POWER SYSTEM REVIEW

2010-11

March 2012

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Disclaimer

The Power System Review (Review) has been prepared by the Utilities Commission (Commission) in accordance with section 45 of the *Electricity Reform Act*.

The Review was prepared using information sourced from Northern Territory electricity industry participants, Northern Territory Government agencies, consultant reports, and publicly available information. The Commission understands this information to be current as at December 2011.

The Review contains forecasts, estimates and statements that are based on the Commission's interpretation of data provided by electricity industry participants and assumptions about the power system, including load growth forecasts and the effect of potential major developments on particular power systems. The Commission considers the Review to be an accurate report within the normal tolerance of economic forecasts.

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CHAPTER 1

Executive Summary

1.1 The Utilities Commission (Commission)'s annual Power System Review (Review) reports on power system performance and capacity in the Northern Territory. This Review reports on actual system and network performance for 2010-11, and forecast system performance for the period 2011-12 to 2020-21.

1.2 The Review is prepared in accordance with the *Electricity Reform Act* [s45], which requires the Commission to:

- report forecasts of electricity load and generating capacity;
- report on the performance of the Territory's power systems;
- advise on matters relating to the future capacity and reliability of the Territory's power systems relative to forecast load;
- advise on other electricity supply industry and market policy matters; and
- review the prospective trends in the capacity and reliability of the Territory's power systems relative to projected load growth.

1.3 The Review relates only to the Darwin-Katherine, Alice Springs and Tennant Creek power systems (referred to as the market systems).[1] In reporting its forecasts, the Act requires the Commission to consult with participants in the electricity supply industry.

1.4 The Act also requires the Commission to report its forecasts to the Minister and electricity entities and to submit to the Minister, and publish, an annual review of the prospective trends in the capacity and reliability of the Territory's power system relative to projected load growth.

1.5 The Act requires electricity entities operating in the Territory's power system to provide information and technical assistance that the Commission reasonably requires to perform its responsibilities in preparing the annual Power System Review.

1.6 The Commission engaged Evans & Peck[2] to assist the Commission to prepare the 2010-11 Review, particularly by providing expert advice on power system and distribution planning, and reliability performance.

1.7 Evans & Peck assisted in the development of information requests to electricity industry participants, collected relevant information, and provided an assessment of the performance and capacity of the Territory's power systems and distribution networks.

1.8 Consistent with the approach taken in 2009-10, the 2010-11 Review draws on other reports prepared for the Commission during 2010-11.

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[1] The activities of electricity industry participants and customers in the market systems are regulated under the *Electricity Reform Act*, *Electricity Networks (Third Party Access) Act* and Code and associated legislation.

[2] Evans & Peck (a subsidiary of the WorleyParsons Group) is an infrastructure focused advisory company with experience in economic regulation and pricing, and the planning, construction and operation of energy, water and resources projects and facilities.

Key findings

Overall

1.9 The 2010-11 Review continues the increased focus on electricity demand analysis that was commenced in the 2009-10 Review, in order to provide a robust assessment of the adequacy of the power system, including generation, transmission and distribution networks.

1.10 Regular and comprehensive reporting on power system and distribution network performance and health is a feature of the electricity supply industry throughout Australia. Electricity businesses in other Australian jurisdictions have developed systems and processes for regular and comprehensive reporting of power system and distribution network performance over a period of time.

1.11 For the 2009-10 Review, it was acknowledged that not all the information requested from electricity industry participants in the Territory, primarily the Power and Water Corporation (PWC), would be available.

1.12 For the 2010-11 Review, there was an improvement in the data provided by electricity industry participants and it is expected that further improvements will occur in future reviews.

1.13 It is noted that PWC is instituting new business processes that are intended to provide a more comprehensive approach to forecasts from 2012. It is expected that PWC will in the future be in a position to develop a system demand forecast that is sufficiently robust for the purpose of accurately assessing overall supply-demand balance.

Generation adequacy

1.14 The generation supply-demand balance provides an assessment of generation adequacy relative to forecast electricity demand in the Darwin-Katherine, Alice Springs and Tennant Creek systems for the period 2011-12 to 2020-21.

1.15 Currently, a system is deemed to have adequate generation if there is sufficient capacity available to maintain supply despite the loss of the two largest units of generation plant, known as an N-2 event.

1.16 Further work is necessary to identify an optimum level of generation capacity for the Territory's power systems that recognises reliability, performance and cost objectives, including a probabilistic analysis of the adequacy of generation capacity. This approach is most commonly used in Australia for identifying the potential for capacity constraints and is a more useful measure for generation planning purposes.

Generation adequacy – Darwin-Katherine

1.17 The Darwin-Katherine system is expected to have sufficient generation capacity under an N-2 event from late 2011 to 2020–21, with the additional capacity currently planned.

1.18 There was a credible risk of generation capacity constraints and poor generation reliability during late 2011, prior to the commissioning of Channel Island Power Station Units 8 and 9, which occurred in January 2012. There will continue to be potential ongoing capacity constraints if the new Channel Island plant experiences early operational issues[3] and/or forced outages of the existing plant.

[3] It should be noted that new plant can experience early operational issues after commissioning or testing stages, which could delay the full capacity of the new generation sets becoming available for service.

1.19 It appears unlikely that new capacity on the Darwin-Katherine system will be needed until the end of 2020-21, with the commissioning of Channel Island Power Station Units 8 and 9, Weddell Power Station Unit 3 and Katherine Power Station Units 4 and 5.[4]

Generation adequacy – Alice Springs

1.20 The Alice Springs system is expected to have sufficient generation capacity to meet forecast peak demand under any credible electricity demand growth scenario to 2020–21 with the additional capacity currently planned.

1.21 There was a credible risk of generation capacity constraints and poor generation reliability during 2011. The key risk period was prior to the commissioning of Owen Springs Power Station Units 1 to 3.[5] There is the potential for ongoing capacity constraints if the new Owen Springs plant experiences early operational issues and/or forced outages of existing plant.

1.22 The level of the available capacity in the Alice Springs system is influenced by the timing of commissioning new capacity at Owen Springs Power Station and decommissioning of capacity at Ron Goodin Power Station. It is recommended that PWC keep the timing of the installation of new plant under review to optimise the amount of plant installed or decommissioned on a yearly basis.

1.23 There could be an opportunity to defer the installation of Units 4, 5 and 6 at Owen Springs Power Station based on the current assumptions regarding load growth in Alice Springs.

Generation adequacy – Tennant Creek

1.24 The generation supply-demand balance in the Tennant Creek system is adequate for the period to 2020-21.

1.25 New capacity was commissioned in mid-2011, providing sufficient capacity to meet an N-2 event for the period to 2020-21.

Fuel supply

1.26 Natural gas is the main fuel for electricity generation in the Darwin-Katherine, Alice Springs and Tennant Creek systems. However, a number of generation units are dual fuel, and able to use liquid fuels (ie diesel) as an alternative fuel source.

1.27 PWC has a range of contingency arrangements to maintain electricity supply in the event of the partial or complete loss of the primary gas supply from Blacktip, with a contingency supply arrangement with the Darwin Liquefied Natural Gas (DLNG) plant, line-pack gas and diesel stocks. These arrangements provide multiple fuel supply contingencies.

1.28 These alternate fuel sources should provide access to a continued fuel supply to power stations, even in the circumstances of partial or complete loss of gas from Blacktip due to production or processing equipment failure, cyclonic activity or pipeline rupture.

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[4] Channel Island Units 8 and 9 were commissioned in January 2012, Weddell Unit 3 is scheduled for July 2012, and Katherine Units 4 and 5 are scheduled for May 2012 and October 2015 respectively.

[5] PWC has advised that the commissioning date for Owen Springs Units 1 and 2 was 22 September 2011, and testing of Unit 3 is still on-going.

Electricity networks adequacy

Transmission network adequacy – lines

1.29 A high level assessment of capacity and constraints in the Darwin-Katherine system was undertaken due to the criticality of the transmission/sub-transmission network to security of supply.

1.30 The 2009-10 Review identified a potential capacity constraint in the Palmerston sub-system, with potential overloading of the Hudson Creek-Palmerston and Hudson Creek – McMinn's 66 kV network under first contingency conditions (N-1). Recent analysis indicates that this was relieved by the completion of Archer zone substation in late 2011.

1.31 It is noted that PWC Networks, PWC Generation and the System Controller are jointly developing an integrated model of the generation/transmission system that will enable both transient and steady state analysis of the system to be conducted in accordance with good industry practice. It is expected that this will provide a more authoritative assessment in future reviews.

Transmission network adequacy – substations

1.32 There are 28 bulk and zone substations across the Darwin-Katherine, Alice Springs and Tennant Creek systems, with assessment of substation utilisation possible for 23 substations.

1.33 With all transformers in service, all 23 zone substations should have sufficient capacity to meet forecast load for 2011-12.

1.34 Under N-1 conditions (i.e. the loss of one transformer), three substations face capacity constraints between 2011-12 and 2014-15:

- Berrimah 66/11 kV, with 101 per cent utilisation in 2011-12. PWC Networks is planning construction of a new East Arm substation (operating from about 2015-16) to support the Berrimah substation. In the meantime, emergency support is available from the turbine at Berrimah Power Station.
- Centre Yard 66/11 kV in the Darwin-Katherine system, with 100 per cent utilisation in 2011-12 and 120 per cent forecast utilisation in 2014-15. Centre Yard is a small (0.5 MVA) substation which could be supported by emergency generators.
- Katherine 132/22 kV, with 103 per cent utilisation in 2011-12 and 106 per cent forecast utilisation in 2014-15. The Katherine substation is supported by Pine Creek (until April 2011) and Katherine generation. Accounting for this generation should resolve the apparent constraint.

1.35 The condition of equipment at the City Zone and Snell Street substations (in particular) makes a multiple contingency event a possibility which warrants a continued priority being given to the capital program associated with the development of Frances Bay substation, the development of Woolner substation to replace Snell Street substation and replacement of City Zone substation.

Distribution network adequacy

1.36 PWC Networks was unable to provide load flow studies or measurements on the low voltage (11/22 kV) distribution network necessary for an assessment of loading and capacity for the 2009-10 and 2010-11 Reviews. The availability of this data is important and it is expected that PWC Networks will provide such information for future Reviews.

Reliability

Generation performance trend

1.37 Territory customers experienced an average of 2.6 generation related outages a year (SAIFI) between 2006-07 and 2010-11. This is significantly more than observed in the National Electricity Market (NEM) connected systems (for example, for the 12 months ended 31 March 2010, Ergon Energy reported a generation SAIFI of 0.02) due to poor spinning reserves and load shedding.

1.38 It is expected that generation reliability performance will improve in the coming years with the commissioning of a new generation plant (especially Channel Island Units 8 and 9, which were commissioned in January 2012).

1.39 There would appear to be merit in reviewing PWC spinning reserves policies with the levels of spinning reserves being clearly defined and the costs associated with spinning reserves being balanced against the economic impact of load shedding practices on customers.

Network performance trend – feeder performance

1.40 Examining feeder performance to identify network performance trends is the accepted approach in Australia. This is the second year this data has been reported by PWC.

1.41 In the CBD, Urban and Short Rural categories, feeder performance was worse in 2010-11 than the previous year. There was an improvement in Long Rural feeder performance for the same period. It is noted that given the small number of Rural feeders in the Territory, performance outcomes for this type of feeder can be volatile from year to year.

1.42 In comparison to average performance standards applicable to comparable network categories in Queensland, PWC feeder performance in 2009-10 was reasonable but deteriorated during 2010-11. While much of the poor performance has been attributed to the impacts of cyclone Carlos, underlying performance of the network at times other than those impacted by the cyclone were also comparatively poor in 2010-11.

1.43 PWC is proposing significant increases in both capital and maintenance expenditure on network assets over coming years. It is acknowledged that PWC networks are regularly exposed to abnormal natural events, and it is expected that PWC will continue to focus on improving the networks' resilience to such events.

1.44 Future reviews will place increased focus on feeder performance.

Customer service performance

Reconnections/connections

1.45 The percentage of reconnections (i.e. those typically made when a customer moves into an existing residence) made within 24 hours was greater than 99 per cent.

1.46 The percentage of connections to a property in a new subdivision in an urban area made within five working days was 93.3 per cent, continuing the improvement in performance from 80.7 per cent in 2006-07.

1.47 The percentage of connections to a property in a new subdivision in an urban area where minor works are required made within 10 weeks was 18.4 per cent, which is worse than in 2009-10 and an area that appears to require attention by PWC.

Quality of supply complaints

1.48 The total number of quality of supply complaints increased to 1425 in 2010-11 (1.9 per cent of customers), the highest result in five years and high in comparison to industry standards. No reason has been given to the Commission for this increase.

1.49 It is noted that deteriorating performance reported in 2010-11 could be partially due to an improved level of performance reporting by PWC. In this regard, particular attention will be placed on reliability performance indicators for the next review period.

1.50 There is concern that these results may relate to the absence of a structured planning process for the low voltage network and this will require further investigation. These statistics will be closely monitored in future Reviews to identify whether this is attributable to a statistical outlier, or is reflective of an emerging issue.

Telephone call response times

1.51 The reported percentage of telephone calls to PWC answered within 20 seconds of the customer choosing to speak to a human operator was 62 per cent in 2010-11. This was slightly down on 2009-10 and marginally below Agreed Minimum Standard of 63 per cent. It is well below the 76 per cent achieved in 2005-06.

Customer complaints

1.52 PWC received 2220 electricity service related complaints[6] during 2010-11, down slightly from 2009-10.

Commission's focus for the 2011-12 Review

1.53 For the 2011-12 Review, the Commission will pay particular focus on PWC's progress in the following areas:

- increased levels of asset performance information;
- provision of load flow studies or measurements on the low voltage (11/22 kV) distribution network necessary for an assessment of loading and capacity;
- development of a more robust forecasting methodology for assessing the supply-demand balance and investment needs;
- provision of information on forecast network peak demand and the capacity of transmission/sub-transmission feeders and distribution feeders in order to identify potential network capacity constraints;
- provision of network demand forecast for the Alice Springs network as loading information for the Sadadeen and Ron Goodin substations becomes available;
- provision of loading or capacity information for distribution substations to identify actual or potential constraints in the distribution network; and
- improvements in the network's resilience to abnormal natural events as a result of increased capital and maintenance expenditure on the network assets.

[6] This figure is exclusive of quality of supply complaints.

CHAPTER 2

Background

2.1 The Commission's annual Power System Review reports on power system performance and capacity in the Northern Territory. The Review provides information and analysis of historical and forecast power system performance, focusing on the previous financial year, and the upcoming 10 years.

2.2 The Review is prepared with the assistance and advice of participants in the electricity supply industry, other electricity industry stakeholders and consultant reports. The input of all those who have contributed is appreciated. The views expressed in the Review are those of the Commission, and may not necessarily reflect those of the parties consulted.

Availability of information

2.3 An information request template that detailed the information required for the 2010-11 Review was provided to system participants. The data specification was based on arrangements for reporting on system and distribution network health in place elsewhere in Australia.

2.4 While comparisons between organisations provide valuable benchmarks, trends within PWC over a number of years are considered the most important indicator of performance stability and improvement. As a consequence, the 2010-11 Review focuses on maintaining consistency with the approach adopted for the 2009-10 Review.

2.5 The Australian Energy Regulator (AER) publishes an annual State of the Energy Market report to provide a high level overview of energy market activity in Australia, and supplement the AER's extensive technical reporting on the energy sector. The Australian Energy Market Operator (AEMO) publishes detailed reports on system planning and the operation of energy markets, notably the National Transmission Network Development Plan, Electricity Statement of Opportunities report and Power System Adequacy report. At the distribution network level, distribution network service providers generally have requirements under jurisdiction-specific obligations to report on distribution planning and performance.

2.6 These reporting arrangements have developed over the past decade or more, during which time industry participants have built their capacity to provide relevant information.

2.7 Many aspects of the reporting arrangements in the NEM are relevant to the Territory context and may be used as models for future reviews.

2.8 It is expected that PWC will progressively improve its systems and business processes so as to increase the level of asset performance information available in each annual review. While gaps still exist, progress has been made between 2009-10 and 2010-11.

Structure and scope of Review

2.9 The structure and scope of this Review is:

- Chapter 3 provides some details of the Territory's electricity industry;
- Chapter 4 provides an assessment of the adequacy of electricity generation supplies relative to forecast peak demand and an assessment of fuel supply adequacy for the medium term (next three years to 2013-14) and long-term (next 10 years to 2020-21);
- Chapter 5 provides an assessment of the adequacy of the electricity transmission/sub-transmission and distribution networks capacity relative to forecast peak demand for the period to 2014-15; and
- Chapter 6 reports on customer service performance and reliability of supply.

CHAPTER 3

Electricity supply in the Territory

3.1 This chapter provides details of the Territory electricity industry and noteworthy industry developments and events in 2010-11.

Figure 3.1: Northern Territory energy supply infrastructure

Source: Power and Water Corporation

Electricity industry participants

3.2 Electricity industry participants licensed to operate in the Darwin-Katherine, Alice Springs and Tennant Creek power systems at 30 June 2011 are listed in Table 3.1.

Table 3.1: Electricity licence holders at 30 June 2011

Licensees	Darwin-Katherine	Alice Springs	Tennant Creek
Generation	PWC Generation NGD (NT) P/L Cosmo Power P/L LMS Generation P/L	PWC Generation Central Energy Power P/L Uterne Power Plant P/L	PWC Generation
Network	PWC Networks	PWC Networks	PWC Networks
Retail	PWC Retail QEnergy P/L	PWC Retail QEnergy P/L	PWC Retail QEnergy P/L

Source: Utilities Commission

3.3 PWC generates most electricity for household and business use, operates the electricity distribution networks and provides retail services to customers in the Darwin-Katherine, Alice Springs and Tennant Creek power systems.

3.4 PWC is a vertically integrated Northern Territory government owned corporation with generation, network and retail business units operating as separate 'ring-fenced' businesses. The commercial relationship and transactions between each business unit are subject to oversight and regulation by the Commission. PWC is also subject to oversight by a shareholding Minister (the Treasurer) and portfolio Minister (the Minister for Essential Services) under the *Government Owned Corporations Act*.

3.5 The System Control Group (which is located in the Networks business unit) is responsible for the function of monitoring and controlling the operation of the power system with a view to ensuring that the system operates reliably, safely and securely in accordance with the System Control Technical Code.[7] The Group Manager System Control is the System Controller.[8]

3.6 There are five privately owned generation businesses. Three operate in the Darwin-Katherine system and two in the Alice Springs system, two of which are a renewable energy (photovoltaic and land-fill gas) facility. These five businesses generate electricity under power purchase agreements with PWC.[9]

3.7 The Commission granted a standard electricity retail licence to QEnergy Ltd (QEnergy) in February 2011.

[7] *Electricity Reform Act*, s38(1).

[8] As required by the PWC System Control Licence, PWC advised the Commission in August 2010 that the Manager System Control was the System Controller (effective from 13 September 2010).

[9] The power purchase agreement for supply from the Pine Creek Power Station is expected to expire in April 2016.

Market statistics

3.8 Table 3.2 provides key market statistics for the Darwin-Katherine, Alice Springs and Tennant Creek power systems.

Table 3.2: Key market statistics at 30 June 2011

	Darwin-Katherine	Alice Springs	Tennant Creek
Customers (connections)	61 830	11 667	1 533
Generation capacity (MW)	367	73	18
Peak demand (MW)	287	56	7
Electricity sent out (GWh)	1 494	224	29
Network length (km)	6 756	960	415

Figures rounded to nearest whole number.
Source: Power and Water Corporation.

Industry developments and key events

Priority work program

3.9 In August 2009, the Northern Territory Government requested that the Commission undertake a priority work program to increase the efficiency of PWC, improve customer standards of service and reliability, and where possible, align the Territory electricity industry with NEM practice.

3.10 The priority work program involved eight reviews all of which have now been completed.

3.11 The completed reviews provide a framework for change to the regulatory and institutional arrangements governing the Territory electricity industry, covering:

- retail contestability and customer protection;
- customer service and reliability standards;
- retail price oversight;
- wholesale electricity market operation;
- industry governance structures;
- system planning requirements; and
- compliance and performance monitoring and reporting.

3.12 Each review involved extensive analysis and consultation with electricity industry participants, consumers and interest groups.

Natural gas supply

3.13 Natural gas for PWC's requirements is supplied from the Blacktip field in the Bonaparte Gulf, with back-up supply available from the Darwin LNG plant at Wickham Point.[10]

[10] Until January 2012, some gas continued to be supplied by the Palm Valley field in the Amadeus Basin, west of Alice Springs.

System Black events

3.14 A system black is the most significant and disruptive event that can affect a power system, and warrants a detailed analysis of the causes and response to identify implications for system reliability and security. During 2010-11, the following system black events occurred:

- 5 and 6 January 2011, system black events occurred in the Tennant Creek system due to a fault on an outgoing 11 kV feeder. The exact cause has not been conclusively determined, but may be attributable to interference from flying foxes. Outage times ranged from 12 to 30 minutes for the first event, and 13 to 289 minutes for the second.
- 15 January 2011 and 14 March 2011, trips on the 132 kV line to Katherine resulted in interruptions in Katherine, with interruption times ranging from 40 minutes to 283 minutes.
- 22 April 2011, generating Unit 15 at Tennant Creek tripped, resulting in a system black. Outage time was 17 minutes.
- 8 June 2011, a fault occurred at the "Old Power Station" in Alice Springs[11], resulting in a system black condition. Customer restoration time was between 55 and 116 minutes. The Old Power Station has since been disconnected.
- There have been a number of significant load shedding events in the Alice Springs system due to trips of Units 9 and 10 at Ron Goodin. These events occurred on 26 September 2010, 7 October 2010, 28 October 2010, 13 January 2011, 20 May 2011, 2 June 2011 and 5 June 2011. The event on 7 October 2010 resulted in a system black in the Alice Springs system.

3.15 The system black events were investigated by the System Controller.

3.16 The following observations have been made in relation to the events above:

- In relation to the events at Tennant Creek, the system is quite small with low electrical “inertia”. Faults will occur from time to time that result in total loss of supply. Nevertheless, improved system modelling capability currently being deployed across the Territory’s power systems, including Tennant Creek, will give PWC the ability to optimise generation and network protection systems and settings. This modelling should minimise power system incidents.
- In relation to the event at Alice Springs on 8 June 2011, the root cause of this problem was removed with the complete disconnection of the “Old Power Station”, facilitated by the construction of Owen Springs Power Station. While it is acknowledged that the Old Power Station in Alice Springs was at the end of its lifecycle, it is expected that PWC will ensure all equipment connected to the PWC systems is in a safe and reliable operative state.
- In relation to the events at Alice Springs which resulted in a system black on 7 October 2010, gas turbine Units 9 and 10 at the Ron Goodin substation (11.7MW and 10 MW) are significantly larger than the remaining units (the largest being 5.5 MW). The trip of one of the larger units would usually result in under frequency load shedding due to a lack of spinning reserve. The issue should

[11] The Old Power Station is adjacent to Ron Goodin Power Station.

improve with the commissioning of Owen Springs Power Station with three larger units (each being 10 MW).

