UTILITIES COMMISSION
OF THE NORTHERN TERRITORY

Northern Territory Power System Performance Review

2019-20

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Disclaimer

About this review

Since 2018, the Utilities Commission of the Northern Territory (Commission) has published an annual Northern Territory Power System Performance Review (NTPSPR), which focuses on generation and network performance of the regulated power systems (an electricity network where network access legislation applies), being the Darwin-Katherine, Alice Springs and Tennant Creek power systems. Where possible, the NTPSPR compares current performance to historical data to identify trends.

The 2019-20 NTPSPR is prepared in accordance with section 45 of the *Electricity Reform Act 2000* and is restricted to the Northern Territory's regulated power systems.

The NTPSPR's main purpose is to inform the responsible minister, government, licence holders and stakeholders of the 2019-20 generation and network performance in the Territory's regulated power systems, and highlight any areas of concern.

Regular reporting on the electricity supply industry should help increase understanding and transparency of issues and, consequently, improve planning, investment, understanding of value for money (price compared to level of service) and general performance by holding electricity businesses accountable for their performance and impact on customers.

The content of the NTPSPR was largely produced by Entura on behalf of and with the assistance of the Commission, and with input from licensees (Power and Water Corporation (PWC) Power Services and System Control, EDL NGD (NT) Pty Ltd (EDL) and Territory Generation), with the inclusion of more comprehensive stakeholder consultation in this year's review. The Commission supports the analysis, conclusions and recommendations made on its behalf by Entura.

Key findings and recommendations

Overall performance

Overall the review found the performance of the Darwin-Katherine power system to be satisfactory in 2019-20, although the level of performance was lower in the Katherine region, while generation performed poorly in Alice Springs and the overall performance in Tennant Creek was poor.

During the reporting period, the Alice Springs power system was impacted by a significant system black on 13 October 2019. Following the system black, the Territory Government requested the Commission to conduct an independent investigation of the incident. The 2019-20 NTPSPR does not seek to cover this incident in detail or duplicate recommendations made in the Commission's independent investigation as both are extensively covered in the investigation report. Further, the 2019-20 NTPSPR does not seek to cover in detail progress made during 2020-21 regarding implementation of the independent investigation recommendations, which has been positive and is covered in the Commission's six-monthly progress reports.

The 2019-20 period saw continued change in each of the three regions. The Alice Springs and Tennant Creek power systems continue to undergo large-scale change in their generation mix with older units being phased out of service. The Darwin-Katherine and Alice Springs regions are seeing increased behind-the-meter solar photovoltaic (PV) connections and Darwin-Katherine is preparing to connect the first of a number of large-scale solar PV power stations.

This changing environment must be proactively managed, and there are signs of this mindset in the licensees' approach to the changes and challenges. However, there remains a large gap to close.

It is encouraging to see more rigorous systems around communication between licensees. The regular dialogue and other administrative controls appear to be delivering better performance and an improved culture of collaboration.

While there are obvious differences across the three power systems in terms of scale, network topology and generation mix, there are some common issues, which are discussed in detail in this review.

All of the recommendations from the 2018-19 NTPSPR remain in progress, noting the recommendations are those of the Commission and are not enforceable unless they relate to non-compliance. The performance of the power systems in 2019-20 demonstrates that these recommendations remain valid or are not yet completed to a satisfactory extent.

While progress is slow, the Commission considers that intentional work is being undertaken to address recommendations and there is some evidence the pace of progress may be increasing. Where progress is being made, the benefits are showing in terms of the performance of the power systems. A summary of progress against these recommendations follows the individual power system performance summaries in this section of the review.

Summary of recommendations

The following recommendations, listed in order of importance, result from the investigations and analysis undertaken as part of the review:

1. More thorough investigation of single unit trips (page 14)

It is now exceedingly rare for a single unit trip in Darwin-Katherine and Alice Springs to lead to the operation of load shedding and subsequently impact customers, however it remains important for generation licensees to understand why their generation units tripped in the first place.

There are two seemingly related issues regarding single generator trips that generation licensees need to understand. These issues are why the generation units trip in the first place and why it is that once a generation unit has tripped, it seems more likely the unit will trip again on the same day.

Single generator trips will continue to occur (and seemingly at greater frequency) unless more thorough investigation of the cause of single unit trips and identified issues are addressed. Entura considers this to be good electricity industry practice and should be part of normal asset management practices.

2. Alice Springs power system operability (page 39)

Consistent with previous NTPSPR recommendations, appropriate power system modelling needs to be undertaken to determine how the Alice Springs power system can be operated once generation is solely or predominantly located at the Owen Springs power station. This remains important work to ensure the eventual transition in Alice Springs does not expose customers to further decreases in reliability while the system controller reacts to failures.

The work should include sufficient system studies to understand the voltage and frequency regulation requirements of the Alice Springs power system across the range of customer demand and network conditions. In particular, it should inform operational protocols around appropriate voltage profiles and network switching arrangements to ensure operation of the network can occur in a consistent and robust way.

3. Investigate alternatives to the Weddell power station constraint (page 23)

There is currently a constraint imposed on the operation of the Weddell power station under certain load conditions due to thermal capacity limits in the network to allow for secure operation. Similar situations are managed through a run-back scheme in other jurisdictions and should be investigated along with other alternatives to remove this constraint. This may allow the Weddell power station to be operated with greater flexibility, which is important given the expected generation mix changes in the Darwin-Katherine region, and should lead to more efficient generation dispatch.

4. Better post-commissioning support mechanisms (page 37)

Entura has observed a number of the upgrades and new connections to the power systems have had lingering post-commissioning performance issues. Some of these performance issues have had a large customer impact over an extended period of time. This pattern of performance across multiple new installations leads Entura to conclude that there may be a need for more effective management of post-commissioning performance.

It is recommended that post-commissioning support mechanisms supplied by original equipment manufacturers and other service providers be reviewed in terms of the scope, duration and terms of any existing agreements. Effective commercial relationships with third parties will enhance the effectiveness of power system assets through faster issue resolution and or return to service.

5. Coordination of generation protection and power system requirements (page 48)

The setting of protection limits for over and under voltage and frequency on generating units should always represent the capability of the generation units themselves rather than the power system limits, which are lower. Setting generation protection limits to levels that represent the capability of the generation units, and not that of the power system limits, should allow for some margin between the power system limits of operation and the range over which a generating unit can safely operate. Entura has seen instances where generating unit protection settings are set too close to the power system limits. In Entura's opinion, this overly conservative protection can and has exposed the power system to security issues. It is recommend that closer attention is paid to the protection settings of all power system equipment. Licensees should have accurate records of these settings and System Control should hold current copies of, or have access to, licensees' settings databases for the purposes of audit and incident investigation.

6. Management of voltage in Alice Springs (page 42)

Previous reviews have highlighted the need for investigation of, and potential investment in, managing supply voltages in the low voltage parts of the distribution network in the Darwin-Katherine power system. Supply voltage issues related to deviations outside of the 'preferred zone', which can have implications for customers' equipment connected to the network, arise in the low voltage parts of the distribution network for two reasons:

- lightly loaded low voltage (LV), medium voltage (MV) or high voltage networks
- behind-the-meter rooftop solar PV unloading distribution networks.

As well as being present in Darwin-Katherine, the two causes of supply voltage issues are also present in Alice Springs and will become more apparent once the influence of the Ron Goodin power station is removed or diminished.

There is an opportunity to proactively manage this problem as it looms, rather than once it eventuates in full.

The battery energy storage system (BESS) may be able to play some role, however its primary purpose of frequency regulation should not be sacrificed by being loaded with absorbing reactive power without first considering other solutions.

Darwin-Katherine

A review of generation and network performance in the Darwin-Katherine power system in 2019-20 found satisfactory performance, noting the level of performance is lower in the Katherine region of the system. While the overall performance trend is assessed to be flat or improving, warning signs remain that indicate significant issues must be addressed to maintain or improve performance in the future.

The frequency of single unit trips continues to increase. This is a vulnerability in a power system that is undergoing a transition to include more variable renewable forms of generation. Previously, the NTPSPR has recommended analysing the reason for these trips more thoroughly, however this has not happened to date.

In contrast, it is encouraging to see more rigorous systems around communicating between licensees. The regular dialogue and other administrative controls appear to be delivering better performance and an improved culture of collaboration.

Detail on the performance of the Darwin-Katherine power system in 2019-20, including comparisons to historical data, comprehensive discussion in relation to the identified issues and concerns, and highlights is provided in Chapter 1 of this review.

Table i: Generation and network performance in the Darwin-Katherine power system in 2019-20

	Performance	Trend	Issue/concern	Highlights
Generation	Satisfactory	Flat	• Investigation of single unit trips may not be consistent with good electricity industry practice • Single unit reliability • Over reliance on Channel Island • Advanced age of generation fleet • Katherine/Pine Creek island operation is not robust • Testing and abnormal plant condition management • Longer, more frequent incidents affecting customers	• No incidents initiated by generation in the Darwin region • No single generator trip under frequency load shedding events • Channel Island reliability • Strong reporting culture for non-reliable notices • Increasing customer reliability through System Control issued constraints, although likely with some cost to generators • Increased preventative maintenance • Management procedures and reporting is improved in relation to overlapping outages and system risk
Network	Satisfactory	Improving	• Transmission interruptions cascaded to generation • Katherine frequency of incidents high • Katherine voltage regulation is not managing over-voltages • Network limitations resulting in constrained generation • Testing and abnormal plant condition management • Four Katherine island blacks	• Low number of distribution level incidents • Planning for managing peak demand is effective • Improvements in outage coordination

Alice Springs

A review of generation and network performance in the Alice Springs power system in 2019-20 found network performance is satisfactory, however the generating units are not performing adequately, as summarised in Table ii.

The performance of the Alice Springs power system in 2019-20 is clouded by the system black that occurred on 13 October 2019. This event revealed many short-comings in the power system and its management. The event reinforces the importance of previous recommendations relating to design and commissioning practices, and power system operability planning. Licensees are engaged in addressing the asset-related shortcomings, however it has been advised by licensees that COVID-19 has made getting access to specific expertise from other parts of Australia and the world more difficult. There remains much to do to ensure the generators, BESS and network equipment can function in an acceptable manner.

The continuing reliance on the Ron Goodin power station due to delays in gaining full reliability from the Jenbacher generating units at the Owen Springs power station is of concern. While it appears that Territory Generation are working well to keep as many Ron Goodin power station generation units as functional as possible, the age of the generation units is leading to poor reliability. A combination of good management and more conservative spinning reserve practices (likely at increased cost) has insulated customers from much of the effect of these issues at the Ron Goodin power station and the ongoing Jenbacher issues at the Owen Springs power station. However, the system black more than eclipsed these efforts in terms of customer impact.

Detail on the performance of the Alice Springs power system in 2019-20, including comparisons to historical data, comprehensive discussion in relation to the identified issues and concerns, and highlights is provided in Chapter 2 of this review.

Table ii: Generation and network performance in the Alice Springs power system in 2019-20

	Performance	Trend	Issue/concern	Highlights
Generation	Poor	Flat	• Robustness of generating plant • Reliability and availability of the Owen Springs power station is not improving • Reduced availability of the ageing Ron Goodin power station • Testing and abnormal plant condition management • BESS fault ride through • Increased frequency of single generator trips • System black and the remaining issues around black start and machine reliability	• Reduced customer impact from single unit generation incidents • Better management of spinning reserve • General focus on new asset knowledge and familiarity • No single generator trip under frequency load shedding events
Network	Satisfactory	Flat	• Operational planning required to ensure system operability under changed generation scenarios • Distribution network faults leading to loss of generation and under frequency load shedding (UFLS) operation	• Visibility of network issues and appropriate action to maintain security • No major incidents caused by the transmission network • All feeder types within the power system under the average interruption duration index global target • Upgrades to manage peak demand are well planned

Tennant Creek

A review of generation and network performance in the Tennant Creek power system in 2019-20 found neither the generation nor the network is performing adequately, as summarised in Table iii.

The Commission wrote to PWC and Territory Generation on 30 September 2019 to highlight its concerns and requested a response to explain the poor performance in the system from their perspective, along with advice on how the two licensees may address the issues to improve the level of service to customers. The details are discussed in the 2018-19 NTPSPR.

The performance of the Tennant Creek power system has improved from a customer perspective in 2019-20 compared with 2018-19, however it is still underperforming. Fundamental elements of good electricity industry practice are not evident in the operation of the power system, leading to low levels of generation availability, high co-incidence of network and generator incidents, and protection equipment failures.

Details on the performance of the Tennant Creek power system in 2019-20, including comparisons to historical data, comprehensive discussion in relation to the identified issues and concerns, and highlights are provided in Chapter 3 of this review.

Table iii: Generation and network performance in the Tennant Creek power system in 2019-20

	Performance	Trend	Issue/concern	Highlights
Generation	Poor	Improving	• Testing and abnormal plant condition management • Communications protocol between System Control operators and Territory Generation station operators needs to be improved • Too many network events lead to generation incidents	• Low level of unplanned outages • Increased planned maintenance • Significant reduction in generation incidents • Minimum spinning reserve management
Network	Poor	Flat	• Level of customer minutes without supply not improving • Too many network events lead to generation incidents • Protection and auto re-close coordination	• Less frequent incidents leading to load-shedding • Feeder loading well below nominal ratings

Review of progress on 2018-19 NTPSPR recommendations

The following table summarises the status of the recommendations from the 2018-19 NTPSPR, noting the recommendations are those of the Commission and not enforceable unless they relate to non-compliance.

Table iv: General recommendations from 2018-19 NTPSPR

	Recommendation	Comments on observed progress	Overall assessment
1	**Generation and demand change planning:** Detailed planning work is required to understand the operability of the three power systems with increased variable renewable energy penetration. This should include consideration of frequency, and voltage control and regulation.	Some work has begun in relation to the Darwin-Katherine power system.	In progress
2	**Balance pro-active and reactive system improvement strategies:** • improved condition monitoring • better visibility of plant limits in real time.	Lower unplanned outage rates show evidence of better preventative maintenance.	In progress
3	**Manage testing and abnormal plant conditions:** Outage protocols including switching sheets, isolations and workspace delineation need greater focus from plant owners to ensure the number of inadvertent trips and faults are minimised.	The only generation incident in Darwin-Katherine in 2019-20 involved the incorrect operation of a generating unit under test.	In progress
4	**Operation of the Katherine/Pine Creek Island:** Accurate and reliable islanding identification and clear and robustly implemented protocols are required.	There is a project underway to address these issues. It is scheduled for completion in 2022.	In progress
5	**Knowledge of Jenbacher units:** The October 2019 system black in Alice Springs demonstrated that the level of knowledge Territory Generation has of the original equipment manufacturer controls of the Jenbacher generators is insufficient to assure correct operation while operating near or at the generators' expected capacity.	There remain difficulties in getting proper support for these units. These difficulties appear to be contractual as well as logistical.	In progress
6	**Management of low voltage supply voltages:** The voltage quality statistics for Darwin-Katherine, particularly in Katherine, show supply voltages are trending towards the high end of the allowable spectrum.	There is a project underway to address these issues.	In progress

Contents

1 | Darwin-Katherine power system

This chapter focuses on the 2019-20 generation and network performance of the Darwin-Katherine power system. Where possible, it compares 2019-20 performance to historical data to identify trends. Specifically this chapter considers:

- incidents
- generator performance, observed UFLS and single generator trips, generation availability, non-reliable periods and generation constraints
- network performance, network utilisation, network constraints, network power quality and network complaints.

Power system description

The Darwin-Katherine power system is the largest of the three regulated power systems in the Northern Territory. It supplies Darwin city, Palmerston, suburbs and surrounding areas of Darwin, the township of Katherine and its surrounding rural areas.

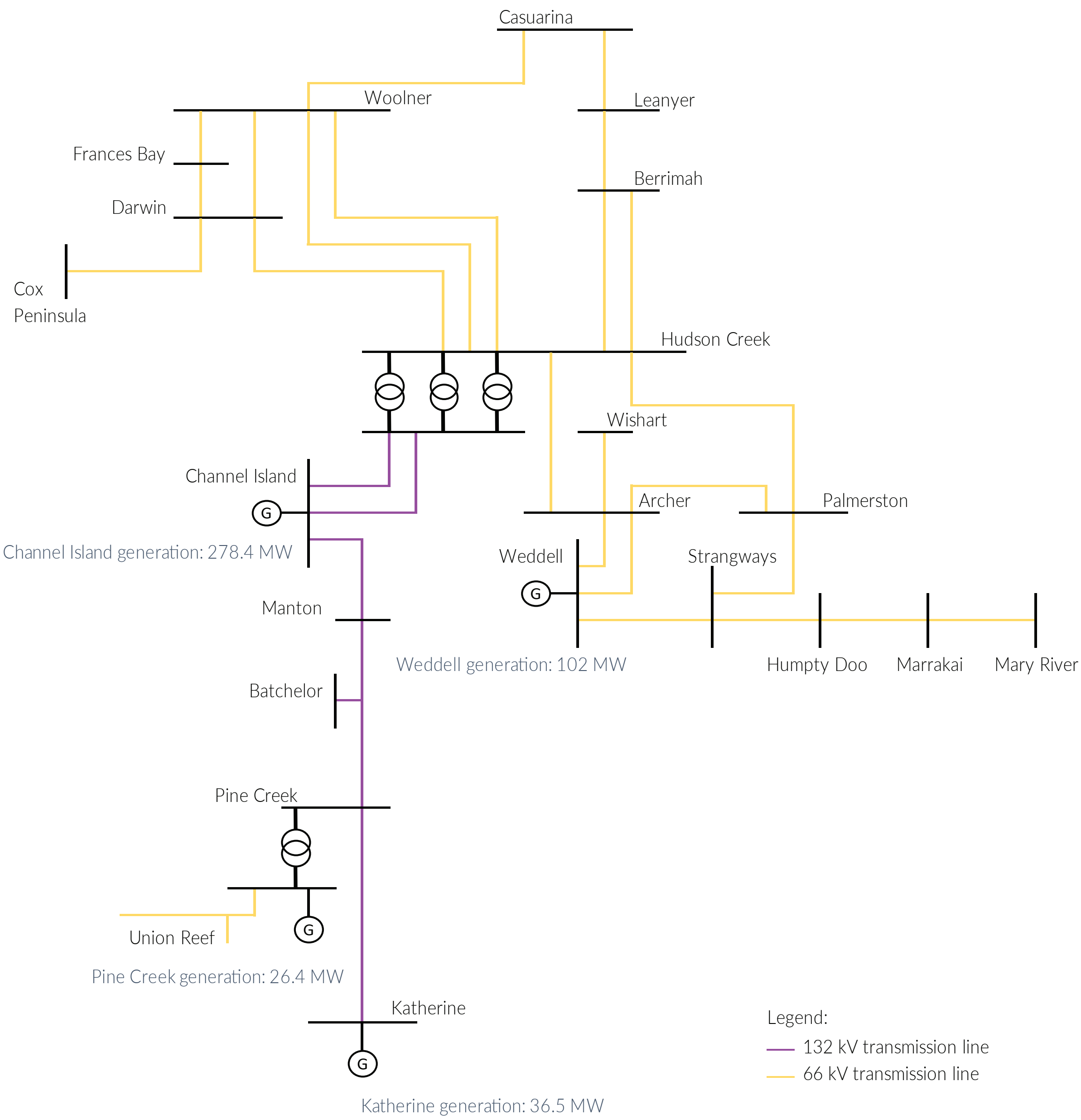
The energy sent out by grid-connected generators in 2019-20 is shown in the Table 1.

Table 1: Darwin-Katherine energy sent out in 2019-20

	Energy sent out (GWh)
Darwin-Katherine power system	1 506

Figure 1 shows a simplified representation of the Darwin-Katherine power system. The major transmission lines in this system are lines from Katherine to Channel Island and Channel Island to Hudson Creek. A double-circuit overhead 132 kilovolt (kV) transmission line from Channel Island to Hudson Creek serves the Darwin area. The 300 kilometre single circuit Channel Island – Katherine 132 kV line runs south from Darwin to Manton, Batchelor, Pine Creek and Katherine.

Figure 1: Darwin-Katherine power system[1]



Incidents

A reportable incident is a power system event that had or could have had a significant adverse effect on security or reliability of electricity supply, and is determined by the Power System Controller in accordance with the System Control Technical Code (SCTC). Further, the Power System Controller determines whether a reportable incident is classified as a major or minor incident. Major incidents are subject to a more detailed investigation and reporting requirements.

The Commission considers the purpose of incident reporting is to ensure power system events that would benefit from investigation are investigated to identify and address issues, and improve the safety and reliability of electricity supply to customers.

1 Generation capacities relate to non-summer (dry season) capacities in accordance with the 2020 NTEOR.

This section considers the overall customer impact from major and minor incidents, provides an overview of major incidents and discusses the tracking and implementation of System Control recommendations following the investigation of major incidents.

Overall customer impact

This section shows the overall impact of major and minor incidents on customers in the Darwin-Katherine region across the last four years (Table 2).

