CHAPTER 6

Network capability and performance

6 Network capability and performance

Key highlights

- Generation commitments since the 2019 Transmission Annual Planning Report (TAPR) add 1,498MW to Queensland's semi-scheduled variable renewable energy (VRE) generation capacity taking the total existing and committed semi-scheduled VRE generation capacity to 3,960MW.
- The Central Queensland to South Queensland (CQ-SQ) grid section was highly utilised during 2019/20, reflecting high generation levels in North Queensland (NQ) as a result of recently commissioned VRE generators.
- Committed generation is expected to continue to alter power transfers, particularly during daylight hours, increasing the likelihood of congestion across the Gladstone, CQ-SQ and Queensland/New South Wales (NSW) Interconnector (QNI) grid sections.
- Record peak transmission delivered demands were recorded in the Central West, Surat and Bulli zones during 2019/20.
- The transmission network has performed reliably during 2019/20, with Queensland grid sections largely unconstrained.

6.1 Introduction

This chapter on network capability and performance provides:

- an outline of existing and committed generation capacity over the next three years
- a summary of network control facilities configured to disconnect load as a consequence of noncredible events
- single line diagrams of the existing high voltage (HV) network configuration
- background on factors that influence network capability
- zonal energy transfers for the two most recent years
- historical constraint times and power flow duration curves at key sections of Powerlink Queensland's transmission network
- a qualitative explanation of factors affecting power transfer capability at key sections of Powerlink's transmission network
- historical system normal constraint times and load duration curves at key zones of Powerlink's transmission network
- double circuit transmission lines categorised as vulnerable by the Australian Energy Market Operator (AEMO)
- a summary of the management of high voltages associated with light load conditions.

The capability of Powerlink's transmission network to meet forecast demand is dependent on a number of factors. Queensland's transmission network is predominantly utilised more during summer than winter. During higher summer temperatures, reactive power requirements are greater and transmission plant has lower power carrying capability. Also, higher demands occur in summer as shown in Figure 2.12.

The location and pattern of generation dispatch influences power flows across most of the Queensland network. Future generation dispatch patterns and interconnector flows are uncertain in the deregulated electricity market and will vary substantially due to output of VRE generation and due to the effect of planned or unplanned outages of generation plant. Power flows can also vary substantially with planned or unplanned outages of transmission network elements. Power flows may also be higher at times of local area or zone maximum demands (refer to Table 2.13) and/or when embedded generation output is lower.

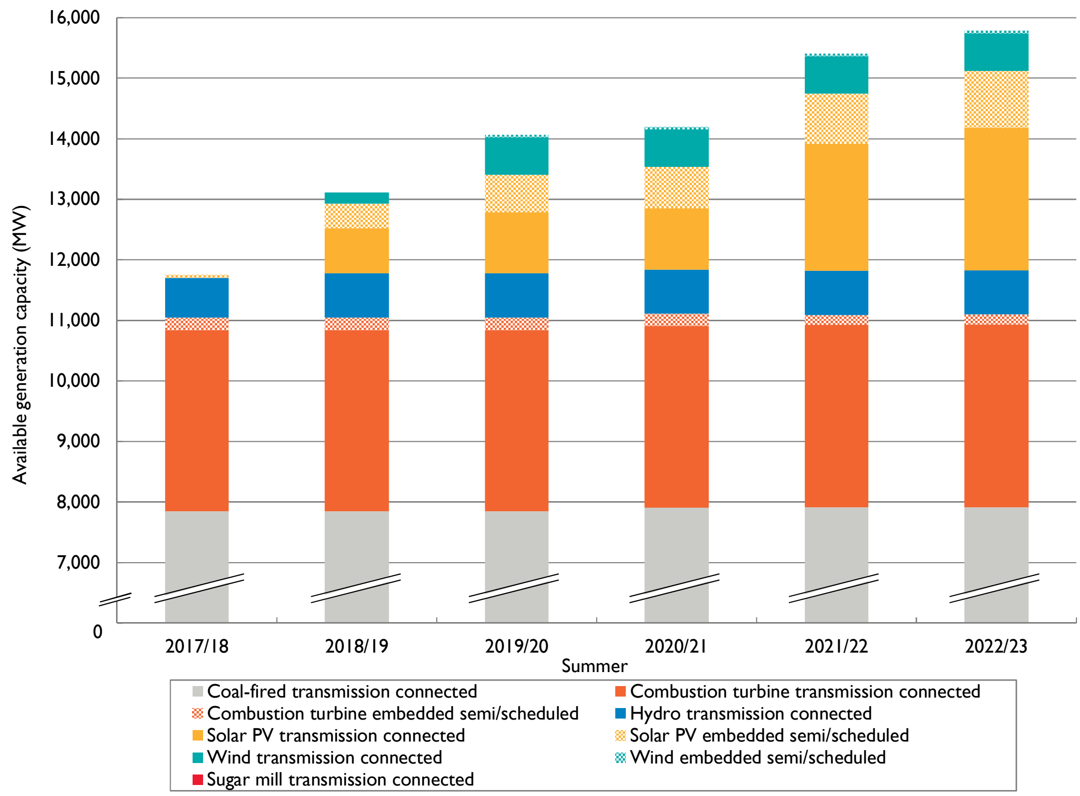
The updated release date of the TAPR has allowed reporting to be modified to align with financial years. The reporting in previous TAPRs was based on the April to March of the following year period. Therefore historical figures are not directly comparable with previous editions of the TAPR.

6.2 Available generation capacity

Scheduled generation in Queensland is predominantly a combination of coal-fired, gas turbine and hydro-electric generators.

AEMO's definition of 'committed' from the System Strength Impact Assessment Guidelines[1] (effective 1 July 2018) has been adopted for the purposes of this year's TAPR. During 2019/20, commitments have added 1,498MW of capacity, taking Queensland's semi-scheduled VRE generation capacity to 3,960MW. Figure 6.1 illustrates the expected changes to available and committed generation capacity in Queensland from summer 2017/18 to summer 2022/23.

Figure 6.1 Summer available generation capacity by energy source



6.2.1 Existing and committed transmission connected and direct connect embedded generation

Table 6.1 summarises the available generation capacity of power stations connected, or committed to be connected to Powerlink's transmission network (including the non-scheduled generators at Yarwun, Invicta and Koombooloomba) or connected to direct connect customers.

Semi-scheduled transmission connected solar farms Moura, Rodds Bay, Woolooga Energy Park, Bluegrass, Columboola, Gangarri and Western Downs Green Power Hub have reached committed status since the 2019 TAPR.

Information in this Table has been provided to AEMO by the owners of the generators. Details of registration and generator capacities can be found on AEMO's website. In accordance with Clause 5.18A of the National Electricity Rules (NER), Powerlink's Register of Large Generator Connections with information on generators connected to Powerlink's network can be found on Powerlink's website.

1 AEMO, System Strength Impact Assessment Guidelines, June 2018.

Table 6.1 Available generation capacity – existing and committed generators connected to the Powerlink transmission network or direct connect customers

Generator	Location	Available generation capacity (MW) (1)					
		Summer 2020/21	Winter 2021	Summer 2021/22	Winter 2022	Summer 2022/23	Winter 2023
Coal-fired							
Stanwell	Stanwell	1,460	1,460	1,460	1,460	1,460	1,460
Gladstone	Calliope River	1,680	1,680	1,680	1,680	1,680	1,680
Callide B	Calvale	700	700	700	700	700	700
Callide Power Plant	Calvale	840	840	840	840	840	840
Tarong North	Tarong	443	443	443	443	443	443
Tarong	Tarong	1,400	1,400	1,400	1,400	1,400	1,400
Kogan Creek	Kogan Creek PS	709	750	721	750	721	750
Millmerran	Millmerran PS	672	852	672	852	672	852
Total coal-fired		7,904	8,125	7,916	8,125	7,916	8,125
Combustion turbine							
Townsville 132kV	Townsville PS	150	165	150	165	150	165
Mt Stuart	Townsville South	387	400	387	400	387	400
Yarwun (2)	Yarwun	160	155	160	155	160	155
Condamine (3)	Columboola	139	144	139	144	139	144
Braemar 1	Braemar	491	530	491	543	501	543
Braemar 2	Braemar	480	519	480	519	480	519
Darling Downs	Braemar	563	630	563	630	563	630
Oakey (4)	Tangkam	288	346	288	346	288	346
Swanbank E	Swanbank E PS	350	365	350	365	350	365
Total combustion turbine		3,008	3,254	3,008	3,267	3,018	3,267
Hydro-electric							
Barron Gorge	Kamerunga	66	66	66	66	66	66
Kareeya (including Koombooloomba) (5)	Chalumbin	93	93	93	93	93	93
Wivenhoe (6)	Mt. England	570	570	570	570	570	570
Total hydro-electric		729	729	729	729	729	729
Solar PV (7)							
Ross River	Ross	116	116	116	116	116	116
Sun Metals (3)	Townsville Zinc	107	107	107	107	107	107
Haughton	Haughton River	100	100	100	100	100	100
Clare	Clare South	100	100	100	100	100	100
Whitsunday	Strathmore	57	57	57	57	57	57

Table 6.1 Available generation capacity – existing and committed generators connected to the Powerlink transmission network or direct connect customers (*continued*)

Generator	Location	Available generation capacity (MW) (1)					
		Summer 2020/21	Winter 2021	Summer 2021/22	Winter 2022	Summer 2022/23	Winter 2023
Hamilton	Strathmore	57	57	57	57	57	57
Daydream	Strathmore	150	150	150	150	150	150
Hayman	Strathmore	50	50	50	50	50	50
Rugby Run	Moranbah	65	65	65	65	65	65
Lilyvale	Lilyvale	100	100	100	100	100	100
Moura	Moura			82	82	82	82
Rodds Bay	South of Wurdong				250	250	250
Woolooga Energy Park	Woolooga			176	176	176	176
Bluegrass	Chinchilla			148	148	148	148
Columboola	Columboola		162	162	162	162	162
Gangarri	Wandoan South		120	120	120	120	120
Western Downs Green Power Hub	Western Downs			400	400	400	400
Darling Downs	Braemar	108	108	108	108	108	108
Total solar PV		1,010	1,292	2,098	2,348	2,348	2,348
Wind (7)							
Mt Emerald	Walkamin	180	180	180	180	180	180
Coopers Gap	Coopers Gap	440	440	440	440	440	440
Total wind		620	620	620	620	620	620
Sugar mill							
Invicta (5)	Invicta Mill	0	34	0	34	0	34
Total sugar mill		0	34	0	34	0	34
Total all stations		13,271	14,054	14,371	15,123	14,631	15,123

Notes:

(1) Synchronous generator capacities shown are at the generator terminals and are therefore greater than power station net sent out nominal capacity due to station auxiliary loads and step-up transformer losses. The capacities are nominal as the generator rating depends on ambient conditions. Some additional overload capacity is available at some power stations depending on ambient conditions.

(2) Yarwun is a non-scheduled generator, but is required to comply with some of the obligations of a scheduled generator.

(3) Condamine and Sun Metals are direct connected embedded generators.

(4) Oakey Power Station is an open-cycle, dual-fuel, gas-fired power station. The generated capacity quoted is based on gas fuel operation.

(5) Koombooloomba and Invicta are transmission connected non-scheduled generators.

(6) Wivenhoe Power Station is shown at full capacity (570MW). However, output can be limited depending on water storage levels in the dam.

(7) VRE generators shown at maximum capacity at the point of connection.

6.2.2 Existing and committed scheduled and semi-scheduled distribution connected embedded generation

Table 6.2 summarises the available generation capacity of embedded scheduled and semi-scheduled power stations connected, or committed to be connected to Queensland's distribution network.

Semi-scheduled embedded solar farms Munna Creek and Kingaroy have reached committed status since the 2019 TAPR.

Information in this Table has been provided to AEMO by the owners of the generators. Details of registration and generator capacities can be found on AEMO's website.

Table 6.2 Available generation capacity – existing and committed scheduled or semi-scheduled generators connected to the Energex and Ergon Energy (part of the Energy Queensland Group) distribution networks.

Generator	Location	Available generation capacity (MW)					
		Summer 2020/21	Winter 2021	Summer 2021/22	Winter 2022	Summer 2022/23	Winter 2023
Combustion turbine (1)							
Townsville 66kV	Townsville PS	78	82	78	82	78	82
Mackay (2)	Mackay	34	34				
Barcaldine	Barcaldine	32	37	32	37	32	37
Roma	Roma	54	68	54	68	54	68
Total combustion turbine		198	221	164	187	164	187
Solar PV (3)							
Kidston	Kidston	50	50	50	50	50	50
Kennedy Energy Park	Hughenden	15	15	15	15	15	15
Collinsville	Collinsville North	42	42	42	42	42	42
Clermont	Clermont	75	75	75	75	75	75
Middlemount	Lilyvale	26	26	26	26	26	26
Emerald	Emerald	72	72	72	72	72	72
Aramara	Aramara			104	104	104	104
Susan River	Maryborough	75	75	75	75	75	75
Childers	Isis	56	56	56	56	56	56
Munna Creek	Kilkivan					120	120
Kingaroy	Kingaroy			40	40	40	40
Maryrorough	Yarranlea	27	27	27	27	27	27
Yarranlea	Yarranlea	103	103	103	103	103	103
Oakey 1	Oakey	25	25	25	25	25	25
Oakey 2	Oakey	55	55	55	55	55	55
Warwick	Warwick	64	64	64	64	64	64
Total solar PV		685	685	829	829	949	949
Wind (3)							
Kennedy Energy Park	Hughenden	43	43	43	43	43	43
Total Wind		43	43	43	43	43	43
Total all stations		926	949	1,036	1,059	1,156	1,179

Notes:

(1) Synchronous generator capacities shown are at the generator terminals and are therefore greater than power station net sent out nominal capacity due to station auxiliary loads and step-up transformer losses. The capacities are nominal as the generator rating depends on ambient conditions. Some additional overload capacity is available at some power stations depending on ambient conditions.

(2) AEMO's generating unit expected closure year, July 2020 Version, quotes an expected closure date of 1st April 2021 for Mackay GT.

(3) VRE generators shown at maximum capacity at the point of connection.

6.3 Network control facilities

Powerlink participated in the second Power System Frequency Risk Review[2] (PSFRR) in 2020. The PSFRR, as part of the Emergency Frequency Control Schemes (EFCS) rule change[3], placed an obligation on AEMO to undertake, in collaboration with Transmission Network Service Providers (TNSPs), an integrated, periodic review of power system frequency risks associated with non-credible contingency events.

AEMO published the Final 2020 PSFRR – Stage 1 Report on 31 July 2020. For Queensland, the recommendation involved the expansion of Powerlink's CQ-SQ Special Protection Scheme (SPS). The existing scheme disconnects one or two highest generating Callide units, depending on CQ-SQ transfer, for the unplanned loss of both Calvale to Halys 275kV feeders. The existing scheme is limited to transfers lower than 1,700MW and relies on the ability to disconnect high output generating units. Powerlink has initiated a project to implement new Wide area monitoring protection and control (WAMPAC) architecture into CQ-SQ SPS by mid-2021. The scheme is expected to include approximately 600MW of renewable generators and run along with the existing SPS.

AEMO is considering whether a protected event should be declared to manage residual risk through operational measures. AEMO will be investigating the cost-benefit of this proposal in Stage 2 of the 2020 PSFRR due by the end of 2020.

Stage 2 of the 2020 PSFRR will also review the requirement for an Over Frequency Generation Shedding (OFGS) scheme as part of the QNI upgrade.

Powerlink owns other network control facilities which minimise or reduce the consequences of multiple contingency events. Network control facilities owned by Powerlink which may disconnect load following a multiple non-credible contingency event are listed in Table 6.3.

2 AEMO, Draft 2020 PSFRR– Stage 1, July 2020.
3 AEMC, Rule Determination National Electricity Amendment (Emergency Frequency Control Schemes) Rule 2017, 30 March 2017.