- In relation to the events at Katherine, there is a risk that an outage on the single interconnection between Darwin and Katherine will cause a major disruption. Improved system modelling should identify changes required to ensure such events can be restricted to selective load shedding rather than a system black condition. PWC has advised that the loss of the 132kV line to Katherine is currently met by ensuring sufficient online/offline generation capacity is available to restore load after the contingency.

Cyclone Carlos

3.17 While not a system black condition, between 15 and 18 February 2011, tropical cyclone Carlos impacted Darwin and its surrounds. High gusting winds and heavy rain resulted in significant damage to the overhead transmission and distribution network and resulted in outages to approximately 48 000 customers. This resulted in a loss of 115 SAIDI minutes on 16 February 2011 – equivalent to all customers in Darwin being without power for nearly two hours.

3.18 The Commission's main observations about the event and the subsequent response are:

- events of this type are largely outside of the control of PWC; and
- PWC has proposed significant increases in both capital and maintenance expenditure on the network over coming years. While acknowledging that the PWC system is highly exposed to such natural events, the Commission expects that this expenditure will progressively increase the resilience of the network to such events, increase the level of resourcing available to respond, and reduce the impact on PWC's customers over coming years.

3.19 PWC Generation experienced delays in the commissioning of two new 45 MW dual-fuel gas turbines at Channel Island Power Station. Originally planned to be operating for the 2010-11 wet season, the commissioning of the new units experienced significant delays and they finally were commissioned in January 2012**.** The units will provide additional capacity to meet increasing peak demand and provide additional reserve capacity to allow major maintenance on existing generation plant. The reasons for the delay were canvassed in the 2009-10 Review, and included the project delivery methodology, late delivery of the gas skid and insufficient planning of the connection of the machines to the system. PWC has advised that the delay also related to the System Controller applying greater rigour to compliance with requirements under the System Control Technical Code and Network Connection Technical Code.

3.20 Owen Springs Power Station was originally scheduled to be completed in April 2011. While also experiencing delays, full availability of the plant was expected to be achieved before the end of 2011.[12] The reasons for the delay are similar to those for Channel Island Units 8 and 9. In addition, there were problems with the commissioning of the transmission connection from Owen Springs to Lovegrove Substation.

[12] The commissioning date for Units 1 and 2 at Owen Springs was 22 September 2011. At the time of writing, Unit 3 was still under test.

3.21 The technologically advanced Owen Springs Power Station adds significantly to the efficiency and capacity of generation in the Alice Springs system.

Subsequent developments

3.22 The Commission notes that subsequent developments since July 2011 will be addressed in more detail in the 2011-12 Review, including:

- Major investments by PWC in new generation at Channel Island and Owen Springs Power Station, originally scheduled to be completed in time for the 2010-11 wet season, were on line in January 2012, during the 2011-12 wet season. While it is recognised that there may be teething issues in the early stages of operation, it is expected that real progressive benefits to PWC's customers will be received in the form of reduced outages attributable to generation.
- Archer Zone Substation was commissioned in November 2011. This will relieve pressure on Palmerston Zone Substation. A second Weddell – Archer 66 kV line, and a 66 kV line from Archer to Snell Street will also be completed in 2011-12.

CHAPTER 4

Electricity Generation

4.1 This chapter examines the capacity and adequacy of electricity generation in the Darwin-Katherine, Alice Springs and Tennant Creek systems, and reports:

- generation capacity at 30 June 2011;
- system demand forecasts for the medium term (to 2013-14) and long term (to 2020-21);
- supply-demand balance for the system to 2013-14 and to 2020-21 (a projected assessment of system adequacy), and actual and potential system constraints related to generation capacity;
- adequacy of generation capacity and the reserve margin to 2013-14 and potential capacity to 2020-21, based on available, committed and proposed generating capacity; and
- adequacy of fuel supplies for electricity generation.

Generation capacity

4.2 Electricity supplied in the Darwin-Katherine, Alice Springs and Tennant Creek systems is generated by PWC Generation and five other licensed generation suppliers with agreements with PWC.

4.3 Table 4.1 presents generation capacity figures as at 30 June 2011. The capacity reported is the sustainable installed capacity figure for generation plant (that is, the capacity available under normal operating conditions).

Table 4.1: Generation capacity in the Darwin-Katherine, Alice Springs and Tennant Creek systems as at 30 June 2011

Darwin-Katherine	Operator	Capacity (MW)	Fuel
Channel Island	PWC	232	Dual natural gas/liquid fuel Natural gas
Weddell	PWC	86	Natural gas
Katherine	PWC	21	Dual natural gas/liquid fuel
Pine Creek[13]	NGD(NT) Cosmo Power	27	Dual natural gas/liquid fuel
LMS Shoal Bay	LMS Generation	1	Landfill gas
Total		**367**	

[13] The power purchase agreement for supply from the Pine Creek Power Station is expected to expire in April 2016.

Alice Springs	Operator	Capacity (MW)	Fuel
Ron Goodin	PWC	60	Dual natural gas/liquid fuel Liquid fuel
Owen Springs	PWC	4	Dual natural gas/liquid fuel
Brewer	Central Energy Power	9	Dual natural gas/liquid fuel
Uterne	Uterne Power	1	Solar
Total		**74**	

Tennant Creek	Operator	Capacity (MW)	Fuel
Tennant Creek	PWC	18	Dual natural gas/liquid fuel Natural gas Liquid fuel
Total		**18**	

Note: Berrimah Power Station is restricted to emergency use only, and can supply 10 MW.

Figures are rounded to the nearest whole number.

Source: Power and Water Corporation.

Darwin-Katherine – 2010-11

4.4 80 per cent of total generation capacity is located in the Darwin-Katherine system, with 16 per cent in the Alice Springs system and the remaining 4 per cent in the Tennant Creek system. Channel Island Power Station is by far the largest, accounting for over half of the capacity on the combined systems. Weddell, also on the Darwin-Katherine system, accounts for a further 19 per cent of capacity.

4.5 Channel Island Power Station has five dual-fuel (gas and diesel) combustion turbines (Units 1 to 5) with a capacity of 31.6 MW each, one gas fuelled combustion turbine (Unit 7) with a capacity of 42 MW, and one steam turbine (Unit 6) which operates as part of a combined cycle block, using the waste heat from units 4 and 5, to provide 32 MW capacity.

4.6 The combined cycle block formed by Units 4, 5 and 6 can produce 95 MW, representing about 26 per cent of capacity in the Darwin-Katherine system. Due to the capture of the waste heat for use in the steam turbine, it is the most efficient plant in the Darwin-Katherine system.

4.7 Weddell Power Station has a capacity of 86 MW, comprising two gas-fuelled turbines, each with a capacity of 43 MW. Each unit represents about 9 per cent of total capacity of the Darwin-Katherine system. These units, and Unit 7 at Channel Island, are aero derivative gas turbines and are significantly more fuel efficient than Units 1-3 at Channel Island.

4.8 Berrimah Power Station consisted of two kerosene-fuelled 15 MW turbines. Unit 1 is considered no longer serviceable and was retired in June 2011. Unit 2 has been derated to 10 MW, and is available for emergency use only.

4.9 Pine Creek Power Station, operated by NGD (NT) Pty Ltd and Cosmo Power Pty Ltd (subsidiaries of Energy Developments Ltd), has 26.6 MW from two gas-fuelled

combustion turbines and a steam turbine utilising hot exhaust gases from these turbines. The Pine Creek Power Station supplies electricity to PWC Generation under a power purchase agreement which will expire in April 2016.

4.10 Also supplying PWC Generation with electricity under a power purchase agreement in the Darwin-Katherine system is LMS Generation Pty Ltd, which operates a 1.1 MW land fill gas generation facility at the Darwin City Council Shoal Bay waste facility.

Alice Springs – 2010-11

4.11 Ron Goodin Power Station in Alice Springs has a capacity of 59.6 MW comprising three diesel engines (Units 1, 2 and J) with a combined capacity of 4.7 MW, six dual fuel engines (Units 3-8) with a combined capacity of 29.1 MW and four gas turbines (Units 9, 10, F and G) with a combined capacity of 25.8 MW.

4.12 As at 30 June 2011, Owen Springs Power Station in Alice Springs had a capacity of 3.9 MW, being a dual-fuel combustion turbine that was relocated from Ron Goodin in June 2009. Three dual-fuel reciprocating engines, each with 10.7 MW of capacity were installed at the Owen Springs Power Station during 2010-11. The commissioning of Units 1 and 2 occurred in September 2011 and Unit 3 is still being tested.

4.13 The Owen Springs Power Station is intended to replace Ron Goodin Power Station, where generating units will be retired gradually over the period to 2020-21. Units F and G are expected to be retired in 2011-12, and Unit 10 will be relocated to Katherine. Units 1 and 2 are scheduled to be retired in 2012-13.

4.14 Brewer Power Station, operated by Central Energy Power Pty Ltd, has 8.5 MW from four spark-fired reciprocating engines. Brewer operates under a power purchase agreement with PWC Generation.

4.15 Renewable energy generation capacity in Alice Springs has increased by approximately 1 MW with a 1 MW photovoltaic system installed at the Uterne Solar Power Station. Uterne operates under a power purchase agreement with PWC Generation.

Tennant Creek – 2010-11

4.16 The Tennant Creek Power Station has a capacity of 18.2 MW, comprising seven diesel engines (Units 1 to 5, 16 and 17) with a combined capacity of 9.5 MW, five gas engines (Units 10 to 14) with a combined capacity of 4.8 MW and a dual-fuel turbine (Unit 15) with a capacity of 3.9 MW.

Power purchase agreements

4.17 PWC Generation was supplied electricity during 2010-11 by five businesses licensed to operate as independent power producers:

- Darwin-Katherine system, NGD (NT) Pty Ltd and Cosmo Power Pty Ltd (subsidiaries of Energy Developments Ltd) operate Pine Creek Power Station;[14]
- Darwin-Katherine system, LMS Generation Pty Ltd operates a land fill gas generation facility at the Darwin City Council Shoal Bay rubbish waste facility;

[14] The power purchase agreement for supply from the Pine Creek Power Station is expected to expire in April 2016.

- Alice Springs system, Central Energy Power Pty Ltd operates Brewer Estate Power Station; and
- Alice Springs system, Uterne Power Plant Pty Ltd (a subsidiary of SunPower Corporation Pty Ltd) operates the Uterne photovoltaic facility.

4.18 As at 30 June 2011, these five firms operated generation equipment with a total capacity of about 37 MW, or potentially about 8 per cent of total generation capacity of the market systems.

Generation supply-demand balance

4.19 The generation supply-demand balance is an assessment of whether available generation capacity is adequate to meet forecast electricity demand. To undertake this forecast demand assessment the following were reviewed:

- generation capacity projections for 2011-12 to 2013-14; and
- electricity demand forecasts for 2011-12 to 2020-21.

Projected available generation capacity

4.20 Capacity projections are based on advice by industry participants of available capacity, planned generation additions and retirements in the period 2011-12 to 2020-21. Capacity projections for the period 2014-15 to 2020-21 are not reported due to uncertainty about outcomes versus plans. It is noted that the timing of additions and retirements of capacity may vary in response to commercial priorities of electricity industry participants, construction or commissioning delays and changing electricity peak demand forecasts.

Darwin-Katherine system

4.21 Table 4.2 provides an assessment of generation capacity in the Darwin-Katherine system for 2011-12 to 2013-14. The starting capacity of the Darwin-Katherine system for 2011-12 is 367 MW. This capacity does not include the new Units 8 and 9 at Channel Island with a combined capacity of 90 MW which were commissioned in January 2012. The new units at Channel Island Power Station were initially to be commissioned by October 2010.[15]

Table 4.2: Darwin-Katherine capacity projections (MW) 2011-12 to 2013-14

Year (30 June)	Retirements	New capacity	Total Capacity	Comment
2011-12	-	90	457	Plus Channel Island Units 8 & 9
2012-13	-	54	511	Plus Weddell Unit 3 Plus Katherine Unit 4
2013-14	-	-	511	

Source: Power and Water Corporation

[15] Power and Water Corporation website, viewed 17 February 2011, http://www.powerwater.com.au/newsroom/news_item/2010/rolls_royce_power_for_channel_island.

4.22 Berrimah Power Station was removed from regular service in 2010-11, reducing the system capacity by 30 MW and excluded from the calculation of available generation capacity for 2011-12 on the understanding that one of the units is completely unserviceable, and the second unit has been derated to 10 MW. This capacity is only available for service in an emergency situation.

4.23 PWC advised that the expiry of the Pine Creek B power purchase agreement in April 2011 reduced available capacity by 7.5 MW in 2010-11. Capacity is expected to be further reduced by 27 MW with the expiry of the Pine Creek power purchase agreement in April 2016.

4.24 PWC advises that the plant was commissioned in January 2012.

4.25 New capacity of 54.1 MW is expected to become available in 2011-12 with the commissioning of:

- Katherine Power Station Unit 4 in May 2012, adding 12.1 MW of capacity. PWC advises that this unit is to be relocated from Ron Goodin Power Station (where it is currently designated as Unit 10) during 2011-12, but has not yet been able to advise the timing of the unit being decommissioned at Ron Goodin Power Station or recommissioned at Katherine, due to operational issues at Ron Goodin Power Station. It is assumed the unit will be decommissioned once new capacity is available from Owen Springs Power Station[16], and that the relocation and upgrading will take four months; and
- Weddell Power Station Unit 3 (42 MW) in July 2012.

Alice Springs system

4.26 The starting capacity of the Alice Springs system for 2011-12 is 73 MW.

Table 4.3: Alice Springs capacity projection (MW) 2011-12 to 2013-14

Year (30 June)	Retirements	New capacity	Total Capacity	Comment
2011-12	14	32	91	Plus Owen Springs Units 1,2&3 Less Ron Goodin Units 10, F&G
2012-13	4		87	Less Ron Goodin Units 1&2
2013-14			87	

Source: Power and Water Corporation and Utilities Commission.

4.27 New capacity of 32.1 MW is expected in the 2011-12 period with the commissioning of Owen Springs Power Station Units 1, 2 and 3, each with 10.7 MW of capacity. PWC advises that electricity has been available from this new plant since the last quarter of 2011.[17]

4.28 As part of the Alice Springs Solar Cities program a 0.96 MW Solar Power Station began operating in Alice Springs from May 2011. The facility is owned by Uterne

[16] Owen Springs Power Station Units 1 and 2 were commissioned in September 2011 and Unit 3 is still being tested.

[17] Power and Water Corporation website, viewed 17 February 2011, http://www.powerwater.com.au/about_us/major_projects/owen_springs_power_station.

Power Plant Pty Ltd, and all production is sold to PWC Generation under a power purchase agreement.[18]

4.29 Also as part of the Solar Cities program a 0.2 MW photovoltaic (PV) system at the Alice Springs Airport was commissioned in September 2010. This PV system is not included in calculations of system capacity because the electricity is generated for use on site only. Under optimal operating conditions the Alice Springs Airport PV system is estimated to supply about 25 per cent of the airport electricity demand. [19]

4.30 The new capacity becoming available in 2011 is to offset a 14.1 MW reduction in capacity from the planned retirement of Ron Goodin Units F (2 MW) and G (2 MW), and the planned relocation of Ron Goodin Power Station Unit 10 (10 MW) to the Katherine Power Station from May 2011. PWC has advised that the plant at Ron Goodin would be decommissioned in the 2011-12 period, but has not advised the month of decommissioning. It was assumed the units would be decommissioned once new capacity is available from Owen Springs Power Station.

4.31 PWC advises that Ron Goodin Units 1 and 2 (3.8 MW total) are to be retired in 2012-13. It is assumed that the units will be decommissioned in January 2013. All generation at Ron Goodin is to be gradually removed from service between 2010-11 and 2021-22. Units 1 and 2 will continue to be available for emergency use.

Tennant Creek system

4.32 The reported starting capacity of the Tennant Creek system for 2011-12 is 18.2 MW.

Table 4.4: Tennant Creek capacity projection (MW) 2011-12 to 2013-14

Year (30 June)	Retirements	New capacity	Total Capacity	Comment
2011-12	-	-	18.2	
2012-13	-	-	18.2	
2013-14	-	-	18.2	

Note: Capacity at Tennant Creek Power Station increased by 1.5 MW at the beginning of 2011-12 following the commissioning of a new 1.5 MW set.

Source: Power and Water Corporation

System demand forecasts

4.33 System demand is determined by household, business and industrial electricity consumption patterns, which are influenced by weather, population growth and household formation, economic growth and the development of energy intensive industrial projects.

4.34 The focus of a system demand forecast is the expectation of maximum or 'peak' demand. Forecasts of peak demand are used to inform decisions about the supply-demand balance and the management of the electricity system in both the short term and long term to ensure a reliable and secure electricity supply:

[18] Alice Solar City website <www.alicesolarcity.com.au>, viewed 17 February 2011, http://www.alicesolarcity.com.au/sites/default/files/Media%20Release%20-%20Uterne%20Solar%20Power%20Station%20announcement%2015%20Dec%202010.pdf.

[19] Alice Solar City website <www.alicesolarcity.com.au>, viewed 17 February 2011, http://www.alicesolarcity.com.au/iconic-projects.

- the system operator (the System Controller in the Territory) uses peak demand forecasts to determine the generation capacity operating and in reserve that must be available in the short term (for example, in the next half hour and over the day) to meet customer energy use; and
- system participants use peak demand forecasts to develop their maintenance program and to identify generation and network investment needs in the medium to longer term (for example, in three years' time).

Development of system demand forecast scenarios

4.35 System demand forecasts for Territory power systems are produced by:

- PWC, which through its System Controller role, develops demand forecasts to ensure there is sufficient generation capacity available to meet demand as part of the day-to-day operation of the power systems; and
- the Commission, which is required under the *Electricity Reform Act* (s45(1)(a)) to develop forecasts of overall electricity load and generating capacity in consultation with participants in the electricity supply industry.

4.36 PWC Generation, PWC Networks and PWC Retail (and any other generator and retailer operating in the Territory) also require system demand forecasts to schedule maintenance, to identify potential generation investment opportunities, potential network constraints and to inform estimates of energy sales.

4.37 Prior to February 2011, PWC was the sole market generator and sole retailer operating in the Territory, which put it in a unique situation for Australia of having access to comprehensive information on historical and prospective peak demand and energy consumption. A second retailer, QEnergy, was licensed in February 2011.

4.38 While still in its infancy, the emergence of a competing retailer makes it important that both the System Controller and PWC Networks develop forecasts that reflect all sales transactions in the Territory.

2010-11 Actuals vs 2009-10 Review Forecasts

4.39 In the 2009-10 Review, the Commission published forecasts for the period 2010-11 to 2019-20 for the Darwin-Katherine, Alice Springs and Tennant Creek systems.

4.40 Table 4.5 compares the actual 2010-11 maximum demand with the forecasts made last year:

Table 4.5: Comparison between actual and forecast demand in 2010-11

System	2010-11 (Actual) MW	E&P (Medium) MW	PWC (Medium) MW	PWC (High) MW
Darwin-Katherine	287.0	281.1	279.4	280.5
Alice Springs	55.7	55.9	55.6	55.8
Tennant Creek	6.8	7.5	7.4	7.5

Source: Evans & Peck and Power and Water Corporation

4.41 Demand growth in the Darwin-Katherine system has been higher than forecast by Evans & Peck by approximately 5.9 MW, or 2.1 per cent. This should be seen in the context of relatively cool weather conditions which may have suppressed demand by

up to 6-7 MW indicating that on a weather corrected basis, demand may have been up to 12 MW above forecast.

4.42 Growth in Alice Springs has been 0.2 MW less than forecast by Evans & Peck. This difference is largely explained by the cooler temperatures experienced over the wet season.

4.43 Tennant Creek maximum demand was 9 per cent below forecast. An analysis of weather conditions shows very mild temperature conditions over the cooler months, which were a likely contributor to this demand reduction.

4.44 A range of quantitative and qualitative data was reviewed to determine if the PWC forecasts represent credible system demand scenarios. In the 2009-10 Review, a number of areas for continuous improvement were identified, and it was noted that PWC was taking steps to address some of the deficiencies in the forecasting process. For the 2010-11 Review the data includes:

- A new spatial demand forecasting procedure prepared by PWC Networks that will underpin PWC's capital and operating expenditure programs by highlighting where network constraints are expected to emerge. [20]
- From 2012, weather correction of the spatial demand history will be undertaken by PWC Networks in order to develop forecasts of demand. The procedure will be fully implemented in 2011-12 and aims to identify the main drivers of peak demand, any changes in these drivers and the factors behind those changes.

4.45 The forecast process is made at three levels:

- regional level, to inform PWC Generation forecasts;
- zone substation forecast; and
- high voltage feeder forecast.

4.46 While some short-term misalignment between actual and forecast demand can be invariably expected, even when using best industry practice forecasting techniques, multi-factorial, statistical approaches provide more reliable long-term forecast outcomes. In addition, developing low, medium and high scenarios are important to stress test PWC's capital program if underpinning assumptions change within reasonable bounds.

4.47 Forecasting the impact of some of the key drivers of electricity demand in the Territory, such as economic growth and business investment in large projects, has become quite problematic, particularly in the context of the volatility in world economic conditions. However, it is expected that PWC's proposed forecasting methodology will result in a forecast that is sufficiently robust for the purposes of reasonably accurately assessing the supply-demand balance and investment needs.

Forecast system demand scenarios

4.48 For the purposes of the 2010-11 Review, Evans & Peck produced a forecast for each of the systems. The Evans & Peck "P50" forecast reflects average weather conditions.

4.49 Table 4.6 compares the Evans & Peck scenario with the current PWC forecast for the period to 2011-12 to 2020-21.

[20] PWC advise that the Power Networks Spatial Demand Forecasting Process" is scheduled for implementation during 2012.