Table 2: Overall customer impact from major and minor incidents in the Darwin-Katherine power system

		2016-17	2017-18[2]	2018-19	2019-20
Darwin-Katherine	Number of incidents	78	71	61	80
	Customers impacted	131 976	111 368	81 105	97 880
	Total duration (minutes)	10 853	10 939	8 823	12 170
	SAIDI	169.30	194.30	115.00	158.56
	SAIFI	1.95	1.55	1.16	1.38
	Reliability (% of year)	99.97	99.97	99.98	99.97
	System blacks				
	Region wide	0	0	0	0
	Katherine island blacks[3]	7	7	3	4
Darwin	Number of incidents	68	61	51	66
	Customers impacted	106 876	83 523	62 335	80 302
	Total duration (minutes)	10 269	9 933	7 548	8 936
	SAIDI	156.90	178.20	108.60	139.80
	SAIFI	1.68	1.24	0.95	1.21
	Reliability (% of year)	99.97	99.97	99.98	99.97
Katherine	Number of incidents	10	10	10	14
	Customers impacted	25 100	27 845	18 770	17 578
	Total duration (minutes)	584	1 006	1 275	3 234
	SAIDI	360.20	442.90	210.30	439.90
	SAIFI	6.07	6.35	4.25	3.97
	Reliability (% of year)	99.93	99.92	99.96	99.92

SAIDI is a measure in minutes of the average duration of an incident weighted by the number of customers affected by each event. That is, if 10 customers suffer a 10 minute interruption and there are 100 customers in the region, then that would equal a SAIDI of 1 minute. Multiple incidents are added together, so if a second incident of 15 minutes affected 10 customers, then that would be added to the first incident and lead to a SAIDI of 2.5 minutes.

2 Excluding Tropical Cyclone Marcus that resulted in a major incident on the 17 March 2018. The major incident is attributable to 473,440,000 customer minutes without supply in the Darwin-Katherine power system, however has been removed from the data for the analysis in this review as it masks underlying power system performance.

3 A Katherine island black is a system black for the region south of the point where a disconnection occurs of the 132kV transmission line from Darwin to Katherine.

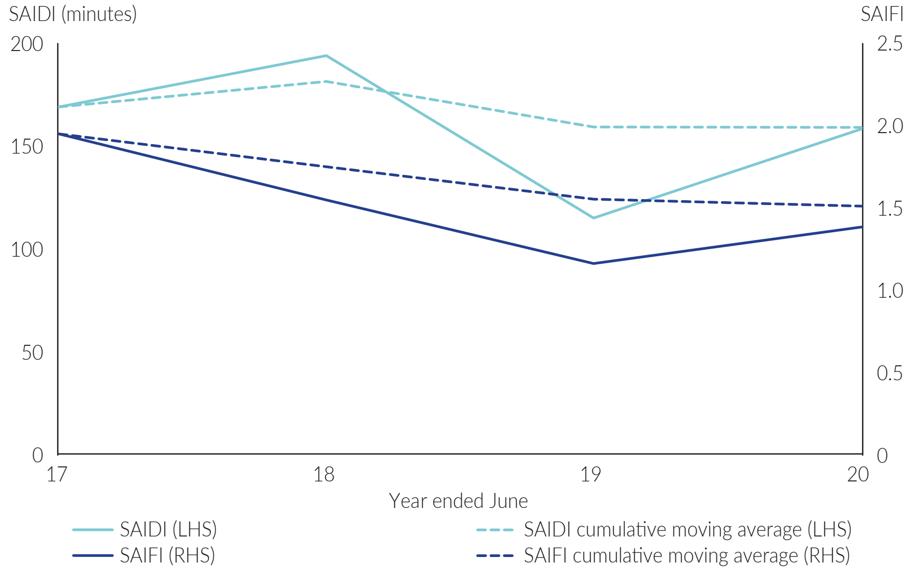
System Average Interruption Frequency Index (SAIFI) is a measure of the average number of incidents weighted by the number of customers affected by each incident. Using the examples above, the SAIFI would be 0.1 after the first incident and 0.2 after the second incident.

Reliability (percentage of year) is calculated based on SAIDI. It is the percentage of a year the average duration in minutes of incidents per customer represents, subtracted from the total number of minutes in a year. This is different from the unserved energy based reliability standard[4] for generation of 0.002% applied in the National Electricity Market, which is also adopted by the Commission in its Northern Territory Electricity Outlook Report (NTEOR) reliability assessments in the absence of a formal Territory target.

The number of customers impacted and total duration (minutes) of an incident is reported by System Control to the Commission as part of its SCTC obligations. As customers are restored in stages, not all customers are impacted for the full duration of the incident. Therefore, indicators derived from the number of customers impacted and total duration (minutes) of an incident to show the impact on customers, such as System Average Interruption Distribution Index (SAIDI), may be overstated and are considered a 'worst case'. However, the Commission considers the results and trends to be indicative.

The SAIDI and SAIFI indices for the combined Darwin-Katherine region are shown in Figure 2.

Figure 2: Overall SAIDI and SAIFI performance indices, Darwin-Katherine region[5]



The 2019-20 reporting period shows an increase in SAIDI and SAIFI from 2018-19. Based on the cumulative moving average, SAIDI is trending slightly upwards while the SAIFI remains flat.

4 https://www.aemc.gov.au/sites/default/files/content/2f4045ef-9e8f-4e57-a79c-c4b7e9946b5d/Fact-sheet-reliability-standard.pdf.

5 Based on data from System Control incident reporting ('customers impacted' and 'total duration (minutes)'), specifically initial notifications.

Comparing the performance between the Darwin and Katherine subregions it is evident that customers in the Katherine region are experiencing a much higher impact from power system incidents than those in Darwin, with SAIDI doubling in 2019-20 compared with 2018-19 in the Katherine region. The incidents noted in the following sections and Entura's analysis as to the causes of these incidents suggest an overall improvement in generation and network performance, however the increased number of Katherine island blacks still has significant impact on the regional SAIDI. PWC is actively working to resolve the issues at the Katherine end of the Darwin-Katherine power system.

Major incidents

There were nine major incidents recorded in the Darwin-Katherine power system in 2019-20, which is consistent with 2018-19. The incidents are summarised in Table 3.

Table 3: Darwin-Katherine major incident summary[6]

ID	Date of incident	Description	Category	Cause	UFLS/black	Incident duration (minutes)	Customers affected
1	07-Aug-19	Channel Island bus 3 trip	Networks	Operator error	Katherine system black/ UFLS stage 1Y	36	9 393
2	27-Oct-19	11 kV Pine Creek bus tripped	Networks	Equipment failure		33	182
3	23-Dec-19	132 kV Manton – Pine Creek line trip	Networks	Weather/lightning	Katherine system black	24	340
4	09-Jan-20	132 kV Pine Creek – Katherine line tripped	Networks	Weather/lightning	Katherine system black	19	4 427
5	24-Feb-20	Channel Island unit 7 (C7)	Generation	Unauthorised generation dispatch		11	0
6	15-Mar-20	66 kV separation event, dual trip HC-AR/HC-PA	Networks	Transient fault – lightning		87	9 818
7	24-Mar-20	66 kV PC-CH tripped – Pine Creek power station tripped	Networks	Weather/transient		328	5
8	16-Apr-20	11 kV Leanyer bus 1 tripped	Networks	Operator error		8	2 226
9	22-May-20	132 kV Pine Creek – Katherine line tripped	Networks	Transient fault	Katherine system black	228	4 620

The incidents fall in three categories, namely operator error, weather and equipment failure:

1. Operator error

Incidents 1, 5 and 8 fall into this category.

Incident 1 occurred due to maintenance personnel inadvertently causing a bus zone trip. A similar root cause is assigned to incident 8, where operator error caused the 11 kV bus at the Leanyer zone substation to trip. Entura's view is that loss of supply through secondary system failures on the network should be rare. The design of redundancy, modern supervision techniques and record management should allow systems to be designed, implemented, tested and monitored so they do not fail with resulting loss of load.

6 Based on data from System Control incident reporting ('customers impacted' and 'total duration (minutes)'), specifically initial notifications.

Incident 5 occurred due to a generating unit at the Channel Island power station being brought back into service after testing without prior approval from System Control. This incident is evidence that recommendation 3 from the 2018-19 NTPSPR, manage testing and abnormal plant conditions, remains valid and unresolved.

2. Weather

Incidents 3, 4, 6, 7 and 9 fall into this category.

This category of incidents is unavoidable, however the impact may not always need to be as severe.

Incidents 3, 4 and 9 demonstrate the difficulties managing the long 132 kV transmission line to Katherine. This appears to be made more difficult due to the failure of controls that would allow the inter-operation of Territory Generation's Katherine power station generating units with EDL's Pine Creek power station generating units. The failure of secondary systems and communications with System Control appears to be at the core of the cause for the customer impact from these incidents. It appears to Entura the existing operating protocols and equipment do not deliver the levels of robustness that could reasonably be expected.

Incident 6 and 7 shows the coordination of auto re-close (ARC) in meshed networks is important particularly when islands with generation can form. The recommendation for a synch check review is key to this incident not repeating. Entura notes this recommendation has been made in relation to multiple incidents across the last two years.

As a result of incident 6 occurring, voltages on the HV network increased to unacceptable levels. Entura is pleased to see that recommendations from the incident report are being implemented, namely reviewing the voltage control and capacitor bank control in the Darwin region.

3. Equipment failure

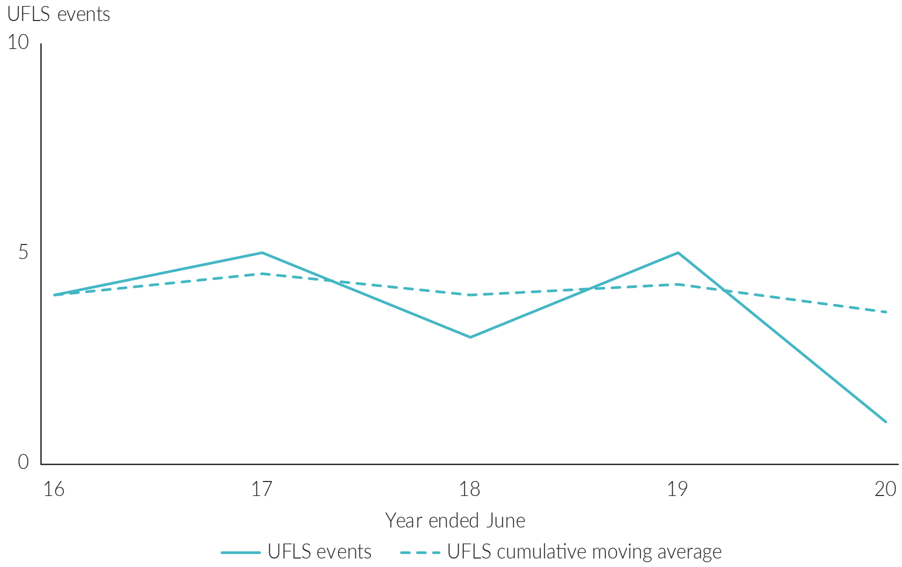
Incident 2 falls into this category.

Simultaneous tripping of transformers is generally a rare occurrence in distribution zone substations with the exception of bus faults. Protection schemes' design and implementation must ensure only the faulted plant is disconnected from the power system, while in this incident a number of generating units and all transformers were tripped. Entura believes it is crucial for root cause investigations to be conducted in a timely manner to ensure such events are not repeated in the future.

Impact of major incidents

A significant improvement in the Darwin-Katherine power system has been the reduction in UFLS events. This general decline is mainly due to the changes around spinning reserve allocation and management, noting this has likely increased costs. Figure 3 shows a significant decline with the number of UFLS events, lower than the previous five years.

Figure 3: Number of UFLS incidents in Darwin-Katherine



Major incident report recommendations

Recommendations made by System Control, as a result of its investigation of major reportable incidents, are consolidated in a recommendation tracking spreadsheet, which is periodically provided to the Commission.

In the Commission's independent investigation of a system black in Alice Springs on 13 October 2019, the Commission made a recommendation regarding placing a focus on determining if the recommendations of the independent investigation report and other major event reports have been tracked and implemented during its annual power system reviews, which the Territory Government accepted. Accordingly, as part of the NTPSPR, Entura has assessed System Control's recommendation tracking spreadsheet, based on data provided by System Control on 16 September 2020.

System Control's recommendations are categorised into seven areas: asset management, energy management system (EMS), modelling, power system studies, procedural, protection and training.

While the Commission is aware of significant progress since it made its recommendations following the Alice Springs system black, Entura notes the completion of recommendations is not consistent across System Control recommendation categories. From Entura's assessment, consistent with the Alice Springs and Tennant Creek power systems, it appears the focus for the past few years has been more on asset management and procedural-related recommendations. Further, Entura notes that no EMS or modelling-related recommendations and only one power system study-related recommendation has been completed, even though some recommendations in these categories were made more than four years ago.

Generation

The total in-front-of-the-meter generation capacity in the system is over 444 megawatts (MW)[7]. This does not include behind-the-meter rooftop solar PV generation capacity, which totalled around 80 MW in 2019-20. The fuel type of the generation currently comprises dual fuel (gas/diesel), gas only, heat recovery steam and landfill gas.

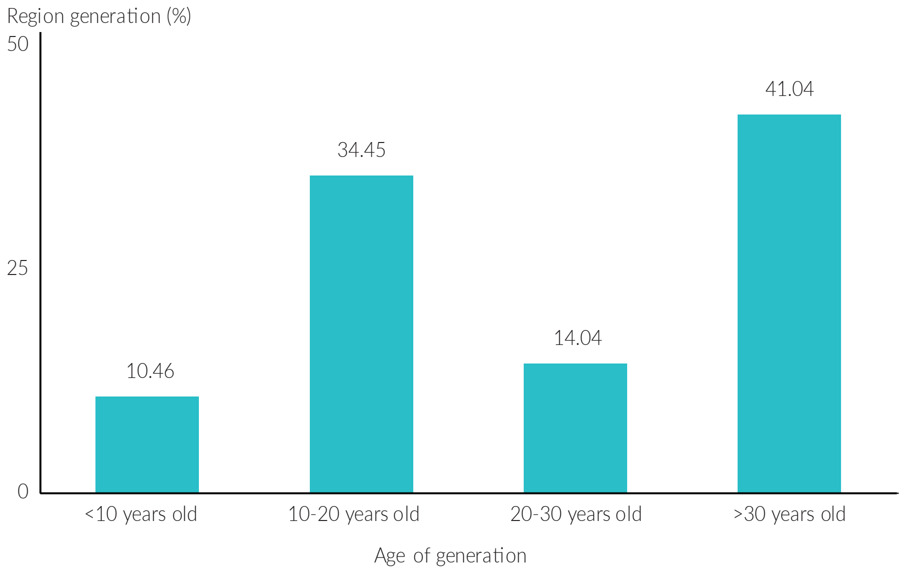
7 Generation capacity relates to non-summer (dry season) grid connected in-front-of-the-meter generation capacities.

Table 6: Maximum non-summer (dry season) grid connected in-front-of-the-meter generation capacity in Darwin-Katherine[8]

	Capacity (MW)
Channel Island	278.4
Weddell	102
Katherine	36.5
Pine Creek (EDL)	26.4
Shoal Bay landfill	1.1
Total generation	**444.4**

Figure 4 shows around 41% of Darwin-Katherine power system generation capacity is more than 30 years old.

Figure 4: Age of generators in Darwin-Katherine by percentage of maximum generation capacity[9]



The following sections show the generation within the region continues to perform within a satisfactory band but with room for improvement. Those necessary improvements relate to:

- design and commissioning processes for system protection and communications
- condition monitoring.

The reliability of ageing plant (Figure 4) will inevitably reduce with condition monitoring needed to ensure maintenance or refurbishment prior to unplanned outages occurring. More unreliability and maintenance work leads to more instances in which generating units must be safely returned to service or re-commissioned. Therefore, the processes of both condition monitoring and management of the plant in abnormal conditions, such as testing or commissioning, will require careful consideration by licensees.

8 Generation capacities relate to non-summer (dry season) capacities in accordance with the 2020 NTEOR.

9 Generation capacity relates to non-summer (dry season) grid connected in-front-of-the-meter generation capacities. Further, the age of generators is based on the original commissioning date, noting this does not take into consideration where engines have been replaced.

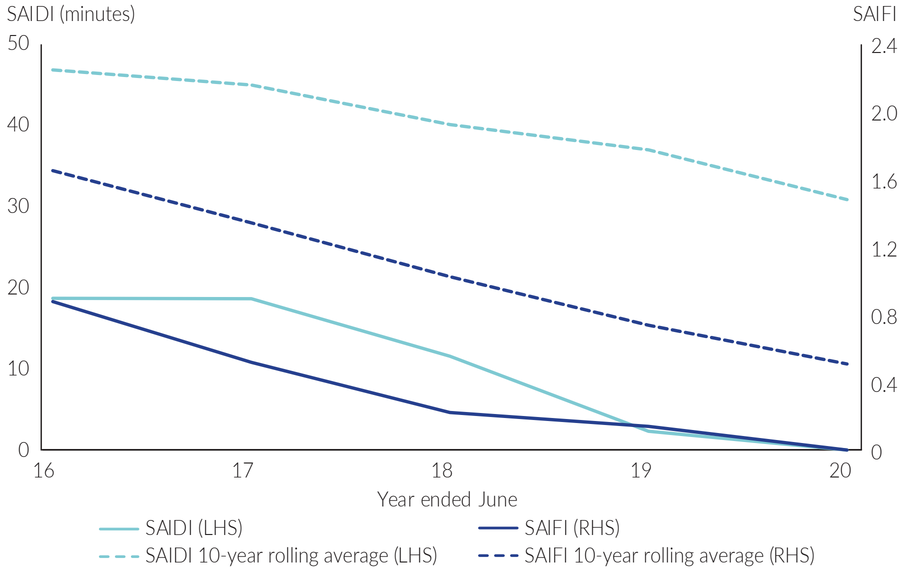
Generator performance

The Electricity Industry Performance Code (EIP Code) does not set targets for generation SAIDI and SAIFI performance indicators. Historical performance is used to provide commentary on generator performance in 2019-20.

Darwin region

The generation service level for the Darwin region is shown using the SAIDI and SAIFI performance (see Figure 5).

Figure 5: SAIDI and SAIFI performance for generation, Darwin



The trend for these indices continues to improve. That is, the generation fleet is performing well relative to the 10-year average. In 2019-20, Territory Generation reported a SAIDI and SAIFI of zero in the Darwin region, giving an ideal result. The majority of this improvement can be attributed to the reduction in customer interruptions due to single unit trips, which has been achieved in part by changes to spinning reserve. While the number of single unit trips has increased from the previous year, this did not lead to any UFLS events. Therefore, while the robustness of the generating units themselves is not improving, the impact of that robustness, or lack thereof, is not being felt by customers. The high number of single generator unit trips is discussed in the following section.

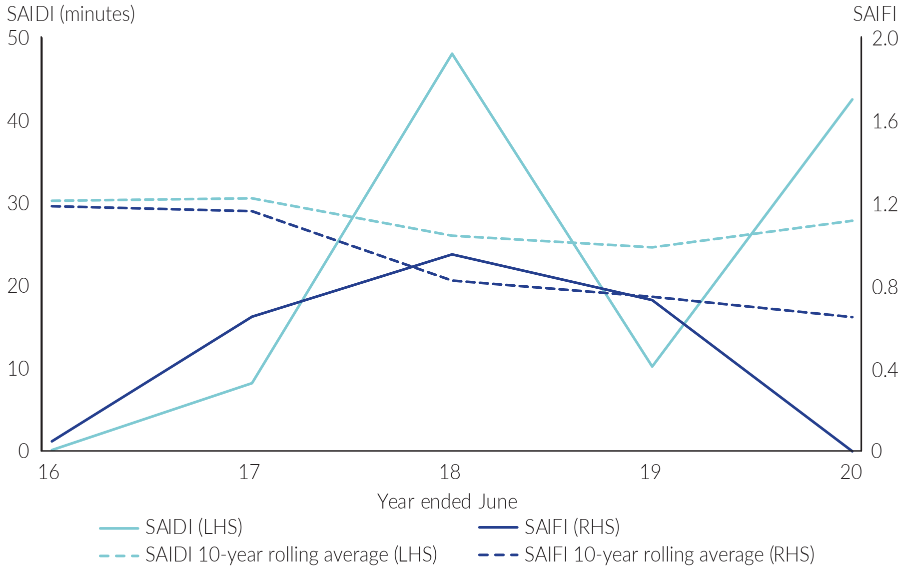
Intuitively, SAIDI and SAIFI for generating units in a multiple power station system should be very low. Power stations should have few common modes of failure and the power system should be run so the loss of a single unit does not lead to load shedding. It is positive that both of these indices are reported as zero in 2019-20 for the Darwin region.

Katherine region

SAIDI and SAIFI are compiled for the generating units in the Katherine region separately (Figure 6).

In 2019-20, EDL, which operates the Pine Creek power station, reported SAIDI and SAIFI indices of 0.1 and 0, respectively. This result indicates incidents relating to the Pine Creek power station were not initiated by EDL, however may have extended the outage period, which explains a SAIFI result of zero.

Figure 6: SAIDI and SAIFI performance for generation, Katherine



SAIDI shows a significant deterioration from 2018-19. SAIDI has increased to levels comparable to the performance of the 2017-18 period, which is the worst performing year in the last five years, and is above the 10-year average by a substantial level. SAIFI continues to trend downwards with a significant improvement from 2018-19, with a recorded index of zero. A recorded SAIFI of zero is possible if incidents were not initiated by generation but generation caused the outage period to be extended mainly due to failure of units during restoration. This seems to be the case for the Katherine region.