Table 6.3 Powerlink owned network control facilities configured to disconnect load as a consequence of non-credible events during system normal conditions

Scheme	Purpose
FNQ Under Voltage Load Shed (UVLS) scheme	Minimise risk of voltage collapse in FNQ
North Goonyella Under Frequency Load Shed (UFLS) relay	Raise system frequency
Dysart UVLS	Minimise risk of voltage collapse in Dysart area
Eagle Downs UVLS	Minimise risk of voltage collapse in Eagle Downs area
Boyne Island UFLS relay	Raise system frequency
Queensland UFLS Inhibit Scheme	Minimise risk of QNI separation for an UFLS event for moderate to high southern transfers on QNI compared to Queensland demand
Tarong UFLS relay	Raise system frequency
Middle Ridge UFLS relays	Raise system frequency
Mudgeeraba Emergency Control Scheme (ECS)	Minimise risk of voltage collapse in the Gold Coast zone

6.4 Existing network configuration

Figures 6.2, 6.3, 6.4 and 6.5 illustrate Powerlink's network as of July 2020.

Figure 6.2 Existing HV network July 2020 - NQ

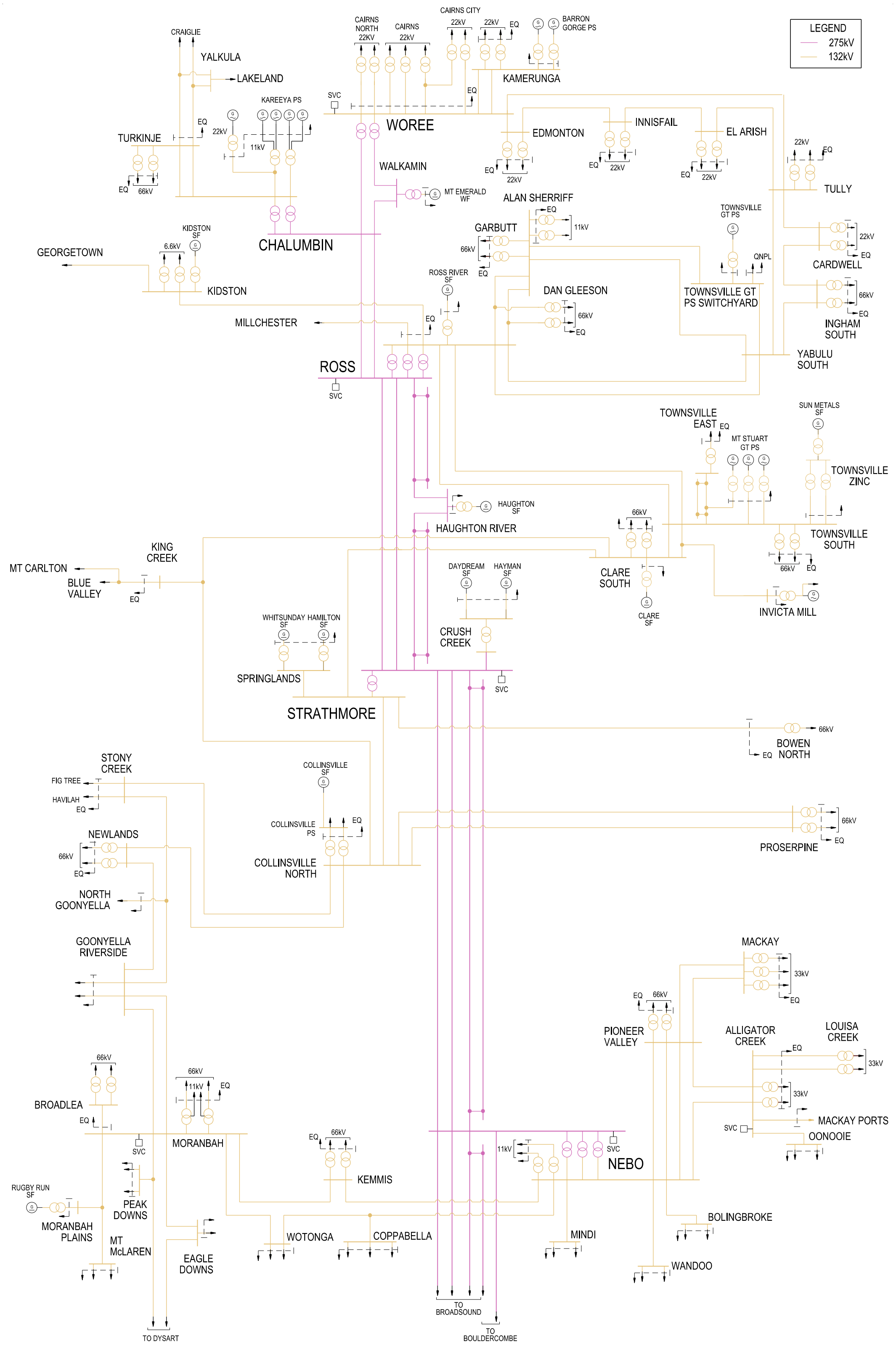


Figure 6.3 Existing HV network July 2020 - CQ

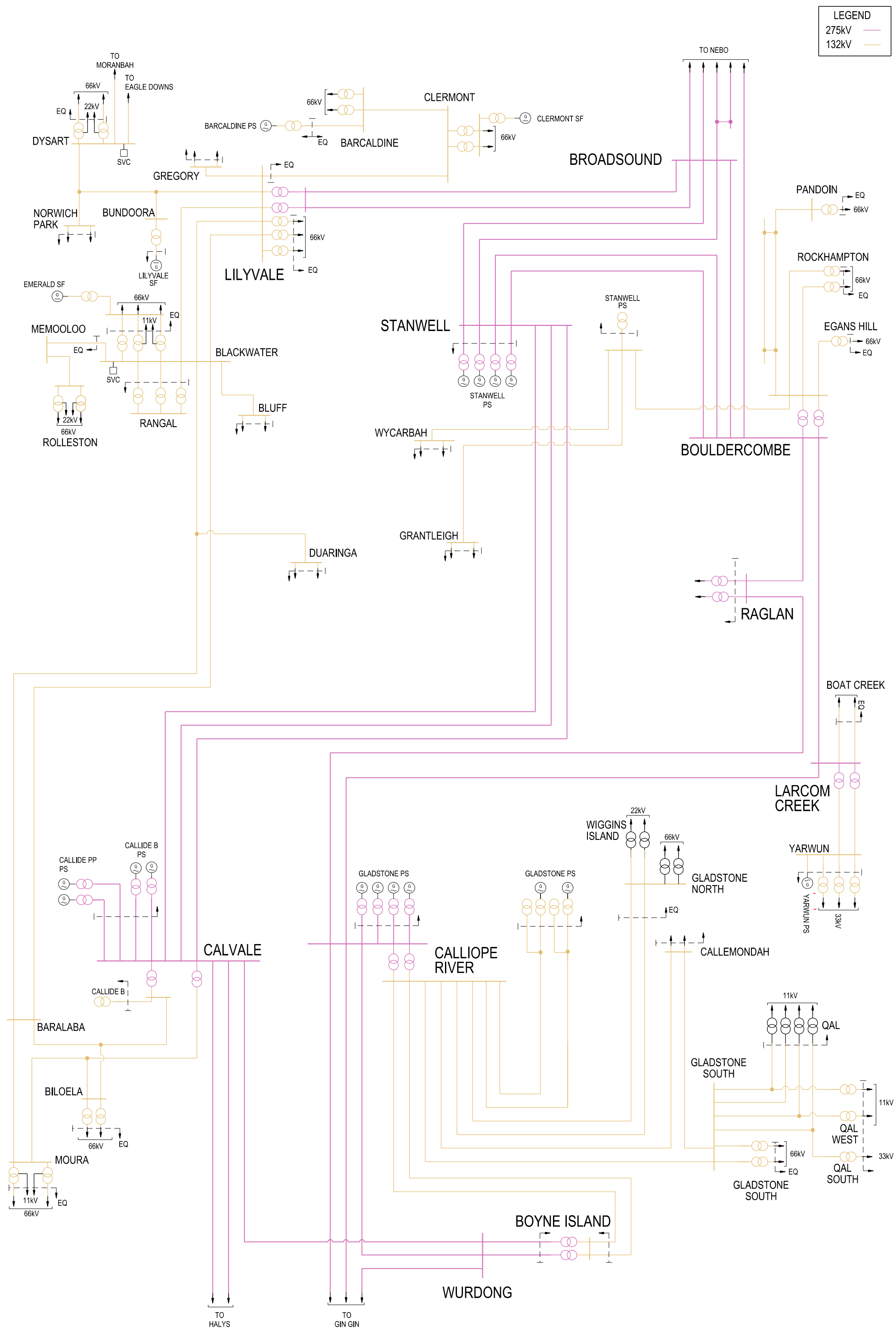


Figure 6.4 Existing HV network July 2020 - South West Queensland

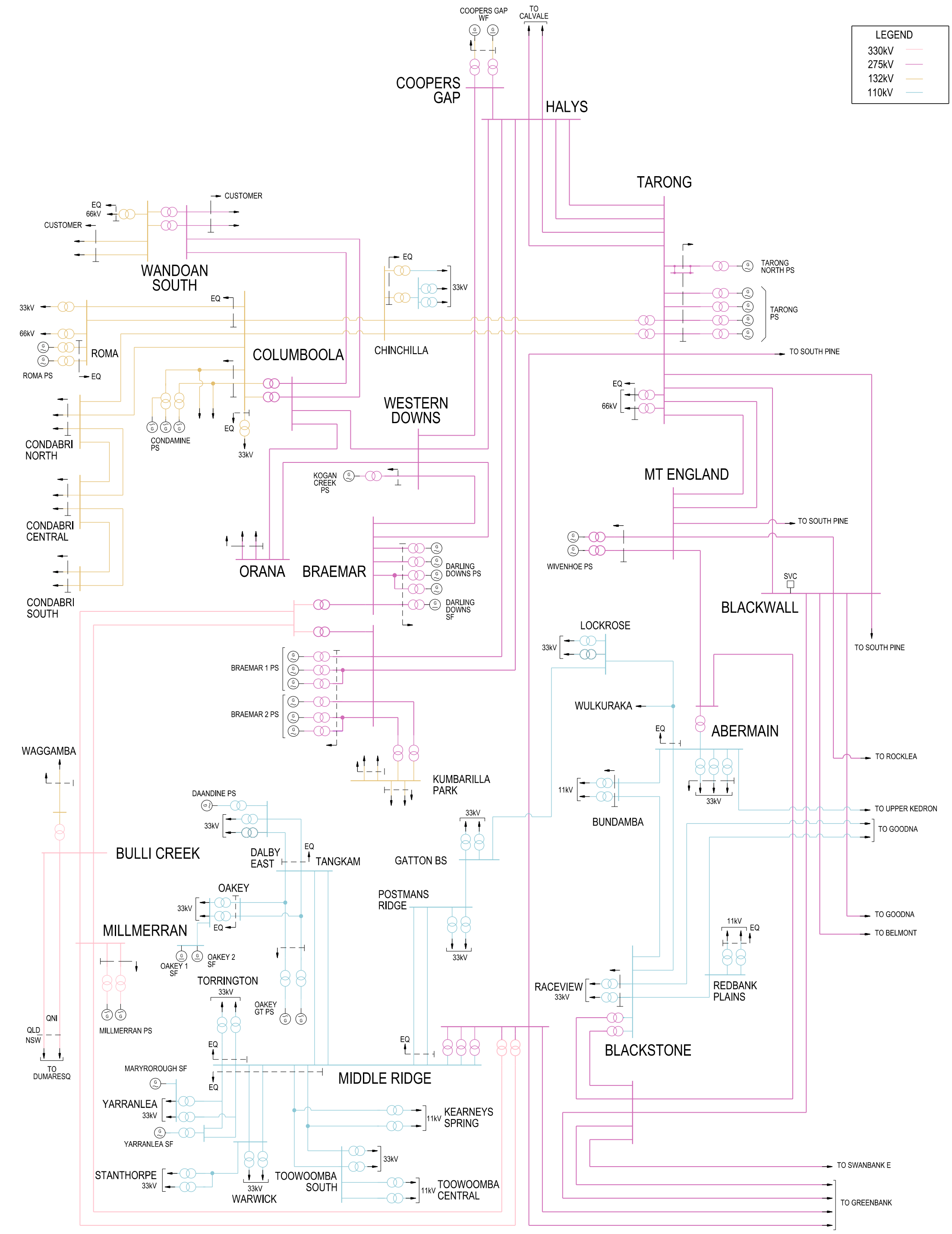
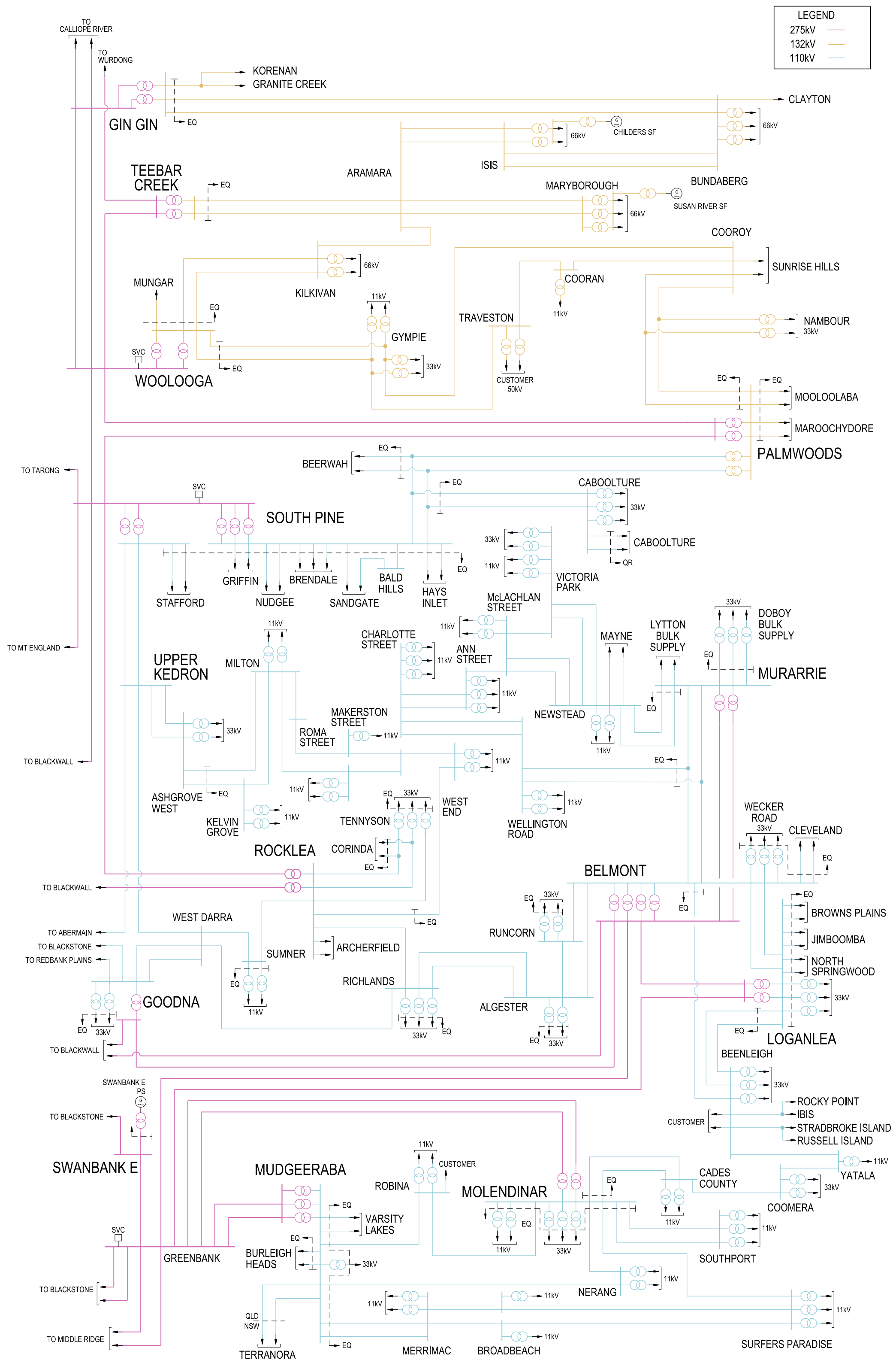


Figure 6.5 Existing HV network July 2020 - South East Queensland



6.5 Transfer capability

6.5.1 Location of grid sections

Powerlink has identified a number of grid sections that allow network capability and forecast limitations to be assessed in a structured manner. Limit equations have been derived for these grid sections to quantify maximum secure power transfer. Maximum power transfer capability may be set by transient stability, voltage stability, thermal plant ratings or protection relay load limits. AEMO has incorporated these limit equations into constraint equations within the National Electricity Market Dispatch Engine (NEMDE), Table C.2 provides definitions and Figure C.2 in Appendix C shows the location of relevant grid sections on the Queensland network.