Table 4.6: System demand growth scenarios for 2011-12 to 2020-21

Forecast demand growth (% per annum)	E&P (Medium)	PWC[21]
Darwin-Katherine	3.6	2.5
Alice Springs	2.0	2.5
Tennant Creek	1.3	2.5

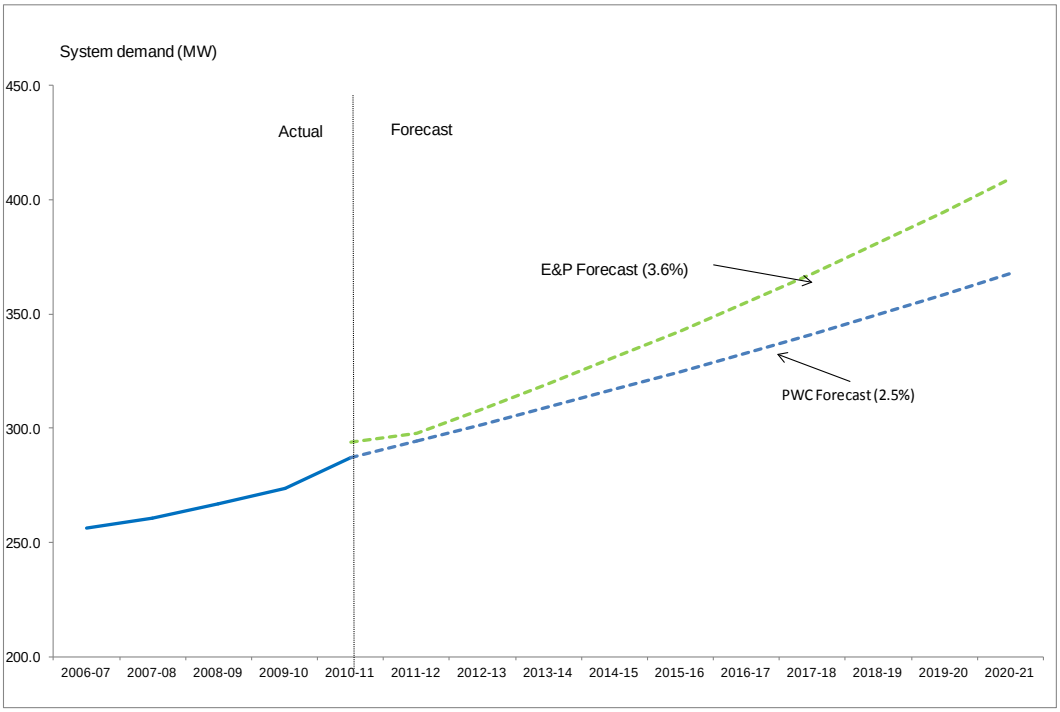
Source: Evans & Peck and Power and Water Corporation.

4.50 For the 2010-11 Review, the demand forecast provided by PWC did not include any low, medium and high scenarios and the same rate was applied to all power systems.

4.51 PWC demand forecast may be modified depending on whether a number of large block loads eventuate. PWC treats these loads on a case-by-case basis. As outlined above, PWC is developing more effective forecasting techniques and capability to improve the reliability of longer term demand forecasts and the current forecasts are subject to revision when this methodology is implemented.

4.52 The Evans & Peck (baseline scenario forecast) and PWC forecast system demand scenarios for the Darwin-Katherine, Tennant Creek and Alice Springs systems are presented in Figures 4.1, 4.2 and 4.3. Tables A.1, A.2 and A.3 in Appendix A provide the forecast maximum demand for 2011-12 to 2020-21. It should be noted that Evans & Peck has weather corrected the 2010-11 actual maximum demand to use as the starting point for forecasts.

Figure 4.1: Forecast Darwin-Katherine annual maximum system demand 2011-12 to 2020-21

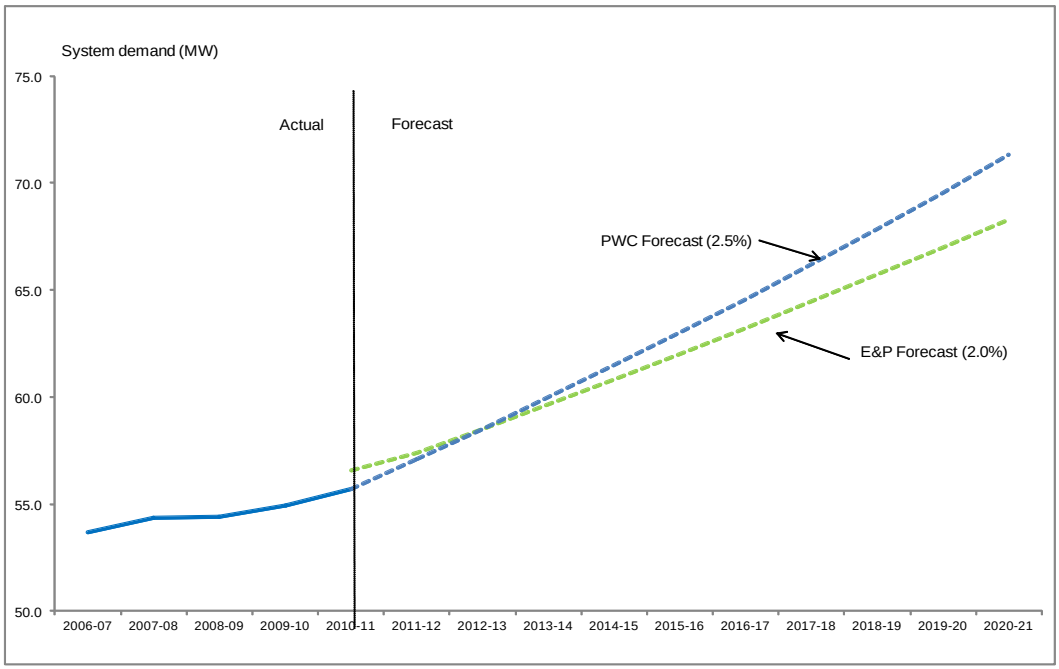


Source: Evans & Peck and Power and Water Corporation.

[21] PWC has advised that it assumes a 2.5 per cent demand growth forecast for all power systems over a 1 to 5 year timeframe. PWC Generation has adopted a 4 per cent peak demand growth rate for its planning horizon for its 5 to 10 years planning horizon for the Darwin-Katherine system.

4.53 The Evans & Peck baseline scenario forecast for the Darwin-Katherine system is higher than the PWC forecast. Both PWC and Evans & Peck have lifted their rate of growth expectation by 0.3 per cent from the 2009-10 Review based on the high demand experienced in 2010-11.

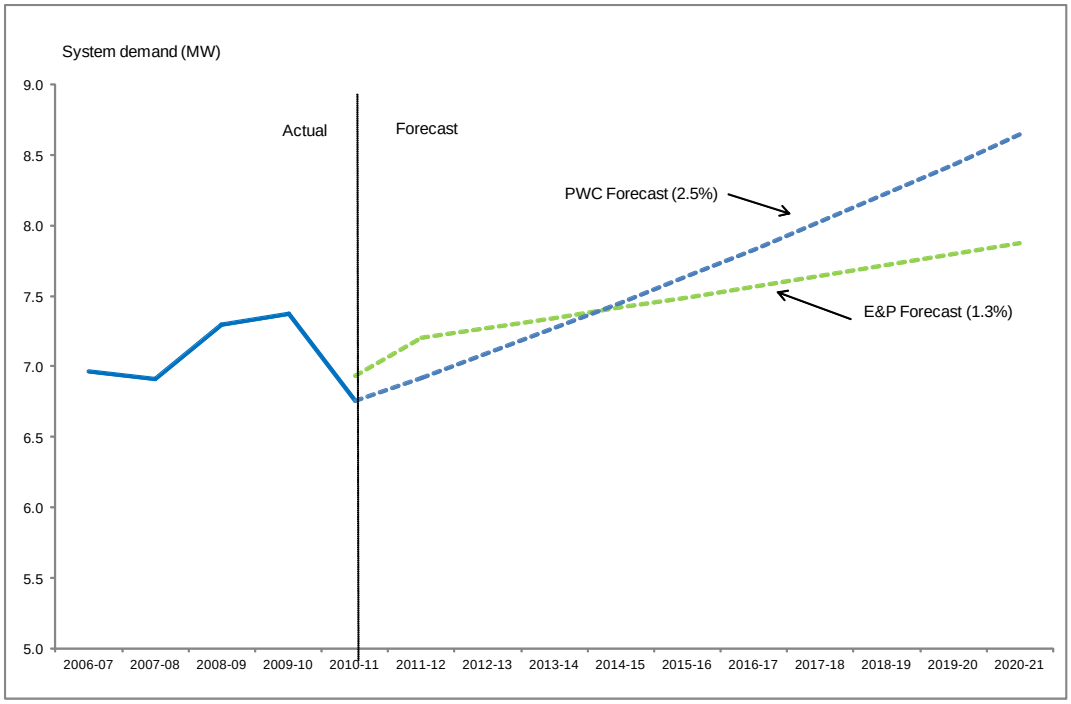
Figure 4.2: Forecast Alice Springs annual maximum system demand for 2011-12 to 2020-21



Source: Evans & Peck and Power and Water Corporation.

4.54 Evans & Peck has increased its forecast growth rate in the Alice Springs system to 2 per cent, up from the 1.7 per cent in the 2009-10 Review. However, PWC's forecast has increased from 1.2 per cent per annum in the 2009-10 Review to 2.5 per cent. This value may be refined with introduction of the new forecasting process.

Figure 4.3: Forecast Tennant Creek annual maximum system demand for 2011-12 to 2020-21



Source: Evans & Peck and Power and Water Corporation.

4.55 Following a significant reduction in demand at Tennant Creek in 2010-11 over the 2009-10 level, Evans & Peck reduced its forecast growth rate from 2.0 per cent in the 2009-10 Review to 1.3 per cent in 2010-11. PWC however has increased its growth projection from 0.6 per cent per annum to 2.5 per cent per annum. This is considered as an interim value pending the application of the revised forecasting process. Evans & Peck's starting point for forecasts is based on the weather corrected 2010-11 value, whereas PWC projects forward from the actual recorded value.

Major projects

4.56 Consistent with the methodology adopted by PWC, and the approach taken in previous Reviews, major energy using projects should be excluded from the forecasting process and treated on a case-by-case 'contingent' project basis because:

- major projects have varying impacts on energy infrastructure, depending on energy intensity, onshore or offshore locations and the multiplier effects in the local community;
- the Territory's electricity system and distribution networks are relatively small, and a major project can represent a significant percentage of generation capacity;
- these projects may have their own generation capacity, and may not require electricity from the system; and
- there is considerable uncertainty about the timing of projects, due to factors such as global markets, availability of finance and timing of local and national approvals processes.

4.57 No major projects are factored into the PWC demand forecast scenarios for 2011-12 to 2013-14.[22]

Generation supply-demand balance

4.58 The generation supply-demand balance provides an assessment of generation adequacy relative to forecast electricity demand in the Darwin-Katherine, Alice Springs and Tennant Creek systems for:

- short to medium term – 2011-12 to 2013-14; and
- medium to long term – 2014-15 to 2020-21.

4.59 Two techniques were used to assess the generation supply-demand balance:

- N-X analysis of generation adequacy, which tests whether generation capacity is adequate to meet peak system demand under the medium growth scenario at N-X. This is the approach adopted by the Commission for previous Reviews; and
- probabilistic analysis, which establishes a loss of load probability (LOLP) to identify the likelihood of generation constraints occurring over the assessment period, for the Darwin-Katherine system only, consistent with the approach in the 2009-10 Review and best industry practice in Australia.

N-X analysis of generation adequacy

4.60 An N-X analysis of generation adequacy involves progressively subtracting the largest unit of capacity from total installed capacity. For example:

[22] For the purpose of its demand forecast scenarios, PWC has not considered the impact of the January 2012 decision by INPEX and Total to proceed with the Ichthys project.

- N is the system capacity regarded as available for service;
- N-1 is the system capacity minus the largest unit of generation in the system; and
- N-2 is the system capacity minus the two largest units in the system.

4.61 The N-X approach is a straightforward method for assessing the level of reserve capacity and identifying actual or potential generation constraints at a point in time at a given level of demand.

4.62 The N-X capacity for the Darwin-Katherine, Alice Springs and Tennant Creek systems for the period 2011-12 to 2020-21 have been identified based on advice from system participants about future generation capacity. Table 4.7 provides the capacity available in each system at N-1 and N-2 as at 31 December 2011.

Table 4.7: N-X capacity for 2010-11

N-X capacity (MW)	N	N-1	N-2
Darwin-Katherine	457	409.4	361.8
Alice Springs	91	79.3	68.6
Tennant Creek	18.2	14.3	12.8

Source: Utilities Commission. Note: the N-X capacities change over time as generation units are added and replaced.

4.63 In the Darwin-Katherine system:

- N-1 is a capacity reduction of 47.6 MW, which represents the loss of 50 per cent of the capacity of the combined cycle block at Channel Island Power Station (ie the loss of one dual-fuel turbine and 50 per cent of the steam turbine); and
- N-2 is a capacity reduction of 95.2 MW, which represents the loss of the total combined cycle block at Channel Island Power Station.

4.64 In the Alice Springs system:

- N-1 is a capacity reduction of 11.7 MW, which represents the loss of Unit 9 at Ron Goodin Power Station; and
- N-2 is a capacity reduction of 22.4 MW, which represents the loss of Unit 9 at Ron Goodin Power Station and one of Units 1, 2 or 3 (10.7 MW) at Owen Springs Power Station.

4.65 In the Tennant Creek system:

- N-1 is a capacity reduction of 3.9 MW, which represents the loss of Unit 15 at Tennant Creek Power Station; and
- N-2 is a capacity reduction of 5.4 MW, which represents the loss of Unit 15 and one of Units 16 or 17 (1.5 MW) at Tennant Creek Power Station.

Loss of load probability

4.66 The LOLP is an indicator of generation reliability commonly used in Australia for assessing system adequacy and generation planning purposes. The LOLP indicates the probability that generation capacity will be insufficient to meet demand at some point over some specific period. It is considered a more useful measure for planning purposes than the N-X methodology.

4.67 A probabilistic analysis of the adequacy of generation capacity, such as the LOLP, was applied in the 2010-11 Review for the Darwin-Katherine system. PWC Generation does not currently undertake any probabilistic analysis.

Generation supply-demand balance – Darwin-Katherine system

4.68 The Darwin-Katherine system is expected to have sufficient generation capacity to meet forecast peak demand under any credible demand growth scenario in the medium and long term.

4.69 In the short term, there was a credible risk of generation capacity constraints and poor generation reliability during 2011 due to the late commissioning of Units 8 and 9 at Channel Island Power Station. The key risk period was prior to December 2011 and the commissioning of Channel Island Units 8 and 9. There is the potential for ongoing capacity constraints if the new Channel Island plant experience early operational issues and / or from forced outages of the existing plant.

4.70 For the period 2013 to 2020-21, there appears to be sufficient generation capacity available to provide an estimated average reserve margin of 43 per cent. In the period, January 2012 to April 2016, the average reserve plant margin is estimated at 63 per cent. The minimum reserve plant margin in the period is 26 per cent in late 2019 early 2020 when forecast peak demand reaches 394.7 MW against capacity of 497 MW (representing reserve capacity of 102.3 MW). This exceeds the N-2 criterion of 95.2 MW.

4.71 The supply-demand balance and generation adequacy is influenced by the current maintenance program for 2011 to 2017 for generation plant in the Darwin-Katherine system.[23]

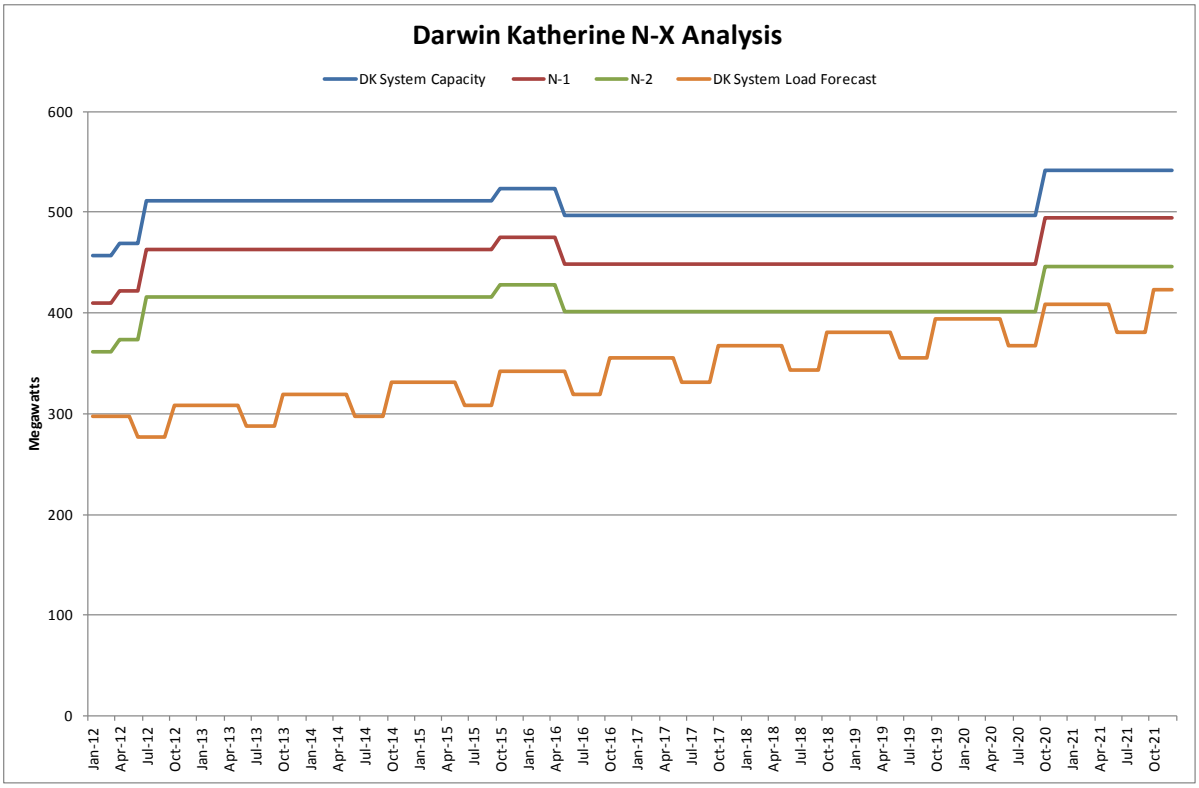
4.72 Accounting for planned maintenance in the period January 2012 to April 2016, the average reserve plant margin is estimated at 49 per cent. The minimum reserve plant margin experienced in the period is 28 per cent in February and March 2012 when forecast peak demand reaches 298 MW against available capacity of 380 MW (representing reserve capacity of 82 MW). This is below the N-2 criterion of 95.2 MW, but considered unlikely to cause issues provided Channel Island Units 8 and 9 perform as expected.

N-X analysis – Darwin-Katherine

4.73 The N-X analysis of the supply-demand balance for the Darwin-Katherine system is presented in Figure 4.4. The analysis assumes that peak demand increases according to the Evans & Peck load forecast, and that all capacity is available (ie without accounting for planned maintenance). The key point is that the plant proposed to be commissioned during the period provides sufficient capacity to meet in excess of an N-2 event throughout the period.

[23] PWC Generation, Generation North Five Year Maintenance Program for 2011 to 2017.

Figure 4.4: Darwin-Katherine system supply-demand balance for 2011-12 to 2020-21



Source: Evans & Peck.

4.74 The potential for capacity constraints to cause adverse reliability outcomes during 2011-12 remains a concern until early operational issues following the commissioning of Channel Island Units 8 and 9 are totally resolved. The effect on reliability associated with new plant may be demonstrated by the reliability problems experienced when PWC generation was bringing Weddell Power Station Units 1 and 2 into service in 2008-09.

4.75 Subject to industry standard operation and maintenance practices being followed, generation capacity should be sufficient to provide spare capacity above the N-2 criterion from January 2012 to 2020-21 under credible demand forecast scenarios.

Reserve plant margin

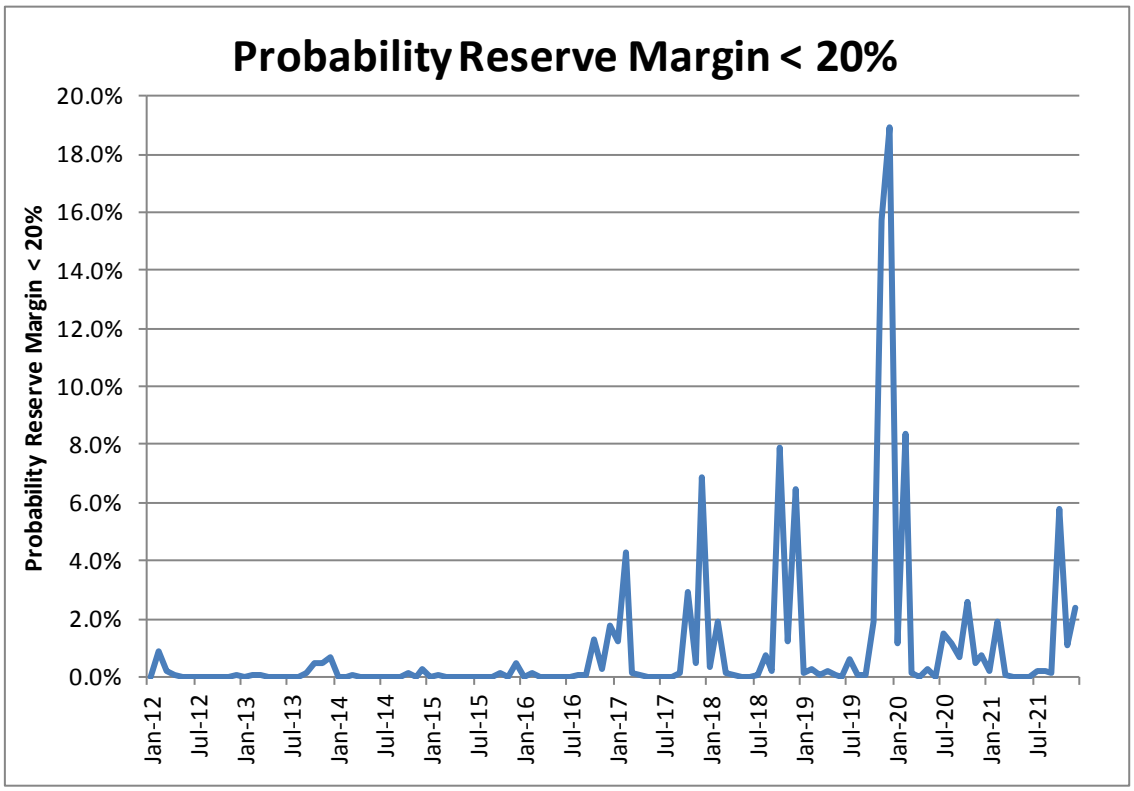
4.76 An alternative indicator of system adequacy is the reserve plant margin, which is calculated as the total system capacity available less the actual maximum demand for electricity in a particular year, expressed as a percentage of maximum demand.