It has been suggested that with the introduction of additional generation licensees, which is particularly relevant to the Katherine region, other than a whole of system measure, SAIDI and SAIFI may no longer be sensible or useful.

In Entura's opinion, the allocation of incidents between generation and networks is generally clear cut and therefore calculating generation SAIDI and SAIFI seems to be reasonable. Further, each generating unit can have a proportion of that SAIDI and SAIFI allocated to it based on causality.

However, the severity of an event can be influenced by external factors to the generating unit. Specifically, where single unit trips cause UFLS when the system constraints should stop that from occurring, the customer minutes without supply should be allocated to the systems and other units that may have not performed as expected, rather than the initial generating unit that tripped.

Therefore on balance, in Entura's opinion, SAIDI and SAIFI remain valid indices of overall generation performance for now, however detailed analysis of system incidents is required to understand where the performance is being adversely affected. Entura considers the level of analysis being undertaken by System Control in incident reports is adequate for this purpose.

The reporting requirements within the schedules of the EIP Code, which include generation SAIDI and SAIFI, are being considered by the Commission as part of a review of the EIP Code, which commenced with the publication of an issues paper on 16 September 2020.

Observed UFLS and single generator trips

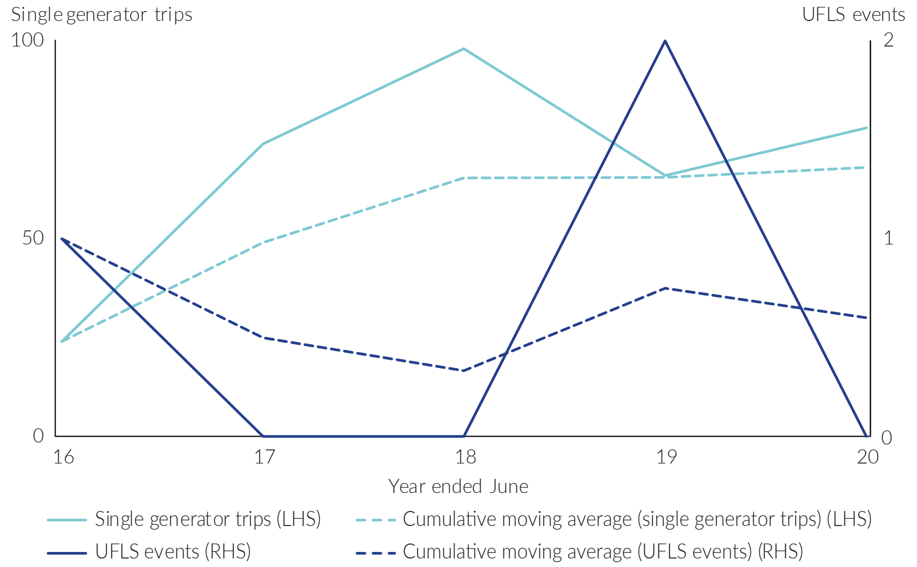
This review has focused on single unit trips and their impact on customers for a number of years. The focus is due to the high incidence of single unit trips (relative to other power systems) and the challenge smaller power systems, such as Darwin-Katherine, have in managing these incidents without loss of load, due to the large relative size of the generating units.

Until recently, the Darwin-Katherine power system was dispatched in such a way as to require UFLS to arrest frequency fall for most large single generating unit incidents. This practice was ended in an attempt to improve power system performance. Since that time the power system has seen a steady increase in single unit trips but a stark reduction in coincident UFLS incidents. In fact there have only been three such incidents across the last five years, which indicates a significant improvement in the effectiveness of managing these incidents.

However, the Commission notes this improvement has been achieved in part through System Control changes to spinning reserve, which may increase costs, particularly for Territory Generation. Further, given there is no competitive process for the provision of spinning reserve, or ancillary services more broadly, there is little incentive for the associated increased costs to be minimised. The Commission notes the Territory Government's Office of Sustainable Energy is currently considering this issue as part of its essential system services work stream.

System Control biannual reports[10] to the Commission show a rise in unit trips over the last year, however none caused load shedding (Figure 7).

Figure 7: Darwin-Katherine single generator trips versus UFLS (due to single generator trips)



In 2019-20, the number of single unit trips increased compared with 2018-19, however is still lower than a high in 2017-18, and there were no UFLS incidents. Entura considers this to be a good result as it indicates the upward trend in generator trips may be slowing and may indicate an improvement in robustness.

10 As required by the SCTC.

System Control also provides the statistics relating to the time between single unit trips. While single unit trips were more frequent in 2019-20, often with less than a week between trips, the overall trend remains similar. Of the 78 single unit trips that occurred in 2019-20, 23 were related to days where individual generators suffered from multiple failed restoration attempts, indicating deteriorating performance of the associated units. For some incidents it took five restoration attempts before supply returned to normal.

As per previous recommendations (recommendation 4 from 2017-18, reporting of causes for single unit trips), Entura recommends tracking the causes of these trips to determine if there are trends and possible remedial actions. The System Control biannual reports to the Commission show the generating unit and loading for each trip, however the causes are not yet fully investigated according to Territory Generation.

The high number of unit trips at the Pine Creek power station in 2019-20, relative to other power stations in the Darwin-Katherine power system, are mostly related to the Darwin and Katherine regions being isolated from each other and connected by a single 132 kV transmission line. The current islanding scheme is considered by Entura to be quite slow and unreliable, which is the main contributor to these tripping events. Entura notes there are plans to upgrade the islanding scheme with enhanced fast tripping communications, which Entura expects will see significant improvement to the southern region of the Darwin-Katherine power system.

Generation availability

A number of indices are calculated as per the EIP Code for generating units to reflect their reliability. The factors discussed in the following section are:

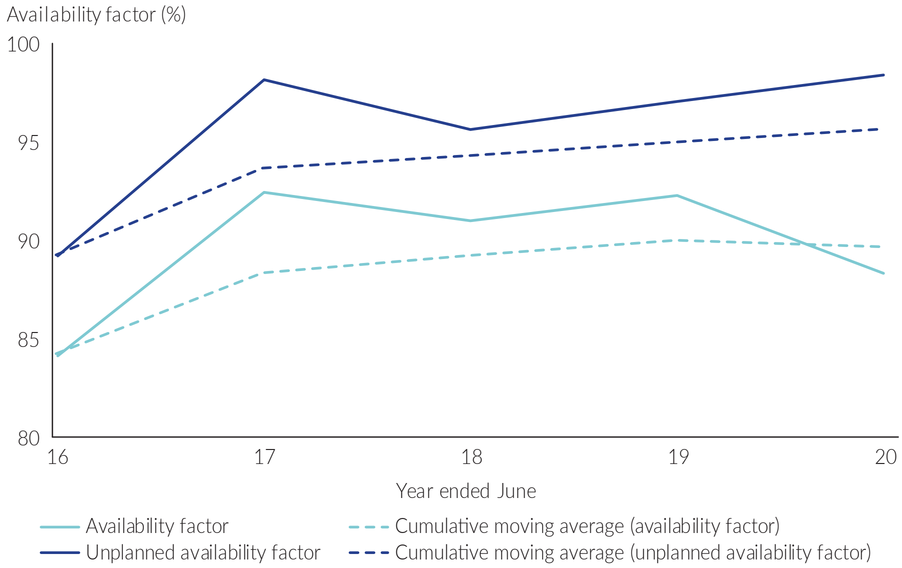
- availability factors (availability factor and unplanned availability factor) – the availability factor represents the percentage of time a unit is available to generate despite both planned and unplanned maintenance, whereas the unplanned availability factor indicates the percentage of time a unit is available to generate despite unplanned maintenance. The difference between these two indices is the percentage of time a unit is unavailable to generate due to planned maintenance. Planned maintenance is scheduled in advance, usually based on original equipment manufacturer maintenance schedules, and notified to System Control in accordance with the SCTC. Unplanned maintenance is maintenance that is required but can wait until a particular convenient window of time, such as the next period of low power system demand
- forced outage factor – the forced outage factor is the percentage of time the unit is not available for dispatch due to an immediate issue with the generator, such as a breakdown, which cannot be deferred. This includes time taken to repair the unit if it is damaged or a component requires replacement or refurbishment due to a breakdown or failure.

These measures provide some insight into the availability of the generating units and allow an assessment to be made as to the adequacy of condition monitoring and preventative maintenance. Ideally, planned maintenance should be to a level and adequacy that minimises the level of unplanned maintenance and forced outages as much as reasonably feasible, noting it is unreasonable to expect zero unplanned maintenance or forced outage events. Planned maintenance activities can be planned for by generators and the Power System Controller, whereas forced outages, and to a lesser extent unplanned outages, can lead to system reliability and security risks, with limited or no notice.

Availability factors

Figure 8 shows the capacity weighted average availability and unplanned availability factors for the Darwin-Katherine power system over the last five years.

Figure 8: Capacity weighted average availability and unplanned availability factors for Darwin-Katherine generating units



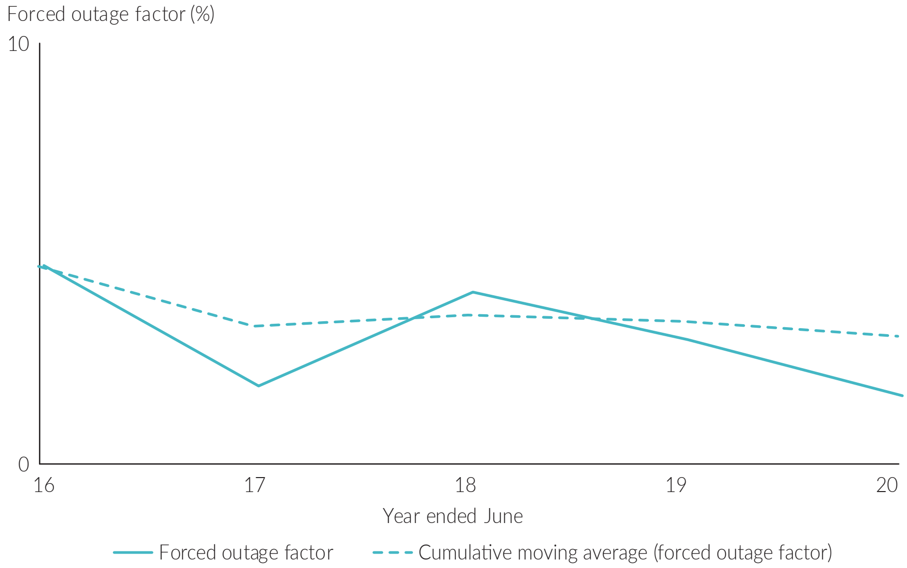
In 2019-20, the unplanned availability of generators in the Darwin-Katherine power system returned to around 2016-17 levels, which is the lowest level of unplanned outages in the last five years, however slightly worse than the cumulative moving average, as shown in Figure 8. A decrease in the availability factor and significant divergence of the factors in 2019-20 (Figure 8) indicates an increase in the level of planned maintenance (discussed below). However, the difference between the cumulative moving average of availability and unplanned availability factors indicates the level of planned maintenance across all generators in the Darwin-Katherine power system has been fairly consistent over the period shown in Figure 8.

Following a very high level of unplanned maintenance in 2018-19, EDL reported its lowest level over the last four years in 2019-20, which indicates the maintenance activities carried out in 2018-19 are providing a positive impact. Unplanned maintenance has trended down at both the Channel Island and Weddell power stations over the last eight years, while planned maintenance has trended upwards, with significant increases in 2019-20, particularly at the Channel Island power station, which reported the highest level of planned maintenance by all Darwin-Katherine generators. The increased planned maintenance and low levels of unplanned maintenance suggest the aging assets at the Channel Island power station are being managed well by Territory Generation, resulting in improved ability of the Power System Controller to manage system reliability and security. The Katherine power station remains at similar low levels of both planned and unplanned maintenance to previous years, and is likely due to the power station being relied on less than others to meet power system demand.

Forced outage factor

Figure 9 shows the capacity weighted average forced outage factor for the Darwin-Katherine power system over the last five years.

Figure 9: Capacity weighted average forced outage factor for Darwin-Katherine generating units



The performance in 2019-20 is now at the same level as 2016-17, which was the best performing year in the last five years, and below the cumulative moving average. Improvements in performance at the Pine Creek and Weddell power stations, in terms of forced outages, contributed to a better overall result. The 2019-20 result continues the encouraging downward trend in forced outage factor.

While the forced outage factor has significantly reduced for the Pine Creek power station, and to a lesser extent at the Weddell and Katherine power stations, an increased number of faults has caused the forced outage factor for the Channel Island power station to double in comparison to 2018-19.

The data indicates consistency in management of generating units across the power system, which leads to better supply adequacy. The concern for future years will be the forced outage factors for generating units at the Channel Island power station. As mentioned earlier in this chapter, the generating units at Channel Island power station are ageing with some nearing end of life (starting in 2026-27). Until they are retired, the probability of extended outages may increase if the necessary condition monitoring and fault investigation is not undertaken in a timely manner.

Comparison with similar Australian regions

Table 8 compares the forced and planned outage rates from the Darwin-Katherine power system with those from the Western Australian South West Interconnected System (SWIS). The SWIS is a larger power system but has similar generating unit types to select as points of comparison. Entura has used a selection of 18 units ranging in size from 26 to 342 MW.

Table 8: Capacity weighted average outage and unavailability rates for Darwin-Katherine generating units compared with equivalent units in the Western Australian SWIS[11]

	Darwin-Katherine 2019-20 (%)	Darwin-Katherine cumulative moving average (%)	SWIS WA average 2016-19 (%)
Forced outage rate	1.7	3.3	2.2
Planned outage rate	10.0	10.0	8.4
Equivalent unavailability	11.7	13.3	10.7

The forced and planned outage rates for generating units in the Darwin-Katherine power system compares well with the average performance of similar open cycle gas turbine (OCGT) type generating units in the SWIS. Entura would expect a slightly higher planned outage rate in the Darwin-Katherine power system based on two main factors: the surplus of generation in the region, owned predominantly by a single owner; and the age of the units, as they are older.

The cumulative moving average for the Darwin-Katherine power system remains worse than the level of performance in the SWIS, however it has improved over the last five years.

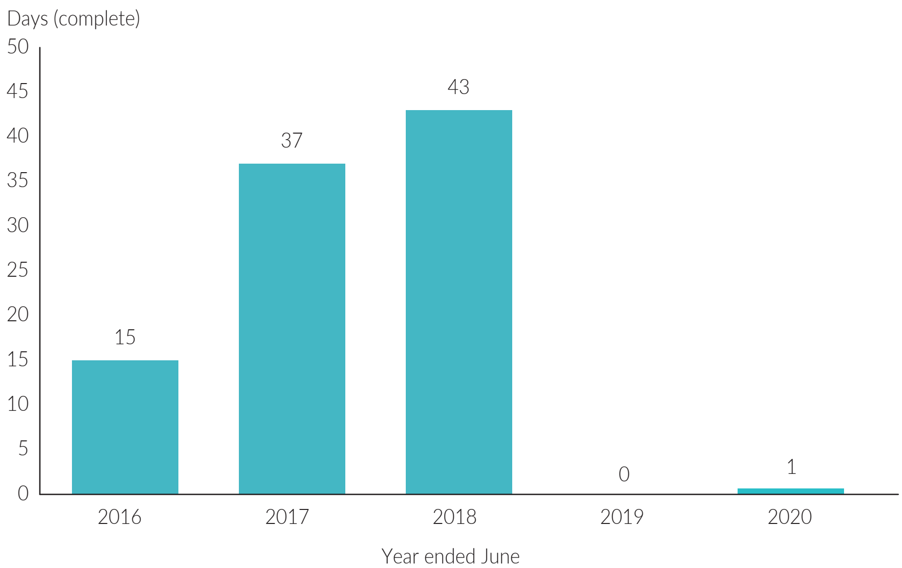
Non-reliable periods

Non-reliable periods are a forward-looking assessment, rather than in response to system incidents, and are declared when the Power System Controller identifies that power system reliability cannot be maintained. There are a number of causes, including:

- planned, unplanned or forced outages that reduce reliability for all or part of the power system
- lack of generation to meet demand and or requirements for spinning reserve.

There was one non-reliable period declared in the Darwin-Katherine power system in 2019-20 as shown in Figure 10.

Figure 10: Non-reliable periods for generators in Darwin-Katherine



11 Report on the effectiveness of the Wholesale Electricity Market 2020 (28 August 2020) Microsoft Word – WEM Report – Final – 2020 (v4.1 Redacted)(rev 9) (erawa.com.au) pages 73 and 74.

Although there has been a slight increase in non-reliable period in 2019-20 from 2018-19, the trend remains positive. In previous reviews Entura has made note of overlapping activities in risk notices. The continued low number of non-reliable periods in 2019-20 suggests that some of these issues around outage planning and the like have been resolved. Discussions with Territory Generation, the largest generator in the Darwin-Katherine power system, and System Control suggest there are regular positive communications between the two organisations.

Generation constraints

Table 9 summarises the generation constraints in the Darwin-Katherine region.

Table 9: Darwin-Katherine normal system constraints

	Constraint description	Applied to	Limit	System condition	Comments
1	C1 dispatch and maximum output constraint	Channel Island unit C1	30 MW	Ongoing	Due to additional cracks in stage 1 Nozzle Block
2	C8/C9 maximum output constraint	Channel Island units C8 and C9	35 MW each	System demand above 180 MW	Prevents UFLS operation from a C8 or C9 trip
3	C8/C9 maximum output constraint	Channel Island units C8 and C9	30 MW each	System demand below 180 MW	
4	C4/C5/C6 maximum output constraint	Channel Island units C4, C5 and C6	Combined output less than 75% of system demand	In practice this limit applies at low demand times	Controls rate of change of frequency to within the technical envelope of the UFLS scheme such that simultaneous loss of C4/C5/C6 does not lead to system black.
5	C1/C7 dispatch	Channel Island units C1 and C7	-	Ongoing	Only one unit of C1 or C7 can be dispatched online at all times
6	C8/C9 dispatch	Channel Island units C8 and C9	-	Ongoing	C8 to be dispatched only after C9
7	C2 Start-up restriction	Channel Island unit C2	Higher than 20 MW	First 40 minutes after starting	To avoid vibration issues occurring during start-up of machine

The number of constraints in the 2019-20 period increased in comparison to the previous year.

In general, the constraints shown in Table 9 lead to inefficiency in the dispatch of generation in the Darwin-Katherine power system, noting the low level of inertia on units other than the older frame 6 machines at the Channel Island power station and limited governor response of some of the remaining fleet make frequency management in the power system difficult.

System Control has put in place these constraints to limit the contingency size of the largest credible generation event in order to minimise the rate of change of frequency (RoCoF). RoCoF is proportional to the event size and inversely proportional to the system inertia. That is, a large event on a low inertia system has a higher level of RoCoF than a smaller event with the same inertia or the same event with a higher inertia. RoCoF must be managed to ensure secondary controls, such as UFLS, can operate fast enough to maintain frequency within the frequency standard.

In Entura's opinion, larger spinning reserve margins or faster governor response may allow constraints 2 and 3 to be lifted. However, there would be a cost of supply implication to this course of action.

Constraints 1 and 7 demonstrate how the aging frame 6 generation units at the Channel Island power station are impacting the power system leading to more operational restrictions.

Network

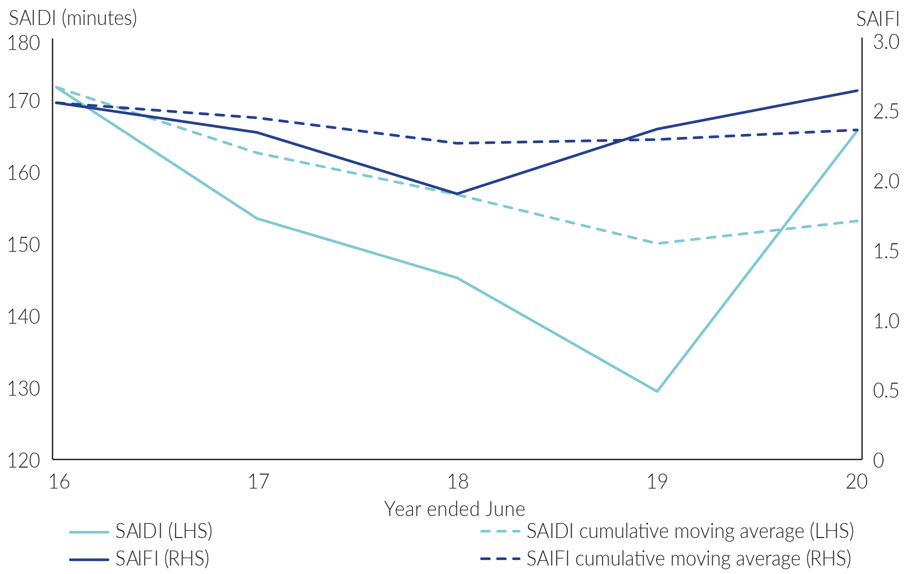
The Darwin-Katherine network covers the Darwin and Katherine areas with a corridor between Darwin and Katherine to the south. The highest transmission voltage is 132 kV. The network in Darwin is relatively robust with the 66 kV network forming a series of loops. The 132 kV and 66 kV networks are strongly interconnected, albeit at a single point at Hudson Creek.