6.5.2 Determining transfer capability

Transfer capability across each grid section varies with different system operating conditions. Transfer limits in the National Electricity Market (NEM) are not generally amenable to definition by a single number. Instead, TNSPs define the capability of their network using multi-term equations. These equations quantify the relationship between system operating conditions and transfer capability, and are implemented into NEMDE, following AEMO's due diligence, for optimal dispatch of generation. In Queensland the transfer capability is highly dependent on which generators are in-service and their dispatch level. The limit equations maximise transmission capability available to electricity market participants under prevailing system conditions.

Limit equations derived by Powerlink which are current at the time of publication of this TAPR are provided in Appendix D. Limit equations will change over time with demand, generation and network development and/or network reconfiguration. Such detailed and extensive analysis on limit equations has not been carried out for future network and generation developments for this TAPR. However, expected limit improvements for committed works are incorporated in all future planning. Section 6.6 provides a qualitative description of the main system conditions that affect the capability of each grid section.

6.6 Grid section performance

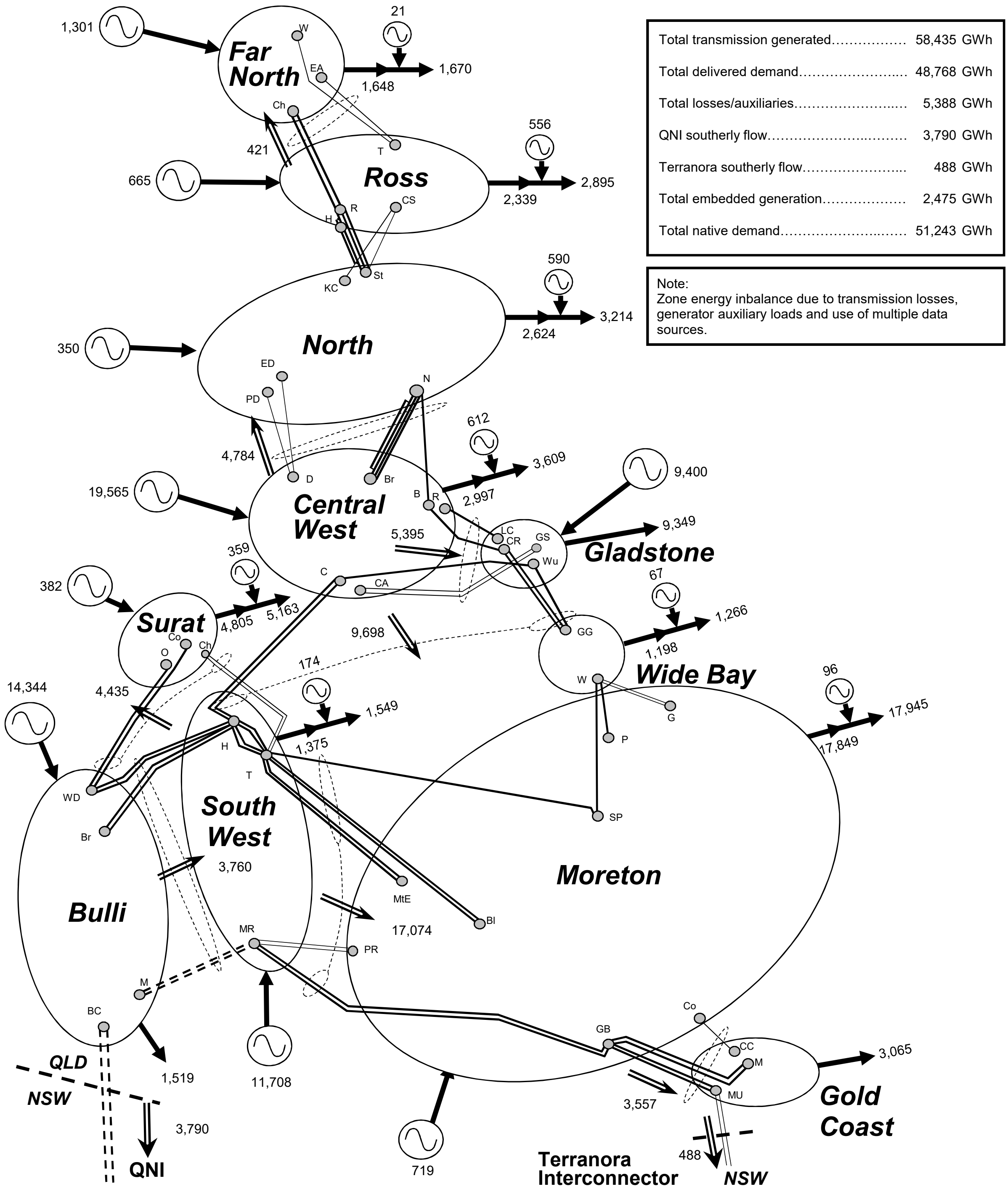
This section is a qualitative summary of system conditions with major effects on transfer capability across key grid sections of the Queensland network.

For each grid section, the time that the relevant constraint equations have bound over the last 10 years is provided categorised as occurring during intact or outage conditions based on AEMO's constraint description. Constraint times can be associated with a combination of generator unavailability, network outages, unfavourable dispatches and/or high loads. Constraint times do not include occurrences of binding constraints associated with network support agreements. Binding constraints whilst network support is dispatched are not classed as congestion. Although high constraint times may not be indicative of the cost of market impact, they serve as a trigger for the analysis of the economics for overcoming the congestion.

Binding constraint information is sourced from AEMO. Historical binding constraint information is not intended to imply a prediction of constraints in the future.

Historical transfer duration curves for the last five years are included for each grid section. Grid section transfers are predominantly affected by load, generation and transfers to neighbouring zones. Figures 6.6 and 6.7 provide 2018/19 and 2019/20 zonal energy as generated into the transmission network (refer to Figure C.1 in Appendix C for generators included in each zone) and by major embedded generators, transmission delivered energy to Distribution Network Service Providers (DNSPs) and direct connect customers and grid section energy transfers. Figure 6.8 provides the changes in energy transfers from 2018/19 to 2019/20. These figures assist in the explanation of differences between 2018/19 and 2019/20 grid section transfer duration curves.

Figure 6.6 2018/19 zonal electrical energy transfers (GWh)



Total transmission generated	58,435 GWh
Total delivered demand	48,768 GWh
Total losses/auxiliaries	5,388 GWh
QNI southerly flow	3,790 GWh
Terranora southerly flow	488 GWh
Total embedded generation	2,475 GWh
Total native demand	51,243 GWh

Note:
Zone energy inbalance due to transmission losses, generator auxiliary loads and use of multiple data sources.

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Figure 6.7 2019/20 zonal electrical energy transfers (GWh)

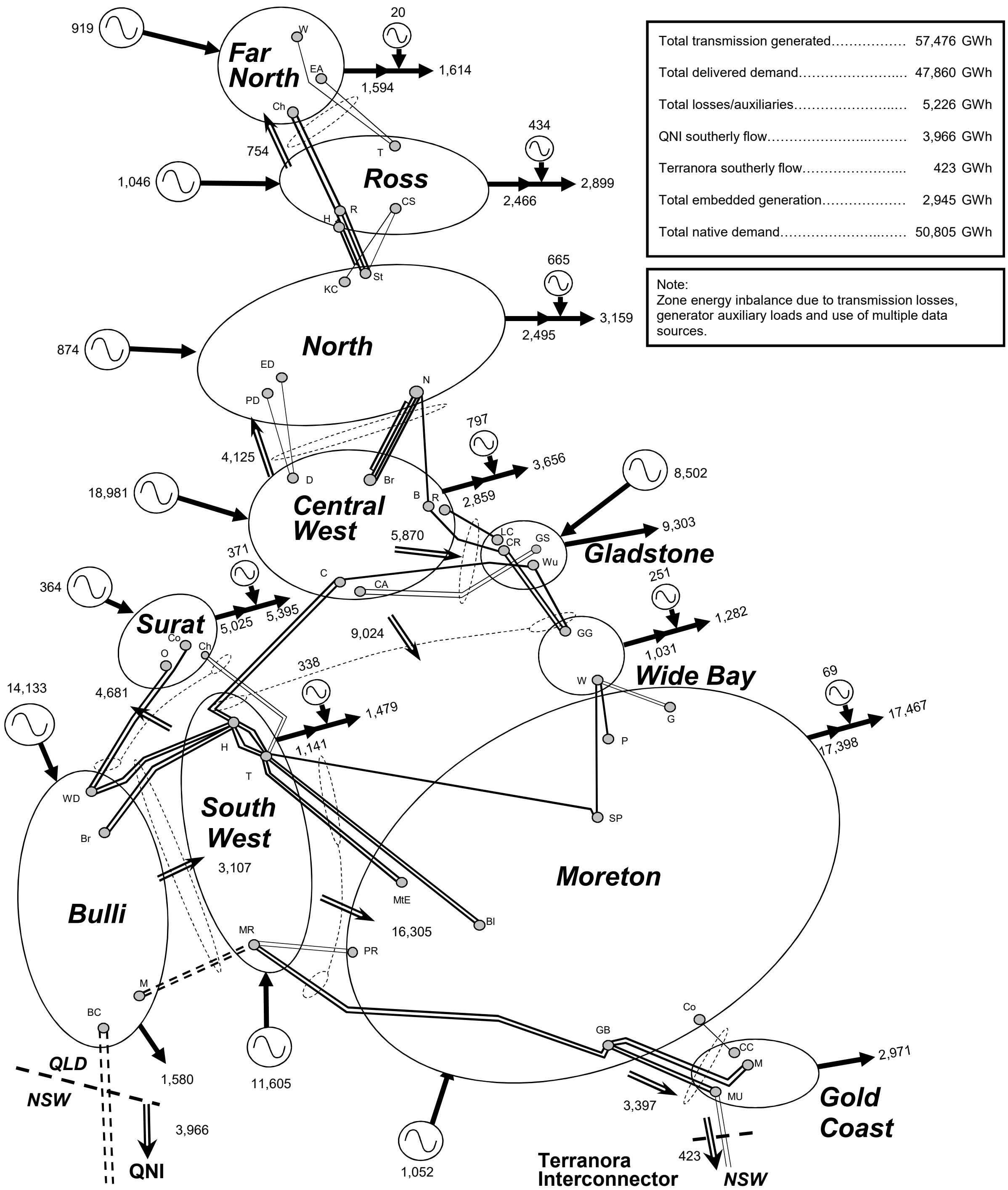
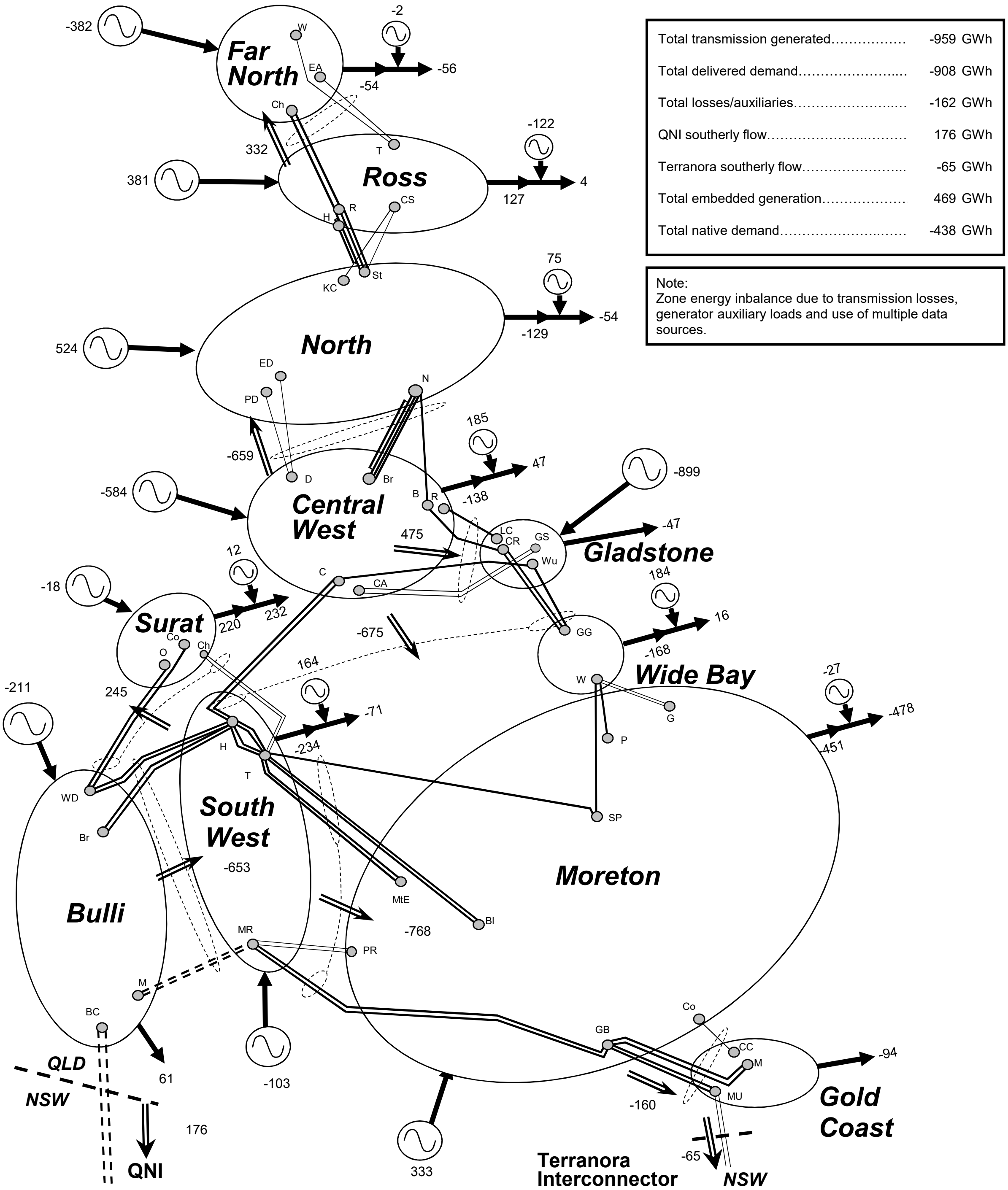


Figure 6.8 Change in zonal electrical energy transfers (GWh)



Total transmission generated	-959 GWh
Total delivered demand	-908 GWh
Total losses/auxiliaries	-162 GWh
QNI southerly flow	176 GWh
Terranora southerly flow	-65 GWh
Total embedded generation	469 GWh
Total native demand	-438 GWh

Note:
Zone energy inbalance due to transmission losses, generator auxiliary loads and use of multiple data sources.

6.6.1 Far North Queensland (FNQ) grid section

Maximum power transfer across the FNQ grid section is set by voltage stability associated with an outage of a Ross to Chalumbin 275kV circuit.

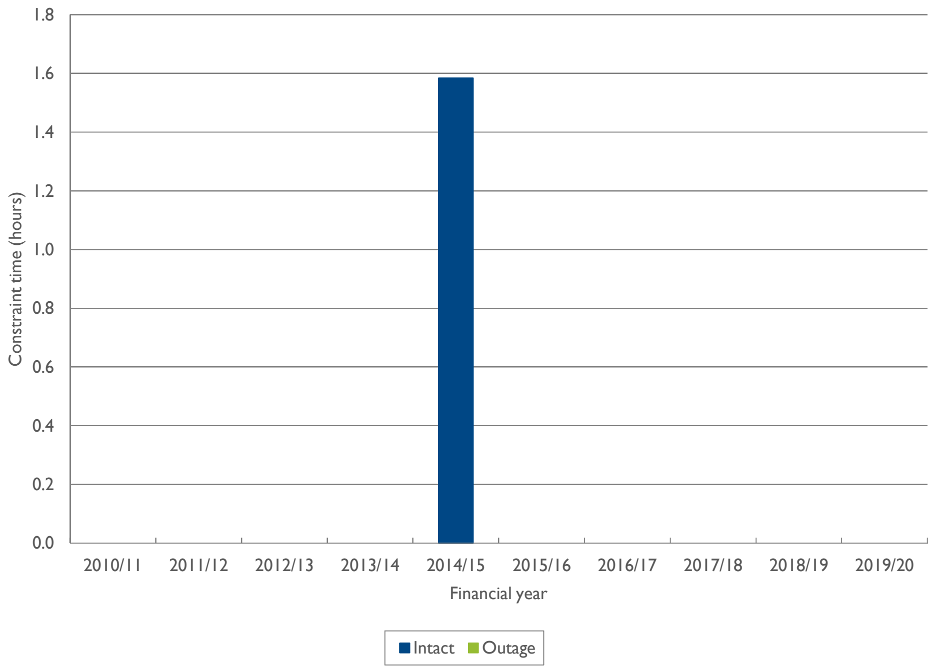
The limit equation in Table D.1 of Appendix D shows that the following variables have a significant effect on transfer capability:

- Far North zone to northern Queensland area[4] demand ratio
- Far North and Ross zones generation.