4.77 A view is yet to be established on an appropriate benchmark reserve plant margin for each Territory power system. Evans & Peck advised that a starting point benchmark for a small power system is upwards of 20 per cent, subject to factors including the size of individual plant relative to total system load.

4.78 The Darwin-Katherine system (accounting for planned outages) has an estimated average reserve plant margin of 37 per cent for the period of this Review. While the reserve plant margin reaches a minimum of 14 per cent in late 2019, it is above 30 per cent until July 2016.The low levels of reserve plant margin are far enough in the future not to be of concern at this time, but will need to be closely monitored in future reviews.

4.79 Figure 4.5 presents the estimated probability of the Darwin-Katherine reserve plant margin falling below 20 per cent in the period 2011-12 to 2020-21.

Figure 4.5: Probability of a Darwin-Katherine system reserve plant margin of below 20 per cent 2011-12 to 2020-21



Source: Evans & Peck.

Darwin-Katherine system LOLP (due to generation)

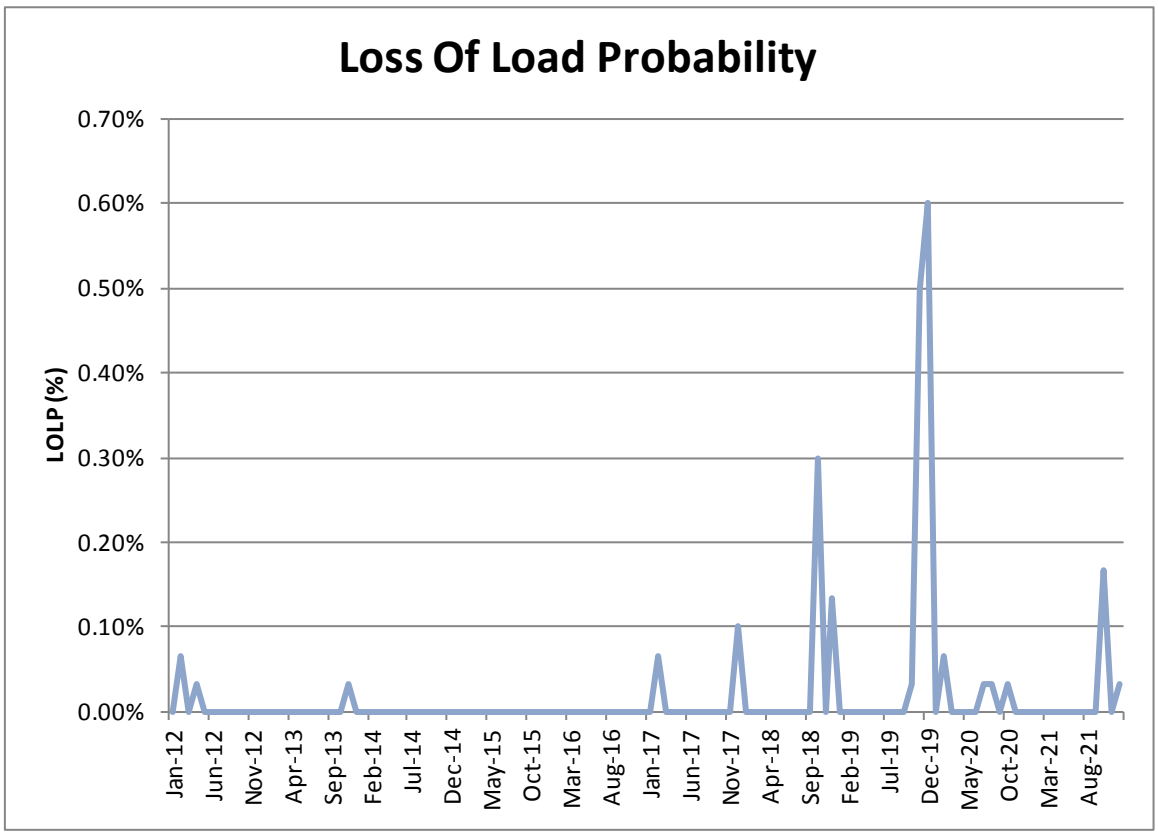
4.80 To supplement the N-X analysis of adequacy in the Darwin-Katherine system, the LOLP has been assessed, using an LOLP of a one day loss in 10 years (or 0.027 per cent) as the benchmark of a reliable system. An LOLP greater than 0.027 per cent is indicative of an unreliable system.

4.81 Evans & Peck developed a simple probabilistic model for the Darwin-Katherine system to complement the N-X analysis of generation adequacy. It should be stressed that the LOLP assessment has limitations, with additional information required to reflect good industry practice, and provide a robust planning tool.[24] However, participants in the Territory's electricity sector are encouraged to use probabilistic analysis as the primary tool for assessing system adequacy and generation planning purposes, as they represent industry best practice.

4.82 Figure 4.6 shows that the LOLP for the Darwin-Katherine system for the period 2011-12 to 2020-21 is generally at an acceptable level, with an average LOLP over the Review period of 0.019 per cent.

[24] Load forecasts should be conducted every half hour, not just twice a year. Plant overload, capability, demand management systems and other network balancing procedures could also be included.

Figure 4.6: Darwin-Katherine monthly system loss of load probability (LOLP) 2010-11 to 2019-20



Source: Evans & Peck.

4.83 The annual average LOLPs are presented in Table 4.8. Years where the average is greater than the benchmark of 0.027 per cent are shaded.

Table 4.8: Darwin-Katherine system average annual LOLP for 2011-12 to 2020-21

Period	LOLP (%)	Period	LOLP (%)
2012	0.008	2017	0.014
2013	0.003	2018	0.036
2014	0.000	2019	0.094
2015	0.000	2020	0.014
2016	0.000	2021	0.017

Source: Evans & Peck.

4.84 Table 4.8 (with Figures 4.5, 4.6 and 4.7) highlight that the most critical period for potential poor generation reliability in the Darwin-Katherine system is the summer of 2019-20. However this is far enough in the future not to require any action at this time apart from close monitoring in future reviews.

Implications of generation plant condition and the maintenance program

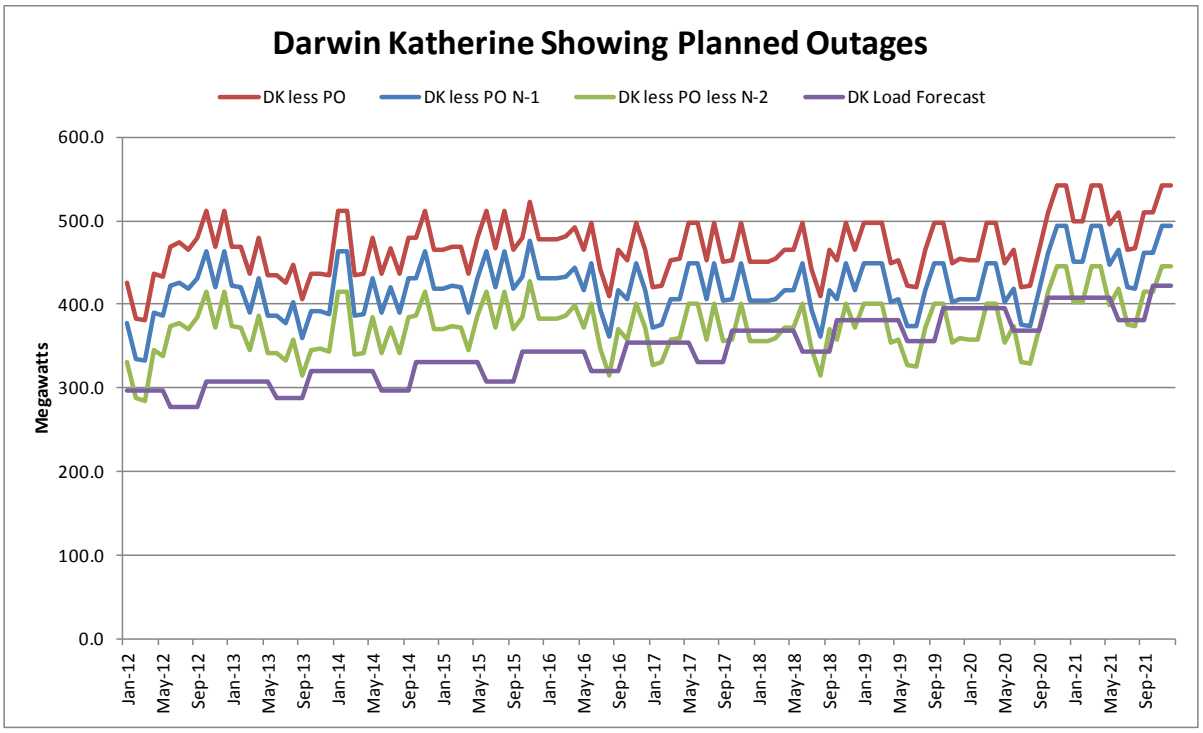
4.85 Planned and unplanned outages could have a significant influence on the incidence of generation constraints. The model has been set up to account for planned outages as advised by PWC and a forced outage rate of 3 per cent, again as advised by PWC. Evans & Peck also advises that a 3 per cent planned outage rate is appropriate for planning purposes.

4.86 Historical generation reliability performance suggests that maintaining a reliable system under N-2 conditions is not guaranteed. As noted in the PWC 2010-11 Statement of Corporate Intent:[25]

…ongoing investigations have found that the previous estimates of the residual life of many assets may have been optimistic and that additional urgent refurbishment or replacement of key assets is needed….Because of increasing reliability issues with generation assets, a revised Generation capital investment strategy was developed and approved in February 2010.

4.87 Figure 4.7 presents the generation supply-demand balance for the Darwin-Katherine system, with capacity adjusted to exclude generation plant not available due to scheduled maintenance. The figure shows that even considering planned outages (which are normally considered as part of the N-X analysis) the system meets N-2 until 2016, confirming that the system has a very comfortable level of generation capacity in the medium term.

Figure 4.7: Darwin-Katherine supply-demand balance for 2010-11 to 2019-20 (with planned maintenance)



Source: Evans & Peck.

4.88 The maintenance schedule used by Evans & Peck to determine available capacity in each month was provided by PWC Generation. It is noted that variations to the timing and duration of planned maintenance could have implications for generation constraints and reliability performance.

4.89 Similarly, unplanned outages due to plant failure could have adverse implications for generation reliability performance. It should be noted that new plant can experience early operational issues, which could delay the full capacity (Channel Island Units 8 and 9, Weddell Unit 3) becoming available for service. Consequently, there could be an ongoing credible risk of generation capacity constraints in the short term.

[25] Power and Water Corporation, 2010-11 Statement of Corporate Intent, page 24.

Concluding comments – Darwin-Katherine system adequacy

4.90 A central concern has been that the generation capital and maintenance programs may not be aligned. It is understood that the capital program is intended to provide additional capacity to meet increasing demand, but also in the case of higher failure rates and extended outages for maintenance of generation plant at Channel Island.

4.91 It is noted that a large proportion of the required maintenance on the older units at Channel Island has been completed. As such the current maintenance program supplied by PWC no longer contains significant overlap of major outages, with all major outages on these units completed during 2014-15. With better reliability performance that can now be expected from these units, and from the new capacity that has been added or is being added to the system, it is expected that better reliability of generation plant will become evident on the Darwin-Katherine system through 2012. Generation reliability will continue to be monitored in future Reviews.

4.92 It is noted that through 2010-11 PWC has changed its maintenance planning for Units 1-5 at Channel Island Power Station to be based on Equivalent Operating Hours[26], as recommended by the manufacturer and identified in the 2009-10 Review. This change will assist in maintaining the reliability of these units into the future.

Generation supply demand balance – Alice Springs

4.93 The Alice Springs system is expected to have sufficient generation capacity in the medium and long term to meet forecast peak demand under any reasonable demand growth scenario with the planned capacity additions.

4.94 In the short term, there is a credible risk of generation capacity constraints and poor generation reliability during 2011-12. The key risk period was prior to the commissioning of Owen Springs Units 1 to 3. There is the potential for ongoing capacity constraints after December 2011 as the new Owen Springs plant appears to be experiencing early operational issues.

4.95 For the period 2012 to 2020-21 there appears to be sufficient generation capacity available given the planned retirements and additions of plant, providing an estimated average reserve plant margin of 60 per cent, with a minimum reserve plant margin of 33 per cent in late 2021 when forecast peak demand reaches 69.7 MW against capacity of 92.4 MW (representing reserve capacity of 22.7 MW). This matches the N-2 criterion of 22.4 MW.

4.96 The level of the reserve plant margin for the Alice Springs system is influenced by the timing of new capacity at Owen Springs Power Station and decommissioning of capacity at Ron Goodin Power Station. The timing of the installation of new plant and the decommissioning of plant at Ron Goodin Power Station should be kept under review to optimise the amount of plant installed on a yearly basis.

N-X analysis – Alice Springs system

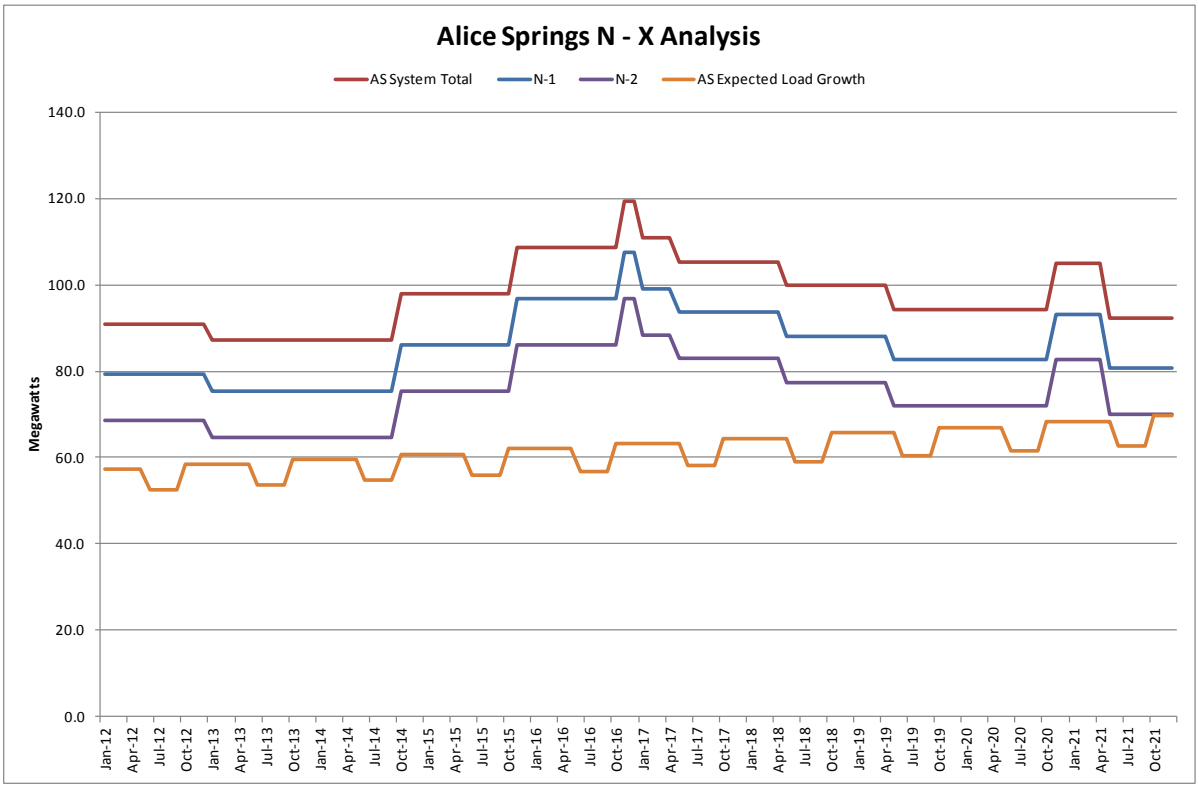
4.97 The N-X analysis of the supply-demand balance for the Alice Springs system is presented in Figure 4.8. The analysis assumes that peak demand increases according

[26] Equivalent Operating Hours (EOH) are determined from the base load operating hours, the start/stop cycles and operations such as unit trips, with weighting factors applied to each event. For example, one hour of base load operation is defined as one EOH, while one start with normal loading gradient may be equivalent to 10 EOH.

to the Evans & Peck forecast (2.0 per cent a year) and that all capacity is available (i.e. without accounting for planned maintenance). The key points are:

- sufficient capacity to meet an N-2 event throughout the Review period; and
- opportunity to defer the installation of Units 4, 5 and 6 at Owen Springs Power Station from their currently planned commissioning dates of 2014, 2015 and 2016.

Figure 4.8: Alice Springs system supply-demand balance for 2011-12 to 2020-21



Source: Evans & Peck.

Concluding comments – Alice Springs system adequacy

4.98 There is a potential for capacity constraints and adverse generation reliability during 2011-12, if the new plant at Owen Springs experiences teething problems.

4.99 Supply-demand balance for the period 2010-11 to 2019-20 is subject to the scheduled commissioning / decommissioning program for plant at Owen Springs and Ron Goodin, and the generation plant maintenance program. An opportunity has been identified to defer the installation of Units 4, 5 and 6 at Owen Springs without significantly affecting generation reliability on the system.

Generation supply demand balance – Tennant Creek

4.100 The generation supply-demand balance in the Tennant Creek system is adequate for the period to 2020-21.

N-X analysis – Tennant Creek system

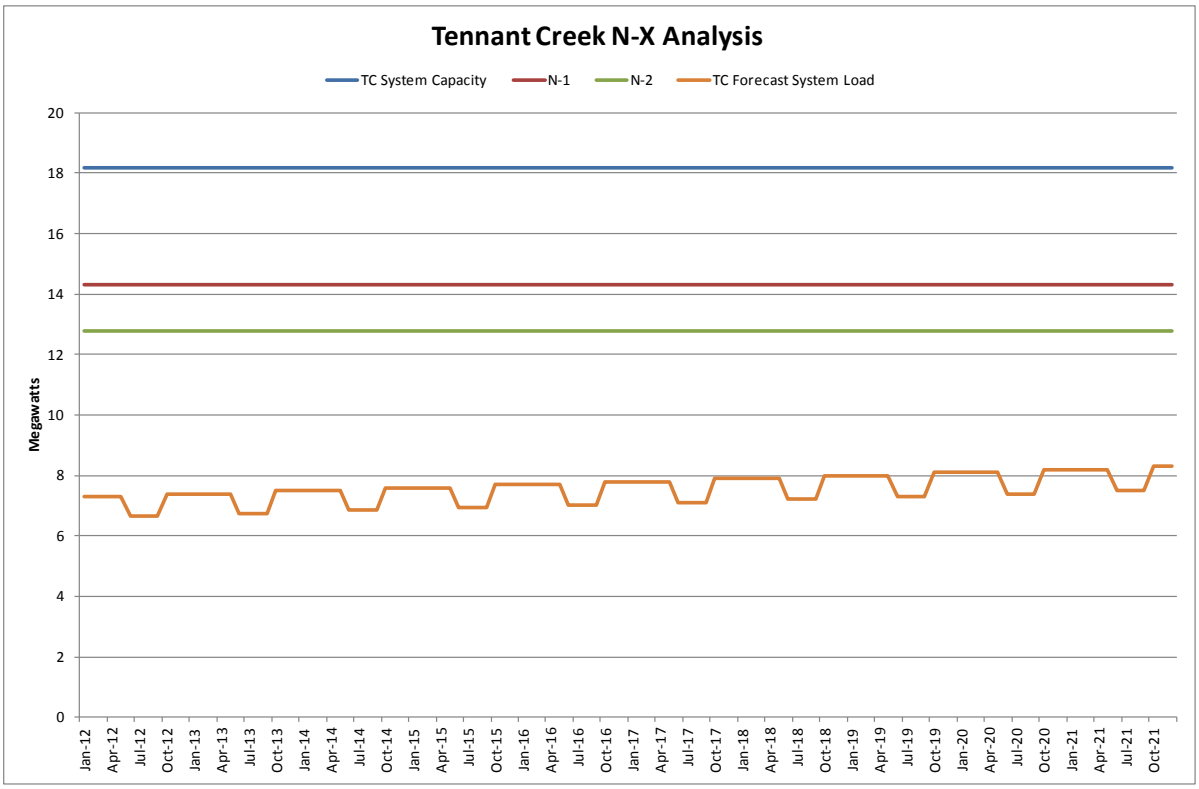
4.101 The N-X analysis of the supply-demand balance for the Tennant Creek system is presented in Figure 4.9. The analysis assumes that peak demand increases according to the Evans & Peck forecast (1.3 per cent a year) and that all capacity is available (i.e. without accounting for planned maintenance).

4.102 The key points are:

- new capacity of 1.5 MW was commissioned in mid 2011; and

- there is sufficient capacity to meet an N-2 situation for the period 2011-12 to 2020-21.

Figure 4.9: Tennant Creek system supply-demand balance for 2010-11 to 2019-20



Source: Evans & Peck.

4.103 The estimated average reserve plant margin for the period January 2012 to December 2021 is 142 per cent, with a minimum of 119 per cent in late 2021.

Concluding comments – Tennant Creek system adequacy

4.104 Subject to industry standard operation and maintenance practices being followed, generation capacity is sufficient to meet forecast demand, with a significant reserve margin for the Review period.

PWC's comment

4.105 PWC has advised that because the major elements of its generation capital program are nearing completion (Weddell Units 1 and 2 commissioned in late 2008, Channel Island Units 8 and 9 commissioned in January 2012 and Owen Springs Power Station Units 1 and 2 commissioned in September 2011) it now has adequate capacity to meet known future demand increases (including the Ichthys project) as well as improving generation reliability.

Fuel supplies

4.106 Natural gas is the main fuel for electricity generation in the Darwin-Katherine, Alice Springs and Tennant Creek systems. However, a number of generation units are dual-fuel, and able to use liquid fuels (such as diesel) as an alternative fuel source. While diesel has historically been the primary back-up fuel, PWC now has an alternative gas supply that covers most of its gas requirements, providing it with multiple options to deal with contingencies.

Natural gas supply

Amadeus Basin gas fields

4.107 Natural gas originally from the Palm Valley field and subsequently from the Mereenie field in the Amadeus Basin in central Australia has been the main fuel for electricity generation in the Territory for many years, starting with Alice Springs in 1983. Gas has been used for electricity generation in the Darwin-Katherine and Tennant Creek systems since 1987, following the commissioning of the Amadeus Basin to Darwin gas pipeline (now termed the Amadeus Gas Pipeline or AGP) in December 1986.

