Supporting Document 12.1.7 Reliability Strategy - CEOP2463 2019-2024

April 2018

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1. EXECUTIVE SUMMARY

Asset Management Plan	Reliability Strategy 2019-2024: CEOP2463				
Description	This document sets out Essential Energy's Network Reliability Strategy. It provides direction across the business to ensure compliance with NSW Reliability and Performance Licence Conditions for Electricity Distributors (the Licence Conditions) and the National Electricity Rules (NER) and conveys accepted industry practice. It also draws on our experience and insight, gained through a strong history of customer engagement.				
Objectives	To set out strategies that Essential Energy will use to manage the reliability of the network in line with corporate requirements. In addition, this document will break down the Asset Management Objectives, as directed by the overarching Strategic Asset Management Plan (SAMP), into more specific Asset System and Class objectives and targets, which are to be used in the Asset Management Plans and Investment Cases.				
Approach	The document provides an overview of the Reliability Standards and Essential Energy's thresholds. Our modelling establishes expected gaps in reliability performance and these thresholds; we forecast performance gaps in relation to Schedule 3 of the Licence Conditions and in the area of worst-served feeder segments. Details of the approach we will use to manage the performance gaps are listed below and in further detail in later this document. Poor-Performing Feeder Approach: We produce quarterly feeder performance reports and analyse the affected equipment and parts of the networks and the causes. Causal analysis differentiates between feeders with an underlying issue, those with poor performance caused by non-recurrent events such as the environment, and those that only require operational actions to restore performance We identify options to rectify the underlying causes of poor feeder performance based on remediation options. These are assessed to identify the most appropriate and cost-effective option. Worst-Served Feeder Segment approach: We produce quarterly feeder segment performance reports and analyse the affected equipment and parts of the networks and the causes. Causal analysis differentiates between feeder segments with an underlying issue, those with poor performance caused by non-recurrent events such as the environment, and those that only require operational actions to restore performance Feeder segments that are being addressed under the Individual Feeder Standards Management are identified and excluded from consideration We identify options to rectify the underlying causes of poor segment performance based on remediation options. These are assessed to identify the most appropriate option.				
Customer benefits	Provision of an affordable electricity supply of acceptable quality and reliability. Essential Energy's engagement with customers[1] reinforces the importance they place on having a reliable electricity supply. As a result, we have developed two core programs as part of this Strategy to improve the reliability of feeder segments serving customers who are experiencing poor performance.				
Implementation timing	2019/20 – 2023/24				
CAPEX phased forecast $ million (2019 Real) (1)	2019/2020	2020/21	2021/22	2022/23	2023/24
	$9.8	$9.57	$9.43	$9.31	$9.3
OPEX phased forecast $ million (2019 Real) (1)	2019/2020	2020/21	2021/22	2022/23	2023/24
	$0	$0	$0	$0	$0
Total forecasts $ million (2019 Real) (1)	CAPEX Total - $47.42		OPEX Total - $0		

[1] TBA Woolcott Research & Engagement

2. Strategic Synopsis

This document details the strategies that Essential Energy uses to manage the reliability of the electricity network. It guides our decision-making around each reliability requirement specified in the NSW Reliability and Performance Licence Conditions for Electricity Distributors – 1 July 2014 (the Licence Conditions) and the National Electricity Rules (NER).

The document provides an overview of the Reliability Standards and relevant Essential Energy thresholds, reliability performance trends and performance gaps.

We have made significant improvements to the reliability performance of the distribution network since 2009. These gains have come either from specific reliability works or dedicated projects to meet security of supply requirements in the Licence Conditions. Historically, we have implemented the specific reliability programs to meet mandated Reliability Standards. Once compliance with the standards has been achieved, we have suspended these programs.

Our broader Asset Management Strategies maintain intrinsic network reliability performance while targeted reliability programs improve network reliability performance. The modelling that underpins the Reliability Strategy assumes there will be no changes to the outcomes of other asset management practices.

The modelling undertaken — as detailed in section 7.1 — indicates that Essential Energy will continue to meet the network average Reliability Standards with at least a 95% confidence level. Consequently, no future expenditure is proposed for network average reliability performance improvement at this stage. Instead, we are focused on maintaining the current level of network average reliability.

As the network is largely overhead and radial, some customers periodically endure poor reliability performance. This document illustrates that, even though network-wide reliability performance is within the standards specified in the Licence Conditions, the performance of many of our 5,892 distribution feeder segments**Error! Bookmark not defined.** will deteriorate unless we implement targeted remediation programs.

Our customer engagement[2] reinforces the importance customers place on having a reliable electricity supply. As a result, we have developed two core programs as part of this Strategy to improve the reliability of feeder segments serving customers who experience poor performance:

- Poor-Performing Feeder remediation (designed to meet Individual Feeder Standards).
- Worst-Served Feeder Segment remediation.

Table 1 provides a summary of the forecast capital expenditure for the reliability programs of work from 2019 to 2024.

Table 1: Reliability Expenditure Forecast (2019 $M, real CAPEX, Direct Costs)

Capital Expenditure Program	2019/2020	2020/21	2021/22	2022/23	2023/24	5 Year Total
Individual Feeder Standards	$8.	$7.88	$7.79	$7.7	$7.7	$39.08
Worst-Served Feeder Segments	$1.81	$1.69	$1.64	$1.61	$1.6	$8.34
Worst-Served Feeder Segment Microgrid Trial	$2.0	$0	$0	$0	$0	$2.0

This document does not include network investment related to specific refurbishment programs that are associated with the age, condition and risk profile of distribution feeders other than those identified as poor-performing feeders or worst-served feeder segments. These matters, and the capital expenditure associated with addressing them, are covered in separate Investment Cases.

3. INTRODUCTION

This document sets out Essential Energy's Network Reliability Strategy. It provides direction across the business to ensure compliance with NSW Reliability and Performance Licence Conditions for Electricity Distributors (the

[2] Community Deliberative Forum Report – Phase 1 & 2- Woolcott Research & Engagement

Licence Conditions), the National Electricity Rules and accepted industry practice. It also deals with the interaction between targeted programs of works in low customer density areas driven by jurisdictional licence compliance and overall network performance, which is linked to performance incentives.

3.1 Purpose

The purpose of this document is to set out the strategies we will use to manage the reliability of the distribution network. We have developed these strategies to guide decision-making around each reliability requirement specified by our Licence Conditions and NER obligations.

Essential Energy has established the strategies in this document to instil a systematic and consistent approach across the business's asset management practices and processes so we can effectively manage distribution network reliability.

Our customer engagement reinforces the importance they place on having a reliable electricity supply. Reliability is the second most important value associated with their electricity supply. Customers need confidence in their electricity supply but understand there are times where interruptions are unavoidable. For urban residential customers, outages are inconvenient. On the other hand, outages can impact rural and small business customers financially due to loss of stock or inability to serve customers.

This document is a part of Essential Energy's Asset Management System (AMS) and is a direct output of the Strategic Asset Management Plan (SAMP). The four key measurable Asset Management Objectives that form the purpose of this strategy are;

- Meet the Network Reliability Performance targets as set by the business objectives
- Customers receive a quality of service that is in line with community expectations
- Manage our assets so investment decisions result in sustainable, cost-effective asset performance outcomes for the present and the future
- Comply with applicable statutory and regulatory obligations or requirements for asset management

In addition, this document is intended to provide guidance to, and be an input for, all Essential Energy's Investment Cases.

3.2 Scope

This Strategy covers measurement, monitoring, maintenance and improvement of reliability performance across Essential Energy's electricity distribution network.

3.3 Customer Engagement

Our engagement with customers has reinforced the importance customers place on having a reliable supply of electricity, with customers placing reliability as the second most important value, associated with their electricity supply. Customers need confidence in their electricity supply, but understand that there are times where interruptions are unavoidable. For urban residential customers outages are inconvenient. Rural and small business customers on the other hand risk suffering financial impacts due to loss of stock or inability to serve customers[3].

We work with customers to engage on all key issues impacting them, no issue is more prominent for customers on an ongoing basis then network reliability. As such during Essential Energy's 2017 customer engagement reliability was featured in all communication mediums and all phases of the engagement. These engagement formats included online surveys, in-depth interviews, and large deliberative forums, this has enabled Essential Energy to progress from simply informing customers to involving them in the issues that impact them.

[3] Community Deliberative Forum Report – Phase 2 - Woolcott Research & Engagement

This involvement has shaped the strategies employed and outlined in this document. Specifically, the approach taken on network average reliability, the continuation and adaption of a dedicated programming targeting our worst served customers, as well as the acceleration of plans to apply microgrid based solutions to reliability constraints.

3.4 Regulatory Context

Essential Energy's technical and economic obligations relating to the reliability of the Electricity Distribution Network are contained in the following legislative instruments:

- NSW Reliability and Performance Licence Conditions for Electricity Distributors (Licence Conditions 2014), published under the Electricity Supply Act 1995.
- National Electricity Rules.

The purpose of the Licence Conditions is to facilitate the safe and reliable supply of electricity. They impose the following service standards on Essential Energy:

- Minimum average Reliability Standards by feeder category.
- Minimum individual Reliability Standards by feeder category.
- Customer service standards for customers who have experienced poor reliability.

The NER deal with the economic regulation of Essential Energy as a Distribution Network Service Provider (DNSP). As an economic regulator, the Australian Energy Regulator (AER) monitors our compliance with the NER, with the objective of ensuring that all DNSPs develop, operate and maintain their networks in a prudent and efficient manner to meet the long-term needs of customers.

The key instrument detailed in the NER and used by the AER to manage DNSP reliability performance is the Service Target Performance Incentive Scheme (STPIS). This scheme was applied by the AER under Essential Energy's current 2014-2019 determination. As such, Essential Energy's current reliability performance is subject to incentives against targets set by the AER during the determination process. For further details, see section 5.4 Service Target Performance Incentive Scheme.

3.5 Information Sources

This Strategy has used information from the following sources:

- *Essential Energy Operational Procedure Supply Standards: Electricity Supply Standard CEOP8026*.
- *NER version 88.*
- *Electricity Distribution Network Service Providers' Service Target Performance Incentive Scheme, Australian Energy Regulator, Nov 2009.*
- *Reliability and Performance Licence Conditions for Electricity Distributors, 1 July 2014 (NSW).*

4. Background

Essential Energy understands the role electricity plays in customers' lives and their need to have confidence in its supply. We also appreciate there is a threshold beyond which customers may find it difficult to see the value of network investment. Customer engagement has shown that for average network performance, we have reached this point, where customers are not willing to invest further in overall network performance improvements[4].

We are therefore focused on maintaining reliability at current standards and taking appropriate action where feeders fall below minimum standards. Safety for the public and our employees will remain paramount in our response strategies, and our zero harm approach to safety will not be jeopardised when making investment decisions.

[4] Community Deliberative Forum Report – Phase 1 - Woolcott Research & Engagement

This section provides an overview of the analysis, strategies and programs of work previously undertaken by Essential Energy to manage reliability performance and comply with the Licence Conditions. In addition, we present emerging issues that need to be considered in developing our strategies for the 2019/20-2024/25 period.

This section also provides an understanding of the work that has led to our current position, which forms the basis of our strategies going forward.

4.1 Developments in Asset Data and Modelling

To support the development and review of this Network Reliability Strategy, we undertook the following initiatives.

Improved asset data

Essential Energy has an ongoing program to review and improve the relevance and quality of interruption data. The main developments that have occurred in this area to date include improving access within the business to this data. We have identified this as critical for leveraging the benefits of distributed planning and decision-making.

Our operating model leaves network planners in regional positions, close to the network assets they are responsible for. This allows feedback from field staff on specific network issues, something that is difficult to replicate under a centralised model. However, it does require simple, fast and effective information on the performance of feeders and feeder segments to be available in an easy-to-use format; any resources spent on training and extracting individual data are multiplied exponentially by the number of staff required to be able to access this data when compared to a centralised reliability planning model.

With accurate outage causal data, we can better understand underlying issues that affect network reliability and develop tailored remediation plans.

Network average reliability modelling

In 2007, Essential Energy implemented a new reliability model to predict future performance and provide confidence that the business would be able to meet the Reliability Standards mandated by the Licence Conditions.

The model uses a probabilistic approach, based on the Monte Carlo simulation methodology. It uses random sampling of historical data to predict future performance and determine the probability of failing to meet the Reliability Standards. Given a specific confidence level, the model predicts a reliability service level that we use to determine whether a program of works is required to ensure compliance with the Reliability Standards.

Essential Energy's broader Asset Management Strategies maintain intrinsic network reliability performance while targeted reliability programs improve network reliability performance. The modelling that underpins this Reliability Strategy assumes there will be no changes to the outcomes of other asset management practices.

Individual feeder reliability modelling

Essential Energy applies a correlation between network outage duration performance and number of feeders exceeding schedule 3 Licence Conditions (defined in section 5.2) to forecast the number of feeders we expect to exceed these Licence Conditions for a given level of network performance. We use historical data to develop this correlation, then apply it to annual forecasting by populating the model with the most recent data and applicable network performance target.

Worst-served feeder segment modelling

We apply a trend-line to historical data to forecast the number of feeder segments exceeding the Essential Energy threshold, as set out in section 6.5 Worst-performing Feeder Segments.

We review this forecast every year to monitor the effectiveness of programs of work that address any gaps between worst-served feeder segment performance and our threshold.

4.2 History of Capital Works

From 2009 to 2012, we implemented programs of work aimed to improve network performance and comply with Schedules 1, 2 and 3 of the Licence Conditions. These works continued during the 2009-14 regulatory period. There were three key focus areas:

- Design planning criteria (Schedule 1) to improve security of supply.

- Reliability Standards (Schedule 2) to improve network average reliability performance by feeder type.
- Individual Feeder Standards (Schedule 3) to improve the reliability performance of individual feeders.

The program of works that addressed the Schedule 1 requirements focused on ensuring feeder capacity was sufficient and that adequate switchable interconnection was provided to adjacent feeders in regional centres[5].

The program of works that addressed Schedule 2 requirements focused on improving the average network reliability performance for urban and short rural feeders while maintaining performance for long rural feeders. The work primarily involved installing reclosers as this was the most cost-effective approach. In late 2012, as part of our annual Network Reliability Strategy review, modelling using the latest data predicted that Reliability Standards were likely to be achieved to a 95% confidence level.

