SA Power Networks

Supporting document 5.17

2020-25 Reliability & Resilience Programs - Hardening the Network

2020-25 Revised Regulatory Proposal

10 December 2019

SA Power Networks

2020-2025 Reliability & Resilience Programs - Hardening the Network

December 2019

Contents

Executive Summary 5
Overview of program 5
Our obligations and this program 5
Our hardening the network program 6
Customer Service Level Improvements 7
Economic benefits of the program 7
Customer support for the program 8
The companion Hardening the Network Regulatory model 9
Regulatory treatment 9
1 Purpose and structure 11
2 Introduction 12
2.1 Hardening the network program 12
2.2 Hardening the network program and our previous regulatory proposal 16
2.3 Program scope 17
2.4 Key features of our forecasting and evaluation methodology 17
3 Our obligations 18
3.1 Network hardening 19
4 The drivers and need for this program 20
4.1 Customer service levels during major event days 20
4.2 Customers most impacted during Major Event Days 23
4.3 The economic benefits of hardening 24
4.4 Other costs associated major event day interruptions 25
5 Program options considered 26
5.1 Options considered and our methodology to identify the optimal solution 26
6 Cost benefit analysis of the program 27
6.1 The customer service level benefits 28
6.2 Regional benefit from the program 30
6.3 Economic benefits and net benefit of the program 30
7 Customer support for the program 32
8 The preferred program and program scope 36
8.1 Rationale for selecting the preferred hardening the network program 36
8.2 Hardening the network program cost and scope 36
8.3 The customer service level benefits achieved by the Program 37
8.4 The economic benefits achieved by the hardening the network program 38
8.5 Program timescale 39
8.6 Relationship of the hardening the network program to other programs 40
9 Regulatory treatment 42
9.1 The limitations of the STPIS as an appropriate revenue mechanism 42

9.2 Our reasoning for including in the cost of this program in our capex forecast 42
9.2.1 The NER capex objectives 42
9.2.2 The NER capex criteria 43
9.2.3 The NER factors and our consumer preferences 43
9.3 The capex forecast and other adjustments 43
9.4 Concluding statements on why we believe the AER should accept our treatment of this program 44
Appendix A. Relationship to business strategies and other programs 46
Appendix B. Project risks and financial evaluation summary 47
Appendix C. Evaluation methodology 49
Appendix D. Feeder level summary results 50
Appendix E. Relationship to National Electricity Rules Chapter 6 requirements 51
Appendix F. Evidence of program efficiency 53

Executive Summary

Overview of program

We have developed a $16.2 million Hardening the Network augmentation program to mitigate extended duration interruptions experienced by 53,800 customers whom are significantly impacted during periods classified as Major Event Days (**MED**s). This program is proposed to be continued and implemented over the next regulatory control period (**RCP**), 2020 to 2025.

This program will cover a combination of strategies, across 35 feeders, aimed at addressing the specific causes that contribute to extended duration interruptions to our customers during MEDs, including:

- Minimising insulator failures due to lightning by re-insulating vulnerable sections of overhead lines with lightning resistant insulators;
- Reducing vegetation outages and damage from outside the prescribed vegetation clearance zone by constructing alternative network asset configuration / standards; and by
- Reducing the number of customers interrupted during MEDs by installing mid line switches.

We estimate that this program will provide, on average, 119 minutes improvement in the System Average Interruption Duration Index (**SAIDI**) for customers supplied by these feeders, representing a 37% improvement in their supply reliability (including MEDs).

This program only includes work elements that we have found to be economically viable (ie the benefits exceed the costs in present value terms). We estimate the total economic benefit due to the implementation of the program is $5.2 million per annum.

The need for the 'Hardening' program to continue through to 2025 has been validated through customer feedback supporting the program submitted with the SA Power Networks' Regulatory Proposal for the 2020-25 RCP (**Original Proposal**)[1&2], a review of network performance that has impacted our customers since 2010/11, and a prediction and extrapolation of weather-related performance trends in line with the risks identified by the Bureau of Meteorology's report, *Climate extremes analysis update for South Australian Power Network operations*. This report predicts increases in severity and frequency of weather events in the future, which are likely to further negatively impact network performance and customer service, unless specific action is taken.

Our obligations and this program

There is no technical criteria that defines how we should identify and monitor our customers most impacted during MED. We acknowledge that we do not have a specific obligation to mitigate MED interruptions to customers but consider that there is an expectation to implement mitigation solutions where economically viable and where there is suitable customer support and subsequently submit for funding approval. We also acknowledge Essential Services Commission of South Australia (**ESCoSA**) Service standards in clause 2 of the Code exclude unplanned interruptions that qualify as MEDs.

That said, we consider that there is a clear expectation that we will undertake some form of augmentation where it is economic to do so and are resubmitting for funding approval. We also consider that this interpretation is in line with the National Electricity Law (**NEL**) objectives, as to <u>not</u> do so in these circumstances would not be in the long-term interests of our customers.
Consequently, we consider that we have an expectation to undertake actions to mitigate long duration interruptions that occur during MEDs to these customers where it is prudent and efficient and economical to do so (subject to appropriate regulatory funding being provided).

---

[1] Supporting Document 0.7 – MDC Planning and Directions Workshop Report, Original Proposal
[2] Supporting Document 0.13 – AnnShawRungie Capex Deep Dive Workshops Report, Original Proposal

We must comply with the South Australian Electricity Distribution Code (**EDC**) as a condition of our Distribution Licence[3]. The EDC defines various service standards we must comply with. Reliability capital expenditure is required to maintain reliability performance for our customers and to comply with the ESCoSA service standards for reliability as set out in the South Australian EDC[4].

This program is also in accordance with the National Electricity Rules (**NER**) to provide evidence to the Australian Energy Regulatory (**AER**) (to accompany regulatory proposals) that SA Power Networks has "engaged with electricity consumers and has sought to address any relevant concerns identified as a result of that engagement" (NER 6.8.2 (c1) (2) and 6.5.7(a) provides that SA Power Networks must submit a building block proposal that includes a forecast of the capital expenditure (**capex**) required to meet the capital expenditure objectives for the 2020-2025 RCP.

This program seeks to address the specific concerns of electricity consumers for continued investment for ensuring acceptable levels of reliability for all customers, in particular, those customers who experience repeated and long duration interruptions as a result of network damage from major storms (namely, MEDs).

This includes capital expenditure required to comply with all applicable regulatory obligations or requirements associated with the provision of Standard Control Services (**SCS**) and to maintain the reliability of SA Power Networks SCS.

Our Hardening Program only includes solutions that are economically viable and our customer engagement has demonstrated customer support[5].

Our hardening the network program

Although we do not have a specific obligation to mitigate MED interruptions, the need for the Hardening the Network program to continue through to 2020-2025 has been identified through customer engagement and a review of overall network performance that has impacted our customers since 2010/11 and a prediction and extrapolation of weather-related performance trends.

This performance aligns with the risks as identified in *Climate extremes analysis update for South Australian Power Network operations* which predicts increases in severity and frequency of weather events in the future, and which is likely to further negatively impact network performance and customer service, unless specific action is taken.

The State of the Climate 2018 report[6], as published by The Bureau of Meteorology and CSIRO, also paints a consistent picture of ongoing, long-term climate change particularly in weather and climate extremes where over coming decades Australia will experience more extreme hot/cold days, intense heavy rainfall events and fewer cyclones but greater proportion of high-intensity storms. It is expected that these weather predictions will have an adverse impact on customer service levels.

Although underlying performance remains stable, customers are increasingly being severely impacted during MEDs due to the greater intensity of extreme weather impacts on the network; customer service is deteriorating for 35 feeders included in the 2020-2025 Hardening the Network program when taking MEDs into account.

[3] Distribution Licence Clause 7.1. "*The licensee must comply with all applicable regulatory instruments…*" and applicable regulatory instruments includes the EDC issues by ESCoSA
[4] Clause 2, EDC
[5] Supporting Documents 0.7 & 0.13, Original Propsoal
[6] Bureau of Meteorology & CSIRO (2018) *State of the Climate 2018*.

The Hardening the Network program focuses on mitigation of storm related interruptions predominately in the Adelaide Hills and Adelaide Foothills, where MEDs have impacted the majority of our customers.

This declining performance is negatively impacting the service levels of our customers, increasing the economic cost of this poor performance, and in turn increasing the need for corrective action.

- There has been a step increase in storms which have exceeded the MED threshold from 2010/11, resulting in a deterioration in overall customer service
- The storm-related interruptions caused through lightning and vegetation from outside the clearance zones[7] on the SA Power Networks have been increasing over this period.

Customers are increasingly being severely impacted during MEDs due to the greater intensity of extreme weather impacts on the network. As a consequence, customers are experiencing an additional 41 minutes off supply per year on average for the current regulatory period in comparison to the previous regulatory period on MEDs.

Customer Service Level Improvements

Our Hardening the Network Program will reduce long duration interruptions during MEDs to 53,795 customers including 527 registered "Life Support Customers", representing approximately 7% of SA Power Networks' customers.

These customers on average experience a significantly greater amount of time without supply because of major event days in comparison to all customers across the SA Power Network.

These customers are predominantly supplied via overhead bare-wire conductor construction which are far more prone to being affected by storms and so customers supplied from these feeders tend to experience significantly more minutes off supply when including MEDs, compared to other customer groups.

The Hardening the Network program focuses on mitigation of storm related interruptions predominately in the Adelaide Hills and Adelaide Metropolitan Area, where MEDs impact the greatest number of customers.

We estimate that this program should deliver on average a 119-minute improvement in SAIDI per annum (including MEDs) to customers targeted.

It should be also noted that these customers are not considered to be supplied by Low Reliability Feeders (**LRF**s) as the criteria to determine an LRF excludes MED impact. We have also confirmed that there is no overlap between our reliability programs.

Economic benefits of the program

In response to AER feedback, we have considered various augmentation work options that should provide long-term sustainable performance benefits of the feeders targeted for hardening. These options reflect the methods we have been applying for the current successful hardening program. Furthermore, we have used an independent statistician to validate the scale of the improvement we can typically expect from these types of options (ie option effectiveness), and so we can have confidence in the scale of the improvements that should be realized through these approaches.

[7] Refer SA Power Networks Protocol for Vegetation Management near powerlines 2019-2021. SA Power Networks is able to manage vegetation in the clearance zone which is prescribed based on the voltage of the lines traversing that zone. Vegetation outside of this clearance zone can still impact the network infrastructure. For example, a tree that is located outside of the clearance zone may break or fall over in a storm and impact on the network infrastructure. SA Power Networks will need to manage this type of vegetation issue through alternative plans, outside of the standard vegetation clearance activities.

In the development of an optimal set of options for each feeder section, we have undertaken a detailed review of all the outage locations and causes (over the last 8 years) for the feeders most impacted by MEDs and applied the most prudent and efficient (and proven) solutions for each feeder section to address the range of causes of the outages on that feeder.

The benefit of a solution was calculated within the model based on mitigation of historical faults in each targeted section had the solution been in place and not on other faults at other locations on a feeder.

In response to the AER's statement that "*customers may still experience outages if faults occur at other locations along a feeder*" it's important to note that the proposed solutions are not meant to prevent faults at unique locations but to prevent faults along certain sections of feeders. We have also provided feeder plans with specific fault locations to support this in the Appendices; and more detailed information on the range of solutions for each feeder is contained in the Supporting Document 5.17.1 Hardening the Network model where this analysis is contained.

Based on our analysis of historical outages, we undertook a detailed and comprehensive review of our highest 173 MED impacted feeders to determine the causes of extended outages and develop the best solutions to mitigate these causes.

The proposal includes the highest NPV positive projects only, where the economic benefit of each project exceeds cost, based on the VCR benefit up to a limit of continuing hardening investment at current levels rather than increasing our spend and proposing all Net Present Value (**NPV)** positive projects identified.

This program only includes work elements that we have found to be economically viable (ie the benefits exceed the costs in present value terms). We estimate the total economic benefit due to the implementation of the program is $5.2 million per annum or $46.2 million over a 15-year period.
The economic benefit associated with individual feeders is on average $140,101 per annum, but ranges between $9,406 and $364,920 depending on the feeder.

As noted above, we have ensured that all individual solutions in this program have a positive net-benefit (ie the economic benefit of the solution exceeds the cost of the solution – in present value terms).

The individual feeder upgrades have an average benefit-cost ratio of 8.2 (ie the economic benefit is over eight times higher than the costs); with this ratio ranging between 2.2 and 72.6 depending on the solution, refer Supporting Document 5.17.1 Hardening the Network Regulatory model (the **HN Regulatory model**).

Customer support for the program

We have engaged extensively with our customers and stakeholders during the development of our original and revised proposals. As part of this engagement, we have spoken with our customers on their views on supply reliability and price trade-offs. In a series of 'Directions' workshops held across the State in the early stages of our engagement, customers were asked to prioritise what was most important to them. While network price and preparing for the future were identified as high priorities, at the time of the workshops network reliability and resilience was identified as the highest priority for customers, particularly regional and rural customers. More detailed workshop results are summarised below, and full details are available in Supporting Document 0.7 – MDC Planning and Directions Workshop Report, Original Proposal:

- Network reliability and resilience matters most to regional and rural customers, especially those in the Adelaide Hills and on the Eyre Peninsula;
- Reliability standards should not be lowered;
- It is important to ensure acceptable levels of reliability for all customers, and regional customers would benefit from having reliability standards more aligned to metropolitan customers; and

- Different sectors have different expectations and needs in terms of reliability of supply and customers are looking for a system that can accommodate this.

Following this early engagement with customers, SA Power Networks developed preliminary expenditure forecasts that were discussed with stakeholders in a series of 'deep dive' workshops in 2018 and used as the basis for our 2020-2025 Draft Plan. Through the Draft Plan consultation process, regional councils and business representative organisations such as Business SA and the SA Wine Industry Association supported targeted, economically viable reliability improvement programs. Vulnerable customer advocates acknowledged the need for such programs but expressed concerns about customers' ability to pay for them. As a result of this feedback, we subsequently revised the scope and investment required to deliver the program.

When discussing the Hardening the Network program with customers and stakeholders in the development of our Revised Proposal, there were divided views. Some stakeholders representing vulnerable customers questioned whether all customers should have to pay for the program, while many advocates, particularly those representing business and regional customers, were very supportive of making targeted improvements where it is economic to do so.

In our direct engagement with customers via our online channels such as social media and the talkingpower.com.au website, customers have consistently expressed concerns about reliability and the ability of the network to withstand the impact of storms and weather-related events. They have indicated their support of SA Power Networks continuing our program harden the network in priority areas.

We consider that, on balance, there is greater customer support for the Hardening Program than against.

The companion Hardening the Network Regulatory model

The analysis and results discussed in this document are provided in an excel workbook, Supporting Document 5.17.1 Hardening the Network Regulatory model. The HN Regulatory model provides detailed data and analysis on:

- detailed historical outage data of all feeders considered through this program;
- customer service level analysis, covering measures such as System Average Interruption Frequency Index (**SAIFI**), SAIDI, customer minutes (including and excluding MEDs);
- economic costing of reliability via VCR calculations;
- individual solution scope and costs, and underlying unit costs assumptions;
- formal cost-benefit analysis of solutions;
- Service Target Performance Incentive Scheme (**STPIS**) reward/penalty estimates (assuming a notionally uncapped mechanism); and
- other key inputs and assumptions.

It also includes most of the summary results, tables and charts that are provided in this document. It also provides more comprehensive regional and feeder category summary tables, and detailed feeder-level and solutions-level tables, which can be referred to for a more detailed view of our analysis and results.

Regulatory treatment

The Hardening the Network program is a reliability augmentation program and so the reliability benefits can *notionally* affect STPIS outcomes. However, the benefit-cost ratios for these types of projects are typically much lower than our more usual reliability projects, which are aimed at addressing underlying reliability. The consequence of this is that the existing STPIS mechanism does not provide the appropriate incentives to fund the types of work identified under this program, as MED interruptions are excluded from STPIS.

Therefore, STPIS does not provide sufficient revenue reward to justify incurring the investment to mitigate MED events (ie the appropriate return on and of the capital investment over the regulatory period would be below the revenue provided by the STPIS).

Therefore, in our Revised Regulatory Proposal for the 2020-25 RCP (**Revised Proposal**) to the AER, we will include the capital cost of this program and the required adjustments to the STPIS targets if that capital expenditure is included in our capex allowance.

We believe that the AER can have confidence that the $16.2 million capital cost of this program is in accordance with the NER capital expenditure objectives, criteria and factors, given the following:

- the detailed analysis we have conducted to develop this program;
- the cost-benefit analysis we have applied to ensure that it only includes work elements that provide a positive net benefit; and
- the findings of our customer and stakeholder engagement which support in principle the Hardening the Network program and in circumstances where it is economically viable to do so.

Once the programme is <u>fully</u> implemented by June 2025, the improvement to service targets achieved through this program are estimated to be as follows:

- SAIDI targets (ex MEDs) – 0.71 minutes at the state level, 1.27 minutes to Long Rural feeders, 1.07 minutes to Short Rural feeders, and 0.52 minutes to Urban feeders.
- SAIFI targets (ex MEDs) – 0.009 interruptions at the state level, 0.012 interruptions to Long Rural feeders, 0.008 interruptions to Short Rural feeders, and 0.008 interruptions to Urban feeders.

However, we propose that the STPIS targets be <u>adjusted by half</u> the ultimate improvement to reflect that the program will be progressively implemented over the 2020-25 RCP and as such will have minimal impact in 2020/21 and nearly full impact in 2024/25.

It is important to note that both the STPIS target adjustments will occur incrementally over the 2020-25 RCP as the program is rolled out. We would be happy to work with the AER and other stakeholders, such as ESCoSA, to ensure that appropriate mechanisms are in place to ensure that this program is implemented in-line with our plans.

The 2020-2025 Hardening the Network program includes elements designed to better serve our customers most impacted by interruptions during MEDs and meet customers' expectations, particularly during MEDs to address Consumer Needs and Concerns (as per AER requirement in NER Clause 6.8.2 (c1) (2)).

1 Purpose and structure

The purpose of this document is to demonstrate that the:

- **scope and cost of our Hardening the Network program is appropriate**, in the context of our obligations and customer preferences; and

- **costs of our Hardening the Network program are being treated appropriately** in our Revised Proposal to the AER.

To achieve these aims:

- In *section 2 (Introduction)*, we will provide relevant background information associated with this program. We will also summarise the key features of the methodology we have used to determine this program.

- In *section 3 (Obligations)*, we summarise the legal obligations that underpin how we should assess the service levels of our customers most impacted by storms and the criteria we should be applying when deciding whether we should improve these service levels.

- We then set out the key drivers of the program in *section 4 (the drivers and need for the program)*. Importantly, this section quantifies the existing service levels of our feeders most impacted by storms and the economic cost associated with this poor performance.

- In *section 5 (Program options considered)*, we discuss the options we have considered to improve the performance of our feeders most impacted by storms, including the methodology we have used to determine and cost appropriate options.

- In the following three sections, we will discuss our analysis and reasoning that we consider is important in justifying our Hardening the Network program.
    - in *sections 6 (cost benefit analysis)* we will discuss the results of our cost-benefit analysis, where we have quantified the benefits (both in terms of improvements to customer service level and the economic cost) of our proposed option and used this to undertake a formal cost-benefit analysis of these options;
    - following this, in *section 7 (customer engagement),* we discuss the consumer engagement we have undertaken and how the findings from this process also support us undertaking this program; and
    - finally, in *section 8 (the preferred program)* we draw together these matters to explain how we have arrived at our Hardening the Network program and provide further details of its scope.
- The document concludes in *section 9 (conclusion)* by discussing how we believe the costs and consequences of this program should be treated in our next regulatory proposal. This section concludes with a recap of the important matters that we believe should provide confidence that:

    1) the scope and cost of the program is appropriate; and

    2) we have treated this program appropriately in our regulatory proposal to the AER.

2 Introduction

Hardening the network program

A key customer service level that we monitor and manage concerns the reliability of the electricity supply we provide to our customers. This service level is typically measured in terms of the following two measures:

- Unplanned System Average Interruption Duration Index (**USAIDI**), which measures the average unplanned duration that the average customer will not be supplied over a period; and

- Unplanned System Average Interruption Frequency Index (**USAIFI**), which measures the average unplanned number of interruptions to supply that the average customer will see over a period.

These measures provide an aggregate average reliability performance measure across groups of customers over a defined period, which typically represent one year[8].

Regulatory targets and performance reported excludes MEDs but significant variability in the supply reliability is still experienced by customers during MEDs.

As MED reliability contribution is excluded from the STPIS, there is no financial incentive for SA Power Networks to mitigate or reduce MED impact, so there is a trade-off between the reliability of supply we can provide to these customers and the cost/price of providing this reliability.

These customers are predominantly supplied via overhead bare-wire conductor construction which are far more prone to being affected by storms and so customers supplied from these feeders tend to experience significantly more time off supply during MEDs, compared to other customer groups.

It should be also noted that these customers are not considered to be supplied by LRFs as the criteria to determine an LRF excludes MED impact. We have also checked that there is no overlap between our reliability programs.

Most notably for the program discussed here, a large portion of customers are typically prone to having the lower (worse) reliability of supply than the underlying performance reported, because these customers are typically supplied from feeders, most impacted during MEDs.

The original Hardening the Network program proposed was to run over two RCPs through to 2025 after commencing in 2015-20 and continues to be supported through: customer feedback, a review of network performance that has impacted our customers since 2010/11, and a prediction and extrapolation of weather-related performance trends in line with the risks as identified by the Bureau of Meteorology's report "*Climate extremes analysis update for South Australian Power Network operations*," which predicts increases in severity and frequency of weather events in the future, and which is likely to further negatively impact network performance and customer service, unless specific action is taken.

The State of the Climate 2018 report[9], as published by The Bureau of Meteorology and CSIRO, also paints a consistent picture of ongoing, long-term climate change, particularly in weather and climate extremes.

