2020 REPORT INTO THE RELIABILITY OF ELECTRICITY NETWORK SERVICES IN TASMANIA

Issued by the Tasmanian Economic Regulator

OFFICE OF THE TASMANIAN ECONOMIC REGULATOR

CONTACT DETAILS

Office of the Tasmanian Economic Regulator

Office hours:	8.45am to 5.00pm, Monday to Friday (except public holidays)
Street address:	Level 3, 21 Murray Street, Hobart, Tasmania 7000
Postal address:	GPO Box 770, Hobart, Tasmania 7001
Telephone:	(03) 6166 4422 or international +61 3 6166 4422
Email:	office@economicregulator.tas.gov.au
Website:	www.economicregulator.tas.gov.au

Published February 2020

ISBN 978-0-7246-5539-7

TABLE OF CONTENTS

ABBREVIATIONS

AEMC	Australian Electricity Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
APR	Annual Planning Report
Basslink	Interconnector between Tasmania and Victoria
BOA	Basslink Operations Agreement
CAIDI	Customer Average Interruption Duration Index
DC	direct current
DNSP	Distribution Network Service Provider
ESI	Electricity Supply Industry
ESI Act	*Electricity Supply Industry Act 1995*
ESI Regulations	*Electricity Supply Industry (Network Planning Requirements) Regulations 2018*
GSL	Guaranteed Service Level
HV	high voltage
Hz	Hertz
kVA	kilovolt amps
LOS	Loss of supply
LV	low voltage
MAIFI	Momentary Average Interruption Frequency Index
MEDs	Major event days
NEM	National Electricity Market
NER	National Electricity Rules
OTTER	Office of the Tasmanian Economic Regulator
PQ	Power quality
PV	Photovoltaic
SAPS	Stand-alone power systems
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
STPIS	Service Target Performance Incentive Scheme
TEC	Tasmanian Electricity Code
TNSP	Transmission Network Service Provider
TasNetworks	TasNetworks Pty Ltd
USE	Unserved Energy
VCR	Values of Customer Reliability

EXECUTIVE SUMMARY

Background

This Report provides the outcomes from a review of the reliability of Tasmanian electricity network services from 1 July 2016 to 30 June 2019 inclusive (the reporting period). Section 10B of the Electricity Supply Industry Act 1995 requires the Regulator to conduct a review into the reliability of Tasmanian electricity network services at least once every three years. The previous review covered the period from 1 July 2013 to 30 June 2016 and was completed in October 2016.

In July 2019, the Regulator published, and called for submissions on, the draft terms of reference for the review. A submission was received from TasNetworks and is available on the Regulator's website. The final terms of reference were published in August 2019.

Prior to publishing this Report, the Regulator liaised with TasNetworks, Basslink and Hydro Tasmania to ensure it did not contain any errors of fact.

Reliability

Reliability in terms of electricity network services refers to the capability of network infrastructure to transport electricity from the generation location to end use customers.

Network reliability is measured by the frequency and duration of loss of electricity supply (outages). The frequency of outages is determined by the quantity, type and management of network assets while the duration of outages is determined by how quickly a network service provider is able to restore electricity supply.

Reliability of supply in the mainland Tasmanian transmission system is measured by unserved energy (USE) and system minutes off supply. Mainland Tasmania's transmission network reliability performance has been satisfactory over the reporting period, in particular in 2018-19 with less USE, and fewer system minutes off supply than in previous years. In addition, the number of Loss of Supply (LOS) events was below the relevant LOS limits during the reporting period.

Reliability of supply in the mainland Tasmanian distribution system is measured in terms of the number and duration of interruptions on a per customer basis. The two main indicators are SAIFI (System Average Interruption Frequency Index) and SAIDI (System Average Interruption Duration Index).

Distribution network reliability performance data are provided on an adjusted basis, under which the data excludes Major Event Days (MEDs), which are major (force majeure) events that affect large sections of the network and are beyond the control of the service provider. The aim of excluding major event days is to give a better indication of the underlying performance of the network.

The supply reliability indicators for the distribution system show that reliability performance varies from year to year but, overall, distribution network reliability performance was satisfactory over the reporting period.

At the community category level[1], the frequency of outages for all categories met the standards in the Tasmanian Electricity Code (TEC) during the reporting period. In contrast, the duration of outages was longer than the TEC standards for all categories for at least one year during the reporting period.

TasNetworks has stated that for a number of communities in Tasmania there was consistently poor reliability of supply. TasNetworks has identified 10 where the reliability of network services will be reviewed.

Basslink's reliability performance has been satisfactory during the reporting period. The only prolonged outage was in March 2018 and was caused by third party damage at a transition station in Victoria.

The overall reliability performance of the Bass Strait Islands' distribution network deteriorated in terms of both SAIDI and SAIFI on both islands over the reporting period. Hydro Tasmania is upgrading the network on both islands to improve reliability of supply.

Quality of supply

The quality of supply is measured in terms of whether the power factor and voltage are within certain pre-determined ranges[2] and, therefore, whether the electricity supply is suitable for use by customers.

There was a general decrease in the incidence of over-voltage during the reporting period. The exception was in relation to the number of customers receiving over-voltage due to high voltage injections, which increased significantly during 2018-19. This was due to voltage surges resulting from equipment failure, caused by a weather event.

Reliability-related issues

There is a significant amount of non-synchronous generation in Tasmania, mainly in the form of large scale wind farms and, to a lesser extent, small-scale solar photo voltaic installations (rooftop PV). The Australian Energy Market Operator (AEMO) has noted that this has contributed to a shortage of inertia in the Tasmanian power system[3], which is needed to maintain the frequency within the network at the desired level. To address this issue, the AEMC made a rule change, effective from 1 July 2018, to require Transmission Network Service Providers (TNSPs) to procure sufficient inertia services to meet minimum inertia requirements in each region (as determined by AEMO).[4]

AEMO has also had to respond to the impact of the increase in wind generation on power system strength by managing fault levels. AEMO stated that "A reduction in system strength in certain areas of the network may mean that generators are no longer able to meet their technical performance standards and may be unable to remain connected to the system at certain times. It may also lead to voltage instability and a reduction in the effectiveness of the protection systems used by network businesses, generators and large customers. If not addressed, these effects could lead to system instability and potential major supply interruptions".[5] AEMO has also prepared guidelines for assessing the system strength.[6] To this end a National Electricity Market rule change has been made, effective

[1] For the purpose of measuring distribution network performance, Tasmania is divided into 101 supply reliability areas referred to as "communities". These communities are aggregated into one of the following five supply reliability categories: Critical Infrastructure; High Density Commercial; Urban, Higher Density Rural; and Lower Density Rural. The supply reliability standards for each community and classification are set out in Clause 8.6.11 of the TEC. More information about distribution network performance is available at: https://www.economicregulator.tas.gov.au/electricity/regulatory-framework/distribution-network-performance-standards

[2] See clauses 8.6.3 and 8.6.4 of the TEC respectively.

[3] *Notice of Inertia Fault Level Shortfalls Tasmania*, Nov. 2019, AEMO.

[4] https://www.aemc.gov.au/rule-changes/managing-the-rate-of-change-of-power-system-freque

[5] AEMO, *Information Sheet, Managing power system fault levels*, 19 September 2017.

[6] AEMO, *System strength impact assessment guidelines*, 1 July 2018.

1 July 2019, which requires TasNetworks (and other TNSPs) to procure system strength services needed to ensure faults are at or below levels determined by AEMO.

The increased amount of rooftop PV generation has also contributed to over-voltage and other voltage issues which TasNetworks is addressing for mainland Tasmania, and Hydro Tasmania is addressing on the Bass Strait Islands.

TasNetworks has identified five potential stand-alone power systems (SAPS). The AEMC has proposed a legislative and a regulatory framework to address issues raised by the introduction of SAPS. However, the necessary changes are yet to be implemented and involve changes to the National Electricity Market law and rules and also jurisdictional legislative changes as reliability and guaranteed service levels are currently the responsibility of the relevant jurisdictions.

Medium term outlook

Based on customer feedback, TasNetworks plans to maintain network performance at current levels rather than carrying out capital expenditure to improve reliability which would lead to higher network charges. However, TasNetworks will review reliability of supply in a number of areas where there has been consistent underperformance. TasNetworks has also undertaken to incorporate the outcomes from the current Values of Customer Reliability review (VCR) when considering reliability-related capital expenditure.

TasNetworks will also continue to monitor and analyse the effect of increased non-synchronous and distributed generation on both the reliability of supply and power quality.

Hydro Tasmania has stated that it will continue to investigate and invest in technologies and materials that will improve network reliability on the Bass Strait islands at the least cost to electricity consumers. In response to the increased amounts of rooftop PV generation on the islands, Hydro Tasmania has proposed a changes to the Tasmanian Electricity Code to enable it to maintain power system security on the islands.

Conclusion

While there are annual fluctuations in reliability performance (usually related to weather events) overall reliability of the transmission and distribution networks in Tasmania was satisfactory during the reporting period with no major issues affecting reliability.

Issues that will need to be addressed in the medium term on mainland Tasmania are improving supply reliability in the communities where performance has been poor, and managing fault and inertia levels.

For the Bass Strait Islands, the Regulator has noted that Hydro Tasmania intends to upgrade the distribution network to increase the reliability of supply and has not identified any major issues over the medium term.

1 INTRODUCTION

1.1 Background

The requirement for the Tasmanian Economic Regulator to review the reliability of Tasmania's electricity network services was formalised in 2000 in chapter 12.7 of the Tasmanian Electricity Code (TEC), though the Regulator had prepared annual network reliability reviews in several earlier years.

From 2002 to 2011, the Regulator conducted annual, stand-alone network reliability reviews. From 2012, these reviews were included in the Regulator's annual performance report on the Tasmanian energy sector, the *Energy in Tasmania* reports.

In 2014, the Government reviewed the roles and functions of the Regulator and consequently amended the *Tasmanian Economic Regulator Act 2009* which, amongst other things, introduced specific provisions in relation to the Regulator conducting network reliability reviews and reporting on the outcomes of those reviews.

In addition, the Government released its *Restoring Tasmania's energy advantage* report in 2015 which outlined the Government's energy strategy. One of the aims of the strategy is to ensure customers receive a reliable supply of electricity at the most efficient cost.

The ESI Act was subsequently amended to include Section 10B which to require the Regulator to conduct a review into the reliability of network services at least once every three years. The Regulator may conduct the review on its own initiative, or if directed to do so by the Minister for Energy and the Minister responsible for the administration of the Economic Regulator Act.