4.108 The Palm Valley and Mereenie fields have declining reserves, and were not able to supply sufficient gas from late 2008 for all of PWC's electricity generation requirements in the Darwin-Katherine, Alice Springs and Tennant Creek systems.

4.109 Gas supply from Mereenie to PWC terminated in line with contractual arrangements in 2009-10. Palm Valley gas was supplied to PWC until January 2012.

Blacktip gas field

4.110 The Blacktip gas field is located in the Bonaparte Gulf about 100 km west of Wadeye, and is owned and operated by Eni Australia B.V. (Eni). The field has been developed to supply gas to PWC for electricity generation to replace the Amadeus Basin fields. PWC and Eni entered a 25 year gas supply arrangement in 2006 for the supply of 740 petajoules (PJ) of gas from Blacktip field plus additional gas if required and available.

4.111 The first gas from Blacktip was supplied in October 2009. The gas comes onshore to Eni's gas processing plant near Wadeye, and is transported by APA Group's 286 km Bonaparte gas pipeline (BGP) to join the AGP at Ban Ban Springs.

4.112 For the period to 2020-21 and beyond, the volumes of gas available under the PWC/Eni gas supply contract are considered sufficient to meet forecast electricity demand.

Alternative fuel sources

4.113 PWC has two alternative fuel sources for electricity generation – natural gas from the Darwin Liquefied Natural Gas (DLNG) facility at Wickham Point on Darwin harbour, and liquid fuels (such as diesel) held in storage at most sites. Kerosene is also retained as the primary fuel for the single remaining generation unit at Berrimah should it be required to operate in an emergency.

Contingency gas supply

4.114 PWC agreed to a contingency gas supply arrangement with DLNG in 2009 involving the supply of a quantity of gas from the DLNG plant to the Darwin city gate gas hub in certain defined circumstances. This arrangement has operated successfully, most recently in the 2010-11 year, during a scheduled outage of the Blacktip facilities.

4.115 The DLNG plant and Blacktip production and processing systems are geographically separate, thereby reducing the risk of both supply sources being impacted simultaneously by mechanical failure, cyclonic activity or other natural disaster.

Contingency diesel supply

4.116 PWC Generation maintains a portfolio of generation plant able to use diesel as a last resort contingency if gas is not available, and has significant diesel storage facilities at Channel Island, Katherine and Tennant Creek Power Stations, and in Alice Springs.

4.117 Based on advice from PWC Generation, the diesel only capacity of each system is:

- 211.33 MW for the Darwin-Katherine system, against a peak demand of 287 MW in 2010-11. This capacity does not include Berrimah Power Station (10 MW) or LMS Shoal Bay PPA (1.1 MW);)
- 63.5 MW for the Alice Springs system, against a peak demand of 55.7 MW in 2010-11; and
- 11.9 MW for the Tennant Creek system, against a peak demand of 6.8 MW in 2010-11.

4.118 PWC Generation advises that the diesel stocks at Channel Island are sufficient to meet one day of diesel only operation. Diesel stocks in Alice Springs and Tennant Creek are sufficient to meet four days of diesel only operation. In this context, it is noted that diesel at Channel Island Power Station is a contingency behind the alternative DLNG natural gas supply.

Adequacy of fuel supplies

4.119 PWC has advised that its average daily requirement for power generation and sales for 2010-11 was some 63 terajoules (approximately 23 PJ a year). The annual quantity of gas to be supplied from the Blacktip field over the 25 year term of the contract ranges from 23 PJ to 37 PJ per year.[27]

4.120 The gas volumes available from the Blacktip field are projected to be sufficient to meet gas demand to well beyond the Review period to 2020-21.

4.121 In particular, the commissioning of more efficient generation plant in both the Darwin-Katherine and Alice Springs systems should result in significant improvements in thermal efficiency and a decrease in the quantity of fuel consumed per unit of electrical output. The heat rate, which is the quantity of fuel consumed per unit of generation output, has improved in 2010-11 over the 2009-10 year as follows:

- Darwin: 13.5%
- Alice Springs: 18.4%
- Tennant Creek: 7.0%

4.122 Further improvements in thermal efficiency are forecast in 2011-12 with the commissioning of Channel Island Units 8 and 9, Unit 3 at Weddell Power Station and Units 1 to 3 at Owen Springs Power Station.

Adequacy of contingency arrangements

4.123 PWC has a range of contingency arrangements to maintain electricity supply in the event of the partial or complete loss of the primary gas supply from Blacktip:

- DLNG gas. The DLNG contingency gas supply arrangement is not a complete replacement supply from Blacktip. However, the DLNG gas would provide a second gas supply in the event of pipeline rupture or temporary production/processing problems that should reduce or eliminate the need to use diesel for electricity generation. These arrangements provide for up to 30 days' supply into the interconnected Darwin-Alice Springs pipeline system at current peak rates, significantly longer at the lower average consumption rates, and when supplemented by gas from pipeline line-pack and by diesel fuel;

[27] Press article, Blacktip gas feed in pipeline soon, Northern Territory News, 18 August 2008.

- line-pack gas, which is gas stored in the pipeline. Line-pack gas may be sufficient to provide a short term (i.e. possibly a few days) source of supply if there is a disruption to the primary supply, particularly if there is forewarning so the pipeline can be brought to its maximum operating pressure; and
- diesel stocks held by PWC provide a last resort fuel source for dual-fuel or diesel burning units.

4.124 Alternate fuel sources should provide access to a continued fuel supply to power stations, even in the circumstances of partial or complete loss of gas from Blacktip due to production or processing equipment failure, cyclonic activity or a pipeline rupture.

4.125 A multiple gas failure, for example, from both Blacktip and DLNG, would see full capacity available from diesel generation. The limiting factors in this case would be the adequacy of diesel generation capacity, availability of diesel stocks and the necessary transportation from bulk fuel depots to replenish PWC stocks. In a worst case of an extended total gas supply failure, there could be a gradual decline in diesel stocks as they may not be able to be replenished at the same rate as they are used.

4.126 The availability of Blacktip, DLNG gas and line-pack gas is considered to provide sufficient diversity of supply to ensure adequate fuel supplies are available to avoid prolonged use of diesel which would effectively be the third contingency.

4.127 Under an extreme and unlikely scenario of a double event, the rupture of the Amadeus Basin-Darwin pipeline adjacent to the Channel Island Power Station cutting off gas supply to the generation plant and supply from Blacktip being unavailable, gas should be available from DLNG to Weddell and Katherine. In such a case, gas fired capacity would be about 134 MW (increasing to 188 MW with the proposed additional units at Weddell and Katherine in 2011-12). From the end of 2011, the Channel Island Power Station will have 232 MW of dual-fuel (diesel) capacity at N-1 contingency and 280 MW at full capacity.

4.128 Another extreme but even less likely scenario would be a gas failure at City Gate which would cut off gas supply to Channel Island. This event would not affect the gas supply to the Weddell Power Station. However, it would require a number of generation sets at Channel Island to be operated with diesel fuel to be able to meet electricity peak demand. Given that the newly installed generation sets 8 and 9 at Channel Island are dual-fuel (gas/diesel) fired engines with a capacity of 90 MW, load shedding in the Darwin-Katherine system could be avoided on the condition that sufficient levels of diesel fuel can be made available after having used all available fuel stocks.

4.129 The most disruptive (and quite unlikely) event for Alice Springs and Tennant Creek would be a rupture of the supply pipeline near the power stations. It is expected that the four day diesel fuel stocks would in almost all circumstances be sufficient to cover the duration of repairs to the pipeline. Moreover, diesel fuel supply could be supplemented by road from local terminals.

Pipeline transportation

4.130 Firm gas transportation entitlements in the AGP, the spur pipeline from DLNG and BGP are understood to match the PWC gas purchase entitlements, which exceed current and projected peak flow rates for the period of this Review.

CHAPTER 5

Electricity networks

5.1 This chapter examines the capacity and adequacy of the Darwin-Katherine, Alice Springs and Tennant Creek transmission and distribution networks using the following data:

- network capacity (firm delivery capacity and demand) at 30 June 2011;
- network demand forecasts for 2011-12 to 2015-16, and forecast capacity and firm delivery capacity at the sub-transmission and zone substation level;
- the supply-demand balance and supply-demand outlook at the sub-transmission and zone substation level to 2014-15, and actual and potential constraints related to sub-transmission assets and zone substations; and
- ideally, feeders that have exceeded their normal operating conditions in 2010-11, or are expected to exceed such conditions in 2011-12.

Scope of assessment and availability of data

5.2 For the 2009-10 Review, the Commission expanded the scope of the assessment of the network by requesting PWC Networks business unit (as owner/operator of the Darwin-Katherine, Alice Springs and Tennant Creek networks) to provide equivalent information to that routinely reported by transmission and distribution network operators in the NEM. This has been repeated in the 2010-11 Review.

5.3 Consistent with the 2009-10 Review, PWC Networks advised that not all the information sought was available.

5.4 This is not unexpected given the experience of network operators elsewhere in Australia, and in the 2009-10 Review it was anticipated that PWC Networks would take two or three years to establish the systems and processes necessary to routinely record the relevant information. It is expected the data required will be progressively provided over future Reviews.

5.5 Evans & Peck has reported that the implementation across each PWC business unit of new information technology systems and business processes through the PWC Asset Management Capability project has improved the availability of some information, but there is still some way to go before all of the comprehensive and detailed network asset information required for an effective assessment of network capacity and adequacy is available.

Transmission and distribution networks in the Territory

5.6 The Darwin-Katherine, Alice Springs and Tennant Creek networks are subject to the third party access regime established by the Territory's *Electricity Networks (Third*

Party Access) Act and Code, which provides a framework for setting the conditions of service and charges for transporting electricity over the network.[28]

5.7 The Commission is responsible for determining network conditions and charges, and monitoring and enforcing compliance with the determination. The arrangements for the period 1 July 2009 to 30 June 2014 were determined in March 2009.[29]

Network infrastructure

5.8 The PWC Networks business unit operates the Darwin-Katherine, Alice Springs and Tennant Creek transmission and distribution networks, which comprise the poles, wires, substations, transformers, switching, monitoring and signalling equipment involved in transporting electricity from the generator to the customer.

5.9 The transmission and distribution network control function is undertaken by the System Controller, and the PWC System Control business unit which is a part of PWC Networks. The System Controller has statutory responsibilities for monitoring and controlling the operation of the system and network to ensure a reliable, safe and secure electricity supply.[30]

5.10 Table 5.1 provides some key details of the Territory's transmission and distribution network infrastructure, and operating characteristics.

Table 5.1: Transmission and distribution network characteristics

System/network	Darwin-Katherine	Alice Springs	Tennant Creek
Connections (customers at 30 June 2011)			
Household	52 797	9 742	1 232
Government	8 479	1 814	264
Business	554	111	37
Energy use (GWh for 2010-11)	1 494	224	29
Transmission/sub-transmission network (km at 30 June 2011)	663	47	-
Distribution network (km at 30 June 2011)	6 094	912	415
Zone substations (number at 30 June 2011)	21	1	1
Distribution substations (number at 30 June 2011)	3 421	429	115

Note: the transmission/sub-transmission network is defined as 66 kV and above.

Source: Power and Water Corporation.

5.11 There has been a significant increase in the reported length of the distribution system in all systems over the values shown in the 2009-10 Review. PWC has advised that as

[28] The Territory's regional and remote networks are not subject to the third party access framework and the Commission has no role in setting conditions of service and charges. These networks transport electricity to customers in the 72 communities and 82 outstations where essential services are provided through the Territory Government Indigenous Essential Services program; eight remote townships and three mining townships.

[29] Utilities Commission, March 2009, Final Determination Networks Pricing: 2009 Regulatory Reset.

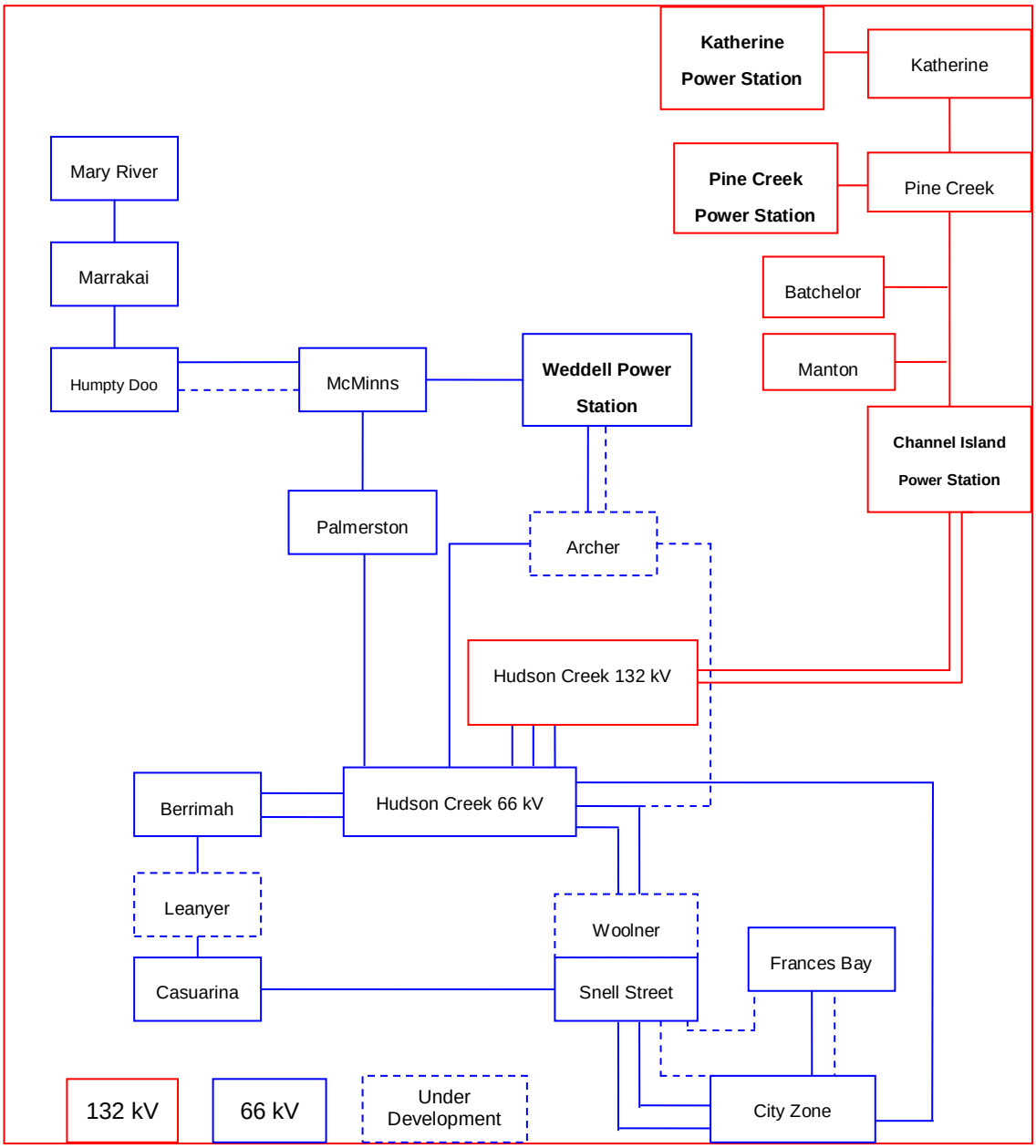
[30] *Electricity Reform Act*, s38. The functions and duties of the System Controller are detailed in the System Control Technical Code and Network Connection Technical Code.

a result of the Asset Management Capability Project and the associated data cleansing, a higher resolution of data was available in 2010-11. Service line lengths and streetlight line length are now able to be captured in the reporting.

5.12 A transmission/sub-transmission network overlay exists in the Darwin region to transport electricity produced at three power station locations (Channel Island, Weddell and Berrimah) to primary load centres via two 132 kV transmission lines and a number of 66 kV lines. This transmission network is also connected with power stations and loads at Pine Creek and Katherine via a 132 kV line from the Channel Island Power Station.

5.13 A schematic of the Darwin-Katherine transmission and distribution network is presented in Figure 5.1.

Figure 5.1: Darwin-Katherine transmission and distribution network (major components) as at 30 June 2011



Note: Archer substation was completed in November 2011.

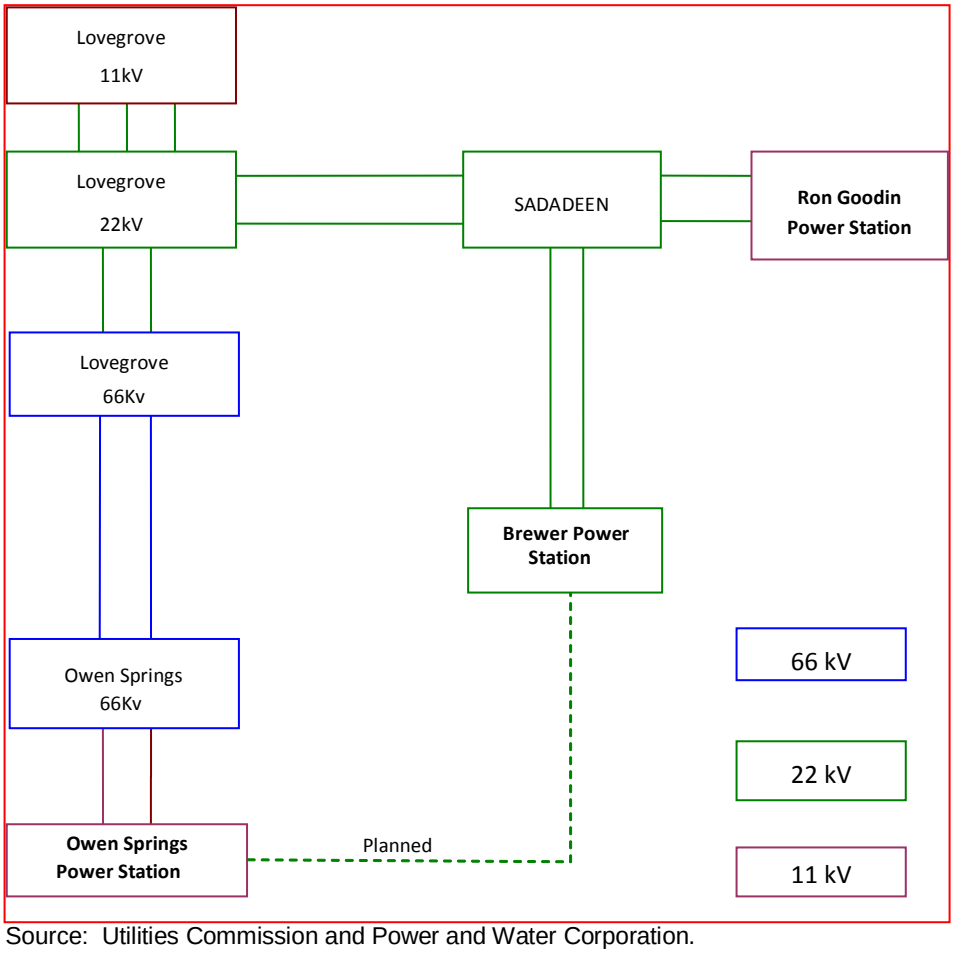
Source: Utilities Commission and Power and Water Corporation.

Note 2: The Commission understands that, following commissioning of the Archer to Woolner 66kV line, one of the existing lines from Snell Street to Hudson Creek will be diverted to Woolner-Archer, and bypass Hudson Creek. The redundant section of line will be disconnected from service.

5.14 Traditionally, electricity generated in the Alice Springs and Tennant Creek systems has been supplied directly into the distribution network. A transmission network has been constructed in Alice Springs, with electricity produced at the Owen Springs Power Station supplied into the distribution network via a 66 kV transmission line and two 66 kV zone substations (Owen Springs and Lovegrove).

5.15 A schematic of the Alice Springs transmission and distribution network is presented in Figure 5.2.

Figure 5.2: Alice Springs transmission and distribution network as at 30 June 2011



Source: Utilities Commission and Power and Water Corporation.

Network capacity and constraints

5.16 Advice was sought from PWC Networks on forecast network peak demand and the capacity of transmission/sub-transmission feeders, distribution feeders, and substations. The intention was to identify potential network capacity constraints in the period 2011-12 to 2015-16:

- Transmission/sub-transmission feeders that might exceed normal rating. Identifying potential feeder constraints requires rating and loading data. While rating data was provided, no loading data was available for the transmission/sub-transmission feeders. It is noted, however, that an integrated system model in “industry standard” commercial modelling software is being developed by PWC Generation, PWC Networks and System Control and this should address this issue. This development is welcomed.
- Bulk and zone substations that might exceed normal rating. Identifying potential substation constraints requires rating and loading data. This information was available for bulk and zone substations.

- Distribution feeders that might exceed normal rating. Identifying potential feeder constraints requires rating and loading data. No rating or loading data was available for distribution feeders.

5.17 PWC Networks was not able to provide all the information necessary to identify potential transmission/sub-transmission or distribution feeder constraints, but is expected to have the capability to do so in future. It is expected that a more comprehensive analysis of network capacity and constraints will be conducted in future Reviews. The development of an integrated model, as outlined in 5.16 above, should assist in the understanding of transmission and sub-transmission constraints under a range of generation and load conditions.

Network peak demand forecasts

5.18 Network demand forecasts are influenced by energy consumption patterns in the substation service area. Therefore, a whole of network demand forecast is the aggregate of forecast loading/demand for individual substations, which is determined by factors including household and business energy use patterns, and residential and commercial developments.

5.19 Appendix B presents information from PWC Networks on actual and forecast zone substation demand and capacity for 2008-09 to 2016-17.

5.20 The aggregate Darwin-Katherine network demand growth for 2011-12 to 2015-16 is presented in Table 5.2.

Table 5.2: Annual network peak demand for the Darwin-Katherine system

Aggregate substation load	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**
MVA	305.0	**318.0**	335.4	343.4	351.0
Maximum demand growth (%)	4.3	**4.2**	5.5	2.4	2.2

Source: Evans & Peck and Power and Water Corporation

5.21 This forecast of network demand growth for the Darwin-Katherine system was derived from the demand forecasts developed by PWC Networks for each bulk and zone substation.

5.22 A network demand forecast could not be developed for the Alice Springs network as loading information for the Sadadeen and Ron Goodin substations was not available. The loading of these substations depends on generation dispatch patterns, particularly in the context of the new Owen Springs Power Station. The Commission expects this data to be made available by PWC Networks for future reviews.