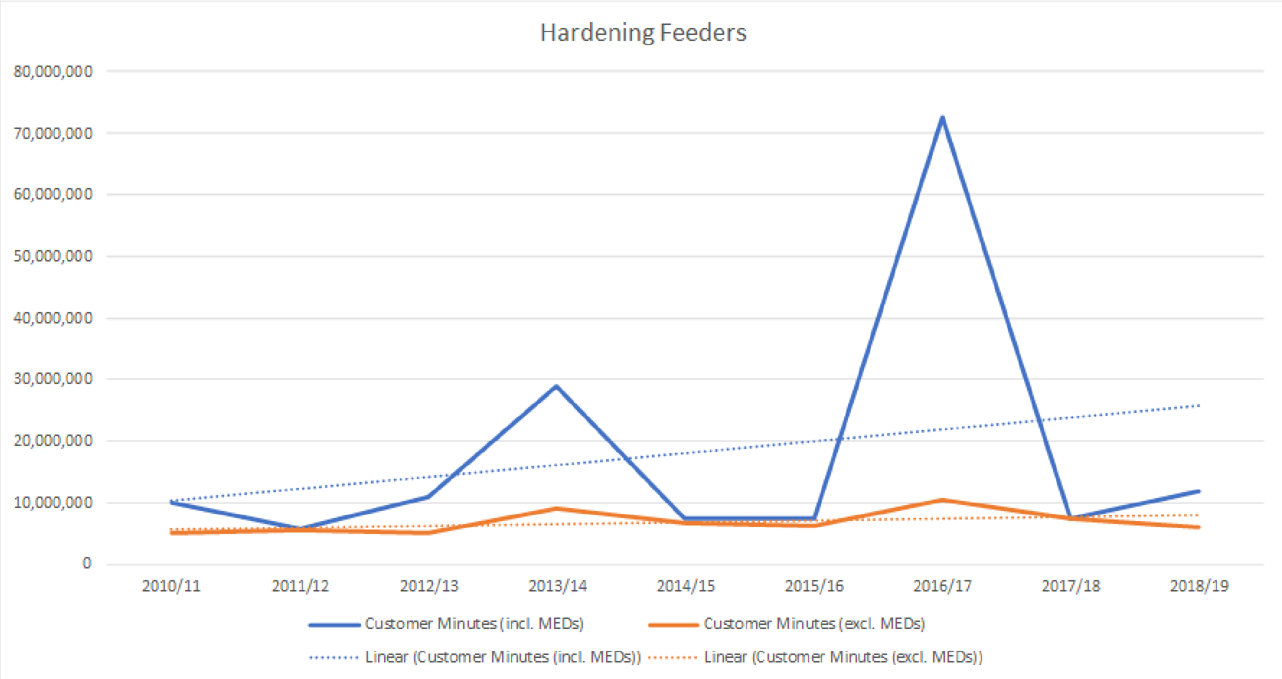
[8] For the purposes here, the measure also only captures unplanned outages and so are defined as USAIDI and USAIFI.
[9] The CSIRO and BOM (2018) *State of the Climate 2018*.

Australia's national climate projections indicate that over coming decades Australia will experience:

- further increase in temperatures, with more extremely hot days and fewer extremely cool days
- more intense heavy rainfall throughout Australia, particularly for short-duration extreme rainfall events
- fewer tropical cyclones, but a greater proportion of high-intensity storms, with ongoing large variations from year to year.

It is expected that these predictions will have an adverse impact on Network reliability performance. Although underlying performance remains stable, customers are increasingly being severely impacted during MEDs due to the greater intensity of extreme weather impacts on the network as represented in the graph below - customer service is deteriorating for 35 feeders included in the 2020-2025 Hardening program when taking MEDs into account.

Figure 1: 2020-25 Hardening the Networks Feeders Customer Minutes off Supply



The Hardening the Network program focuses on mitigation of storm related interruptions predominately in the Adelaide Hills and Adelaide Foothills, where Major Event Days have impacted the majority of our customers.

This declining performance is negatively impacting the service levels of our customers during major storms, increasing the economic cost of this poor performance, and in turn increasing the need for corrective action.

Extreme weather in 2016/17 (and previously in 2010/11 and 2013/14) caused significant network outages resulting in loss of electricity supply to customers for extended durations. The scale and impact of extreme weather, in terms of network damage and customer impact, exceeded anything previously experienced in South Australia. This has focused attention on:

- the capability of the distribution network to withstand extreme weather,
- the way SA Power Networks responds when outages occur, and
- the timeliness and accuracy of communications with customers.

The ESCoSA, as part of its 2020 Reliability Standards Review[10], final decision released in January 2019, has identified issues that relate specifically to the performance of the distribution network through engagement processes, one of which, is the impact of extreme weather in 2016-17, which caused significant network outages resulting in loss of electricity supply to customers for extended durations. The scale and impact of extreme weather, in terms of network damage and customer impact, exceeded anything previously experienced in South Australia.

This has focused attention on the capability of the distribution network to withstand extreme weather, the way SA Power Networks responds when outages occur, and the timeliness and accuracy of communications with customers.

It is likely that the current customer prolonged outages on MEDs will continue or deteriorate over the coming regulatory period, unless additional augmentation work is carried out to manage the performance and further harden the network against MEDs. This expenditure is also considered prudent to manage the risks identified.

The 2020-2025 Hardening the Network program includes elements designed to better serve our customers most impacted by interruptions during MEDs and meet customers' expectations, particularly during MEDs to address Consumer Needs and Concerns (as per AER requirement in NER Clause 6.8.2 (c1) (2)).

This program is developed to address the continuing deterioration of service experienced by customers and communities through a significant increase in extended interruptions, as a result of our assets repeatedly being damaged (at the same location typically) by severe weather events. Customers have expressed concerns about the ability of the network to withstand the impact of severe storms, and largely support the continuation of the Hardening the Network program in priority areas, in a cost-effective manner and where economically viable.

The reliability performance that customers have experienced during MEDs since 2005, demonstrates that customers are being impacted by increased outages and longer durations. The increasing trend can be seen from the Figure 2 below.

[10] ESCoSA, *SA Power Networks 2020 reliability standards review* – Dec 2017

Figure 2: Historical SAIDI including MEDS

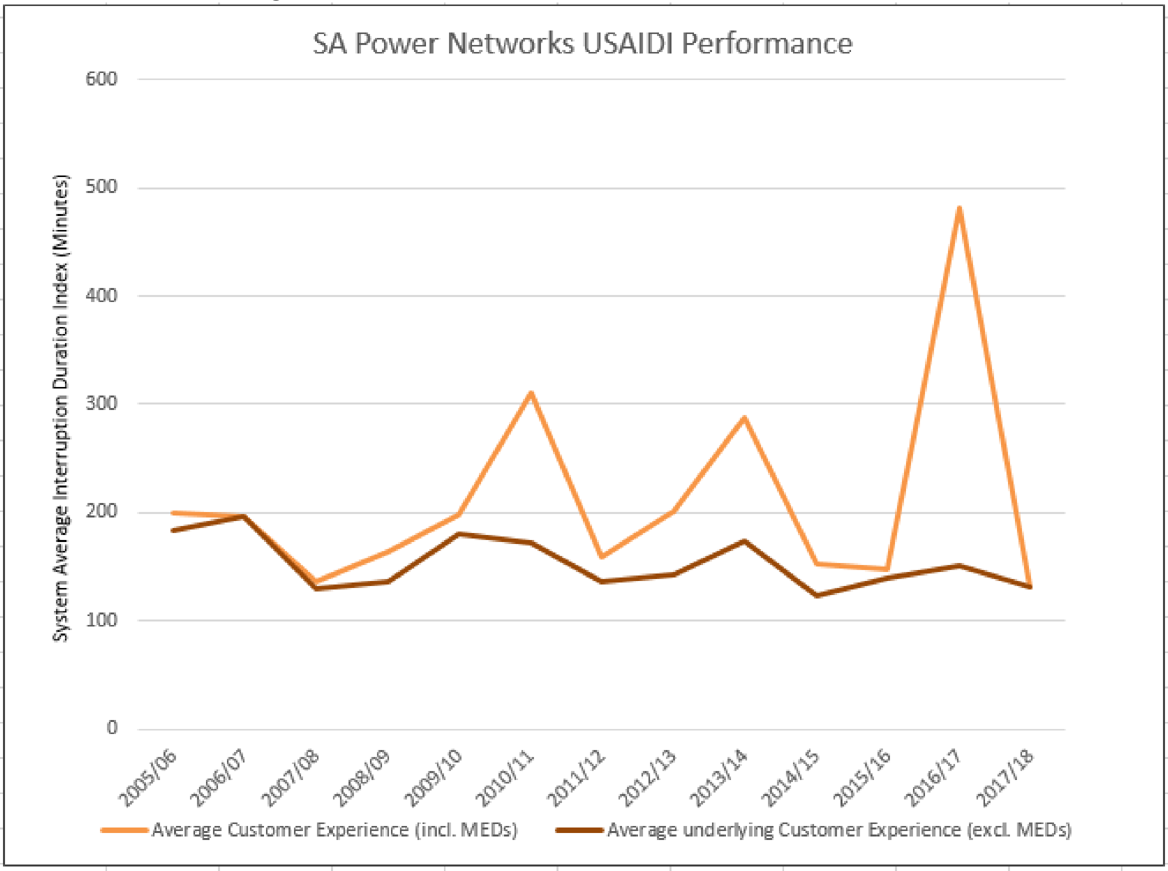
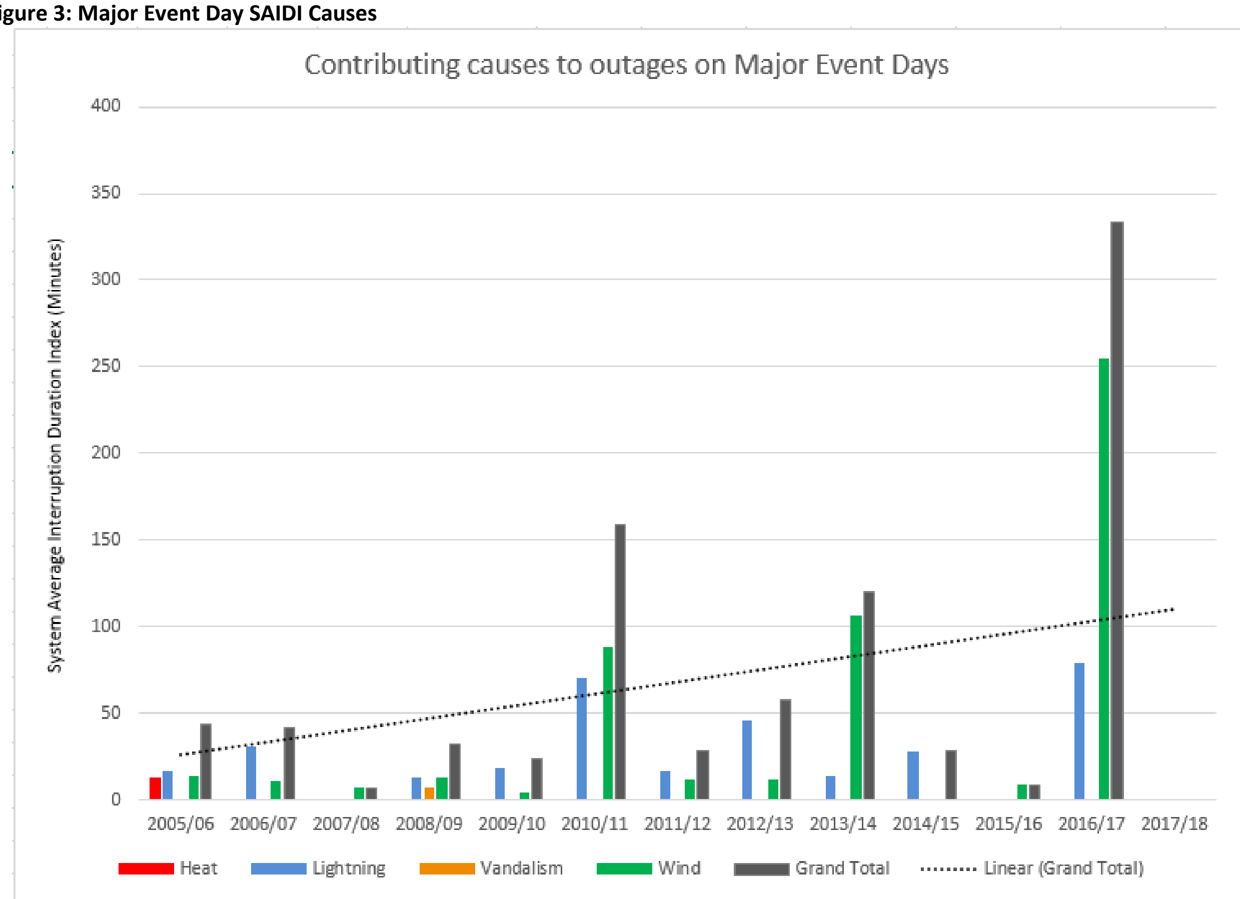


Figure 3 below shows the major causes of outages during MEDs and their contribution to the USAIDI.

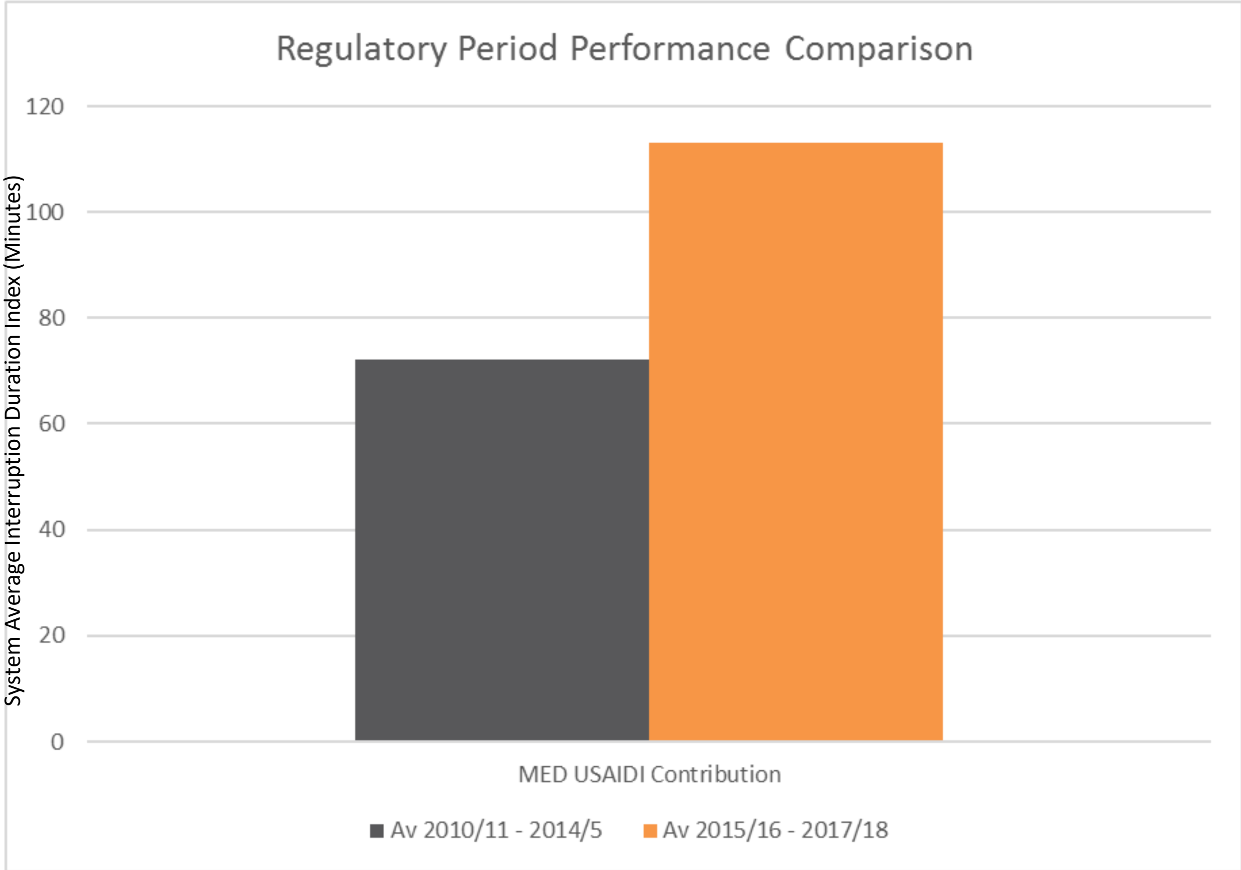
Figure 3: Major Event Day SAIDI Causes



Customers are increasingly being severely impacted during MEDs due to the greater intensity of extreme weather impact on the network.

As a consequence, customers are experiencing an additional 41 minutes off supply per year on average for the current regulatory period in comparison to the previous regulatory period on MEDs as detailed in Figure 4.

Figure 4: Regulatory period performance comparison (MED SAIDI)



The escalation of MED interruptions is the result of an increase in storm event frequency and intensity (such as strong winds and lightning), in which there has been a step increase in the impact of such events since 2010 (as shown in the graphs above and as experienced by our customers), and which has resulted in a deterioration of overall reliability performance and customer service (ie when taking MEDs into account).

Our Hardening the Network program is specifically aimed at mitigation of MED impacts on our customers, where we consider augmentation to be prudent and efficient and economically viable (ie benefits exceed the costs).

Hardening the network program and our previous regulatory proposal

A similar Hardening the Network program to keep more customers and communities connected during MEDs included an allowance of $16.6 million of capex and was approved in the SA Power Networks - Determination 2015-2020 by the AER[11]. The AER were satisfied this forecast reasonably reflected the capex criteria because it:

- is reasonably required to maintain reliability on its network; and
- reflects prudent and efficient costs because it was supported by appropriate cost benefit analysis using VCR calculations.

[11] AER - Final decision SA Power Networks distribution determination - Attachment 6 - Capital expenditure - October 2015

Although the AER found it difficult to determine at the time if impacts of severe weather on reliability are isolated events or demonstrate an expected trend in reliability deterioration, so far in the 2015-2020 period it is clear that recent weather events (eg storms and lightning) are correlated with significant decreases in reliability of supply to customers.

Taking into account the Bureau of Meteorology's predictions that the recent trends in severe weather events may continue, the AER accepted that there was a risk that overall network reliability could deteriorate further over the 2015–2020 period due to the impact of major weather events[12]. This weather prediction has now been experienced during the current regulatory period.

SA Power Networks developed this program with cost-benefit analysis using the VCR and modelled the impact of this program based on the historic performance of its network during the 2010–2018 period.

SA Power Networks concluded that had the augmentation been in place during the 2010–2018 period, the benefits to customers (in terms of the cost of reliability using VCR) would exceed the cost of the program in just over three years, demonstrating that the cost of the program was prudent and efficient from a customer perspective.

In addition, the results of our extensive customer engagement program suggest that customers are largely supportive of hardening the network and the continuation of such a program in the 2020-2025 period.

In preparing this forecast for the continuation of the program:

- We have conducted detailed cost-benefit analysis on the Hardening the Network program to determine the net benefits. Importantly, we have only included program components where we find that the benefits should outweigh the costs (ie there is a positive net benefit).
- We have explained why including the cost of this program in the capex forecast is in line with the NER capex objectives, criteria and factors.
- We have also explained how we have tested customer preferences for this program through our engagement and shown how our customers and stakeholders largely support this program.

Program scope

The Hardening the Network program we propose here represents a $16.2 million capital program. The program will mitigate extended duration interruptions experienced by customers whom are significantly impacted during MEDs, improving supplies to 53,795 customers.

This program will cover a combination of strategies, across 35 feeders, aimed at addressing the specific causes of extended duration interruptions to our customers during MEDs, including:

- Minimising insulator failures due to lightning by re-insulating vulnerable sections of overhead lines with lightning resistant insulators;
- Reducing vegetation outages and damage from outside the prescribed vegetation clearance zone by constructing alternative network asset configuration / standards; and by
- Reducing the number of customers interrupted during MEDs by installing mid line switches.

Key features of our forecasting and evaluation methodology

There are a number of important features to the method we have applied to arrive at this program, and its costs that should provide confidence that the program's scale and scope is appropriate:

[12] AER Final Decision on SA Power Networks 2015-2020 page 6-49

- We have undertaken a detailed and comprehensive review of the historical performance of our highest 173 MED impacted feeders to determine the causes of extended outages and develop the best solutions to mitigate these causes.
- We have estimated the economic cost of the supply reliability using accepted VCR assumptions and methodology.
- We have undertaken a formal cost-benefit analysis of each program component identified as a possible corrective action to ensure all components included in our program should deliver a positive net benefit (ie benefits will exceed the costs).
- We have consulted with customers and stakeholders to confirm that they agree, in principle, with the need for a program of this type.[13]
- We have analysed the effect of the program on existing reliability incentive mechanisms to ensure that program costs are treated correctly in our next regulatory proposal to the AER.
- We have cross checked other SA Power Networks proposed programs to ensure no overlap of other programs.

The above matters will be further discussed throughout the remainder of this document.

3 Our obligations

In this section, we discuss our obligations for managing the supply to our customers most impacted during MEDs, which in-turn, underpins the need for the continuation of our Hardening the Network program. Our more general obligations to manage network and supply reliability are covered in more detail in Supporting Document 5.25 – Reliability and Resilience Performance Management Strategy, Original Proposal.

There is no technical criteria that defines how we should identify and monitor our customers most impacted during MEDs. We acknowledge that we do not have a specific obligation to mitigate MED interruptions to customers but consider that there is an expectation to implement mitigation solutions where economically viable and where there is suitable customer support and subsequently submit for funding approval.

We also acknowledge ESCoSA Service standards in clause 2 of the Code exclude unplanned interruptions that qualify as MEDs.

That said, we consider that there is a clear expectation that we will undertake some form of augmentation where it is economic to do so and are resubmitting for funding approval.

We also consider that this interpretation is in line with the NEL objectives, as to not to do so in these circumstances would not be in the long-term interests of our customers.

Consequently, we consider that we have an expectation to undertake actions to mitigate long duration interruptions that occur during MEDs to these customers where it is prudent and efficient and economical to do so (subject to appropriate regulatory funding being provided).

[13] Business advocates and Local Government supported regional reliability improvements. Refer to 2020-25 Draft Plan submissions received from Business SA, the Adelaide Hills Council, the City of Playford, Alexandrina Council, Southern Mallee District Council, Tatiara District Council, District Council of Robe, District Council of Grant, Wakefield Regional Council, and the Mid Murray Council, located at https://www.talkingpower.com.au/DraftPlan_Feedback/documents. Further, the Capex Deep Dive workshops demonstrated that 58% of the participants were supportive of the program (Supporting Document 0.13, Original Proposal).

Network hardening

We must comply with the South Australian Electricity Distribution Code as a condition of our Distribution Licence[14]. The EDC defines various service standards we must comply with. Reliability capital expenditure is required to maintain reliability performance for our customers and to comply with the ESCoSA service standards for reliability as set out in the EDC [15].