After conducting the review, the Regulator is to prepare a Network Reliability Report (the Report) setting out the findings from its review. A copy of the Report must be tabled in both Houses of Parliament within seven sitting days of its preparation and made available to members of the public.

Network services are defined in the ESI Act as:

(a) the transmission and distribution of electricity between electricity entities and from electricity entities to customers; and

(b) controlling and regulating the quality of electricity.

This Report is the first network reliability report to review the reliability of the Bass Strait Islands (BSI) electricity network.

In Tasmania network services are provided by:

- TasNetworks, the transmission and distribution network provider on mainland Tasmania,
- Basslink Pty Ltd, a market network service provider that owns and operates the interconnector (Basslink) between Tasmania and Victoria, and
- Hydro Tasmania, which provides distribution services on the Bass Strait Islands.

In terms of network services, reliability generally refers to the capability of network infrastructure to transport electricity from the point of generation to the point of consumption. Historically this has involved transporting electricity one way through the electricity network from a relatively small number of large generators to a large number of end users. The introduction of rooftop PV, and other forms of distributed generation, means that the distribution network must now, cater for the two way flow of electricity.

Although, quality with regards to electricity is not defined in the ESI Act, it refers to characteristics of electricity supply such as voltage, frequency and waveform.

Network reliability is measured in terms of the frequency and duration of loss of supply of electricity to end users. Most instances of loss of supply are caused within the distribution network and have a local impact. In contrast, the transmission system accounts for a relatively minor number of loss of supply events although, generally, the impact is more widespread.

1.2 Managing the reliability/cost trade-off

Achieving a target level of reliability of network services involves investing in infrastructure and incurring maintenance and operating costs, almost all of which are ultimately paid for by electricity consumers.

The cost of maintaining and improving reliability is the single largest component of TasNetworks' expenditure and accounted for around 40-50 per cent of annual expenditure during the reporting period. There is a trade-off between increasing network reliability and reducing or preventing price increases to customers. An efficient outcome is where the actual level of service is consistent with the level that customers are willing to pay for. When networks are meeting performance targets that reflect community choices, their reliability can be assessed as satisfactory.

Results from customer satisfaction surveys conducted by TasNetworks[7] indicate that TasNetworks has been perceived to be meeting most customers' needs from an overall network performance perspective. TasNetworks reports that the consistent and clear feedback from its customers is that:

- the risk of a less reliable service is not acceptable as a trade-off for lower prices; and
- an increase in reliability is also not supported if it came at a higher price.

The trade-offs between network reliability and price mean that reliability standards tend to be high for transmission networks (and electricity generation) because an outage can have widespread effects.

In comparison, standards tend to be less strict for distribution networks, where the impact of an outage is more likely to be localised. The capital intensive nature of networks also makes it expensive to build in high levels of redundancy in distribution networks to improve reliability.

Similarly, the network standards for the one Critical Infrastructure community (part of the Hobart CBD), and High Density Commercial communities, with concentrated customer and load density, tend to be higher than for a highly dispersed rural network, with a small customer base and small load density. The costs of redundancy in rural networks are generally high in relation to the load that is likely to be affected by an outage.

1.3 Transmission reliability performance measures

The reliability of the transmission network is measured by the amount of unserved energy and the number and duration of the loss of supply measured in system minutes. Loss of supply (LOS) in the transmission system is measured in system minutes, which is the amount of electricity that would

[7] TasNetworks, Tasmanian Transmission Revenue and Distribution Regulatory Proposal, January 2018, page 48.

otherwise have been supplied, in MWh, divided by the maximum demand (MW) and then multiplied by 60.[8]

Reliability of supply in the transmission network can be affected by factors including:

- the availability of adequate generating plant capacity to meet demand;
- the impact of unexpected contingency events on generation and transmission equipment;
- the availability of adequate transmission capability; and
- the performance of the distribution network connecting the transmission network to the customer's premises.

1.4 Distribution performance measures

Distribution network performance measures generally cover the frequency and duration of electricity supply interruptions on a per customer basis.

The two main measures of distribution network reliability are the following indices:

- system average interruption frequency index (SAIFI) - the number of interruptions, on average, a customer experiences, as measured by the annual total number of customers whose supply was interrupted divided by the total number of Tasmanian customers;
- system average interruption duration index (SAIDI) - for interruptions of over three minutes, the average number of minutes of interrupted supply for all Tasmanian customers, as measured by the total number of minutes of interrupted supply experienced by customers annually, divided by the total number of Tasmanian customers.

The following two indices also measure distribution reliability but are less widely used:

- momentary system average interruption frequency index (MAIFI) – the likelihood of a customer experiencing an interruption of three minutes or less, as measured by the annual total number of customers whose supply was interrupted for this duration, divided by the total number of Tasmanian customers; and
- customer average interruption duration index (CAIDI) – the average duration of interrupted supply, expressed in minutes for those customers whose supply was interrupted, as measured by the total number of minutes of interrupted supply experienced by customers annually, divided by the total number of affected customers.

These indices are calculated for planned and unplanned interruptions, and can be adjusted to exclude Major Event Days (MEDs), which are days when there are interruptions caused by events beyond the reasonable control of the distribution network provider e.g. extreme weather events. When adjusting the data, the MED is replaced by a statistically average day. The objective of removing MEDs from the data is to provide an indication of the underlying performance of the network under normal conditions.

[8] For example, if, as a result of an outage, 30 MWh that would have been supplied was not supplied and the maximum demand is 400 MW, the LOS is 4.5 system minutes.

1.5 Power quality

Power quality (PQ) generally refers to the characteristics of the electricity supply that customers receive. PQ includes issues such as deviations from the normal 230/400 volts-50-Hertz supply, including momentary voltage sags and swells, dips and spikes, harmonics, brownouts (also known as part or half power) and other electrical noise or pollution. PQ focuses on voltage changes as these have the most impact on customers' use of electricity.

Customers expect an appropriate quality of electricity supply to ensure that their electrical equipment and appliances operate as designed and can be used to full capability, operate continuously when required with minimal risk of interruption, and are at minimal risk of damage when connected to the system.

Regulators typically stipulate voltage limits and the performance of regulated utilities is assessed, in part, by the extent to which electricity is supplied at the required voltage. For Tasmanian customers the applicable voltage limits are set out in the National Electricity Rules and the TEC for mainland Tasmania and the TEC for the Bass Strait Islands.

PQ performance is assessed in terms of:

- power frequency voltage (which deals with over and under voltage);
- voltage fluctuations (which deals with flicker);
- voltage waveform distortion (which deals with harmonics); and
- voltage unbalance.

1.6 AEMC Reliability Review

The AEMC periodically conducts a reliability review. The AEMC is responsible for the reliability of the overall power system/NEM. The outcomes from its last review were released by the AEMC in July 2018[9].

The AEMC review looks at the power system as a whole and defines a reliable power system as one which "has enough generation, demand response and network capacity to supply customers with the energy that they demand with a very high degree of confidence." The review focuses on ensuring sufficient generation and redundancy is available to meet demand. Consequently, the review is concerned with interruptions due to lack of supply rather than network-related interruptions, which is the focus of the Regulator's review and this Report.

1.7 Terms of Reference

The Terms of Reference for the Regulator's review are attached as Appendix A.

[9] https://www.aemc.gov.au/sites/default/files/2018-04/Reliability%20Panel%20Final%20Report.pdf

2 THE TASMANIAN ELECTRICITY NETWORK

Electricity is supplied to Tasmanian electricity customers within Tasmania via two separate networks:

- the mainland Tasmanian network; and
- the BSI network.

2.1 The mainland Tasmanian network

2.1.1 Transmission

On mainland Tasmania, the transmission system comprises a 220 kV, and some parallel 110 kV, bulk transmission network that connects the main generation locations with the main transmission substations and load centres. A peripheral 110 kV transmission network provides connections to other load centres and generation locations.

There are 34 220 kV transmission line circuits extending 1 670 km and 68 110 kV transmission line circuits extending 1 824 km, giving a total of 3 494 transmission line circuit km in the system, together with 48 substations and 9 switching stations. These substations operate at voltages of 220, 110, 44, 33, 22, 11 and 6.6 kV.

2.2 Generation connections

On mainland Tasmania, power stations connect to the 220 kV transmission network at Farrell, Sheffield, Palmerston, George Town, Liapootah, Cluny and Gordon, and to the 110 kV network at Farrell, Sheffield, Palmerston, Trevallyn and in the Derwent area.

The Tamar Valley thermal power station connects at both 220 kV and 110 kV at George Town Substation.

The Studland Bay and Bluff Point wind farms connect to Smithton at 110 kV, and Musselroe wind farm connects to Derby at 110 kV. Wild Cattle Hill Wind Farm connects to Waddamana Substation at 220 kV and Granville Harbour Wind Farm connects at 220 kV to Pieman switching station.

2.2.1 Load connections

On mainland Tasmania, the main load centres are supplied from substations via the bulk transmission network at 220 kV at George Town, Chapel Street and Lindisfarne (supplying Hobart), Sheffield (supplying Devonport and Burnie) and Hadspen (supplying Launceston and North-East areas).

Other load centres are supplied from the 110 kV peripheral transmission network.

Power transfers take place between the bulk transmission network and the peripheral transmission network via 220/110 kV transformers at Sheffield, Burnie, Palmerston, George Town, Chapel Street, Lindisfarne, Farrell and Hadspen substations.

2.2.2 Basslink

The Basslink interconnector connects the 220 kV bulk transmission network at George Town in Tasmania with the mainland power system at Loy Yang in Victoria. It consists of a 400 kV mono-polar direct current (DC) cable and a separate 25 kV metallic return cable with converter stations at each end.

Basslink has a nominal capacity of 594 MW from Tasmania to Victoria and 478 MW from Victoria to Tasmania. There is a non-operational zone between 50 MW import and 50 MW export.

The converter station at George Town has one 98 MVAr and five 43 MVAr AC harmonic filters to meet voltage and harmonic performance requirements.

2.2.3 Distribution

The electricity distribution system supplies electricity to approximately 289 000 customers on mainland Tasmania and comprises 20 061 km of overhead lines and 2 299 km of underground cables.

On mainland Tasmania, some 313 high voltage (HV) feeders, operating at 44 kV, 33 kV, 22 kV, 11 kV, or 6.6kV supply 31 015 pole mounted and ground type substations to supply TasNetworks' customers at 400/230 volts.