Following the 2009-2014 program of works, we reduced the reliability program during 2009-14. We focused on maintaining the current average network reliability as well as the current level of individual poor-performing feeders. We undertook a wide range of work, with each solution tailored to the individual feeder's circumstances and the specific causes of interruptions so we could apply the lowest-cost solution for each cause. The key types of work included:

- Advanced replacement of bare overhead conductor and poletop assets.
- Installing reclosers.
- Installing sectionalisers.
- Interconnecting or reinforcing tie feeders to other rural feeders.
- Protecting coordination reviews.

The outcome of these works was that we maintained the number of feeders exceeding the standards, in line with our current overall network performance target.

4.3 Emerging Issues

Several emerging issues may impact network reliability in 2019/20–2024/25.

- Long-term, climate change is expected to result in more extreme weather patterns, such as severe storms or extended dry periods. These will affect network performance by leading to events such as vegetation being blown onto conductors or bushfires. The early evidence of this occurring has emerged through an increasing trend in major event days as a result of serve weather events. Although, as specific forecasts as to the likely rate of change of major weather impacts haven't been developed currently, the Reliability Strategy has been developed with the assumption that they will have a negligible impact on network performance over the 2019/20 to 2024/25 period.
- Following the *Review of Distribution Reliability Measures* produced by the Australian Energy Market Commission (AEMC) in 2014, the NSW Government tasked the Independent Pricing and Regulatory Tribunal (IPART) with developing a probabilistic reliability standard for NSW's Transmission Network Service Provider (TNSP), TransGrid. This led to a slight relaxation in the amount of unserved energy at Essential Energy's transmission connection points and linked future transmission network performance to the value of customer reliability (VCR). Although any changes in TNSP reliability will not be reflected in our reported reliability results, our customers could see a step-change in reliability delivered to their downstream connection points. A watching brief is required to manage customer perception during these changes, as customers cannot easily distinguish between transmission network outages and distribution network outages. There may also be some subsequent changes to potential alternative supply arrangements that Essential Energy currently provides or maybe required to provide in the future.
- Maintaining our historic operational response capability, as depots are rationalised to manage operational expenditure within regulated levels. To date, the impact of any changes has been well managed. However, over the remainder of the current and into the next regulatory period, we may have to make further difficult decisions when incentive scheme penalties are outweighed by the cost of providing a given level of operational response for a specific location.
- During 2016/2017, Essential Energy's network has experienced an unprecedented number of major event days. These were all related to significant widespread weather events and mark an emerging trend in increasing

[5] Refer to Appendix B for the definition of a regional centre.

variability in daily network performance i.e. longer ongoing periods of good network performance marked by significant days of poor network performance, typically driven by widespread weather events.

We have summarised the emerging issues in Appendix A Emerging Issues.

4.4 Customer Engagement

During 2017, Essential Energy has undertaken a multiple-stage, multi-medium engagement program to inform several operation and investment trade-offs that are part of our Regulatory Proposal for 2019 to 2024.

This engagement process is key to meeting our identified Asset Management Objective: “Customers receive a quality of service that is in line with community expectations”. This Objective recognises Essential Energy’s place in the community as an essential service provider, focused on balancing the two key values of affordability and reliability, as have been identified by customers as part of our engagement.

During the engagement process, we made a significant investment in community education to encourage energy consumers to discuss topics that were often outside their comfort zone. They supported some proposed directions while disagreeing with others. We have used their feedback to shape our proposed programs and, because of the consultation process, we expect improved community support for them.

The primary method of engagement were deliberative forums which enabled us to engage with customers in two-way dialogue that benefited complex topics such as network reliability. Customers grasped the concept of reliability easily as it is one of the key measurable outcomes experienced by them as a result of the investment we make on their behalf.

Our engagement resulted in an improved level of understanding within the community of the trade-off that we make between investment and reliability levels. We are confident that their feedback, which indicated that the current level of reliability is appropriate, is a true reflection of community sentiment. Small groups of customers said that they may tolerate a slight decrease to their reliability level if a corresponding reduction in bills could be achieved.

Customer Engagement Findings – Reliability

Across all regions, customers consistently expressed that they were satisfied with their current level of reliability (90% of deliberative forum customers and 80% of survey customers noting that their electricity supply was reliable).

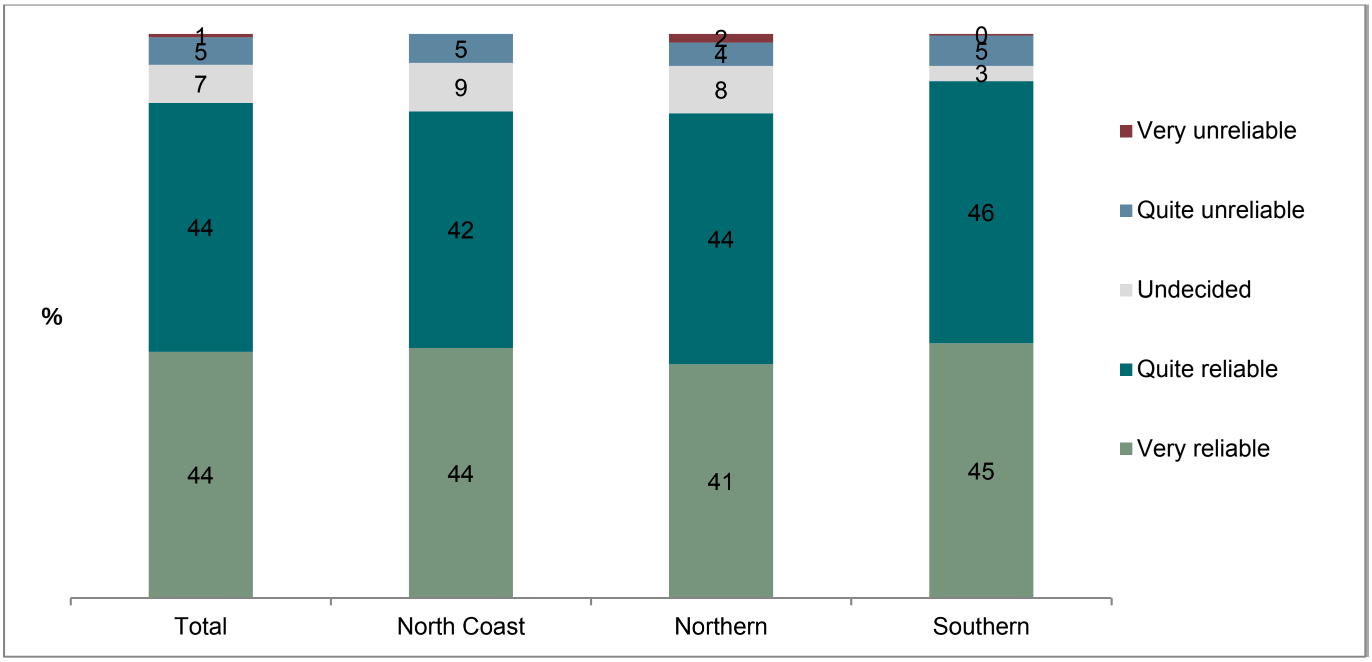


Figure 1 - Perceived reliability of electricity supply

Our findings did not indicate a clear preference on the frequency and duration of outages as roughly half of our customers would prefer more outages of shorter duration and half would prefer fewer outages but longer duration. These findings suggest that we should specify outage windows that are most efficient for work delivery, as no option will please all consumers.

When faced with the concept of a trade off on length and frequency of outages against cost, findings varied between the forums and the online surveys. Due to the current satisfaction with reliability, a consistent finding was that the clear majority were not willing to pay more to reduce their outage duration. Nor were customers willing to extend the duration of unplanned outages, as there was a general overarching sense that electricity constitutes an essential service, and as such there should not be any form of delay in the restoration of service. However, customers were open to an increase in the number of unplanned interruptions per year for a significant reduction in their bill.

When online survey customers were asked about avoiding significant widespread outages such as a 24hour outage once every 10 years, only 20% of customers surveyed were willing to fund avoiding this at $20 per quarter. This indicates that customers were currently happy with the level of resilience provided by the network, and aligns with past customer engagement that highlighted a high level of understanding where unplanned outages are the result of significant weather events.

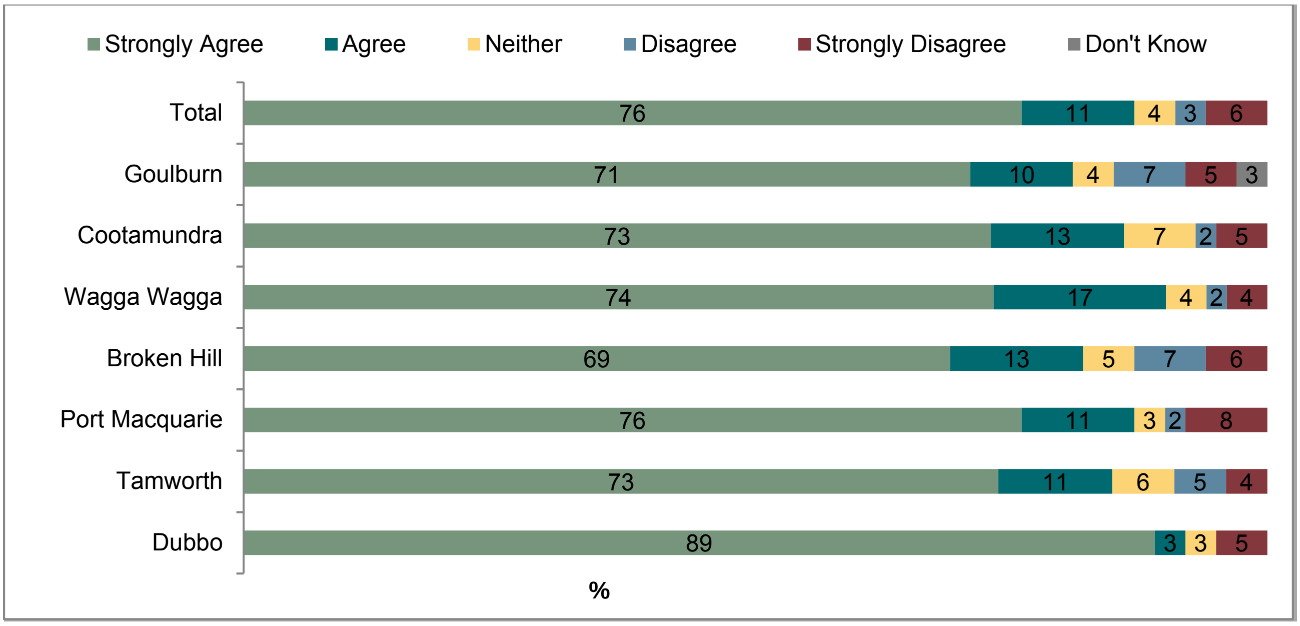


Figure 2 - Agreement with price increase for reliability improvements in lower availability areas by Region[6]

These engagement findings have been reflected in the structure of our reliability strategy, predominately through the inclusion of a targeted worst performing feeder segment program and the approach used for the management of individual feeder standard compliance. Both these approaches balance the overall view among customer that reliability should not improve, however that there is a strong sense that due to electricity being an essential service an element of geographic equity in network performance should be maintained.

With our approach to manage the overall network performance by not investing in maintaining the current level of performance, it is likely that that customers will experience a continuation of the current performance with potential for a slight deterioration in performance over the period, subject to long terms weather patterns.

5. Performance Requirements

As per our Asset Management Objectives: "Comply to applicable statutory and regulatory obligations or requirements that apply to Essential Energy's management of assets" and "Meet the Network Reliability Performance targets as set by the business objectives", this section outlines the network reliability performance requirements that result from:

- Schedules 2 and 3 of the Licence Conditions, which specify the minimum reliability service standards required.
- The AER's reliability incentives scheme, which provides financial incentives for achieving reliability performance.
- Corporate requirements to improve the performance of sections of the network supplying the worst-served customers, by targeting the worst-performing feeder segments

These requirements are detailed further in the following sections.

5.1 Reliability Standards (Schedule 2)

Schedule 2 of the Licence Conditions sets mandatory average System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI)[7] Reliability Standards by feeder type. These are shown in Table 2 and define the minimum average reliability performance that must be achieved across the network.

[6] Community Deliberative Forum Report – Phase 2 - Woolcott Research & Engagement

[7] Refer to Appendix B Definitions

Table 2: Average Feeder Reliability Standards

Feeder type[8]	SAIDI	SAIFI
Urban	125	1.8
Short Rural	300	3.0
Long Rural	700	4.5

5.2 Individual Feeder Standards (Schedule 3)

The Licence Conditions specify minimum service standards for individual feeder performance. Specifically, Schedule 3 of the Licence Conditions sets SAIDI and SAIFI thresholds for individual feeders by feeder type, which are set out in Table 3.

Table 3: Individual Feeder Reliability Standards

Feeder type	SAIDI	SAIFI
	Minutes per customer	Number per customer
Urban	400	6
Short Rural	1000	8
Long Rural	1400	10

Under the requirements of the Licence Conditions, we measure the performance of individual feeders quarterly for the previous 12-month period. Where an individual feeder exceeds SAIDI or SAIFI standards, Essential Energy must:

> Investigate the causes and develop a Reliability Improvement Planning Report, which must be completed by the end of the quarter following the quarter in which the feeder first exceeded the Individual Feeder Standards.
> Implement appropriate operational actions by the end of the third quarter following the quarter in which the feeder first exceeded the standards.
> Where the investigation report identifies actions (other than operational actions), develop a project plan including an implementation timetable, and commence implementation by the end of the second quarter following the quarter in which the feeder first exceeded the Individual Feeder Standards.

5.3 Customer Service Standards

Under the Licence Conditions, the customer service standards provide financial recognition to individual customers who have experienced poor reliability performance. Table 4shows the payments that apply where the minimum service levels are exceeded (see Table 3).