This proposal is also in accordance with the NER to provide evidence to the AER (to accompany regulatory proposals) that SA Power Networks has "engaged with electricity consumers and has sought to address any relevant concerns identified as a result of that engagement" (NER Clause 6.8.2 (c1) (2) and Clause 6.5.7(a)) provides that SA Power Networks must submit a building block proposal that includes a forecast of the capital expenditure required to meet the capital expenditure objectives for the 2020-2025 RCP.

This program seeks to address the specific concerns of electricity consumers for continued investment for ensuring acceptable levels of reliability for all customers, in particular, those customers who experience repeated and long duration interruptions as a result of network damage from major storms (namely, MEDs).

Clause 6.5.7(a) of the NER provides that SA Power Networks must submit a building block proposal that includes a forecast of the capital expenditure required to meet the capital expenditure objectives for the 2020-2025 RCP.

This includes capital expenditure required to comply with all applicable regulatory obligations or requirements associated with the provision of SCS and to maintain the reliability of SA Power Networks' SCS.

Our Hardening program only includes solutions that are economically viable and our customer engagement has demonstrated customer support.

The AER must accept the proposed capital expenditure forecast that SA Power Networks includes in its building block proposal if the AER is satisfied the forecast capital expenditure for the 2020-2025 RCP reasonably reflects the capital expenditure criteria. In making this assessment the AER must have regard to the capital expenditure factors.

In particular, in assessing the expenditure required to comply with all of these obligations, in accordance with the NER, SA Power Networks is to provide evidence to the AER (to accompany regulatory proposals) that SA Power Networks has –

> "*engaged with electricity consumers and has sought to address any relevant concerns identified as a result of that engagement*" (NER Clause 6.8.2 (c1) (2))

and is required to have regard to

> *"the extent to which the forecast includes expenditure to address the concerns of electricity consumers identified by the DNSP in the course of its engagement with electricity consumers"* [16] (Consumer Engagement Factor).

[14] Distribution Licence Clause 7.1. "*The licensee must comply with all applicable regulatory instruments*…" and applicable regulatory instruments includes the SA Electricity Distribution Code issues by ESCoSA
[15] Clause 2, Electricity Distribution Code
[16] NER clause 6.5.6(e)(5A).

4 The drivers and need for this program

In this section, we set out the current performance of our network providing:

- An overview of the service levels our customers most impacted during MEDs experience
- An overview of the economic cost impact, based on our calculations using the current VCR during MEDs
- A summary of other costs associated with this poor customer experience.

A comprehensive summary of the performance of individual feeders targeted for hardening is provided in Appendix D.

Customer service levels during major event days

Over the period from 2010 to date, the overall performance to customers has been worsening due to the escalating impact of MEDs. This declining performance is negatively impacting the service levels to our customers, increasing the economic cost of this poor performance, and in turn increasing the need for corrective action.

This decline in performance as shown in the Figure 2, illustrates the variability in customer service levels with and without MEDs which charts the total minutes not supplied to customers across all the feeders, including and excluding outages on major event days.

As demonstrated in Figure 3, our analysis suggests that the increase in minutes not supplied to customers has been driven by the following:

- A step increase in storm activity which has resulted in major infrastructure damage exceeding the MED threshold from 2010/11, resulting in a deterioration in overall customer service
- The storm-related interruptions are caused through lightning and or damage from vegetation outside the prescribed vegetation clearance zone[17] and other wind-borne debris (eg roofing iron).

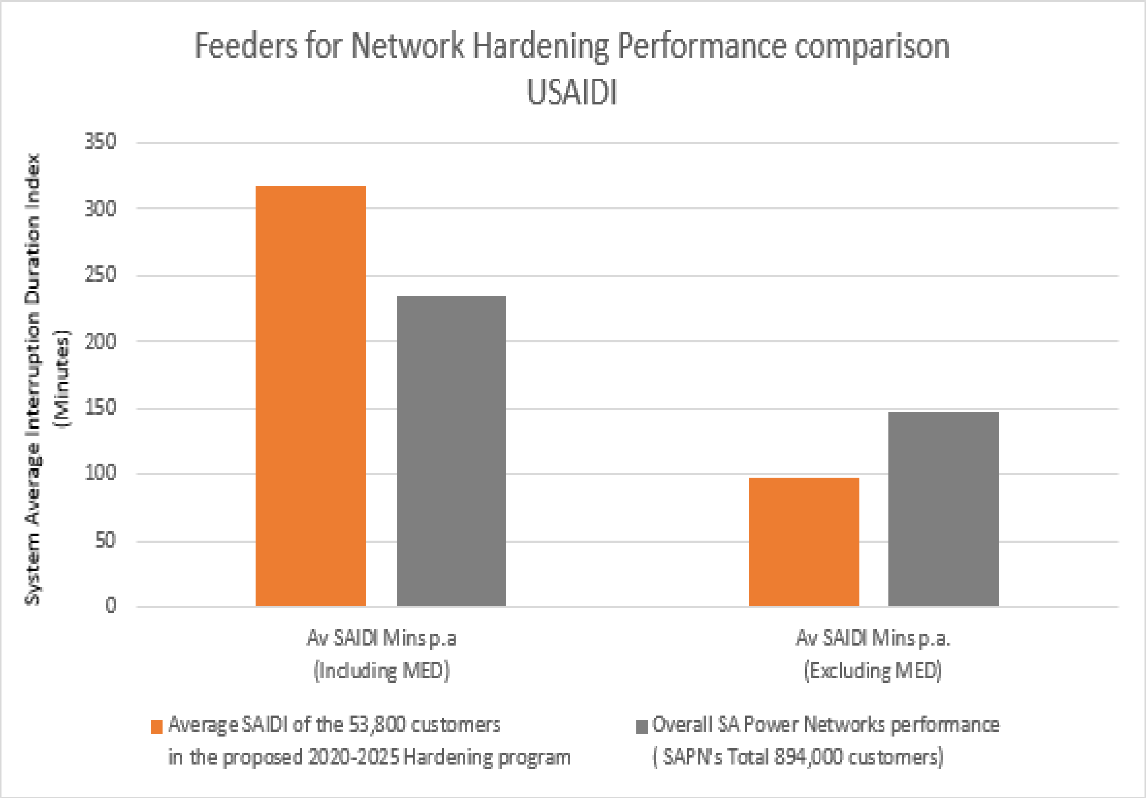
As a consequence, customers are experiencing an additional 41 minutes off supply per year on average for the current RCP in comparison to the previous RCP on MEDs as indicated in Figure 4.

The 35 feeders identified in the 2020-2025 Hardening the Network program supply approximately 53,800 customers and represent approximately 7% of SA Power Networks customers.

These customers on average experience a significantly greater amount of time without supply because of major event days in comparison to all customers across the SA Power Network as shown in Figure 5 below.

[17] This would be vegetation that is outside of our prescribed vegetation clearance zone. This vegetation can still contact our lines, particularly during high wind events. We have other processes to manage vegetation, including vegetation inside and outside our prescribed clearance zone. The solutions discussed here should provide sustainable improvements, where enhanced vegetation management would not be effective or efficient.

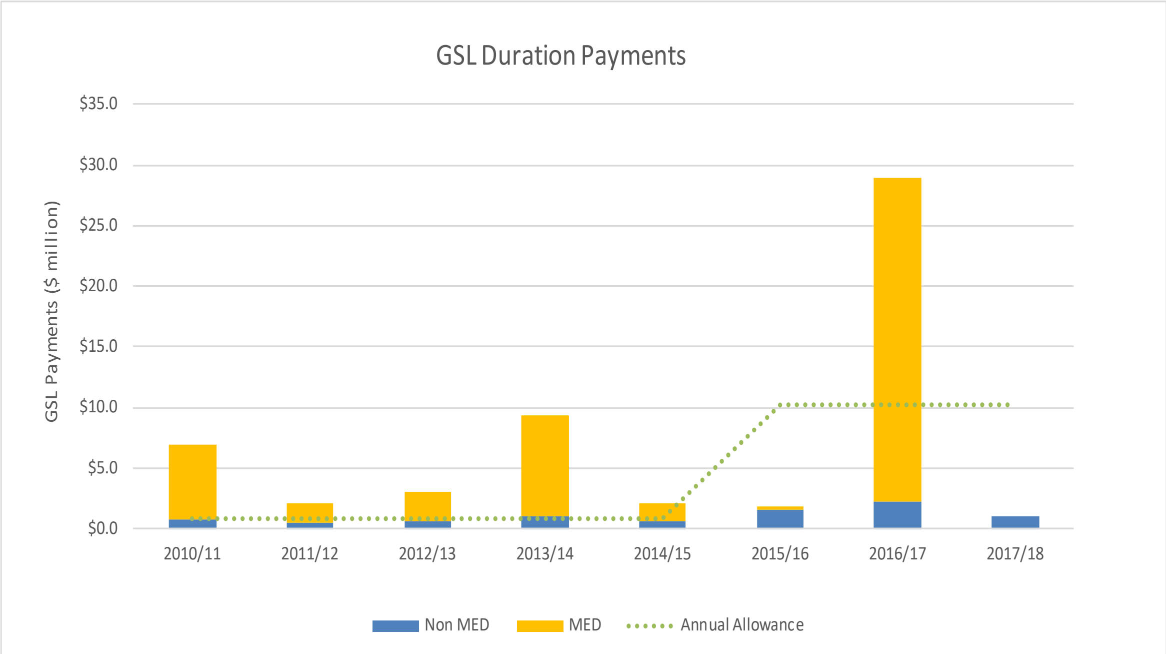
Figure 5: SAIDI performance comparison of feeders targeted in 2020-2025 Hardening the Network program



These storms causing a decline in customer service, also contribute to GSL payments over this period. GSL interruption duration payments have significantly escalated with the increased frequency and intensity of storm related outages as shown in the figure below.

Because of these severe weather events and the accompanying asset damage, customers are experiencing long duration interruptions resulting in an escalation of GSL duration payments to customers, the cost of which in the long term is borne by all South Australian Electricity customers, Figure 6 below, which shows that the majority of GSL payments are mainly due to the impact of MEDs).

Figure 6: Historical Duration GSL Payments



Our main performance incentive scheme (ie STPIS) excludes MEDs and therefore does not provide financial incentive under STPIS for SA Power Networks to invest in mitigating interruptions which occur during MEDs.

Although our GSL Payment scheme includes payments to customers that have experienced long duration interruptions during major storm event interruptions, in particular MEDs, GSL payments are largely dependent on supply restoration activity and priority, crew availability and the overall impact in an area rather than network design and configuration, so payments are difficult to mitigate - due to restoration times for individual interruptions being driven mainly by operational activity. Similar to the above, there is little financial incentive for SA Power Networks to invest in network mitigation projects to offset GSL duration payments.

We believe that it is reasonable to assume that this recent deteriorating performance is reflective of what is deemed by the weather experts as the new normal conditions that can be expected moving forward, and there is a good possibility that events could worsen marginally over the next regulatory period. This view is supported by a recent BOM report that predicts future increases in severe weather events (frequency and severity).

It is also supported in the report commissioned by the Premier of South Australia following the extreme weather event on 28 September 2016, titled "Independent Review of the Extreme Weather Event South Australia 28 September – 5 October 2016" (refer extract below)[18].

> The Commonwealth Scientific and Industrial Research Organisation (CSIRO) and BoM have reported that 2016 was a year of extreme weather events, wetter than average overall, and the fourth warmest on record for Australia and that there is significant evidence that climate change will increase the frequency and intensity of extreme weather events (CSIRO & Bureau of Meterology, 2016).
>
> *As the global climate system has warmed, changes have occurred to both the frequency and severity of extreme weather.*
>
> *Extreme rainfall events are likely to increase in intensity by the end of the century across most of Australia*
>
> *(CSIRO & Bureau of Meterology, 2016).*
>
> All indications are that, increased frequency and severity of severe weather events are part of the 'new normal', and the SA emergency services sector will need to adapt to ensure that prevention, preparedness, response and recovery activities are sustainable in the long-term.

Over the recent period, we have been undertaking corrective action on a selection of feeders most impacted by MEDs with the 2015-2020 Hardening the Network allowance with good success. However, this is only addressing a small subset of customers and with the continued escalation of weather events, there is still a need for the continuation of The Program during 2020-2025 to further offset the impact of storms to customers. Although most customers understand the impact weather has, they can tolerate a small outage, but the severe weather events of 2016/17 have heightened customer expectations for adequate action to be taken to reduce the adverse impact on customers from long duration outages during these MEDs.

We will show in the following sections, there are additional feeder sections where the costs are outweighed by the Value of Customer Reliability benefits to be realised in the proposed hardening projects, and this need is even more pressing given the BOM's view that storm activity could worsen leading to potentially even greater benefits than that calculated in our analysis.

[18] Burns, G., Adams, L. and G. Buckley (2017). *Review of the Extreme Weather Event South Australia 28 September – 5 October 2016*

Customers most impacted during Major Event Days

Customers considered for the 2020-2025 Hardening the Network program are those that have contributed the most customer minutes on MED classified days during the 8-year period 2010/11 to 2017/18.

173 feeders repeatedly damaged by storms (at the same location typically), were analysed by identifying the historical interruptions that could have been mitigated if hardening augmentation was in place and then the VCR benefit calculated based of the interruptions saved.

37 projects have been selected on 35 of these feeders for the 2020-2025 Hardening the Network program where the VCR benefit of the project most exceeded the cost of the recommended augmentation and where the NPV of the associated STPIS benefit was negative.

The targeted 35 feeders identified for Hardening supply approximately 53,795 customers representing approximately 7% of SA Power Networks customers.

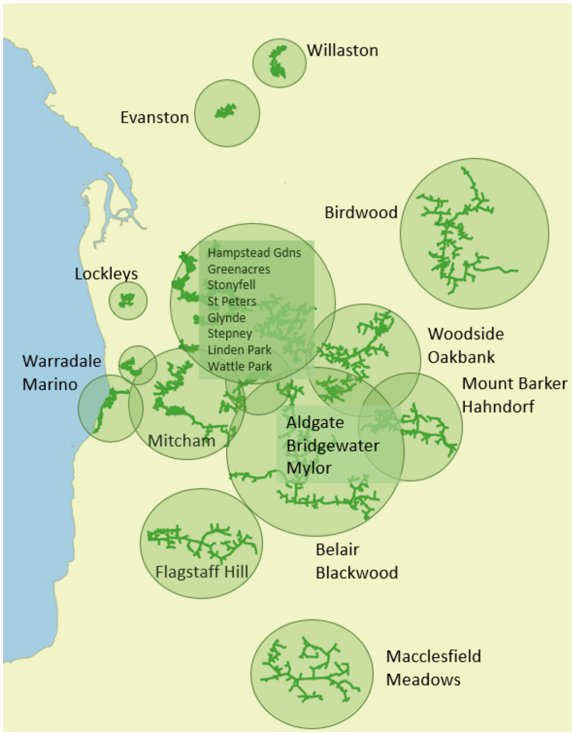
As expected, these feeders are predominately in areas most impacted by vegetation and or lightning causes.

The program targets specific feeders with a positive net benefit to the customers in terms of VCR but had a negative return based on STPIS.

The 35 feeders selected for the 2020-2025 program are identified on the maps in Figure 7 below.

Figure 7: Regions benefiting from the 2020-2025 Hardening the Network proposal

Hardening – SA Regional



Hardening – Adelaide metro

In addition to the mapped locations presented above, our analysis has identified customers whom will benefit by The Program by region and by council area and by feeders listed in Appendix D.

Furthermore, our Hardening the Network program will reduce long duration interruptions during MEDs on feeders that serve some of our registered "Life Support Customers". Our analysis shows that this program will mitigate MED outages to 527 registered life support customers.

The targeted 35 feeders included in the Program will reinforce supply to 53,795 customers and represents approximately 7% of SA Power Networks customers.

In summary these customers in comparison to all customers across the SA Power Network experience;

- a significantly greater amount of time without supply because of MEDs,
- considerably worse performance than other customers during MEDs.

The service level for customers supplied by individual feeders can be worse (or better) than the averages shown in Table 1.

Table 1: Targeted Hardening Feeder performance vs average network performance (averages over an 8-year period 2010/11 to 2017/18)

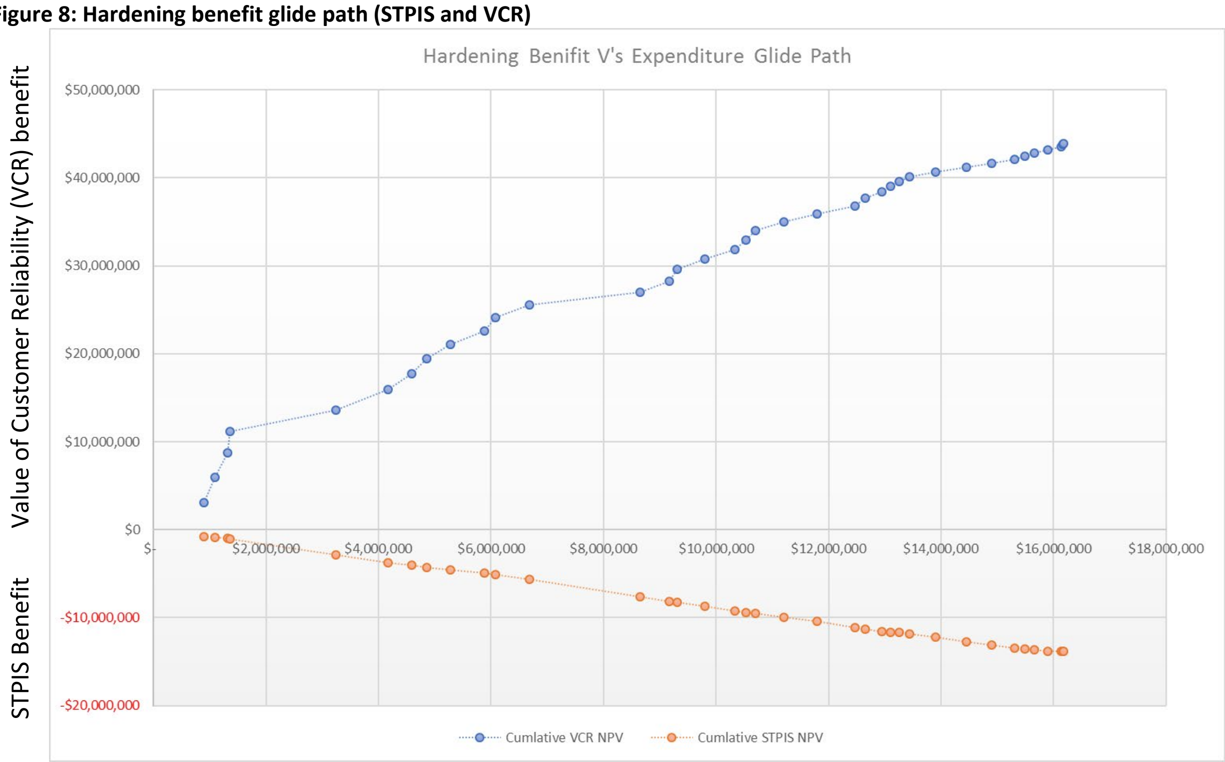
Customer Experience	Overall Average SAIDI Per annum including MEDs (minutes)	Underlying Average SAIDI Per annum excluding MEDs (minutes)
53,795 customers included in the 2020 -2025 Program	318	97
Overall SA Power Networks performance	234	146

The economic benefits of hardening

The above section has shown that our customers that are served by feeders most impacted by Major Event Days are experiencing significantly longer outage durations than our average customers. However, as noted in "Our obligations" section above, we only need to undertake significant corrective action where it is economic to do so, within given funding allowances.

Figure 8 below demonstrates that the VCR benefits of the project undertaken exceed the costs of the individual projects. This is important to ensure that only viable projects are undertaken, and each project is assessed on its merits calculated at the individual feeder level.

Figure 8: Hardening benefit glide path (STPIS and VCR)



The chart also demonstrates that for each project, the NPV of the STPIS incentives is negative, confirming that these projects would not proceed purely based on the economics of the performance incentive benefit to SA Power Networks via the STPIS.

However, given a positive return based on VCR benefit, it is economic to mitigate interruptions these customers experience, and, therefore these projects are submitted for corrective action and funding allowance consideration.

Other costs associated major event day interruptions

The above section has discussed the economic cost due to extended outages during storms impacting customers. However, there are other costs that we incur because of these interruptions. These costs are not as significant as the economic cost of minimising the impacts but would still be reduced.

The two costs we consider may provide potential operational savings are as follows:

- The response and repair cost of the network damage that cause the interruptions to supply on sections of feeders targeted for hardening; and
- The Guaranteed Service Level (**GSL**) payments that are made to customers as a result of interruptions on feeder sections targeted for hardening

Both costs typically are expensed and may form part of our operating expenditure reduction.

Although our GSL payment scheme includes payments to customers that have experienced long duration interruptions during major storm event interruptions, GSL payments are largely dependent on supply restoration activity and priority, crew availability and the overall impact in an area rather than network design and configuration, so payments are driven mainly by operational activity.

It is also noted that the proposed Hardening the Network program may potentially reduce GSL payments. This would result in a potential opportunity to gain a reduction in operating expenditure. Detailed modelling will need to occur to forecast the potential GSL offset for the period 2020-25, taking into account the revised 2020-25 GSL scheme. Therefore, SA Power Networks will consider adjusting the GSL potential operational savings if the potential GSL payment reductions can be accurately modelled.

5 Program options considered

Options considered and our methodology to identify the optimal solution

We have considered various augmentation work options that should provide long-term sustainable performance benefits of the feeders targeted for hardening. These options reflect the methods we have been applying. Furthermore, we have used an independent statistician to validate the scale of the improvement we can typically expect from these types of options (i.e. option effectiveness), and so we can have confidence in the scale of the improvements that should be realized through these approaches.

The options are tailored to address specific causes of network outages. The key options being considered are summarised in table 4 below.

Table 2: Mitigation options - solutions vs outage causes and effects

Hardening Augmentation Options	Primary outage causes addressed and effect
Augmenting insulators with high lightning withstand capability	Reduces outages caused by lightning - reducing the likelihood of future outages
Augmenting critical bare wire line sections with insulated overhead conductor	Reduces outages caused by vegetation contact from outside the prescribed vegetation clearance zone - reducing the likelihood of future outages
Undergrounding of critical line sections	Reduces outages and damage caused by vegetation bringing down overhead wires from outside the prescribed vegetation clearance zone – eliminating future outages
Installation of reclosers and sectionalisers	Does not reduce the number of network outages, but reduces the number of customers that will have a sustained interruption following a network fault

In order to develop an optimal set of options for each feeder, we have undertaken a detailed review of all the outage locations and causes (over the last 8 years) for the feeders most impacted by Major Event Days. Knowledge gained from this review has been used to define the set of solutions for each feeder or feeder section that would be most appropriate to address the range of causes of the outages on that feeder.