The high voltage (HV) distribution network comprises predominantly overhead lines in rural and suburban areas, with underground power lines in central business districts (CBD), commercial centres and more recent subdivisions. Rural feeders generally tend to be long, between 50 and 500 km (including spur lines), and radial in nature; therefore, there is limited ability to be interconnected with other adjacent feeders. Consequently, rural feeders tend to have more frequent and longer outages. In addition, line length affects voltage and other power quality characteristics. In contrast, feeders in urban areas are relatively short and increased interconnection means urban feeders have greater flexibility to provide alternative means of supplying electricity to customers.

2.2.4 The Bass Strait Islands network

The BSI refers to Flinders and King Island but excludes Cape Barren Island. The BSI are not part of the NEM and the power system on the islands is operated by Hydro Tasmania and supplies electricity to around 1 260 customers.

There is no transmission network on the islands. Flinders Island has three 11kv overhead feeders and the distribution network has a total length of approximately 330km. King Island has four 11kv feeders and the distribution network has a total length of approximately 401.4km, of which around 400km is overhead and 1.4km is underground.

The feeders on each island are set out in Table 2.1.

Table 2.1 BSI feeder details

Location	Feeder name	Low/high rural density
Flinders Island	Lady Barron	Low
Flinders Island	Palana	Low
Flinders Island	Whitemark	High
King Island	Cape Wickham	Low
King Island	Currie	High
King Island	Grassy	Low
King Island	Industrial	High

Source: Clause 4A.4.1, TEC

3 RELIABLITY PERFORMANCE FOR MAINLAND TASMANIA

3.1 Overview

Transmission and distribution network service providers in Tasmania must be licensed by the Regulator and are subject to the terms of their licence. Among these requirements is the obligation to provide the Regulator with quarterly and annual performance information on the transmission and distribution network's reliability. The information required is specified in chapters six and seven of the Regulator's *Electricity Supply Industry Performance and Information Reporting Guideline September 2014* (Performance Guideline).

Licensees must also report on significant incidents that affect, or may affect, the network in accordance with the Regulator's *Incident Reporting Guideline for the Tasmanian Electricity Supply Industry* (July 2019).

In addition to these obligations, TasNetworks is also required to meet the requirements of the *Electricity Supply Industry (Network Planning Requirements) Regulations 2018* which specify the minimum network performance requirements that the TasNetworks must meet for its transmission network.

3.2 Performance standards and reporting requirements

3.2.1 Transmission

Across the NEM, AEMO is responsible for transmission reliability in the context of maintaining the security of the overall power system. The NEM standard for reliability is that there should be sufficient generation and bulk transmission capacity so that, over the long term, no more than 0.002 per cent of the annual energy consumption in any region is at risk of not being supplied or, that is, the unserved energy (USE) limit is 0.002 per cent.

In accordance with Part 6 of the Performance Guideline, TasNetworks provides data based on the following measures:

- the number of LOS events where LOS exceeded 0.1 system minutes in a year; and
- the number of LOS events where LOS exceeded 1.0 system minutes in a year.

3.2.2 Distribution

The performance of a distribution network and the applicable reliability standards are the responsibility of individual NEM jurisdictions. In Tasmania, the relevant standards are specified in the TEC. Chapter 8 of the TEC includes performance measures for TasNetworks on mainland Tasmania. Clause 8.6.11 of the TEC imposes performance measures based on 101 geographical areas referred to as 'communities' which are aggregated into one of the following five supply reliability categories (also referred to as 'community categories'):

- Critical Infrastructure;
- High Density Commercial;
- Urban;

- Higher Density Rural; or
- Lower Density Rural.

The performance measures operate on the premise it is appropriate to have different reliability standards for different types of distribution areas, and that similar distribution areas should receive similar levels of supply reliability.

For the community categories and constituent communities in each category there are different outage frequency and duration standards, as shown in Table 3.1. The frequency and duration standards are expressed on a per customer basis.

Table 3.1 TEC Reliability performance standards

Community Category (number of communities)	Outage Frequency Standard (SAIFI)		Outage Duration Standard (SAIDI)	
	Category	Each community area	Category	Each community area
Critical Infrastructure (1)	0.2	0.2	30	30
High Density Commercial (8)	1	2	60	120
Urban and Regional Centres (32)	2	4	120	240
Higher Density Rural (33)	4	6	480	600
Lower Density Rural (27)	6	8	600	720

Source: Clause 8.6.11 of the TEC

The TEC requires TasNetworks to use reasonable endeavours to ensure that the average number of both planned and unplanned supply interruptions per year does not exceed the specified values for frequency and duration for each category and for each community area.

3.2.3 AER performance standards

In regulating the transmission and distribution networks, the AER uses a mix of capital expenditure allowances and incentive schemes designed to ensure that investment is both efficient and sufficient to meet acceptable reliability standards. Every five years, the AER sets a revenue cap for each network, which includes an allowance for capital investment. The AER also imposes a number of reliability performance measures. The Service Target Performance Incentive Scheme (STPIS) aims to incentivise TasNetworks to improve network performance by providing financial incentives for meeting targets for performance indicators.

The targets for each entity are calculated using each entity's past performance data. The targets are reviewed and updated every five years as part of AER's transmission and distribution regulated revenue investigations.

In accordance with its performance incentive scheme, TasNetworks provides performance information for its transmission network to the AER in terms of the following measures:

- the guaranteed service level scheme;
- the number of LOS events of more than 0.1 system minutes in a year;
- the number of LOS events of more than 1.0 system minutes in a year; and
- the average LOS duration (minutes).

With regard to the distribution network and in accordance with its performance incentive scheme, TasNetworks provides SAIDI and SAIFI data to the AER based on the same five community categories as listed above.

However, the AER does not recognise the 101 communities. Therefore, there are no financially based performance measures relating to the performance of the distribution network across the 101 communities.

3.2.4 Guaranteed Service Level Scheme

TasNetworks is subject to a guaranteed service level (GSL) scheme, as provided for in clause 8.5 of the TEC and as set out in the Regulator's Guideline, *Guaranteed Service Level (GSL) Scheme, July 2012*.

Under the scheme, distribution customers are paid an amount when the frequency and/or duration of a supply interruption exceeds the thresholds specified in the GSL Guideline. The GSL Guideline does not apply where the interruption is of such a scale that, in the opinion of the Regulator, TasNetworks is not reasonably able to mitigate against the impacts of the interruption.[10]

The aim of the scheme is to provide an incentive to TasNetworks to maintain and/or improve electricity supply reliability. It also provides compensation to customers for inconvenience. The AER includes an allowance for the GSL scheme payments in TasNetworks' regulated revenue allowance. If the value of GSL payments exceeds the amount provided for in the allowance, TasNetworks must fund the difference from its other revenue. If the value of GSL payments is less than the amount provided for in the allowance, TasNetworks is able to retain the difference.

[10] *Guideline, Guaranteed Service Level (GSL) Scheme, July 2012* (page 3).

Table 3.2shows the frequency and duration of outages criteria and the respective amounts payable under the scheme. GSL scheme schedule of payments and criteria to receive payments.

Table 3.2 GSL scheme schedule of payments and criteria to receive payments

GSL conditions for single outage duration payments	Outage duration threshold (hours)	
Critical Infrastructure, High Density Commercial and Urban and Regional Centres	> 8	> 16
Higher Density Rural	> 8	> 16
Lower Density Rural	> 12	> 24
Timely Restoration Payment	$80.00	$160.00
GSL conditions for frequency of outages payments	**Number of outages in 12 months threshold[11]**	
Critical Infrastructure, High Density Commercial and Urban and Regional Centres	10	
Higher Density Rural	13	
Lower Density Rural	16	
Timely Restoration Payment	$80.00	

Source: *Guaranteed Service Level (GSL) Scheme, July 2012*.

3.2.5 Basslink

Regulation of Basslink's availability performance is not the Regulator's responsibility. Consequently, the Regulator does not set performance targets for Basslink.

The *Independent Review of Tasmania's Electricity Supply Industry Report*, released in 2012[12], states that Basslink's Operations Agreement (BOA) with the State of Tasmania includes an annual minimum availability requirement of 97 per cent with an annual target of 97.5 per cent (excluding force majeure events), assessed on a rolling 12 month basis and taking into account unavailability due to both planned and unplanned outages. The review also stated that the BOA also sets a limit of 5 unplanned outages per year.

[11] Once the threshold number is reached the tally is reset to zero.

[12] Electricity Supply Industry Expert Panel, An Independent Review of the Tasmanian Electricity Supply Industry - Final Report, Volume 2, March 2012.pdf

3.2.6 Power quality

Schedules 5.1a, 5.1 and 5.3 of the NER describe planning, design and operating criteria that apply to the distribution network for power quality.

TasNetworks identifies power quality issues:

- from customer feedback - generally relating to over or under voltages;
- during operation of the network; and
- through load or voltage studies of new connections or network limitations [13]

Section 7.3 of the Performance Guideline includes the quality of supply performance indicators shown in Table 3.3.

Table 3.3 Voltage performance indicators

Performance Indicator
Over voltage events due to high voltage injection events High voltage injection events relate to reported incidents involving HV/LV contact and transmission over voltage events.
Customers receiving over voltage due to high voltage injection Number of customers receiving over voltage due to high voltage injection taken from number of claims made by customers for damaged equipment relating to those events.
Over voltage events due to lightning Over voltage events due to lightning relates to number of reported interruptions where the reported cause was lightning.
Customers receiving over voltage due to lightning Number of customers receiving over voltage due to lightning taken from number of claims made by customers for damaged equipment relating to those events.
Over voltage events due to voltage regulation or other causes Non-standard voltage events due to voltage regulation and other causes and number of customers receiving over or under voltage due to those events, are taken from number of complaints attended where a recording of the supply voltage has verified the non-standard voltage situation.
Customers receiving over voltage due to voltage regulation or other causes. Non-standard voltage events due to voltage regulation and other causes and number of customers receiving over or under voltage due to those events, are taken from number of complaints attended where a recording of the supply voltage has verified the non-standard voltage situation.

[13] TasNetworks, *Annual Planning Report 2019*, page 43.

3.3 Reliability Performance

3.3.1 Transmission

TasNetworks' transmission system reliability performance for the reporting period is set out in Table 3.4. For each year of the reporting period, the amount of unserved energy (USE) was well below the reliability standard established in the NEM of 0.002 per cent of total energy consumption.

Table 3.4 TasNetworks transmission system reliability performance

Performance Measure	2016-17	2017-18	2018-19
% Unserved Energy	0.00073	0.00072	0.0003
Loss of Supply - System Minutes	2.38	2.47	0.98

Source: TasNetworks, *2019 Annual Performance Report*

TasNetworks' transmission reliability performance, in terms of both USE and LOS system minutes, improved considerably during 2018-19 compared to the previous two years.