The southern extremities of the network are supported by EDL's Pine Creek and Territory Generation's Katherine power stations. The long single circuit provides challenges from a system robustness perspective.

Network performance

Network performance is measured and reported by Power Services as part of EIP Code requirements. The SAIDI and SAIFI performance for the Darwin-Katherine network is presented in Figure 11.

Figure 11: Adjusted SAIDI and SAIFI performance for the Darwin-Katherine network[12]



12 The EIP Code allows licensees to adjust SAIDI and SAIFI values by excluding incidents that meet an exclusion criteria included in the code, with the list of the excluded incidents required to be included in the reporting. The SAIDI and SAIFI values are derived from Power Services' EIP Code reporting by combining data reported for Darwin and Katherine, weighted by the number of customers in each region.

The SAIDI and SAIFI reported by Power Services show a decline in performance in 2019-20 when compared with 2018-19. There is no standard stipulated for overall network SAIDI or SAIFI, but it is worth considering how the performance relates to customer experience. On average in 2019-20, a customer was likely to be impacted by a total of 165 minutes (SAIDI) of interruption and each customer was likely have 2.6 interruptions (SAIFI) from network incidents.

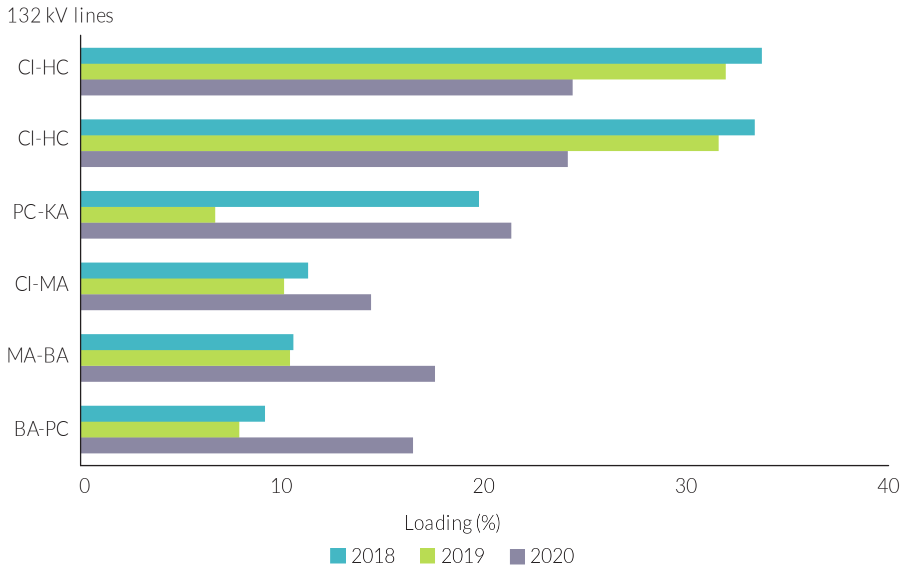
The SAIDI and SAIFI numbers discussed above are designated as adjusted. The EIP Code allows adjustment based on a range of criteria (excluded events) to identify underlying network performance. Power Services' reporting includes a list of the permitted excluded events and the number of exclusions per exclusion category.

Network utilisation

Transmission network

The transmission network utilisation is shown in Figure 12.

Figure 12: Transmission network utilisation Darwin-Katherine (132 kV)



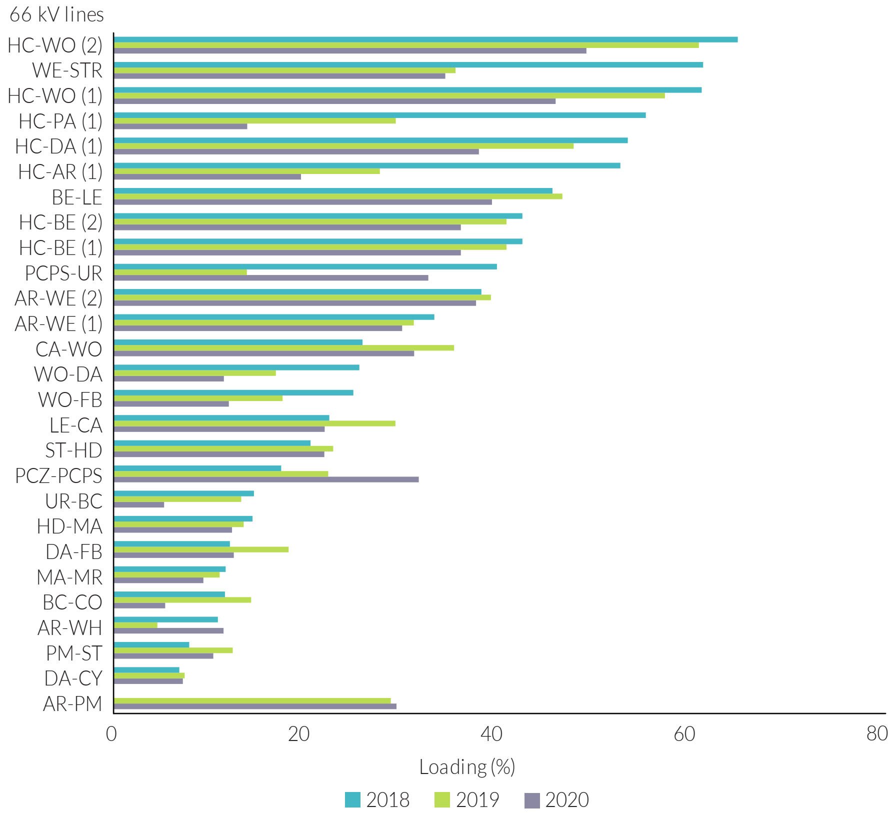
The 132 kV line loadings remain well within rating. Entura makes this assessment on the following basis:

- parallel lines such as the CI-HC lines do not exceed 50% of their rating and so can be considered to run firm. This means in normal operation one of the lines could trip due to a fault and full flow could be maintained on the other line
- other lines are below their rating and the remaining lines are essentially radial Channel Island via Manton, Bachelor and Pine Creek to Katherine. Therefore, they must operate at or below their rating but are not required to provide increased flow in the event of a contingency.

The addition of new solar PV generation south of Channel Island is likely to lead to higher flows on the CI-MA and MA-BA lines in coming years. There is currently spare capacity on those lines to allow for some additional generation in that region.

The 66 kV line loadings are shown in Figure 13.

Figure 13: Transmission network utilisation Darwin-Katherine (66 kV)



In general, flows on the 66 kV in 2019-20 were somewhat less than in previous years, leading to N-1 contingency capacity for all double circuit lines.

The upgrades between Hudson Creek and Palmerston appear to have been effective in reducing flows on the existing circuits in that corridor. Entura notes the ongoing load balancing issues required in the Weddell 66 kV loop. The Archer-Palmerston 66 kV line has reduced the reliance on generation from the Weddell power station to manage network flows.

Zone substations

The zone substation transformer loading under N and N-1 conditions for 2019-20 is shown in Figure 14. The substations of concern in the figure are those where either the N (single and multiple transformer substations) or N-1 (multiple transformer substations) loading exceeds 100%.

Generally, where a substation has multiple transformers, it is expected a substation can supply the full substation load with one transformer out of service (N-1), and where a substation is a single transformer substation, it can supply the full substation load under normal conditions (N), however supply would be lost should the single transformer fail. Should a transformer fail at a single transformer substation, such as Marrakai or Mary River substations, PWC indicates in its 2020 Transmission and Distribution Annual Planning Report (TDAPR) that a spare transformer may be able to be transported to the substation to restore supply.

Figure 14: Substation utilisation for N and N-1 conditions Darwin-Katherine

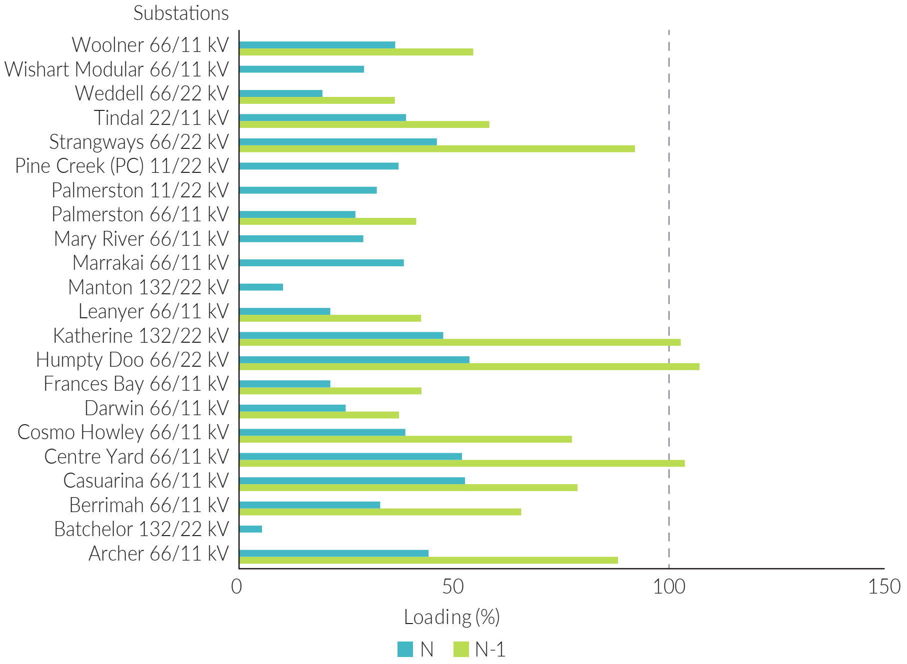


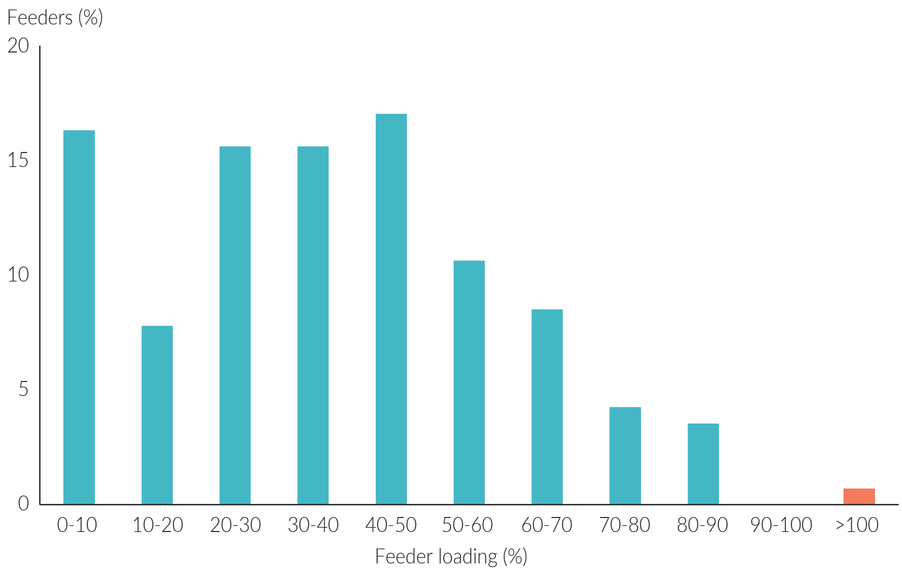
Figure 14 shows actual zone substation loading in 2019-20. On the basis that substation loading, either N or N-1, should not exceed 100%, in 2019-20, Katherine, Humpty Doo and Centre Yard substations were at risk of not fully supplying the substation load had one transformer gone out of service (N-1).

PWC's 2020 TDAPR states that PWC has a generator in place with 1 MW capacity in case of an emergency event at the Centre Yard substation. At the Humpty Doo substation, PWC states it can install a spare transformer in an emergency as load transfers to adjacent zone substations cannot address the N-1 limitation. As for the Katherine substation, PWC is currently exploring options to procure generators that can directly connect to the 22 kV bus at the Katherine substation, which would allow load to be supplied for a short period if an overload event occurs under N-1 conditions.

Feeders

The distribution of feeder loadings for the Darwin-Katherine power system is shown in Figure 15.

Figure 15: Feeder utilisation for Darwin-Katherine



Based on data provided directly from PWC, 1% of feeders exceeded their nominal capacity in 2019-20, which relates to one feeder, the 11CA15 HOSPITAL feeder out of the Casuarina zone substation. However, PWC's 2020 TDAPR does not identify any feeder limitations over the planning period, including the 11CA15 HOSPITAL feeder, which indicates the issue has been resolved since the 2019-20 feeder utilisation data was provided to the Commission.

Network constraints

Table 10 summarises the network constraints in the Darwin-Katherine region, which have remained unchanged since 2018-19.

Table 10: Darwin-Katherine normal system constraints

	Constraint description	Applied to	Limit	System condition	Comments
1	Weddell generation constraint	Total Weddell output	64 MVA line flow: constraint to generation calculated based on demand	A two-part formula as a function of load determines the limit. The limit is implemented in the supervisory control and data acquisition system	Prevents post-contingency line overloads. The constraint was updated based on network changes on 24/01/2019.
2	132 kV Channel Island – Katherine	Pine Creek and Katherine power stations	Minimises load flow on transmission section that may trip due to storm activity	Localised storm activity leading to risk of islanding	

Constraint 1 is understood to be a permanent reduction in generation from the Weddell power station under certain demand conditions in case of the loss of transmission. PWC has been working to reduce the impact of this constraint by reviewing the line ratings. The introduction of the Palmerston-Archer line has also acted to relieve the impact of this constraint. It may be that an automated run-back could be used to manage this flow limit, which would free the Weddell power station generating units to be operated at higher power output levels as long as the amount of load reduction can be managed within the spinning reserve allowances. Entura recommends investigating the benefits of using a run-back scheme to manage this constraint if the other actions do not completely mitigate it. The constraint could have a long-term impact on the efficiency of dispatch.

Constraint 2 requires generation to be dispatched in the Katherine region, when it may not have been ordinarily required, in order to limit the amount of electricity transmission across the 132 kV line where there is storm activity that may lead to a disconnection. This constraint highlights the system security implications of the single circuit line to Katherine.

While the Commission notes that System Control's obligations include ensuring the system operates reliably, safely and securely, the Commission considers this constraint may not be the most efficient solution and encourages licensees and other stakeholders more broadly to appropriately consider the costs and benefits of generator dispatch and network solutions as part of addressing system security issues. This constraint will likely become more of an issue once Eni Australia Limited's Katherine solar power station is commissioned and electricity transmission across the 132 kV line increases.

Network power quality

Low voltage quality

Figure 16 and Figure 17 show the steady state voltage distribution for the Darwin and Katherine regions in 2019-20, respectively.

Figure 16: Steady-state voltage performance, Darwin

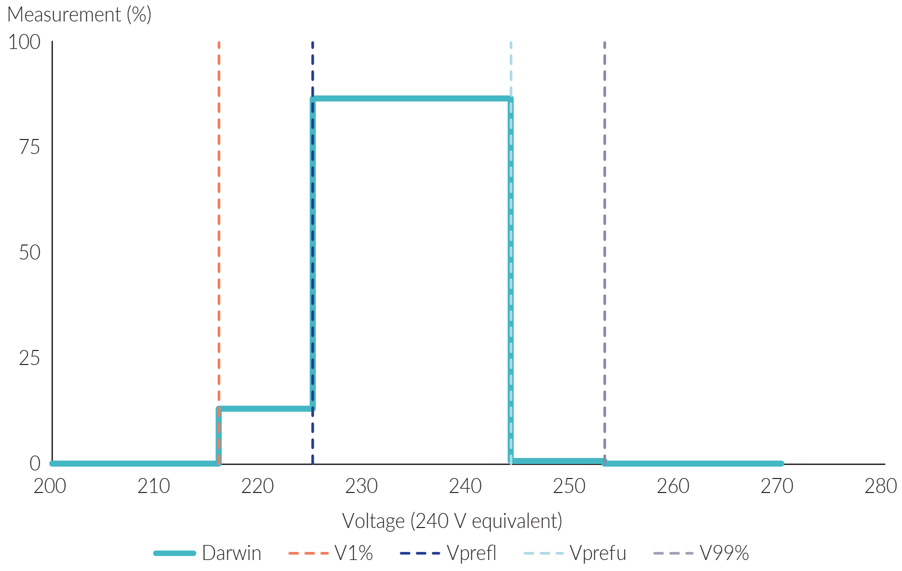
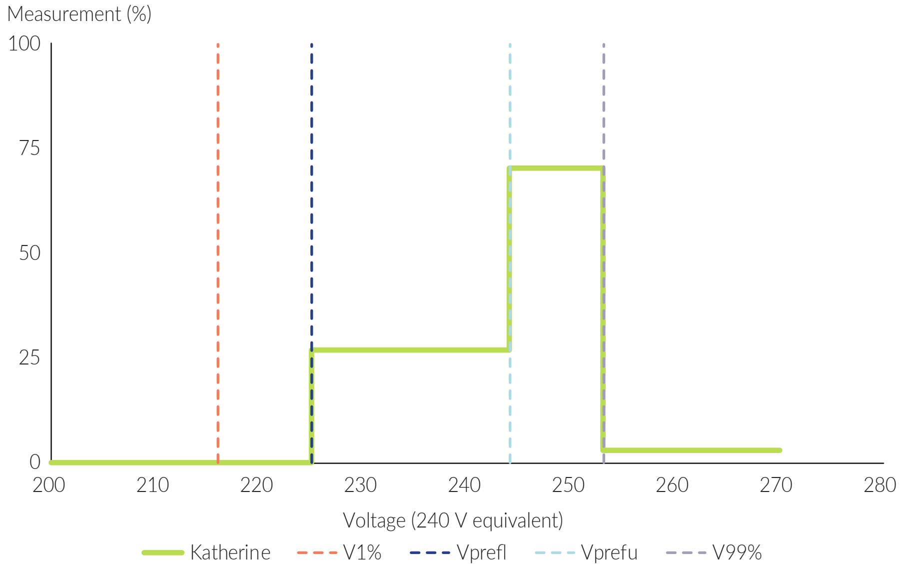


Figure 17: Steady-state voltage performance, Katherine



The measurement and reporting against this criterion is important in modern power systems where voltage can no longer be reliably regulated by the distribution transformer alone. In 2019-20, voltage regulation in Darwin slightly declined where voltage in the preferred zone (that is, between Vprefl and Vprefu) was around 86% in comparison to 91% in 2018-19. The high voltage periods have reduced while low voltage periods have increased from 7% to 13%. This is contrasted by the Katherine region where Power Services report a lack of buck (voltage reducing) taps on the transformers, in conjunction with the long line to Darwin, leads to some high and extremely high voltage periods. This has significantly increased in comparison to 2018-19 where high voltages are occurring more than 70% of the time. Entura considers this to be quite concerning. Power Services advises the Darwin-Katherine power system voltage management strategy is currently being reviewed in conjunction with plans to install inductive compensation to lower voltages in zone substations. This is expected to be completed by the end of 2021.

Network complaints

Power Services is required by the EIP Code to report on the percentage and total number complaints it receives that are associated with network quality of supply issues and associated with network-related activities.

Complaints associated with network quality of supply issues in Darwin-Katherine decreased from 3,227 in 2018-19 to 2,900 in 2019-20, and continued a downward trend over the last five years. Complaints are mostly made in relation to the Darwin region of the network, which is to be expected given the larger number of customers in the region compared with the Katherine region. Further, complaints continue to be mostly in relation to no power rather than part and low power, or fluctuations in power, which is consistent across the last five years.

Complaints associated with network-related activities are categorised as administration process and customer service, connections, reliability of supply, technical quality of supply or other. There was a small number of complaints regarding the Darwin-Katherine network in 2019-20 compared with the number of customers in the region. Over 50% of the complaints were categorised as administration process and customer service related.

2 | Alice Springs power system

This chapter focuses on the 2019-20 generation and network performance of the Alice Springs power system. Where possible it compares 2019-20 performance to historical data to identify trends. Specifically this chapter considers:

- incidents
- generator performance, observed UFLS and single generator trips, generation availability, non-reliable periods and generation constraints
- network performance, network utilisation, network constraints, network power quality and network complaints.

Power system description

The Alice Springs power system is the second largest power system in the Territory. It supplies the township of Alice Springs and surrounding rural areas from the Ron Goodin, Owen Springs and Uterne (solar) power stations.