For each solution identified through this process, we develop:

- the analyses and scope of work to implement that solution, based on the where these outages have occurred on the feeder;
- the cost of that solution (based on its scope), the number of units required and using historical unit costs; and
- assess the expected mitigation of the solution, applying the independent statistical analysis of improvement type effectiveness.

This analysis has ensured that for each feeder we have a set of mutually exclusive solutions that we can separately analyse (via the cost-benefit analysis discussed in the next section).

Comment on do-nothing option
It is important to note that our cost-benefit analysis approach inherently considered the "do nothing" option as the benefits of any solution are measured relative to doing nothing. Therefore, although we have not explicitly listed a "do nothing" option above, this does not mean we have not considered the effects of doing nothing in our evaluation. We also believe based on consumer feedback obtained from our customer engagement program, that the "do nothing" option would not be a suitable option as discussed in the section 'Our obligations' and would not be considered acceptable by our customers.

Based on this analysis, we have developed unique solutions to address the specific causes of outages on each feeder, to reduce outages during MEDs on those feeders. Table 3 below summarises the extent of the solutions we have identified and have been analysed through this process.

Table 3: Mitigation options – Hardening the Network

Option	No. of Feeders sections	Total solution units	Total Cost ($'2017 millions)
Underground of critical line sections	13 Feeder Sections	123 Spans	$9.3
Augmenting critical bare wire line sections with insulated overhead conductor	16 Feeder Sections	331 Spans	$5.0
Installation of reclosers and sectionalisers	6 Feeders	13 Switches	$1.0
Augmenting insulators with high lightning withstand capability	1 Feeder Sections	335 Poles	$0.9
Total			$16.2

The Hardening programme focuses mainly on augmentation of sections of bare overhead line with either insulated overhead line or underground cables to mitigate MED outages.

In appreciating the significance of the information in this table, it is important to note that this is provided as a guide only, as other deteriorating feeders may need mitigation as identified during the 2020-2025 Program.

More detailed information on the range of solutions for each feeder is contained in the Hardening the Network model where this analysis is contained.

6 Cost benefit analysis of the program

In Section 4 we have discussed drivers for Hardening the Network, including the economic cost of this poor performance. In Section 5, we discussed the possible solutions to address this poor performance.

In this section, we discuss the customer benefits we would expect to achieve by implementing these solutions. Importantly, we present the results of our cost-benefit analysis of these solutions. We have applied this cost-benefit analysis to determine whether the benefits exceed the costs for each solution (using discounted cash flow techniques). The results of this analysis tell us whether there is an economic case to implement any of the solutions, and how strong the evidence is.

As we will show below, our analysis suggests all the solutions, discussed in the section above, should provide a positive net benefit if implemented.

A summary of the results of the analysis of individual feeders targeted for hardening is provided in Appendix D and can also be referenced through to the model where this analysis is contained.

The customer service level benefits

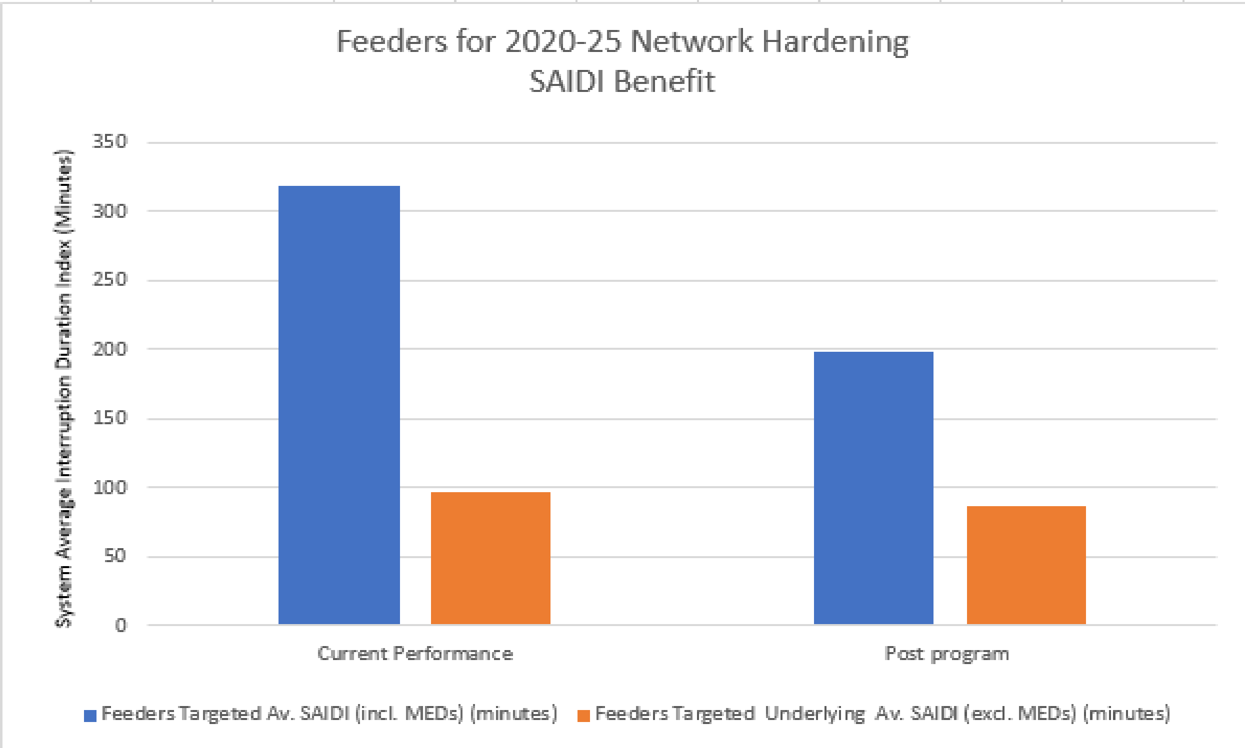
The Hardening the Network program we propose here represents a $16.2 million capital program. The program will mitigate extended duration interruptions experienced by customers whom are significantly impacted by MEDs, improving supplies to 53,795 customers.

Table 4 (and Figure 9) indicates that there is the potential to improve the service levels to our customers most impacted by storms by, on average, 119 SAIDI minutes, a 37% improvement from their current service levels.

Table 4: Forecast annual USAIDI & USAIFI benefits from Hardening the Network

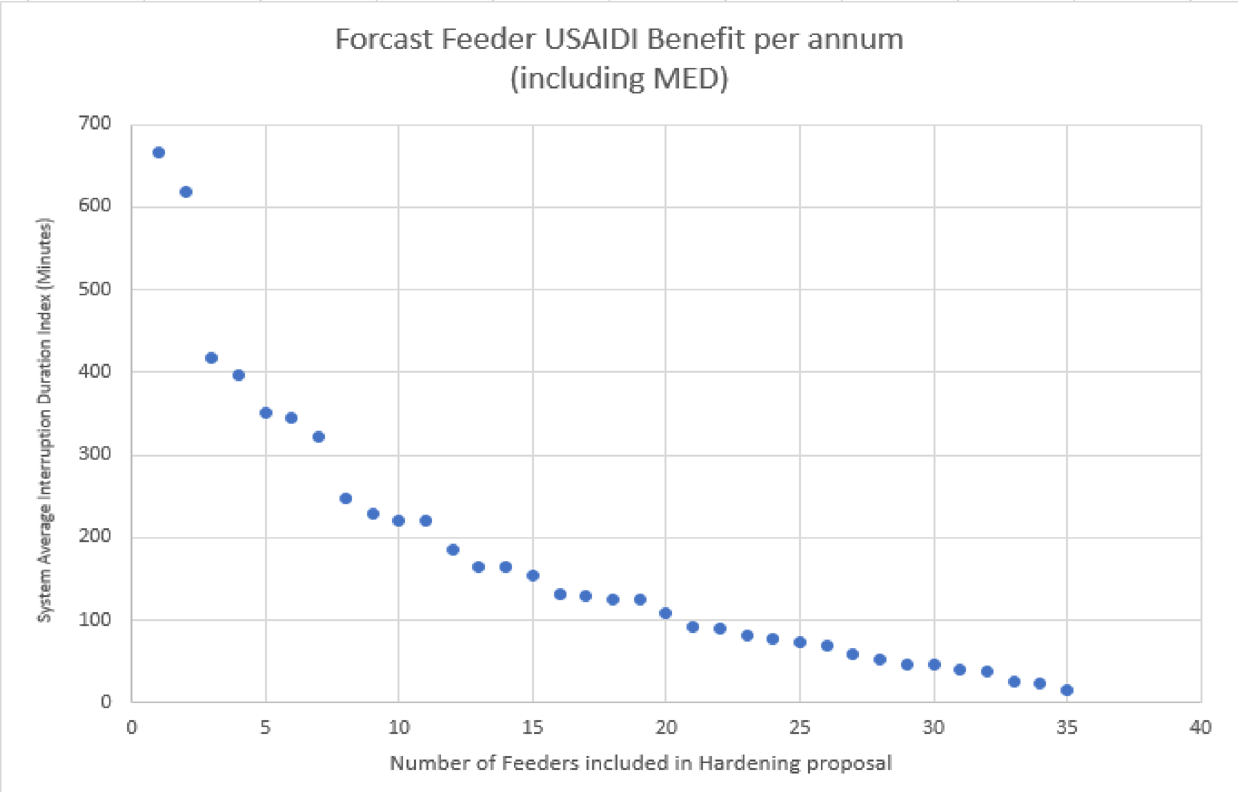
Performance 2020-25 Hardening Feeders	Current Performance	Post program	Step change customer improvement
Feeders Targeted Av. SAIDI (incl. MEDs) (minutes)	318	199	119
Feeders Targeted Underlying Av. SAIDI (excl. MEDs) (minutes)	97	88	9
Feeders Targeted Overall Av. SAIFI (incl. MEDs) (number)	1.3	1.1	0.3
Feeders Targeted Underlying Av. SAIFI (excl. MEDs) (number)	1.0	0.8	0.1

Figure 9: Hardening the Network forecast SAIDI Benefit comparison



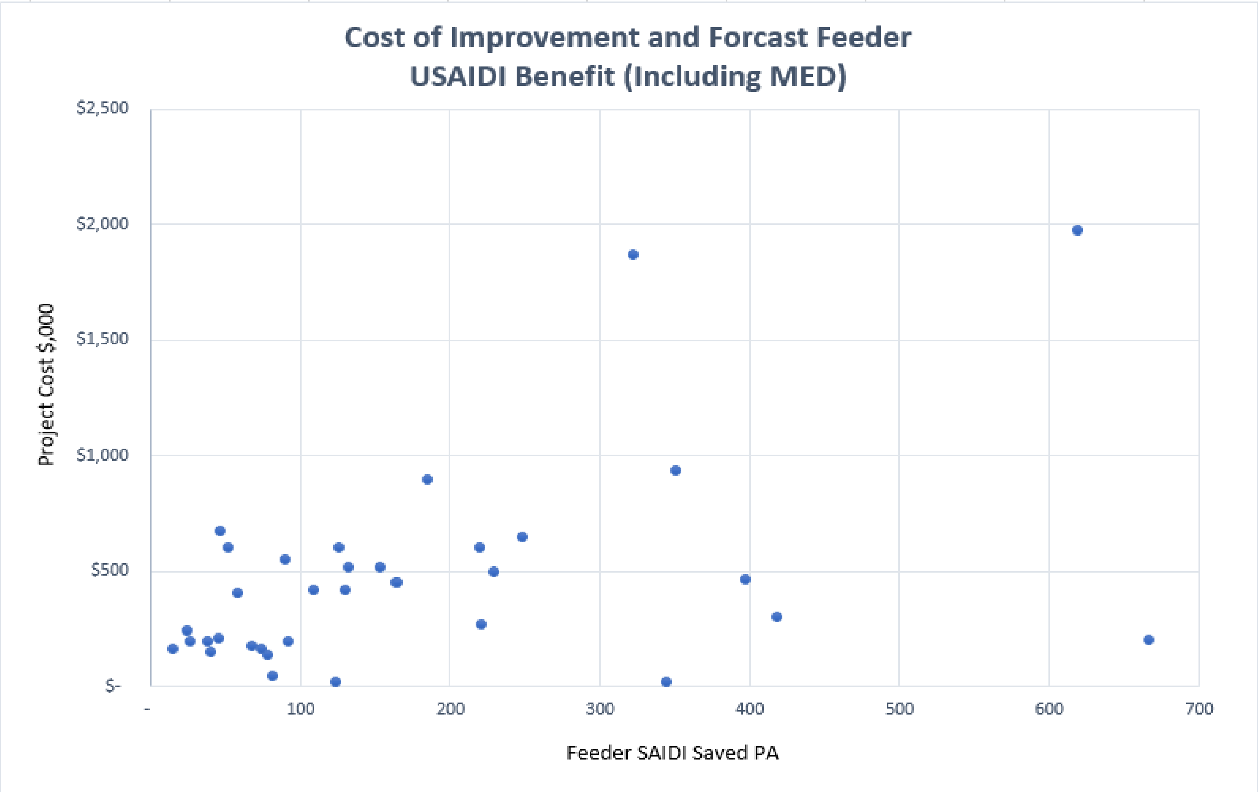
The service level benefit expected to be achieved by the various solutions differs across the selected feeders. Figure 10 below shows the distribution of the scale of benefit by augmentation across the selected feeders (as measured by USAIDI) ranging from between 15 minutes and 666 minutes per annum.

Figure 10: Distribution of USAIDI benefit across targeted feeders



The range of benefit is shown further in Figure 11 below, which show a scatter plot of individual solutions with the cost of the solution plotted against its expected USAIDI benefit.

Figure 11: Solution costs vs USAIDI improvements



Regional benefit from the program

The program targets specific feeders with a positive net benefit to the customers in terms of VCR but a negative return based on STPIS.

The Hardening program focuses on mitigation of storm related interruptions predominately in the Adelaide Hills and Adelaide Metropolitan Area.

Table 5: Regions and customer benefiting from Hardening the Network

ESCoSA Region	Customers benefitting from Hardening	Augmentation Spend
Eastern Hills	10,462	$ 7,333,000
Adelaide Metro Area	37,964	$ 6,939,000
Upper North	3,385	$ 1,393,060
Fleurieu Peninsula	279	$ 300,000
Metro Regional	1,488	$ 175,000
Barossa / Mid Nth / Yorke	112	$ 20,000
Riverland / Murray land	106	$ 20,000
Grand Total	**53,795**	**$ 16,180,060**

Feeders selected for the 2020-2025 Program were identified on the maps in Figure 7. In addition to these mapped locations presented, individual feeder benefit details are listed in Appendix D.

In addition to the stratification by location, our Hardening the Network Program will result in reducing long duration interruptions that serve 527 of our registered “Life Support Customers”.

Economic benefits and net benefit of the program

In the sub-section above, we have discussed all benefits expected from the identified solutions. Importantly, these are not limited to only the solutions that could be economic. In this section, we examine this issue further.

To undertake this analysis, we have estimated the economic cost of the resulting feeder performance assuming a solution is implemented using the same VCR methodology used to define the economic cost of the current performance. The economic benefit of implementing the solution is defined as the difference between these two measures (ie the reduction in the economic cost).

Although our GSL payment scheme includes payments to customers that have experienced long duration interruptions during major storm event interruptions, GSL payments are largely dependent on supply restoration activity and priority, crew availability and the overall impact in an area rather than network design and configuration, so payments are driven mainly by operational activity.

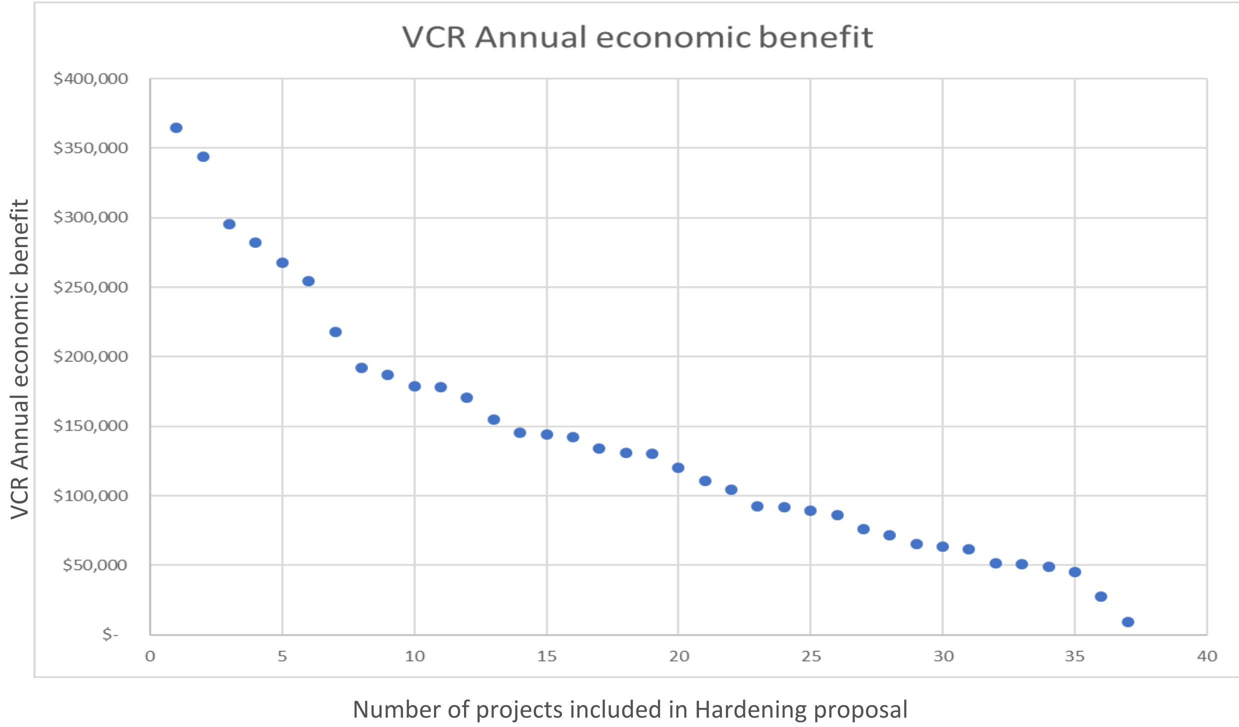
It is also noted that the proposed Hardening the Network program may potentially reduce GSL payments. This would result in a potential opportunity to gain a reduction in operating expenditure. Detailed modelling will need to occur to forecast the potential GSL offset for the period 2020- 25, taking into account the revised 2020-25 GSL scheme. Therefore, SA Power Networks will consider adjusting the GSL potential operational savings if the potential GSL payment reductions can be accurately modelled.

Using this method, we estimate that the total net economic (VCR) benefit due to implementing all solutions would be $5.2 million per annum.

The net benefit for each solution has been calculated as the economic benefits associated with that solution less the solution costs, using discounted cash flow techniques. For this analysis, we have used the equivalent annual cost[19] of the solutions to allow comparisons between the annual benefits and the solution cost.

Figure 12 below shows that the net economic (VCR) benefits by individual Hardening projects range between $365,000 and $9,500 per annum.

Figure 12: Distribution of economic benefit of each hardening project



Also see Figure 8 which demonstrates that the benefits of each project undertaken exceed the costs of the individual projects. This is important to ensure that only viable projects are undertaken, and each project is assessed on its merits calculated at the individual feeder level.

The chart also demonstrates that for each project, the NPV of the STPIS incentives is negative, confirming that none of these projects would proceed on the economics of the performance incentive scheme payments alone.

The overall 2020 -2025 Hardening program expenditure proposal is in line with customers' support for continued investment for ensuring acceptable levels of reliability for all customers, in particular, addressing those customers repeatedly impacted by MEDs and takes into account cost-benefit analysis for reliability augmentation for those customers.

The proposal includes the highest NPV positive projects only, where the economic benefit of each project exceeds cost, based on the VCR benefit up to a limit of continuing hardening investment at current levels rather than increasing our spend and proposing all NPV positive projects identified.

[19] The equivalent annual cost is a method of defining an equivalent annual cost stream, in present value terms, of a capitalized cost, which uses the capital cost of an asset, its life and a discount rate to produce the equivalent annual cost.

Additional feeders were assessed for hardening but if solutions had a lower net benefit or a negative net benefit or performance mitigation has already been implemented, solutions for these feeders are excluded from the program.

7 Customer support for the program

This section discusses the customer and stakeholder engagement we have conducted on matters associated with the Hardening the Network reliability program. We consider that the findings from this engagement support us implementing a Hardening the Network program where it is economic to do so.

We do not agree with the AER's view in the Draft Decision that we did not provide sufficient evidence to indicate customer support, because of the limited sample size of the survey and the level of uncertainty from stakeholders in response to the question itself. The AER also claimed that the survey results appear inconsistent with stakeholders' views, particularly regarding the need to improve reliability beyond its current levels.

To be clear, we did not seek funding to improve underlying reliability beyond its current levels. We sought funding for modest, targeted programs that were mindful of customer's concerns about electricity prices, while addressing the strong customer feedback we received that it was important to ensure 'an acceptable level of reliability for all customers.'

The NER require SA Power Networks to engage with its customers directly and demonstrate how customer concerns have been taken into account in developing its revenue proposal for the AER. This section discusses the customer and stakeholder engagement program that was undertaken to inform the development of our 2020-2025 Original Proposal and Revised Proposal.

This engagement program helped us deepen our understanding of the concerns, issues, wants and needs of our customers now and in the future. It involved extensive customer research, conducting focus groups, engagement with targeted groups such as vulnerable and culturally diverse customers, online engagement and workshops in a number of locations across the State. Early in the engagement program, the reliability and resilience of the network emerged through research as an important priority for customers and become one of the themes central to the engagement program. It was subsequently discussed through all engagement activities and the results of these discussions are outlined below. Importantly, we consider that the findings from this engagement support us implementing a hardening program, where it is economic to do so.

The engagement program was developed in consultation with the ESCoSA which had representatives attend several workshops, and engagement outcomes were shared with ESCoSA to inform its Reliability Standards Review for 2020-2025.