TasNetworks' reliability performance in terms of the measures set out in Section 6.3 of the Performance Guideline is provided Table 3.5.

Table 3.5 Transmission performance indicators

Performance Measure	Limit	2016-17	2017-18	2018-19
Number of LOS events > 0.1 system minutes	≤ 15	2	4	2
Number of LOS events > 1.0 system minutes	≤ 2	1	1	0

Source: TasNetworks, *2019 Annual Performance Report*.

As the number of LOS events for each performance measure was under the respective limits, the Regulator has concluded that the transmission network's reliability performance was satisfactory during the reporting period.

3.3.2 Basslink

Basslink's reliability performance over the reporting period relative to the targets in the BOA (as reported above) is provided in Table 3.6.

Table 3.6 Basslink reliability performance

	Target (BOA)	2016-2017	2017-18	2018-19
Availability %	97	98.72	79.77	99.4
Unplanned outages	5	4	1	2

Source: Basslink, 2018-19 Annual Performance Report.

Basslink's availability was above target, as reported for the BOA, in all years except during 2017-18 when a third party contractor damaged equipment at a transition station in Victoria resulting in a two month service outage between March 2018 and May 2018.

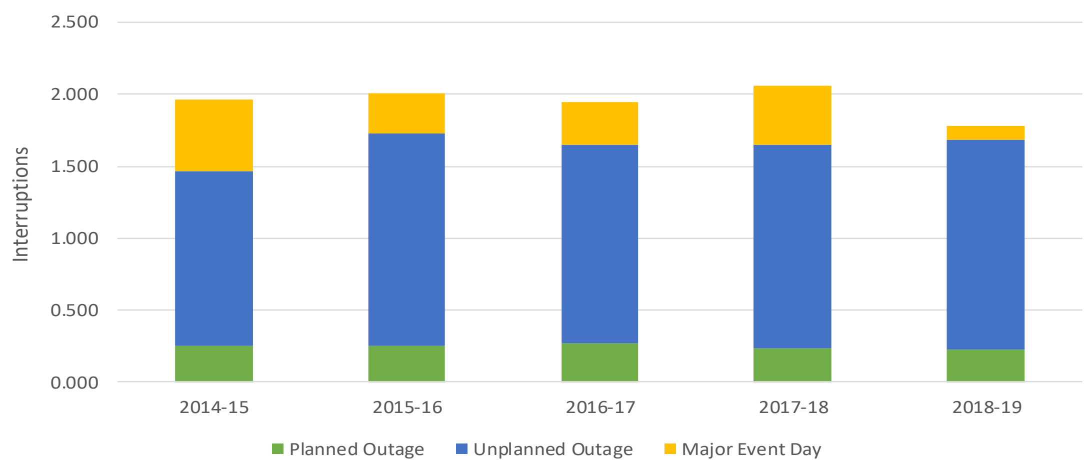
The Regulator has concluded that Basslink's performance was satisfactory during the reporting period as the number of unplanned outages was below the annual target, as reported for the BOA, in each year of the reporting period and Basslink's availability exceeded the target, as reported for the BOA, for two of the three years.

3.3.3 Distribution

To assess the performance of TasNetworks' distribution network over the reporting period, it is useful to refer to TasNetworks' performance in earlier years. This is unlike the assessment of TasNetworks' transmission network, where outcomes can be assessed against performance measures. For this reason, data are presented over the past five years for TasNetworks' distribution network.

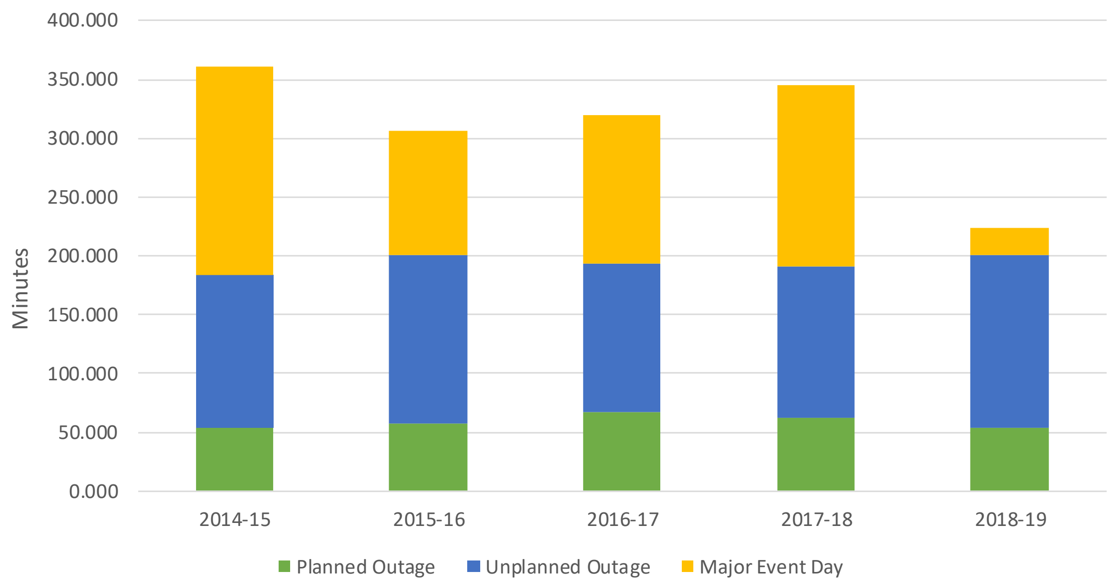
The following graphs show the overall distribution system reliability performance, in terms of frequency of interruptions and duration of interruptions since 2014-15. Frequency of distribution network interruptions (SAIFI) - interruptions per customer (average)

Figure 3.1 Frequency of distribution network interruptions (SAIFI) - interruptions per customer (average)



Source: TasNetworks, *2019 Annual Performance Report*.

Figure 3.2 Duration of distribution network interruptions (SAIDI) - per customer (average)



Source: TasNetworks, *2019 Annual Performance Report*.

In 2018-19, the number of MEDs was significantly lower than in previous years (Table 3.7).

Table 3.7 Major Event Days (MEDs)

		2014-15	2015-16	2016-17	2017-18	2018-19
Number of MEDs	Days	5	5	4	6	2

Source: TasNetworks, *2019 Annual Performance Report*.

When the impact of MEDs is removed from the performance figures, the underlying performance of the distribution network has marginally deteriorated with regard to both the frequency and duration of outages. However, the Regulator notes that distribution reliability performance is inherently variable and, based on past performance, considers that TasNetworks' performance during the reporting period was satisfactory.

3.3.3.1 Causes of supply interruptions

The main factors contributing to the number of interruptions, as measured by SAIFI, are:

- unknown causes;
- equipment failure;
- environmental conditions;
- planned work; and
- vegetation.

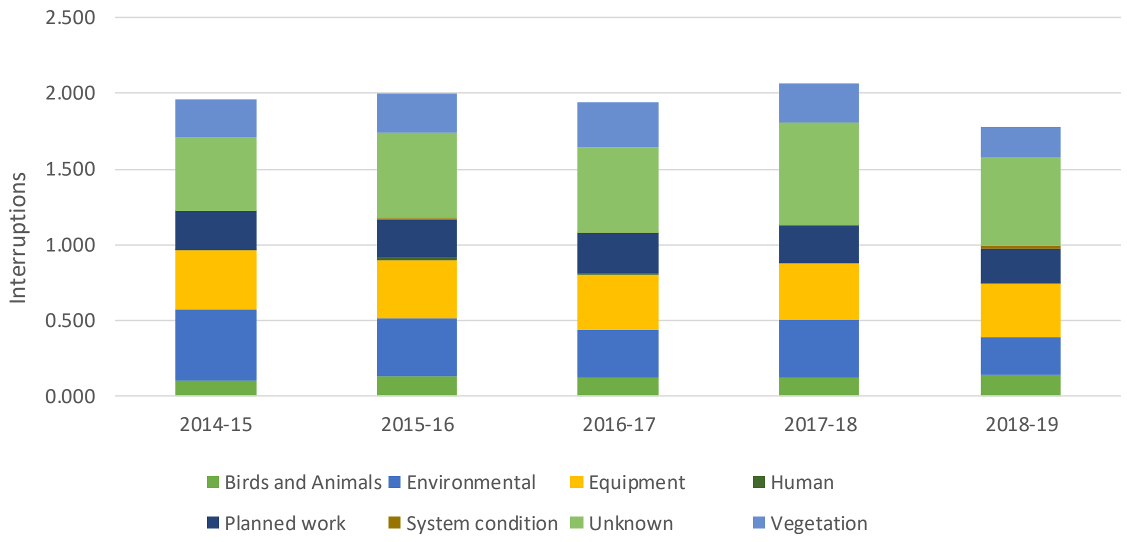
The main factors that contribute to the duration of interruptions, as measured by SAIDI, are:

- environmental conditions;
- planned outages;
- unknown causes;
- equipment failure; and
- vegetation.

The contribution of the various causes to the annual SAIDI and SAIFI values varies from year to year. The causes of supply interruptions are shown in the figures 3.2, 3.3 and 3.4 below.[14] The decrease in both SAIDI and SAIFI in 2018-19 is mainly due to a decrease in environmental (weather-related) causes and reflects the large decrease in MEDs during 2018-19 compared to the previous four years.