Local hydro generation reduces transfer capability but allows more demand to be securely supported in the Far North zone. This is because reactive margins increase with additional local generation, allowing further load to be delivered before reaching minimum allowable reactive margins. However, due to its distributed and reactive nature, increases in delivered demand erode reactive margins at greater rates than they were created by the additional local generation. Limiting power transfers are thereby lower with the increased local generation but a greater load can be delivered.

The FNQ grid section did not constrain operation during 2019/20. Information pertaining to the historical duration of constrained operation for the FNQ grid section is summarised in Figure 6.9.

Figure 6.9 Historical FNQ grid section constraint times

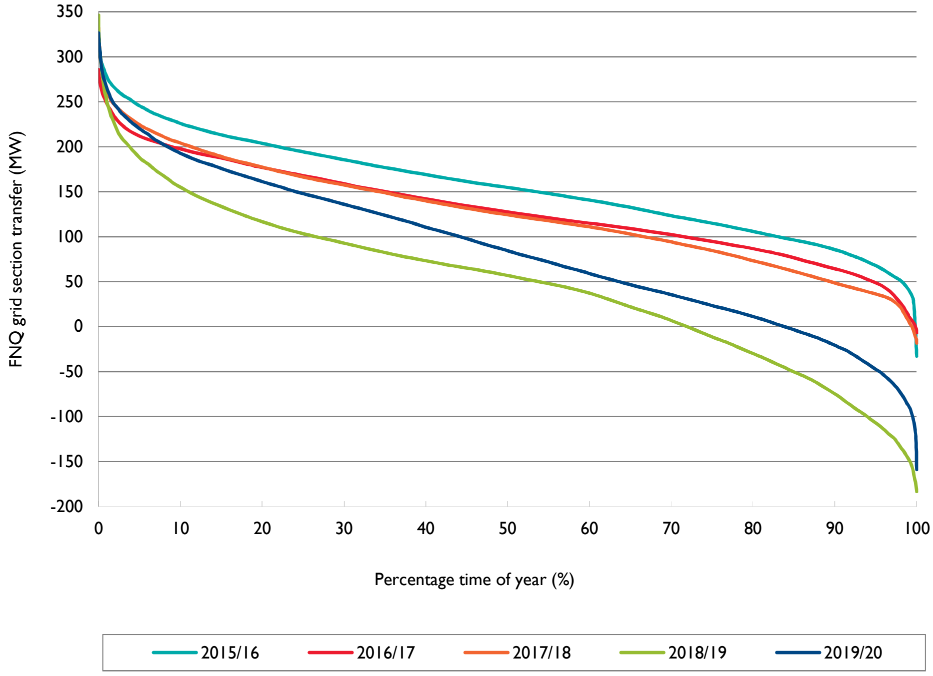


There have been minimal constraints in this grid section since 2010/11.

Figure 6.10 provides historical transfer duration curves showing a large decrease in energy transfer but similar peak transfers over 2019/20. This is predominantly attributed to the commissioned Mount Emerald wind farm located between Chalumbin and Woree substations. Historically, changes in peak flow and energy delivered to the Far North zone by the transmission network have been dependant on the Far North zone load and generation from the hydro generating power stations at Barron Gorge and Kareeya. These vary depending on rainfall levels in the Far North zone. The combined hydro generating power station capacity factor has reduced between 2018/19 and 2019/20 meaning there is still scope for lower northerly energy transfers (refer to figures 6.6, 6.7 and 6.8).

4 Northern Queensland area is defined as the combined demand of the Far North, Ross and North zones.

Figure 6.10 Historical FNQ grid section transfer duration curves



Network augmentations are not planned to occur as a result of network limitations across this grid section within the five-year outlook period.

6.6.2 Central Queensland to North Queensland (CQ-NQ) grid section

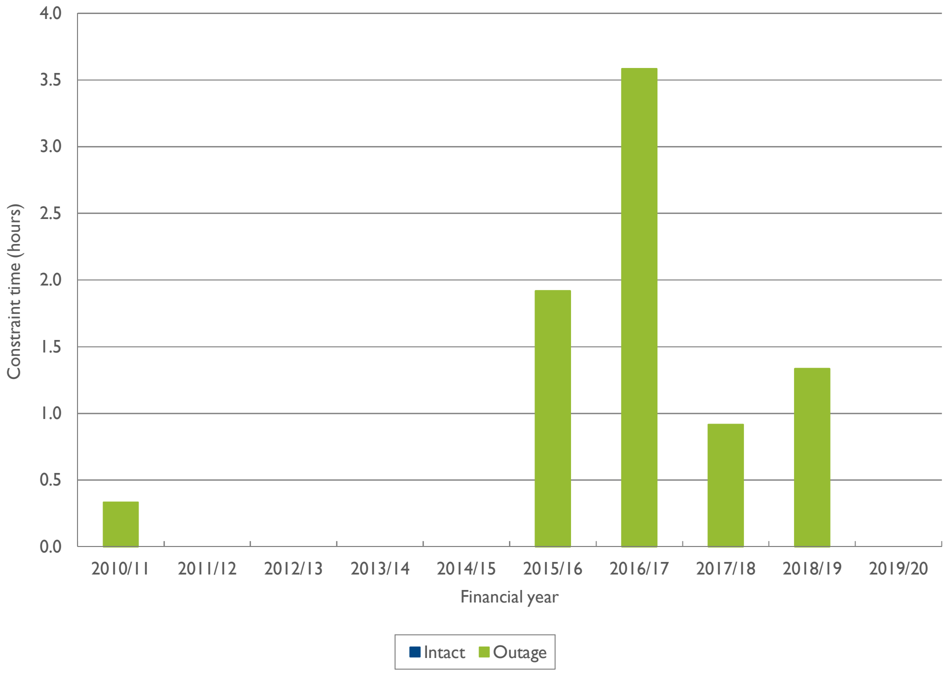
Maximum power transfer across the CQ-NQ grid section may be set by thermal ratings associated with an outage of a Stanwell to Broadsound 275kV circuit, under certain prevailing ambient conditions. Power transfers may also be constrained by voltage stability limitations associated with the contingency of the Townsville gas turbine or a Stanwell to Broadsound 275kV circuit.

The limit equations in Table D.2 of Appendix D show that the following variables have a significant effect on transfer capability:

- level of Townsville gas turbine generation
- Ross and North zones shunt compensation levels.

The CQ-NQ grid section did not constrain operation during 2019/20. Information pertaining to the historical duration of constrained operation for the CQ-NQ grid section is summarised in Figure 6.11.

Figure 6.11 Historical CQ-NQ grid section constraint times



The staged commissioning of double circuit lines from Broadsound to Ross completed in 2010/11 provided increased capacity to this grid section. Since this time constraint times were associated with thermal constraint equations during planned outages to ensure operation within plant thermal ratings. There have been minimal constraints in this grid section since 2010/11.

Figure 6.12 provides historical transfer duration curves showing a large decrease in energy transfer but similar peak transfers over the 2019/20 year. This is predominantly attributed to the recently commissioned Ross River, Sun Metals, Clare, Haughton, Collinsville, Whitsunday, Hamilton, Daydream, Hayman, Rugby Run solar farms and the Mt Emerald Wind Farm. The curves illustrate the ramping with commissioning activities over the last two years. Notably, peak transfers continue to be maintained at similar levels, as high net loading conditions continue to coincide (refer to figures 6.6, 6.7 and 6.8).

Figure 6.12 Historical CQ-NQ grid section transfer duration curves

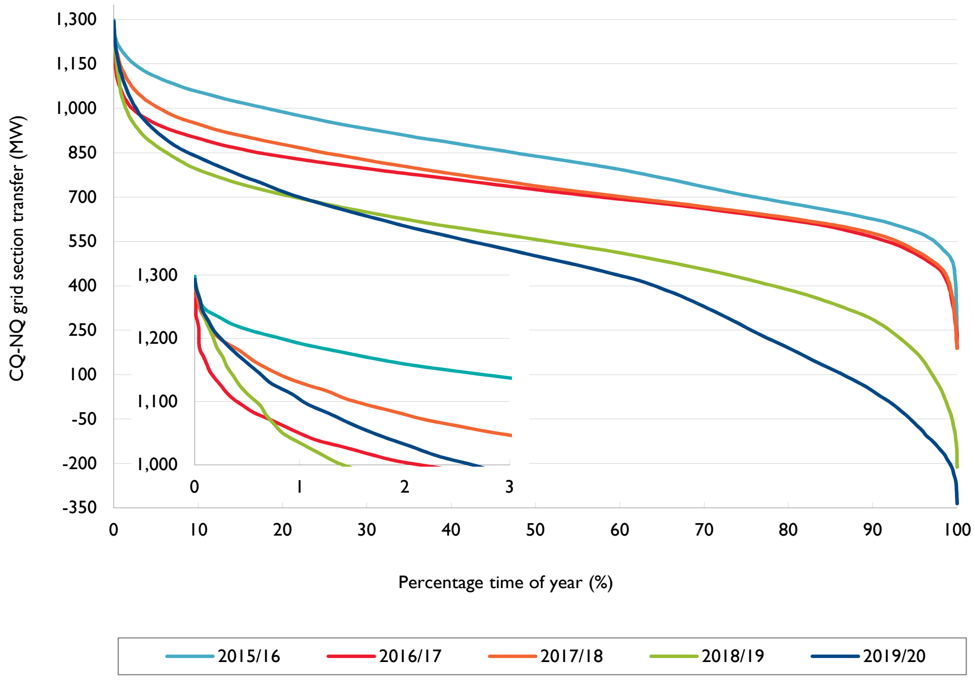
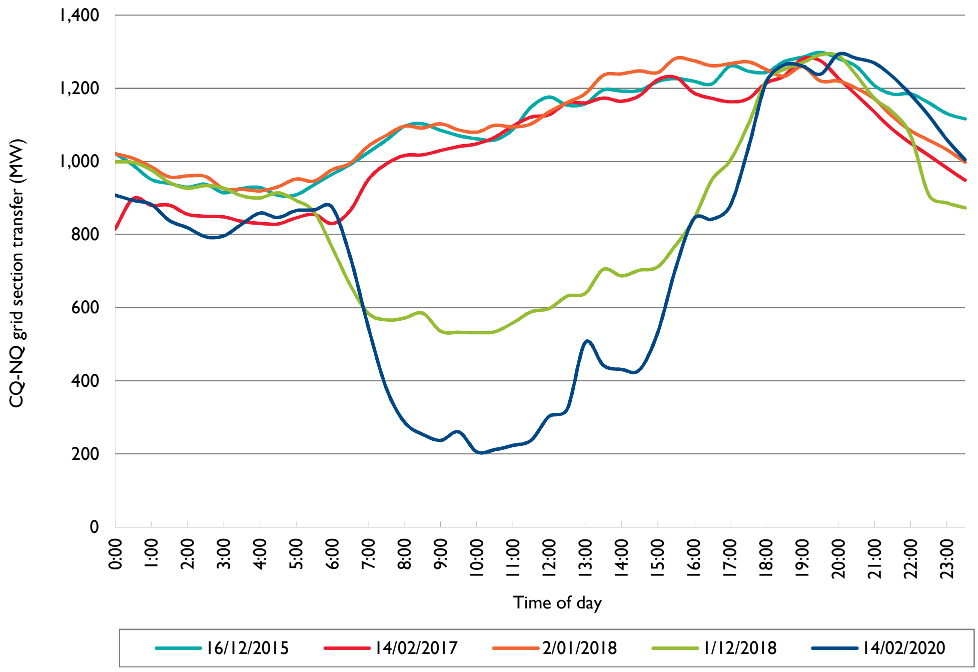


Figure 6.13 provides a different view of the altered power flows experienced over the last year.

Figure 6.13 Historical CQ-NQ peak grid section transfer daily profile



These midday reductions in transfers are introducing operational challenges in voltage control. Midday transfers are forecast to continue reducing with commissioning of additional capacity of VRE generators and integration of additional rooftop photovoltaic (PV) in NQ. Correspondingly, voltage control is forecast to become increasingly challenging for longer durations. Subject to Regulatory Investment Test for Transmission (RIT-T) consultation, Section 5.7.4 proposes the installation of a bus reactor to mitigate the risk of over voltages.

6.6.3 NQ System Strength

The Minimum Fault Level rule change that was introduced in 2018 required Powerlink to build a system-wide model to study system strength and its impact on the stability and performance of the power system. Through this work Powerlink understand that the dominant limitation to hosting capacity is the potential for multiple generators, and other transmission-connected dynamic plant, to interact in an unstable manner. These dynamic plant control interactions manifest as an unstable or undamped oscillation in the power system voltage. The frequency of the oscillation is dependent on the participating plants, but is broadly characterised as between 8Hz and 15Hz. The only way to gain an understanding of these oscillations is through detailed, PSCAD system-wide modelling.

In April 2020, AEMO declared a fault level shortfall in NQ at Ross node. As Queensland's TNSP, and therefore System Strength Service Provider, it is Powerlink's responsibility to ensure the minimum fault level is maintained at key nodes as defined by AEMO. In the short-term, Powerlink has achieved this by entering into an interim arrangement with CleanCo Queensland to utilise its assets in FNQ for system strength support. In addition, AEMO has provided preliminary confirmation to Powerlink that, subject to the final exchange of modelling and other details, inverter tuning could reduce the overall system strength requirement at Ross. Consequently Powerlink has entered into an agreement with Daydream, Hamilton, Hayman and Whitsunday Solar Farms in NQ to validate the expected positive benefits of inverter tuning. Powerlink is now working towards a longer-term solution. This is discussed further in sections 5.7.1 and 8.4.

System strength is a measure of the ability of a power system to remain stable under normal conditions and to return to a steady state condition following a system disturbance. System strength can be considered low in areas with low levels of local synchronous generation and deteriorates further with high penetration of inverter-based resources.

The limit equations in Table D.3 of Appendix D show that the following variables currently have a significant effect on NQ system strength:

- number of synchronous units online in Central and NQ
- NQ demand.

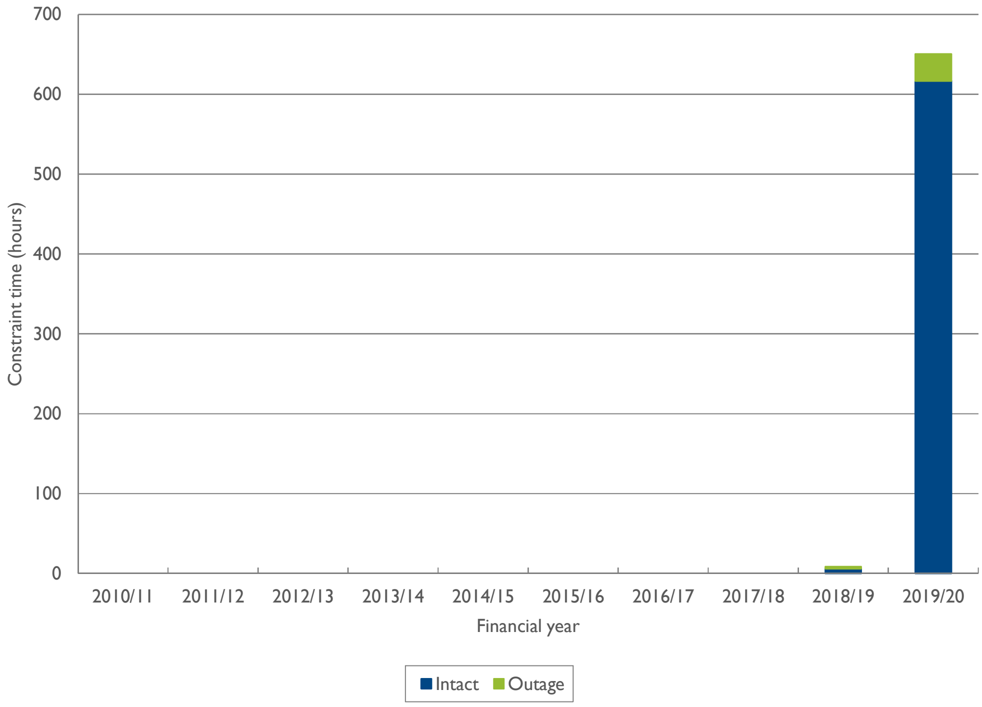
Information pertaining to the historical duration of constrained operation for inverter-based resources in NQ is summarised in Figure 6.14. During 2019/20, inverter-based resources in NQ experienced 650 hours of constrained operation, of which 617 hours occurred during intact system conditions. Constrained operation during intact system conditions has occurred for a number of reasons:

- abnormal power system dispatches resulting in fault levels in NQ below minimum fault level requirements[5]
- Powerlink is in the process of addressing a system strength shortfall in NQ that was declared by AEMO in April 2020 (refer to sections 5.7.1 and 8.4.1)
- Two solar farms in NQ have a system strength remediation obligation and until these are in place these plant may be subject to constraints depending on the synchronous dispatch in Central and NQ.