As part of ESCoSA's 2020 Reliability Standards Review, it released its first consultation paper in December 2017, where it identified issues that relate specifically to the performance of the distribution network. One of these issues was, the impact of extreme weather in 2016-17, which caused significant network outages and substantial loss of electricity supply. The scale and impact of extreme weather, in terms of network damage and customer impact, exceeded anything previously experienced in South Australia.

This has focused attention on the capability of the distribution network to withstand extreme weather, the way SA Power Networks responds when outages occur, and the timeliness and accuracy of communications with customers.

The main themes that emerged through ESCoSA's engagement processes with customers were:

- **Electricity prices are a concern:** particularly amongst vulnerable and business customers

- **Reliability is a priority:** customers expect SA Power Networks to deliver at least current levels of reliability. There is support for ensuring acceptable levels of reliability for all customers, and some support for improving reliability for regional and poorly served customers

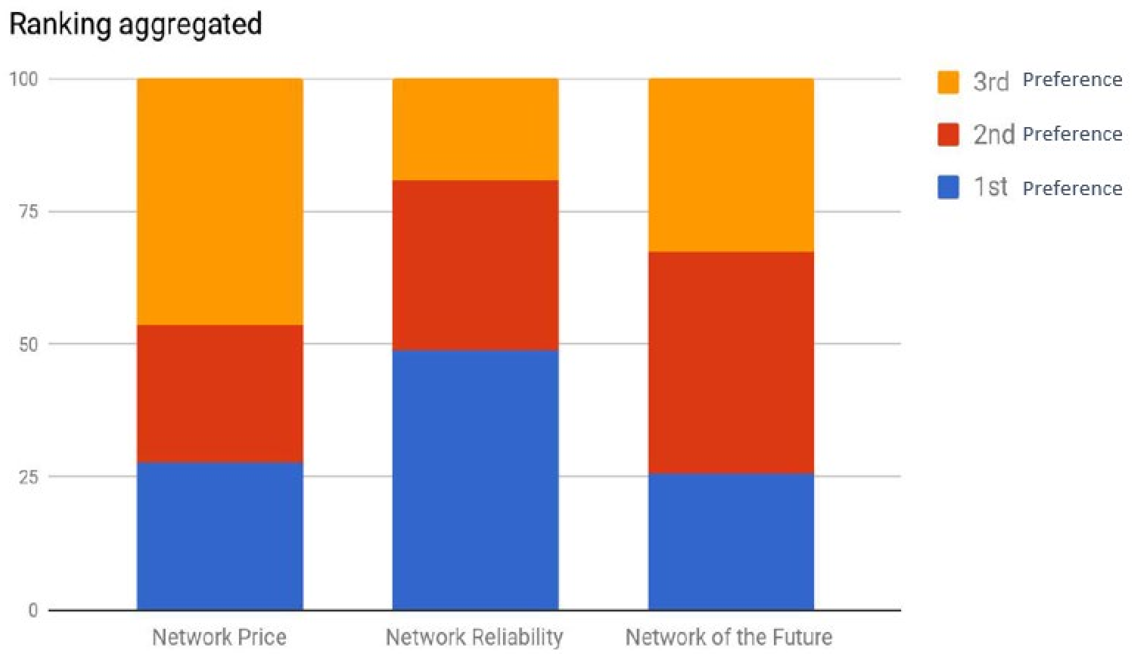
SA Power Networks' engagement program outcomes

In a series of 'Directions' workshops held across the State in 2017, customers were asked to prioritise what was most important to them. While network price and preparing for the future were identified as priorities, at the time of the workshops network reliability and resilience was identified as the highest priority for customers, particularly regional and rural customers. More detailed workshop results are summarised below, and full details are available in Supporting Document 0.7, MDC Planning and Directions Workshop Report:

- *Network reliability and resilience matters most to regional and rural customers, especially those in the Adelaide Hills and on the Eyre Peninsula*
- *Reliability standards should not be lowered*
- *It is important to ensure acceptable levels of reliability for all customers, and regional customers would benefit from having reliability standards more aligned to metropolitan customers*
- *Different sectors have different expectations and needs in terms of reliability of supply and customers are looking for a system that can accommodate this*

Figure 13 below shows the priorities of the 134 customers that attended the Directions workshops (refer Supporting Document 0.7, Original Proposal). After aggregating the data (where all participants had an equal weighting), the results show that 'Network reliability and resilience' was ranked first preference by half of the participating customers.

Figure 13: Customer Engagement Responses from the Directions Workshops



The order of priority was:
1. Network reliability and resilience
2. Network price
3. Network of the future

The key reasons participants gave for ranking 'Network reliability and resilience' at number one can be summarised as:

- Reliability underpins price and future network.
- Electricity is an essential service.
- For business it is central to risk management and confidence; and protecting assets, maintenance and upgrades to secure supply, needs to be a priority, especially in regions.

When these results were discussed with metropolitan-based stakeholders, there was a view that reliability was prioritised in regional areas due to numerous recent extended outages caused by severe weather and the State-wide black-out in September 2016. The view of vulnerable customer advocates especially was that in other circumstances, network price would be the priority for most customers.

Specific themes to emerge from Directions Workshop engagement

Reliability standards

There was widespread support for the proposition that standards should not be lowered.
More participants spoke about the need to improve the standards for business and regional areas. Some participants wanted to see reliability improved but did not necessarily wish to pay more for this to occur.

Acceptable level of reliability for all customers

This topic had most support, except for workshops in Adelaide and Mount Gambier (which has historically good reliability performance).

Regional and poorly served customers

This topic received the most support after acceptable levels of reliability for all. The key themes on this topic were:

- the need for a cost benefit analysis to guide decision-making and set priorities;
- the need to be able to respond to regional specific issues (eg Port Lincoln, Ceduna);
- the importance of considering industry specific impacts (eg farming, fisheries, tourism) and value to State economy; and
- an expectation SA Power Networks should explore opportunities created with new technologies (eg microgrids, batteries) and potential for incentives and partnerships.

Hardening the network

A preparedness to spend a little more for a Hardening of the Network in priority areas was expressed in the majority of the workshops. A small number of participants suggested those requiring higher reliability should pay more for it to occur.

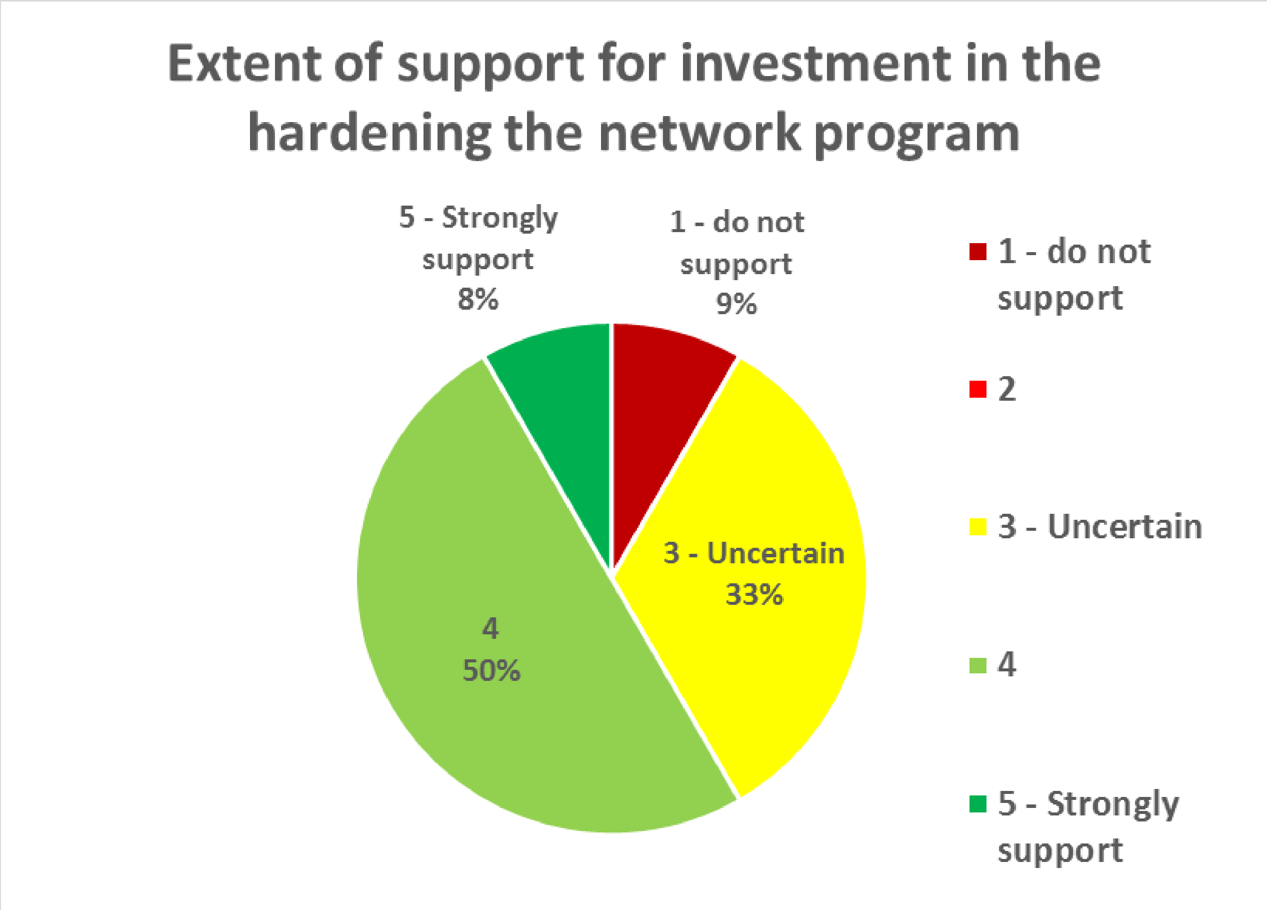
Reliability standards in regional areas

There was broad support of improvements in reliability standards in regional areas, to bring them more into alignment with urban areas. Views on this issue varied across the workshops. (Full details of feedback can be found in Supporting Document 0.7, MDC Planning and Directions Workshop Report).

Deep Dive workshop findings and 2002-25 Draft Plan consultation

This early feedback, which showed a strong customer preference toward reliability, informed our preliminary expenditure forecasts which were discussed with customers and stakeholders during our series of Deep Dive workshops held in early-mid 2018 (full details can be found in Supporting Document 0.13 Ann Shaw Rungie Capex Deep Dive Workshops Report). At these workshops, 58% of participants supported or strongly supported the proposed Hardening Program (see Figure 14).

Figure 14: Customer Engagement Responses Capex Workshops: ***To what extent do you support investment in the hardening the network program?***



Following the Deep Dive workshops, and to address the concerns of stakeholders who didn't support continued investment in the Hardening Program, the forecast was refined before inclusion in our Draft Plan, which was released for consultation in August 2018. While two organisations representing vulnerable customers didn't support the three proposed reliability programs in our 2020-2025 Draft Plan consultation (including the Hardening the Network Program), these programs were supported by:

- Business SA
- SA Wine Industry Association
- Nine regional councils.

Revised Proposal engagement

Engagement on our Revised Proposal has centred around discussions with the SA Power Networks Customer Consultative Panel and members of other SA Power Networks reference groups, largely focussing on proposed capital expenditure programs, including the Hardening the Network Program. In these discussions the views of our stakeholders were again divided on the Hardening program, with advocates representing vulnerable customers questioning whether all customers should have to pay for the program, while many advocates, particularly those representing business and regional customers, were very supportive of making targeted improvements where it is economic to do so.

In our direct engagement with customers via our online channels such as social media and talkingpower.com.au website, customers consistently express concerns about reliability and the ability of the network to withstand the impact of storms and other weather-related events:

> *"we lose power regularly with winter storms, lightning and extreme fire weather events"* (customer, Cummins, Eyre Peninsula, SA)

> *"very unreliable when we have bad weather. When the weather is bad you can almost guarantee the power will go out"* (customer, Thornlea, South Eastern SA)
>
> *"we have a number of power flickers, brownouts and blackouts. We have no mains water or sewage here, so are reliant on power for pumps. Without power in an extended blackout, our homes become unliveable. Three years ago many of us lost power for up to 5 days"* (customer, Mylor, Adelaide Hills, SA)

We consider that, on balance, there is greater customer support for the Hardening Program than against and following this feedback we resubmit our Hardening the Network Program as part of our Revised Proposal.

8 The preferred program and program scope

Rationale for selecting the preferred hardening the network program

In appreciating our rationale for selecting our preferred Program, it is worthwhile recapping important matters discussed in previous sections:

- In section 3, we discussed how we have obligations to engage with electricity consumers and to address any relevant concerns identified as a result of that engagement. We also noted that although there is no strict obligation for us to undertake corrective actions on these feeders, there is an expectation through these obligations that we will undertake corrective actions where it is economic to do so (subject to appropriate regulatory funding being provided) and that SA Power Networks must submit a building block proposal that includes a forecast of the capital expenditure required to address any relevant concerns identified.
- Furthermore, in sections 4 to 6, we discussed that overall network performance has been worsening since around 2010 due to Major Event Days, and the latest BOM reports suggest that the frequency and severity of storm events is only likely to worsen further. We also explained the rigorous process we have applied to develop a set of solutions to address the poor performance on feeders most impacted during Major Event Days, and importantly, presented the results of a formal cost-benefit analysis that we have applied to these solutions. This cost-benefit analysis found all proposed solutions have a positive net benefit.
- Finally, we also noted in section 7 that through our engagement with our customers, they have indicated a preference for SA Power Networks to continue to invest in hardening of the network in priority areas where cost benefit analysis demonstrates that there is a net benefit.

Given these views and findings, we consider it reasonable to propose a Hardening the Network program, which is built up from the solutions that we have determined will have a positive net benefit (i.e. the benefits exceed the costs). We consider that a program that consists of components that meet this criterion will be in accordance with our obligations and our customers' preferences.

Hardening the network program cost and scope

Given the above rationale, the Program we propose here represents a $16.2 million capital program, which will reinforce feeder sections most impacted during Major Event Days over the 2020-2025 regulatory control period. This program includes all the solutions that we have evaluated through our cost-benefit analysis to provide positive net benefits.

This program will harden 35 feeders against storms where sections have been identified as being repeatedly damaged during storms, mitigating long duration MED outages to 53,800 customers.

This program will cover a combination of strategies, aimed at addressing the specific causes of the poor performance of the feeders, including:

- Minimising insulator failures due to lightning by augmenting insulators with high lightning withstand capability;
- Reducing vegetation outages and damage from outside the prescribed vegetation clearance zone by constructing alternative network asset configuration / standards; and by
- Reducing the number of customers interrupted during MEDs by installing mid line switches.

Table 6 below provides a summary of the scope and cost of the various Hardening the Network program mitigation strategies.

Table 6: Mitigation options – Hardening the Network

Option	No. of Feeders sections	Total solution units	Total Cost ($, millions 2017)
Underground of critical line sections	13 Feeder Sections	123 Spans	$9.3
Augmenting critical bare wire line sections with insulated overhead conductor	16 Feeder Sections	331 Spans	$5.0
Installation of reclosers and sectionalisers	6 Feeders	13 Switches	$1.0
Augmenting insulators with high lightning withstand capability	1 Feeder Sections	335 Poles	$0.9
Total			$16.2

Further information on our corporate risk assessment of this program and a summary of its financial appraisal are contained in Appendix B.

The customer service level benefits achieved by the Program

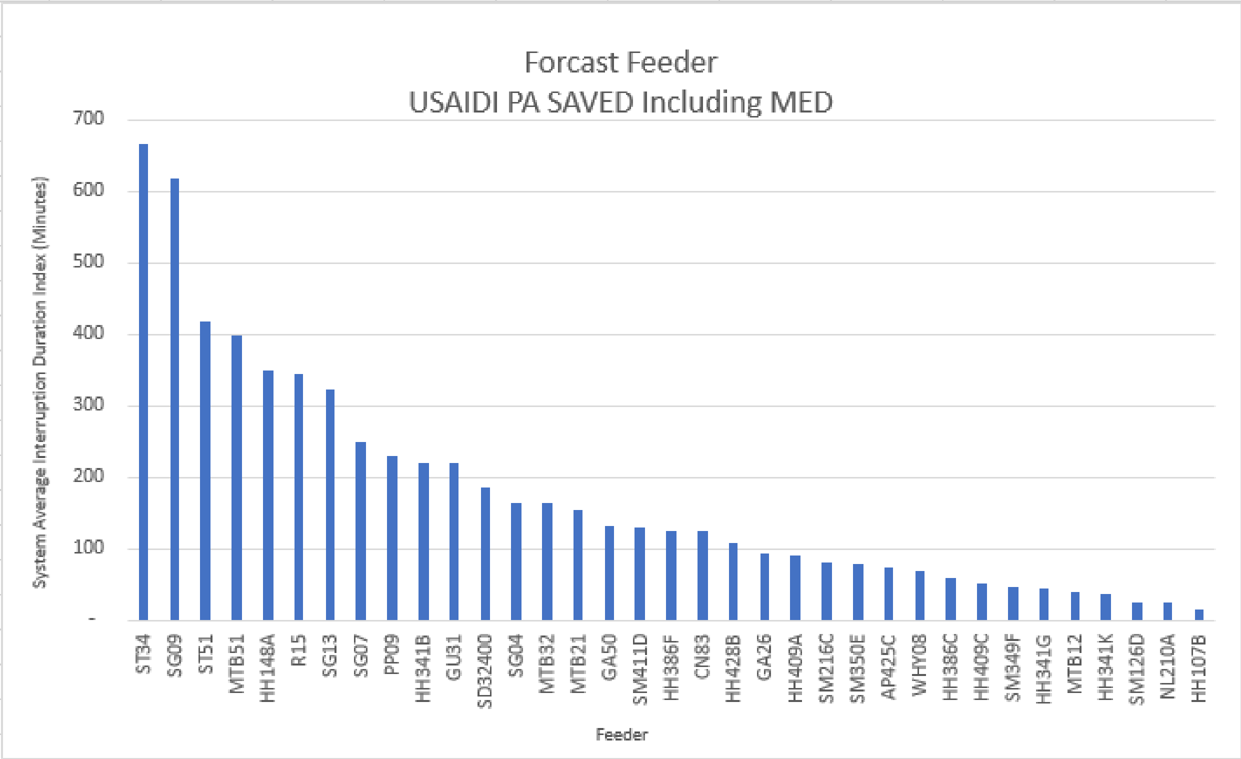
Table 7 below summarises the expected service level benefit achievable through the proposed hardening the network program. This table indicates that this program will benefit customers most impacted on Major Event Days by, on average, 119 SAIDI minutes, representing a 37% improvement from their current service levels.

Table 7: Forecast annual USAIDI & USAIFI benefits from Hardening the Network

Performance 2020-25 Hardening Feeders	Current Performance	Post program	Step change customer improvement
Feeders Targeted Av. SAIDI (incl. MEDs) (minutes)	318	199	119
Feeders Targeted Underlying Av. SAIDI (excl. MEDs) (minutes)	97	88	9
Feeders Targeted Overall Av. SAIFI (incl. MEDs) (number)	1.3	1.1	0.3
Feeders Targeted Underlying Av. SAIFI (excl. MEDs) (number)	1.0	0.8	0.1

The service level benefit is expected to be achieved by the various solutions differs across the feeders addressed through this program. Figure 15 below shows the distribution of the scale of benefit across these 35 feeders (as measured by USAIDI) ranging between 15 minutes and 666 minutes.

Figure 15: Distribution of USAIDI improvement across feeders for hardening.



The economic benefits achieved by the hardening the network program

This economic benefit and net benefit due to this program is shown in table 8 below.

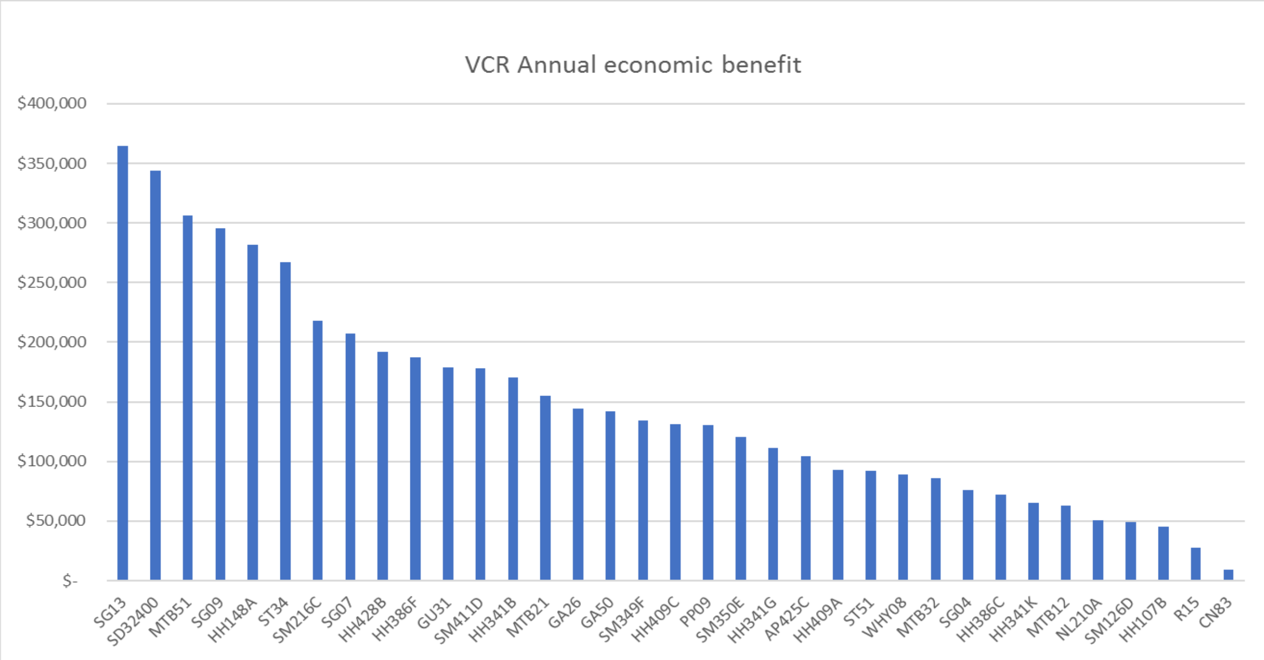
Table 8: Forecast economic benefits achieved by the Hardening the Network Program

	Proposed Augmentation	2015-2020 Reset Determination 2017 $ Incl OH	2015-20 Forecast Expenditure 2017 $ Incl OH	2020-2025 Submission 2017 $ Incl OH	Net Benefit Based on VCR 15 years NPV
Hardening the Network 2020-2025	37 Hardening Projects on 35 Feeders (VCR + STPIS –)	$17.2M	$16.6M	$16.2M	$46.2m (VCR NPV)

Similar to the above, the economic benefit and net benefit to individual feeders can differ. The chart below shows the distribution of the economic net benefit due to the program across the feeders covered by the program.