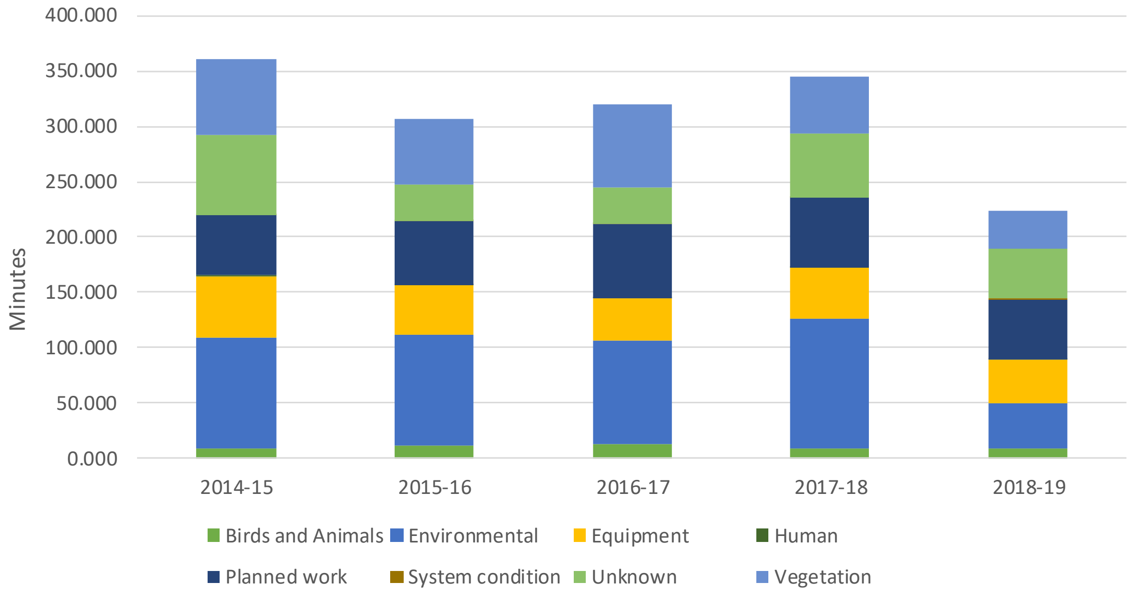
[14] The figures include MEDs.

Figure 3.2 Breakdown of outage causes – contribution to network SAIFI



Source: TasNetworks, *2019 Annual Performance Report*.

Figure 3.2 Breakdown of outage causes - contribution to network SAIDI



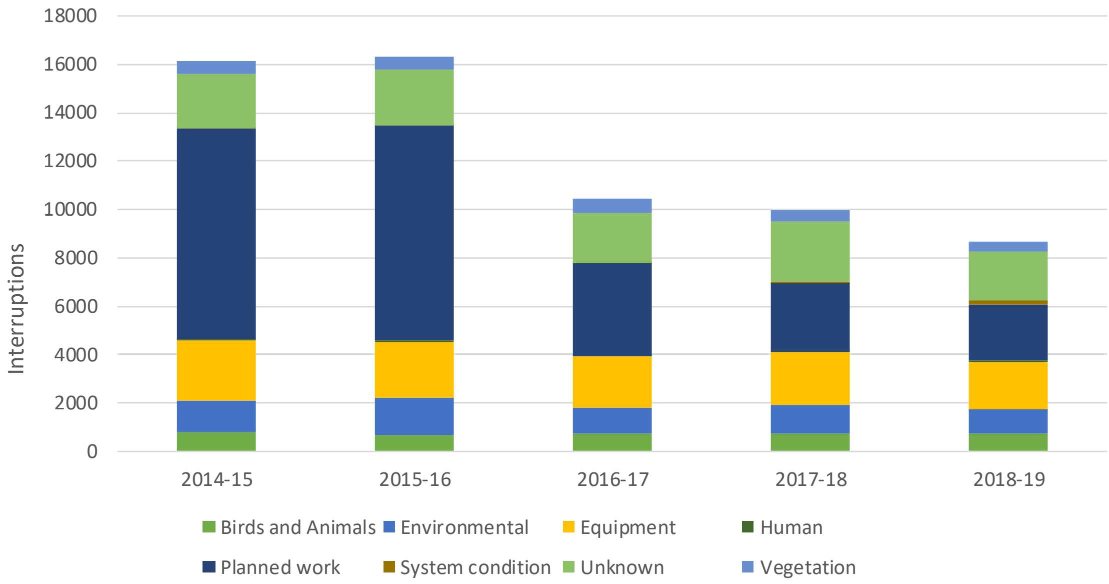
Source: TasNetworks, *2019 Annual Performance Report*.

The number of interruption events declined significantly in the last three years (Figure 3.3) largely due to the reduction in planned outages. The number of events attributable to the other main causes of supply interruptions has remained relatively constant over the past five years.

The main causes of outages are:

- planned work;
- unknown cause;
- equipment failure; and;
- environmental conditions.

Figure 3.3 Breakdown of outage causes – number of interruption events



Source: TasNetworks, *2019 Annual Performance Report*.

3.3.3.2 Network Performance at the community category level

Reliability performance of TasNetworks' distribution network, at the community category level is shown in Figure 3.4. The dashed lines show the TEC standard relating to the duration and frequency of outages for each category during any particular year.

In contrast to the normalised overall performance data, the TEC standards include MEDs but exclude outages caused by generation, transmission or third parties. Reliability performance is therefore affected by the number and duration of major weather events that occur in each year.

TasNetworks' achieved the standards for interruption frequency for all categories during the reporting period except for Critical Infrastructure, where the standard was not met in one year.

In contrast, TasNetworks did not achieve the standards relating to the duration of interruptions; for all categories, the average number of minutes of interruption, in terms of all customers in each community, was above the standard in the TEC. The only discernible trend with respect to the duration of interruptions was that TasNetworks' performance has been improving in the Low Density Rural category.

TasNetworks has advised that, for some communities, the increase in the SAIDI scores was due to more inclement weather events that were below the MEDs threshold but resulted in supply interruptions where power could not be restored promptly.

Figure 3.4 Reliability performance by community category - SAIFI and SAIDI

3.3.3.3 Network performance at the individual community level

TasNetworks achieved the TEC community interruption frequency standards in more than 90 per cent of all communities in each year over the reporting period, as was the case in the previous two years (Table 3.8). In a very large number of communities, consumers experienced a standard of service, with respect to the number of interruptions that was consistent with the Regulator's requirements.

Table 3.8 TasNetworks' performance against TEC frequency standards (individual community level) - SAIFI

Community category	Number of communities in category	Number of communities in each category where the standards were not achieved				
		2014-15	2015-16	2016-17	2017-18	2018-19
Critical Infrastructure	1	1	1	1	0	0
High Density Commercial	8	0	1	0	0	1
Urban and Regional Centres	32	4	5	4	2	1
High Density Rural	33	4	2	4	2	3
Low Density Rural	27	0	1	1	0	1
Total	**101**	**9**	**10**	**10**	**4**	**6**

Source: TasNetworks' 2019 annual performance data.

By contrast, for a much larger large number of communities, TasNetworks did not achieve the TEC interruption duration standards (Table 3.9). In a significant number of communities, consumers experienced a standard of service, with respect to the duration of interruptions that did not meet the Regulator's requirements.

Table 3.9 TasNetworks' performance against TEC duration standards (individual community level) - SAIDI

Community category	Number of communities in category	Number of communities in each category where the standards were not achieved				
		2014-15	2015-16	2016-17	2017-18	2018-19
Critical Infrastructure	1	1	1	0	0	1
High Density Commercial	8	0	1	0	1	1
Urban and Regional Centres	32	15	11	7	13	8
High Density Rural	33	10	4	8	9	5
Low Density Rural	27	14	10	11	12	6
Total	**101**	**40**	**27**	**26**	**35**	**21**

Source: TasNetworks' 2019 annual performance data.

The proportion of communities that did not receive the Regulator's standards of network services with the respect to either interruption frequency or duration (or both) ranged between 21 per cent and 35 per cent over the reporting period (Table 3.10). Communities in the Urban and Regional Centres, and Low Density Rural categories were disproportionally affected, while proportionately fewer communities in the High Density Commercial and High Density Rural received services below the Regulator's standards. It is important to note, however, that as the standards vary per **category,** conclusions cannot be drawn about the absolute level of network services that customers received in these categories.

Table 3.10 TasNetworks' performance against TEC standards (individual community level) - either SAIFI or SAIDI (or both)

Community category	Number of communities in category	Number of communities in each category where the standards where either TEC frequency or duration standards (or both) were not met.				
		2014-15	2015-16	2016-17	2017-18	2018-19
Critical Infrastructure	1	1	1	1	0	1
High Density Commercial	8	0	1	0	1	1
Urban and Regional Centres	32	15	12	8	13	8
High Density Rural	33	10	4	9	9	6
Low Density Rural	27	14	10	11	12	6
Total	**101**	**40**	**28**	**29**	**35**	**22**

Source: TasNetworks' 2019 annual performance data.

The variability of performance for each category, and from year to year, means that it is not possible to identify any trends regarding the quality of TasNetworks' network services at the community level over the reporting period.

Table 3.11 TasNetworks' performance against TEC standards (individual community level) - both SAIFI and SAIDI

Community category	Number of communities in category	Number of communities in each category where the both TEC frequency and duration standards were not met.				
		2014-15	2015-16	2016-17	2017-18	2018-19
Critical Infrastructure	1	1	1	0	0	0
High Density Commercial	8	0	0	0	0	1
Urban and Regional Centres	32	3	3	2	2	1
High Density Rural	33	4	2	3	2	2
Low Density Rural	27	0	1	1	0	1
Total	**101**	**8**	**7**	**6**	**4**	**5**

Source: TasNetworks' annual performance data

At an individual community level, a number of communities have consistently received lower reliability of supply. Based on reliability performance over a number of years, TasNetworks has identified 10 communities as areas which "warrant consideration to improve supply reliability" (Table 3.72).[15]

Table 3.72 Communities experiencing consistently lower reliability of supply

Community	Reliability category
Pirates Bay - Nubeena - Port Arthur	High density rural
Zeehan	High density rural
Mid-Tamar (including Exeter)	High density rural
Highlands	Low density rural
Tasman Peninsula Rural	Low density rural
West Coast	Low density rural
Tamar West	Low density rural
Strahan	Urban and Regional Centres
Tamar South	Urban and Regional Centres
St Helens	Urban and Regional Centres

3.3.3.4 Guaranteed Service Level Scheme

The total annual level of Guaranteed Service Level payments varied over the reporting period, from close to $4 million 2016-17 to less than $1.5 million in 2018-19 (Table 3.83).

[15] TasNetworks, *Annual Planning Report 2019*, page 43.

Table 3.83 GSL Scheme number and value of payments

Performance Measure	Units	2014-15	2015-16	2016-17	2017-18	2018-19
Outage duration - payments made	number	27,940	11,647	31,023	26,976	11,714
Outage duration - amount paid	$	3,203,600	1,222,240	3,526,080	2,901,280	1,177,920
Number of outages - payments made	number	2,207	2,067	3,536	3,869	3,189
Number of outages - amount paid	$	167,440	165,360	282,880	309,520	228,720
Total payments made	number	**30,147**	**13,714**	**34,559**	**30,845**	**14,903**
Total GSL payments paid	$	**3,371,040**	**1,387,600**	**3,808,960**	**3,210,800**	**1,406,640**

GSL payments are not an accurate indicator of distribution network reliability during a particular year as the number and amount of payments in a year is affected by the timing of payments to customers, which may relate to events in the previous financial year. TasNetworks stated that the significant decrease in GSL payments in 2018-19 relative to 2016-17 and 2017-18 reflects fewer MEDs in 2018-19.