System strength limit equations will be revised as remediation strategies become operational.

[5] AEMO, Notice of Queensland System Strength Requirements and Ross Fault Level Shortfall, July 2018.

Figure 6.14 Historical NQ system strength constraint times



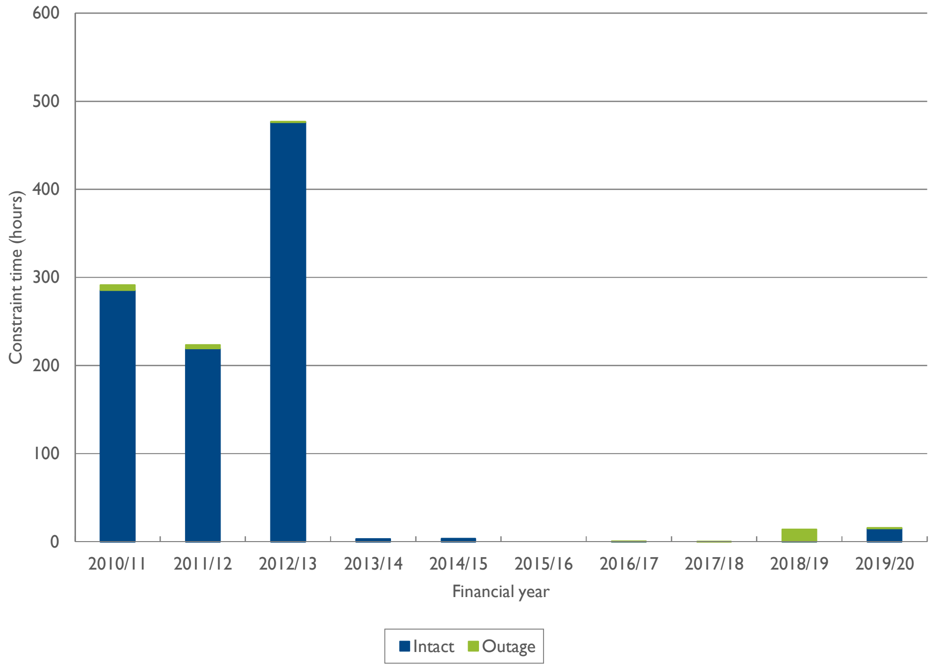
6.6.4 Gladstone grid section

Maximum power transfer across the Gladstone grid section is set by the thermal rating of the Bouldercombe to Raglan, Larcom Creek to Calliope River, Calvale to Wurdong or the Calliope River to Wurdong 275kV circuits.

If the rating would otherwise be exceeded following a critical contingency, generation is constrained to reduce power transfers. Powerlink makes use of dynamic line ratings and rates the relevant circuits to take account of real time prevailing ambient weather conditions to maximise the available capacity of this grid section and, as a result, reduce market impacts. The appropriate ratings are updated in NEMDE.

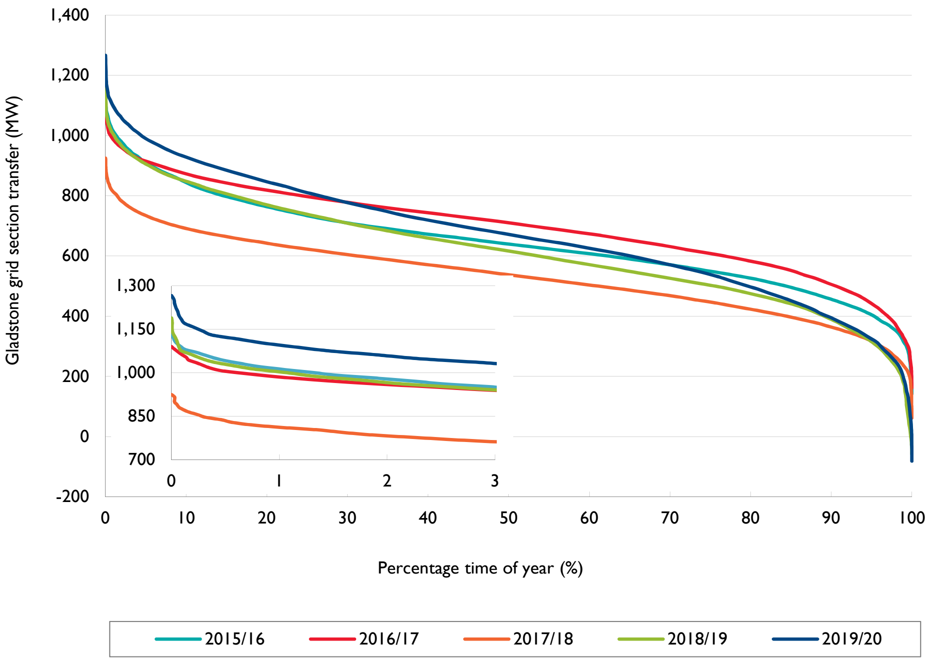
Information pertaining to the historical duration of constrained operation for the Gladstone grid section is summarised in Figure 6.15. During 2019/20, the Gladstone grid section experienced 16 hours of constrained operation, 15 hours during intact system conditions due to a combination of low Gladstone Power Station generation and high CQ-SQ transfers.

Figure 6.15 Historical Gladstone grid section constraint times



Power flows across this grid section are highly dependent on the dispatch of generation in CQ and transfers to southern Queensland. Figure 6.16 provides historical transfer duration curves showing increased utilisation in 2019/20 compared to 2018/19. Reduced capacity factor from Gladstone Power Station is predominantly responsible for the increase in transfer through this grid section (refer to figures 6.6, 6.7 and 6.8).

Figure 6.16 Historical Gladstone grid section transfer duration curves



The utilisation of the Gladstone grid section is expected to continue to increase if the recently committed generators displace Gladstone zone or southern generators as this incremental power makes its way to the load in the Gladstone and/or southern Queensland zones.

6.6.5 CQ-SQ grid section

Maximum power transfer across the CQ-SQ grid section is set by transient or voltage stability following a Calvale to Halys 275kV circuit contingency.

The voltage stability limit is set by insufficient reactive power reserves in the Central West and Gladstone zones following a contingency. More generating units online in these zones increase reactive power support and therefore transfer capability.

The limit equation in Table D.4 of Appendix D shows that the following variables have significant effect on transfer capability:

- number of generating units online in the Central West and Gladstone zones
- level of Gladstone Power Station generation.

Information pertaining to the historical duration of constrained operation for the CQ-SQ grid section is summarised in Figure 6.17. During 2019/20, the CQ-SQ grid section experienced 593 hours of constrained operation. Constrained operation was mainly associated with planned maintenance outages (this project work is now complete), with only 49 hours constrained in a system normal state.

Figure 6.17 Historical CQ-SQ grid section constraint times

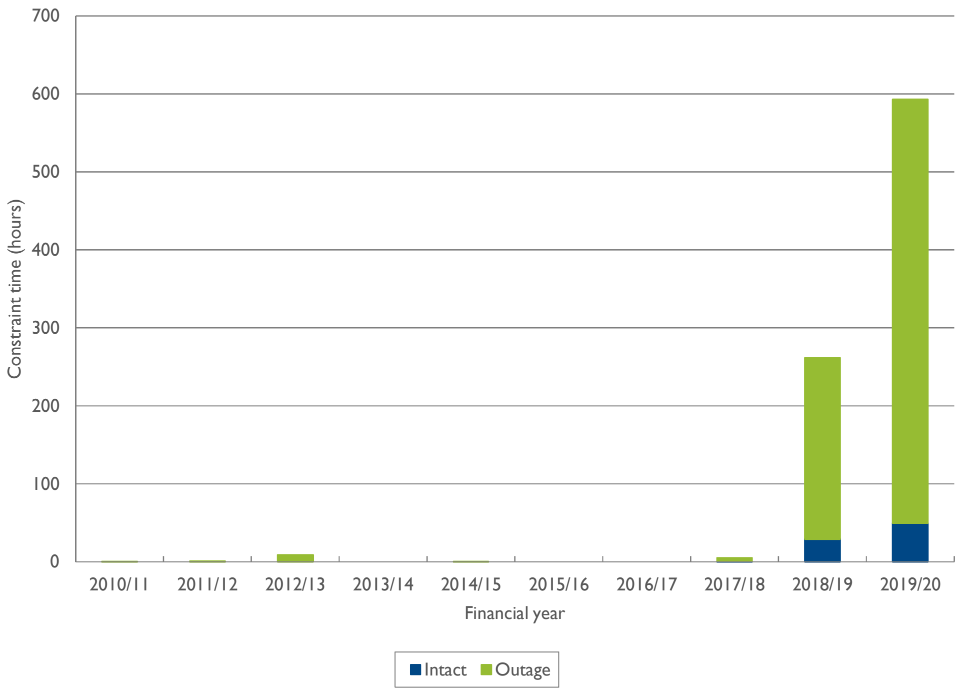
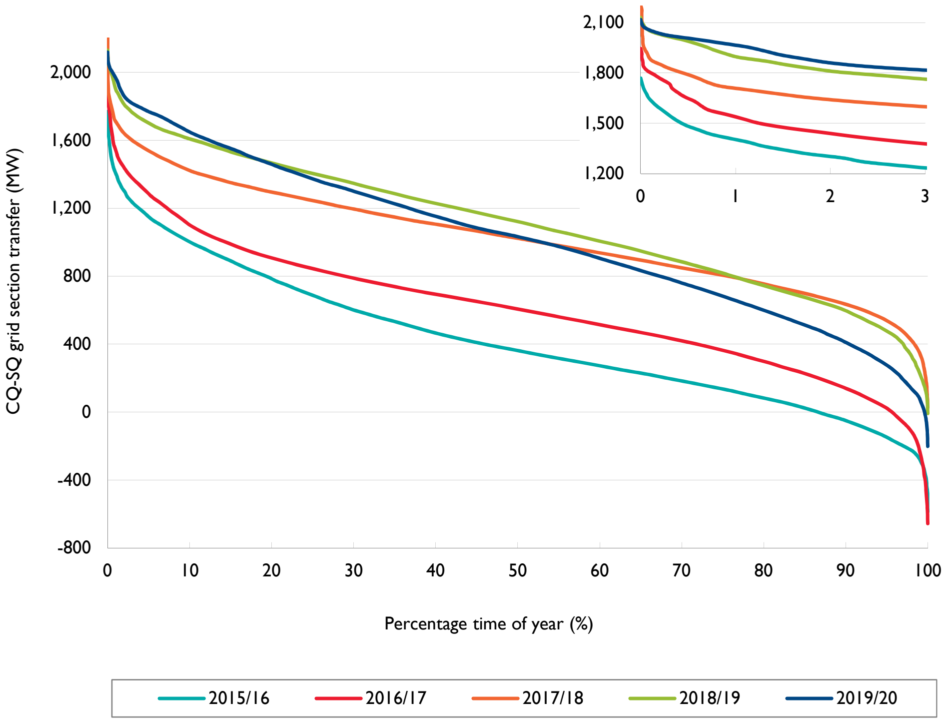


Figure 6.18 provides historical transfer duration curves showing continued increase in utilisation since 2015. This increase in transfer has been predominantly due to a significant reduction in generation from the gas fuelled generators in the Bulli zone and higher interconnector transfers sourced predominantly by generation in central and north Queensland (refer to figures 6.6, 6.7 and 6.8). The utilisation of the CQ-SQ grid section is expected to further increase over time if the newly committed generators in the north displace southern generators.

Figure 6.18 Historical CQ-SQ grid section transfer duration curves



The eastern single circuit transmission lines of CQ-SQ traverse a variety of environmental conditions that have different rates of corrosion resulting in varied risk levels across the transmission lines. Depending on transmission line location, it is expected that sections of lines will be at end of technical service life from the next five to 10 years. This is discussed in Section 5.7.6.

6.6.6 Surat grid section

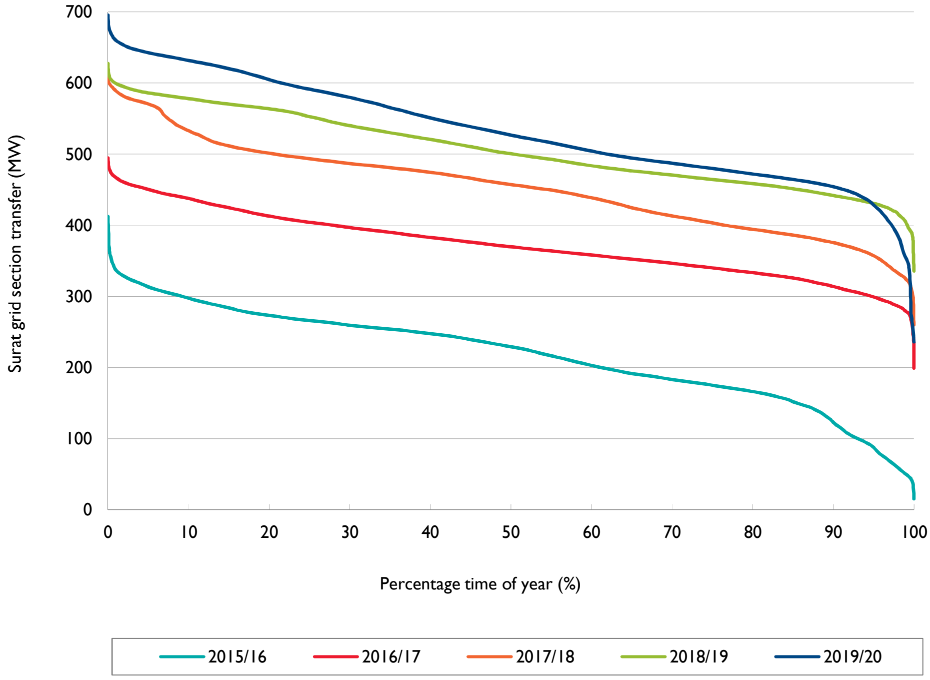
The Surat grid section was introduced in the 2014 TAPR in preparation for the establishment of the Western Downs to Columboola 275kV transmission line[6], Columboola to Wandoan South 275kV transmission line and Wandoan South and Columboola 275kV substations. These network developments were completed in September 2014 and significantly increased the supply capacity to the Surat Basin north west area.

The maximum power transfer across the Surat grid section is set by voltage stability associated with insufficient reactive power reserves in the Surat zone following an outage of a Western Downs to Orana 275kV circuit. More generating units online in the zone increases reactive power support and therefore transfer capability. Local generation reduces transfer capability but allows more demand to be securely supported in the Surat zone. There have been no constraints recorded over the brief history of the Surat grid section.

Figure 6.19 provides the transfer duration curve since the zone's creation. Grid section transfers depict the ramping of coal seam gas (CSG) load. The zone has transformed from a net exporter to a significant net importer of energy. Energy transfers are expected to reduce with the commitment of Bluegrass, Columboola and Gangarri solar farms.

