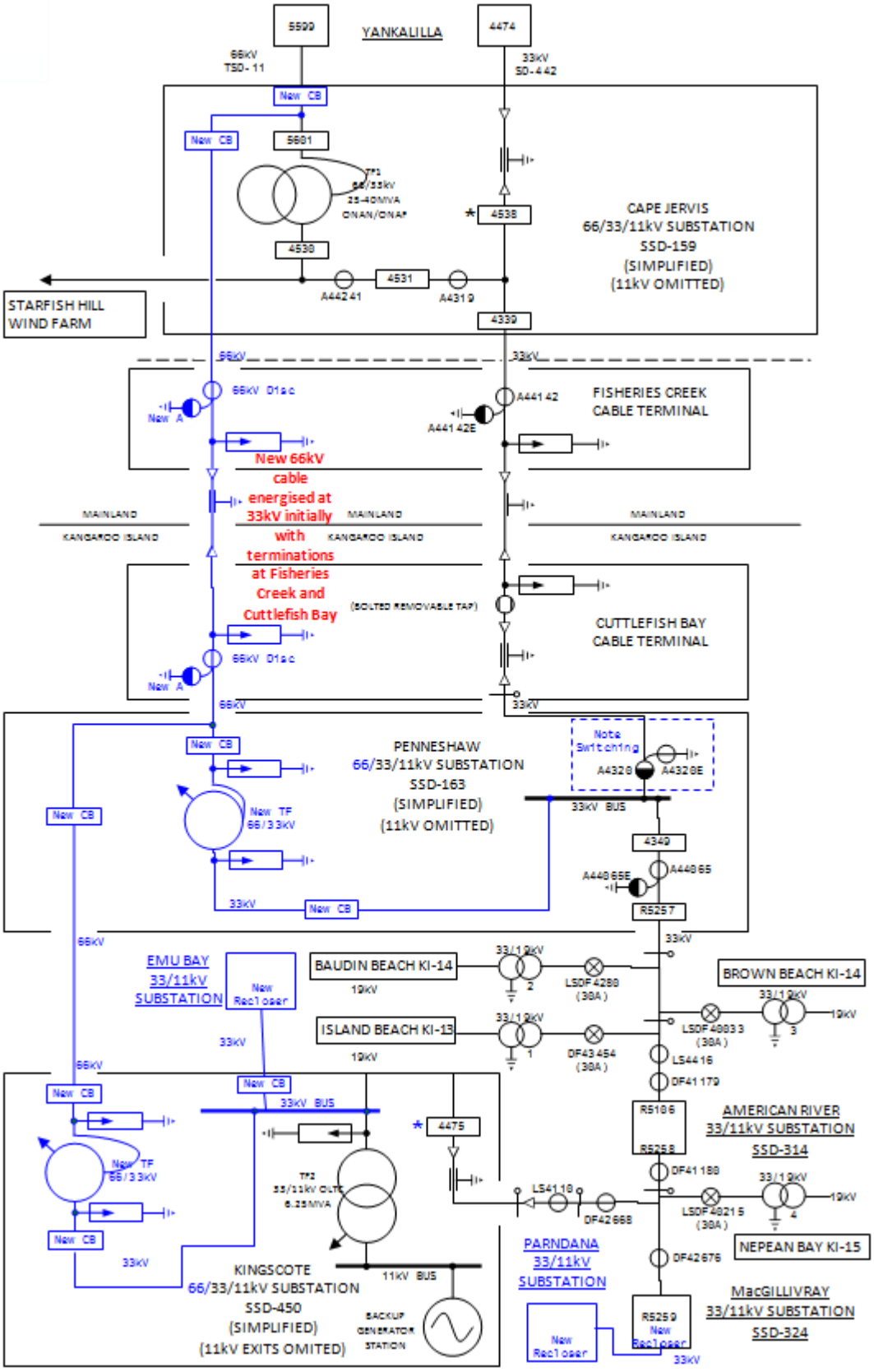
Description	Estimated Cost (2013 $)
Power Station Operational cost	$9,700,000
Mobilisation/ Demobilisation of Leased Gens (Setup and Operation)	$2,300,000
Total Fuel Cost including Fuel Rebate	$16,600,000
Urea Usage	$2,900,000
Engineering/ Control/ Project Management/ Legal Services	$300,000
Total	**$31,800,000**

10. ATTACHMENTS

10.1 Attachment 1: Kangaroo Island Sub-transmission Supply System



10.2 Attachment 2: Existing and Future Sub-transmission Diagram



10.3 Attachment 3: Risk Rating

Risk Name: Loss of Kangaroo Island submarine cable (Loss of supply to all of Kangaroo Island for an extended period – 1 year)