3.3.3.5 Power quality

There was an overall improvement in the quality of supply from TasNetworks' distribution network over the reporting period (Table 3.14). There were generally fewer overvoltage events than in the previous two years and in some categories the number of events was especially low in 2018-19, such as lightning-related events. TasNetworks has advised that the significant reduction in the last two categories relates to TasNetworks implementing a number of measures to reduce overvoltage associated with rooftop PV, which is discussed in Chapter 5 of this report.

The one major exception was in 2018-19 for events in the category of "Customers receiving overvoltage due to high voltage injection". The significant increase in the number of customers affected was the result of a voltage surge caused by an HV/LV connector clashing due to wind. The transformer neutral failed and the excess voltage was not dispersed.

Table 3.14 Quality of supply performance indicators

Performance Indicator	2014-15	2015-16	2016-17	2017-18	2018-19
Over voltage events due to high voltage injection events	1	2	2	2	3
Customers receiving over voltage due to high voltage injection	12	15	6	3	65
Overvoltage events due to lightning	21	81	24	20	16
Customers receiving overvoltage due to lightning	39	127	39	40	25
Overvoltage events due to voltage regulation or other causes	129	98	106	74	34
Customers receiving overvoltage due to voltage regulation or other causes	129	98	106	74	34

Source: TasNetworks, *2019 Annual Performance Report*.

4 RELIABILITY PERFORMANCE FOR THE BASS STRAIT ISLANDS

4.1 Performance Standards

The operation of the power system on the BSI is subject to the requirements set out in the TEC. Chapter 4A of the TEC, Bass Strait Islands (system operations and network service provisions), contains performance standards with respect to the operation of the distribution network on the islands. Clause 4A. 4.1 requires Hydro Tasmania to use reasonable endeavours to ensure that the total number and duration of combined planned and unplanned interruptions to the feeders on the BSI are less than the standards set out in Table 4.1.

Table 4.1 BSI network reliability performance standards

High density rural		Low density rural	
Annual number of supply interruptions	Annual total interruption time	Annual number of supply interruptions	Annual total interruption time
6	480 minutes	8	600 minutes

Source: Tables 4A.4 and 4A.5, TEC Chapter 4A.

4.2 Reporting requirements

Hydro Tasmania is required to report quarterly and annually on the performance of the distribution network on the BSI in accordance with the requirements in Section 9 of Performance Guideline.

Hydro Tasmania calculates SAIFI and SAIDI using rolling 12 month data to smooth out short-term fluctuations and highlight any trends or cycles. Unlike data for the mainland Tasmanian distribution network, SAIDI and SAIDI are not based on customer numbers but on the feeders on each island and interruptions relating to those feeders.

4.3 Overall distribution performance

The performance of Hydro Tasmania's distribution network on both Flinders and King Islands deteriorated over the reporting period with respect to both the frequency and duration of outages. (Figures 4.1 and 4.2).

Figure 4.1 Bass Strait Islands: Hydro Tasmania's overall distribution performance - SAIFI

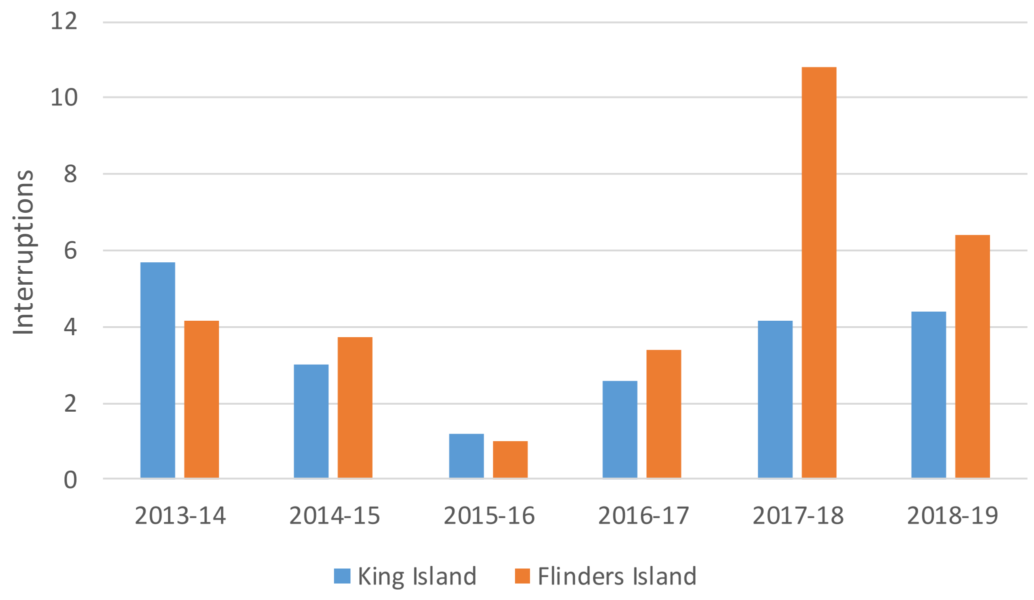
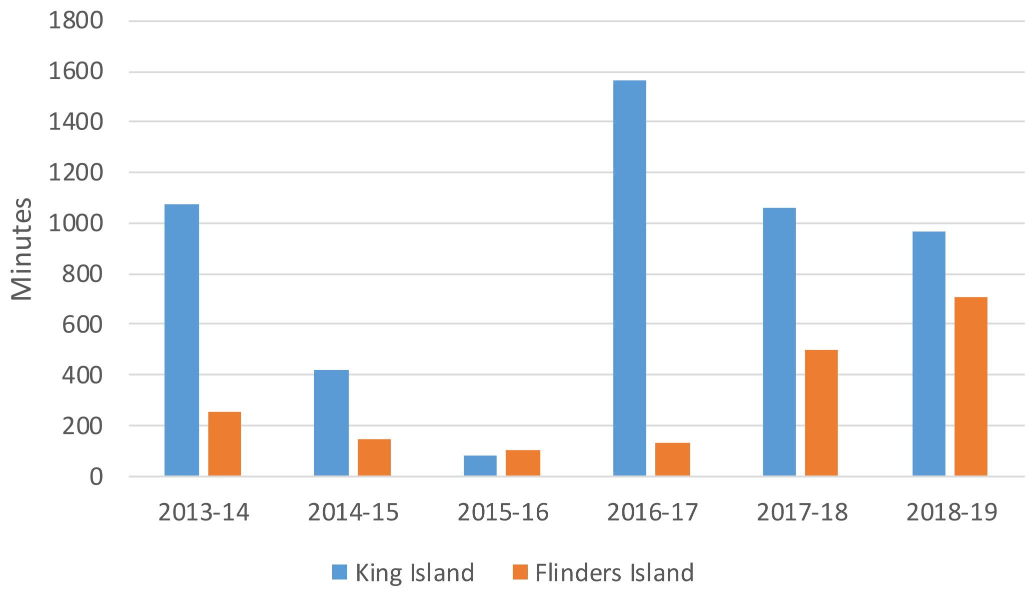


Figure 4.2 Bass Strait Islands: Hydro Tasmania's overall distribution performance - SAIDI

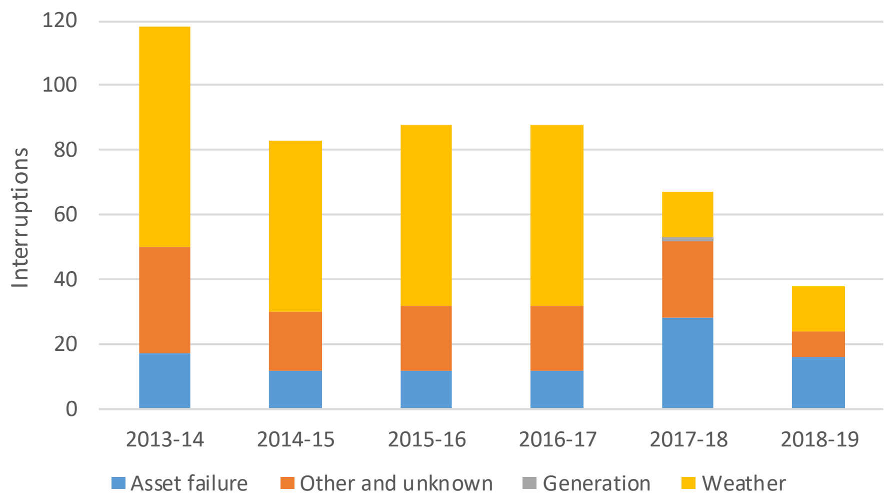


4.3.1 Causes of interruptions

The cause of an outage is recorded by field crews and can be difficult to determine after an interruption event. Figures 4.3 and 4.4 show the annual causes of interruptions on each island.

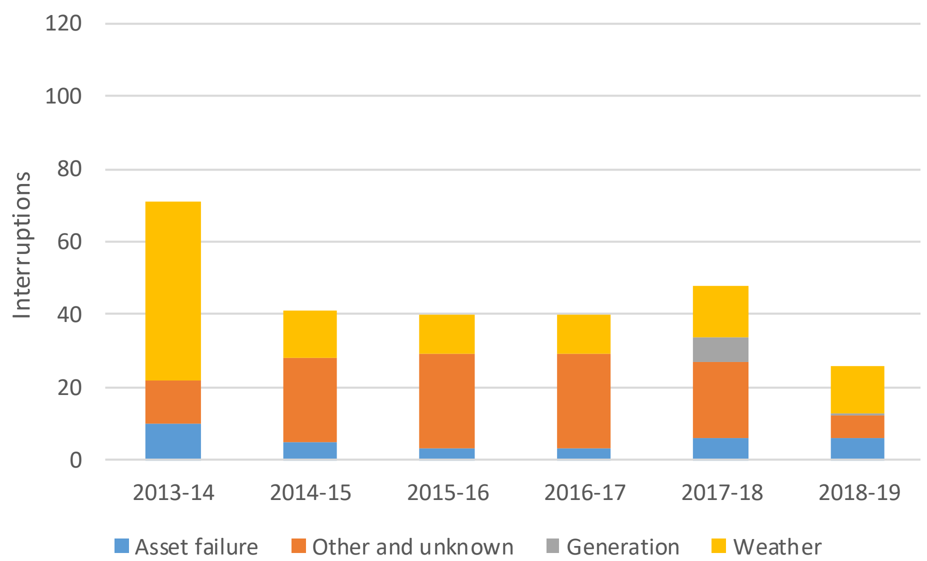
The main cause of outages on Flinders Island has been "other and unknown" (which includes vegetation and contact with wildlife) over the reporting period. The number of interruptions due to weather can vary significantly from year to year on Flinders Island; there was a large number of weather-related interruptions in 2013-14, and some increase in 2017-18 and 2018-19 from relatively few events in the preceding years. There were also more asset-related interruptions in the past two years. In 2018-19, there was a significant decline in interruptions in the "other and unknown" category which accounted for the overall decline in interruptions in that year.