Figure 16 below shows that the net economic (VCR) benefits by individual feeder's range between $365,000 and $9,500 per annum.

Figure 16: Distribution of economic benefit across feeders to be hardened



Program timescale

The program is planned to be undertaken over the entire 2020-2025 regulatory period, as shown in table 9 below. Therefore, its benefits will be felt progressively as each part of the program is delivered.

Table 9: Project timescale

Timescale Activity	Start Date	End Date
Start and end dates of the project	1/07/2020	30/6/2025
Period/Date when business can first expect to accrue the benefits	1/07/2021	Ongoing

Table 10 below is a summary of the program delivery costs.

Table 10: Delivery costs

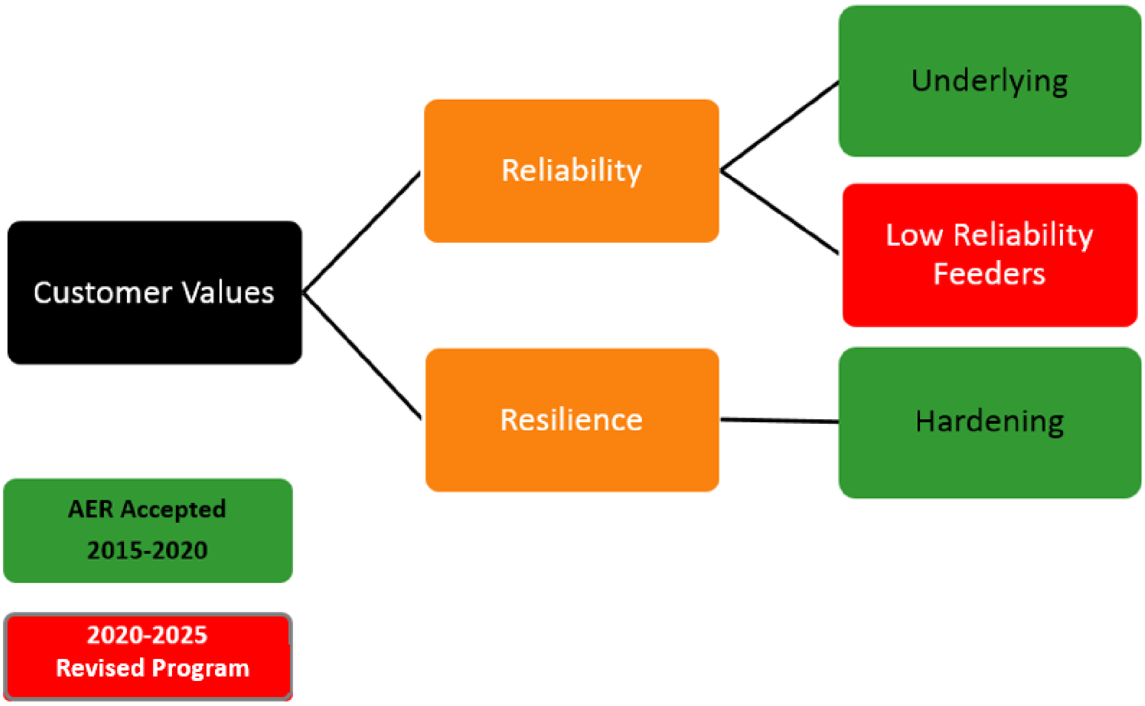
Cost	2020/21	2021/22	2022/23	2023/24	2024/25
($,2017, '000)	3,240	3,240	3,240	3,240	3,240

The proposed 2020-2025 Hardening the Network Program will be implemented smoothly over the 5 year period to allow for a consistent internal 5 year program of works reducing the need to ramp up and down resourcing levels at an additional cost. Projects will be prioritised in the work plan based on customer value and historical customer experience.

Relationship of the hardening the network program to other programs

The AER's concerns regarding synergies between this program and other programs, such as repex and bushfire management has already been addressed in Section 8 of the SA Power Networks – 2020-2025 Reliability & Resilience Programs - Hardening the Network program as well as the 2020-2025 Bushfire Mitigation program. Where it is explained in detail that the works in this program or the anticipated benefit do not overlap or will not be "double counted" with other programs that will form our capital plan.

Figure 17: 2020-25 Resilience & Reliability Programs



In appreciating this view, the following are important to note:

This ***Hardening the Network*** program specifically seeks to address the continuing deterioration of reliability performance specifically during MEDs to reduce extended interruptions to our customers and vulnerable communities and reduce significant network interruptions typically at the same locations subjected to repeated damage from severe weather events and therefore, does not overlap with our other 2020-2025 Reliability and Resilience proposals of:

- ***The Low Reliability Feeder Program*** which specifically seeks to address the continuing deterioration of LRFs (identified in accordance with ESCoSA's proposed definition of a LRF and includes specific low reliability Eyre Peninsula feeders) to reduce extended and frequent interruptions to these customers and vulnerable communities
- The Underlying Reliability Performance Management expenditure which specifically seeks to:
  - Achieve minimum performance standards for all indices as detailed in the Service Standard Framework as defined within the SA Electricity Distribution Code
  - Maintain average underlying performance to achieve ESCoSA service standard targets
  - Manage emerging issues such as declining reliability due to external causes (eg due to the increasing population of flying foxes / bats)
  - Address escalating customer issues.

As overall reliability performance is only partly impacted by the condition of assets (not addressed here but is addressed in other separate asset management plans), the network configuration, changes to network standards, operational and safety procedures and weather patterns, the Supporting Document 5.25 - Reliability & Resilience Performance Management Strategy, Original Proposal includes elements designed to maintain SA Power Networks' underlying performance and to better serve our worst served customers and reduce their impact during MEDs. The scope of works associated with each element does not focus on asset condition and is therefore not sufficient to materially impact the age profile of our assets.

- ***Asset replacement and refurbishment programs*** - asset performance related issues are addressed through the asset replacement programs. These are discussed elsewhere in our set of asset management plans. Our Hardening the Network program is predominantly focused on addressing causes associated with storm events, and not asset performance. Furthermore, the primary goal of repex is to maintain the overall asset risk, and hence, there is typically minimal reliability improvement expected through these programs. Therefore, we do not anticipate a material overlap between these programs. Moreover, we do not consider that there can be re-prioritization between these programs without either materially affecting asset risk (eg safety risk) or customer service levels.
- ***Bushfire Mitigation program*** – The program allows for the installation of a new ultra-fast fault clearance strategy including the installation of mid-line reclosers which could potentially improve supply reliability, however on the days when we implement the ultra-fast clearance. We expect reliability to worsen as the ultra-fast protection settings are more sensitive and hence spurious trips may result. We have undertaken analysis of these reliability benefits and dis-benefits and have found the reliability disbenefits could outweigh the benefits.

Table 11: Relationship of the Hardening the Network program to other programs

Reliability & Resilience Programs	Maintains Underlying Performance to ESCOSA Service Standards	Improves performance to Low Reliability Feeders / Worst Served Customers	Hardens the Network against Storms	Reduces Fire Danger risk
Underlying	Yes	No	No	No
Low Reliability Feeders	No	Yes	No	No
Hardening the Network	No	No	Yes	No
Other Programs				
REPEX Refurbishment & Replacement	Yes	No	No	Yes
Bushfire Recloser Program	No	No	No	Yes

We do not consider that the works in this program, or the anticipated benefits, will overlap or be "double counted" with other programs that will form our capital plan.

9 Regulatory treatment

In this section we will explain why the STPIS is not an appropriate mechanism to incentivise and fund the Hardening the Networks Program and explain why we consider it should be allowed for in the capital expenditure forecast allowance of our building block proposal to the AER.

The limitations of the STPIS as an appropriate revenue mechanism

The Hardening the Network program is an augmentation program which specifically focusses on the mitigation of interruptions on MEDs, where reliability benefits are excluded for MED events, however, this program will also deliver some benefit to underlying performance on non-MEDs, which has been calculated and provides some minor STPIS benefit in the future. However, we do not consider that the existing STPIS mechanism provides the appropriate level of incentives to justify the investment of this work identified for feeders under this program.

Across the range of MED mitigation projects that we may undertake, the works necessary to reduce outages to our customers during Major Event Days tend to have a poor cost to benefit/reward ratio as most reliability benefits are excluded from MED events.

Therefore, the STPIS will not provide sufficient marginal revenue reward to justify incurring the investment (ie the appropriate return on and of the investment over the regulatory period would be below the revenue provided by the STPIS).

As such, the existing STPIS mechanism will not provide the appropriate incentive or revenue mechanism to undertake the hardening the networks program. The AER also appeared to accept this view when it made its final decision on our Regulatory Proposal for the 2015-20 RCP[20].

It is also worth noting that, as we have shown in section 6, the current operating costs associated with the existing performance (ie costs associated with response and repair) are significantly lower than the costs of this program (in an equivalent annual cost sense). Therefore, this program cannot be funded through the Efficiency Benefits Sharing Scheme (**EBSS**) either.

Our reasoning for including in the cost of this program in our capex forecast

Given the above reasoning, for our 2020-2025 regulatory proposal to the AER, we propose to include the total capital cost of this program ($16.2 million) in our capital expenditure forecast of our building block revenue proposal. However, if this program should have some beneficial effect on other incentive mechanisms, we are also proposing adjustments to the SPTIS targets to allow for the benefit we expect to achieve through these programs. We discuss this view further here.

The NER capex objectives

We consider that the costs associated with this program are in accordance with the NER capex objectives[21].

In the context of how we have assessed and developed this program, we consider it reasonable to find that the costs are necessary to comply with applicable regulatory obligations or requirements[22]. In support of this view - and noting the discussion in section 3 ("Our obligations") - we consider that even though we do

[20] AER - Final decision SA Power Networks distribution determination - Attachment 6 - Capital expenditure - October 2015 Ref pg 6-46
[21] NER 6.5.7 (a)
[22] NER 6.5.7 (a)(2)

not have a strict obligation to undertake corrective action to mitigate overall reliability performance under the state-base regime, in circumstances where corrective action is economic then we are obliged to undertake that the corrective action (subject to appropriate regulatory funding being provided). Given we have shown that all elements of our program have a positive net-benefit, then we consider it appropriate to accept this more relaxed interpretation as a regulatory requirement.

Should the AER disagree with this view and consider that the program, as defined here, is not required to comply with regulatory obligations or requirements, then we still consider it reasonable to find that this program is required to maintain the reliability of supply of standard control services[23] and should therefore be funded accordingly.

As we have discussed in section 4, the reliability of supply taking MEDs into account, has been worsening over the recent period and is predicted by the BOM to worsen further resulting in longer duration outages to customers. Given the current performance is significantly worse for feeders targeted than our typical customers, we consider it appropriate to accept that this program meets that objective in circumstances where the NER prudency and efficiency capex criteria are met.

The NER capex criteria

We consider that the costs associated with this program are in accordance with the NER capex criteria[24].

We consider it is reasonable for the AER to accept that the cost underpinning this program's forecast reflect prudent and efficient costs that reflect a realistic expectation of the cost inputs, given the following:

- we have applied a detailed and thorough analysis to assess and develop the individual solutions that form this program, and estimate the benefits we expect from each solution;
- the cost and benefit assumptions have been developed from analysis of our historical costs and performance; and
- we have undertaken a formal cost-benefit analysis on each solution included in this program and ensured that all solutions that form this program have a positive net-benefit.

The NER factors and our consumer preferences

We consider that the costs associated with this program are in accordance with the NER capex factors[25]. Most notably:

- we believe that our Hardening the Network Program is in accordance with our customer's preferences to spend a little more on hardening of the network in priority areas where cost benefit analysis demonstrates that there is a net benefit.
- we have explained above why the STPIS and EBSS are not the appropriate mechanisms to fund this program, but we are proposing some adjustments below on these mechanisms to ensure we are not inappropriately rewarded through them; and
- we have explained in section 6 why we consider that there are not appropriate substitution possibilities, particularly between other programs allowed for in the capex forecast.

The capex forecast and other adjustments

Based on the above reasoning we have included $16.2 million in our capex forecast to cover the costs for the Hardening the Network program over the 2020-2025 regulatory control period.

[23] NER 6.5.7 (a)(3)(iii)
[24] NER 6.5.7 (c)(1)
[25] NER 6.5.7 (e)

However, given this program will result in some modest overall reliability benefits, we are also proposing the following STPIS adjustments to allow for these effects (assumes that the benefits are adjusted by half the ultimate improvement to reflect that the program will be progressively implemented over the 2020-25 RCP).

Table 12: Performance adjustments of Program

	CBD	Urban	Rural Short	Rural Long	State
USAIDI	0	0.26	0.54	0.63	0.36
USAIFI	0	0.0041	0.0042	0.0060	0.004

It is also noted that the proposed Hardening the Network program may potentially reduce GSL payments. This would result in a potential opportunity to gain a reduction in operating expenditure. Detailed modelling will need to occur to forecast the potential GSL offset for the period 2020-25, taking into account the revised 2020-25 GSL scheme. Therefore, SA Power Networks will consider adjusting the GSL potential operational savings if the potential GSL payment reductions can be accurately modelled.

Concluding statements on why we believe the AER should accept our treatment of this program

In summary, we believe that this document should provide confidence to the AER that it can accept our treatment of the Hardening the Network program in our regulatory proposal. Most notably:

- We have obligations to engage with electricity consumers and to address any relevant concerns identified as a result of that engagement and where it is economic to do so, we have developed this program to address these obligations.
- We have undertaken detailed analysis to identify customers and feeders most impacted during MEDs, the causes of their poor performance and the best solutions to mitigate outages during MEDs.
- We have undertaken detailed cost benefit analysis on these possible solutions to develop a program that includes only the solutions that should provide a net economic benefit (i.e. the benefits will outweigh the costs).
- We have engaged with our customers on programs of this type, and they have indicated a preference for us to continue with a program that hardens the networks against storms where it is beneficial to do so.
- We have demonstrated that the STPIS (and EBSS) is not an appropriate incentive mechanism to provide the revenue necessary to fund this type of program.
- We have demonstrated that under these circumstances, the costs of this program are in accordance with the capex objectives and criteria in Rule Ch6, and the NEL objective.
- We have proposed adjustments to the STPIS targets to ensure that we are not overly rewarded for implementing this program.
- We will consider adjusting the GSL payment operating costs if the potential GSL payment reductions can be accurately modelled.
- We have confirmed there is no overlap or double counting with other proposed programs.

The need for the Hardening the Network Program to continue through to 2025 has been identified through customer feedback which supports this program, a review of network performance that has impacted our customers since 2010/11 and a prediction and extrapolation of weather-related performance trends in line with the risks as identified by *Climate extremes analysis update for South Australian Power Network operations*, which predicts increases in severity and frequency of weather events in the future, and which is likely to further negatively impact network performance and customer service, unless specific action is taken.

Appendix A. Relationship to business strategies and other programs

The project contributes to achievement of strategic objectives as described below.

Table 13: Contribution to corporate strategic objectives

Corporate Strategic Objective	Contribution
Providing customers with safe, reliable, value for money electricity distribution services, and information that meets their needs	This program is expected to manage / reinforce reliability performance of the selected feeders and is the least cost means of arresting the continued poor network performance experienced by our customers most impacted during storms The proposal includes NPV positive projects only where the economic benefit of the program exceeds the cost, based on the VCR benefit (over 15 years)
Maintaining our business standing in the community as an exemplary corporate citizen of South Australia	This program is expected to support SA Power Networks standing in the affected feeders / communities by helping to return the reliability performance of specific feeders closer to the average regional (or feeder category) service standards
Ensuring that our workforce is safe, skilled and committed, and that our resourcing arrangements can meet our work program needs	This program will reduce the frequency that our employees operate in relatively hostile and difficult working conditions (i.e. severe storms).
Maintenance and development of key capabilities that will help sustain our success into the future	Not applicable
Maintain the business' risk profile, and protect the long term value of the business	This program is expected to maintain SA Power Networks' risk profile

Table 14: Contribution to corporate core areas of focus

Corporate Core Areas of Focus	Contribution
Energised and responsive customer service	Positive
Excellence in asset management and delivery of service	Positive
Growth through leveraging our capabilities	Not applicable
Investing in our people, assets and systems	Not applicable

Appendix B. Project risks and financial evaluation summary

Major business risks of not proceeding with this project are as follows.

Table 15: Major business risks of not proceeding with the project

Risk ID	Risk Description (Risk Line Item)	Consequence Description	Inherent Likelihood	Inherent Consequences	Risk Rating
1.1	Reliability performance not meeting EDC targets	• Poor customer service • Regulatory intervention • Customer complaints • Media attention	Likely	Minor	Medium
1.2	Detriment to customer service reputation	Negative focus on and additional scrutiny of SA Power Networks' performance	Likely	Minor	Medium

The residual business risks of this preferred option are presented in Table 16 below.

Table 16: Major business risks associated with proceeding with the project

Risk ID	Risk Description (Risk Line Item)	Consequence Description	Inherent Likelihood	Inherent Consequences	Risk Rating
2.1	Detriment to customer service and reputation caused by poor reliability performance	Partly return / restore performance closer to average reliability levels and minimise the likelihood of customer complaints	Unlikely	Minor	Low
2.2	Safety of field crews responding to outages, often in adverse weather conditions, and safety of the public	Fewer outages reduce the safety risk to crews and the public (eg, by reducing the number of wires down)	Possible	Minor	Low

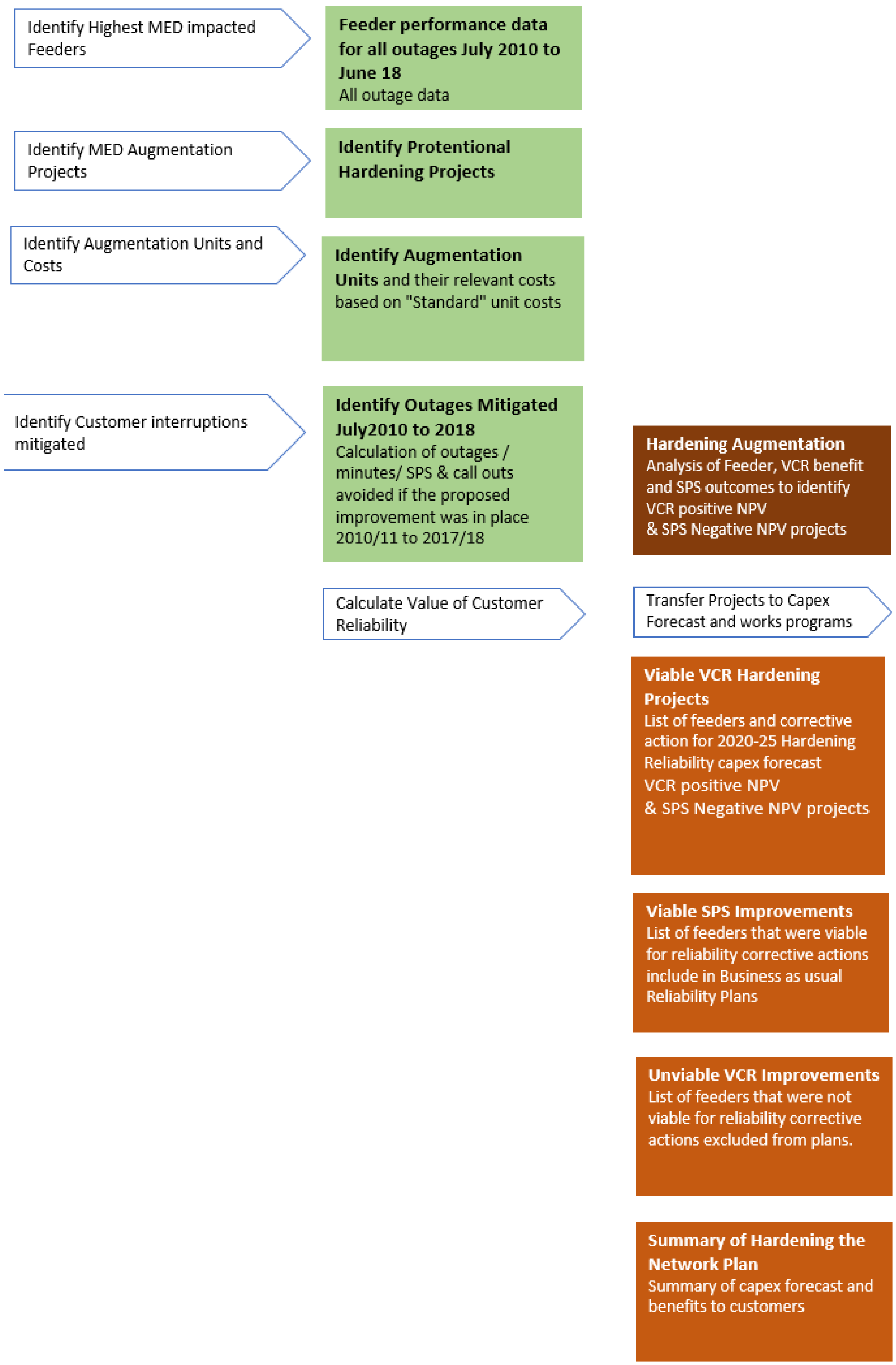
The investment analysis of the Hardening program is summarised in Table 17 below.

Table 17: Investment appraisal

	Harding the Network
CAPEX (5 year) ($million)	$16.2
Overall SAIDI improvement (mins) pa (factors any improvements on non-MEDs)	5.3
Underlying SAIDI improvement (mins) pa (factors any improvements on non-MEDs)	0.4
STPIS Benefit ($M) pa	+$0.3M
VCR Benefit to Customers ($M) pa	+$5.2M
NPV (SAPN perspective ie STPIS) ($M)	-$13.9M
NPV (Customer perspective ie VCR) ($M)	+$46.2M

The overall Network Performance Benefit is based on analysis and assumes benefits are adjusted by half the ultimate improvement to reflect that the program will be progressively implemented over the 2020-25 RCP.