Risk Assessment Worksheet

Project Title	Kangaroo Island Submarine Cable
Step 1 - Risk Identification	
Risk Domain	**Describe Identified Consequences** *(N/A if no significant consequences identified)*
Reliability	~3900 customers without supply for min 24 hours
Financial	1 year of generation >$31.8M, refer KI AMP
Health and Safety	N/A
Environmental	N/A
Reputation	Widespread customer complaints or complaints to Regulator
Regulatory	N/A
Organisational	Significant event which requires specific management

Step 2 - Risk Assessment: *Refer to the Attachment for information on the Risk Assessment*

Evaluate the risk Likelihood and Consequence if the project were not to be conducted in the budget year.

Risk Domain	Likelihood	Consequence	Risk Level	**Risk Evaluation Results:**	
Reliability	3	3	6	**Risk Rating:**	**7**
Financial	3	4	7	**Risk Type:**	**High**
Health and Safety	0	0	Not Yet Rated	**Project Type:**	**Priority**
Environmental	0	0	Not Yet Rated	0	
Reputation	3	3	6	Risk sub-rating:	**0**
Regulatory	0	0	Not Yet Rated	Final Risk Rating:	**7**
Organisational	3	3	6		

Additional notes - please describe reasons for risk ratings.
Loss of KI Cable will require generation to run for a minimum of 12 months.
Provision of fuel and additional generators are a significant logistics exercise.
New cable proposed, only alternative is generation.

Additional notes - Alternatives
Are there any alternatives to the capital proposal that could be introduced to reduce the identified risks? For example, consider existing or potential controls, either as a short term or longer term measure.

10.4 Attachment 4: Breakdown Cost Summary

Please find attached breakdown cost in the following tables:

Deep Ocean Cable Fault (12 months) [20]

Description	Estimated Cost (2013 $)
Fault Location	$100,000
Barge Hire and Wharf Facilities	$3,000,000
Divers and Cable Installation Crew	$1,400,000
Power Cable, Circuit Jointing and Testing	$1,500,000
Supervision and Project Insurance	$3,000,000
Contingencies	$1,800,000
Engineering/ Control/ Project Management/ Legal Services	$600,000
Total	**$11,400,000**

Kangaroo Island Cable and Installation Cost [23]

Description	Estimated Cost (2013 $)
Supply of 66kV Cable	$10,200,00
Basic Cable Installation	$18,500,00
Transportation of Cable	$5,500,00
Overhead Construction Cost	$8,500,00
Fisheries Creek Hut Construction Works	$1,200,000
Cuttlefish Bay Hut Construction Works	$2,000,000
Engineering/ Control/ Project Management/ Legal Services	$1,600,000
Total	**$47,500,000**

Kangaroo Island Cable Fault Scenarios [15-22]

Scenario	Duration (Months)	Cable Repair Cost (2013 $)	KI Generation Cost (2013 $)	VCR Cost (2013 $)
Shallow Water Cable fault (Best Case)	2	$2,870,000	$6,660,000	$600,000
Deep Ocean Cable Fault (Likely)	12	$11,400,000	$31,800,000	$3,400,000
Unsuccessful in locating Cable fault (Worst Case)	24	$1,400,000	$59,400,000	$6,800,000
Deep Ocean Cable Fault (Option 4)	4	$7,350,000	$13,000,000	$1,100,000

10.5 Attachment 5: Stakeholder Letters

Letter from the Minister for Mineral Resources and Energy of South Australia

MMRE14D00523

Government of South Australia

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ADELAIDE S.A. 5001
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treasurer@sa.gov.au

Ms Cathryn Blair
Stakeholder Engagement
2015 to 2020 Directions and Priorities
SA Power Networks
GPO Box 77
ADELAIDE SA 5001

Dear Ms Blair

Thank you for the opportunity to provide a submission to SA Power Networks' 2015 to 2020 Directions and Priorities consultation.

I understand that this consultation will form the basis of SA Power Networks' Regulatory Proposal for 2015-2020 to the Australian Energy Regulator (AER) later this year. The costs and merits of the proposal will then be assessed under the economic regulatory framework established in the National Electricity Rules.

It is pleasing to see that community consultation has occurred in establishing the Directions and Priorities for SA Power Networks. Maintaining and investing in the distribution network is important to ensure that safe and reliable electricity is delivered to South Australian consumers.

In recent years, utility costs have been subject to significant community concern. The South Australian Government is continuing its work on Affordable Living, which was identified as one of the Government's seven strategic priorities. Accordingly, the Government is looking to reduce the burden of costs of living on South Australians, by developing flexible payment options for service charges, well targeted concessions, specific relief initiatives, and by working closely with the non-governmental sector.