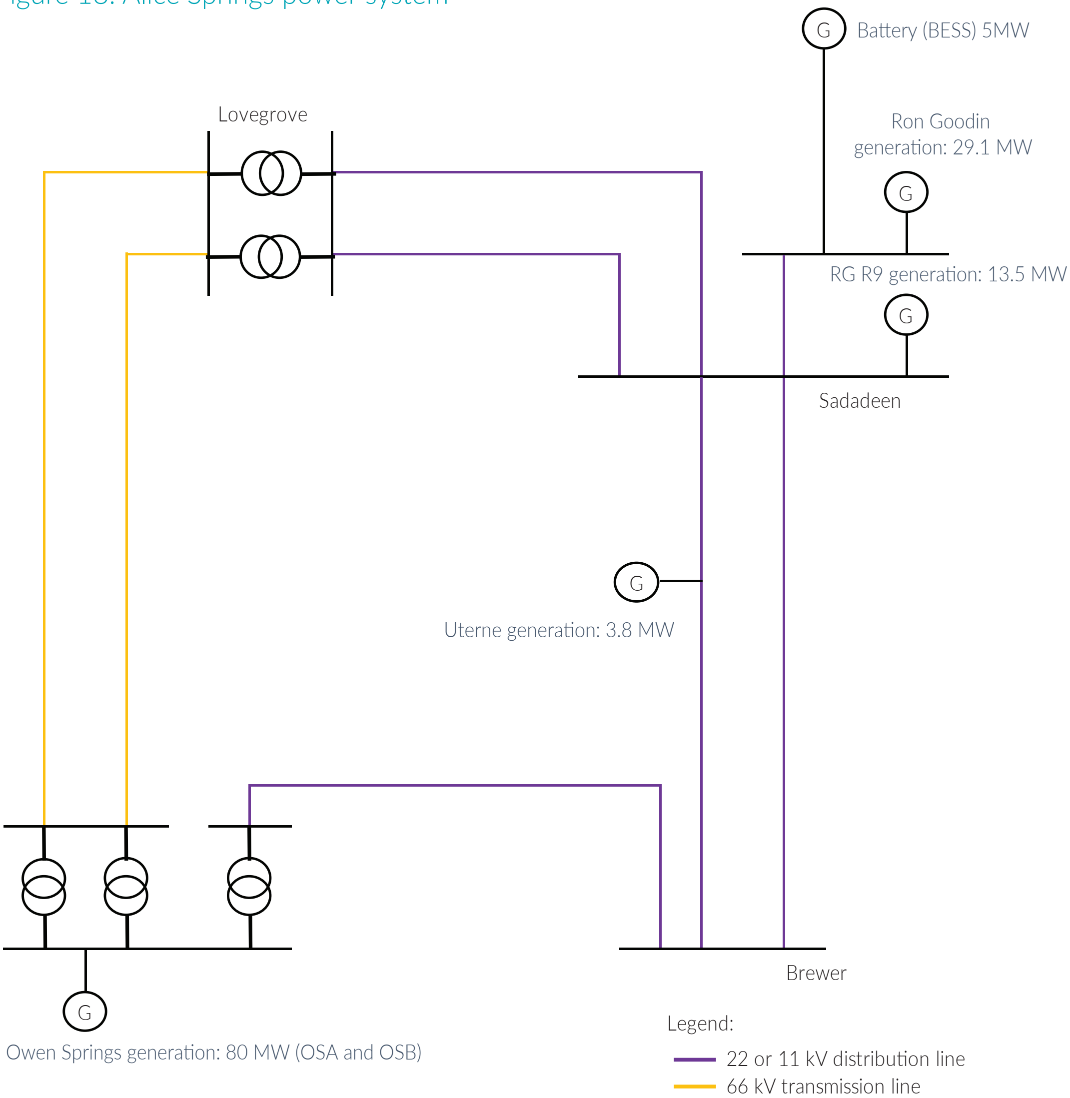
The energy sent out by grid-connected generators in 2019-20 is shown in Table 12.

Table 12: Alice Springs energy sent out in 2019-20

	Energy sent out (GWh)
Alice Springs power system	210.6

Figure 18 shows a simplified representation of the Alice Springs power system. The highest voltage of the network is 66 kV.

Figure 18: Alice Springs power system[13]



Incidents

A reportable incident is a power system event that had or could have had a significant adverse effect on security or reliability of electricity supply, and is determined by the Power System Controller in accordance with the SCTC. Further, the Power System Controller determines whether a reportable incident is classified as a major or minor incident. Major incidents are subject to a more detailed investigation and reporting requirements.

The Commission considers the purpose of incident reporting is to ensure power system events that would benefit from investigation are investigated to identify and address issues, and improve the safety and reliability of electricity supply to customers.

This section considers the overall customer impact from major and minor incidents, provides an overview of major incidents and discusses the tracking and implementation of System Control recommendations following the investigation of major incidents.

13 Generation capacities relate to non-summer capacities in accordance with the 2020 NTEOR.

Overall customer impact

This section shows the overall impact of major and minor incidents on customers in the Alice Springs region across the last four years (Table 13).

Table 13: Overall customer impact from major and minor incidents in the Alice Springs region

	2016-17	2017-18	2018-19	2019-20
Number of incidents	10	14	14	8
Customers impacted	33 730	43 270	18 691	31 205
Total duration (minutes)	415	1 247	1 867	2 157
SAIDI	152.90	570.30	223.00	719.30
SAIFI	2.77	3.45	1.53	2.520
reliability (% of year)	99.97	99.89	99.96	99.86
System blacks				
Number	0	2	0	1

SAIDI is a measure in minutes of the average duration of an incident weighted by the number of customers affected by each incident. That is, if 10 customers suffer a 10-minute interruption and there are 100 customers in the region, then this would equal a SAIDI of 1 minute. Multiple incidents are added together, so if a second incident of 15 minutes affected 10 customers, then that would be added to the first incident and equal a SAIDI of 2.5 minutes.

SAIFI is a measure of the average number of incidents weighted by the number of customers affected by each incident. Using the examples above, the SAIFI would be 0.1 after the first incident and 0.2 after the second incident.

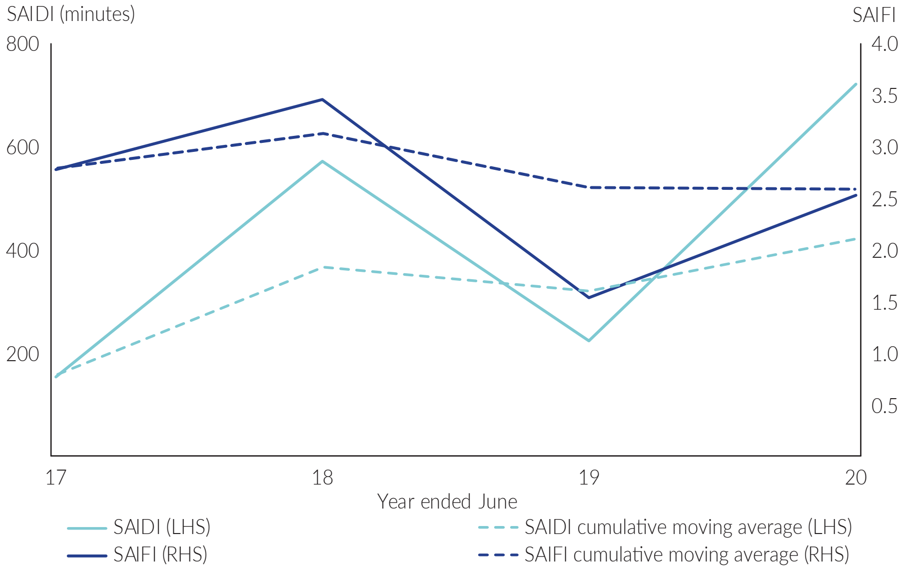
Reliability (percentage of year) is calculated based on SAIDI and is the percentage of a year the average duration in minutes of incidents per customer represents subtracted from the total number of minutes in a year. This is different from the unserved energy based reliability standard[14] for generation of 0.002% applied in the National Electricity Market, which is also adopted by the Commission in its NTEOR reliability assessments in the absence of a formal Territory target.

The number of customers impacted and total duration (minutes) of an incident is reported by System Control to the Commission as part of its SCTC obligations. As customers are restored in stages, not all customers are impacted for the full duration of the incident. Therefore, indicators derived from the number of customers impacted and total duration (minutes) of an incident to show the impact on customers, such as SAIDI, may be overstated and is considered a 'worst case'. However, the Commission considers the results and trends to be indicative.

The overall performance of the power system in 2019-20 is the worst in comparison with the previous three years due to the system black occurring on 13 October 2019, as shown in Figure 19.

14 https://www.aemc.gov.au/sites/default/files/content/2f4045ef-9e8f-4e57-a79c-c4b7e9946b5d/Fact-sheet-reliability-standard.pdf.

Figure 19: Overall SAIDI and SAIFI performance indices, Alice Springs[15]



The 2019-20 period shows an increase in SAIFI from the previous year although it remains less than the level from 2015-16 to 2017-18. The extended outage caused by the system black in October 2019 contributed to a significant increase in SAIDI in 2019-20.

The performance of the Alice Springs power system continues to be inconsistent as seen in Figure 19. Points to note are the small numbers of customers affected but the high number of customer minutes without supply. This suggests there is an imbalance across the power system in terms of customer experience, although the imbalance may be reasonable depending on the circumstances, with the relativities between customer connection types managed through feeder type performance targets.

Major incidents

Table 14 shows a summary of the major incidents in Alice Springs in 2019-20.

Table 14: Alice Springs major generation incident summary[15]

ID	Date of incident	Description	Category	Cause	UFLS/ black	Incident duration (minutes)	Customers affected
1	13-Jul-2019	Multiple generation assets – gen trip O3/ O13/R9	Generation	Equipment failure – BESS response oscillating	UFLS stage 1B	20	3 700
2	6-Oct-2019	Gen trip O1	Generation	Equipment failure – BESS response oscillating	UFLS stage 1B	20	3 333
3	13-Oct-2019	Alice Springs power system black	Generation	Multiple causes	System black	605	11 996
4	23-Nov-2019	22RG13 (SD-BR Tie 1) feeder tripped	Networks	Equipment failure	UFLS stage 3A	114	10 391

15 Based on data from System Control incident reporting ('customers impacted' and 'total duration (minutes)'), specifically initial notifications.

The incidents fall into two broad categories, equipment failure and incorrect control operation:

1. Equipment failure (incidents 1, 2 and 4)

For incidents 1 and 2, the BESS at the Ron Goodin power station failed to regulate frequency following a trip event. The oscillatory behaviour of the BESS caused frequency to fall, which triggered UFLS operation. Incident 2 occurred during testing of the BESS inverters with the original equipment manufacturers. Territory Generation are actively attempting to resolve these control issues.

For incident 4, an unknown transient fault on one of the 22 kV feeders resulted in multiple generating units at the Owen Springs power station and the BESS at the Ron Goodin power station to trip. The incident report suggests incorrect low voltage ride through settings were a factor in causing the Owen Springs power station generators to trip, however the tripping of the BESS was unknown. The lack of knowledge of new assets in the Alice Springs power system continues to be the main factor for outages, however Entura anticipates a reduction of these incidents as familiarisation of these new assets increases with time.

2. Incorrect control operation (incident 3)

The nature of this incident stems from incorrect generation control. In previous reviews, Entura has highlighted concerns with generation control operations. The Alice Springs system black investigation raised a concern over the integration and knowledge of original equipment manufacturer controls relating to the MAN and Jenbacher generators at the Owen Springs power station. Discussions with Territory Generation indicate that implementation of the recommendations from the investigation are top priority.

Impact of major incidents

The number of generation incidents have reduced compared with 2018-19, however the impacts of the system black pushed SAIDI to a record high.

With the increase in the minimum spinning reserve during 2019-20, Entura expects improvement in future years despite the retirement of the Ron Goodin power station being deferred for a couple of years, noting this likely increases costs.

Only one network incident occurred in 2019-20, similar to the previous two years, however the prolonged duration of the incident resulted in a much higher SAIDI than in those years.

Major incident report recommendations

Recommendations made by System Control, as a result of its investigation of major reportable incidents, are consolidated in a recommendation tracking spreadsheet, which is periodically provided to the Commission.

In the Commission's independent investigation of a system black in Alice Springs on 13 October 2019, the Commission made a recommendation regarding placing a focus on determining if the recommendations of the independent investigation report and other major event reports have been tracked and implemented during its annual power system reviews, which the Territory Government accepted. Accordingly, as part of the NTPSPR, Entura has assessed System Control's recommendation tracking spreadsheet, based on data provided by System Control on 16 September 2020.

System Control's recommendations are categorised into seven areas: asset management, EMS, modelling, power system studies, procedural, protection and training.

While the Commission is aware of significant progress since it made its recommendation following the Alice Springs system black, Entura notes the completion of recommendations is not consistent across System Control recommendation categories. From Entura's assessment, consistent with the Darwin-Katherine and Tennant Creek power systems, it appears the focus for the past few years has been more on asset management and procedural-related recommendations. Further, Entura notes that no EMS, modelling or power system study-related recommendations have been completed, even though some recommendations in these categories were made more than four years ago.

Generation

The total in-front-of-the-meter generation capacity is 126.4 MW[16] in Alice Springs and the fuel type of the generation units is currently made up of dual fuel (gas/diesel), diesel only, gas only and solar PV. This does not include behind-the-meter rooftop solar photovoltaic generation capacity, which totalled around 13 MW in 2019-20.

Table 17: Maximum non-summer generation capacity in Alice Springs[19]

	MW
Ron Goodin	42.60
Uterne	3.80
Owen Springs	80.00
Total generation	**126.40**

The Ron Goodin power station was expected to be decommissioned in late 2019, however retirement of the power station is now dependent on a number of technical capability milestones being met post the system black incident in late 2019. The new Jenbacher generators at the Owen Springs power station are now considered to be fully commissioned, although there are lingering performance issues associated with these units.

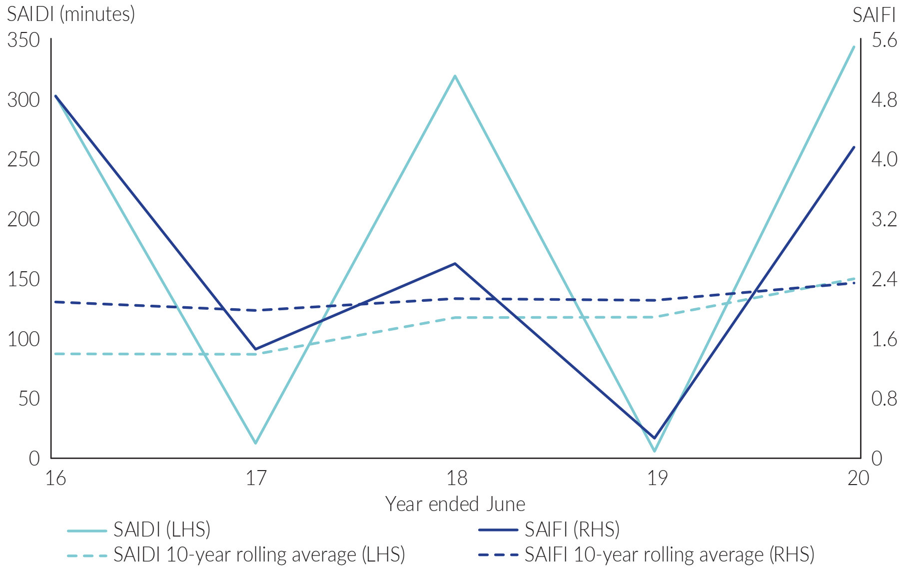
The following sections show the generation in Alice Springs continues to present reliability and availability challenges.

16 Generation capacities relate to non-summer (winter) capacities in accordance with the 2020 NTEOR.

Generator performance

The SAIDI and SAIFI performance for the Alice Springs generating units is presented in Figure 20.

Figure 20: SAIDI and SAIFI performance for generation, Alice Springs



The two indices show the number of issues that have beset the Alice Springs power system over the last five years.

Entura has been expecting the generation upgrades at the Owen Springs power station and the full commercial operation of the BESS to improve the performance. Unfortunately, these upgrades are yet to meet this expectation in a consistent manner. Figure 20 shows the SAIDI minutes, including the large system black event. Unfortunately, reporting SAIDI minutes excluding the system black does not change the customer's experience. Therefore, Entura considers the new generating units at the Owen Springs power station and rearrangement of the network connection continue to cause security issues.

Entura notes, regardless of these upgrades, the generation mix and high penetration of solar PV, resulting in a reducing minimum system demand, leads to a challenging system control problem, particularly in a small system such as Alice Springs. Therefore, careful planning in relation to how the power system is operated and coordination between relevant stakeholders is necessary.

The BESS operation at the Ron Goodin power system continues to give inconsistent performance in relation to frequency regulation, which also results in a higher SAIDI.

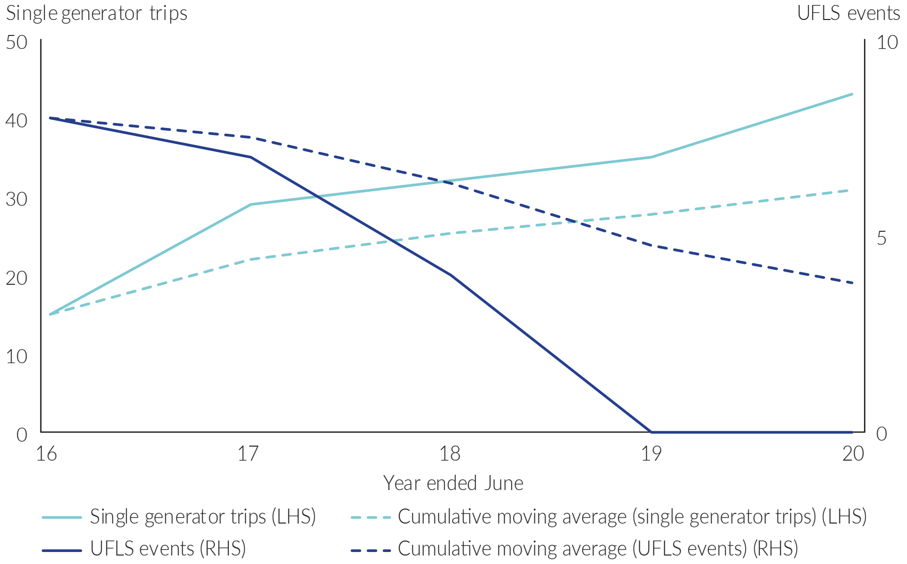
Observed UFLS and single generator trips

This review has focused on single unit trips and their impact on customers for a number of years. The focus is due to the high incidence of single unit trips (relative to other power systems) and the challenge that smaller power systems have in managing these incidents without loss of load due to the relative large size of the generating units.

Until recently, the Alice Springs power system was dispatched in such a way as to require UFLS to arrest frequency fall for most large single generation trips. This practice was ended in an attempt to improve system performance. Since that time the power system has seen a steady increase in single unit trips but a stark reduction in coincident UFLS incidents.

However, the Commission notes this improvement has been achieved in part through System Control changes to spinning reserve, which may increase costs, particularly for Territory Generation. Further, given there is no efficient price or competitive process for the provision of spinning reserve, or ancillary services more broadly, there is little incentive for the associated increased costs to be minimised. The Commission notes the Territory Government's Office of Sustainable Energy is currently considering this issue as part of its essential system services work stream.

Figure 21: Alice Springs single generator trips versus UFLS (due to single generator trips)

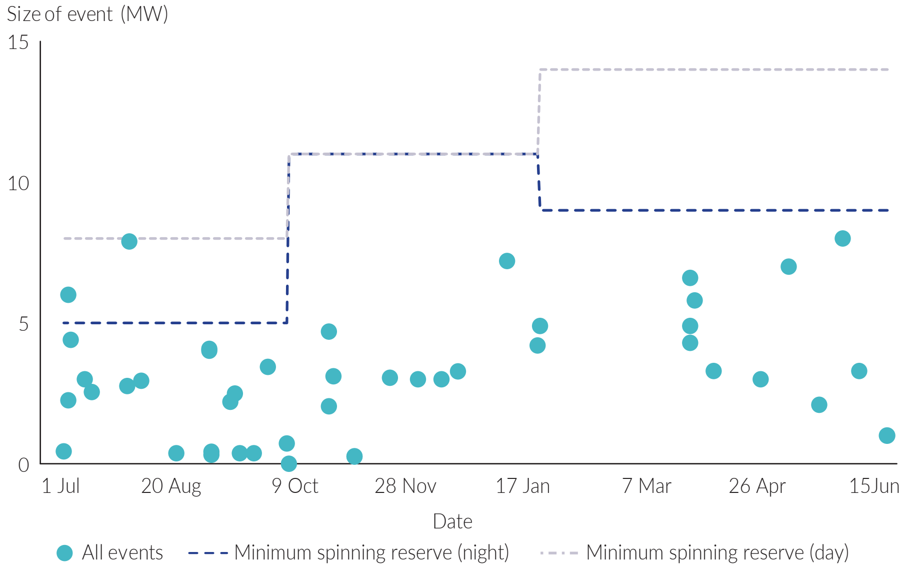


Following on from 2018-19, the Alice Springs power system continues to eliminate UFLS events from single generator trips in 2019-20. Maintaining zero UFLS operations two years in a row is a great result from the customer's perspective. However, the number of single generator unit trips continues to increase. The incidence of these trips continues to be a concern for Entura especially when the trip occurrences have materially increased from the previous two reporting periods in number and distribution. In this respect, it is evident that performance has declined in comparison to previous years.

The combination of running aged machines at the Ron Goodin power station and running Jenbacher machines, in which Territory Generation are still overcoming installation issues, has led to a decline in power system performance. Entura notes Territory Generation is actively working to resolve the issues with both power stations.

The size of single generator trips compared with the day/night minimum spinning reserve in Alice Springs, which changed twice during 2019-20, is shown in Figure 22.

Figure 22: Alice Springs single generator trip by size



Due to the system black event in October 2019, System Control modified the spinning reserve requirements to ensure system security. Directly after the incident the day and night minimum spinning reserve were increased to 11 MW, and then from February 2020 the day and night minimum spinning were nominated at 14 MW and 9 MW, respectively. Figure 22 illustrates that in the second half of 2019-20, all generator unit trips were well below the night minimum spinning reserve. Inherently this is a good result, however Entura considers it may indicate the nominated minimum spinning reserve may be more conservative than required.