5.23 The aggregate Tennant Creek network demand growth for 2011-12 to 2015-16 is presented in Table 5.3.

Table 5.3: Annual network peak demand for the Tennant Creek system

Aggregate substation load	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**
MVA	7.4	7.5	7.7	7.9	8.1
Maximum demand growth (%)	2.5	2.5	2.5	2.5	2.5

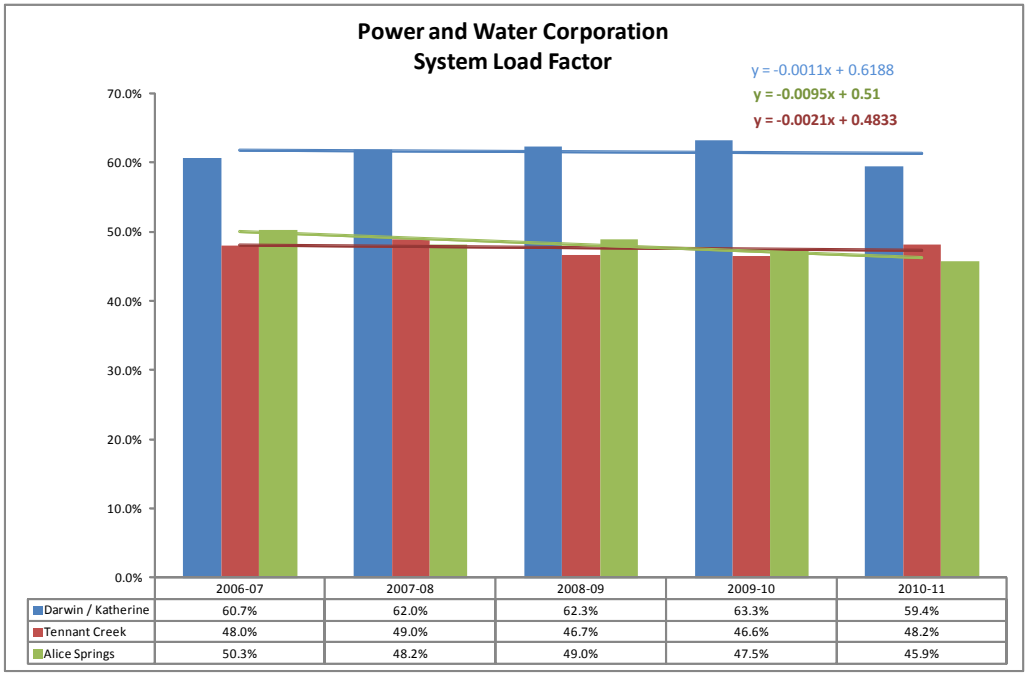
Source: Evans & Peck and Power and Water Corporation.

Energy use forecasts and load factor

5.24 The load factor of each system over the period 2007-08 to 2010-11 has been analysed by Evans & Peck. The load factor is the ratio of average demand over a year to maximum demand, and represents the rate of change in energy use relative to maximum demand. A high load factor tends to be representative of a reasonably flat stable load, whereas a low load factor would tend to represent a peaky volatile load.

5.25 Figure 5.3 presents the trends on load factors in each of the Darwin-Katherine, Alice Springs and Tennant Creek systems from 2006-07 to 2010-11.

Figure 5.3: Trends on load factors for each system over a five year period



	2006-07	2007-08	2008-09	2009-10	2010-11
Darwin / Katherine	60.7%	62.0%	62.3%	63.3%	59.4%
Tennant Creek	48.0%	49.0%	46.7%	46.6%	48.2%
Alice Springs	50.3%	48.2%	49.0%	47.5%	45.9%

5.26 The decreasing trends in the load factors for the Darwin-Katherine, Alice Springs and Tennant Creek networks in the above chart indicate that:

- average energy use is forecast to increase at a marginally higher rate than maximum demand in the Darwin-Katherine system; and
- average energy use is forecast to increase at a lower rate than maximum demand in the Alice Springs and Tennant Creek systems.

5.27 The implication is that peak demand in the Alice Springs and Tennant Creek networks will increase at a faster rate than energy use, raising the prospect of declining efficiency in the use of the network.

Transmission/sub-transmission network capacity and constraints

5.28 The transmission/sub-transmission network comprises:

- all feeders rated at 66 kV and above;
- bulk and zone substations with a highest voltage of 66 kV or above; and
- distribution substations (for example, with a voltage of 11/22 kV) that perform a sub-transmission role.

5.29 It is acknowledged that transmission/sub-transmission assets are not currently specifically identified as such, but these assets play a critical role in network reliability and security due to the radial design of the network and limited number of alternative flow paths. The development of integrated system models on a co-ordinated basis by PWC Networks, PWC Generation and System Control is appropriate.

Feeders

5.30 PWC Networks was not able to provide loading information for the transmission/sub-transmission feeders, preventing a complete assessment of feeder utilisation and adequacy (such as the ratio of maximum demand to the allocated rated capacity of the equipment).

5.31 However, a high level assessment of capacity and constraints in the Darwin-Katherine system has been undertaken due to the criticality of the transmission / sub-transmission network to security of supply. The assessment was undertaken by Evans & Peck by inferring feeder loadings under peak demand conditions using zone substation loading data for the following sub-systems of the Darwin-Katherine system:

- Northern Suburbs sub-system – consisting of Berrimah, Casuarina, and Leanyer (when built), and supplied by two 66kv lines from Hudson Creek to Berrimah, and one from Snell Street to Casuarina;
- City sub-system - consisting of Snell Street/Woolner, City Zone, and Frances Bay, and supplied by two 66kV lines from Hudson Creek to Snell Street, one from Hudson Creek to City Zone, and one from Casuarina to Snell Street;
- Palmerston loop sub-system - consisting of Archer, Weddell, McMinns, and Palmerston, supplied by two 66kV lines, Hudson Creek to Archer and Hudson Creek to Palmerston; the 66kV Arnhem Highway Spur comprises Humpty Doo, Marrakai and Mary River; and
- Katherine sub-system - consisting of Manton, Batchelor, Pine Creek, Katherine, Cosmo Howley, Brock's Creek and Union Reef substation service areas.

5.32 The analysis in the 2009-10 Review indicated a potential capacity constraint in the Palmerston loop sub-system, with potential overloading of the Hudson Creek – Palmerston and Hudson Creek – McMinn's 66 kV network under first contingency conditions (N-1) in 2012-13 and 2013-14. The completion of Archer zone substation (in November 2011) and the ability to generate at Weddell has largely relieved this issue. Completion of a new line from Weddell – Archer – Snell Street, due in 2011-12, will remove this constraint, and also allow the third unit at Weddell to have "N-1" access to loads.

5.33 It should be noted that the assessment relies on a number of simplifying assumptions and completion of planned works, and is presented to provide a high level indication of capacity and potential capacity constraints. It is expected that this issue will be definitively resolved in future Reviews as the necessary system models and data become available.

Bulk and zone substations

5.34 There are 28 actual and planned bulk and zone substations across the Darwin-Katherine, Alice Springs and Tennant Creek systems, with an assessment of substation utilisation completed for 23 substations.[31] Substation capacity and potential constraints have been measured by examining the substation utilisation:

- with all network elements (i.e. transformers) in service (an N rating); and

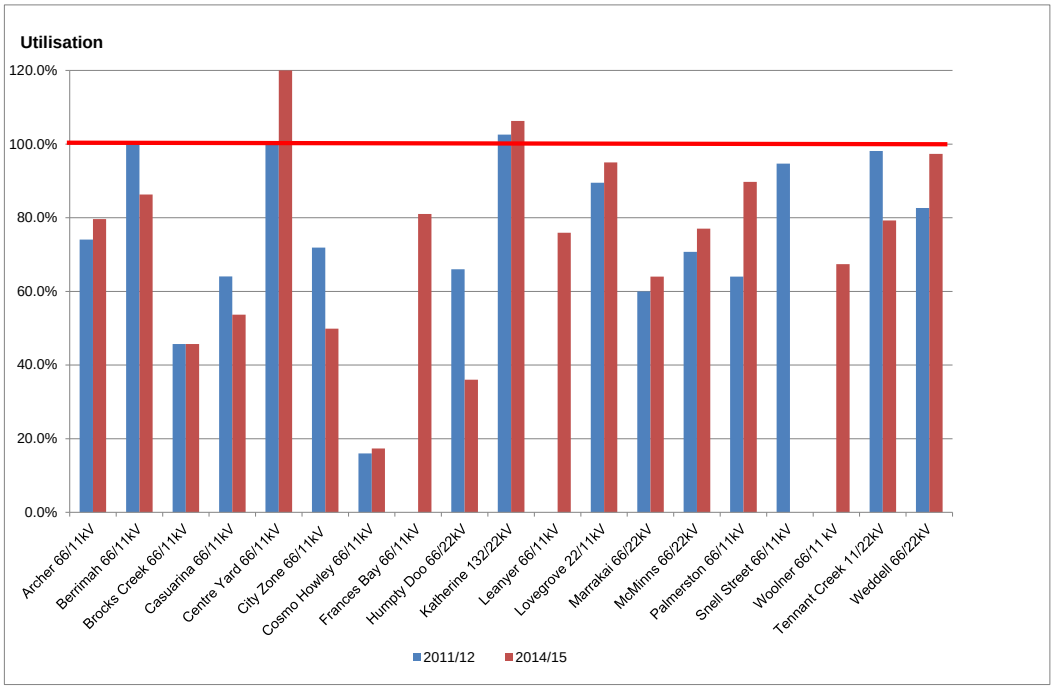
[31] Zone substations at Pine Creek, Sadadeen, Ron Goodin and Tennant Creek are directly connected to power stations. Their loading is highly dependent on generation patterns. Another substation, Union Reef, supplies a single customer under commercially agreed capacity limits.

- with one network element out of service (an N-1 rating).

5.35 With all transformers in service, all 23 zone substations should have sufficient capacity to meet forecast load for 2011-12 and 2014-15, subject to completion of planned upgrades.

5.36 Figure 5.4 presents zone substation utilisation under N-1 conditions (one transformer out of service) in 2011-12 and 2014-15, based on forecast loads and system configuration in 2011-12 and 2014-15.

Figure 5.4 Projected substation utilisation in 2011-12 and 2014-15 (N-1 conditions)



Source: Evans & Peck

5.37 Under N-1 conditions, three substations face capacity constraints in 2011-12 and 2014-15:

- Berrimah 66/11 kV in Darwin, with 100.8 per cent utilisation in 2011-12. PWC has advised that 10 MW of local generation is available for emergency use. PWC Networks is planning to transfer some load to the new Leanyer zone substation in 2013-14.
- Centre Yard 66/11 kV in Alice Springs, with 100 per cent utilisation in 2011-12 and 120 per cent utilisation in 2014-15. Centre Yard is a small (0.5 MVA) substation where PWC Networks would deploy emergency generation in the event of an emergency.
- Katherine 132/22 kV, with 103 per cent utilisation in 2011-12 and 106 per cent utilisation in 2014-15. The Katherine substation is supported by Pine Creek (until April 2012) and Katherine generation. Accounting for this generation should resolve the apparent constraint.

5.38 Two major constraints reported in the 2009-10 Review at Palmerston and Snell Street have been resolved. The new Archer zone substation (completed in November 2011) will relieve Palmerston, and an additional transformer has been installed at Snell Street pending completion of the Woolner zone substation that will replace it by 2012-13.

5.39 The results in Figure 5.2 assume the following work is completed:

- second 40 MVA transformer is installed at Frances Bay by 2012-13;

- an additional 7.5 MVA transformer is installed at Weddell if a major industrial load proceeds;
- three 2.5 MVA transformers at Humpty Doo are replaced by two 10 MVA transformers by 2012-13;
- Woolner zone substation replaces Snell Street by 2012-13; and
- two 7.5 MVA transformers at Tennant Creek are upgraded to two 10 MVA transformers by 2013-14.

5.40 Although industry practice for assessing potential network constraints focuses on the implications of the first contingency event (an N-1 event), Evans & Peck advised that improvements in the condition of network infrastructure[32] would reduce the risk of multiple contingency events.

5.41 In particular, it is noted that the poor condition of equipment at the City Zone and Snell Street substations makes a multiple contingency event a possibility which warrants a continued priority being given to the capital program associated with the development of Frances Bay substation, completion of the development of Woolner substation to replace Snell Street substation and replacement of City Zone substation.

Distribution network capacity and constraints

5.42 PWC Networks was not able to provide the load flow studies or measurements on the low voltage (11/22 kV) distribution network necessary for an assessment of loading and capacity.

5.43 Similarly, PWC Networks was not able to provide loading or capacity information for distribution substations. Consequently, actual or potential constraints in the distribution network were unable to be identified.

5.44 Monitoring of distribution substation loading and capacity is currently based on the incidence of voltage complaints or overloads that activate protection schemes. This has been a common approach across the industry, but emerging industry practice is to:

- integrate information technology into distribution substations to record and report loading, quality of supply, status and fault indication data in real time; and
- integrate geographic information systems with network topology and customer billing information to determine the energy use through individual assets, which can then be combined with standard load profiles to determine substation utilisation.

[32] As identified through the Independent Enquiry into Casuarina Substation Events and Substation Maintenance across Darwin (the Davies Enquiry) and being addressed through the PWC Remedial Asset Management Program.

CHAPTER 6

Customer service and reliability performance

6.1 This chapter reports on customer service performance and reliability of supply outcomes in 2010-11 in the Darwin-Katherine, Alice Springs and Tennant Creek systems.

6.2 Customer service performance and reliability of supply information is reported by PWC Generation, PWC Networks and PWC Retail as a requirement of the Territory's Electricity Standards of Service Code. The 2010-11 Standards of Service: Key Service Performance Indicators Report covers:

- network and generation reliability performance, and network feeder performance; and
- customer service performance, such as network reconnections/new connections, the time taken to answer telephone calls, and customer complaints about quality of supply and service (for example billing).

Reliability performance

6.3 Reliability performance is measured by calculating:

- system average interruption duration index (SAIDI), which indicates the average duration of network and generation related outages experienced by a customer; and
- system average interruption frequency index (SAIFI), which indicates the average number of network and generation related outages experienced by a customer.

6.4 Reliability performance was examined for:

- generation and network performance in the Darwin region and Katherine region (of the Darwin-Katherine system), Alice Springs and Tennant Creek systems for 2006-07 to 2010-11, using a weighted total average of reliability outcomes for each system; and
- central business district (CBD), urban, short rural and long rural feeders for 2010-11 only, using a weighted total average of feeder reliability for each system.

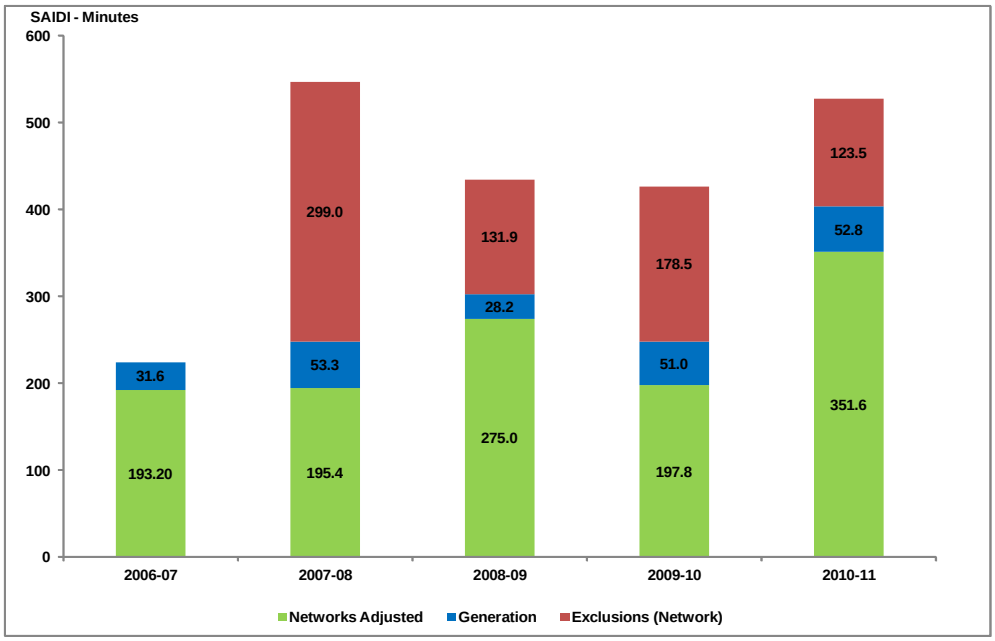
Overall reliability performance

6.5 Figure 6.1 shows the average total minutes off supply for a customer (SAIDI) in the Darwin, Katherine, Alice Springs and Tennant Creek (combined) systems for 2006-07 to 2010-11.

6.6 The key points highlighted are:

- after accounting for exclusions, 2010-11 demonstrated a deterioration in reliability performance (SAIDI) in the five year period 2006-07 to 2010-11;
- generation related outages were at the second highest level over the five year period; and
- there was a slight reduction in the contribution of "exclusions" to the weighted total average minutes off supply in 2010-11 compared to 2007-08, 2008-09 and 2009-10.

Figure 6.1: PWC Networks weighted total average minutes off supply (SAIDI) for 2006-07 to 2010-11



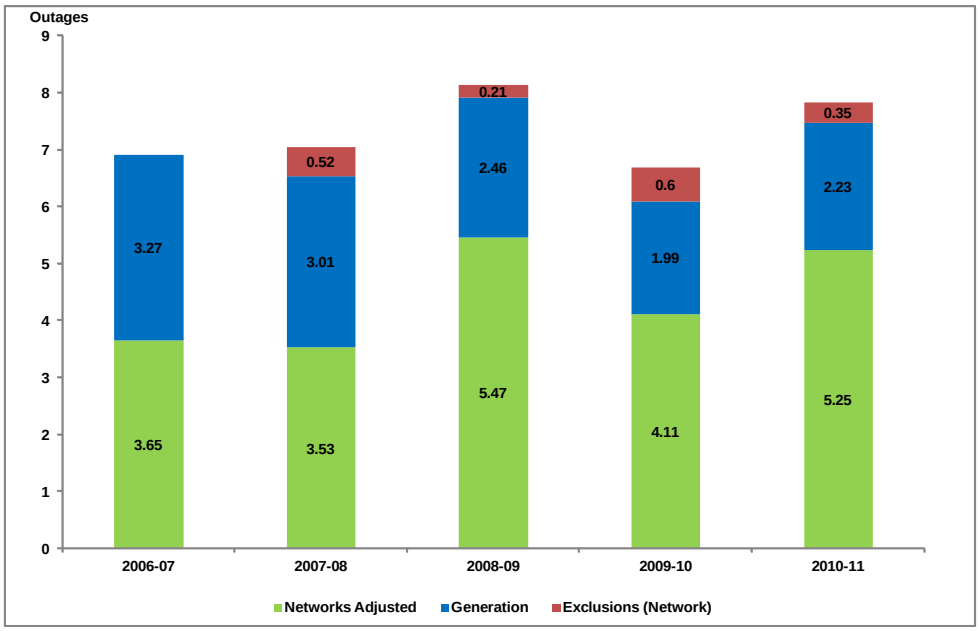
Source: Power and Water Corporation.

6.7 Figure 6.2 shows the average total frequency of outages for a customer (SAIFI) in the Darwin, Katherine, Alice Springs and Tennant Creek (combined) systems for 2006-07 to 2010-11.

6.8 The key points highlighted are:

- after accounting for exclusions, the frequency of network related outages in 2008-09 was the highest over the five year period, and above average;
- the frequency of generation related outages in 2010-11 was the second lowest over the five year period;
- the lack of a clear trend in the underlying network reliability performance (SAIFI) over the five year period 2006-07 to 2010-11;
- a smaller contribution of 'exclusions' to the weighted total average frequency of outages than for SAIDI, indicating a small number of events with a large impact.

Chart 6.2: PWC Networks weighted total average frequency of outages (SAIFI) for 2006-0706 to 2010-11



Source: Power and Water Corporation.

Generation performance trend

6.9 Territory customers experienced an average of 2.6 generation related outages a year (SAIFI) between 2006-07 and 2010-11. This is more than observed in the NEM connected systems (for example, for the 12 months ended 31 March 2010, Ergon Energy reported a SAIFI of 0.02).

6.10 To develop an improved understanding of generation reliability performance, Evans & Peck examined under frequency loss of supply (UFLS) events for the period 2006-07 to 2010-11 for the Darwin-Katherine system:

- there was an average of 17 UFLS events per annum over the five year period, which represents an average of over one UFLS event each three weeks;
- the number of UFLS events in 2010-11 was 14, three below the five year average;
- the average time for full restoration of supply to all customers averaged 48 minutes over the five year period, but this increased to 53 minutes in 2010-11; and
- the average number of customers impacted by each shedding event in 2010-11 was 6 556, below the five year average of 8 819.

6.11 While improvements in the number of outages are noted, it is expected that generation reliability performance in the Darwin-Katherine system will continue to improve in the coming years with the commissioning of new generation plant (especially Channel Island Units 8 and 9 in January 2012) and the completion of major maintenance to existing generation plant.

6.12 While generation performance in the Darwin-Katherine system improved, performance in the Alice Springs and Tennant Creek systems was worse than the five year average.

6.13 The number of UFLS events in Alice Springs was 13, nearly twice the five year average of 6.88. Tennant Creek experienced 8 UFLS events, 38 per cent up on the five year average of 5.8 UFLS events. In Alice Springs, average time for full restoration of the UFLS events was 87 minutes, well up on the five year average of 33 minutes.

6.14 Tennant Creek showed a similar deterioration, increasing from 32 minutes to 89 minutes. Similarly, the average number of customers impacted in Alice Springs was 5 724 in 2010-11, well up on the 5 year average of 3 720, and Tennant Creek 942 in 2010-11 compared to the 5 year average of 615.

6.15 Generation performance will continue to be monitored through regular performance reporting and an incident reporting framework, including progress in future Reviews.

Network performance trend

6.16 In 2010-11, network SAIDI performance was the worst in the five year period 2006-07 to 2010-11, while the 2010-11 network SAIFI performance was the second worst after 2008-09 during the same period. A significant contributor to this poor performance was cyclone Carlos. One day (16 February 2011), amounting to 114.5 minutes, was categorised as an "excluded event"[33]. Surrounding days, which did not qualify as excludable events using the 2.5 Beta method, contributed another 69 minutes to the Darwin SAIDI.

[33] Exclusions are events that have been identified using the 2.5 Beta method, which is a methodology developed by the by the Institute of Electrical and Electronic Engineers (IEEE) to statistically identify reliability events that may not represent business as usual and distort the underlying reliability trend. This is the method commonly used in Australia.