While I am encouraged that SA Power Networks forecasts the price impact will be relatively small, in light of community concerns, SA Power Networks is encouraged to consider any opportunities for expenditure savings that could provide real decreases in electricity prices. This could mean reconsideration of any non-critical projects.

I note for the 2015-2020 period, SA Power Networks has proposed an increase in capital and operating expenditure from the previous regulatory period. The proposal would see capital expenditure of $2.9 billion which compares to total capital

expenditure allowance of $1.59 billion previously; and a $1.5 billion operating expenditure compared to $1.03 billion previously.

I note SA Power Networks' proposal to install a new undersea cable that supplies power to Kangaroo Island. The existing cable, which was commissioned in 1993, is nearing the end of its expected operating life. It is important that a new undersea cable is installed before the existing cable fails to avoid unnecessary impacts for the community and the Island's reputation as a tourist destination. Investment in the 2015-2020 regulatory period will ensure Kangaroo Island residents and businesses have secure electricity supply in the long-term as it would accommodate any demand growth on the island and provide security of supply for at least the next two decades.

The Directions and Priorities paper provides that SA Power Networks' community consultation, including an online survey, showed that those surveyed are willing to pay extra for undergrounding and up to $4 per quarter for improved vegetation clearance management in all areas. It is understood that this would represent a further increase to vegetation management expenditure on top of the already significant rise that was approved in the 2010-2015 regulatory period compared to previous periods.

Following last year's approval by the AER of an additional $35.1 million pass-through cost for vegetation clearance costs resulting from increased rainfall, the Government received a number of letters expressing customer concern regarding the additional charge. The view expressed to SA Power Networks during community consultation may not necessarily be the view held by the majority of consumers.

In addition, the vegetation clearance regulations under the *Electricity Act 1996* were amended in February 2010 to allow SA Power Networks to adopt a risk-based approach for pruning vegetation around low voltage lines in non-bushfire areas of Adelaide representing a less burdensome regulatory requirement. Given these factors, SA Power Networks should consider whether increased costs for vegetation clearance are necessary.

The Directions and Priorities paper also provides that the capital expenditure needed to achieve the proposed work and activities is $2.9 billion comprising a number of key investment programs. With respect to the repair and replacement of ageing network infrastructure, it is understood that SA Power Networks requires sufficient revenue approved to ensure that South Australian consumers have secure and reliable electricity supply; however the extent of this expenditure is somewhat unclear. Capital expenditure costs associated with managing, upgrading and replacing ageing assets has already spanned multiple regulatory periods since 1999 and has continued to be a sizable component of SA Power Networks' proposal to the regulator. Without underestimating the importance of this work and whilst recognising that much of the network infrastructure was built in the 1950s and 1960s, I expect the community would welcome further information about how much more and for how much longer funds will be required for this purpose.

I also note SA Power Networks' proposal to progressively increase the capacity work program to support South Australia's changing demand needs despite a reduction in electricity consumption in recent years. While I appreciate the difficulty in forecasting

demand in the current environment, I encourage SA Power Networks to assess its proposal against the emergence of more distributed generation, in particular with battery storage, competitive advanced metering infrastructure and innovative network tariffs signalling a movement away from a centralized grid model needing expansion.

Finally, I note SA Power Networks' proposal to commence installation of advance meters to all new premises and altered customer installations. As you are aware, the Government supports the competitive provision of advanced meters. The Australian Energy Market Commission (AEMC) is currently developing Rules to facilitate a competitive market for the provision of advanced meters to consumers. Earlier this year, the Government also released a discussion paper entitled *South Australian Policy for New and Replacement Electricity Meters* under which it was proposed that smart ready meters be installed in new and replacement situations unless a customer chooses to opt-out. This proposal is intended to work under the Rules being developed by the AEMC. Any approved expenditure in this area will need to take into account the impact of competition in residential advanced metering installations.

I trust the above information is of assistance.

Yours sincerely

Hon Tom Koutsantonis MP
Minister for Mineral Resources and Energy
12th June 2014

Letter from the Kangaroo Island Council

KANGAROO ISLAND COUNCIL
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Ref. No: E2014/
Cross Ref No: E2014/
File No.: 14.20.8
Initials: AB

25 June 2014

Cathryn Blair
SA Power Networks
1 Anzac Highway
Keswick SA 5035
Email: Cathryn.Blair@sapowernetworks.com.au

Dear Cathryn

Thank you for the opportunity to participate in the consultation process around the 2015-20 Regulatory Period SAPN submission.