Appendix C. Evaluation methodology



Appendix D. Feeder level summary results

Feeder	Feeder Name	Customers (2017/18)	Hardening Cost	SSF Region	Council	Feeder SAIDI PA Including MED	Feeder SAIDI PA SAVED Including MED	% SAIDI Saved by Hardening
ST34	MACCLESFIELD 11kV	561	$ 200,000	Eastern Hills	ALEXANDRINA	1,100	666	61%
SG09	MYLOR 11kV	605	$ 1,976,000	Eastern Hills	ADELAIDE HILLS	1,258	618	49%
ST51	FINNISS 11kV	279	$ 300,000	Fluriue Peninsula	ALEXANDRINA	712	418	59%
MTB51	WOODSIDE 11kV	1078	$ 465,000	Eastern Hills	ADELAIDE HILLS	646	397	61%
HH148A	STONYFELL 11kV	914	$ 936,000	Adelaide Metro Area	ADELAIDE HILLS	395	350	89%
R15	POINT PASS 19kV SWER	112	$ 20,000	Barossa Mid Nth Yorke	CLARE AND GILBERT VALLEYS	1,137	345	30%
SG13	IRONBANK 11kV	1433	$ 1,872,000	Eastern Hills	ADELAIDE HILLS	508	322	63%
SG07	SUMMERTOWN 11kV	1058	$ 650,000	Eastern Hills	ADELAIDE HILLS	610	248	41%
PP09	CRYSTAL BROOK 11kV	793	$ 500,000	Upper North	PORT PIRIE	394	230	58%
HH341B	ST PETERS 11kV	876	$ 270,000	Adelaide Metro Area	BURNSIDE	352	221	63%
GU31	BIRDWOOD 11kV	1136	$ 600,000	Eastern Hills	ADELAIDE HILLS	584	220	38%
SD32400	BUNGAMA-MERRITON	2592	$ 893,060	Upper North	BARUNGA WEST	245	185	76%
SG04	CAREY GULLY 11kV	584	$ 450,000	Eastern Hills	ADELAIDE HILLS	1,080	164	15%
MTB32	ECHUNGA 11kV	733	$ 450,000	Eastern Hills	MOUNT BARKER	1,033	164	16%
MTB21	HAHNDORF 11kV	1275	$ 520,000	Eastern Hills	ADELAIDE HILLS	475	154	32%
GA50	WILLASTON 11KV	1225	$ 520,000	Adelaide Metro Area	GAWLER	205	132	64%
SM411D	GLOUCESTER 11kV	1562	$ 420,000	Adelaide Metro Area	MITCHAM	215	130	60%
HH386F	GLENUNGA 11kV	1687	$ 600,000	Adelaide Metro Area	BURNSIDE	227	126	56%
CN83	COONALPYN 19kV SWER	106	$ 20,000	Riverlans/ Murray land	THE COORONG	419	124	30%
HH428B	STRATHMONT 11kVR	2010	$ 420,000	Adelaide Metro Area	PORT ADELAIDE ENFIELD	154	108	70%
GA26	EVANSTON 11kV	1778	$ 195,000	Adelaide Metro Area	GAWLER	255	92	36%
HH409A	WATTLE PARK 11kV	1172	$ 550,000	Adelaide Metro Area	ADELAIDE HILLS	592	90	15%
SM216C	WARRADALE 11kV	3033	$ 45,000	Adelaide Metro Area	MARION	166	81	49%
SM350E	MITCHAM 11kV	1749	$ 135,000	Adelaide Metro Area	MITCHAM	177	78	44%
AP425C	LOCKLEYS 11kV	1612	$ 165,000	Adelaide Metro Area	CHARLES STURT	201	74	37%
WHY08	OPIE STREET 11kV	1488	$ 175,000	Metro Regional	WHYALLA	138	68	49%
HH386C	BEAUMONT 11kV	1407	$ 405,000	Adelaide Metro Area	BURNSIDE	320	58	18%
HH409C	HECTORVILLE 11kV	2860	$ 600,000	Adelaide Metro Area	CAMPBELLTOWN	321	52	16%
SM349F	MARINO 11kV	3266	$ 675,000	Adelaide Metro Area	HOLDFAST BAY	116	47	40%
HH341G	FIRLE 11kV	2793	$ 208,000	Adelaide Metro Area	BURNSIDE	255	45	18%
MTB12	MOUNT BARKER 11kV	2001	$ 150,000	Eastern Hills	MOUNT BARKER	155	40	26%
HH341K	STEPNEY 11KV	1968	$ 195,000	Adelaide Metro Area	ADELAIDE	444	38	8%
SM126D	EDEN 11kV	2138	$ 195,000	Adelaide Metro Area	MITCHAM	178	26	15%
NL210A	CRAIGBURN 11kV	2419	$ 240,000	Adelaide Metro Area	ONKAPARINGA	113	24	21%
HH107B	GREENACRES 11kV	3499	$ 165,000	Adelaide Metro Area	PORT ADELAIDE ENFIELD	270	15	5%

Appendix E. Relationship to National Electricity Rules Chapter 6 requirements

Table 18: Contribution to the National Electricity Rules expenditure objectives

National Expenditure Objectives	Contribution
Meet or manage expected demand over the period	Not applicable
Comply with regulatory obligations	In submitting its regulatory proposal, SA Power Networks must satisfy the AER of the extent to which the capital expenditure forecast includes expenditure to address the concerns of electricity consumers as identified in the course of engagement with electricity consumers This program seeks to directly address this requirement to the develop a program that hardens the networks against storms where it is beneficial to do so The proposal includes NPV positive projects only where the economic benefit exceeds cost, based on the Value of Customer Reliability (**VCR**) benefit (over a 15 year period)
Maintain the quality, reliability and security of supply of services provided by SA Power Networks	This program will manage/reinforce the reliability and security of supply of services provided by SA Power Networks on the selected feeders and customers most impacted by MEDs
Maintain the reliability and security of the distribution system ie the electricity networks	This program will manage/reinforce the reliability and security of supply of services provided by SA Power Networks on the selected feeders and customers most impacted by MEDs

The costs estimated to achieve this project represent efficient and prudent expenditure as detailed below.

Table 19: Activities to Meet the National Electricity Rules expenditure criteria

National Expenditure Criteria	Activity
Efficient cost of achieving the objective(s)	All reliability mitigation options have been considered with the most cost efficient solutions included in the proposed program Estimated costs have been calculated based on actual historical costs of other programs Where possible competitive prices have been obtained. Costs are considered to be efficient based on historical expenditure and returns on investment The proposal includes NPV positive projects only where the economic benefit exceeds cost, based on the Value of Customer Reliability (VCR) benefit (over a 15 year period)
Cost of a prudent operator	The planned scope of works incorporates a set of highly targeted and prioritised strategies from which optimised cost-effective solutions are selected SA Power Networks' personnel also have regard to industry developments to ensure our practices are in line with good industry practice
Realistic expectation of forecast and cost inputs	Forecast reliability outcomes and benefits are based on an ongoing independent statistical review of the effectiveness of previous network reliability improvements on the SA Power network Analysis of individual projects within this proposal has been carried out using reliability performance information since July 2010 through to June 2018) and assessing the improvement benefit that would have occurred if the proposed programs had been in place across this period

Appendix F. Evidence of program efficiency

Following the AER's feedback in the Draft Decision the following examples are provided to further demonstrate how we have calculated the effectiveness of our reliability solutions (which is consistent with our current successful hardening program).

This methodology is also explained under Section 5 "Options considered and our methodology to identify the optimal solutions" in both SA Power Networks – 2020-2025 Reliability & Resilience Programs:

- Supporting Document 5.17 Hardening the Network program; and the
- Supporting Document 5.16 Low Reliability Feeder program.

Detailed information regarding the outages mitigated and the solutions for each project is contained in both the program models provided with the programs.

Each project benefit was calculated based on mitigation of historical faults in each **<u>targeted section</u>** had the solution been in place and **<u>not on other faults at other locations on a feeder.</u>**

The following examples are provided including fault location mark ups for proposed 2020-2025 projects:
- **HH386C Beaumont 11kV feeder – 2020-2025 Hardening the Network- IUC project**
- **G31 Mannanarie SWER feeder – 2020-2025 Low Reliability Feeder - Re-insulation project**

Examples are also provided for completed projects to demonstrate "real life" actual effectiveness of implemented solutions for:

- **Insulated Unscreened Conductor (IUC) project effectiveness**
    - SM350D – Springfield 11kV Feeder

and

- **Re-insulation project effectiveness**
    - LC06 – Copley – Nepabunna 33kV Feeder

These projects demonstrate the effectiveness of fault reduction of these solutions in the sections targeted and customer minutes off supply reduction for feeders and customers targeted by the projects.

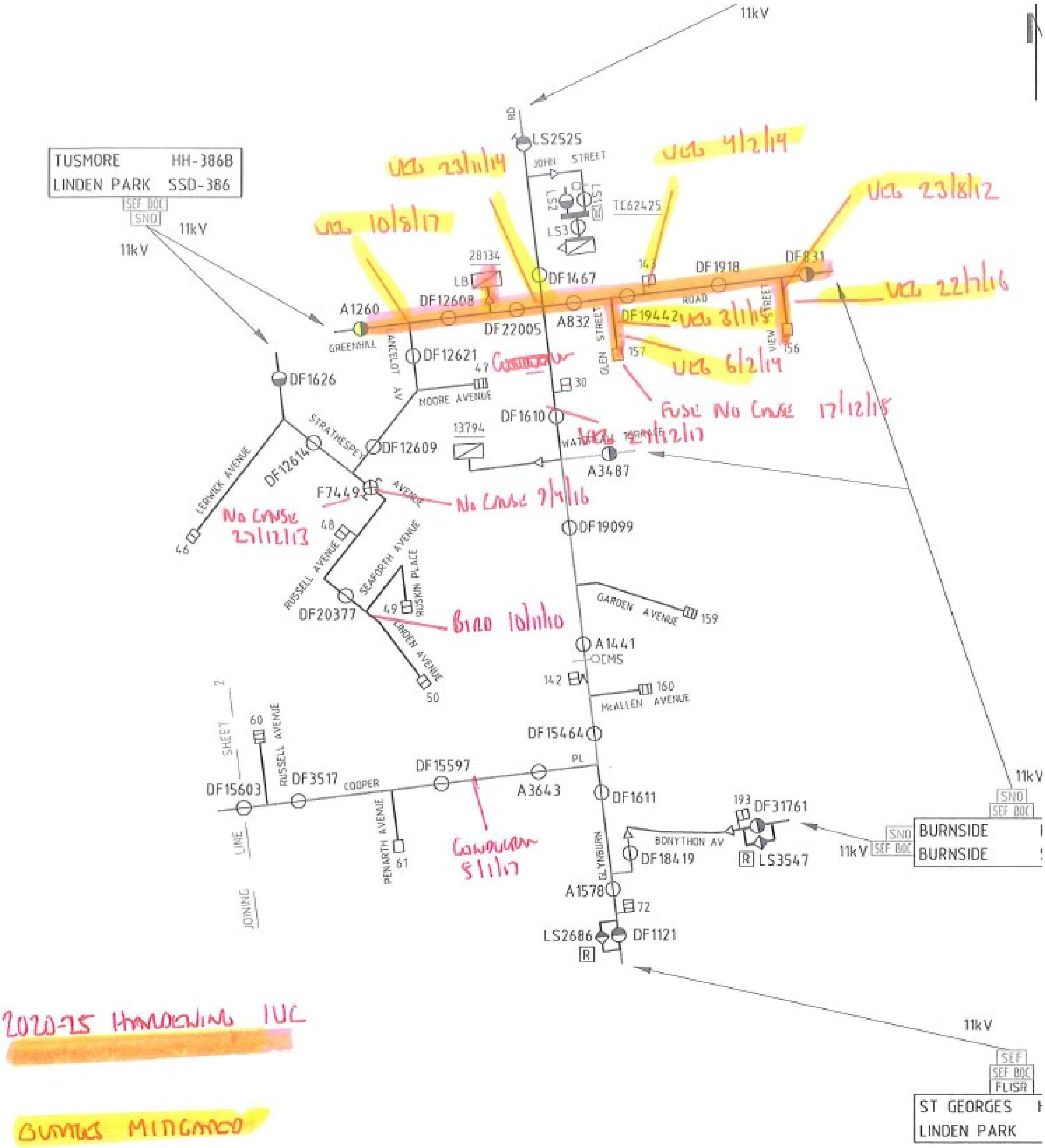
2020-2025 Hardening IUC Project - HH386C Beaumont feeder

Table 20: List of faults on HH386C Beaumont feeder mitigated by 2020-2025 Hardening IUC Project (as per HN Regulatory model)

Date	Outages Mitigated by Viable plan	Time	Feeder	Area Affected	Restoration Time (Final)	HV Daily Customers Affected	HV Daily Description
06-Feb-14	Y	10:00	HH386C	BEAUMONT	11:57	54	2x11kV Fuse operated (TF157) - Vegetation
23-Aug-12	Y	10:34	HH386C	BEAUMONT	11:19	1,372	11kV Circuit breaker locked out (CB1927) - Vegetation (tee-off to TF156)
04-Feb-14	Y	05:34	HH386C	BEAUMONT	14:43	1,360	11kV Circuit Breaker lockout (CB1927) - Vegetation (Green St & Greenhill Rd)
23-Nov-14	Y	21:34	HH386C	BEAUMONT	22:12	1,366	11kV Circuit Breaker lockout (CB1927) - Vegetation (Cnr Green Hill Rd & Glynburn Rd)
03-Jan-15	Y	11:09	HH386C	BEAUMONT	12:32	0	1 x 11kV fuse operated (TF157) - Quality of supply affected (54 customers) - Vegetation near TF157 Note: CB1927 reclosed affecting 1364 customers
22-Jul-16	Y	18:32	HH386C	BEAUMONT 11kV	23:10	1,436	Vegetation (tee-off to TF156)
10-Aug-17	Y	15:14	HH386C	BEAUMONT 11kV	16:46	1475	Vegetation Tree branch on conductors Greenhill Rd near tee off to Lancelot Ave
10-Nov-10	Not mitigated	07:45	HH386C	BEAUMONT	09:40	147	2 x 11kV Fuses operated (F7449) - Bird (between TF49 & TF49 tee)
23-Dec-12	Not mitigated	21:25	HH386C	BEAUMONT	22:58	1,372	11kV Circuit breaker locked out (CB1927) - Cable fault (feeder exit)
27-Dec-13	Not mitigated	07:24	HH386C	BEAUMONT	08:25	0	1x11kV Fuse operated (F7449) - Quality of supply affected (162 customers) - Nothing found - Weather fine
14-Mar-14	Not mitigated	20:30	HH386C	BEAUMONT	22:15	54	Forced Interruption (TF52) - HV isolation to replace oil leaking transformer
17-Dec-15	Not mitigated	00:41	HH386C	BEAUMONT	01:51	49	2x11kV Fuse operated (TF157) - Nothing found, - Weather hot Note: CB1927 was opened during restoration affecting 1416 customers
09-Apr-16	Not mitigated	19:27	HH386C	BEAUMONT 11kV	20:29	166	Blown H phase HV fuse at F7449, have patrolled nothing found
24-Nov-16	Not mitigated	14:02	HH386C	BEAUMONT 11kV	15:05	33	Repair floating insulator at tee-off to TF102
5/01/2017	Not mitigated	05:41	HH386C	BEAUMONT 11kV		60	Vibration
27-Dec-17	Not mitigated	02:08	HH386C	BEAUMONT 11kV	03:53	1494	Vegetation Found tree branch across H & J phase near DF1610 will
10-Jun-18	Not mitigated	08:48	HH386C	BEAUMONT 11kV	08:57	1416	Operational issue
10-Nov-10	Not mitigated	07:45	HH386C	BEAUMONT	09:40	147	2 x 11kV Fuses operated (F7449) - Bird (between TF49 & TF49 tee)

Fault locations and proposed IUC section for HH386C Beaumont feeder (Sheet 1)

- The section of feeder highlighted in orange represents the section where IUC is proposed to be installed
- Faults highlighted in yellow represent the faults that would have been mitigated by the proposed IUC had it been in place (and aligns with the faults in the first table above)
- Faults that are not highlighted in yellow represent the faults that would **not** have been mitigated by the proposed IUC had it been in place (and aligns with the second table above) ie these have **not** been included in the viability assessment



Faults locations and proposed IUC section for HH386C Beaumont feeder (Sheet 2)

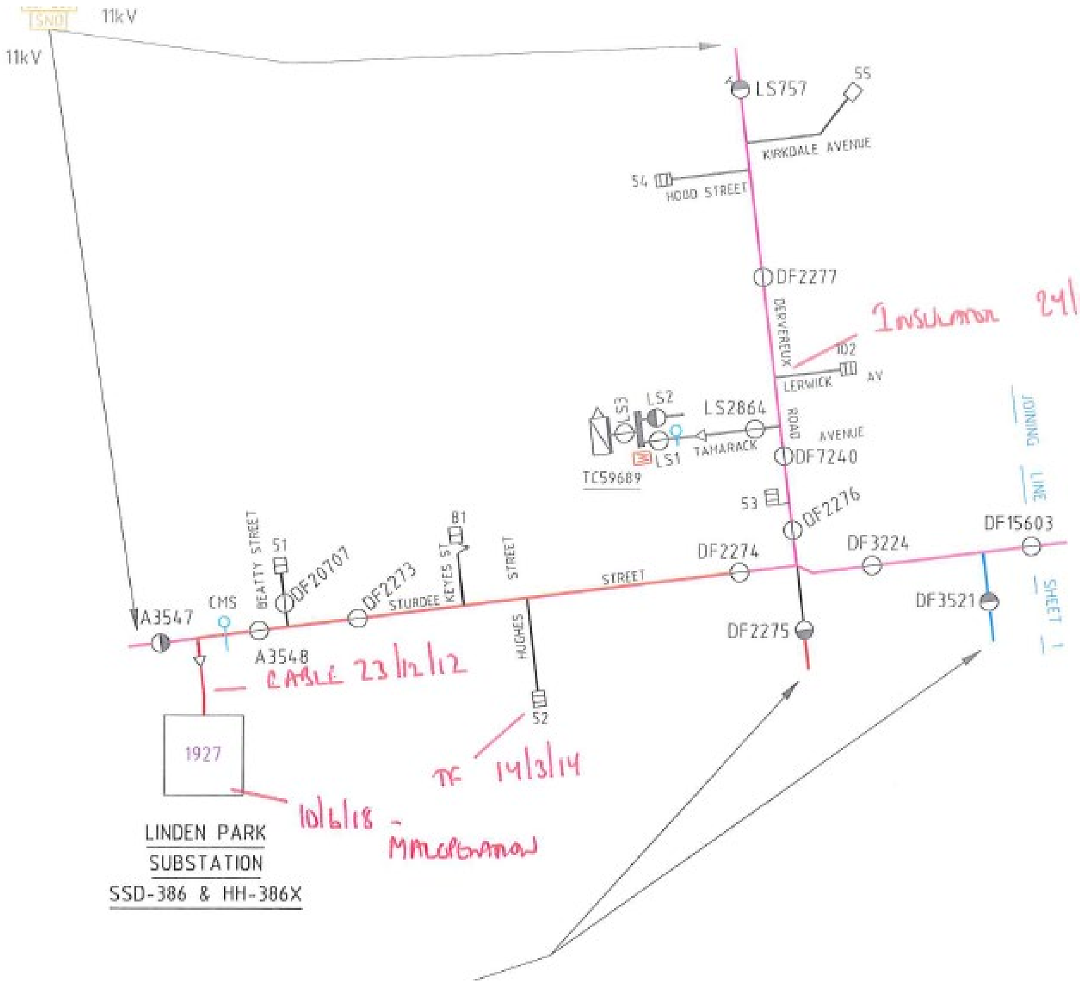


Table 21: HH386C Beaumont - 2020-2025 Hardening- IUC Project – NPV Calculation summary (only includes the mitigation of those faults highlighted in yellow above and not the unhighlighted faults)

Feeder	Feeder Name	Proposed Improvement	Solution	Solution Units	FS Est Cost	Call outs reduced from 1/7/10
HH386C	BEAUMONT 11kV	IUC between A1260 and DF831 with tee-offs	IUC per span	27	$405,000	7
Forecast Customer Minutes Improvement PA	**Feeder Category Forecast SAIDI Improvement (minutes)**	**VCR benefit PA**	**SPS benefit PA**	**NPV (VCR)**	**NPV (SPS)**	**Discount Rate**
81,602	0.13	$71,877	$11,265	$459,930	-$353,248	2.89%

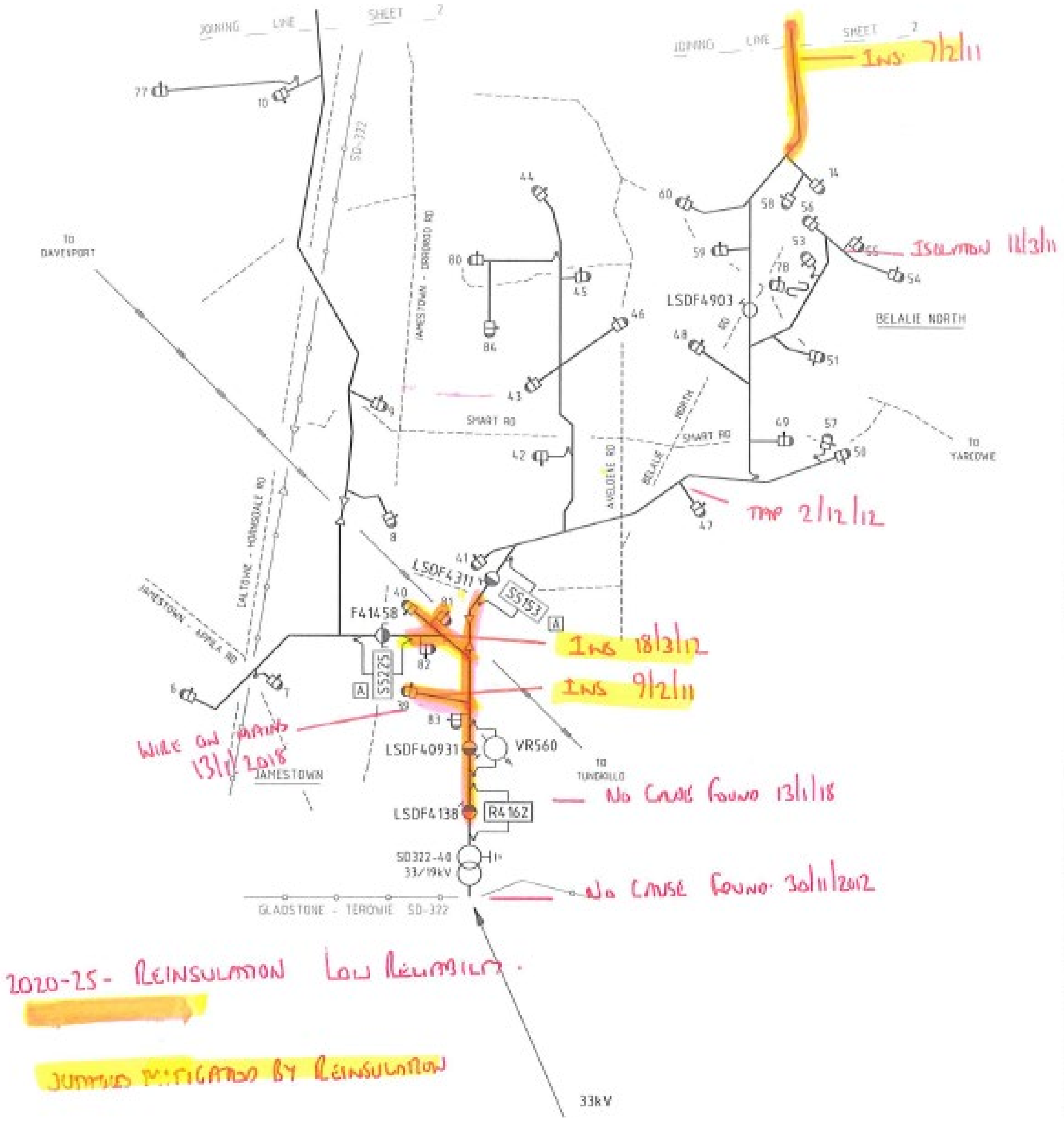
2020-2025 – Low Reliability Feeder- Re-insulation Project - G31 Mannanarie SWER feeder