Table 4: Customer Service Standards

Feeder type	Outage duration	Number of outages	Payment
Any	> 18 hrs	1	$80
Any	≥ 5 hrs	4	$80

[8] Refer to Appendix B Definitions

The Licence Conditions also specify that the customer must make payment claims within three months, and that the maximum payment in any one financial year is $320. Interruptions that are excluded from these payments are in accordance with Schedule 5 of the NSW Reliability and Performance Licence Conditions.

5.4 Service Target Performance Incentive Scheme

From 1 July 2015, the Service Target Performance Incentive Scheme (STPIS) applied to Essential Energy.

STPIS provides financial incentives for Essential Energy to maintain and improve service performance. Under an incentive regulation framework, DNSPs have an incentive to reduce costs for the benefit of both the DNSP and its customers. STPIS seeks to ensure that an increase in financial efficiency does not result in a deterioration in service performance for customers.

Under STPIS, SAIDI and SAIFI targets are based on the historic performance of the network. The financial benefit or penalty is applied for exceeding or failing to meet these targets, and is capped.

It is important to note that the performance analysis and strategies in this document are not driven by, and have no material impact on, average network performance, and therefore have no material impact on STPIS. Where we expect a regulated program of works to have a material impact, we would calculate the expected average network reliability impact to allow for reasonable adjustments to STPIS.

For details on Essential Energy's approach to STPIS, refer to the relevant regulatory document, *Application of STPIS to Essential Energy 2019-2024.*

5.5 Worst-Served Feeder Segments

Individual customers on small sections of the network may experience very poor reliability. However, this does not always result in the feeder supplying the area exceeding the Individual Feeder Standards (Schedule 3 of the Licence Conditions). Based on our community engagement, allowing this level of network performance to continue unmanaged is not in line with community expectations and therefore does not meet Essential Energy's Asset Management Objective: “Customers receive a quality of service that is in line with community expectations”.

Customers situated on these worst-performing feeder segments do not experience average feeder performance; rather, they experience the feeder's individual reliability performance, which can result in substantial dissatisfaction.

Even though the standards do not require Essential Energy to remediate the worst-served feeder segments, we have tested the concept of worst-served feeder segment remediation with customer groups through continued stakeholder engagement. At the deliberative forums we held across NSW, more than 80 per cent of customers strongly supported a program to address these segments. During the consultation, we showed the costs involved and made clear they would be paid by all customers.

In each case, the groups supported the worst-served feeder segments program of works and strongly agreed that it was in line with customer needs. As a result, Essential Energy believes we have a supported social responsibility to address worst performance where it is justified.

Figure 3 illustrates the approach we have taken, using performance data from the long rural feeder class.

Figure 3 - Concept for Assessing Worst Performance (using long rural feeder SAIFI performance as example)

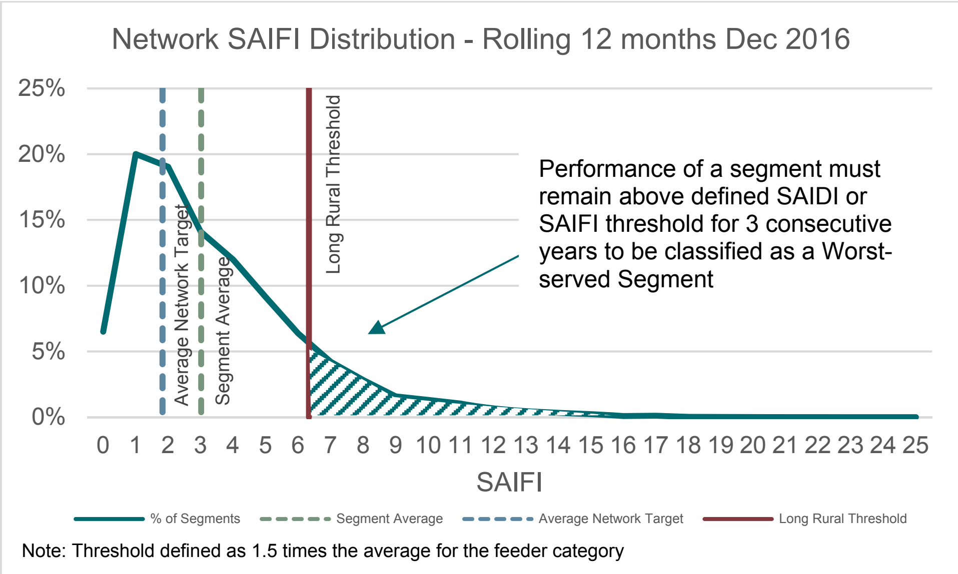


Table 5 defines the threshold for worst-served feeder segments.

Table 5: Feeder Segment Threshold

Performance type	Feeder type	Essential Energy thresholds	
		SAIDI	SAIFI
Individual Feeder Segment SAIDI & SAIFI	Urban	179.4	1.45
	Short Rural	719.2	4.04
	Long Rural	1266.7	6.33

We have changed the method of identifying worst-served segments from being based solely on SAIFI to a combination of SAIDI and SAIFI over time. We did this to reduce the level of quarterly variability in the tracked segments.

This approach sets a threshold of 1.5 times the average SAIDI and SAIFI performance of specific feeder category in a given 12-month period. Where a segment exceeds the SAIDI or SAIFI threshold for three consecutive years, it is defined as a worst-served feeder segment. While this approach generally identifies slightly fewer feeder segments, it focuses on tracking segments that are repeat offenders.

For further details on the development and application of this approach, see section 6.5 Worst-performing Feeder Segments.

6. Performance and Gap Analysis

6.1 Network Average Reliability Performance

This section analyses Essential Energy's performance against the Reliability Standards (see section 5. Performance Requirements) and considers any gaps and their causes.

Essential Energy has continued to achieve a level of reliability that complies with the Licence Conditions. Table 6 and Table 7 show our average network performance as assessed for the reporting year ending June 2016.

Table 6: Reliability Standard Performance and Gap Analysis – SAIDI

Feeder type		Standards (Schedule 2)	Performance (June 2016)	Performance gap
SAIDI	Urban	125	66	0
	Short Rural	300	204	0
	Long Rural	700	458	0

Table 7: Reliability Standard Performance and Gap Analysis – SAIFI

Feeder type		Standards (Schedule 2)	Performance (June 2016)	Performance gap
SAIFI	Urban	1.80	0.75	0
	Short Rural	3.00	1.83	0
	Long Rural	4.50	2.91	0

Several network performance trends and performance factors affect our network average reliability performance.

Performance trend

Figure 4 and Figure 5 show the network SAIDI and SAIFI performance since 2004/05 and expected performance over the 2019-2024 period.

We have used modelling to forecast the expected network performance in future years. From 2005/06 to 2011/12, the results show improved performance due to our reliability programs of work. This trend stabilised over the 2011/12 to 2015/16 period as we did not invest in any further in network performance improvement.

For the 2019 to 2024 period, we have assumed that:

- No network-wide reliability performance gains are realised from any previous programs of work.
- As has been the case over the 2013/14 to 2018/19 period, programs of work from 2019 to 2024 are designed to maintain current network performance.
- Asset management practices will continue to target the management of current asset failure rates
- The impact of weather on underlying performance remains unchanged at current levels.

To summarise, our overall network SAIDI and SAIFI performance complies with the Schedule 2 requirements.

Figure 4 - SAIDI Performance compared to Schedule 2 Requirements

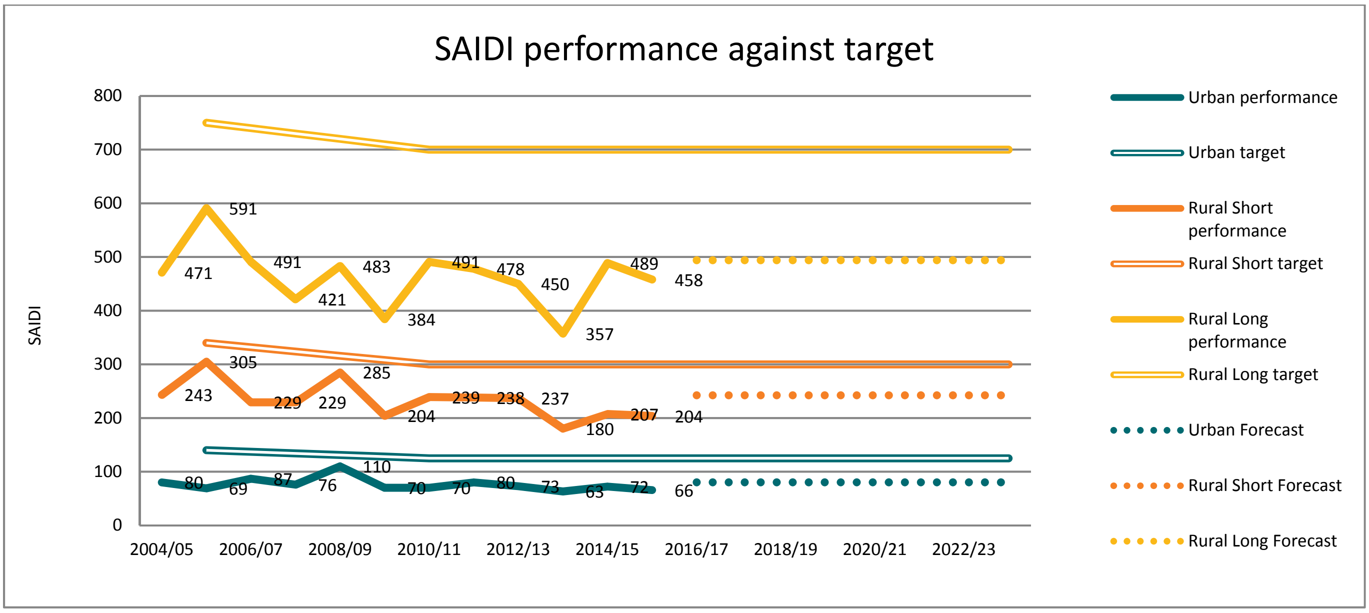
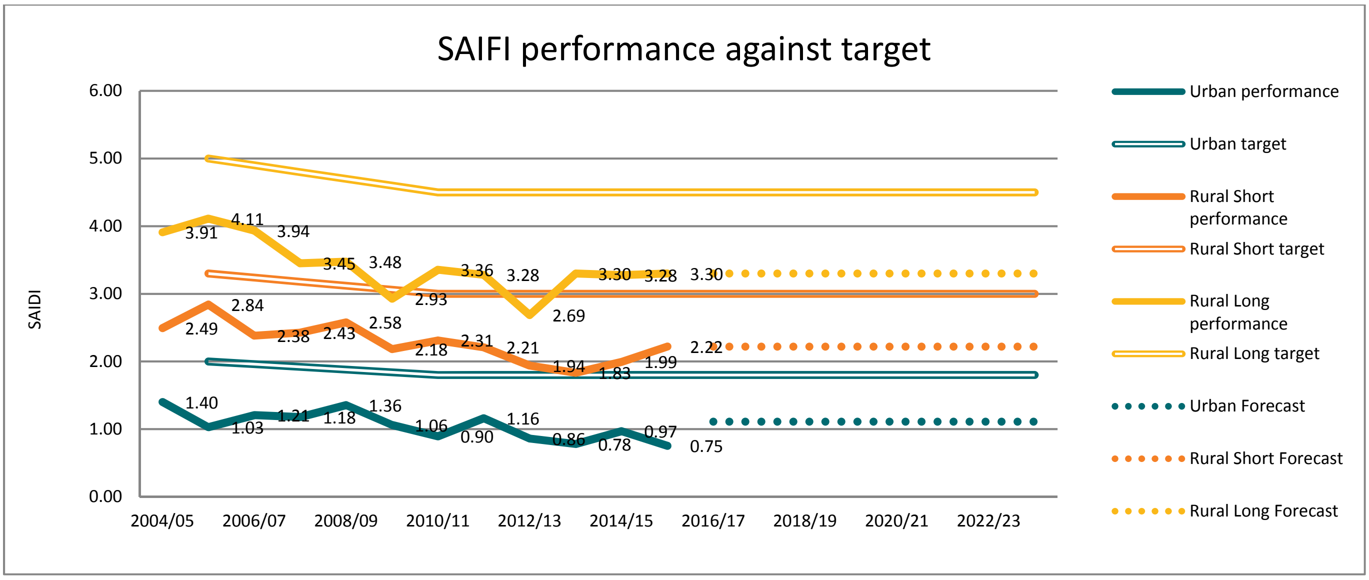


Figure 5 - SAIFI Performance Compared to Schedule 2 Requirements



Performance factors

Causal analysis

Figure 6 and Figure 7 show the breakdown of outages by major cause codes[9] for the reporting periods June 2011 ending June 2016.