6 The Orana Substation is connected to one of the Western Downs to Columboola 275kV transmission lines.

Figure 6.19 Historical Surat grid section transfer duration curve



Network augmentations are not planned to occur as a result of network limitations across this grid section within the five-year outlook period.

The development of large loads in Surat (additional to those included in the forecasts), without corresponding increases in generation, can significantly increase the levels of Surat grid section transfers. This is discussed in Section 7.3.5.

6.6.7 South West Queensland (SWQ) grid section

The SWQ grid section defines the capability of the transmission network to transfer power from generating stations located in the Bulli zone and northerly flow on QNI to the rest of Queensland. The grid section is not expected to impose limitations to power transfer under intact system conditions with existing levels of generating capacity.

The SWQ grid section did not constrain operation during 2019/20. Information pertaining to the historical duration of constrained operation for the SWQ grid section is summarised in Figure 6.20.

Figure 6.20 Historical SWQ grid section constraint times

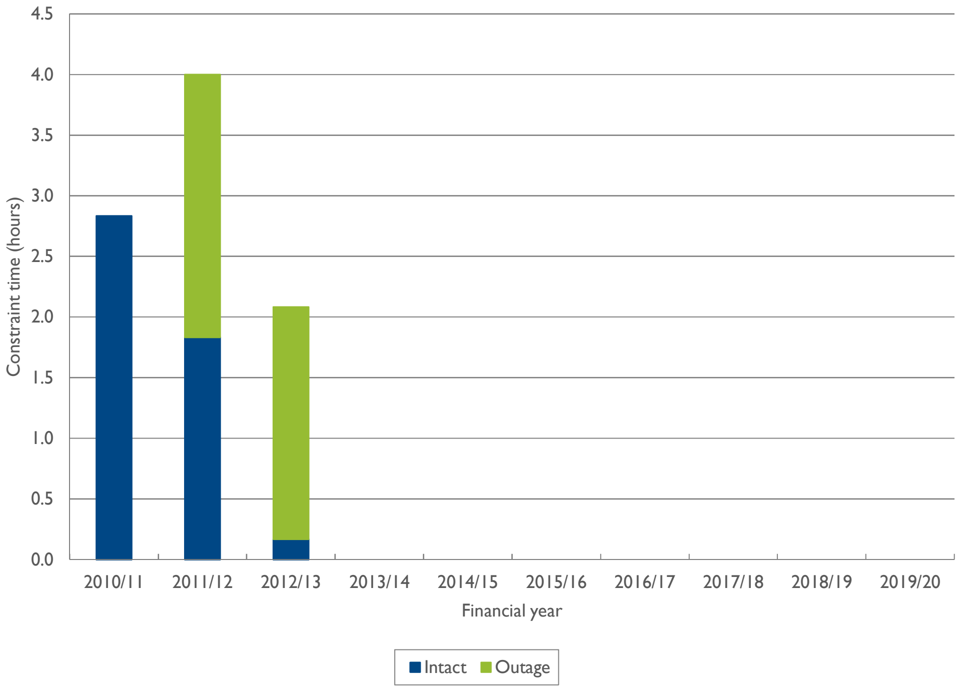
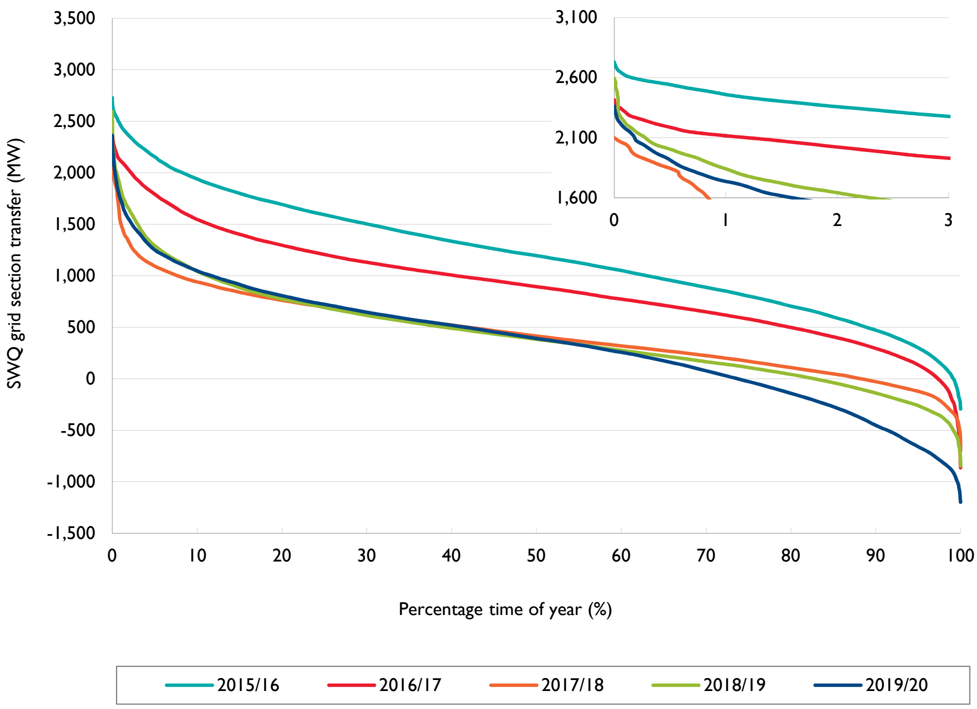


Figure 6.21 provides historical transfer duration curves showing reductions in energy transfer since 2015/16. Reductions in South West, Wide Bay, Moreton and Gold Coast delivered demands (refer to figures 6.6, 6.7 and 6.8) are predominantly responsible for the reduction in SWQ utilisation.

Figure 6.21 Historical SWQ grid section transfer duration curves



Network augmentations are not planned to occur as a result of network limitations across this grid section within the five-year outlook period.

6.6.8 Tarong grid section

Maximum power transfer across the Tarong grid section is set by voltage stability associated with the loss of a Calvale to Halys 275kV circuit. The limitation arises from insufficient reactive power reserves in southern Queensland.

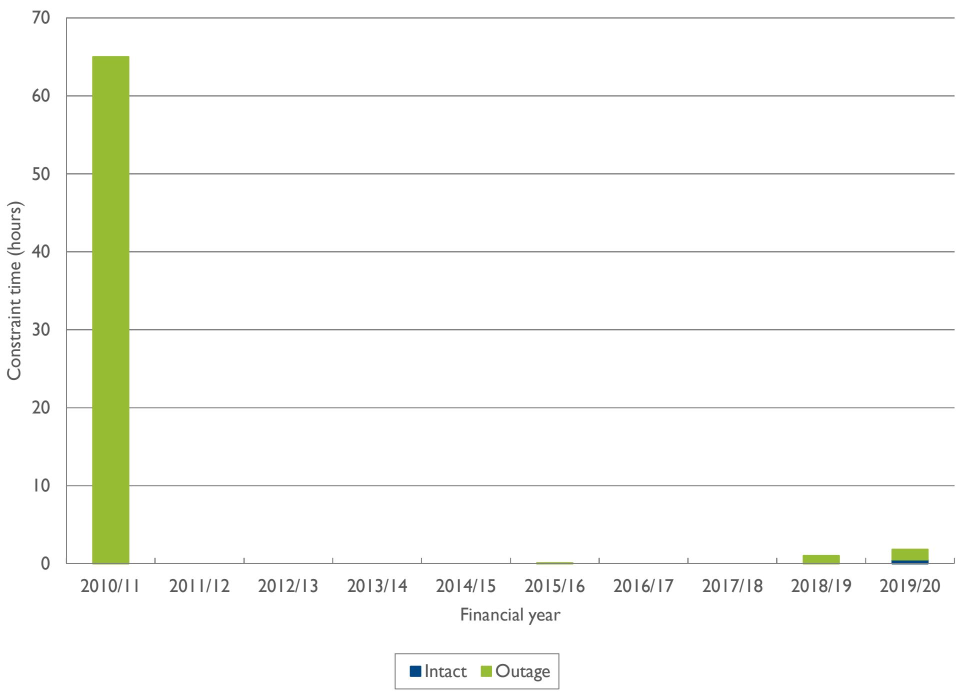
Limit equations in Table D.5 of Appendix D show that the following variables have a significant effect on transfer capability:

- QNI transfer and South West and Bulli zones generation
- level of Moreton zone generation
- Moreton and Gold Coast zones capacitive compensation levels.

Any increase in generation west of this grid section, with a corresponding reduction in generation north of the grid section, reduces the CQ-SQ power flow and increases the Tarong limit. Increasing generation east of the grid section reduces the transfer capability, but increases the overall amount of supportable South East Queensland (SEQ) demand. This is because reactive margins increase with additional local generation, allowing further load to be delivered before reaching minimum allowable reactive margins. However, due to its distributed and reactive nature, increases in delivered demand erode reactive margins at greater rates than they were created by the additional local generation. Limiting power transfers are thereby lower with the increased local generation but a greater load can be delivered.

Information pertaining to the historical duration of constrained operation for the Tarong grid section is summarised in Figure 6.22. During 2019/20, the Tarong grid section appears to have been constrained for two hours and one hour during 2018/19. Powerlink is working with AEMO to investigate the reason for this congestion.

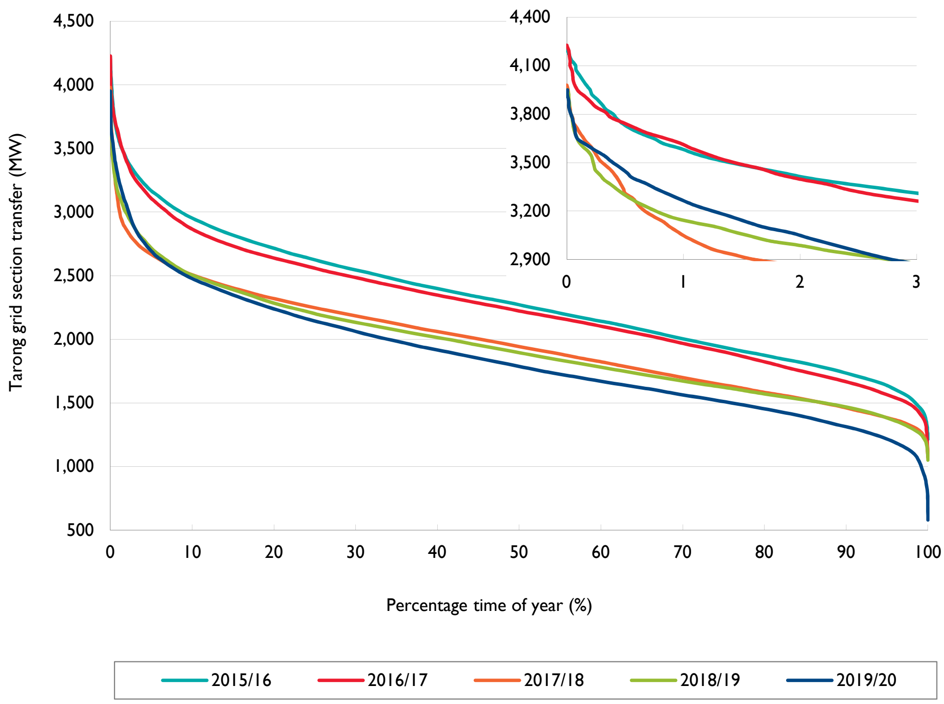
Figure 6.22 Historical Tarong grid section constraint times



Constraint times have been minimal over the last 10 years, with the exception of 2010/11, where constraint times are associated with line outages as a result of severe weather events in January 2011.

Figure 6.23 provides historical transfer duration curves showing small annual differences in grid section transfer demands. The reduction in transfer between 2016/17 and 2017/18 is predominantly attributed to the return to service of Swanbank E from its mothballed state. The 2019/20 trace reflects lower energy transfers into SEQ as a result of Wivenhoe and Swanbank E generation and lower Wide Bay, Moreton and Gold Coast delivered demands (refer to figures 6.6, 6.7 and 6.8).

Figure 6.23 Historical Tarong grid section transfer duration curves



Network augmentations are not planned to occur as a result of network limitations across this grid section within the five year outlook period.

6.6.9 Gold Coast grid section

Maximum power transfer across the Gold Coast grid section is set by voltage stability associated with the loss of a Greenbank to Molendinar 275kV circuit, or Greenbank to Mudgeeraba 275kV circuit.

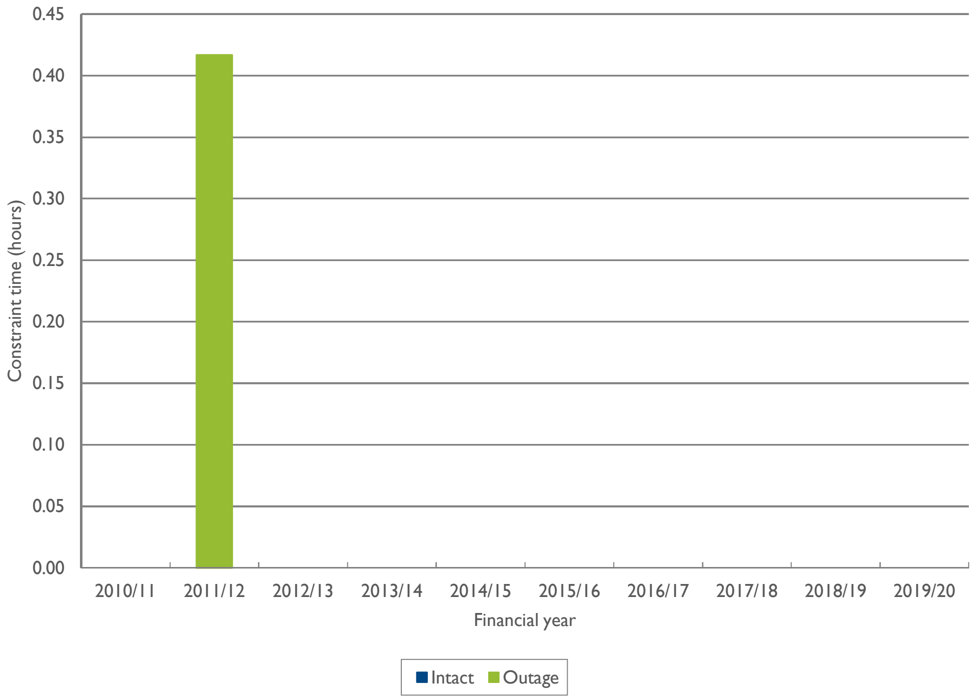
The limit equation in Table D.6 of Appendix D shows that the following variables have a significant effect on transfer capability:

- number of generating units online in Moreton zone
- level of Terranora Interconnector transmission line transfer
- Moreton and Gold Coast zones capacitive compensation levels
- Moreton zone to the Gold Coast zone demand ratio.

Reducing southerly flow on Terranora Interconnector reduces transfer capability, but increases the overall amount of supportable Gold Coast demand. This is because reactive margins increase with reductions in southerly Terranora Interconnector flow, allowing further load to be delivered before reaching minimum allowable reactive margins. However, due to its distributed and reactive nature, increases in delivered demand erode reactive margins at greater rates than they were created by the reduction in Terranora Interconnector southerly transfer. Limiting power transfers are thereby lower with reduced Terranora Interconnector southerly transfer but a greater load can be delivered.

The Gold Coast grid section did not constrain operation during 2019/20. Information pertaining to the historical duration of constrained operation for the Gold Coast grid section is summarised in Figure 6.24.