6.17 It is accepted that such events are largely out of the control of PWC Networks, however it is expected that efforts will continue to focus on improving the resilience of the network to such events, and ensuring response efforts are optimised to reduce outage times.

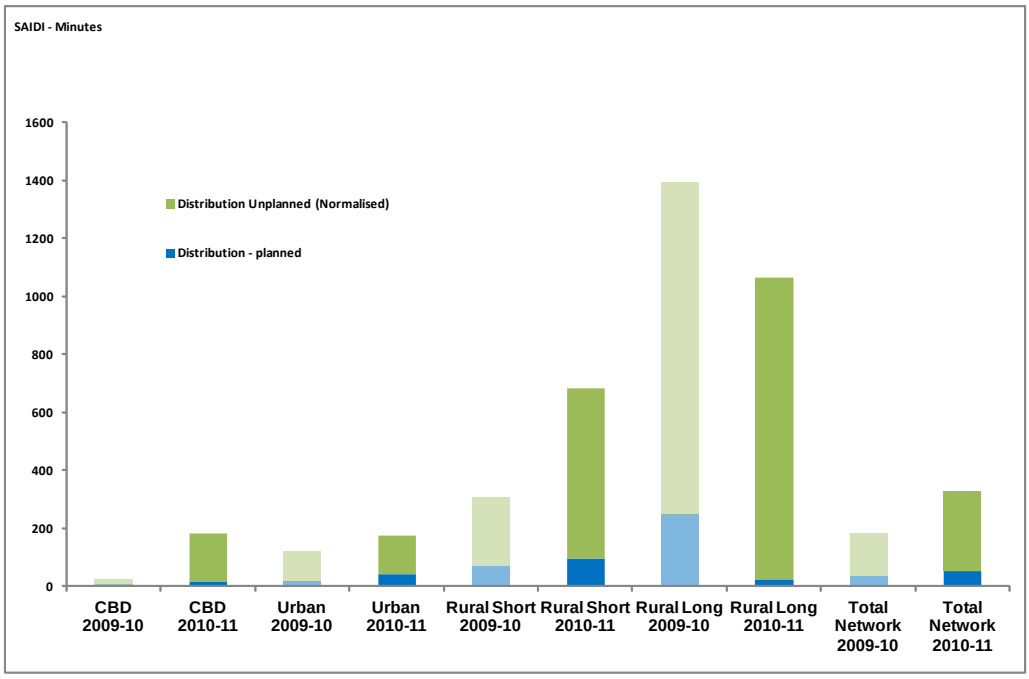
6.18 For the 2009-10 Review, PWC Networks were requested to report reliability performance based on feeder type, consistent with the approach adopted across Australia.[34] This approach has been repeated for the 2010-11 Review:

- CBD – a feeder predominantly supplying commercial, high-rise buildings, supplied by a predominantly underground distribution network containing significant interconnection and redundancy when compared to urban areas;
- Urban – a feeder, which is not a CBD feeder, with actual maximum demand over the reporting period per total feeder route length greater than 0.3 MVA/km;
- Short Rural – a feeder which is not a CBD or urban feeder, with a total feeder route length less than 200 km. Rural short feeders may include feeders in urban areas with low load densities; and
- Long Rural – a feeder which is not a CBD or urban feeder with a total feeder route length greater than 200 km.

6.19 Examining feeder performance to identify network performance trend is the accepted approach in Australia. 2009-10 was the first year this data was reported as part of the Review. CBD, Urban and Short Rural feeders had worse performance in 2010-11 than in 2009-10.

6.20 Figures 6.3 and 6.4 present the relative performance of each feeder category for the (combined) Darwin-Katherine, Alice Springs and Tennant Creek systems for 2010-11.

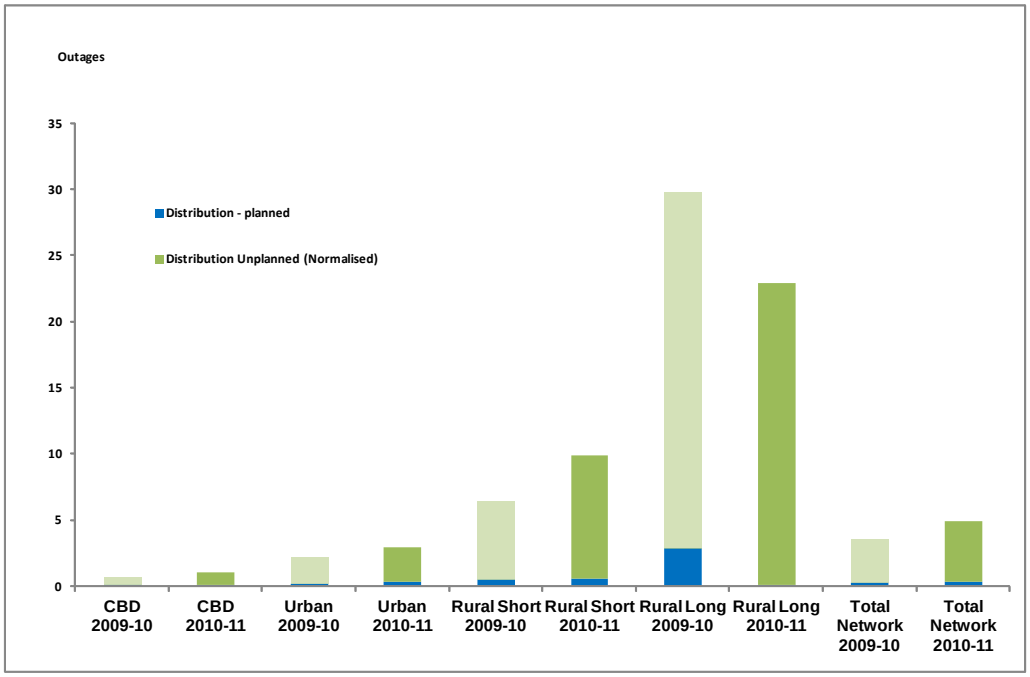
Figure 6.3: PWC Networks average outage duration (SAIDI) by feeder category for 2009-10 and 2010-11



Source: Evans & Peck.

[34] Feeder performance is most commonly reported based on feeder type. The approach is documented in the Utility Regulator's Forum, 2002, National Regulatory Reporting for Electricity Distribution and Retailing Businesses.

Figure 6.4: PWC Networks average frequency of outages (SAIFI) by feeder category for 2009-10 and 2010-11



Source: Evans & Peck.

6.21 It is noted that even with the removal of excluded major event days and generation/transmission outages, both the SAIDI and SAIFI performance of the CBD, Urban and Short Rural feeder categories remain worse in 2010-11 than 2009-10. Long Rural improved on both measures.

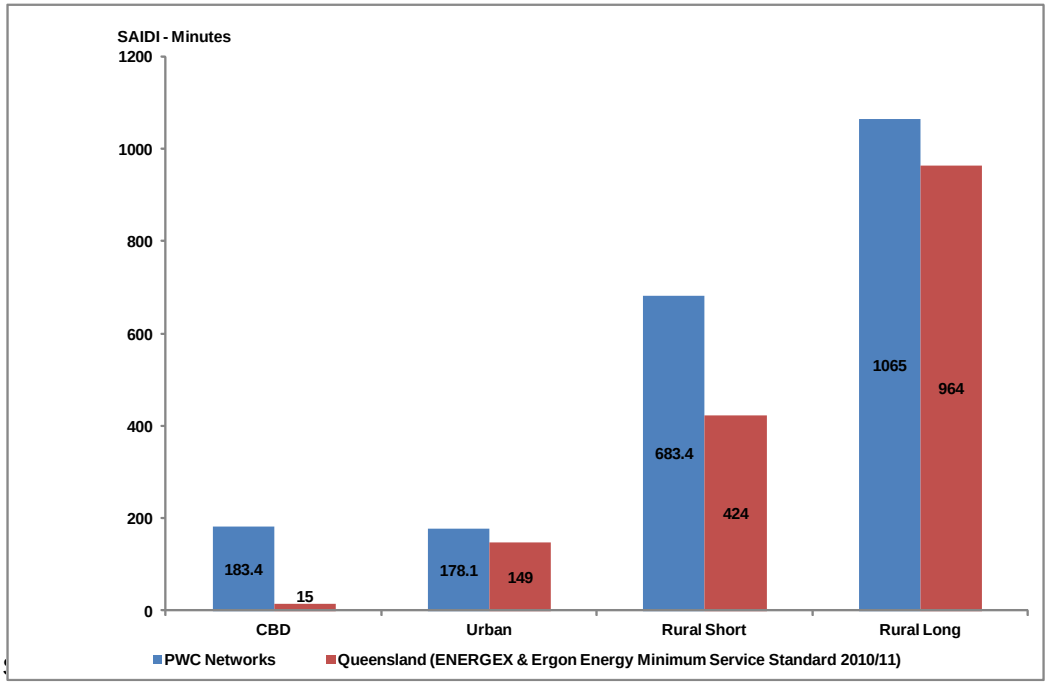
6.22 To assess relative performance of PWC Networks with regulatory expectations elsewhere in Australia, PWC Network "normalised"[35] performance was compared with the minimum service standards applicable in Queensland. Two Queensland electricity networks are considered to provide a reasonable point of comparison to PWC Networks (particularly Ergon Energy).

6.23 Figure 6.5 and 6.6 present a comparison of feeder performance in the Territory with the Queensland minimum service standards.[36]

[35] Normalised means planned and unplanned outages excluding major event days.

[36] 2009-10 Ergon Energy urban, short rural and long rural standards and the Energex CBD standard (Ergon Energy has no CBD feeders). Refer Queensland Competition Authority, October 2010, Report on performance against minimum service standards and compliance with guaranteed service levels by Energex and Ergon Energy for the 2009-10 financial year.

Figure 6.5: Feeder performance (SAIDI) in 2010-11– PWC Networks (actual) and Queensland (minimum service standards)

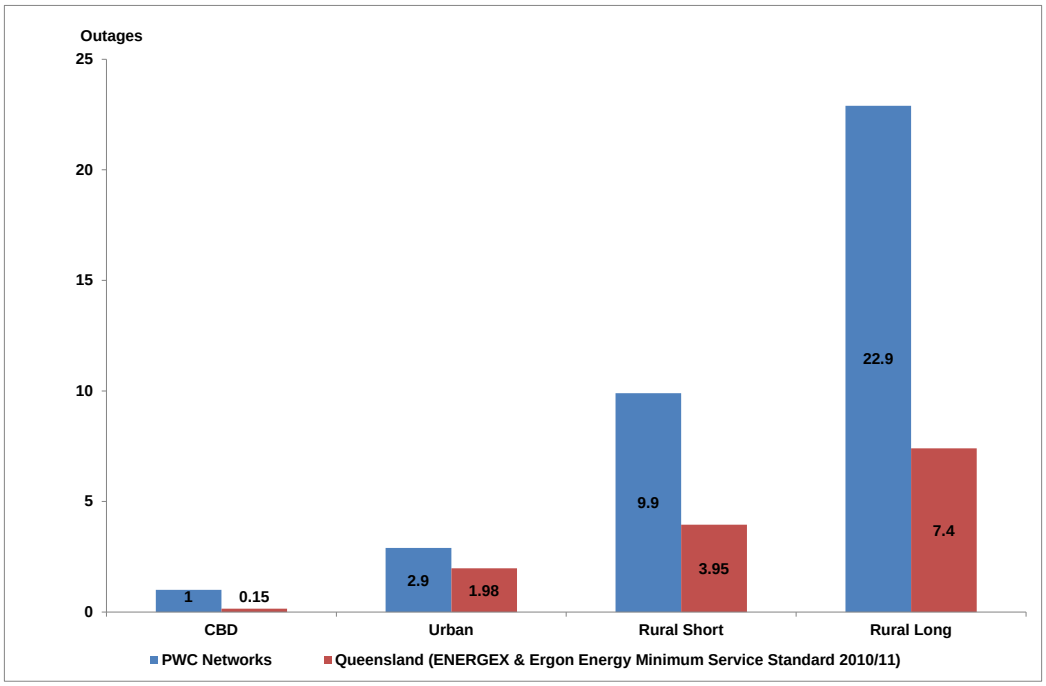


6.24 The following observations were made about the comparison of SAIDI performance:

- PWC Networks CBD feeder performance is significantly worse than the Energex CBD minimum standard and is an area that requires attention by PWC;
- CBD feeder performance is variable across Australia and volatile between years. A single event can have a significant influence on performance. However, adjusted unplanned outages in the PWC Network CBD feeder category were 166 minutes in 2010-11, up from 19 minutes in 2009-10;
- PWC Networks Urban and Short Rural performance both failed to meet the Ergon Energy minimum standards in 2010-11, a deterioration on their performance in 2009-10;[37] and
- PWC Network Long Rural performance is in line with the Ergon Energy minimum standard. As noted in the 2009-10 Review, the small number of long rural feeders in the Territory could cause high statistical variation. The individual feeder performances should be judged on relative length and technical configuration.

[37] Utilities Commission, March 2011, Power System Review 2009-10, page 52.

Figure 6.6: Feeder performance (SAIFI) in 2010-11– PWC Networks (actual) and Queensland (minimum service standards)



Source: Evans & Peck

6.25 The Commission has the following observations about the comparison of SAIFI performance in 2010-11

- PWC Networks CBD, urban and short rural SAIFI performance was worse than the Energex/Ergon Energy minimum standards in all categories. While acknowledging the impact of cyclone Carlos, a greater resilience in the network against such a naturally occurring event is nonetheless expected; and.
- PWC Networks long rural SAIFI performance continues to be worse than the Ergon Energy standard.

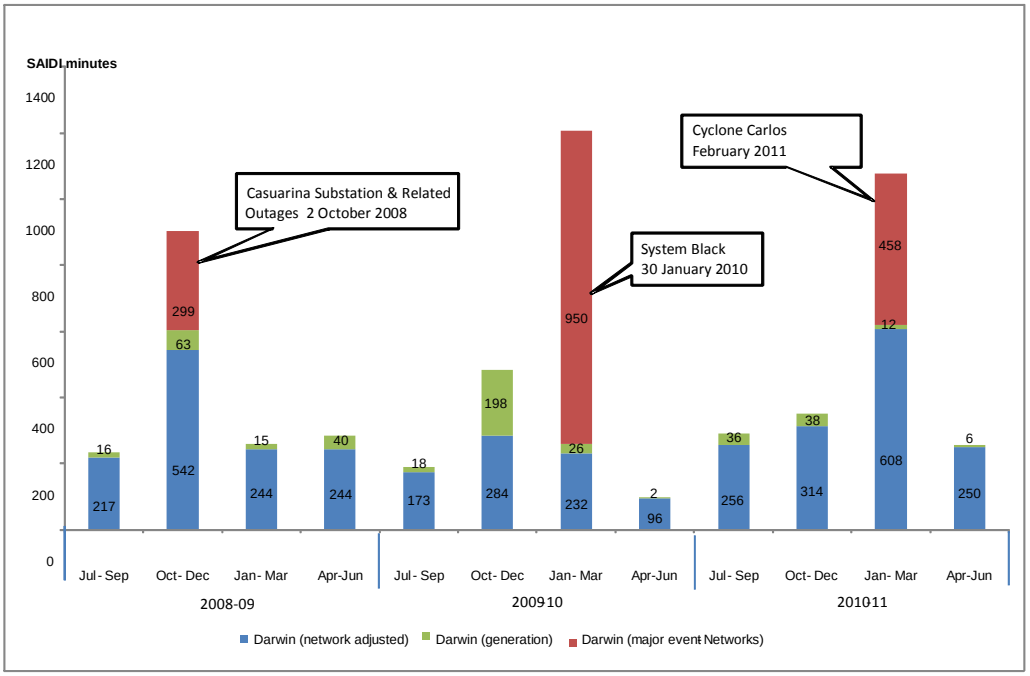
6.26 In future Reviews, feeder performance in the Territory will be compared over time and with that of like network service providers elsewhere in Australia.

Darwin Region reliability performance

6.27 Darwin Region reliability performance for each quarter for 2008-09 to 2010-11 is presented in Charts 6.7 and 6.8.

6.28 The SAIDI performance in 2010-11 was 493.1 minutes off supply, comprising 23.1 minutes due to generation, 355.5 minutes due to networks and 114.5 minutes due to a major event (cyclone Carlos 16 February 2011)

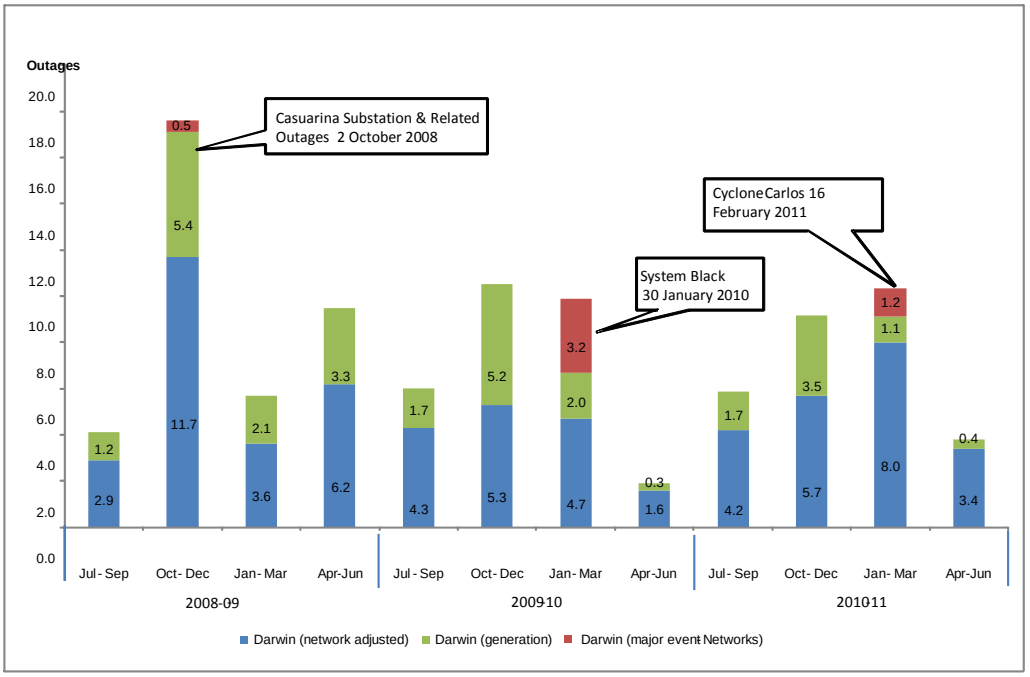
Figure 6.7: Average outage duration for a Darwin customer 2008-09 to 2010-11 (quarterly[38])



Source: Power and Water Corporation

6.29 The average frequency of outages experienced by a customer (SAIFI performance) in 2010-11 was 7.3, comprising 1.7 outages due to generation, 5.3 outages due to networks and 0.3 outages due to cyclone Carlos.

Figure 6.8: Average frequency of outages for a Darwin customer 2008-09 to 2010-11 (quarterly[39])



Source: Utilities Commission.

[38] Annualised quarterly values.

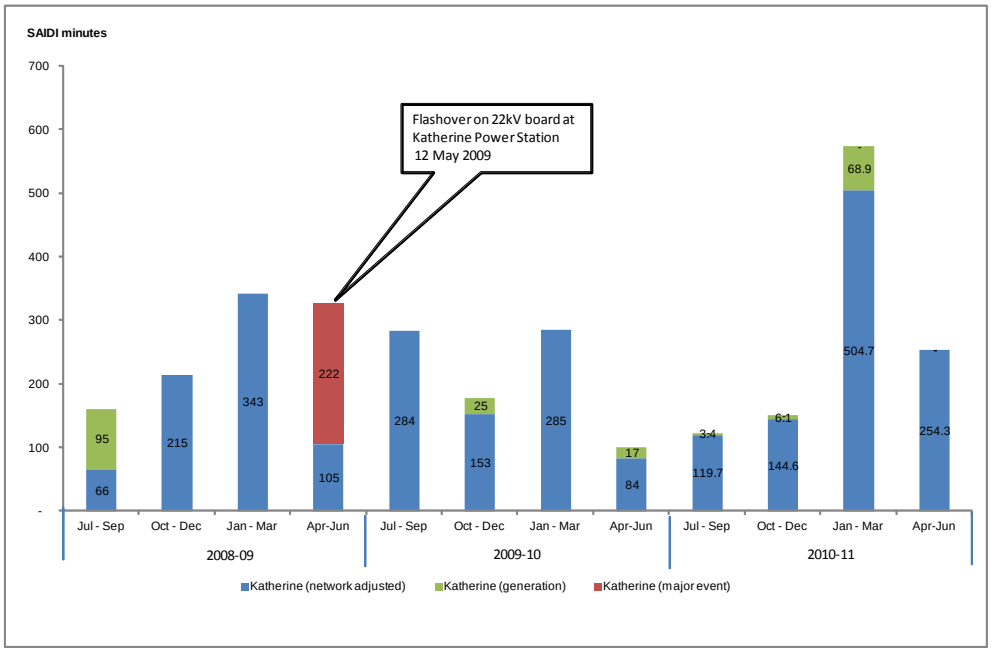
[39] Annualised quarterly values.

Katherine Region reliability performance

6.30 Katherine Region reliability performance for each quarter for 2008-09 to 2010-11 is presented in Figures 6.9 and 6.10.

6.31 SAIDI performance in 2010-11was 275.6 comprising 19.6 minutes due to generation and 256 minutes due to networks.

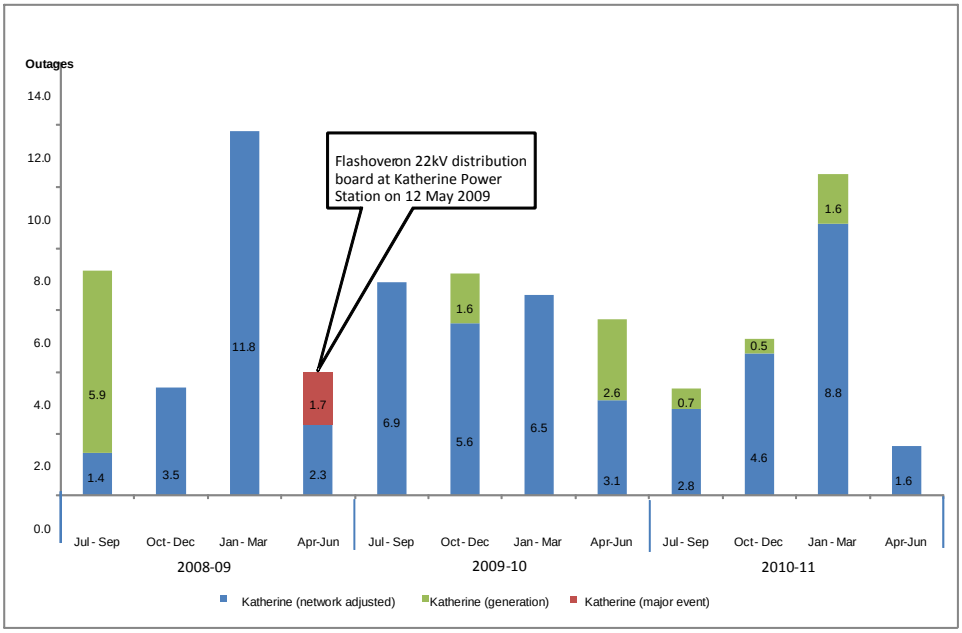
Figure 6.9: Average outage duration for a Katherine customer 2008-09 to 2010-11 (quarterly[40])



Source: Power and Water Corporation.