The level of spinning reserve required limits the ability of the power system to be dispatched with a high percentage of capacity provided by the newer Jenbacher generators, which are very high efficiency reciprocating engines. This is due to engines of this type, regardless of equipment supplier, not being able to rapidly accept or reject load, such as during a contingency event. This makes this type of generator generally inappropriate for the provision of large amounts of spinning reserve from a single machine. This results in a higher spinning reserve amount being required to ensure sufficient governor response to meet the contingency requirement, in the absence of other solutions.

In summary, even though the number of trips are high, management of the spinning reserve is reducing the customer impact, however this may come with increased costs, particularly higher costs for Territory Generation.

Generation availability

A number of indices are calculated as per the EIP Code for generating units to reflect their reliability. The factors discussed in the following section are:

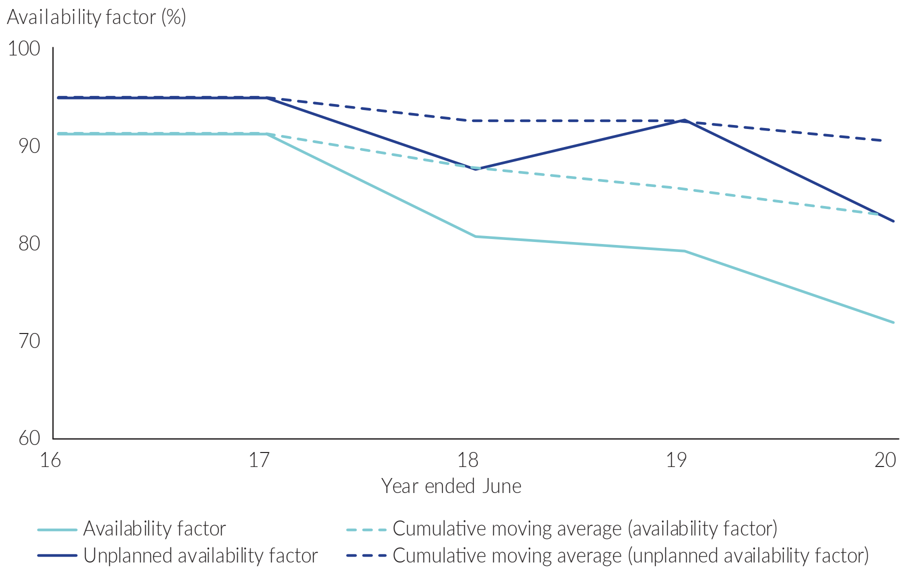
- availability factors (availability factor and unplanned availability factor) – the availability factor represents the percentage of time a unit is available to generate despite both planned and unplanned maintenance, whereas the unplanned availability factor indicates the percentage of time a unit is available to generate despite unplanned maintenance. The difference between these two indices is the percentage of time a unit is unavailable to generate due to planned maintenance. Planned maintenance is scheduled in advance, usually based on original equipment manufacturer maintenance schedules, and notified to System Control in accordance with the SCTC. Unplanned maintenance is maintenance that is required but can wait until a particular convenient window of time, such as the next period of low power system demand.
- forced outage factor – the forced outage factor is the percentage of time the unit is not available for dispatch due to an immediate issue with the generator, such as a breakdown, which cannot be deferred. This includes time taken to repair the unit if it is damaged or a component requires replacement or refurbishment due to a breakdown or failure.

These measures provide some insight into the availability of the generating units and allow an assessment to be made as to the adequacy of condition monitoring and preventative maintenance. Ideally, planned maintenance should be to a level and adequacy that minimises the level of unplanned maintenance and forced outages as much as reasonably feasible, noting it is unreasonable to expect zero unplanned maintenance or forced outage events. Planned Maintenance activities can be planned for by generators and the Power System Controller, whereas forced outages, and to a lesser extent unplanned outages, can lead to system reliability and security risks, with limited or no notice.

Availability factors

Figure 23 shows the capacity weighted average availability and unplanned availability factors for the Alice Springs power system over the last five years.

Figure 23: Capacity weighted average availability and unplanned availability factors for Alice Springs generating units



Ongoing issues at the Owen Springs power station and prolonged use of the Ron Goodin power station have resulted in higher levels of unplanned maintenance across the Alice Springs region. Territory Generation describe this as having a power station at each end of the bathtub curve. That is, a power station at the beginning and a power station at the end of its service life. Specifically, continuing teething problems at the Owen Springs power station and continued ageing effects at the Ron Goodin power station contribute to incidences of unplanned maintenance and forced outages.

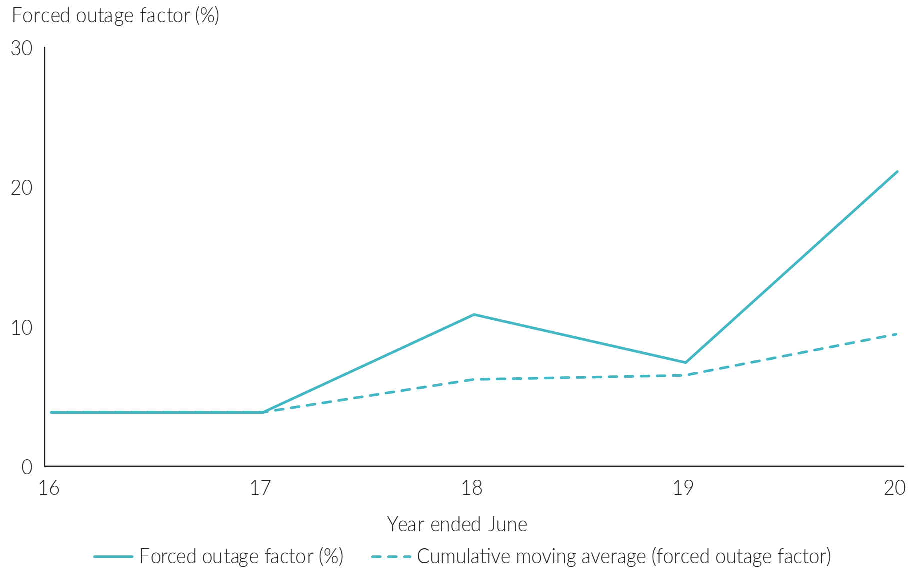
The performance at the Ron Goodin power station and its impact on customers is difficult to mitigate due to the age of the plant, and now the extension of operation beyond the planned decommissioning date.

The level of unplanned maintenance, combined with the high level of forced outages, as discussed below, at both the Owen Springs and Ron Goodin power stations is likely to be having a considerable impact on the Power System Controllers' ability to maintain a reliable and secure power system at periods of high demand.

Forced outage factor

Figure 24 shows the capacity weighted average forced outage factor for the Alice Springs power system over the last five years.

Figure 24: Capacity weighted average forced outage factor for Alice Springs generating units



The forced outage factor for Alice Springs increased significantly in 2019-20, almost tripling, and is considerably higher than the cumulative moving average.

The Owen Springs power station performance declined in 2019-20 compared with previous years. The discovery of technical issues associated with the Jenbacher generators continues to detract from the power station's performance. Territory Generation has advised the effects of COVID-19 have significantly slowed down restoration rates, noting it is reliant on the original equipment manufacturer's support and there appears to be contractual obstacles and a lack of local Jenbacher expertise to address the performance issues at the power station.

The effects of the ageing assets at the Ron Goodin power station are evident from the significant increase in forced outages reported in 2019-20 from already high levels. Territory Generation understands the challenges associated with the Ron Goodin power station, in particular where no pattern of failures are evident, and is currently exploring new ways to increase reliability of the generators by taking parts from one to service another. This also has an impact on the forced outage factor, as the forced outage of the donor generator is likely to become prolonged, if not indefinite.

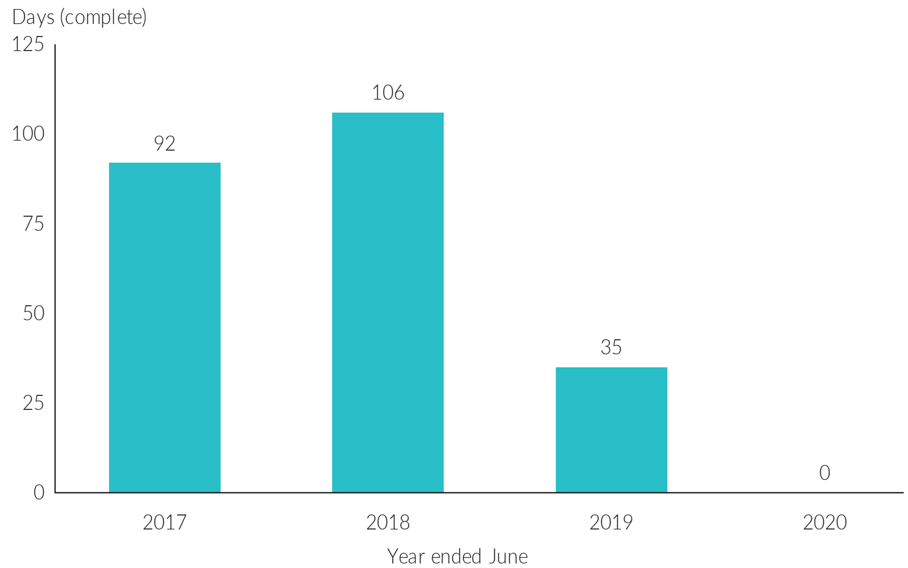
Non-reliable periods

Non-reliable periods are a forward looking assessment, rather than in response to system incidents, and are declared when the Power System Controller identifies that power system reliability cannot be maintained. There are a number of causes, including:

- planned, unplanned or forced outages that reduce reliability for all or part of the power system
- lack of generation to meet demand and or requirements for spinning reserve.

There were no declared non-reliable periods in 2019-20 (see Figure 25).

Figure 25: Non-reliable periods for generation in Alice Springs



A reduction in non-reliable notice periods suggests a more diligent operation of the power system. This is made easy due to the large number of generators available between the Owen Springs and Ron Goodin power stations.

Generation constraints

Table 19 summarises the generation constraints in the Alice Springs region.

Table 19: Alice Springs normal system constraints

	Constraint description	Applied to	Limit	System Condition	Comments
1	Maximum dispatch	OSPS	45 × power factor	All	Prevent overloading of 66/11 kV Owen Springs transformers 1 or 2
2	Dispatch level management	RGPS	17 MVA	All	Manage power flow through RG/ Sadadeen 11/22 kV transformers
3	Dispatch level management	RGPS and OSPS		Prior to system black (13/10/2019)	Increase output of OSPS as decommissioning of RGPS is progressed
4	Dispatch level management	OSPS		All (after system black 13/10/2020)	Decommissioning of RGPS put on hold and OSPS Jenbacher machines placed under restriction

Constraints 1 and 2 are network constraints. The constraints curtail (or preferentially dispatch) generation to manage loading on a network element. Constraint 1 may be able to be relaxed now that the third Owen Springs transformer is available.

Constraint 3 was introduced to cater for the systematic decommissioning of the Ron Goodin power station, however after the system black event this was reversed with the introduction of constraint 4. Constraint 4 is understood to be in place until the point where all recommendations arising from the 13 October 2019 system black event are implemented. There is a need for an investigation of the operability of the Alice Springs power system once the retirement of the Ron Goodin power station occurs. The change in power flows and voltage regulation need to be better understood to allow secure and efficient dispatch and network management under these changed operating conditions.

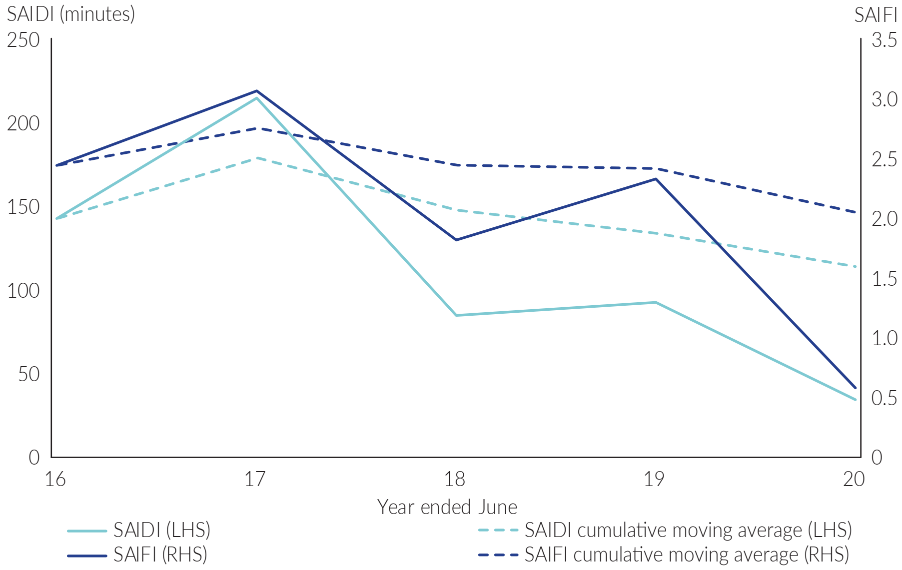
Network

The Alice Springs power system supplies Alice Springs and the surrounding areas through a network of 66 kV sub-transmission and lower voltage distribution feeders. The network forms a ring with Lovegrove zone substation and the Ron Goodin power station at one end and the Owen Springs power station at the other.

Network performance

Network performance is measured and reported by Power Services as part of EIP Code requirements. The SAIDI and SAIFI performance for the Alice Springs network is presented in Figure 26.

Figure 26: Adjusted SAIDI and SAIFI performance indices for the Alice Springs network[17]



Both indices remain below the cumulative moving average in 2019-20, with a sharp fall in SAIDI and SAIFI in comparison with 2018-19. Using the short rural feeder global target as a reference, both indices are well within that benchmark. Further, both the SAIDI and SAIFI results achieve the higher urban feeder benchmark.

Entura notes there has been no transmission level (66 kV lines) outages in Alice Springs across the last five financial years. This is an excellent result, however Entura is concerned the change in operation in the network associated with the eventual decommissioning of the Ron Goodin power station may lead to some unexpected network incidents in the future. Entura expects the Power System Controller to work to pre-empt these issues where possible.

Network utilisation

Transmission network

The 66 kV lines between Owen Springs and Lovegrove are presently lightly loaded due to the continued load sharing between the Ron Goodin and Owen Springs power stations. This loading will change as the Ron Goodin power station is decommissioned. The 66 kV lines will become very important for the Alice Springs supply and the management of the ring (normally open) will need to be carefully considered. The utilisation of these lines will be driven by Alice Springs demand and the operation of the BESS.

Zone substations

The zone substation transformer loading under N-1 conditions in 2019-20 is shown in Figure 27.

Generally, where a substation has multiple transformers, it is expected that a substation can supply the full substation load with one transformer out of service (N-1). The substations of concern in the figure are those where either the N or N-1 loading exceeds 100%.

17 The EIP Code allows licensees to adjust SAIDI and SAIFI values by excluding incidents that meet an exclusion criteria included in the code, with the list of the excluded incidents required to be included in the reporting.

Figure 27: Substation utilisation for N and N-1 conditions Alice Springs

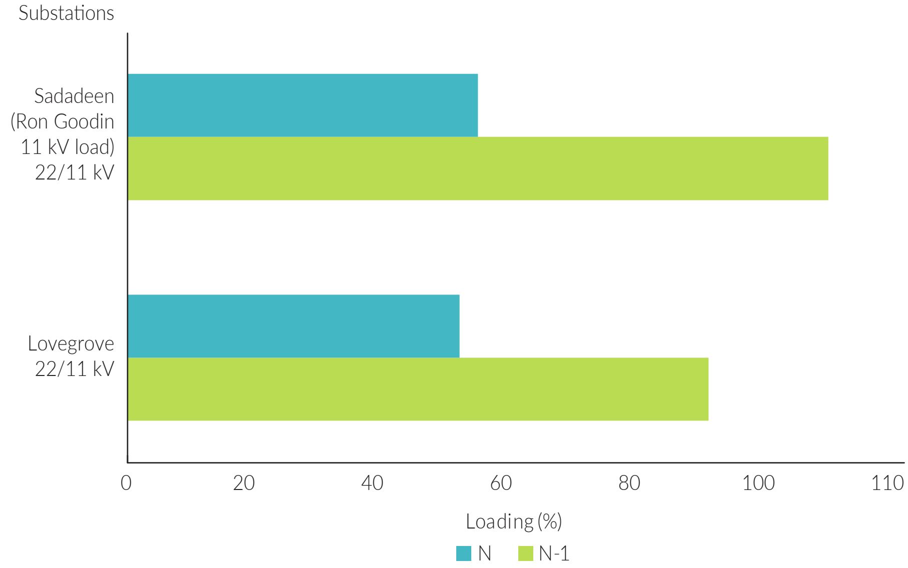
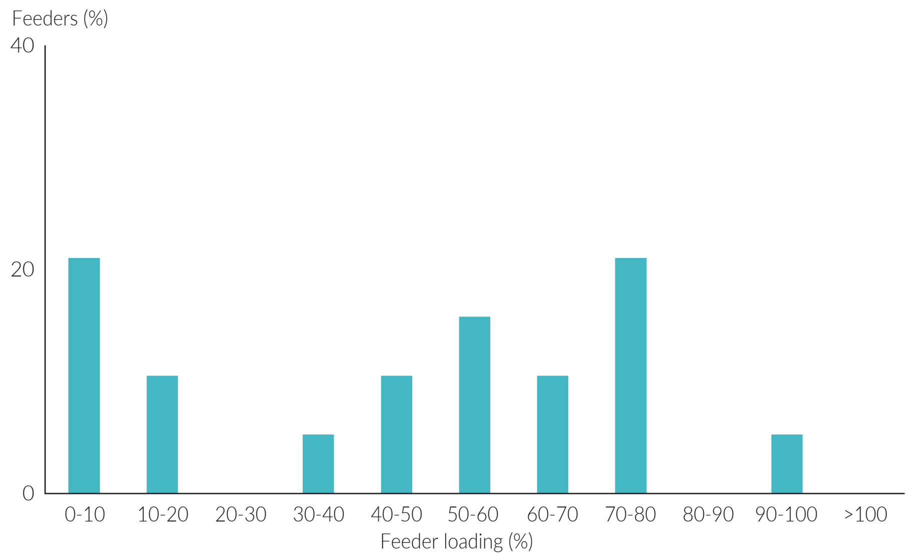


Figure 27 shows actual zone substation loading in 2019-20. On the basis that substation loading should not exceed 100%, for the 2019-20 period Sadadeen 22/11 kV substation was at risk of not fully supplying the substation load had one transformer gone out of service (N-1). According to PWC's 2020 TDAPR, it can address the N-1 limitation by transferring Sadadeen load to Lovegrove Zone Substation, however, this can only be achieved once new feeder cables are installed at the Lovegrove Zone Substation, which was scheduled for March 2021.

Feeders

The distribution of feeder loadings for Alice Springs is shown in Figure 28.

Figure 28: Feeder utilisation for Alice Springs



In 2019-20, no feeders exceeded nominal capacity. This demonstrates that feeder loadings are well managed in the Alice Springs network with all feeders operating below their capacity. Loading on feeder 11RG02 GOLF is approaching capacity (loading of 92% in 2019-20). Depending on the feeder demand growth rate, PWC may have to take action to avoid exceeding capacity in 2020-21.

Network constraints

Table 20 summarises the network constraints in the Alice Springs region.

Table 20: Alice Springs network constraints

	Constraint description	Applied to	Limit	System condition	Comments
1	22/11 kV transformers	Sadadeen	17 MVA	All	

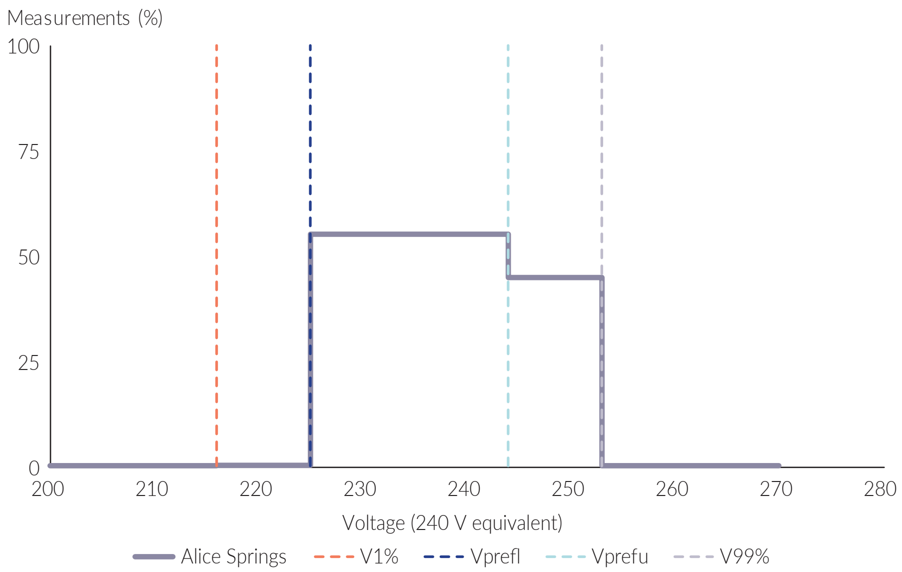
Constraint 1 is a simple thermal limit that represents a limit to the flexibility of the Alice Springs network topography. Entura considers where constraints impact efficient generation dispatch, they should be resolved.