[9] Using Energy Networks Association (ENA) cause codes

Figure 6 - SAIDI Contributions by Category

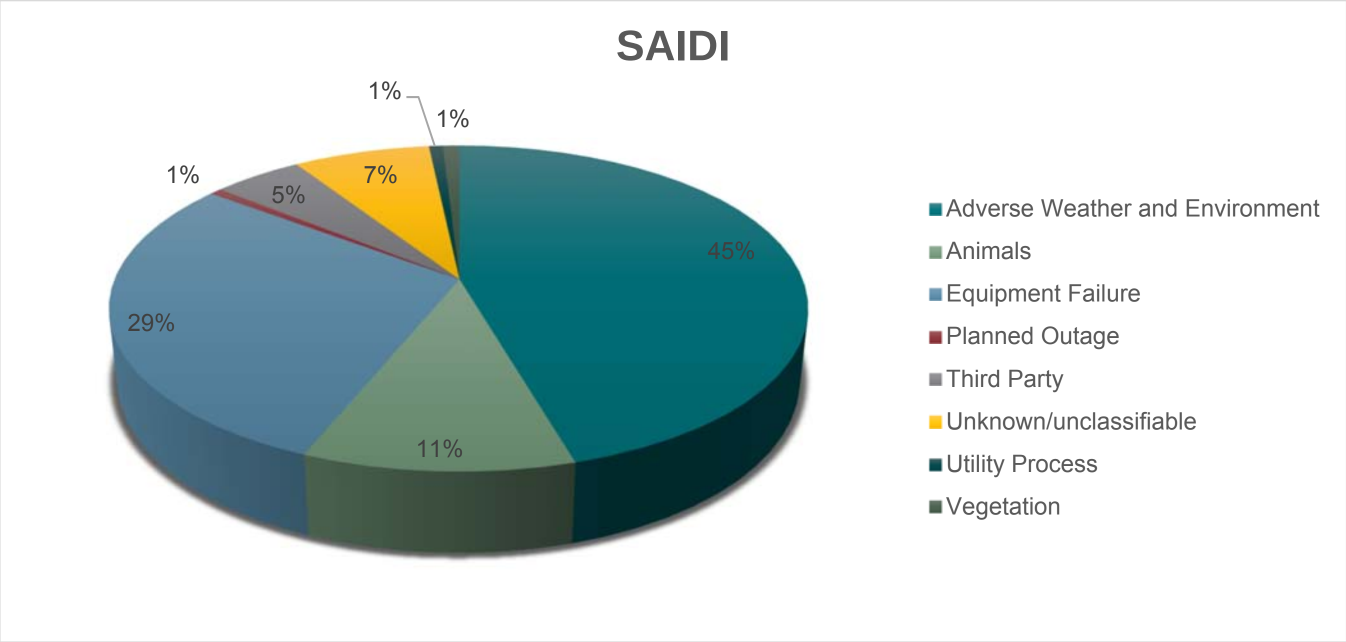
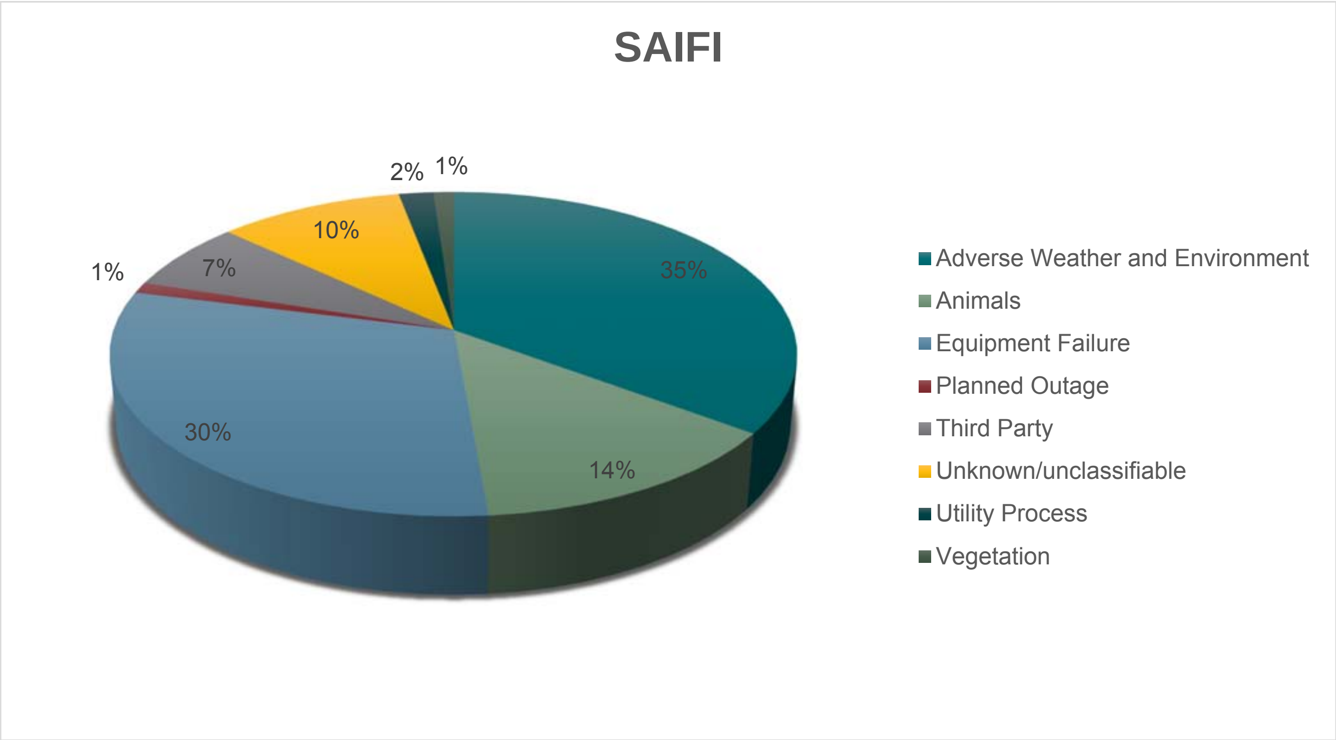


Figure 7 - SAIFI Contributions by Category



The environment category contributed 45% of SAIDI and 35% of SAIFI from June 2011 to June 2016. It was the largest cause of outages and included all weather-related events, such as:

- Debris blown into conductors.
- Storms causing downed trees and branches to contact conductors.
- High winds causing conductor clashes or downed poles.
- Lightning strikes.

- Floods resulting in access problems and the need to de-energise conductors for safety reasons.
- Fires.

This shows that the performance of the network is sensitive to weather conditions. If they deteriorate, we expect network performance to deteriorate too.

Since the environment is beyond our control, we need to mitigate its impacts. This means designing the network (at an appropriate and efficient level of expenditure) to enable load transfers and protect it from environmental factors.

Equipment failure was the second-highest contribution, accounting for 29% of SAIDI and 30% of SAIFI. Equipment failure can be due to condition or overload resulting in a fault. The asset management strategies set out in Essential Energy's Investment Cases have been developed to manage individual asset types. However, sections of the network with poor reliability performance can require targeted programs of work, such as replacing conductor and poletop hardware to meet the standards of the Licence Conditions or Essential Energy's performance thresholds.

Fauna contributes 11% of SAIDI and 14% of SAIFI. It includes animals such as birds, flying foxes and possums causing faults on distribution lines and frogs contributing to faults in zone substations.

Vegetation contributes 1% of SAIDI and 1% of SAIFI. This category excludes vegetation contact with conductors caused by high winds or storms, which are classified under environment. Essential Energy employs cyclic vegetation management programs to control vegetation located within or near network assets.

Third party impacts contribute 5% of SAIDI and 7% of SAIFI. We expect this percentage to remain constant as it is predominantly caused by vehicle impacts. Through appropriate identification and placement of assets, we try to minimise their impact on network performance.

Outage restoration times

Essential Energy recognises that SAIDI can be improved by reducing restoration times (CAIDI)[10].

Several factors affect restoration times, including:

- Extended outage durations due to the inability to transfer load to restore supply.
- Slow restoration of power due to difficulty in locating and isolating the fault.
- Access problems due to ground conditions following rain or flooding.

We use various methods to address these factors, including:

- Installing reclosers with remote communications.
- Using gas switches with remote communications at load transfer points.
- Adding line fault indicators with remote communications.
- Commissioning these devices into the Distribution Management System.
- Using specialist vehicles to access all terrains.

Summary of network average reliability performance

Owing to ongoing customer engagement, Essential Energy has not targeted improvements to network average reliability since 2009/10, as previous network reliability improvements have ensured our continued compliance with Schedule 2 of the Licence Conditions.

Our customer research indicates that the current network average reliability performance is acceptable, provided there is good information about supply interruptions[11].

[10] Refer to Appendix B Definitions

[11] Community Deliberative Forum Reports – Woolcott Research & Engagement.

We are focused on maintaining network-wide average reliability performance in the most cost-effective manner, with a focus on operational business process improvements to deliver enhanced outcomes.

6.2 Individual Feeder Performance

Essential Energy has 1,449 distribution feeders[12]. We monitor their performance and compare it to the standards every quarter.

Table 9 shows the number of non-compliant feeders over a rolling 12-month period, averaged over 18 quarters from December 2009 to December 2015. We selected this period as it best represents the current level of segmentation and condition on the network.

Table 9 Individual Feeder Standards Performance over a Rolling 12-month Period[13]

Feeder type	Standards (Schedule 3)		Average performance of feeders exceeding Schedule 3 (Dec 2015)		Average number of feeders exceeding Schedule 3
	SAIDI	SAIFI	SAIDI	SAIFI	
Urban	400	6	884	5.8	12
Short Rural	1000	8	1333	5.74	79
Long Rural	1400	10	1997	8.61	33
				TOTAL	**124**

Performance trend analysis

As outlined in section 4.1, Essential Energy uses the correlation between historic levels of poor-performing feeders and historic overall network performance. As the number of feeders exceeding Schedule 3 Licence Conditions is related to overall network performance (specifically outage duration) — and therefore for a given network performance target — we can forecast the expected number of feeders exceeding the Schedule 3 Licence Condition.

In 2007, the historical average number of feeders exceeding the Individual Feeder Standards was approximately 180 a year, this fell sharply with the introduction of a targeted remediation program. To develop an accurate correlation between average network performance and feeders exceeding performance targets we examined trends in the number of feeders exceeding standards since the introduction of dedicated reliability remediation program. This post-2008 data provided a dataset that was not significantly impacted by the initial demand of rectifying the long-term backlog of feeders with poor performance issues. We then used this dataset to model the expected number of poor-performing feeders for a given network SAIDI performance.

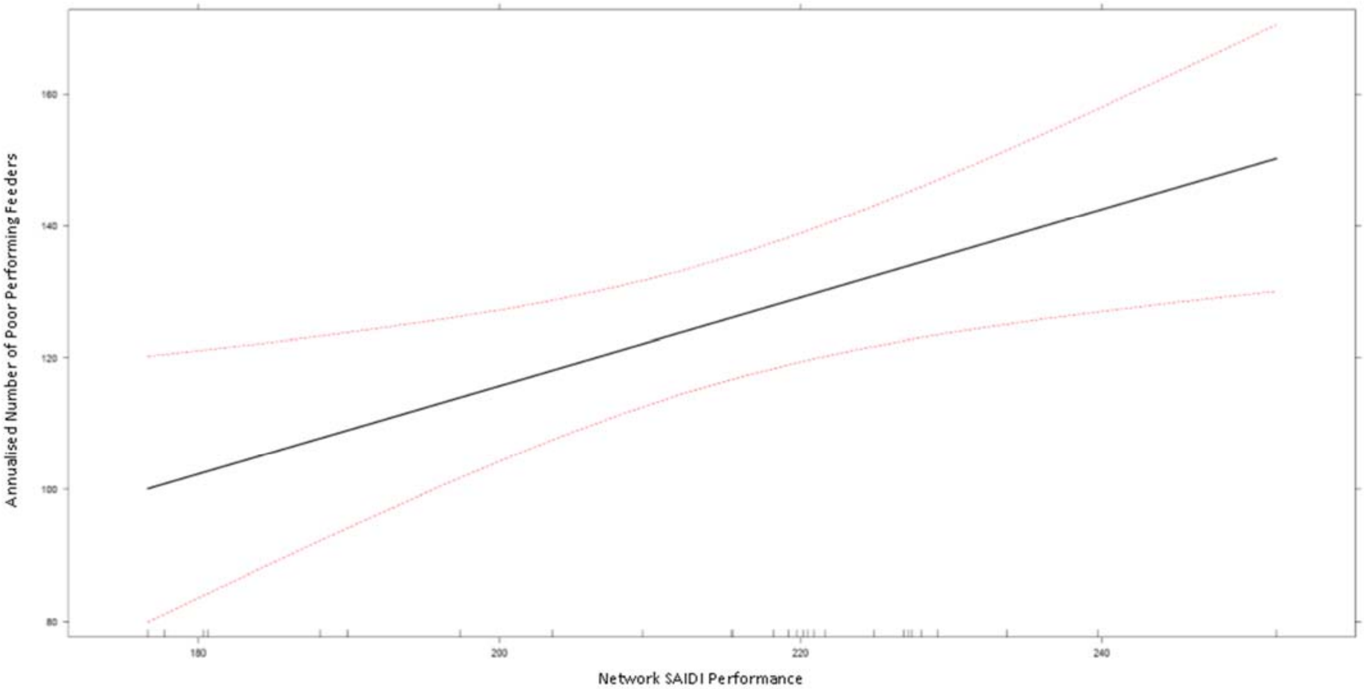
Figure 8 illustrates the modelling we undertook in 2016. This provides the correlation between historic network performance and the historic annualised number of poor-performing feeders.

Using this model against our current network SAIDI performance target provided a forecast of 124 feeders exceeding the Schedule 3 Licence Condition, with a confidence range of 112 to 132. This forecast depends on meeting our target of maintaining overall network reliability by achieving the set targets.

[12] At 1 March 2016

[13] Whereas the quarterly assessment counts all feeders which are non-compliant at the time of assessment, the rolling 12-month count aggregates the mutually exclusive sum of non-compliant feeders over 4 quarters, some of which may have been non-compliant for more than one quarter.

Figure 8 - Correlation between Rolling 12-month Non-compliant Individual Feeders and Network SAIDI Performance



On average, 18 new feeders are assessed as non-compliant each quarter — 72 a year.