Table 22: List of faults on G31 Mannanarie SWER feeder mitigated by 2020-2025 – Low Reliability Feeder- Re-insulation Project (as per LRF Model)

HV Daily Date	Feeder	Area Affected	HV Daily Customers Affected	Mitigated	HV Daily Description	MED
7/02/2011	G31	MANNANARIE	40	Yes	19kV Fuse operated (LSDF4311) - Insulator (between TF14 & TF63 tee) - Suspect damage due to recent storms	
9/02/2011	G31	MANNANARIE	125	Yes	19kV Recloser lockout (R4162) - Insulator (near TF39) - Suspect damage due to recent storms	
18/03/2012	G31	MANNANARIE	122	Yes	19kV Recloser lockout (R4162) - Insulator (tee off to TF81) - Conductor down (tee off to TF81) - Suspect damage due to recent storms	
4/03/2011	G31	MANNANARIE	13	Yes	11kV Sectionaliser operated (S5224) - Insulator (Tee off to TF64) - Weather cool and windy	
8/01/2011	G31	MANNANARIE	13	Not mitigated	19kV Sectionaliser operated (S5224) - Nothing found - Weather showers	
16/03/2011	G31	MANNANARIE	1	Not mitigated	Forced interruption - HV isolation to replace LV fuses (TF55)	
4/04/2011	G31	MANNANARIE	13	Not mitigated	19kV Sectionaliser operated (S5224) - Conductor failed (near TF66) - Corrosion	
30/11/2012	G31	MANNANARIE	124	Not mitigated	1x 33kV Fuse operated (F43189 SWER ISO TF) - Nothing found - Weather storms	MED(LN)
2/12/2012	G31	MANNANARIE	2	Not mitigated	19kV Tap failed (TF47) - Hot joint	
3/12/2013	G31	MANNANARIE	13	Not mitigated	19kV Sectionaliser operated (S5224) - Conductor on ground (near TF67) - Lightning	
22/01/2016	G31	MANNANARIE	121	Not mitigated	19kV Recloser locked out (R4162) - TF28 damaged - Lightning	
13/01/2018	G31	MANNANARIE 19kV SWER	123	Not mitigated	Nothing found	
13/01/2018	G31	MANNANARIE 19kV SWER	123	Not mitigated	Foreign object (Wires on Mains TF39)	

Fault locations and proposed re-insulation sections for G31 Mannanarie SWER feeder (Sheet 1)

- The section of feeder highlighted in orange represents the section where re-insulation is proposed
- Faults highlighted in yellow represent the faults that would have been mitigated by the proposed re-insulation had it been in place (and aligns with the faults in the first table above)
- Faults that are not highlighted in yellow represent the faults that would **not** have been mitigated by the proposed re-insulation had it been in place (and aligns with the second table above) ie these have **not** been included in the viability assessment



Fault locations and proposed re-insulation sections for G31 Mannanarie SWER feeder (Sheet 2)

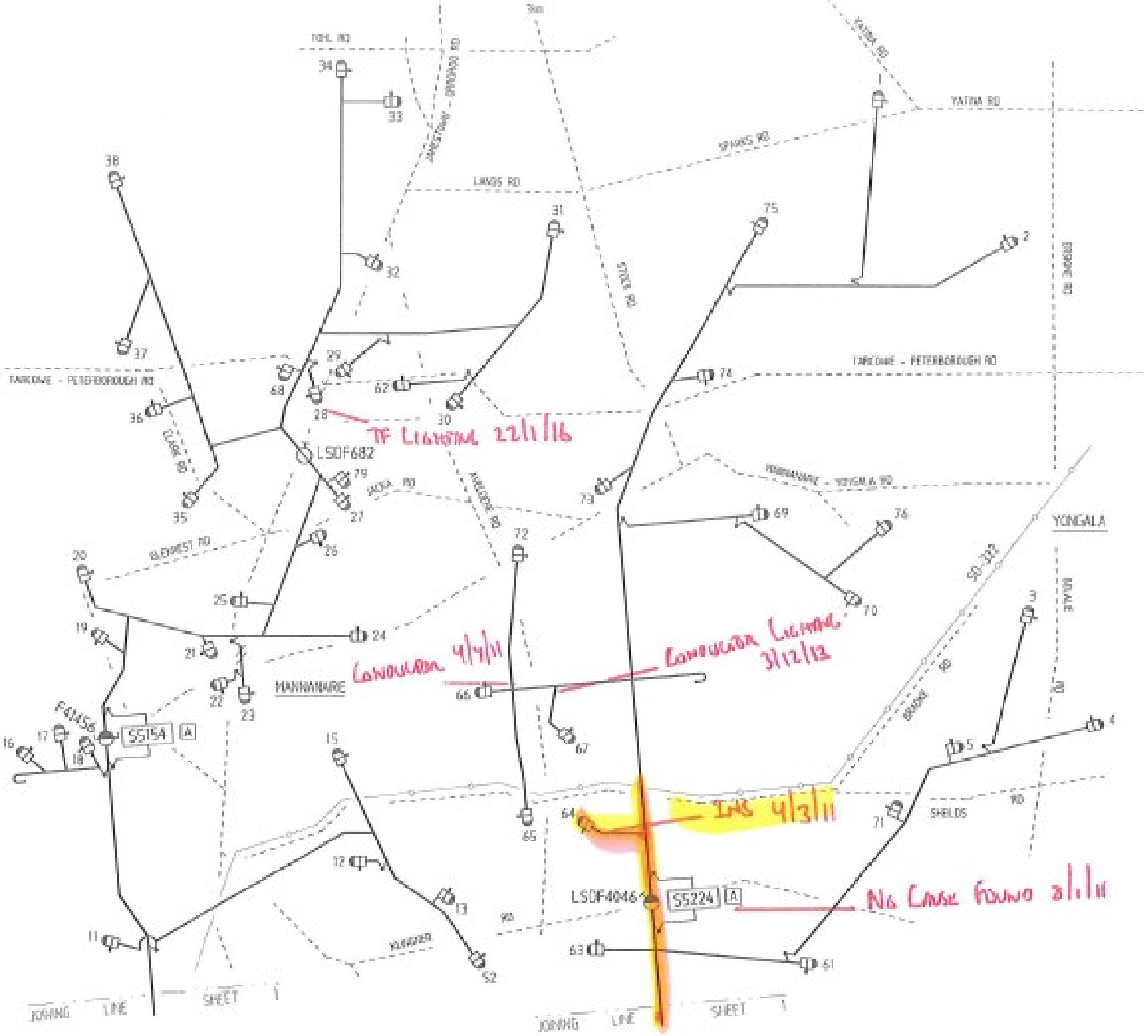


Table 23: G31 Mannanarie SWER feeder Low Reliability Feeder- Re-insulation Project NPV Calculation summary (only includes the mitigation of those faults highlighted in yellow above and not the unhighlighted faults)

Feeder ID	Feeder name	Solution description		Effect on network outage	
G31	MANNANARIE 19kV SWER	Insulator Upgrade - SWER porcelain to Cyclo per pole	Reinsulate approx 12 KM	Reduce likelihood of outage by 95%	
Solution Units	Capital cost	VCR benefit PA	SPS Benefit PA	**Economically viable (benefit cost ratio)**	**SAPN SPS viability test (5-year)**
60	$91,159	$9,426	$7,660	**1.36**	-$55,967.82

Insulated Unscreened Conductor (IUC) project effectiveness case study

SM350D – Springfield 11kV Feeder

22 spans of bare 11kV overhead conductor was replaced with Insulated Unscreened Conductor (IUC) – Completed January 2018

11 feeder outages caused by vegetation occurred between 1/1/10 to 31/12/17 in the previous bare conductor section.

No feeder outages due to vegetation have occurred in the IUC section since the project was completed

This project demonstrates the effectiveness of replacing bare overhead conductor with insulated conductor at targeted locations.

SM350D fault locations 1/1/10 to 4/12/19 (highlighted in yellow) and IUC installation location (highlighted in green).

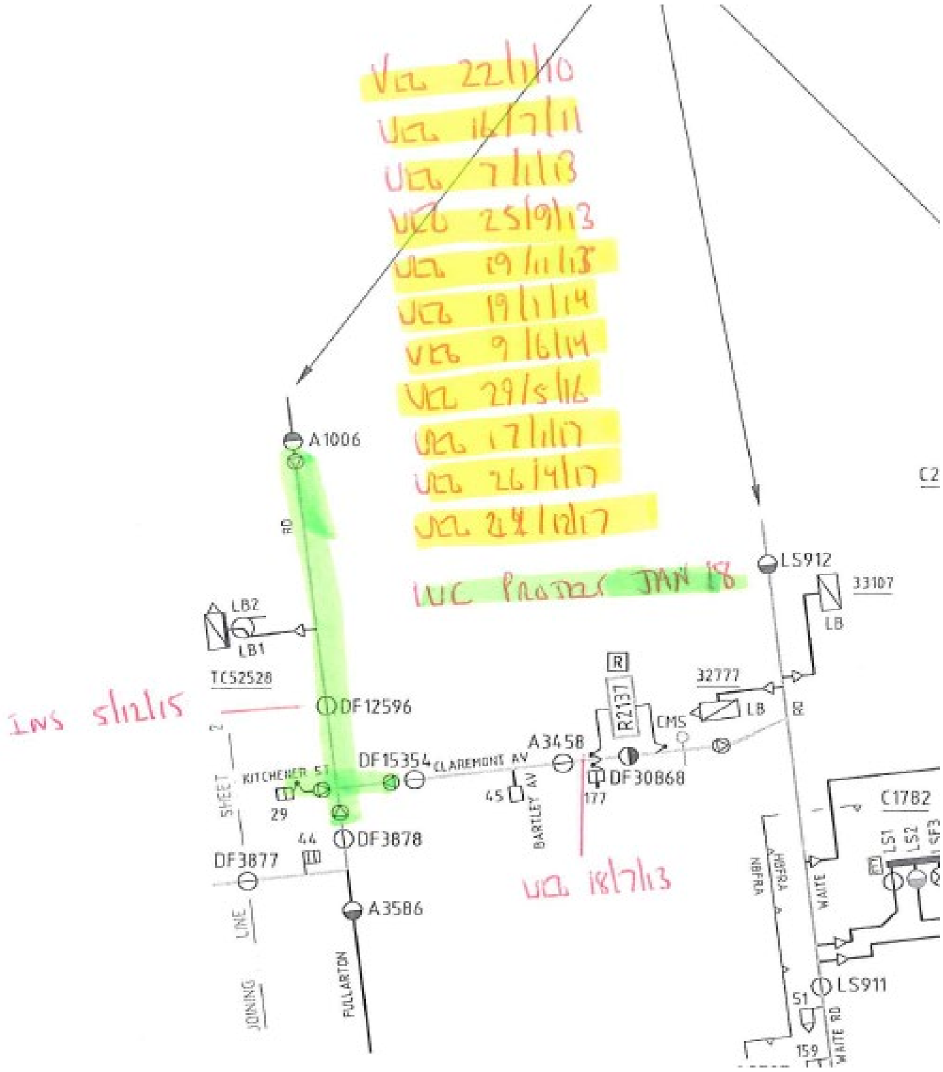
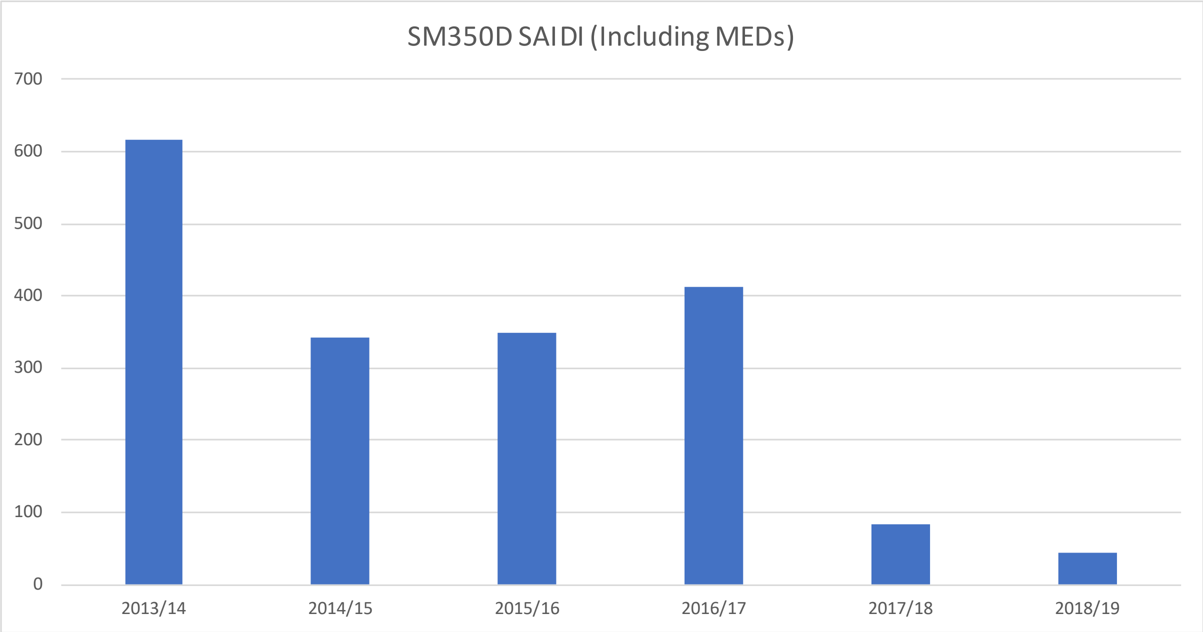


Figure 18. SM350D – Springfield 11kV Feeder – SAIDI Performance



SAIDI minutes off supply has significantly reduced since the IUC project was completed.

This project demonstrates the effectiveness of replacing bare overhead conductor with insulated overhead conductor at targeted locations.

Re-insulation project effectiveness case study

LC06 – Copley – Nepabunna 33kV Feeder

Insulators upgraded on approx. 160 poles on lightning prone sections

- Completed August 2016

15 feeder outages occurred between 1/1/10 to 1/08/16 caused by lightning damaging porcelain insulators in the sections that were upgraded.

No feeder outages due to lightning damaging insulators have occurred since the project was completed.

This project demonstrates the effectiveness of upgrading porcelain insulators to resin insulators at targeted locations.

LC06 fault locations 1/1/10 to 4/12/19 (highlighted in yellow) and sections where insulators were upgraded (highlighted in green).

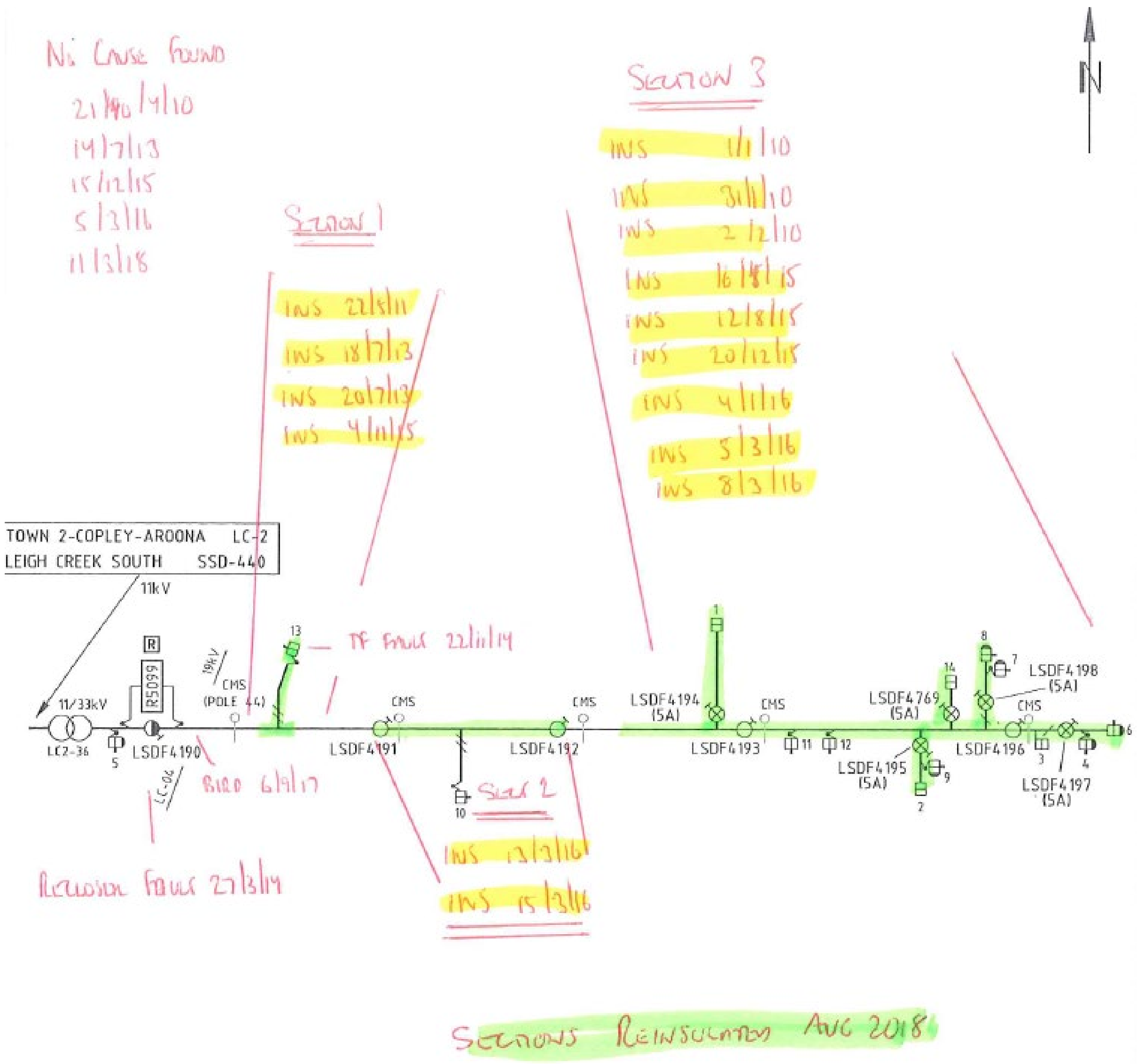
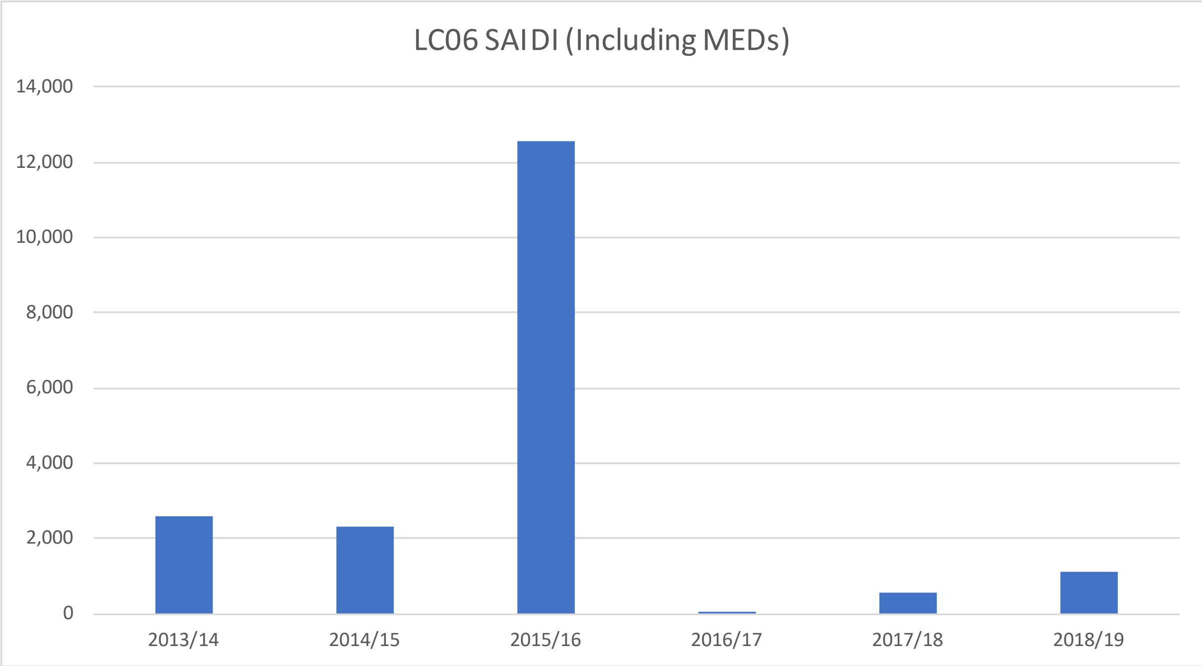


Figure 19. LC06 – Copley – Nepabunna 33kV Feeder – SAIDI Performance



SAIDI minutes off supply has significantly reduced since the re-insulation project was completed.

This project demonstrates the effectiveness of upgrading porcelain insulators to resin insulators at targeted locations.