Network power quality

Low voltage quality

Figure 29 shows the steady-state voltage distribution for the Alice Springs region in 2019-20.

Figure 29: Steady-state voltage performance, Alice Springs



Voltage regulation in 2019-20 is comparable to 2018-19, where voltages are in the preferred zone around 55% of the time. The Alice Springs network topology does not lend itself to strong voltage regulation. This is particularly true when the generating units at the Ron Goodin power station are not dispatched. The distance from the Lovegrove zone substation to the Owen Springs power station means a lot of charging and or line drop must be managed at Lovegrove. It seems this is not possible. The relatively high penetration of behind-the-meter rooftop solar PV in the Alice Springs urban area will also contribute to the high percentage of time the customers experience higher than preferred voltages. These issues must be resolved.

Network complaints

Power Services is required by the EIP Code to report on the percentage and total number complaints it receives that are associated with network quality of supply issues and associated with network-related activities.

Complaints associated with network quality of supply issues in Alice Springs decreased from 482 in 2018-19 to 397 in 2019-20, and continued a downward trend over the last five years. Complaints are mostly made in relation to no power rather than part and low power, or fluctuations in power, which is consistent with the last five years, however the percentage of no power complaints has slightly increased over the same period.

Complaints associated with network-related activities are categorised as administration process and customer service, connections, reliability of supply, technical quality of supply or other. There was a small number of complaints regarding the Alice Springs network in 2019-20 relative to the number of customers in the region. Over 45% of the complaints were categorised as administration process and customer service related.

3 | Tennant Creek power system

This chapter focuses on the 2019-20 generation and network performance of the Tennant Creek power system. Where possible it compares 2019-20 performance to historical data to identify trends. Specifically this chapter considers:

- incidents
- generator performance, observed UFLS and single generator trips, generation availability, non-reliable periods and generation constraints
- network performance, network utilisation, network constraints, network power quality and network complaints.

Power system description

The Tennant Creek power system is the smallest of the regulated power systems in the Territory. The system supplies the township of Tennant Creek and surrounding rural areas from its centrally located power station. The energy sent out by grid-connected generators in 2019-20 is shown in Table 22.

Table 22: Tennant Creek energy sent out in 2019-20

	Energy sent out (GWh)
Tennant Creek power system	29.64

The total in-front-of-the-meter generation capacity in the Tennant Creek power system is 19.75 MW[18], which includes three new Jenbacher generators, consistent with the 2020 NTEOR. This does not include behind-the-meter rooftop solar PV generation capacity, which totalled around 0.4 MW in 2019-20. The fuel type of the generation units is currently made up of diesel and gas.

The power station at Tennant Creek has undergone a significant transformation with the commissioning of new generating units and retirement of a large number of existing units.

Incidents

A reportable incident is a power system event that had or could have had a significant adverse effect on security or reliability of electricity supply. It is determined by the Power System Controller in accordance with the SCTC. Further, the Power System Controller determines whether a reportable incident is classified as a major or minor incident. Major incidents are subject to a more detailed investigation and reporting requirements.

The Commission considers the purpose of incident reporting is to ensure power system events that would benefit from investigation are investigated to identify and address issues, and improve the safety and reliability of electricity supply to customers.

This section considers the overall customer impact from major and minor incidents, provides an overview of major incidents and discusses the tracking and implementation of System Control recommendations following the investigation of major incidents.

18 Generation capacity relates to non-summer (winter) grid connected in-front-of-the-meter generation capacities in accordance with the 2020 NTEOR.

Overall customer impact

This section shows the overall impact of major and minor incidents on customers in the Tennant Creek region across the last four years (Table 23).

Table 23: Overall customer impact from incidents in the Tennant Creek region

	2016-17	2017-18	2018-19	2019-20
Number of incidents	7	11	19	9
Customers impacted	3 780	6 435	16 825	9 183
Total duration (minutes)	225	1 784	667	174
SAIDI	93.70	363.20	587.00	153.40
SAIFI	2.470	4.00	10.82	5.94
Reliability (% of year)	99.98	99.93	99.89	99.97
System blacks				
Number	2	2	3	2

SAIDI and SAIFI have significantly reduced in the 2019-20 compared with 2018-19.

SAIDI is a measure in minutes of the average duration of an incident weighted by the number of customers affected by each incident. That is, if 10 customers suffer a 10-minute interruption and there are 100 customers in the region, then this would equal a SAIDI of 1 minute. Multiple incidents are added together, so if a second incident of 15 minutes affected 10 customers, then it would be added to the first incident and the SAIDI would be 2.5 minutes.

SAIFI is a measure of the average number of incidents weighted by the number of customers affected by each incident. Using the examples above, the SAIFI would be 0.1 after the first incident and 0.2 after the second incident.

Reliability (percentage of year) is calculated based on SAIDI and is the percentage of a year the average duration in minutes of incidents per customer represents subtracted from the total number of minutes in a year. This is different from the unserved energy based reliability standard[19] for generation of 0.002% applied in the National Electricity Market, which is also adopted by the Commission in its NTEOR reliability assessments in the absence of a formal Territory target.

The number of customers impacted and total duration (minutes) of an incident is reported by System Control to the Commission as part of its SCTC obligations. As customers are restored in stages, not all customers are impacted for the full duration of an incident. Therefore, indicators derived from the number of customers impacted and total duration (minutes) of an incident to show the impact on customers, such as SAIDI, may be overstated and are considered a ‘worst case’. However, the Commission considers the results and trends to be indicative.

Tennant Creek performance is improving against each of these indices. The sharp fall in SAIDI and SAIFI in 2019-20 from 2018-19 is shown in Figure 30.

19 https://www.aemc.gov.au/sites/default/files/content/2f4045ef-9e8f-4e57-a79c-c4b7e9946b5d/Fact-sheet-reliability-standard.pdf.

Figure 30: Overall SAIDI and SAIFI performance indices, Tennant Creek[20]

Ongoing poor performance in the Tennant Creek power system led the Commission to write to PWC and Territory Generation on 30 September 2019 to highlight its concerns, and request a response to explain the poor performance in the system from their perspectives, along with advice on how the two licensees may address the issues to improve the level of service to customers. In the letter, the Commission acknowledged that managing a system such as Tennant Creek may be challenging, however the Commission considered that customers in Tennant Creek, which is a regulated system, should receive a level of service similar to that provided in the Darwin-Katherine and Alice Springs systems.

Both licensees provided responses, which were summarised in the 2018-19 Review.

The performance data for 2019-20 suggests these responses and subsequent actions (higher spinning reserve and prioritising more secure generating units) to improve the operation of the power system have been somewhat successful.

PWC advised the Commission that the long-term solution to addressing the issues in the Tennant Creek power system at a high level includes network and generation augmentation and protection changes. To support this view, PWC noted the installation of Jenbacher generators by Territory Generation in Alice Springs was coupled with an engineering solution (installing a BESS) to address the low inertia and step response of the Jenbacher generators.

The Commission considers that any long-term solution should be carefully and appropriately considered by licensees and government, including a thorough cost benefit analysis, to ensure the best outcome for Tennant Creek customers and Territory taxpayers.

Major incidents

There were nine major incidents in the Tennant Creek power system in 2019-20 (Table 24). This is a substantial improvement from the nineteen incidents that occurred in 2018-19.

20 Based on data from System Control incident reporting ('customers impacted' and 'total duration (minutes)'), specifically initial notifications.

Table 24: Tennant Creek generation major incident summary[21]

ID	Date of incident	Description	Category	Cause	UFLS/black	Incident duration (minutes)	Customers affected
1	9-Jul-2019	Dual feeder fault/ re-close	Networks	Transient fault	UFLS stage 4A	17	1 400
2	19-Jul-2019	Set 19 tripped	Generation	Equipment failure	UFLS stage 4A	19	1 438
3	3-Aug-2019	T21 tripped	Generation	Equipment failure	UFLS stage 1	8	49
4	2-Sep-2019	Unit 20 tripped	Generation	Equipment failure	UFLS all stages	16	1 544
5	3-Oct-2019	22TC01 Ali Curung re-close and unit 20 tripped	Networks	Transient fault	UFLS stage 1	28	49
6	9-Oct-2019	Unit 20 tripped	Generation	Equipment failure	UFLS stage 4A	13	1 214
7	15-Oct-2019	Unit 18 tripped	Generation	Equipment failure	UFLS stage 1	6	49
8	24-Apr-2020	Tennant Creek east feeder (22TC02) tripped	Networks	Transient fault	UFLS stage 1	19	746
9	24-Jun-2020	Tennant Creek system black	Networks	Transient event	UFLS stage 1	48	2 694

Incidents 2, 3, 4, 6, and 7 all point to the delicate nature of the Tennant Creek power system. The size of single generating units, their minimum stable load and the low levels of demand make managing spinning reserve in an efficient way difficult. This leaves customers exposed to single unit trips. There are a large number of these trips, mainly due to the commissioning and 'bedding down' of the newer generating units and new switchgear. The incidents, though frequent, are being managed quickly (that is, there are a lot of events but they are generally for short duration) and so the expectation is for both SAIDI and SAIFI to improve or approach an acceptable level once these 'teething' issues are managed. Entura recommends investigating the failure of these assets taking place in a timely manner as the same issue seems to trigger these events.

Incidents 1, 5, 8 and 9 were caused by transient faults on the power system. Smaller power systems are less resilient to these faults because of higher impedances, lower fault levels and smaller numbers of generating units. Most of these incidents are exacerbated by a generating unit also tripping. System Control recommendations stemming from investigating these faults should be considered carefully by Power Services and Territory Generation to try to eliminate avoidable tripping. This power system continues to be unduly affected by unreliable performance of a range of control and protection functions and this level of performance should not be allowed to continue.

Impact of major incidents

SAIDI has considerably improved in comparison with 2018-19 as a result of reduced outage timeframes.

Protection and auto re-close coordination failure are common factors in Tennant Creek incidents. Accordingly, Entura considers the System Control recommendation to review protection settings in the Tennant Creek power system should be Power Services' top priority to reduce incidents in the coming years.

21 Based on data from System Control incident reporting ('customers impacted' and 'total duration (minutes)'), specifically initial notifications.

Major incident report recommendations

Recommendations made by System Control, as a result of its investigation of major reportable incidents, are consolidated in a recommendation tracking spreadsheet, which is periodically provided to the Commission.

In the Commission's independent investigation of a system black in Alice Springs on 13 October 2019, the Commission made a recommendation regarding placing a focus on determining if the recommendations of the independent investigation report and other major event reports have been tracked and implemented during its annual power system reviews, which the Territory Government accepted. Accordingly, as part of the NTPSPR, Entura has assessed System Control's recommendation tracking spreadsheet, based on data provided by System Control on 16 September 2020.

System Control's recommendations are categorised into seven areas: asset management, EMS, modelling, power system studies, procedural, protection and training.

While the Commission is aware of significant progress since it made its recommendation following the Alice Springs system black, Entura notes completion of recommendations is not consistent across System Control recommendation categories. From Entura's assessment, consistent with the Darwin-Katherine and Alice Springs power systems, it appears the focus for the past few years has been more on asset management and procedural-related recommendations. Further, Entura notes that no modelling or training-related recommendations have been completed, even though some recommendations in these categories were made more than four years ago.

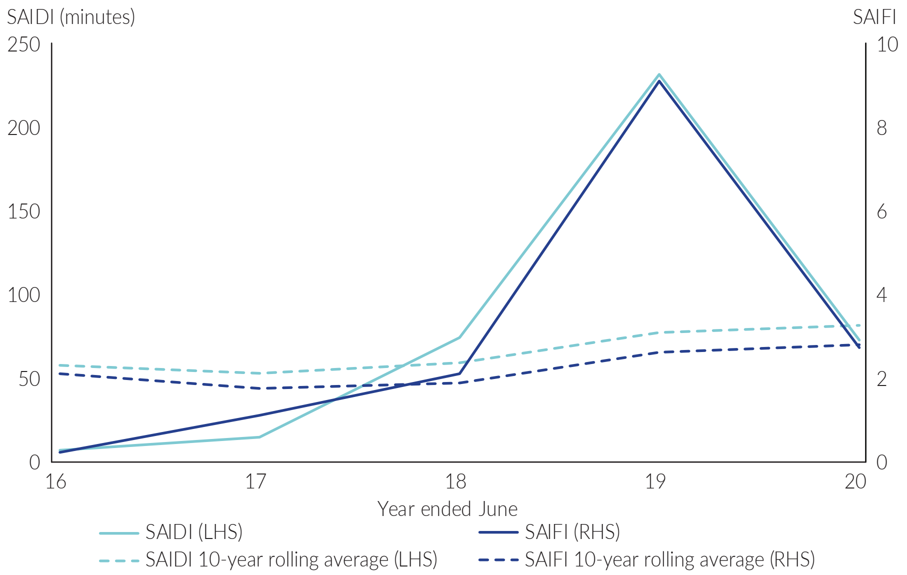
Generation

The generation in Tennant Creek performed significantly better in 2019-20 compared with 2018-19, with SAIDI and SAIFI returning from a high in 2018-19 to 2017-18 levels.

Generator performance

The SAIDI and SAIFI performance for the Tennant Creek generating units is shown in Figure 31.

Figure 31: SAIDI and SAIFI performance indices for generation, Tennant Creek



The performance in 2019-20 was a significant improvement from 2018-19, with the SAIDI and SAIFI below the 10-year average. The improvement can be attributed to changed operational approaches due to continued difficulties with the new Jenbacher generation units.

Observed UFLS and single generator trips

It is rare for a single unit trip to not result in UFLS in Tennant Creek due to the minimum spinning reserve approach taken in this power system. Generation trips were common in Tennant Creek in 2019-20. These trips, which resulted in major incidents, are discussed in the major incidents section of this chapter.

Sourcing spinning reserve can be difficult in small power systems such as Tennant Creek. It is made particularly difficult with high efficiency reciprocating engines like the Jenbachers. Engines of this type, from any equipment supplier, are not able to rapidly accept or reject load. This makes them generally inappropriate for the provision of large amounts of spinning reserve from a single machine. The result is that a higher spinning reserve amount is required to ensure sufficient governor response can occur to meet the contingency requirement.

In Entura's opinion, with current technologies the only options to break the link between single machine trips and UFLS in the Tennant Creek power system are to carry an unreasonable amount of spinning reserve, purchase low efficiency generators or install a BESS. Entura considers advances in battery technology as recent as the last 12 months mean a BESS should be seriously considered to supply the spinning reserve in the Tennant Creek power system, subject to a cost-benefit analysis.

Generation availability

A number of indices are calculated as per the EIP Code for generating units to reflect their reliability. The factors discussed in the following section are:

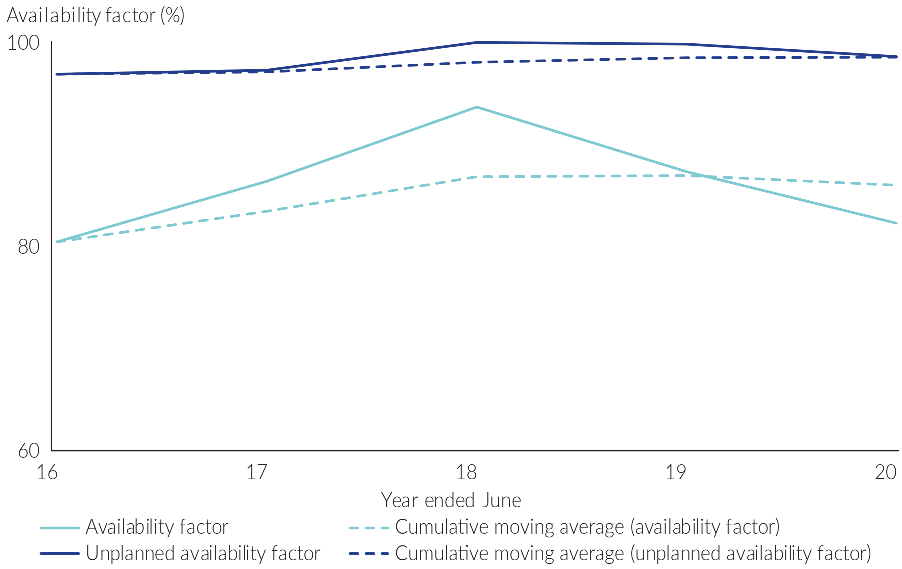
- availability factors (availability factor and unplanned availability factor) – the availability factor represents the percentage of time a unit is available to generate despite both planned and unplanned maintenance, whereas the unplanned availability factor indicates the percentage of time a unit is available to generate despite unplanned maintenance. The difference between these two indices is the percentage of time a unit is unavailable to generate due to planned maintenance. Planned maintenance is maintenance scheduled in advance, usually based on original equipment manufacturer maintenance schedules, and notified to System Control in accordance with the SCTC. Unplanned maintenance is maintenance that is required but can wait until a particular convenient window of time, such as the next period of low power system demand.
- forced outage factor – the forced outage factor is the percentage of time the unit is not available for dispatch due to an immediate issue with the generator, such as a breakdown, which cannot be deferred. This includes time taken to repair the unit if it is damaged or a component requires replacement or refurbishment due to a breakdown or failure.

These measures provide some insight into the availability of the generating units and allow an assessment to be made as to the adequacy of condition monitoring and preventative maintenance. Ideally, planned maintenance should be to a level and adequacy that minimises the level of unplanned maintenance and forced outages as much as reasonably feasible, noting it is unreasonable to expect zero unplanned maintenance or forced outage events. Planned maintenance activities can be planned for by generators and the Power System Controller, whereas forced outages, and to a lesser extent unplanned outages, can lead to system reliability and security risks, with limited or no notice.

Availability factors

Figure 32 shows the availability and unplanned availability factors for the Tennant Creek power system over the last five years.

Figure 32: Availability and unplanned availability factors for generation, Tennant Creek

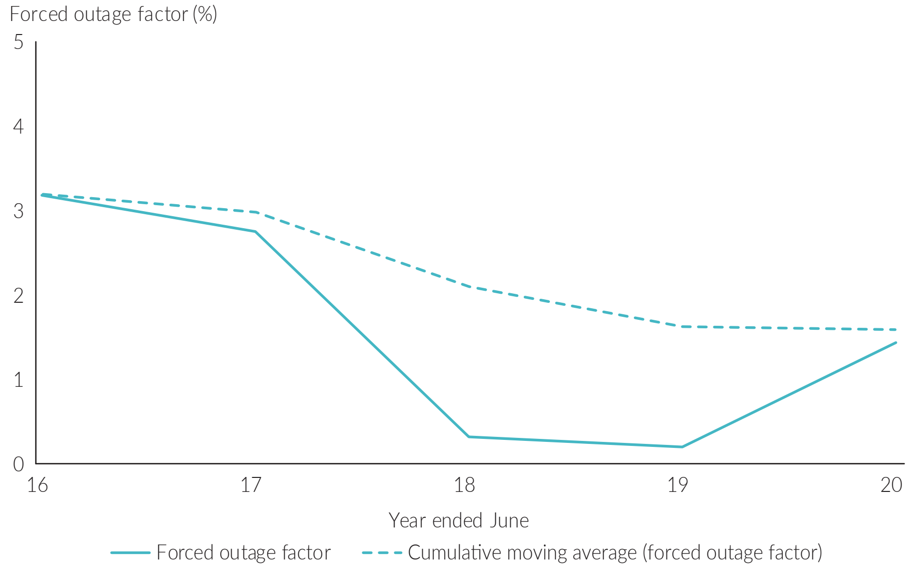


The availability of generators in the Tennant Creek power system has continued to decrease in 2019-20, however this is largely driven by an increase in planned maintenance over the last two years, from a low in 2017-18. While this is positive in terms of showing a higher level of preventative maintenance and or withdrawal from service of units of questionable reliability, it does reduce the amount of capacity available to support the Power System Controller in managing a reliable and secure system. However, this is likely mitigated by the large amount of installed capacity in Tennant Creek compared with the level of system demand.

Forced outage factor

Figure 33 shows the forced outage factor for the Tennant Creek power system over the last five years.

Figure 33: Forced outage factor for generation, Tennant Creek



The forced outage factor has risen in 2019-20 compared with the previous two years, however remains under the cumulative moving average. Tennant Creek is a challenging power system to operate, however these challenges are significantly reduced when the generating units are reliable or managed so that unreliability does not lead to unplanned outages.

Non-reliable periods

Non-reliable periods are a forward-looking assessment, rather than in response to system incidents, and are declared when the Power System Controller identifies that power system reliability cannot be maintained. There are a number of causes, including:

- planned, unplanned or forced outages that reduce reliability for all or part of the power system
- lack of generation to meet demand and or requirements for spinning reserve.

There were no non-reliable periods declared across 2019-20 in the Tennant Creek power system. The system is simple and the abundance of generation options should lead to this level of reliability.

Generation constraints

Table 27 summarises the generation constraints in the Tennant Creek power system.