Of the 72 feeders, we found that:

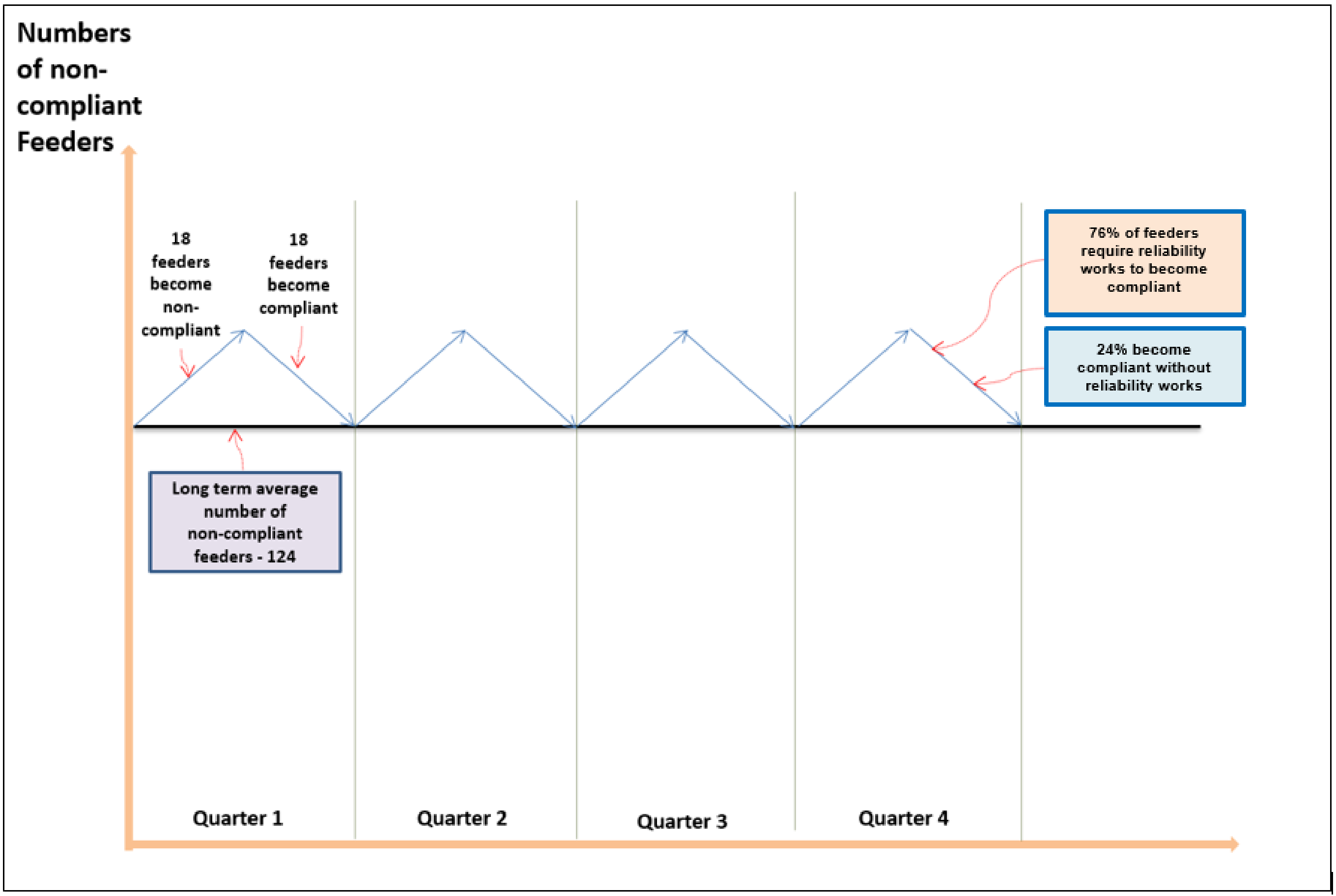
- Approximately 76% (54-56 feeders) had an underlying reliability performance issue and required remediation works before returning to acceptable performance.
- The remaining 24% (16-18 feeders) were due to external (non-recurrent) events, such as the environment. The measured performance either returned to an acceptable standard without remediation or the causes were such that performance returned to an acceptable standard with other asset management practices, such defect rectification, vegetation management or refurbishment.

For these reasons, an average of 18 feeders becomes compliant again each quarter.

Provided our remediation program is maintained at current levels, we expect the long-term average number of non-compliant feeders to stabilise at around 124 for a targeted overall network performance of 212 minutes.

Figure 9 illustrates the concept of non-conforming feeders for Schedule 3.

Figure 9 - Concept for Non-conforming Feeder Numbers



Using further analysis, we have identified that feeder performance is driven by one or two poor-performing feeder segments[14],[15].

We can comply with the standards through remediation works at feeder segment level.

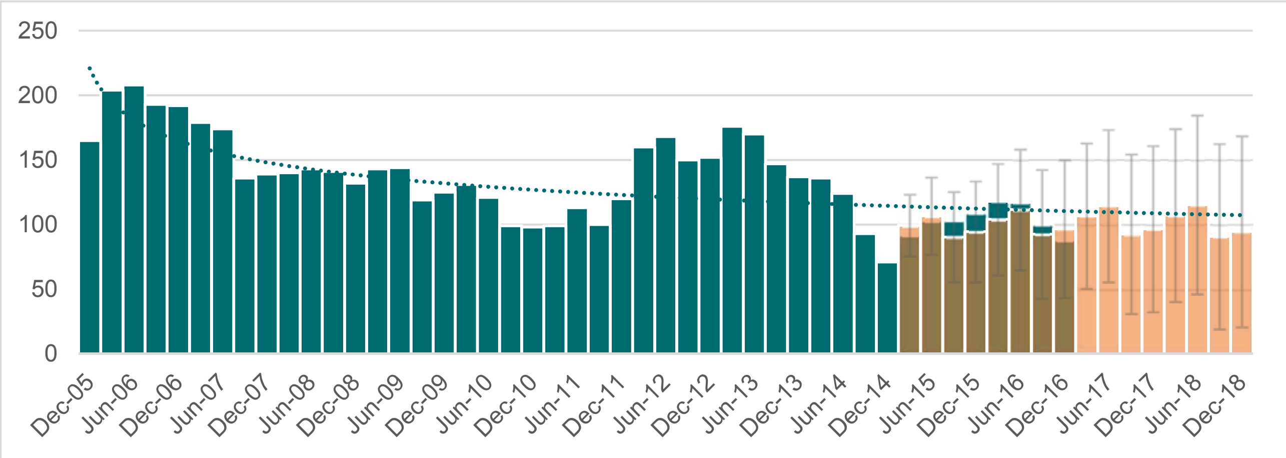
Essential Energy has developed a strategy (see section 7.2) to address individual feeders that do not comply with Schedule 3 of the Licence Conditions. The strategy focuses on the responsible poor-performing feeder segments.

The causal analysis (see section 6.1 Network Average Reliability Performance) that applied at a network-wide level also applies at an individual feeder level, so we have not repeated the detailed analysis in this section.

[14] A feeder segment is a discrete part of a distribution feeder between a circuit breaker and a recloser or between reclosers.

[15] Our 1,458 distribution feeders are made up of 5,868 distribution feeder segments (1 April 2016).

Figure 10 - Historic Individual Feeder Performance Trend



The trend in 8 summarises the historic variability in the number of feeders exceeding individual feeder performance conditions. Most of this variation is due to weather events and we have reflected this uncertainty in the forecasts.

6.3 Customer Service Performance

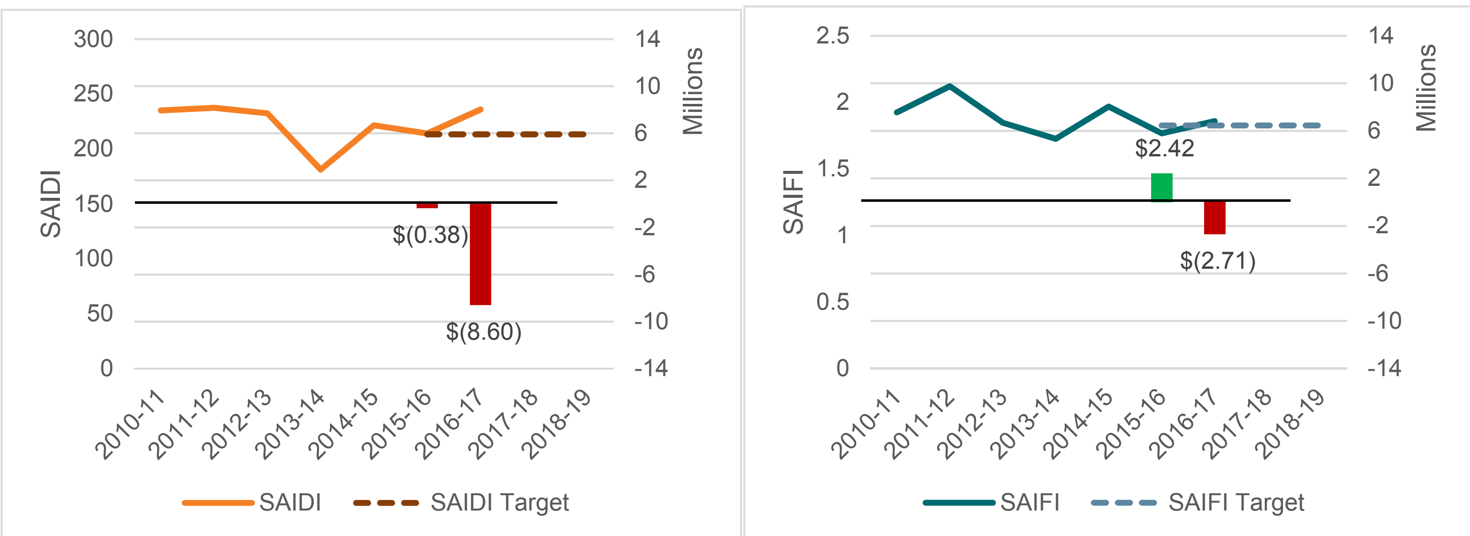
During 2013/14 to 2015/16, a limited number of customer claims were made under the Customer Service Standards so our reliability programs of work do not target performance under this Licence Condition.

6.4 STPIS Performance

The AER's STPIS scheme has applied to Essential Energy since 1 July 2015. The targets set during the 2014-2019 AER determination were based on our actual historic performance over the 2009/10 to 2013/14, adjusted to carry the performance trend from this period forward. These targets were applied with a revenue at-risk component of 2.5% to minimise the risk for both DNSPs and customers.

The charts in Figure 11 show how Essential Energy has performed relative to our reliability targets for the 2014-2019 regulatory period, excluding the customer service component. We have rolled up the data from individual feeder category targets to provide a network level view. This shows our performance was $2M positive in FY16 then $11M negative in FY17.

Figure 11 - Essential Energy's STPIS Performance Trend



The negative result for FY17 was marked by a significant number of widespread weather events, which are typically resource-intensive to recover from — one of the challenges of operating a geographically sparse network with fewer regional staff.

In terms of interaction between the programs in this Strategy and the STPIS scheme, the nature of the programs of work means their interaction is limited. The two main factors are that the programs are only designed to bring performance within jurisdictional licence standards, not to network average performance, and that the customer density of the targeted locations is typically below what is required to fund improvements outside controlled revenue. As a result, the assessment, operation and delivery of these programs centres on maintaining historic overall network performance, which aligns with Essential Energy's current STPIS scheme targets.

Outside these small specific programs of work, we assess reliability improvement projects based on their ability to provide a commercial return. This includes considering the risk of the investment not delivering the forecast improvements. This approach results in the planning group assessing reliability improvement projects, against the likely return that is forecast from reliability improvements delivered under the STPIS scheme; where the scheme is defined by the AER's May 2009 document published under clause 6.6.2 of the NER.

For further details about Essential Energy's historic performance under STPIS and our intended approach for the 2019-2024 regulatory period, see *Application of STPIS to Essential Energy 2019-2024.*

6.5 Worst-performing Feeder Segments

Historically, Essential Energy has used fixed SAIFI thresholds for each feeder class type to determine whether a feeder segment is within the worst-performing parameters. We modified this approach during the last control period because of significant 'churn' in the segments we identified, which made tracking and developing specific solutions difficult.

Before changing our approach, we reviewed how other jurisdictions dealt with the issue to understand what works and what does not. We identified that the approach needed to be relatively simple and to allow performance back-casting. The method also needed to include some mechanism that considered performance over time and worked with Essential Energy's current systems.

The approach we now use to identify and track the worst-performing feeder segments was developed by the Energy Networks Association (ENA) following the AEMC's 2014 *Review of Distribution Reliability Measures*. It is a slight adjustment to the approach taken to Individual Feeder Standard reporting obligations for the Queensland Department of Energy and Water Supply[16]. It works as follows:

A feeder segment is identified as being worst-served if the annual unplanned SAIDI or SAIFI is greater than 1.5 times the unplanned network average SAIDI or SAIFI for the current feeder category in each respective year in three consecutive years.

This identifies feeder segments that have experienced significant, long-term poor performance. Rather than becoming worst-served segments due to a temporary weather event or a migratory fauna problem, these feeder segments have significant challenges that require addressing to restore a level of performance within 1.5 times the average of the feeder category.

Essential Energy has 5,893[17] distribution feeder segments. We monitor the performance of all of them and compare the results to the Essential Energy threshold every quarter.

Table 8 shows the annual number of feeder segments that exceeded the Essential Energy threshold for the three years to October 2016.

Table 8: Number of Feeder Segments Exceeding the Essential Energy Threshold

Current Criteria	3-Year Avg SAIDI	3-Year Avg SAIFI	Number of Segments Exceeding Either Threshold for 3 Years Prior

[16] https://www.dews.qld.gov.au/__data/assets/pdf_file/0004/219487/distribution-authority-d0199-ergon.pdf

[17] December 2016

Urban	179.4	1.45	2
Short Rural	719.2	4.04	79
Long Rural	1266.7	6.33	10

Figure 12 - Worst-served Segments for Three Consecutive Quarters

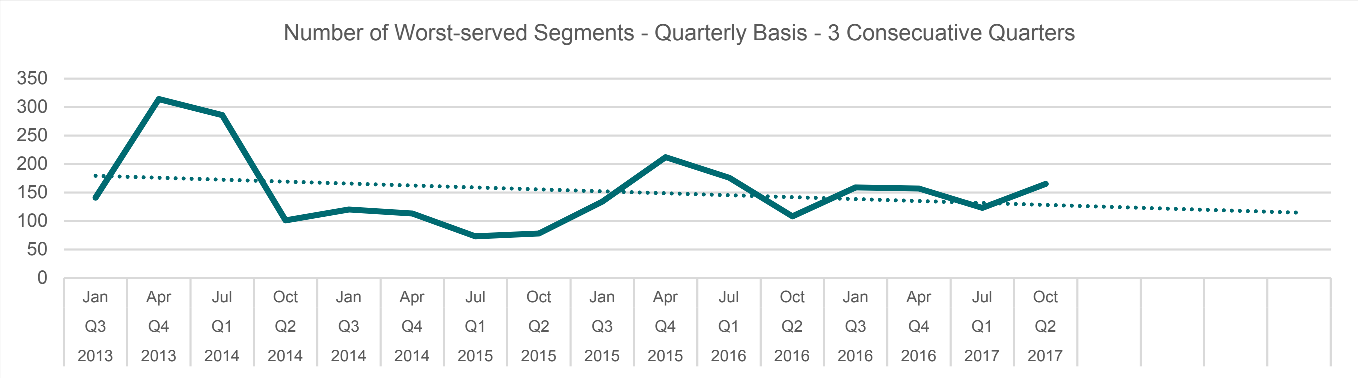


Figure 12 does not directly correlate with the current number of segments that have exceeded the threshold for three years (Table 8), as it is calculated on a quarterly basis. However, it does provide a greater number of data points, allowing performance trend analysis for worst-served feeder segments over the last four years.