6.32 SAIFI performance in 2010-11 was 5.2, with 0.7 outages due to generation and 4.5 outages due to networks.

Figure 6.10: Average frequency of outages for a Katherine customer 2008-09 to 2010-11 (quarterly41)



[40] Annualised quarterly values.

[41] Annualised quarterly values.

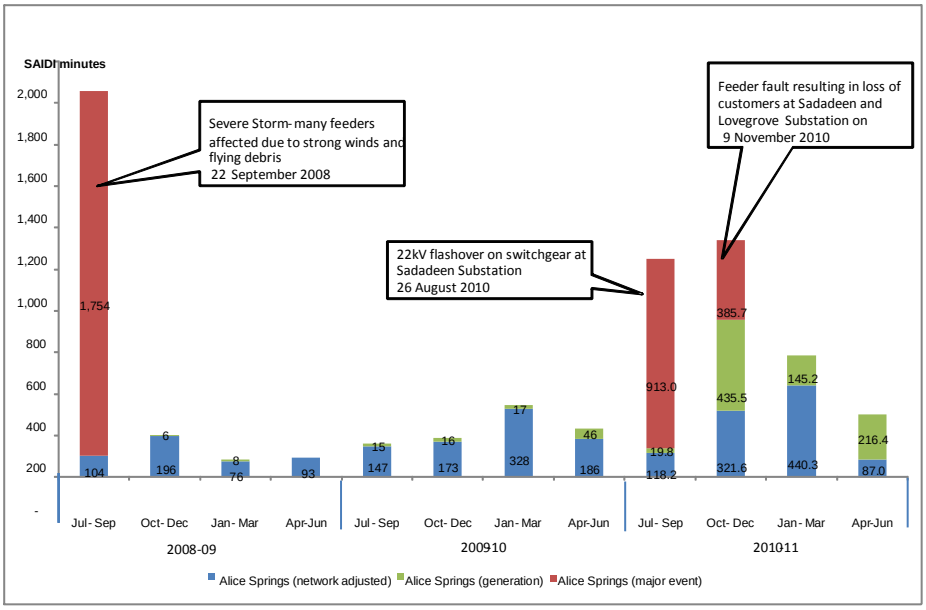
Source: Power and Water Corporation

Alice Springs Region reliability performance

6.33 Alice Springs reliability performance for each quarter for 2008-09 to 2010-11 is presented in Figures 6.11 and 6.12.

6.34 SAIDI performance in 2010-11 was 774.2 minutes, with 204.2 minutes due to generation, 245.3 minutes due to networks and 324.7 minutes due to major events involving a 22 kV fault in the Sadadeen substation switchboard and a subsequent fault on an outgoing feeder from the same substation.

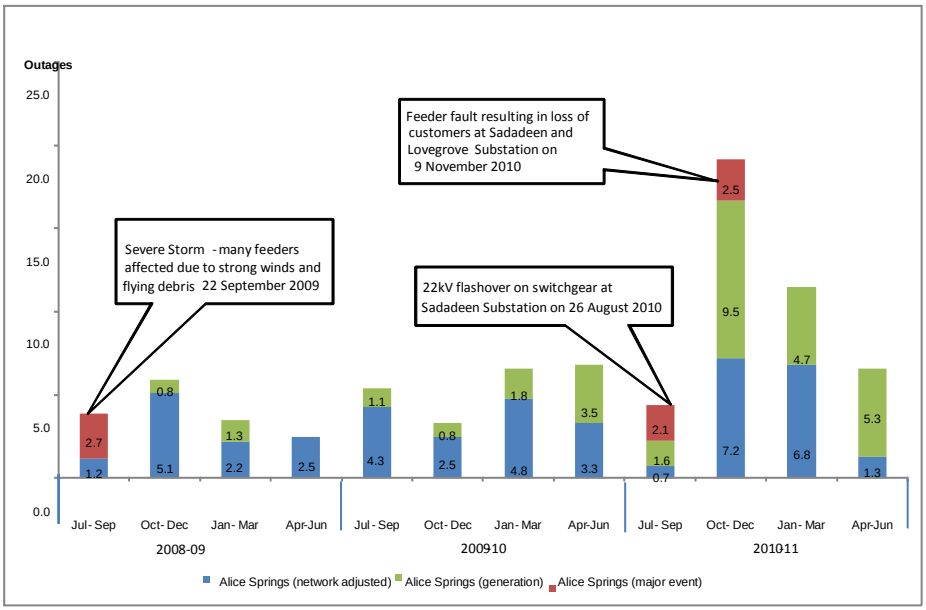
Figure 6.11: Average outage duration for an Alice Springs customer 2008-09 to 2010-11 (quarterly[42])



Source: Power and Water Corporation

6.35 SAIFI performance in 2010-11 was 10.5, with 5.3 outages due to generation, 4 outages due to networks and 1.2 outages due to the two major exclusion events.

Figure 6.12: Average frequency of outages for an Alice Springs customer 2008-09 to 2010-11 (quarterly[43])



[42] Annualised quarterly values.

[43] Annualised quarterly values.

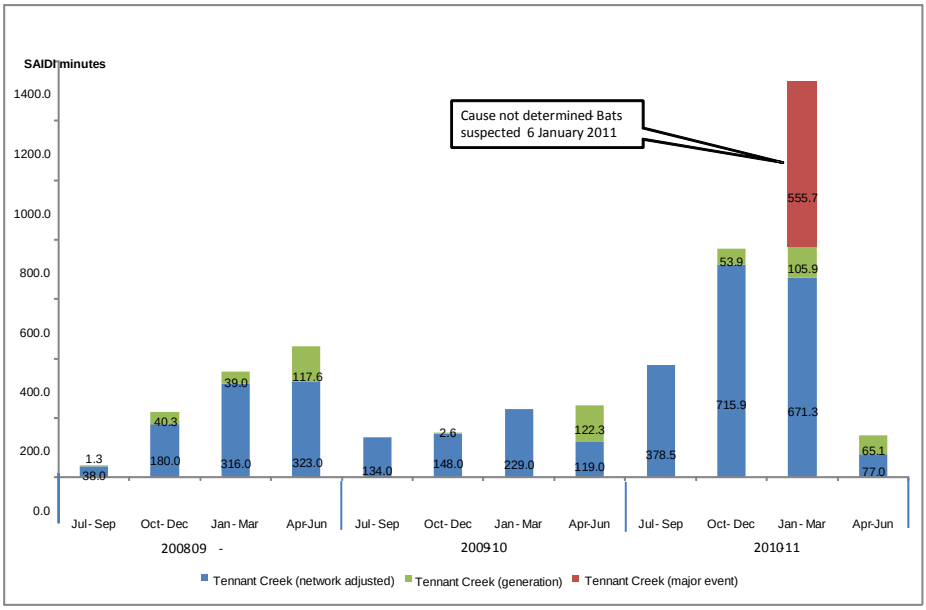
Source: Power and Water Corporation.

Tennant Creek reliability performance

6.36 Tennant Creek reliability performance for each quarter for 2008-09 to 2010-11 is presented in Figures 6.13 and 6.14.

6.37 SAIDI performance in 2010-11 was 654.2, with 56.2 minutes due to generation, 459.1 minutes due to networks and138.9 minutes due to an exclusion event arising from suspected animal interference on an outgoing feeder.

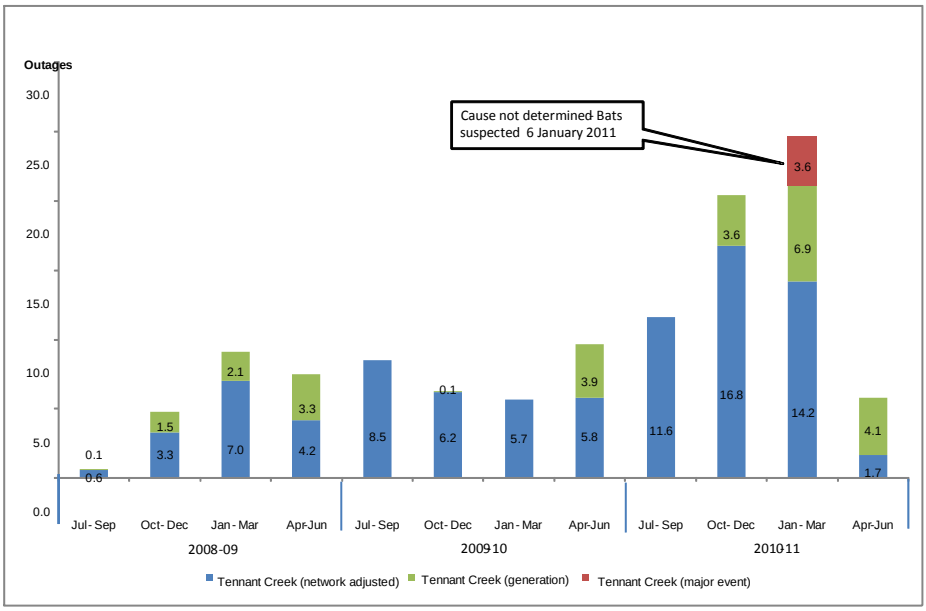
Figure 6.13: Average outage duration for a Tennant Creek customer 2008-09 to 2010-11 (quarterly[44])



Source: Power and Water Corporation

6.38 SAIFI performance in 2010-11 was 14.7 with 3.7 outages due to generation, 11.1 outages due to networks and 0.9 outages due to suspected animal interference.

Figure 6.14: Average frequency of outages for a Tennant Creek customer 2008-09 to 2010-11 (quarterly[45])



[44] Annualised quarterly values.

[45] Annualised quarterly values.

Source: Power and Water Corporation

Customer service performance

6.39 The customer service performance of PWC Networks and PWC Retail is measured using the following indicators:

- time taken to complete reconnections and new connections;
- number of complaints about quality of electricity supply;
- time taken to answer telephone calls (after the customer has chosen to speak to an operator); and
- number of complaints about PWC Networks and PWC Retail customer service.

Reconnections / connections

6.40 PWC Networks reports on the percentage of reconnections and connections of customers that occur after a defined time period:

- reconnections are to occur within 24 hours (connections to a property where there is an existing supply and no extension or augmentation of the network needed);
- connections to a property in a new subdivision in an urban area are to occur within five working days; and
- connections to a property in a new subdivision in an urban area where minor extension or augmentation of the network is required are to occur within 10 weeks.

6.41 The percentage of reconnections and connections not occurring within the defined timeframe for 2006-07 to 2010-11 is presented in Table 6.1.

Table 6.1: Percentage of reconnections / connections not made within the specified time limit

All customers (% not made)	2006-07	2007-08	2008-09	2009-10	2010-11
Reconnections (existing)	1	1	0.8	0.5	0.3
Connections (new subdivision)	19.3	16	8.7	7.9	6.7
Connections (extension needed)	32	32	66.5	69.4	81.6

Source: Power and Water Corporation.

6.42 On time reconnections have reached a level of 99.7 per cent compliance with the specified time limit.

6.43 The number of “on time” connections to a property in a new subdivision is 93.3 per cent, continuing the improvement in the number occurring on time from the low point of 80.7 per cent recorded in 2006-07.

6.44 The number of “on time” connections where minor works are required has reduced to 18.4 per cent, with 81.6 per cent not meeting the required specified time limit. While this result could be attributed to a diversion of resources from routine works to the PWC Networks remedial asset management program, it is considered the current level of performance could be improved.

6.45 PWC has advised that where minor extensions or augmentation is necessary, a longer time frame is required to procure large items of distribution equipment, procure contract resources and arrange internal resources for final connection to the network.

Quality of supply complaints

6.46 PWC Networks reports the number of complaints received in relation to quality of supply (for example, voltage dips, swells and spikes). Table 6.2 presents the number of

quality of supply complaints for 2006-07 to 2010-11. Aggregate data only was reported for 2006-07.

Table 6.2: Quality of supply complaints

Number of complaints	2006-07	2007-08	2008-09	2009-10	2010-11
Northern (Darwin)	NA	801	792	776	1 112
Katherine	NA	194	109	317	149
Southern (Alice Springs)	NA	96	139	114	145
Tennant Creek	NA	26	21	77	19
Total	**1 029**	**1 117**	**1 061**	**1 284**	**1 425**

Source: Power and Water Corporation.

6.47 The data shows an increase in complaints in Darwin in 2010-11 over previous years. No reason has been given by PWC. There is concern that this may relate to the absence of a structured planning process for the low voltage network. These statistics will be closely monitored in future reviews to identify whether this is attributable to a statistical aberration, or is reflective of an emerging issue.

6.48 It is expected that PWC will adopt the emerging industry practice of monitoring distribution substations, as outlined in paragraph 5.44, Chapter 5, so as to be able to identify problem areas on the distribution system. This will allow PWC to address issues identified and reverse the trend of increasing numbers of quality of supply complaints. Given the current level of complaints, quality of supply is an area that requires further attention by PWC.

Telephone call response

6.49 PWC (Networks and Retail) report the number and percentage of telephone calls responded to within 20 seconds of the customer electing to speak to a human operator.

6.50 Table 6.3 presents the percentage and number of telephone calls answered within 20 seconds of the customer electing to speak to a human operator for 2006-07 to 2010-11.

Table 6.3: Percentage and number of telephone calls answered within timeframe

Telephone calls answered	2006-07	2007-08	2008-09	2009-10	2010-11
Percentage	69	58	62	63	62
Number	96 562	78 453	87 013	91 614	88 888

Source: Power and Water Corporation.

6.51 The 2010-11 result is consistent with the previous two years, and is well below the 69 per cent reported in 2006-07.

Customer complaints (excluding Quality of Supply Complaints)

6.52 PWC (Networks and Retail) report the number of complaints received from customers.[46]

[46] A complaint is (as defined in the Australian Standard ISO10002-2006) 'an expression of dissatisfaction made to an organisation, related to its products, or the complaint handling process itself, where a response or resolution is explicitly or implicitly expected'.

6.53 Table 6.4 gives the number of customer complaints received by PWC Networks and PWC Retail for the period 2006-07 to 2010-11.

Table 6.4: Number of customer complaints

Number of complaints	2006-07	2007-08	2008-09	2009-10	2010-11
Darwin	NA	1 778	1 718	1 830	1 553
Katherine	NA	121	160	160	146
Alice Springs	NA	391	318	417	432
Tennant Creek	NA	42	39	70	89
Total	**1 917**	**2 332**	**2 235**	**2 477**	**2 220**

Source: Power and Water Corporation.

6.54 PWC received 2 220 electricity service related complaints during 2010-11. This is in line with the average number received over the five year period, and is marginally lower than 2009-10.

APPENDIX A

System maximum demand forecasts 2011-12 to 2020-21

Table A.1: Forecast Darwin –Katherine annual maximum demand for 2011-12 to 2020-21

MW per annum	E&P (medium – 3.6%)	PWC (medium – 2.5%)
2010-11 (actual)	287.0	287.0
2011-12	297.6	294.2
2012-13	308.3	301.5
2013-14	319.4	309.1
2014-15	330.8	316.8
2015-16	342.7	324.7
2016-17	355.0	332.8
2017-18	367.8	341.2
2018-19	381.0	349.7
2019-20	394.7	358.4
2020-21	408.8	367.4

Source: Evans & Peck and Power and Water Corporation.

Table A.2: Forecast Alice Springs annual maximum demand for 2011-12 to 2020-21

MW per annum	E&P (medium – 2.0%)	PWC (medium – 2.5%)
2010-11 (actual)	55.7	55.7
2011-12	57.4	57.1
2012-13	58.5	58.5
2013-14	59.7	60
2014-15	60.8	61.5
2015-16	62.0	63
2016-17	63.2	64.6
2017-18	64.5	66.2
2018-19	65.7	67.9
2019-20	67.0	69.6
2020-21	68.3	71.3

Source: Evans & Peck and Power and Water Corporation.

Table A.3: Forecast Tenant Creek annual maximum demand for 2011-12 to 2020-21

MW per annum	E&P (medium – 1.3%)	PWC (medium– 2.5%)
2010-11 (actual)	6.8	6.8
2011-12	7.3	6.9
2012-13	7.4	7.1
2013-14	7.5	7.3
2014-15	7.6	7.5
2015-16	7.7	7.6
2016-17	7.8	7.8
2017-18	7.9	8
2018-19	8.0	8.2
2019-20	8.1	8.4
2020-21	8.2	8.6

Source: Evans & Peck and Power and Water Corporation.

APPENDIX B

Zone substation demand for 2008-09 to 2016-17

Source: Power and Water Corporation.

Table 1

							Actual			*Forecast*					
Zone Substations	**Voltage**	**Number of Transformers**	**Max. Capacity MVA**	**Min. Capacity MVA**	**Max. Firm Capacity MVA**	**Min. Firm Capacity MVA**	**2008-09 Demand MVA**	**2009-10 Demand MVA**	**2010-11 Demand MVA**	**2011-12 Demand MVA**	**2012-13 Demand MVA**	**2013-14 Demand MVA**	**2014-15 Demand MVA**	**2015-16 Demand MVA**	**2016-17 Demand MVA**
Archer	66/11 kV	2	54.0	40.0	27.0	20.0	-	-	-	20.0	20.5	21.0	21.5	22.0	22.5
Batchelor	132/22 kV	1	27.0	20.0	0.0 [8]	0.0 [8]	1.8	1.8	1.9	1.9	2.0	2.0	2.1	2.1	2.2
Berrimah	66/11 kV	2	76.0	50.0	38.0	25.0	36.0	40.0	37.3	38.3 [1]	39.2 [1]	32.0 [2]	32.8	33.6	34.5
Brocks Creek	66/11 kV	2	7.0	7.0	3.5	3.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Casuarina	66/11 kV	3	114.0	75.0	76.0	50.0	36.6	49.0	44.0	48.7	50.3	39.5 [2]	40.8	42.1	43.5
Centre Yard	66/11 kV	2	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6 [3]	0.6 [3]	0.6 [3]	0.6 [3]
City Zone	66/11 kV	3	120.0	90.0	80.0	60.0	57.5	57.4	56.4	57.5	38.3 [4]	39.1	39.9	40.8	41.6
Cosmo Howley	66/11 kV	2	15.0	15.0	7.5	7.5	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.4
Frances Bay	66/11 kV	1	40.0	30.0	0.0 [9]	0.0 [9]	-	-	9.9	10.1	30.8 [5]	31.6	32.4	33.2	34.1
Humpty Doo	66/22 kV	3	7.5	7.5	5.0	5.0	3.0	3.1	3.3	3.3	3.4	3.5	3.6	3.6	3.7
Katherine	132/22 kV	2	54.0	40.0	27/31 [6]	27/31 [6]	25.1	26.3	27.3	27.7	28.0	28.4	28.7	29.1	29.5
Leanyer	66/11 kV	2	54.0	40.0	27.0	20.0	-	-	-	-	-	20.0	20.5	21.0	21.5
Manton	132/22 kV	1	27.0	20.0	0.0 [7]	0.0 [7]	6.3	6.3	6.2	6.5	6.8	7.2	7.5	7.9	8.3
Marrakai	66/22 kV	2	5.0	2.5	2.5	2.5	-	-	-	1.5	1.5	1.6	1.6	1.6	1.6
Mary-River	66/22 kV	1	5.0	5.0	0.0	0.0	1.3	1.3	1.3	1.3	0.0 [10]	0.0	0.0	0.0	0.0
McMinns	66/22 kV	3	40.5	30.0	27.0	20.0	19.9	19.8	18.5	19.1	19.6	20.2	20.8	21.4	22.1
Palmerston	66/11 kV	2	80.0	60.0	40.0	30.0	42.4	42.9	43.9	25.6 [11]	30.6 [12]	35.2 [13]	35.9	36.6	39.4 [14]
Pine Creek	11/22 kV	1	1.8	1.8	0.0	0.0	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9
Snell Street	66/11 kV	4	47.0	41.0	35.0	31.0	29.1	28.4	32.4	33.4	- [15]	-	-	-	-
Weddell	66/22 kV	2	15.0	10.0	7.5	5.0	6.0	6.0	6.1	6.2	8.5 [16]	14.5 [17]	14.6	14.8	14.9
Woolner	66/11 kV	3	81.0	60.0	54.0	40.0	-	-	-	-	34.3	35.3	36.4	37.4	38.5
Tennant Creek	11/22 kV	2	15.0	10.0	7.5	5.0	6.3	6.4	7.2	7.4	7.5	7.7 [18]	7.9	8.1	8.3
Lovegrove	22/11 kV	3	35.0	25.0	20.0	15.0	12.6	11.6	17.5	17.9	18.2	18.6	19.0	19.4	19.7
Network - Substation Totals		**49**	**921.8**	**680.8**	**458.0**	**340.0**									

Notes:

1. Local generation (10MW) available at Berrimah ZSS
2. Load transferred to Leanyer ZSS
3. Deploy mobile generator for contingencies
4. Transfer load to Frances Bay ZSS
5. Frances Bay ZSS second zone transformer commissioned
6. Local generation capacity for loss of the 132kV line
7. All Manton ZSS load can be transferred to Batchelor ZSS
8. All Batchelor ZSS load can be transferred to Manton ZSS
9. Prior to commissioning of the second zone transformer, all load can be transferred to City Zone ZSS
10. Mary River ZSS will be decommissioned and load transferred to Marrakai ZSS
11. Load transferred to Archer ZSS
12. New load: Inpex Village
13. New load: New Jail
14. New load: Palmerston Hospital
15. Woolner ZSS will replace Snell Street in 2012-13
16. New Load: Noonamah Abbatoir
17. New Load: Inpex Blaydin Point work site
18. Tennant Creek transformers replaced by 2 x 10 MVA's in 2013-14