Table 27: Tennant Creek normal system constraints

	Constraint description	Applied to	Limit (MW)	System condition	Comments
1	Minimum MW spinning reserve	Tennant Creek power station	1.5	All	Development of constraints based on review of historical events
2	Regulation down reserve	Tennant Creek power station	0.5	All	

System constraints were introduced in the second half of 2019-20 to ensure minimum spinning reserve is achieved at all times. Entura is pleased the necessary steps were taken to ensure system stability.

Network

The Tennant Creek network has a single zone substation and a maximum rated system voltage of 22 kV.

Network performance

The SAIDI and SAIFI performance for the Tennant Creek network is presented in Figure 34.

Figure 34: Adjusted SAIDI and SAIFI performance indices for the Tennant Creek network

The SAIDI and SAIFI for the Tennant Creek network continue to track better than the cumulative moving average. The performance is better than the rural short feeder global target in both cases. This is a very good result considering the nature of the network.

Network utilisation

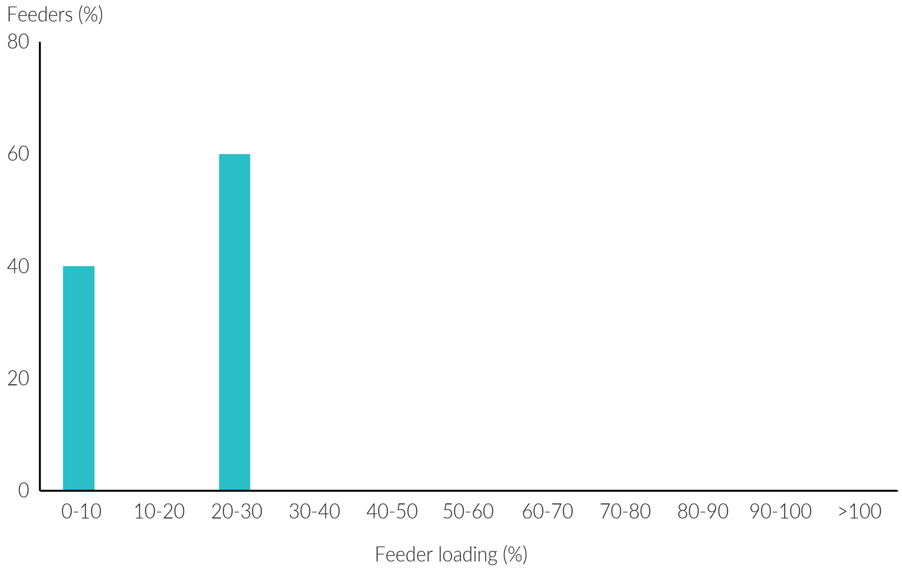
Zone substation

The substation remains under its capacity under N-1 conditions.

Feeders

The feeder loading distribution is shown in Figure 35.

Figure 35: Feeder loading distribution, Tennant Creek



This low level of loading is typical of lightly loaded distribution networks. Cost-effective distribution design relies on standard designs and stock holdings, and so often distribution networks utilise assets built with a higher level of capacity than the expected loads.

Network constraints

There are no network constraints applied to the Tennant Creek network.

Network power quality

Network power quality notification data is not reported by Power Services in relation to the Tennant Creek network.

Network complaints

Power Services is required by the EIP Code to report on the percentage and total number complaints it receives that are associated with network quality of supply issues and associated with network-related activities.

Complaints associated with network quality of supply issues in Tennant Creek decreased from 126 in 2018-19 to 87 in 2019-20, which is more consistent with numbers reported prior to 2018-19. Complaints are mostly made in relation to no power rather than part and low power, or fluctuations in power, which is consistent across the last five years.

Complaints associated with network-related activities are categorised as administration process and customer service, connections, reliability of supply, technical quality of supply or other. There was a very small number of complaints regarding the Tennant Creek network in 2019-20 compared with the number of customers in the region. About 75% of the complaints were categorised as administration process and customer service related.

4 | Territory electricity industry performance

This chapter focuses on the 2019-20 performance data from Power Services' EIP Code reporting that is not region specific. Where possible it compares 2019-20 performance to historical data to identify trends. Specifically this chapter considers:

- distribution feeders (including overall Territory SAIDI and SAIFI, and worst performing feeders)
- guaranteed service level payments
- phone answering
- new connections.

Distribution feeders

Power Services reports against its distribution feeder performance across four feeder categories as per the EIP Code:

- central business district (CBD)
- urban
- rural short
- rural long.

The results for 2019-20 are shown in Table 29.

Table 29: SAIDI and SAIFI performance by feeder type

	Adjusted SAIDI (minutes)			Adjusted SAIFI (interruptions)		
Feeder category	Target standard[22]	Actual performance	Result	Target standard[29]	Actual performance	Result
CBD	4.0	3.83	Target met	0.1	0.03	Target met
Urban	140.0	52.38	Target met	2.0	0.95	Target met
Rural short	190.0	203.94	Target not met	3.0	3.36	Target not met
Rural long	1 500.0	1 473.59	Target met	19.0	14.58	Target met
Whole of network	175.8	147.44	Target met	2.6	2.36	Target met

The results show mixed performance across the feeder categories. Entura is satisfied appropriate actions are planned to improve any unsatisfactory aspects of this performance.

The results are shown graphically in Figure 36.

22 Target standards for a regulatory control period are submitted by PWC to the commission for approval in accordance with the EIP Code, except for the 'whole of network' target, which is a derived target and not required to be approved by the commission. The EIP Code states a network entity must use its best endeavours to meet the target standards.

Figure 36: Feeder performance by feeder type

The figure shows that generally the SAIDI and SAIFI targets are met for the rural long and urban feeders. The CBD performance has varied across the last five years, with 2019-20 meeting the target. The rural short performance is generally outside the target and remains so by a small margin in 2019-20.

A range of actions are being undertaken across the three networks by Power Services to address the performance shortfall for the rural short class, and rural long feeder class, which is just below the target. These actions include hardware upgrades, replacements and improvements to switchgear.

These actions are in line with the best endeavors approach to these targets in accordance with the EIP Code. However, failure to meet these targets on an ongoing basis will draw closer inspection by the Commission.

In addition to reporting on feeder category performance, Power Services are required to report on the five worst performing feeders at the Territory level for each feeder category for the reporting period based on a feeder's SAIDI performance, as per the EIP Code. The five worst performing feeders in each feeder category are shown in Table 30. As there are only three feeders in the rural long feeder category, all three feeders will be identified as the worst performing in each reporting period.

Table 30: Worst-performing distribution feeders

CBD		Urban		Rural short		Rural long	
Feeder name	SAIDI	Feeder name	SAIDI	Feeder name	SAIDI	Feeder name	SAIDI
11DA17 DA-ML	1.86	22KA22 KATHERINE	11.68	22SY11 HERBERT	31.62	22SY04 DUNDEE	1 100.34
11DA14 STATE SQUARE	1.04	11CA12 MARRARA	6.41	22SY03 VIRGINIA	29.59	22KA10 MATARANKA 1	360.43
11MS02 SMITH	0.70	11DA27 STUART PARK	5.27	22PA202 HOWARD SPRINGS	19.32	22TC01 ALI CURUNG	13.62
11ML09 DALY	0.11	11DA19 GARDENS	4.33	22SY02 MCMINNS	11.80		
11AK03 AUSTIN LANE	0.04	11CA16 NAKARA	3.26	11CA24 PARER	11.36		

The practical approach to mitigating feeder performance issues appears appropriate from a purely customer weighted performance perspective. Using SAIDI in this way should ensure feeders with fewer customers are not disadvantaged in the assessment and problematic feeders in any of the regions should appear on the list. Entura considers an improved approach may be to set a threshold for identifying problematic performance of individual feeders, which works to a more objective basis, rather than a list of top five worst performing feeders. The Commission will consider this as part of a review of the EIP Code, which commenced with the publication of an issues paper on 16 September 2020.

Power Services has an annual feeder improvement program, which is intended to identify customers who are experiencing consistently poor levels of reliability and identify opportunities to improve those customers' reliability experience. While not required by the EIP Code, Power Services reports on its annual feeder improvement program in its EIP Code report. Power Services' Poorly Performing Feeder Improvement program assesses each feeder against three criteria to determine whether investment is justified. The three criteria are:

- the worst performing feeders as measured by average SAIDI performance over three years
- identifying customers who have experienced localised poor performance that may be obscured at the feeder level, as measured by guaranteed service level (GSL) payments made to customers
- feeder categories that are not meeting target, or where the trend is approaching the target but it may not be met in the near term or has exceeded the target regularly.

Power Services states that following the identification of the worst performing feeders as part of its Poorly Performing Feeder Improvement program, further analysis is conducted to identify dominant causes and locations of interruptions on each feeder, and identify improvements required to reduce the frequency and or duration of interruptions. Further, improvement solutions are then targeted to provide the most significant improvement for the lowest possible cost.

Following Power Services assessment of feeder performance against its three criteria categories (feeder SAIDI, GSL payments and performance), it determined that no feeder improvement tasks were required in 2019-20 for CBD and urban feeders, noting Power Services has stated that asset replacement activities driven by asset condition are planned during the current regulatory period for CBD feeders. Capital programs are also expected to continue to support reliability on urban feeders. As for the rural short and rural long feeder categories, Power Services have identified eight feeders where feeder improvement works are planned (Table 31).

The upgrades noted in Table 31 target a reduction in the number of customers getting disconnected from a single event and aim at improving restoration times.

Table 31: Feeders identified by Power Services for feeder improvement tasks in 2019-20

Feeder category	Feeder name	Power system	Mitigation planned
CBD	n/a	n/a	nil
Urban	n/a	n/a	nil
Rural short	22SY03 VIRGINIA	Darwin-Katherine	Installation of single phase re-closers
	22PA202 HOWARD SPRINGS	Darwin-Katherine	Reconfiguration of feeder, installation of single phase re-closers and animal protection
	22KA03 FLORINA	Darwin-Katherine	Installation of single phase re-closers
	11BE04 MCMILLANS	Darwin-Katherine	Installation of a single phase re-closer
	22TC09 WARREGO	Tennant Creek	Replacement of HV insulators
Rural long	22SY04 DUNDEE	Darwin-Katherine	Installation of remote-controlled switch and animal protection
	22KA10 MATARANKA 1	Darwin-Katherine	Installation of additional animal protection
	22TC01 ALI CURUNG	Tennant Creek	Installation of re-closers and animal guards, and improved animal protection on transposition poles

Power Services notes in its EIP Code reporting that due to the length of rural feeders, it is challenging to identify specific areas to target for upgrades. Animals and weather-related interruptions can affect different parts of the feeder from year to year, however recently installed diagnostics now reveal locations that provide the highest contribution to unreliability, which can then be targeted, resulting in more efficient and effective mitigation. Power Services' planned tasks on rural long feeders include:

- increased automation of the network by installing remotely operated switches, automatic re-closers and fused sectionalisers, allowing system operators to isolate faults faster and improve restoration time
- installation of animal protection to prevent faults from occurring
- utilisation of distribution fault anticipation systems on feeders to assist in the faster location of faults and more targeted hardware upgrades to reduce the frequency of interruptions, particularly animal-related interruptions.

Guaranteed service level payments

PWC make payments to customers where they do not meet GSLs as set out in the EIP Code. These payments are shown in Table 32.

Table 32: Guaranteed service level payments

GSL measure	Performance indicator	2017-18		2018-19		2019-20	
		Total	Amount $	Total	Amount $	Total	Amount $
Duration of a single interruption	Between 12 and 20 hours	139	11 120	5	400	65	5 850
	More than 20 hours	0	0	1	125	4	565
Frequency of interruptions	> 12	1 225	98 000	2 734	218 720	3 988	358 920
Cumulative duration of interruptions	> 20 hours in FY	578	72 250	633	79 125	1 068	150 588
Time for establishing a connection	Reconnection > 24h[23]	17	1 700	12	2 900	13	2 278
	New connection > 5 business days[24]	27	5 400	2	250	5	1 278
Time for giving notice of planned interruptions	< 2 business days	472	23 600	159	7 950	178	10 005
Keeping appointments	> 30 mins outside agreed time[25]	1	20	0	0	0	0
Total payments			**212 090**		**309 470**		**529 484**

The bulk of the GSL payments are due to the frequency of interruptions and cumulative duration of interruptions (over 75%). The frequency of these payments is increasing. PWC notes this will be addressed by targeted improvements to feeders, with the introduction of distribution fault anticipation technology the frequency of outages is expected to improve as early identification of bat colonies or vegetation causing short-term outage will take place.

Entura is satisfied that PWC appear to be changing asset management approaches to improve the customer experience.

Phone answering

The EIP Code (schedule S.3.6.3) requires licensees providing network services in the Darwin-Katherine, Alice Springs and Tennant Creek power systems to report on customer service performance indicators, which includes performance related to telephone answering. Accordingly, as the only licensee providing network services in the relevant power systems, Table 33 shows PWC's telephone answering performance during business hours over the last two years, at a Territory level. Entura notes that PWC reports on calls received outside of business hours (after hours), however due to after-hours calls going directly to the control room at System Control and not through a telephone answering system, the level of performance is not able to be measured.

23 Small customers.
24 Excluding connections requiring network extension or augmentation.
25 With small customers.

Table 33: Telephone answering performance (business hours)

	2018-19	2019-20
Number of calls received	11 344	11 037
Average waiting time before a call is answered (seconds)	6.0	5.9
Percentage of calls answered within 30 seconds	67%	64%
Percentage of calls abandoned before being answered	7.8%	11%

Changes in the total number of calls to a network provider may be an indicator of the level of customer satisfaction. The percentage of calls answered within 30 seconds, the average waiting time before a call is answered and the percentage of calls abandoned before being answered provide an indication of how long a customer has to wait to speak to the network operator, and whether this wait is considered reasonable by a customer. While the Commission considers it is not always reasonable for a customer to expect to speak to an operator within 30 seconds, especially during spikes in call volumes, it is reasonable to expect a customer's call to be answered before the point where a customer feels the need to abandon their attempt to speak to the network operator, potentially leading to issues going unresolved, which may cause distress. Accordingly, the Commission is particularly interested in the level of performance regarding the percentage of calls being abandoned before being answered.

PWC reported a small decrease from the previous year in the total number of calls it received during business hours in 2019-20, from 11,344 to 11,037. The level of performance in terms of calls answered within 30 seconds and calls abandoned before being answered deteriorated in 2019-20, while the average waiting time before a call is answered marginally improved from six seconds in 2018-19 to 5.9 seconds in 2019-20.

The percentage of calls forwarded to an operator within 30 seconds fell by three percentage points to 64%, and there was an increase of 3.2 percentage points to 11% of calls being abandoned before being answered. As mentioned above, this is a potential increase in the number of customers with unresolved issues, which may cause distress.

As a useful benchmark, the Australian Energy Regulator (AER) used a traffic light system in its 2019-20 Annual Retail Markets report[26] to allow an 'at a glance' overview of retailers performance in relation to phone answering, with the highest 'green' category assigned to a retailer with 80% or more calls taken within 30 seconds. As well as deteriorating from last year, PWC's 2019-20 performance regarding calls answered within 30 seconds during business hours of 64% continues to fall into the lower 'amber' category, which includes retailers that achieved 51 to 79% of calls taken within 30 seconds.

In relation to PWC's performance of 11% regarding the percentage of calls abandoned before being answered during business hours, when compared with the AER's traffic light system, PWC slips from the AER's middle 'amber' category into its lowest 'red' category, which includes retailers that achieve 10% or more of calls abandoned before being answered.

26 https://www.aer.gov.au/retail-markets/performance-reporting/annual-retail-markets-report-2019-20.

New connections

Table 34 shows the average time taken to provide network access to new subdivisions where minor extensions or augmentation is required.

Table 34: New connections in urban areas to new subdivisions

	2015-16	2016-17	2017-18	2018-19	2019-20
Total	83	53	60	58	255
Average weeks	11.10	10.80	11.45	9.96	3.51

The average time taken to complete new connections has reduced in 2019-20 compared with the previous four years despite the volume of new connections almost quadrupling.

Appendix A: 2017-18 NTPSPR recommendations

The following table summarises Entura's assessment of the status of the recommendations from the 2017-18 NTPSPR, noting the recommendations are those of the Commission and not enforceable unless they relate to non-compliance.

	Comments on observed progress	Overall assessment
1 **Condition monitoring and preventative maintenance** The Commission will seek input from generation licence holders as to an appropriate level of reporting regarding condition monitoring.	The Commission has included consideration of condition monitoring and preventative maintenance reporting by generators in its review of the EIP Code, which commenced on 16 September 2020 with the publication of an Issues Paper. Interviews with EDL and Territory Generation indicate that some thought is given to this but little formal effort or reporting is evident.	In progress
2 **Coordination and cooperation between licence holders** Administrative procedures in terms of coordination and cooperation between licence holders to be developed to ensure better customer outcomes.	Sufficient progress is evident in regular coordination meetings, while some improvements may still be required in relation to the coordination and agreement regarding recommendations stemming from incident reports. However, Entura is satisfied that sufficient progress has been made to allow this action to be marked complete.	Complete
3 **Planning and modelling** Better planning, including modelling of system changes and associated operations, by Power Services in consultation with System Control and licensees.	Some improvements in modelling approach are evident, with modelling guidelines being released by PWC. Some proactive work is being done in Darwin-Katherine to use the models to look ahead to changed operation with higher renewable penetration. The response to the Alice Spring system black will be monitored for progress on this recommendation.	In progress
4 **Reporting of causes for single unit trips** The cause of these trips should also be reported to enable better scrutiny of the plant performance.	Only an informal process in place within Territory Generation, however Entura considers that the cause for all unit trips are recorded, which would allow the causes to be reviewed by generation licensees and appropriate action taken if patterns emerge. System Control is now including the generating unit for each trip (and its output at the time of the event) in its biannual reports to the Commission.	In progress

continued

	Comments on observed progress	Overall assessment
5 **Design and commissioning process control and quality assurance** Processes to be developed to ensure intra and inter-company interfaces are managed so system operation and robustness is not undermined by implementation being inconsistent with design. These processes must cover primary and secondary electrical systems and the interface between network, generation and system control.	Power Services has advised it is working on process improvements on a project-by-project basis. Entura is satisfied that sufficient progress has been made with this recommendation that it can be marked complete.	Complete
6 **Tracking of major incident report recommendations** A register should be made and coordinated between relevant parties so the recommendations and progress can be tracked.	As a result of implementing recommendations from the Alice Springs system black investigation, a register is now managed by System Control, however agreement on the incident report recommendations would facilitate a more streamlined approach to completion and clearing this register. While there remains issues around the agreement of report recommendations, the processes between licensees are greatly improved.	Complete
7 **Risk assessment and management** The reduction of risk during outages should be to a reasonable extent, not to the extent that is easy or readily achieved. The System Controller should implement cross-checking of appropriate risk exposure for outages, particularly overlapping outages.	System incidents suggest this had improved across 2018-19. None of the major system incidents stem from accumulation of risk due to overlapping outages.	Complete

continued

	Comments on observed progress	Overall assessment
Darwin – Katherine region (2017-18)		
8 Pine Creek and Katherine Island management Existing protocols are not sufficiently robust to ensure correct operation of this island.	Further evidence in 2018-19 and 2019-20 to support the original recommendation. There is a project underway to address the issue. It is likely to take until 2022 to fully resolve.	Closed as this recommendation is captured by recommendation 4 in the 2018-19 NTPSPR
9 Outage Coordination Coordination of network and generation outages to ensure adequate reliability for customers is maintained.	Communication of outages and coordination now much more effective.	Complete
Alice Springs region (2017-18)		
10 Managing Ron Goodin power station retirement Care to be taken to ensure a robust set of operating protocols is developed to allow safe and secure operation of the Alice Springs network without the support the Ron Goodin power station.	This remains unresolved with no updated timeline for the retirement of the Ron Goodin power station while many of the 2019 system black recommendations are outstanding.	In progress
Tennant Creek region (2017-18)		
Nil		

Appendix B: Glossary

AER	Australian Energy Regulator
BESS	battery energy storage system
EIP Code	Electricity Industry Performance Code
Customer minutes without supply	Number of minutes customers are without supply, calculated by multiplying the number of customers impacted by the duration of the incident
EDL	EDL NGD (NT) Pty Ltd
GSL	Guaranteed Service Level
GW	gigawatt, 1 GW = 1 billion watts
kV	kilovolt, 1 kV = 1 thousand volts
major incident	Defined by section 7.3.2 of the System Control Technical Code version 6
minor incident	Defined by section 7.3.3 of the System Control Technical Code version 6
MVA	megavolt ampere
MW	megawatt, 1 MW = 1 million watts
NTEOR	Northern Territory Electricity Outlook Report
NTPSPR	Northern Territory Power System Performance Review
N-X	Planning criteria allowing for full supply to be maintained to an area supplied by the installed capacity of N independent supply sources, with X number of those sources out of service (with X usually being the units with the largest installed capacity)
OSPS	Territory Generation's Owen Springs power station
PWC	Power and Water Corporation
PV	Photovoltaic
Regulated systems	Northern Territory power systems where network access legislation applies and include Darwin-Katherine, Tennant Creek and Alice Springs power systems
RGPS	Territory Generation's Ron Goodin power station
RoCoF	Rate of change of frequency
SAIDI	System average interruption duration index
SAIFI	System average interruption frequency index
SCTC	System Control Technical Code
TDAPR	Transmission and Distribution Annual Planning Report
UFLS	under frequency load shedding