Performance trend analysis

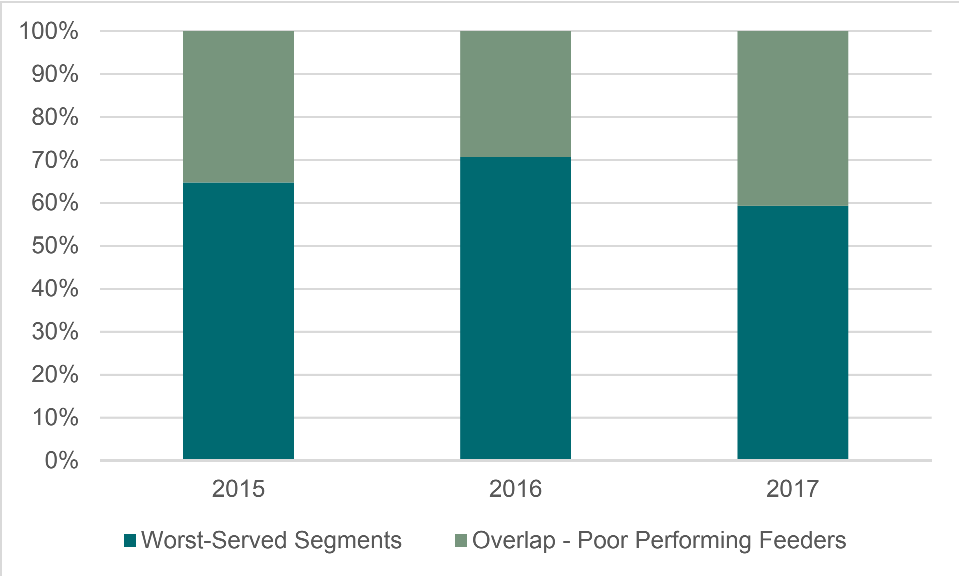
We applied a trend-line to historical data to forecast the number of feeder segments we expected to exceed the Essential Energy threshold. By applying the quarterly trend identified in 10 to the number of segments exceeding the three-year threshold in Table 8, we forecast that worst-served feeder segments would average 75 over the regulatory period 2020-2024, with the continued targeted remediation program delivering a 30 per cent reduction in the number of worst-served segments over the period (in line with the identified trend).

On a quarterly basis, there is a correlation between the parent feeders of the worst-served segments and the feeders exceeding Schedule 3 of the Licence Conditions.

We excluded segments being addressed as part of remediation work for Schedule 3 of the Licence Conditions.

Figure 13 illustrates analysis we did in 2016/2017 that displays the correlation between the poor-performing feeder and worst-served remediation programs. Separate analysis of the trend using historical data shows an average of 91 feeder segments exceeding the Essential Energy threshold each year.

Figure 13 - Percentage Overlap of Non-Compliant Feeder Segments with IPART Individual Feeder Performance Standards



Our analysis indicates that, of the 91 feeder segments currently identified as worst-served feeder segments, 65 per cent (approximately 59) are considered for remediation annually, with the other 35 per cent expected to overlap and be addressed under the Individual Feeder Poor Performance Program.

Using our analysis of the Individual Feeder Standards, we expect that 80 per cent (47-48) will have an underlying performance issue and require remediation. Essential Energy proposes to address half (23) of these feeder segments, prioritising the worst feeder segments every year. We have developed a strategy to address the worst-performing feeder segments: see Section 6.3.

6.6 Summary of Performance

The following table provides a summary of the actual network performance against the requirements of the Licence Conditions and Essential Energy thresholds.

Table 9: Summary of Performance Requirements

Performance type	Feeder type	Standards (Schedule 2)	Actual performance	Gaps
Network average SAIDI	Urban	125	66	0
	Short Rural	300	204	0
	Long Rural	700	248	0
Network average SAIFI	Urban	1.8	0.75	0
	Short Rural	3.0	1.83	0
	Long Rural	4.5	2.91	0
Performance type	**Feeder type**	**Standards (Schedule 3)**	**Number of non-compliant feeders (rolling 12-month period)**	**Feeders remediated per annum**
Individual Feeder SAIDI	Urban	400	12	54-57
Individual Feeder SAIFI	Urban	6		
Individual Feeder SAIDI	Short Rural	1000	79	

Individual Feeder SAIFI	Short Rural	8		
Individual Feeder SAIDI	Long Rural	1400	33	
Individual Feeder SAIFI	Long Rural	10		

Performance type	Feeder type	Essential Energy thresholds		Number of non-compliant feeder segments per annum	Forecast number of feeder segments remediated per annum
		SAIDI	SAIFI		
Individual Feeder Segment SAIDI & SAIFI	Urban	179.4	1.45	91	47-48
	Short Rural	719.2	4.04		
	Long Rural	1266.7	6.33		

7. Reliability Strategy

This section sets out Essential Energy's strategies for managing the reliability performance of the network over the 2019 to 2024 period. We have developed these strategies to achieve the required reliability service levels set out in Section 5 by targeting the performance gaps identified in Section 6.

We have established the following strategic approaches to manage network reliability performance:

- Reliability management framework.
- Individual feeder standards management.
- Worst-served feeder segment management.

In developing these approaches, we considered the emerging issues discussed in Section 4 and alignment with the business's broader asset management strategies, which are discussed in Section 6.4.

7.1 Reliability Management Framework

Essential Energy's reliability management framework supports and enables the overall management of network reliability across the network to achieve and maintain the required service levels set out in Section 5. To achieve this, we employ the following strategic elements:

- Strategy development and review (including customer engagement[18]).
- Modelling and analysis.
- Reliability performance monitoring and response.
- Works program integration.

Strategy development and review

When developing this Reliability Strategy, we took into account: regulations and standards with which we must comply; customer engagement information; and the broader asset strategies of the business. The latter maintain current network reliability performance, while targeted reliability programs improve network reliability performance.

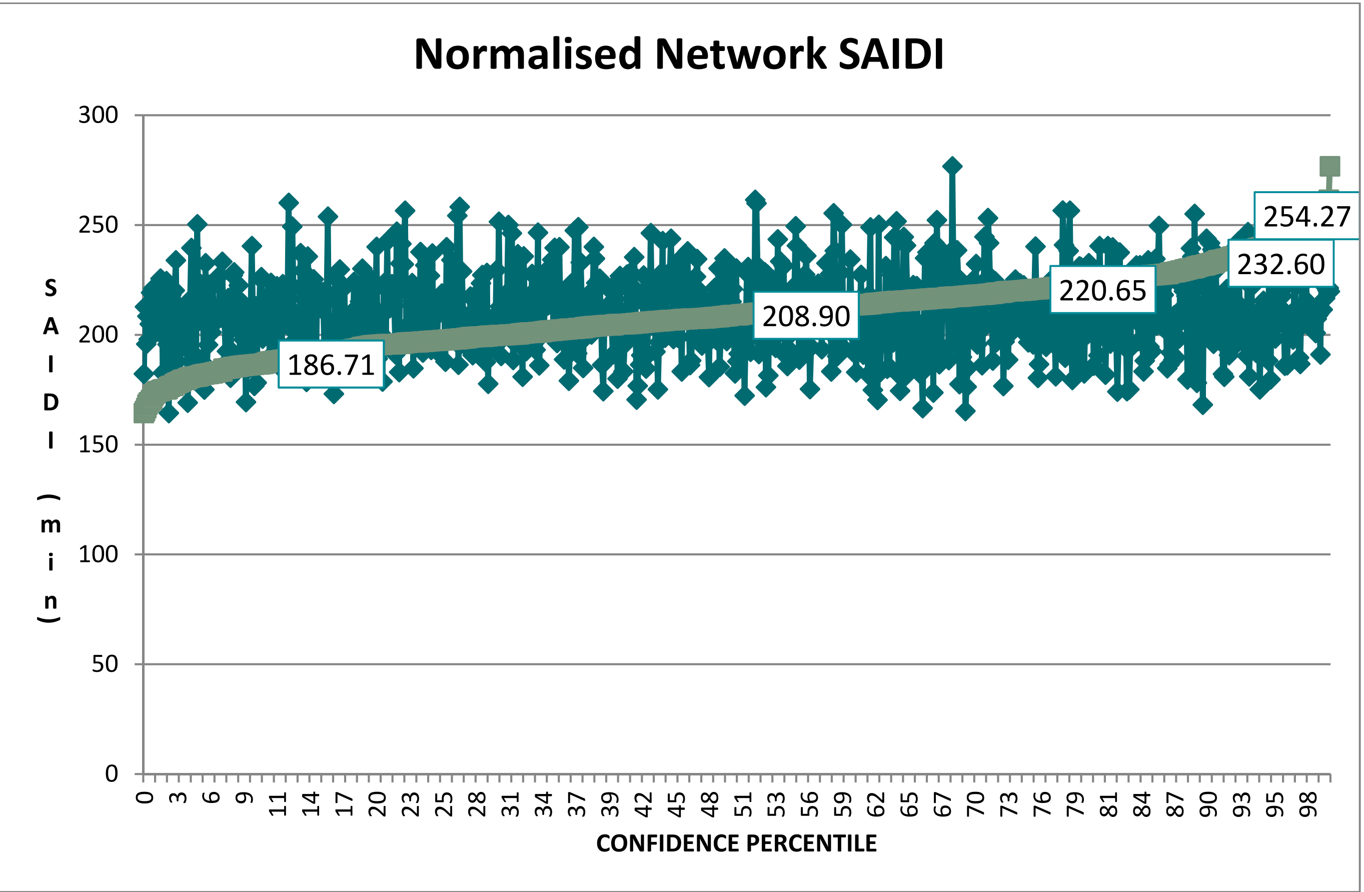
The reliability management framework is structured to meet regulations and standards but not surpass them. Once Essential Energy complies with the Reliability Standards (Schedule 2), the strategies aim to maintain network reliability performance. For the Individual Feeder Standards (Schedule 3) and the worst-performing feeder segments, the programs of works are ongoing.

The Reliability Strategy is under continual review and takes account of the internal and external environmental factors that affect network performance.

Modelling and analysis

[18]Community Deliberative Forum Reports - Woolcott Research & Engagement

Figure 14 - Results of bootstrap analysis of historic reliability data, providing confidence interval for future network SAIDI



As discussed in Section 4, Essential Energy uses a probabilistic model based on Monte Carlo techniques to model network average performance (Schedule 2). This modelling approach has been developed to support strategy development, review network performance, and assess the outcomes achieved by the reliability strategies.

Our analysis of past performance has revealed variations that relate to the influence of the Southern Oscillation Index, which is largely beyond the control of Essential Energy. The network average reliability modelling takes this into account and facilitates an informed and controlled response to emerging reliability issues.

The above chart, Figure 14, details the output of modelling undertaken on network average SAIDI performance, showing the confidence percentile of our network performance for a given year. Based on this we are confident that no further investment in average network performance is required, however we note that there is significant variability in a given years performance, driven predominantly by the variability weather and a large line length exposure.

We note this does still present a significant risk that our network in a specific year may depart from the performance experienced over the last 5 years. We are comfortable operating with this modelled level of downside risk, based on the feedback received from customers during engagement on network reliability, with customers indicating they are either happy with current reliability or may tolerate a slight decrease to their reliability level if a corresponding reduction in bills could be achieved[19].

Reliability performance monitoring and response

We regularly assess network performance to compare it with the Reliability Standards (Schedule 2) and the Individual Feeder Standards (Schedule 3). We have prepared a strategic response, in the event that network average performance deteriorates and is likely to exceed the Reliability Standards.

[19] Community Deliberative Forum Report – Phase 1 & 2- Woolcott Research & Engagement

When assessed quarterly against the Individual Feeder Standards, feeders that exceed the standards undergo a systematic review to determine the causes and we develop remedial actions as appropriate.

Similarly, during our quarterly review of the worst-performing feeder segments, those segments that exceed the Essential Energy threshold undergo a systematic review to determine the causes and we develop remedial actions as appropriate.

Works program integration

Our regionally-based network planning employees are notified every quarter of feeders that exceed the Individual Feeder Standards and Essential Energy thresholds.

Network Planning staff investigate the causes of non-compliant feeders and consider remedial actions. They also develop projects to meet other asset management practices. As well as being regionally-based, they are best-placed to monitor specific local customer concerns. This approach means that Essential Energy's reliability improvement projects consider growth and refurbishment needs and, wherever appropriate, work is bundled for a coordinated result.

In this way, our reliability improvement projects are integrated with the business's broader asset management plans.

7.2 Individual Feeder Standards Management

Where appropriate and prudent, Essential Energy targets reliability improvement of individual distribution feeders to meet the Individual Feeder Standards (Schedule 3), as set out in section 5.

Our management approach considers the following key factors:

> Feeder performance is normally driven by the performance of one or two feeder segments rather than the whole feeder.
> Remediation works are based on a program to improve feeder segment performance.
> These remediation works are designed to improve feeder performance to meet, not exceed, the standard; for example, remediation works for a long rural feeder with a SAIDI of 2000 are designed to improve the SAIDI to below 1400 but not to zero.

As detailed in section 5.2, an ongoing program of work is required to ensure the number of feeders exceeding the standards is maintained at the current level.

Other asset management practices, such as refurbishment, maintain the inherent reliability performance of feeders. Targeted reliability programs of work are required to improve feeder performance.

To comply with clause 16 of the Licence Conditions, Essential Energy's process is as follows:

> Produce quarterly feeder performance reports and identify causes and the equipment and parts of the networks affected.
> Use causal analysis to differentiate between feeders with an underlying issue and those with poor performance caused by non-recurrent events such as the environment and/or those that only require operational actions to restore performance.
> Rectify the underlying cause of poor performance using the most appropriate and cost-effective option from those available.

Based on the historic mix of remediation works and their costs, Essential Energy estimates an average cost of $205,000 per segment ($, direct 2016) for rectification works. We forecast that a total of 38-40 feeders per year will need to be rectified.