Figure 4.3 Cause of interruptions - Flinders Island



For King Island, weather-related factors have tended to account for more interruptions than any other cause, though the number of weather-related supply interruptions declined significantly in the past two years. As with Flinders Island, the number of interruptions caused by asset failure was higher than in **previous** years.

Figure 4.4 Cause of interruptions – King Island



4.3.2 Individual Feeder Performance

The performance of the individual feeders on each island, relative to the targets set by the TEC is shown in Figure 4.5.

Figure 4.5 Individual feeder performance by feeder category 2013-19

There was considerable variability in performance of feeders in terms of the frequency and duration of interruptions, as measured by SAIDI and SAIDI, with the longer rural feeders such as Grassy and Cape Wickham performing significantly worse than feeders in Currie and Whitemark, particularly with regard to the duration of outages. The increase in SAIDI and SAIFI was due to the increase in unplanned interruptions.

Rural feeders on the BSI are generally radial in nature with little interconnection capability and they operate in a marine environment that is subject to frequent inclement weather. In addition, the feeders are located in varying terrain, making access difficult (for example, access to Cape Wickham and Grassy feeders requires traversing wetland areas).

Furthermore, repairs to feeders during inclement weather can be delayed due to safety issues, which further impacts the duration of outages on both islands.

Hydro Tasmania states that contact with vegetation, bird strikes, inclement weather, including lightning, are the major cause of outages on both islands with vegetation-related interruptions a major issue on King Island. In response, Hydro Tasmania is maintaining a pro-active vegetation clearing programme on the island in addition to working with farmers to clear vegetation on private properties.

To improve reliability of supply on the BSI, Hydro Tasmania has been investing in numerous measures to improve and/or maintain network reliability on the BSI. Measures taken include installation of automated reclosers and load breaks and replacing pole top hardware, condemned poles and transformers, upgrading insulators, cross arm pins and re-tying the conductors and replacing hardware with stainless steel and fibreglass composite materials so as the infrastructure can better withstand corrosion.

The Regulator notes deterioration in network performance on the BSI but considers that Hydro Tasmania's recent and ongoing upgrade projects are an adequate response to the reliability issues on the islands.

4.4 Power quality

As the BSI system controller under Chapter 4A of the TEC, Hydro Tasmania is required to assess the impact of proposed new generation on the stability and security of the BSI power system. The increased amount of rooftop PV generation on the islands has reduced the amount of generation that is currently within Hydro Tasmania's control, which can affect the security and stability of the BSI power system.

To enable Hydro Tasmania to maintain power system security, it requested in July 2019 that the Regulator amend the TEC to enable it to:

- implement adequate protection systems for managing voltage fluctuations;
- ensure reserve requirements are managed appropriately; and
- require all new generation connection on the BSI to enter into a connection agreement with enables Hydro Tasmania to interrupt exports to the network in order to maintain system security.

The Regulator consulted on the proposed changes in late 2019 and will finalise the code changes in February 2020.

5 ISSUES RELATING TO RELIABILITY AND POWER QUALITY

5.1 Roof-top photovoltaic (PV)

There are both network-wide and local implications from non-synchronous inverter-based generators accounting for an increasing proportion of the generation within a network. Rooftop PV is the most common non-synchronous inverter-based generator.

At the network level, the disconnection of a large number of these smaller generators during a low frequency disturbance would magnify a frequency deviation which could lead to unanticipated loss of supply.

At a local level, increased amounts of rooftop PV generation impact on voltage and, as a consequence, require increased voltage regulation. Rooftop PV inverters are typically designed to operate in what is known as 'voltage-following' mode and disconnect when voltage moves outside set parameters. This helps protect the equipment and ensure power quality. In situations where there is a large number of rooftop PV systems connected to a feeder this can exacerbate problems. For example, a sudden increase in demand can cause voltage to 'sag' ie fall below prescribed limits. The decrease in voltage may cause a number of inverters to automatically disconnect and, by removing the electricity they were exporting to the grid, exacerbate the issue. Issues related to overvoltage can also occur, particularly at times when generation is high and demand is low, for example during sunny days when household residents are not consuming electricity.

The introduction of performance specifications for inverters in PV installations resulted in a reduction in customers reporting incidences of overvoltage. During its emPOWERing You trial in 2017, TasNetworks identified customers receiving overvoltage in the trial area. Further investigation revealed that overvoltage was more widespread than identified thorough customer feedback and resulted in TasNetworks implementing a number of programs to address the issue, such as transformer re-tapping to regulate voltage. TasNetworks expects these programs to be completed during 2020 .

5.2 Power quality

At the transmission level, the increased amount of non-synchronous generation means the power system is operating closer to its technical boundaries for extended periods and is more susceptible to disruption. Consequently, TasNetworks monitors power quality using an automated management system which records power quality performance.

Section 5.1 of the NER stipulates power system standards. TasNetworks monitors power quality against these standards at the following substations:

- Derby (110 kV and 22 kV);
- George Town (220 kV, 110 kV and 22 kV);
- New Norfolk (110 kV);

- Risdon (110 kV);
- Smithton (110 kV); and
- Waddamana Substation (220 kV).

TasNetworks also has two portable monitoring units, for temporary installation at locations where power quality limitations require investigation, and a portable optical current transformer at the George Town substation for high bandwidth harmonic current measurements.

5.3 Inertia and fault levels

Electrical appliances are designed to work at a particular electrical frequency which is determined by the generation supply-demand balance. When this balance changes, for example due to a sudden loss of demand or generation, the frequency will change and network operators must respond and restore the balance. The rate of change of frequency is determined by the amount of inertia in the electrical system.

Large conventional spinning generators, such as turbines in a hydro-electricity power station, provide inertia, which provides time to adjust the system after a frequency event. When a frequency event occurs, the inertia these large generators provide will slow the rate of frequency change.

In Tasmania the continued increase in small scale generation, in particular rooftop PV, together with the increase in the number of large scale wind farms, has increased the amount of non-synchronous generation relative to the amount of synchronous generation. This has affected the amount of inertia in the Tasmanian grid, creating the risk that there will be insufficient inertia and resulting in grid security being compromised. TasNetworks' 2019 Annual Planning Report stated that:

> "During March 2019, we experienced periods where the sparse dispatch of synchronous generators, especially in northern Tasmania, resulted in very depressed levels of system strength and system inertia. At present, such operating conditions are most likely during Basslink import when Tasmanian wind and solar generation are also at high output."

To address the inertia issue, the AEMC has made a change to the NER whereby, from 1 July 2019, TNSPs are required to contract with inertia providers or install synchronous condensers to provide the minimum level of inertia required for system security as determined by AEMO. A similar NER change, effective from 1 July 2018, requires TNPS to meet minimum levels of system strength at key locations in the power system when shortfalls are identified by AEMO.

5.4 Stand-alone power systems

Advances in technology and decreasing technology costs are making SAPS a viable alternative, in some cases, to the current, large centralised network model of supplying electricity. The AEMC, at the request of the COAG Energy Council, looked at the law and rule changes required to allow local DNSPs or third parties to deploy SAPS where it is economically efficient to do so, while maintaining appropriate consumer protections and service standards. The AEMC released its draft report on this issue on 19 December 2019[16] with submissions due by 13 February 2020.

[16] https://www.aemc.gov.au/sites/default/files/documents/updating_the_regulatory_frameworks_for_distributor-led_stand-alone_power_systems_-_draft_report_-_final.pdf

A major issue in progressing SAPS, with respect to reliability, is that customers should not be disadvantaged with regard to the reliability of supply if they are transitioned to a stand-alone power system. Also, customers generally are not able to choose their retailer if they are in a SAPS.

Under the proposed arrangements the responsibility for reliability of supply and power, quality will vary depending on the characteristics of the stand-alone power system. The reliability standards applicable to grid supplied customers will be applied to SAPS provided by DNSPs. However, applicable standards for SAPS provided by third parties are subject to continued discussion between jurisdictions and the AEMC.

In its review of the regulatory arrangements required for SAPS to be implemented, the AEMC proposed that larger SAPS be governed by jurisdictional licensing arrangements including jurisdictional performance targets while small SAPS be subject to the terms and conditions set out in private contracts with the SAPS third party supplier.[17]

In its Annual Planning Report, TasNetworks stated that it is investigating the use of SAPS as an alternative to connection to electricity supply via distribution lines in areas where supply costs are high relative to the load and/or customer numbers is small.

TasNetworks has identified five potential SAPS sites which it will progress during the next five years and has stated that it is "proactively commencing the project planning for these sites in advance of the AEMC review being finalised so that the first sites can be implemented as soon as practically possible."[18]

5.5 Reliability expectations of network planning requirements for transmission and distribution networks

In its submission[19] on the draft terms of reference, TasNetworks suggested that there would be benefit in reviewing the network planning requirements set out in Regulation 5(1) of the *Electricity Supply Industry (Network Planning Requirements) Regulations 2018* to ensure consistency between the reliability expectations of the transmission and distribution networks.

In particular, TasNetworks pointed out that:

> "In Tasmania, the transmission system includes the peripheral 110 kV network and substations that supply the distribution network at 33, 22 and 11 kV. However, in the rest of the National Energy Market, these parts of the network would largely be classed as part of the distribution network. The regulations set performance requirements suitable for the backbone of the transmission network but applying the same requirements at the periphery can lead to perverse outcomes."

Work is being undertaken by the Office of the Tasmanian Economic Regulator on this issue, in discussion with the Department of State Growth.

[17] AEMC, Draft Report, *Updating the Regulatory Frameworks for Distributor-led Stand-Alone Power Systems*, 19 December 2019.

[18] TasNetworks, *Annual Planning Report 2019*, page 21.

[19] TasNetworks' submission is available on the Regulator's website: https://www.economicregulator.tas.gov.au/electricity/reports/network-reliability-review.

6 MEDIUM TERM OUTLOOK FOR NETWORK SERVICES RELIABILITY AND POWER QUALITY

This Chapter of the Report discusses the outlook for the medium term. For the purposes of this Report, the medium term has been taken to be the next five years.