Over the last 18 months we have worked in conjunction with yourselves and the Kangaroo Island Futures Authority to establish the case for the replacement of the 10MW / 33KVA undersea supply cable before it fails and we believe that the level of risk and costs and disruption that failure before replacement would impose on our Island Community are simply not acceptable. In addition to the huge costs and risks associated with supporting diesel generation for the long term, the potential cost to our residents and businesses would be catastrophic. The inability of the back-up system to cope with peak demands during tourist season have the potential to cause significant financial pressure on a community already struggling with the 26-30% higher costs associated with being an Island Community.

We have businesses here that are totally dependent on a reliable mains power supply and could not manage either the risk or the costs associated with long term diesel generation. The impact on our brand has the potential to be significant and we cannot afford for this to happen as a result of premature failure. As an Island we have limited social resilience – if we lose jobs here we simply cannot go down the road to find others and therefore our elasticity, our capability to deal with significant cost / impact on custom / inability to provide normal services is very limited.

The cost comparison between planned replacement during the next five year Regulatory period as opposed to replacement at failure has clearly identified the potential for major avoided cost associated with 12-18 months of disruption and we would be hopeful that the Australian Energy Regulator (AER) will recognise this. Having a new backbone in place together with the additional works planned will ensure that this Island has a reliable power supply and the capacity to manage both increases in on-Island demand and on-Island co-generation and we recognise the staged approach you are taking as being both prudent and cost effective. We are being successful in attracting new business to the Island – a world-ranking golf course / accommodation venture ($20M) and a significant top-end tourism development ($40M) are both now in advanced planning. Both will require significant base load power and this will place the rest of the network under pressure – particularly in our peak demand periods when the population of the Island can rise from 4,500 to 25-30,000 people in December through to March. We have much more potential and will continue to attract business if we can guarantee that we have a reliable supply and the capacity to meet increases in demand without significant augmentation.

We fully support the elements of your submission to the AER that apply to Kangaroo Island and we are happy to provide further support / submissions if you feel that they will add additional value.

Yours sincerely

Jayne Bates OAM
Mayor

10.6 Attachment 6: Remote Areas Energy Supplies

Generator Summary 2012/13 from the Department for Manufacturing, Innovation, Trade, Resources and Energy (DMITRE)

	Generator	No of Generation Units	Size of Generation units (MW)	Capacity (MW)	Plant availability	Unplanned outages in 2012/13	Description of outage
1	Umuwa (Central Power House)	4	3 x 1.088 1 x 0.400	3.664	**99.93%**	**2**	1 unit's water pump lost seal emptying radiator. Micrologic unit failed.
2	Pukatja	4	3 x 0.180 1 x 0.280	0.820	**100%**	**0**	
3	Amata	2	2 x 0.470	0.940	**100%**	**0**	
4	Murputja	2	1 x 0.180 1 x 0.100	0.280	**99.91%**	**1**	Suspected fuel problem
5	Pipalyatjara	3	1 x 0.280 1 x 0.364 1 x 0.180	0.824	**99.98%**	**0**	
6	Watarru	2	2 x 0.100	0.200	**50.41%**	**4**	2 caused by fuel theft and damage to generators 2 caused from phase imbalance on generator
7	Oak Valley	3	2 x 0.180 1 x 0.100	0.460	**100%**	**0**	
8	Yalata	3	1 x 0.280 1 x 0.180 1 x 0.200	0.660	**99.99%**	**1**	1 unit had a low battery voltage condensation build up inside covers
	Total					**8**	

11. REFERENCES

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11 Cook Strait Submarine Cable Protection Zone. An Information brochure on the Submarine Cable Protection Zone across Cook Strait and how it effects mariners, fishers, divers and the public. https://www.transpower.co.nz/sites/default/files/publications/resources/Cook-Strait-Cable-Protection%202013.pdf

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13 Entura Kangaroo Island 66kV Marine Cable – Constructability Assessment 16 Dec 2013.

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15 KI Generation Cost ERP 28 08 2014_2 months

16 KI Generation Cost ERP 28 08 2014_4 months

17 KI Generation Cost ERP 28 08 2014_12 months

18 KI Generation Cost ERP 28 08 2014_24 months

19 Repair Budget Rev 6 Deep Ocean Fault 20140918 4months

20 Repair Budget Rev 6 Deep Ocean Fault 20140918 12months

21 Repair Budget Rev 6 Shallow Water Fault 20140820 2months

22 Repair Budget Rev 6 Unable to locate cable or fault 20140821

23 KI Cable Project Cost Spreadsheet 20140822

24 KI Cable NPV Calculations Option 1 and 2 September 2014

25 KI Cable NPV Calculations Option 3 September 2014