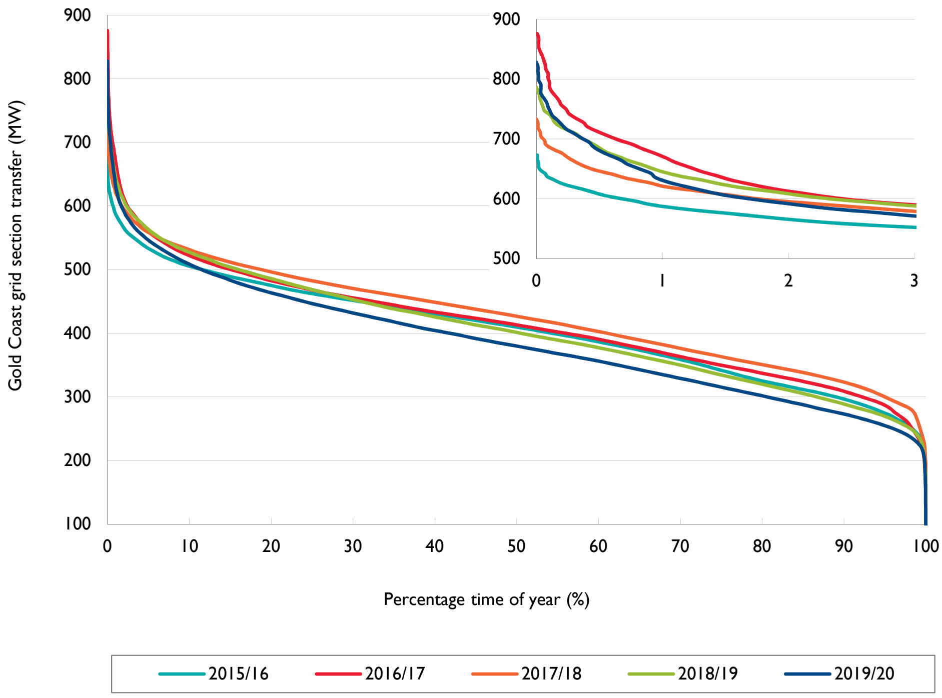
Figure 6.24 Historical Gold Coast grid section constraint times



Constraint times have been minimal since 2007, with the exception of 2010/11 where constraint times are associated with the planned outage of one of the 275kV Greenbank to Mudgeeraba feeders.

Figure 6.25 provides historical transfer duration curves showing changes in grid section transfer demands and energy in line with changes in transfer to northern NSW and changes in Gold Coast loads. Northern NSW transfers and Gold Coast zone demand were lower in 2019/20 compared to 2018/19 (refer to Section 6.7.11).

Figure 6.25 Historical Gold Coast grid section transfer duration curves



Due to condition drivers, Powerlink is proposing to retire one of the aging 275/110kV transformers at Mudgeeraba Substation by 2020. This is discussed further in Section 5.7.11.

6.6.10 QNI and Terranora Interconnector

The transfer capability across QNI is limited by voltage stability, transient stability, oscillatory stability, and line thermal rating considerations. The capability across QNI at any particular time is dependent on a number of factors, including demand levels, generation dispatch, status and availability of transmission equipment, and operating conditions of the network.

AEMO publish Monthly Constraint Reports which includes a section examining each of the NEM interconnectors, including QNI and Terranora Interconnector. Information pertaining to the historical duration of constrained operation for QNI and Terranora Interconnector is contained in these Monthly Constraint Reports. The Monthly Constraint Report can be found on AEMO's website.

For intact system operation, the southerly transfer capability of QNI is most likely to be set by the following:

- voltage stability associated with a fault on the Sapphire to Armidale 330kV transmission line in NSW
- transient stability associated with transmission faults near the Queensland border
- transient stability associated with the trip of a smelter potline load in Queensland
- transient stability associated with transmission faults in the Hunter Valley in NSW
- transient stability associated with a fault on the Hazelwood to South Morang 500kV transmission line in Victoria
- thermal capacity of the 330kV transmission network between Armidale and Liddell in NSW
- oscillatory stability upper limit of 1,200MW.

For intact system operation, the combined northerly transfer capability of QNI and Terranora Interconnector is most likely to be set by the following:

- transient and voltage stability associated with transmission line faults in NSW

- transient stability and voltage stability associated with loss of the largest generating unit in Queensland
- thermal capacity of the 330kV and 132kV transmission network within northern NSW
- oscillatory stability upper limit of 700MW.

In December 2019, Powerlink and TransGrid released a Project Assessment Conclusion Report (PACR) on 'Expanding NSW-Queensland transmission transfer capacity', identifying the preferred option which includes uprating the 330kV Liddell to Tamworth 330kV lines, and installing Static VAr Compensators (SVC) at Tamworth and Dumaresq substations and static capacitor banks at Tamworth, Armidale and Dumaresq substations. The project is expected to be completed by June 2022 at a cost of $217 million.

AEMO's Integrated System Plan (ISP) continues to investigate opportunities for expansion of interconnector capacity. In the 2020 ISP AEMO identified QNI Medium and Large projects as future ISP projects, requiring Powerlink and TransGrid to undertake preparatory activities by 30 June 2021.

6.7 Zone performance

This section presents, where applicable, a summary of:

- the capability of the transmission network to deliver loads
- historical zonal transmission delivered loads
- intra-zonal system normal constraints
- double circuit transmission lines categorised as vulnerable by AEMO
- Powerlink's management of high voltages associated with light load conditions.

Double circuit transmission lines that experience a lightning trip of all phases of both circuits are categorised by AEMO as vulnerable. A double circuit transmission line in the vulnerable list is eligible to be reclassified as a credible contingency event during a lightning storm if a cloud to ground lightning strike is detected close to the line. A double circuit transmission line will remain on the vulnerable list until it is demonstrated that the asset characteristics have been improved to make the likelihood of a double circuit lightning trip no longer reasonably likely to occur or until the Lightning Trip Time Window (LTTW) expires from the last double circuit lightning trip. The LTTW is three years for a single double circuit trip event or five years where multiple double circuit trip events have occurred during the LTTW.

Zonal transmission delivered energy, in general, has remained steady in 2019/20, compared to 2018/19 (refer to Figure 6.8), despite reductions in the last quarter of the financial year due to COVID-19 pandemic impacts, significant increases in embedded VRE generation and Queensland's installed rooftop PV reaching 3,285MW in June 2020.

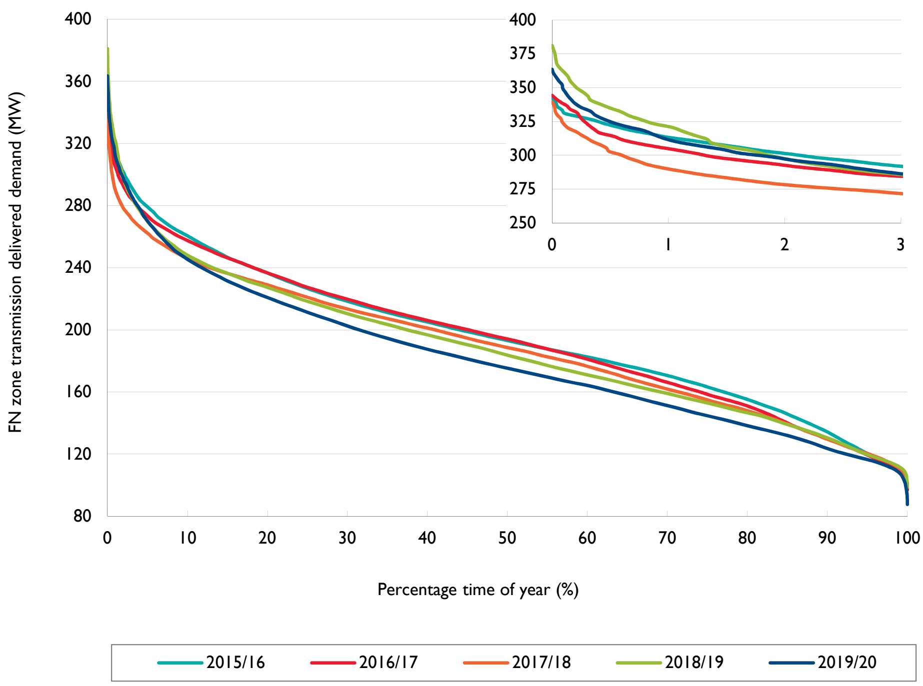
6.7.1 Far North zone

The Far North zone experienced no load loss for a single network element outage during 2019/20.

The Far North zone includes the non-scheduled embedded generator Lakeland Solar and Storage as defined in Figure 2.6. This embedded generator provided approximately 20GWh during 2019/20.

Figure 6.26 provides historical transmission delivered load duration curves for the Far North zone. Energy delivered from the transmission network has reduced by 3.3% between 2018/19 and 2019/20. The maximum transmission delivered demand in the zone was 364MW, which is below the highest maximum demand over the last five years of 381MW set in 2018/19. The minimum transmission delivered demand in the zone was 88MW, which is the lowest minimum demand over the last five years.

Figure 6.26 Historical Far North zone transmission delivered load duration curves



High voltages associated with these light load conditions are currently managed with existing reactive sources. However, voltage control within Powerlink's and Ergon Energy's network is forecast to become increasingly challenging for longer durations.

As a result of double circuit outages associated with lightning strikes, AEMO has included Chalumbin to Turkinje 132kV in the vulnerable list. This double circuit tripped due to lightning in January 2016.

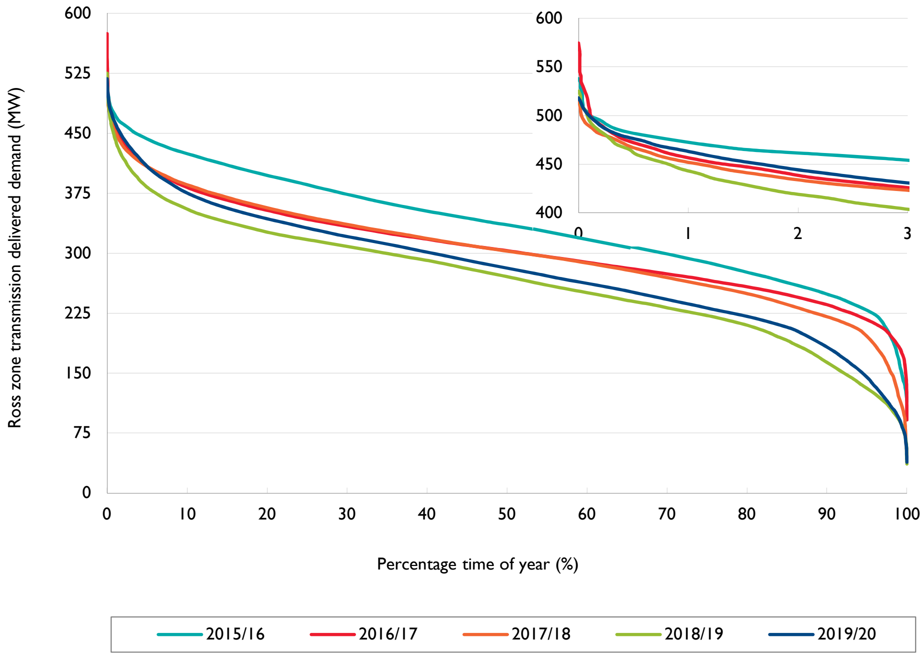
6.7.2 Ross zone

The Ross zone experienced no load loss for a single network element outage during 2019/20.

The Ross zone includes the scheduled embedded Townsville Power Station 66kV component, semi-scheduled distribution connected embedded Kidston Solar Farm, Kennedy Energy Park and direct connected embedded Sun Metals Solar Farm, and the significant non-scheduled embedded generators Hughenden Solar Farm and Pioneer Mill as defined in Figure 2.6. These embedded generators provided approximately 434GWh during 2019/20.

Figure 6.27 provides historical transmission delivered load duration curves for the Ross zone. Energy delivered from the transmission network has increased by 5.4% between 2018/19 and 2019/20. The increase in energy delivered is predominantly due to the reduction in energy from embedded generation. The peak transmission delivered demand in the zone was 518MW which is below the highest maximum demand over the last five years of 574MW set in 2016/17. The minimum transmission delivered demand in the zone was 39MW, which is above the lowest demand over the last five years of 36MW set in 2018/19.

Figure 6.27 Historical Ross zone transmission delivered load duration curves



As a result of double circuit outages associated with lightning strikes, AEMO has included the Ross to Chalumbin 275kV double circuit transmission line in the vulnerable list. This double circuit tripped due to lightning in January 2020.

High voltages associated with light load conditions are managed with existing reactive sources.

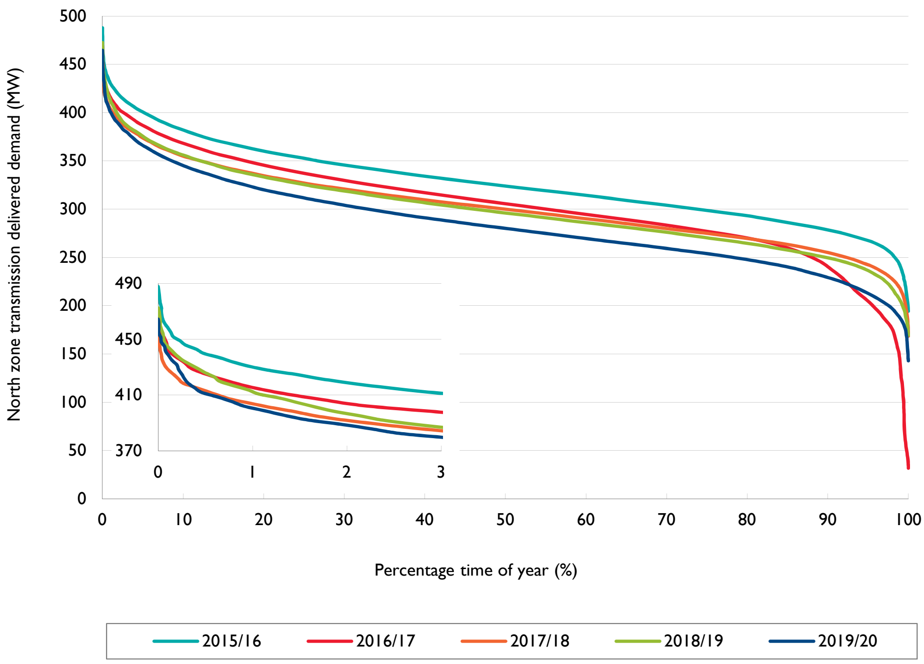
6.7.3 North zone

The North zone experienced no load loss for a single network element outage during 2019/20.

The North zone includes the scheduled embedded Mackay generator, semi-scheduled embedded generator Collinsville Solar Farm and significant non-scheduled embedded generators Moranbah North, Moranbah and Racecourse Mill as defined in Figure 2.6. These embedded generators provided approximately 665GWh during 2019/20.

Figure 6.28 provides historical transmission delivered load duration curves for the North zone. Energy delivered from the transmission network has reduced by 4.9% between 2018/19 and 2019/20. The peak transmission delivered demand in the zone was 464MW, which is below the highest maximum demand over the last five years of 488MW set in 2015/16. The minimum transmission delivered demand in the zone was 143MW, which is above the lowest demand over the last five years of 32MW set in 2016/17 as a result of lost load following Ex-Tropical Cyclone Debbie.

Figure 6.28 Historical North zone transmission delivered load duration curves



As a result of double circuit outages associated with lightning strikes, AEMO includes the following double circuits in the North zone in the vulnerable list:

- Strathmore to Clare South and Collinsville North to King Creek to Clare South 132kV double circuit transmission line, last tripped January 2019
- Collinsville North to Proserpine 132kV double circuit transmission line, last tripped February 2018
- Collinsville North to Stony Creek and Collinsville North to Newlands 132kV double circuit transmission line, last tripped February 2016
- Goonyella to North Goonyella and Goonyella to Newlands 132kV double circuit transmission line, last tripped February 2018
- Moranbah to Goonyella Riverside 132kV double circuit transmission line, last tripped December 2014.

High voltages associated with light load conditions are currently managed with existing reactive sources. However, midday power transfer levels continue to reduce as capacity is released from commissioning activities of VRE generators and additional rooftop PV is installed in NQ. As a result, voltage control is forecast to become increasingly challenging for longer durations. This is discussed in sections 6.6.2 and 5.7.4.