6.1 Power quality

TasNetworks' current power quality monitoring program was discussed in Chapter 5 of this Report. In its 2019 Annual Planning Report, TasNetworks states that it may expand its monitoring program, to cover a greater network area, as connection proposals are received. The objective of this initiative is to enable TasNetworks to more readily, and in a timelier manner, identify sources of power quality disturbances.

With the Granville Harbour and Cattle Hill wind farms coming into production in 2019-20, the composition of Tasmania's generation will change significantly as wind generation will account for almost 20 per cent of generation in the State. This will further increase the amount of non-synchronous generation relative to the amount of synchronous generation.

6.2 Network reliability

TasNetworks intends maintaining current network reliability performance levels while ensuring compliance with its regulatory obligations. It will, however, aim to improve reliability levels in poorer performing areas to meet regulatory requirements.

TasNetworks will continue to maintain and improve reliability through:

- targeted investigations into the worst-performing distribution lines,
- network reinforcement; and
- ongoing asset management activities.

Asset management activities include:

- vegetation management (trimmed or removed) to prevent contact with distribution lines resulting in supply interruptions;
- prioritising defect rectification programs to ensure assets posing a risk to reliability are repaired to reduce the likelihood of supply interruptions;
- reviewing protection settings to ensure as few customers as possible lose supply following faults;
- targeted and specialised inspections programs, such as aerial and thermographic surveys, that focus on high-risk assets or specific asset failure modes; and

- introducing new technologies, such as line fault indicators, to assist field crews in finding failed assets or restoring distribution line sections more quickly, minimising duration of supply interruptions and assisting in root cause analysis and reducing recurrences.

6.3 Values of Customer Reliability

Values of Customer Reliability (VCRs) attempts to identify the value customers place on a reliable supply of electricity. The AER is responsible for developing VCR's for all jurisdictions, except Western Australia, and published its final report in December 2019.[20]

The AER developed VCRs, measured in dollars per kilowatt hours, for different regions and types of customers. In general, business customer VCRs are higher than residential customer VCRs. The current VCRs apply from 30 December 2019 and will be updated by the AER annually.

As mentioned in Section 1.2 of this report, there is a trade-off between increased reliability and the cost of supply. The most efficient outcome is where customers receive the reliability of supply they are willing to pay for. These VCRs will assist TasNetworks to determine the amount to invest in order to maintain a safe and reliable supply of electricity and avoid expenditure on assets where customers do not value the increased expenditure.

6.4 Stand-alone power systems

TasNetworks is proceeding with a SAPS programme. The impact on reliability performance of moving customers from the existing network to a SAP is currently unknown.

The creation of SAPS will require changes to the NER, NEL and jurisdictional legislation to provide a regulatory framework that can accommodate the different characteristics of each stand-alone power system and provide appropriate customer protections.

6.5 Electric vehicles, batteries and distributed generation

Ownership of electric vehicles and home batteries in Tasmania is at relatively low levels[21] but is expected to increase, together with the amount of distributed generation, as more customers seek increased control over their electricity usage.[22] Currently, there appear to be no major reliability or power quality issues relating to electric vehicles, home batteries and distributed generation. TasNetworks is currently investigating the potential impact of these technologies on the network.[23]

6.6 Inertia and fault levels

AEMO's *Inertia Requirements and Shortfalls Report* sets out AEMO's approach to assessing the adequacy of the minimum inertia in each inertia sub-network (currently defined by reference to regional boundaries). Based on these minimum inertia requirements and its *2018 National Transmission Network Development Plan*[24], in November 2019 AEMO published its *Notice of Inertia and Fault Level Shortfalls in Tasmania report.*[25]

[20] AER, *Values of Customer Reliability, Final report on VCR values*, December 2019.

[21] TasNetworks, *2019 Annual Planning Report*, page 19.

[22] Ibid, page 12.

[23] Ibid, page 12.

[24] AEMO, *National Transmission Network Development Plan*, December 2018

[25] AEMO, *Notice of Inertia Fault Level Shortfalls in Tasmania*, November 2019.

The report constitutes AEMO's notice of its assessment of inertia and fault levels and is a formal declaration of shortfalls under the NER. TasNetworks has 12 months to procure sufficient inertia and fault level services to meet the minimum requirements. AEMO is continuing to review the Tasmanian requirements for inertia, and three phase fault levels at designated fault level nodes. Following completion of this review, AEMO may issue a further declaration on shortfalls in inertia or system strength.

7 CONCLUSION

Based on the information examined during the course of its review, the Regulator has concluded that the reliability of the transmission network, including Basslink, has been satisfactory during the reporting period and no major issues have been identified that are likely to impact on reliability in the medium term.

The reliability of the distribution network on mainland Tasmania has deteriorated slightly during the reporting period. However, the Regulator accepts that performance fluctuates from year to year and has concluded that, overall, performance has been satisfactory. The Regulator also supports TasNetworks' targeted review of supply reliability in the poorer performing communities.

The Regulator also notes that reliability performance on the BSI has deteriorated during the reporting period. However, the Regulator recognises that Hydro Tasmania has invested, and continues to invest, in upgrading the network to improve reliability performance of the BSI network.

The Regulator notes that the NER changes with regards to the procurement of inertia and fault level services are designed to address shortages in Tasmania thereby improving the stability of the Tasmanian power system.

APPENDIX A – TERMS OF REFERENCE

2019 Network Reliability Review

Terms of Reference, August 2019

Objective

The objective of the 2019 Network Reliability Review is to review the reliability of network services in Tasmania over the previous three years and to identify issues that may impact on the reliability of network services in future years.

Background

Section 10B (1) of the *Electricity Supply Industry Act 1995* requires the Regulator to conduct a review into the reliability of network services at least once every three years.

After conducting the review, the Regulator is to prepare a Network Reliability Report (the Report) setting out the findings from its review. A copy of the Report must be tabled in both Houses of Parliament and made available to members of the public.

Under section 3 of the Act, network services means:

> (a) the transmission and distribution of electricity between electricity entities and from electricity entities to customers; and
>
> (b) controlling and regulating the quality of electricity;

The Tasmanian Electricity Code defines reliability as "the probability of a system, device, plant or equipment performing its function adequately for the period of time intended, under the operating conditions encountered."

Electricity network reliability is currently addressed by a number of regulatory arrangements within the National Electricity Market (NEM). These arrangements are largely focused on detailed network operations and planning. The Network Reliability Review will not duplicate these arrangements.

The *Electricity Supply Industry Performance and Information Reporting Guideline, 2014* requires TasNetworks to provide the Tasmanian Economic Regulator with information annually on the performance of the electricity network on mainland Tasmania. The Network Reliability Review will review, summarise and comment on the annual performance information provided over the previous three years. The review will also report on the reliability of network services on the Bass Strait Islands.

Electricity networks are currently facing a number of developments that have the potential to change how networks are designed and operated. Electricity networks are increasingly being used as a means of exchanging electricity from various sources, rather than solely transporting electricity from large scale generators to customers.

The review will therefore also examine generation and demand factors that may impact on network reliability.

Terms of reference

(1) The Regulator will review the reliability of network services in the Tasmanian power system taking account of the Regulator's objectives under the *Electricity Supply Industry Act 1995* to:

(a) establish and maintain a safe and efficient system of electricity generation, transmission, distribution and supply;

(b) establish and enforce proper standards of safety, security, reliability and quality in the industry; and

(c) protect the interests of consumers of electricity.

(2) The Regulator will make recommendations to the Treasurer and/or the Minister for Energy, as appropriate, with respect to the current or future reliability of network services in the Tasmanian power system.

(3) In particular, the Regulator will:

(a) consider the performance of network services against standards, requirements and targets for reliability;

(b) identify issues which may impact on the reliability of network services in the medium term (the next three to five years);

(c) identify measures to address any issues identified and/or mitigate their impact; and

(d) comment on the status of the implementation of recommendations from previous reviews.

(4) In conducting this review, the Regulator will take into account:

(a) relevant legislative requirements;

(b) the size and nature of Tasmania's power system (including the impact of connection to the NEM via Basslink);

(c) consistency of Tasmanian network reliability standards with the National Electricity Network Reliability Principles as endorsed by the COAG Energy Council;

(d) performance against relevant transmission and distribution performance requirements;

(e) the impact on the reliability of network services of demand side management programs and customer participation programs;

(f) any potential impacts arising from likely future changes in load;

(g) the Government's energy strategy, *Restoring Tasmania's Energy Advantage 2015*; and

(h) to the extent they are applicable, the results and conclusions from relevant/applicable reviews, studies and documents in relation to network reliability published by:

- the Australian Energy Market Operator;

- the Australian Energy Market Commission;
- the Australian Energy Regulator; and
- regulated and licensed entities.

(5) In this review, the Regulator will also consider:

(a) the potential impact on the future reliability of electricity network services in Tasmania of:

- intermittent and low inertia generation;
- solar PV generation;
- battery storage; and
- electric vehicles

Review outcomes

The outcomes of the review will be presented in the Network Reliability Report. The Report will identify high level issues that may impact on the reliability of the Tasmanian electricity network over the medium term. The Report is intended to inform stakeholders and assist energy policy development in the State.

The review will not address detailed or specific network reliability issues, as these are addressed through existing regulatory frameworks within the NEM.

Review process

The review will be conducted as follows:

(a) the Regulator will advise stakeholders that it will conduct a review, provide them with the terms of reference, and invite comments and submissions on the matters covered by the review's terms of reference from stakeholders and any other interested parties;

(b) the Regulator will meet with stakeholders to discuss the reliability of network services over the past three years and identify, consider and discuss issues that are likely to affect the reliability of network services in the Tasmania in the medium and longer term;

(c) the Regulator will publish the Report on its website; and

(d) the Regulator will arrange for the Report to be tabled in Parliament.

Timetable

The timetable for the review is as follows:

Milestone	Target dates
Regulator writes to stakeholders advising of the upcoming review	28 June 2019
Regulator releases the terms of reference for the review and seeks comments and submissions from stakeholders and any other interested parties on the matters in the terms of reference	1 July 2019
Comments and submissions due on matters contained in the terms of reference	19 July 2019
Regulator approves release of draft report for comment	11 November 2019
Comments due from stakeholders on the draft report	30 November 2019
Regulator considers submissions, meets with stakeholders as necessary and prepares final report	December 2019
Regulator approves final report	17 January 2020
Regulator publishes final report	31 January 2020
Report tabled in Parliament	2020 Autumn session