Programs of work — remediation options

To remediate feeders that exceed the Individual Feeder Reliability Standards, Essential Energy uses various programs of work based on a technical and economic assessment of each individual feeder's requirements.

The main programs are:

- Replacing overhead conductor and poletop hardware.
- New reclosers and sectionalisers.
- Interconnection to other feeders.

Replacing overhead conductor and poletop hardware

The causal analysis in Section 6.1 Network Average Reliability Performance indicates that, on average, 30 per cent of reliability performance is attributable to equipment failure such as poletop components and line conductors.

Due to legacy issues, a wide variety of bare line conductor types have been used in rural areas. Such materials as older light hard drawn copper (HDC) and steel conductor and poletop hardware fail due to weathering and environmental factors.

Where causal analysis of the feeder supports the case, our program involves targeted replacement of conductors and the associated hardware to improve reliability performance.

For each feeder, we consider opportunities to reduce restoration times by installing line fault indicators with communications. Depending on the nature of the existing design and environment, we also consider opportunities to reduce the possibility of fauna intervention.

Based on historical information — as shown in Table 12 — we estimate that 80-120 kilometres of conductor and associated poletop hardware will be replaced for reliability reasons each year.

Table 12 History of Conductor Replacement from 2009 to 2016

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Conductor replacement (kilometres)	151	134	225	75	64	146	95

New reclosers and sectionalisers

Transient faults on the network account for 75 per cent[20] of all faults. These faults are self-clearing, provided they occur downstream from a reclosing device. In many cases, a recloser will automatically restore supply without the need for attendance by field staff.

Reclosers are installed on urban fringes, rural backbone lines and major spurs to limit the impact of network faults on customers. The installation of a recloser on an overhead feeder increases the number of feeder segments, reducing the number of customers affected by a fault.

We install sectionalisers with an upstream recloser to disconnect faulty sections of line. They are an economical way to improve reliability and often provide advantages in protection coordination.

All new and replacement reclosers are normally communications-enabled and integrated into our Distribution Management System. This allows remote interrogation and expedites restoration of supply.

Based on the installations over recent years — as shown in Table 13 — we estimate that 55 reclosers and 15 sectionalisers will be installed or replaced across the network for reliability reasons each year.

Table 13 History of Recloser and Sectionaliser Installations from 2009 to 2016

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Recloser/Sectionaliser Installations	81	139	76	89	66	48	25

[20] Essential Energy Report - Recloser Effectiveness and TOBAN Analysis

Interconnection to other feeders

Interconnections with adjacent rural feeders can make it possible to bypass a faulted section of a feeder and restore supply to downstream customers before a fault has been repaired, reducing restoration times for affected customers.

The degree to which this is possible depends on the technical and economic feasibility of providing interconnection capacity. Interconnection may be achieved by:

- Ensuring adequate capacity and appropriate switching facilities are available to support load transfers.
- Constructing a new tie line.

To improve outage restoration times, we consider including communications to gas switches installed on interconnection points to facilitate remote switching.

Based on historical information — as shown in Table 14 — we estimate that seven kilometres of augmented and new interconnections will be required for reliability reasons each year.

Table 14 History of Interconnections from 2009 to 2016

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Interconnections (kilometres)	6.4	9.2	14.5	N/A	4.5	11.1	1

Application of Microgrids

To date, Essential Energy has not applied microgrids as a remediation option for a feeder failing to achieve Schedule 3 compliance. However, emerging changes mean that microgrids may, in some applications, become the lowest-cost solution to addressing Individual Feeder Standard compliance.

These emerging changes are:

> The rapid cost path decrease in energy storage and embedded generation.
> The rapid industry development of sophisticated integration solutions to allow for islanded operation of high-penetration renewable networks.
> The likely change in definition of a sustained outage to three minutes from the current one minute.

Essential Energy has developed a business case detailing an approach that balances the cost, performance, and risk of using microgrids as a least-cost solution for the management of Schedule 3 Individual Feeder Standard compliance. The approach details the rollout of a single microgrid site that we can use to work through the technical, legal and customer engagement components of microgrid application. This project will act as a pilot, de-risking the use of microgrids as a solution for Individual Feeder Standard compliance.

This means that (pending the actual cost curve that the technology follows) a microgrid solution could offset several Individual Feeder Standard constraints from 2021 onwards and we could deliver it as part of our Individual Feeder Standards Management program of works.

7.3 Worst-Served Feeder Segment Management

We target reliability improvement of worst-performing feeder segments to meet the Essential Energy threshold — as set out in section 5 — wherever it is justified.

Our management approach considers the following key factors:

- Remediation works are designed to improve feeder segment performance to meet, not exceed, the Essential Energy threshold; for example, for a long rural feeder segment with a SAIFI of 30, remediation works are designed to improve the SAIFI to below 20 but not to zero.
- Some feeder segments that exceed the Essential Energy threshold may be addressed under Individual Feeder Standards management so we have excluded them from consideration under the worst-served feeder segment management.

- Other asset management practices such as refurbishment maintain the inherent reliability performance of feeder segments, whereas targeted reliability programs of work are required to improve segment performance.

The proposed management process is as follows:

- Produce quarterly feeder segment performance reports and identify causes and affected equipment and the parts of the networks.
- Use causal analysis to differentiate between feeder segments with an underlying issue and those with poor performance caused by non-recurrent events such as the environment and/or those that only require operational actions to restore performance.
- Identify feeder segments that are being addressed under the Individual Feeder Standards Management and exclude them from consideration.
- Identify options to rectify the underlying causes of poor segment performance based on the remediation options and assess them to identify the most appropriate option.

We have assessed several projects that addressed worst-served performance during the last regulatory period. This analysis revealed that the average project expenditure was $77,500 ($, direct 2016). We expect that approximately 23 feeder segments will require remediation each year.

Programs of work — remediation options

To remediate feeder segments that exceed the Essential Energy threshold, we use various programs of work based on a technical and economic assessment of each individual feeder segment's requirements.

The main programs are:

> Replacing overhead conductor and poletop hardware.

> New reclosers, sectionalisers, fuses, line fault indicators and Fusesavers.

Replacing overhead conductor and poletop hardware

Where causal analysis of feeder supports the case, this program involves targeted replacement of conductors and associated hardware to improve reliability performance.

Reclosers, sectionalisers, fuses and Fusesavers

Reclosers and sectionalisers are an economical way to improve reliability and often provide protection coordination advantages, particularly on spurs at the extremities of the feeder.

We use fuses on minor spurs in some areas to contain the fault to the local spur.

A Fusesaver is a fault-interrupting device that is installed with a fuse to protect it from transient faults. As these represent 75 per cent[21] of all faults, a Fusesaver can improve the reliability performance of small pockets of the network.

Emerging options and options under development

The current cost of installing and maintaining a stand-alone power system or microgrid that replicates the capacity of a typical rural grid connection is not yet a cost-effective replacement for an existing grid connection. However, it is often comparable in cost for new customers. This, along with the forecast rate of likely cost decreases in the sector, makes it likely that within the next regulatory control period, these systems will represent the least-cost approach for addressing some network reliability constraints.

To allow these innovative solutions to be unlocked as soon as the decreasing cost curve makes them viable, Essential Energy has put together the approach outlined in the Reliability Microgrid business case. This approach will ensure that we have the necessary capability, policies, processes and procedures to open up the application of microgrids and stand-alone power systems to meet reliability constraints as they emerge.

[21] Essential Energy Report - Recloser Effectiveness and TOBAN Analysis

7.4 Assessment of proposed strategy against corporate objectives

Corporate Objectives	Alignment
Best Practice Systems, Technology & Processes • Productivity gains and costs kept under control • A smarter business that knows its customers and engages with them • Updated technology and more accurate data, leading to improved decision making • Technology that meets customer and stakeholder needs	The approach is used in tracking, identifying and developing solutions to the management of individual feeder standards outlined, uses an array of automated reporting and analytic functions, this supports optimate decision making.
Develop Commercial Services • Tap into emerging market opportunities • Support and promote renewable energy solutions, generating income for the business	Through the microgrid trial detailed as part of this strategy and outlined in the attached business case, Essential Energy will act to support emerging market segments such as grid support services. The emergence of these services will assist new approaches to be taken to address identified constraints, at lowest cost.
Customer Connected • Gain a sharp insight into how customer needs are changing in an evolving energy ecosystem • Recognition as an energy solutions provider of choice, able to take advantage of new opportunities • Be a key player in the regulatory and policy environment, optimising stakeholder relationships • Leverage customer data to enhance services and commercial opportunities	The approaches taken as part of this reliability strategy are the product of Essential Energy's most widespread and detailed customer engagement program to date. With regional and remote customers expressing their views on how they perceive their reliability as well as what programs Essential Energy should continue or develop to manage network performance.
Commercially Capable People • Employee capability, confidence and engagement • A commercial and customer focused culture – safe, effective and efficient • The right people in the right place making the right decisions	This strategy does not seek to add to the development of employee capability, however it directly benefits from work being delivered by people that have the right capability to make efficient commercial decisions with customers interests at heart.

7.5 Assessment of proposed programs under the rules

National Electricity Rules Expenditure Objectives	Alignment

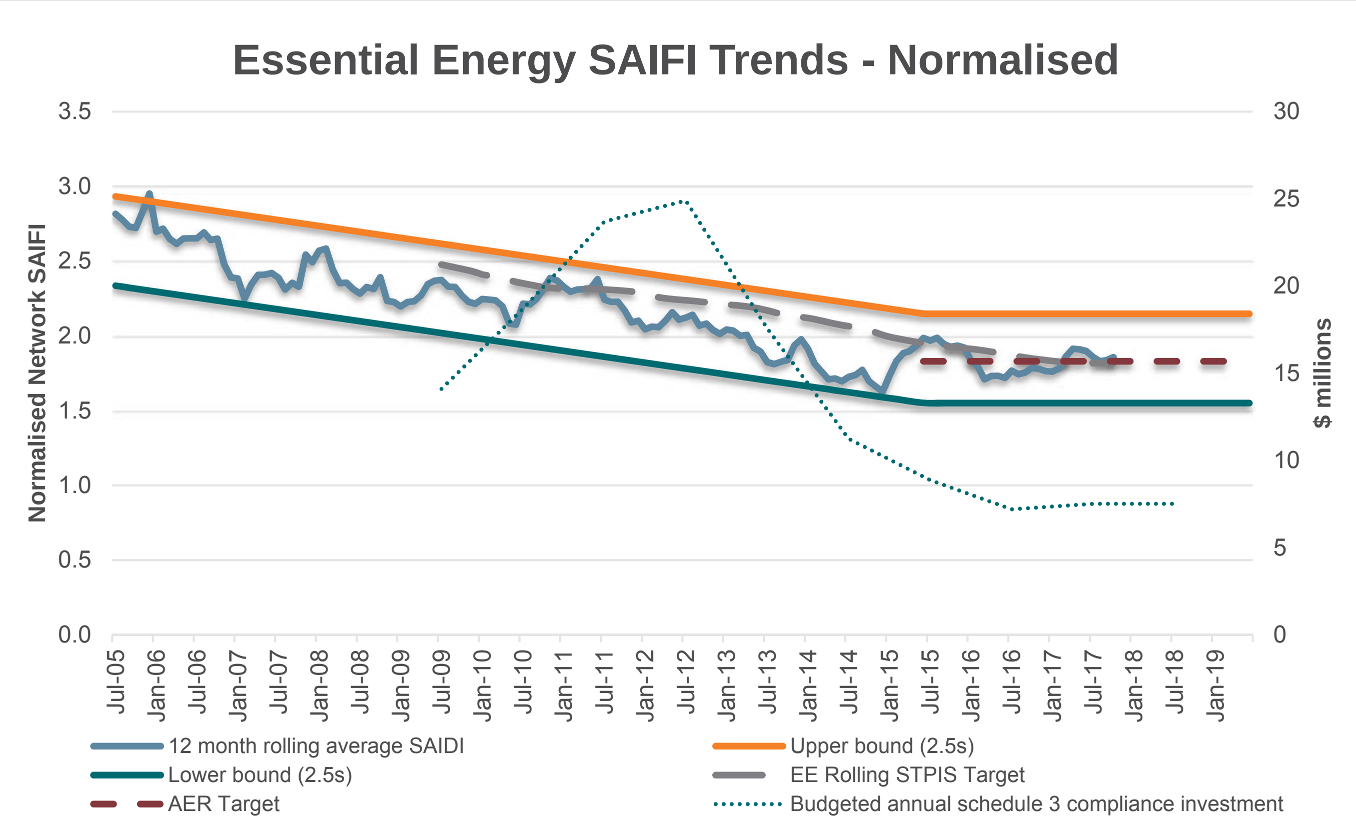
Meet or manage the expected demand for standard control services over that period;	Not Applicable
Comply with all applicable regulatory obligations or requirements associated with the provision of standard control services;	This strategy and the programs detailed within are the primary approach by for maintaining compliance with Essential Energy's network reliability obligations. - NSW Reliability and Performance Licence Conditions, details Individual feeder standards that are required to be met, *"The purposes of the individual feeder standards are to:* o *specify minimum standards of reliability performance for individual feeders;* o *require a distributor to focus continually on improving the reliability of its feeders where economically justifiable; and"* the strategy puts in place the program that is required to meet our obligations for the management individual feeders, while considering customer feedback to appropriately size and target significant areas of poor performance. As providing a geographically equitable outcome that was strongly supported by customers. - 6.5.7(e)(5A) – *"AER must have regard to the following; the extent to which the capital expenditure forecast includes expenditure to address the* ***concerns of electricity consumers*** *as identified by the Distribution Network Service Provider in the course of its engagement with electricity consumers"* through the course of engagement with customers, it was clear that investment in improving the performance of our worst served customers was well supported with 87% in agreement with a price increase to fund reliability investment for worst served customers.
To the extent that there is no applicable regulatory obligation or requirement in relation to: (i) the quality, reliability or security of supply of standard control services; or (ii) the reliability or security of the distribution system through the supply of standard control services, to the relevant extent: (iii) maintain the quality, reliability and security of supply of standard control services; and	As the area of reliability is subject to significant regulation, this requirement in not the primary driver on management and investment of overall network performance. However, beyond the management of individual feeder performance this strategy is focused on maintaining the overall reliability of supply for standard control services. This is achieved through a proactive monitoring approach coupled with an ongoing probabilistic network average reliability modelling process.

(iv) maintain the reliability and security of the distribution system through the supply of standard control services;	
Maintain the safety of the distribution system through the supply of standard control services	Not directly applicable to this trial.

7.6 Interaction with STPIS

As outlined in section 6.4, there is limited interaction between the programs detailed in this Strategy and the STPIS scheme. We have based this on observed performance[22] and the degree of individual feeder improvement that we are targeting relative to the network average.

Figure 15 - Trend analysis of network SAIFI, against schedule 3 compliance expenditure



Our feeder intervention programs are only designed to bring performance within Licence standards, not to the network average performance levels. As a result, our assessment, operation and delivery of the Schedule 3 compliance program centres on maintaining historic overall network performance, which aligns with Essential Energy current STPIS scheme targets.

This interrelationship is to be expected, as the IPART Schedule 3 Licence Conditions are designed to protect the most vulnerable customers from a deterioration in network performance when it is not economic for DNSPs to invest for overall network reliability management. This is different from the approach of the STPIS scheme, where networks are incentivised to target network performance wherever customer density generates a willingness for them to pay for these improvements.

[22] Investments in meeting Schedule 3 compliance have not resulted in measurable improvements in overall network SAIDI

7.6 Strategic Alignment

Essential Energy acknowledges the need to align this Reliability Strategy with other asset management strategies to maximise the efficiency of network management and ensure a fair and unbiased valuation of all network risks and strategies. We have created a value framework to oversee this balance. We consider the methodology for measuring reliability in all relevant Investment Cases and in our investment decision optimisation solution, C55.

We assess reliability by considering the impact of any event or equipment failure that would cause an unforeseen outage. The value framework captures the reliability risks and benefits and shapes questionnaires for C55, which take into account:

- Customers connected downstream of the upstream protection device.
- Value of customer reliability (VCR).
- Number of sensitive load customers.
- Restoration time of fault, based on travel time from depot.
- N-1 or ring feed capability.
- Asset spares and restoration practices.
- Regularity of fault occurrence.
- Annualised likelihood of failure based on degradation curves driven by condition or age.

8. Reliability Investment Plans

8.1 System and Process Efficiencies

For the 2019-24 period, we have identified opportunities to improve value for customers. By 2023-24, we plan to deliver our services even more efficiently through targeted initiatives and investment in enabling technologies to help us achieve best practice systems and processes. In particular, optimising our capital works using a risk based approach and improving present governance practices will have significant impact on the capital portfolio. Our forecast expenditure in this strategy directly reflects the benefits delivered by this investment over the 2019-24 period.

8.2 Individual Feeder Standards Compliance Plan

Table 15 details the historical expenditure and the forecast expenditure to implement the plan for Individual Feeder Standards management, as set out in Section 6.2, to meet the requirements of Schedule 3 of the Licence Conditions.

Table 15 Individual Feeder Standards Compliance Plan Forecast ($M, direct 2019)

$ Million	Historical Budgeted Expenditure (direct 2016)										Forecast Expenditure (direct 2019)				
	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Replacement of overhead conductors and poletop hardware	10.66	13.78	21.43	22.83	15.58	9.96	7.86	6.39	6.67	6.67	6.59	6.49	6.42	6.34	6.34
Reclosers and sectionalisers	3.12	4.95	2.91	3.66	2.23	1.42	1.12	0.92	0.96	0.96	0.94	0.93	0.91	0.91	0.91
Interconnection to other feeders	1.40	1.29	1.18	0.32	1.11	0.71	0.56	0.45	0.47	0.47	0.47	0.46	0.46	0.46	0.45
Total – system capital expenditure	**15.18**	**20.14**	**25.52**	**26.81**	**18.92**	**12.10**	**9.55**	**7.75**	**8.10**	**8.10**	**8.**	**7.88**	**7.79**	**7.7**	**7.7**

8.3 Worst-performing Feeder Segments Plan

Table 16 details the forecast expenditure to implement the plan for the worst-performing feeder segments, as set out in Section 6.3.

Table 16 Worst-performing Feeder Segment Plan Forecast ($M, direct 2019)

$ Million	Historical Budgeted Expenditure					Forecast Expenditure				
	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Replacement of overhead conductors and poletop hardware, reclosers, sectionalisers, fuses and Fusesavers	1.71	1.40	0.89	0.88	0.90	1.81	1.69	1.64	1.61	1.6
Total – system capital expenditure	**1.71**	**1.40**	**0.89**	**0.88**	**0.90**	**1.81**	**1.69**	**1.64**	**1.61**	**1.6**

In part, the downward trend in historical expenditure is due to the application of a fixed SAIFI methodology, which over time resulted in fewer forecast worst-served segments over the regulatory period. However, during our engagement process, we presented customers with the options of either a slight reduction in their quarterly bill or investing in a $2M annual worst-performing feeder segment program. This investment value was developed to allow for the rectification of a reasonable number of segments p.a. in line with community expectation. Overwhelmingly, this investment was supported by the community, even when it was explained that these customers would still not receive average network reliability but rather an improvement from their current performance.

The size of the program balances the forecast number of worst-served feeder segments (identified in the modelling in section 6.5), community expectations and customers' willingness to pay[23].

Transformer Auto-Changeover Schemes

We plan to review our substation operation practices to optimise the use of existing assets that customers are funding. The review will not make a wholesale one-size-fits-all change to how transformers are managed within zone substations, Instead, it will take a risk-based approach to operating each substation by considering: transformer design, tap-changer types, transformer mechanical strength, impacts to short circuit levels and clearing times. We expect this approach to result in a recommendation that, rather than operate on 'cold standby', some sites should be run in parallel while others are fitted with auto-changeover schemes to significantly reduce customer outage time.

At the time of writing, this review has not yet commenced, so no forecast for the number of auto-changeover schemes required is available. However, we plan to fund this program outside controlled revenue through the forecast improvements in reliability, with only sites that provide sufficient payback being selected.

Reliability Microgrid

The primary objective of investing in an initial microgrid is to develop the business policies, processes and procedures required to enable microgrids as a lowest cost reliability improvement option. This approach will de-risk future microgrid projects bringing forward the cross over point for cost competitiveness with traditional network based solutions.

This fits into Essential Energy's broader strategy of building a granular network economics model that can assist in identifying and tracking the cost base of particular sections of the network. By linking this accurate network cost driver information with future demand for investments, we can avoid making unnecessary investment in traditional network solutions, reducing the risk of customers having to fund stranded assets.

Additionally, our engagement process revealed that customers expect Essential Energy to be looking at innovative ways to deliver the services the community expects. Taking a forward-looking approach to understanding the benefits and risks of using microgrids to meet our licence obligations is part of our strategy for meeting these expectations.

For detailed information about the proposed investment, return and drivers for a trial microgrid, please refer to the separate business case, *Reliability Microgrid – Reliability and Performance Conditions*.

9. Reliability Performance Monitoring Plan

This section summarises key measures used to inform and monitor the reliability strategy, some of which are outlined in above sections, with a summary here.

Initiative	Recurrence	Owner	Measure of Success
Output from audits are logged under continuous improvement register	As required	Multiple	>0 Continuous Improvement Items logged relating to Reliability Strategy

[23] Community Deliberative Forum Report – Phase 2 - Woolcott Research & Engagement

Annual targets checked if achieved	Annual	Reliability Engineer	Targets as per section 6
IPART reporting	Annual	Regulatory Affairs	No non-conformances relating to asset behaviour
Review of reliability-driven programs identified within Investment Cases	Annual	Reliability Engineer	No asset reliability programs identified in Investment Cases that aim to improve overall network reliability rather than maintaining it

Appendix A Emerging Issues

Several issues could change this Reliability Strategy.

Service Target Performance Incentive Scheme

The AER is currently reviewing STPIS. Depending on the outcome, we may need to consider some changes. One of the most likely scenarios is a move from a one-minute to a three-minute Momentary Average Interruption Frequency Index (MAIFI) threshold. This would enable us to greatly expand our automated switching capabilities. Any work generated by this change would be funded through the STPIS scheme.

Customer expectations

Over the last 15 years, ‘sea change’ and ‘tree change’ relocations have brought customers from urban areas to rural locations, where they experience an unanticipated change in reliability performance that does not generally fit with their expectations. Coupled with their increased reliance on technology, this is likely to result in customers demanding improved reliability.

Small-scale renewables

Issues with schemes such as the solar bonus scheme have emerged and will continue to impact our network. When connected to the distribution network, embedded generation can lead to adversely impacted voltage regulation, voltage fluctuations, supply interruptions, harmonic distortion, poor power factor and other negative impacts on power quality.

As the penetration of renewables has increased in specific communities, adding Essential Energy-owned standby generation to the mix to enabled islanded operation is becoming a possibility. These innovative solutions could become economic during the next regulatory period.

Climate change

Anticipated climate changes may necessitate more expensive design requirements so the network can withstand extreme weather events.

Appendix B Definitions

Customer types

The AER uses standard definitions of customer types when applying reliability measures under the Reliability and Performance Licence Conditions.

- CBD – supplies mostly high-rise commercial buildings using a predominantly underground distribution network containing significant interconnection and redundancy compared to urban areas.
- Urban – not a CBD feeder, with actual maximum demand over the reporting period per total feeder route length greater than 0.3 MVA/km.
- Rural short – not a CBD or Urban feeder, with a total feeder route length less than 200km.
- Rural long – not a CBD or Urban feeder. with a total feeder route length greater than 200km.

Essential Energy's network comprises Urban and Rural type feeders and does not have any CBD-type feeders.

These definitions are used for reporting on network average reliability, individual feeder reliability and STPIS.

Note: Until 30 June 2014, 'regional centre' meant the towns of Tweed Heads, Wagga Wagga, Coffs Harbour (including Sawtell), Albury, Port Macquarie, Queanbeyan, Orange, Tamworth, Dubbo, Bathurst, Lismore and Broken Hill. From 1 July 2014, the term was no longer applicable.

Reliability measures

The AER defines standard reliability measures to assess the average network performance. These measures assess the outage duration and frequency of interruption as an average across the entire network and feeder categories using the following definitions:

- **System Average Interruption Duration Index (SAIDI)**: Sum of the duration of each sustained customer interruption measured in minutes, divided by the total number of customers (averaged over the financial year)[24].
- **System Average Interruption Frequency Index (SAIFI)**: Total number of sustained customer interruptions divided by the total number of customers (averaged over the financial year)[25].
- **Customer Average Interruption Duration Index (CAIDI)**: Sum of the duration of each sustained customer interruption (measured in minutes), divided by the total number of sustained customer interruptions (SAIDI divided by SAIFI).
- **Momentary Average Interruption Frequency Index (MAIFI)**: Total number of momentary customer interruptions divided by the total number of customers (averaged over the financial year).
- **Momentary Average Interruption Frequency Index Event (MAIFIe)**: Total number of momentary customer interruption events divided by the total number of customers (averaged over the financial year). This is slightly different to MAIFI. When calculating MAIFI, each operation of an automatic reclose device is counted as a separate interruption. For MAIFIe, multiple recloses that result in a successful reclose are counted as one event. Sustained interruptions that occur when a recloser locks out after several attempts to reclose are excluded.

Network elements

Feeder segment: Discrete part of a distribution feeder between a circuit breaker and a recloser, or between reclosers.

Feeder: means a high-voltage line operating at over 1kV and generally at or below 33kV that connects between a zone substation and a distribution substation,

[24] The calculation of SAIDI excludes momentary outages.

[25] The calculation of SAIFI excludes momentary outages.

Appendix C Modelling Assumptions

The modelling that underpins this Reliability Strategy relies on some assumptions.

- Historical performance is indicative of future performance. This is a valid approach as the network does not change significantly over the years and, by its nature, the historical data set contains extraneous and random events (such as weather) that affect the reliability outcome.
- Inspection and maintenance practices remain as effective as they are at present. If inspection regimes are reduced without maintaining current defect identification and rectification standards, the modelling is no longer valid.
- Existing maintenance and replacement activities maintain the inherent network performance. Only targeted reliability programs such as recloser installations result in improved network performance.
- Past weather occurrences will be like future weather occurrences. We have not modelled changes in climate or weather events that are not representative of the historical data set. Essential Energy is yet to model outcomes due to climate change as we do not know their correlation to utility performance.
- Planning standards for security of supply remain unchanged. The modelling inherently reflects past standards by utilising the historical dataset.
- The sampling period selected is representative of the standards for security of supply, design, maintenance, refurbishment and operations.

Appendix D – Referenced Documents, Policies and Legislation

Internal Documents

Document	Relevance to Network Strategy
Community Deliberative Forum Report – Phase 2 - Woolcott Research & Engagement	Internal documents that provide guidance for target setting, process flow or are an output of the AMS.
Community Deliberative Forum Report – Phase 1 - Woolcott Research & Engagement	
Application of STPIS to Essential Energy 2019-2024	
Reliability Microgrid – Reliability and Performance Licence Conditions	
CEOP2111.01 - Asset Risk Management	
CECP0002.32 - Financial Management Investment Evaluation Procedure	
Strategic Asset Management Plan	
Network Strategies	
Investment Cases	
Asset Management Plans	
Essential Energy Report - Recloser Effectiveness and TOBAN Analysis	

Legislation

Document	Relevance to Network Strategy
Electricity Supply Act 1995	Legislation that Essential Energy must adhere to. Provides guidance to reliability-based target setting and used to meet the Asset Management Objective on Compliance.
Electricity Distribution Network Service Providers' Service Target Performance Incentive Scheme, Australian Energy Regulator, Nov 2009	
National Electricity Rules	
NSW Reliability and Performance Licence Conditions for Electricity Distributors – 1 July 2014	
Electrical Safety Act 2002	

External Documents

Document	Relevance to Network Strategy
AEMC - 2014 *Review of Distribution Reliability Measures*	External documents that provide guidance for target setting, process flow or are an output of the AMS.
NSW Electricity Transmission Reliability Standards	
Review of Distribution Reliability Measures	
Distribution Authority - No. D01/99 *Ergon Energy Corporation Limited*	