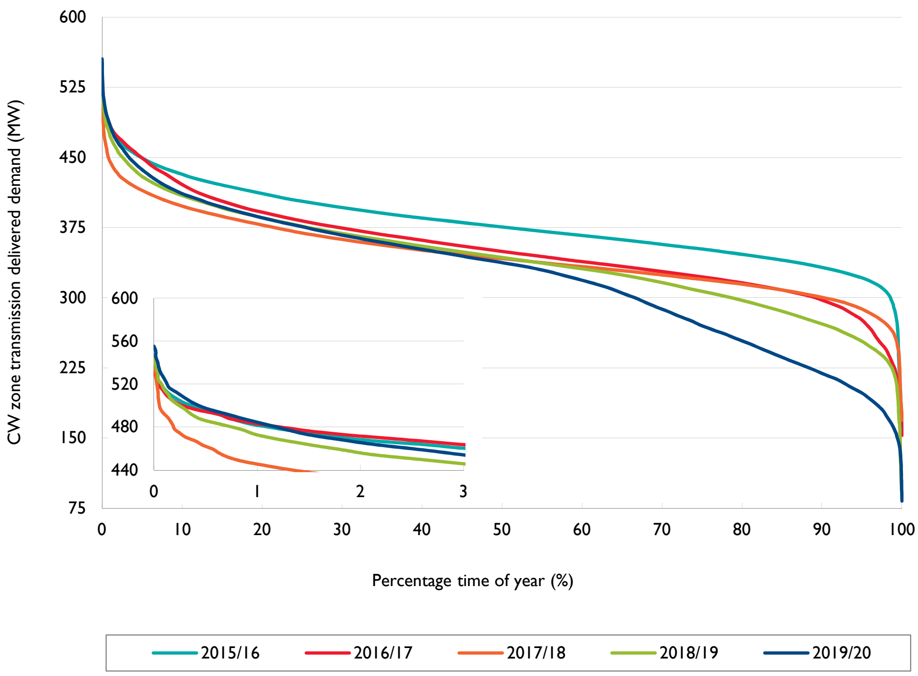
6.7.4 Central West zone

The Central West zone experienced no load loss for a single network element outage during 2019/20.

The Central West zone includes the scheduled embedded Barcaldine generator, semi-scheduled embedded generators Clermont Solar Farm and Emerald Solar Farm and significant non-scheduled embedded generators Barcaldine Solar Farm, Longreach Solar Farm, German Creek and Oaky Creek as defined in Figure 2.6. These embedded generators provided approximately 797GWh during 2019/20.

Figure 6.29 provides historical transmission delivered load duration curves for the Central West zone. Energy delivered from the transmission network has reduced by 4.6% between 2018/19 and 2019/20. The reduction in energy delivered is due to the increase in energy from embedded generation. The peak transmission delivered demand in the zone was 555MW, which is the highest maximum demand over the last five years. The minimum transmission delivered demand in the zone was 83MW, which is the lowest demand on record.

Figure 6.29 Historical Central West zone transmission delivered load duration curves



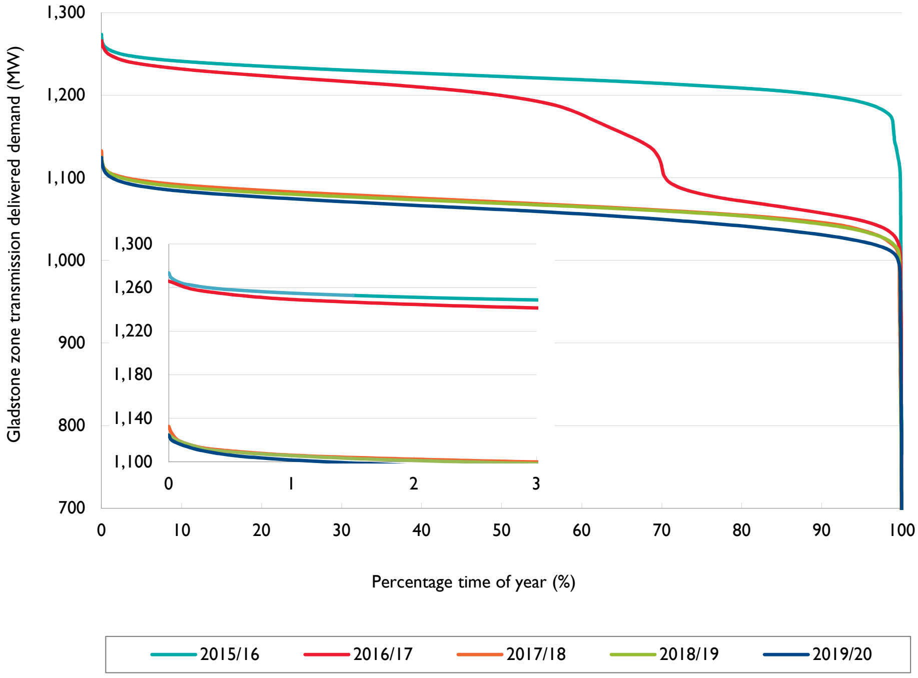
6.7.5 Gladstone zone

The Gladstone zone experienced no load loss for a single network element outage during 2019/20.

The Gladstone zone contains no scheduled, semi-scheduled or significant non-scheduled embedded generators as defined in Figure 2.6.

Figure 6.30 provides historical transmission delivered load duration curves for the Gladstone zone. The Figure clearly shows a reduction in demand between 2015/16 and 2016/17 due to changed operation by Boyne Smelters Limited (BSL). Energy delivered from the transmission network has reduced by 0.5% between 2018/19 and 2019/20. The peak transmission delivered demand in the zone was 1,125MW, which is below the highest maximum demand over the last five years of 1,274MW set in 2015/16. Minimum demand coincides with small periods when one or more smelter potlines are out of service. The minimum transmission delivered demand in the zone was 638MW, which is above the lowest demand over the last five years of 418MW set in 2016/17.

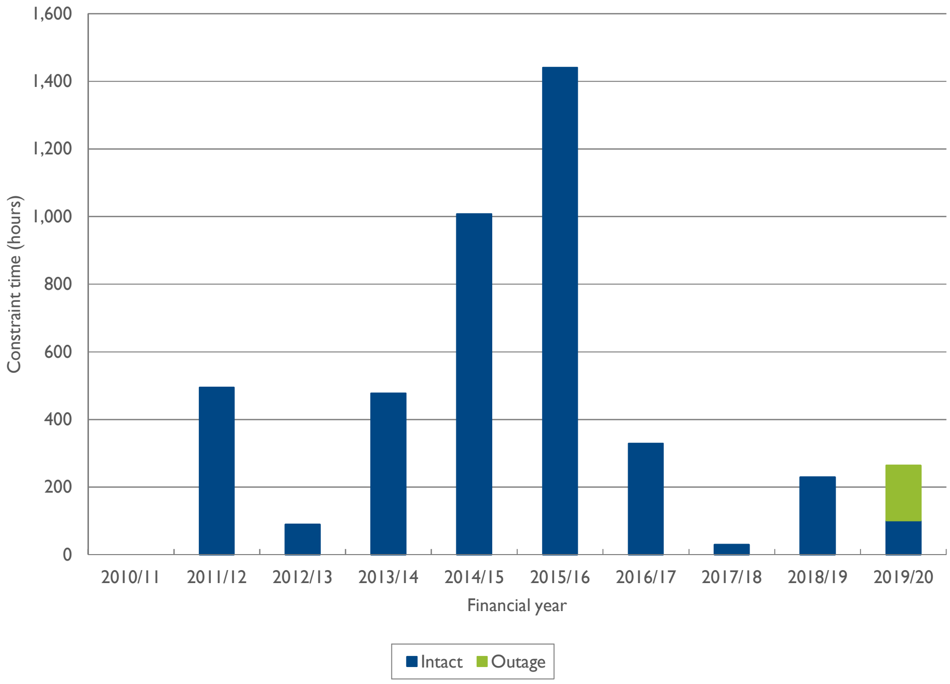
Figure 6.30 Historical Gladstone zone transmission delivered load duration curves



Constraints occur within the Gladstone zone under intact network conditions. These constraints are associated with maintaining power flows within the continuous current rating of a 132kV feeder bushing within BSL's substation. The constraint limits generation from Gladstone Power Station, mainly from the units connected at 132kV. AEMO identifies this constraint by constraint identifier Q>NIL_BI_FB. This constraint was implemented in AEMO's market system from September 2011.

Information pertaining to the historical duration of constrained operation due to this constraint is summarised in Figure 6.31. During 2019/20, the feeder bushing constraint experienced 264 hours of constrained operation, 163 hours during outage of 275kV feeders between Calliope River and Woolooga.

Figure 6.31 Historical Q>NIL_BI_FB constraint times



6.7.6 Wide Bay zone

The Wide Bay zone experienced no load loss for a single network element outage during 2019/20.

The Wide Bay zone includes the semi-scheduled embedded generators Childers Solar Farm and Susan River Solar Farm, and significant non-scheduled embedded generator Isis Central Sugar Mill as defined in Figure 2.6. These embedded generators provided approximately 251GWh during 2019/20.

Figure 6.32 provides historical transmission delivered load duration curves for the Wide Bay zone. Wide Bay zone is one of two zones in Queensland where the delivered demand reaches negative values, meaning that the embedded generation exceeds the native load, the transmission network supplying the zone is often operated at zero and near zero loading, and the embedded generation makes use of the transmission network to feed loads in other zones. Figure 6.33 provides the daily load profile for the minimum transmission delivered days over the last five years.

Whilst energy has seen significant reductions, the peak demand, which occurs at night, remains at similar levels. Energy delivered from the transmission network reduced by 14.0% between 2018/19 and 2019/20. The reduction in energy delivered is due to the increase in energy from embedded generation. The peak transmission delivered demand in the zone was 295MW, which is below the highest maximum demand over the last five years of 301MW set in 2017/18. The minimum transmission delivered demand in the zone was -82MW, which is the lowest demand on record.

Figure 6.32 Historical Wide Bay zone transmission delivered load duration curves

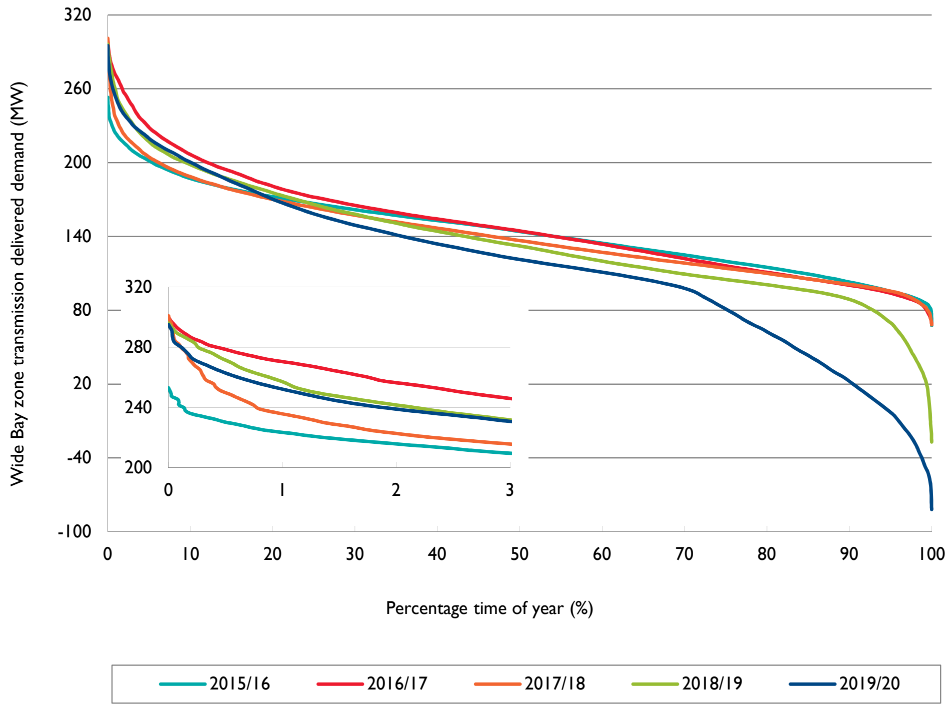
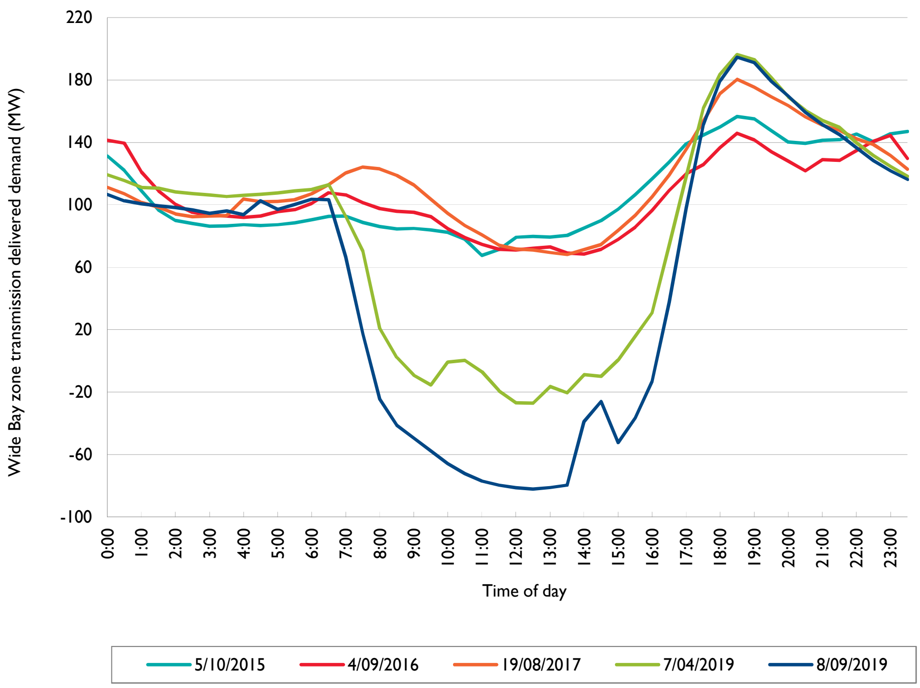


Figure 6.33 Historical Wide Bay zone minimum transmission delivered daily profile



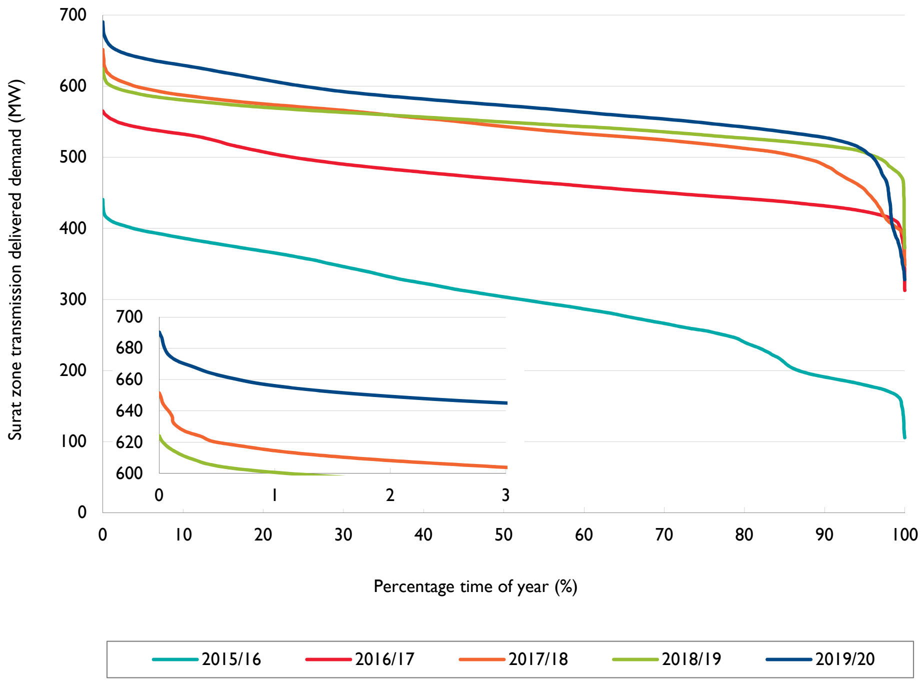
6.7.7 Surat zone

The Surat zone experienced no load loss for a single network element outage during 2019/20.

The Surat zone includes the scheduled embedded Roma and Condamine generators and significant non-scheduled embedded generator Baking Board Solar Farm as defined in Figure 2.6. These embedded generators provided approximately 371GWh during 2019/20.

Figure 6.34 provides historical transmission delivered load duration curves for the Surat zone. Energy delivered from the transmission network has increased by approximately 4.6% between 2018/19 and 2019/20. The peak transmission delivered demand in the zone was 690MW, which is the highest maximum demand over the last five years. The CSG load in the zone has now reached expected demand levels. The minimum transmission delivered demand in the zone was 328MW, which is above the lowest demand over the last five years of 106MW set in 2015/16.

Figure 6.34 Historical Surat zone transmission delivered load duration curves



As a result of double circuit outages associated with lightning strikes, AEMO includes the Tarong to Chinchilla 132kV double circuit transmission line in the vulnerable list. This double circuit tripped due to lightning in February 2018.

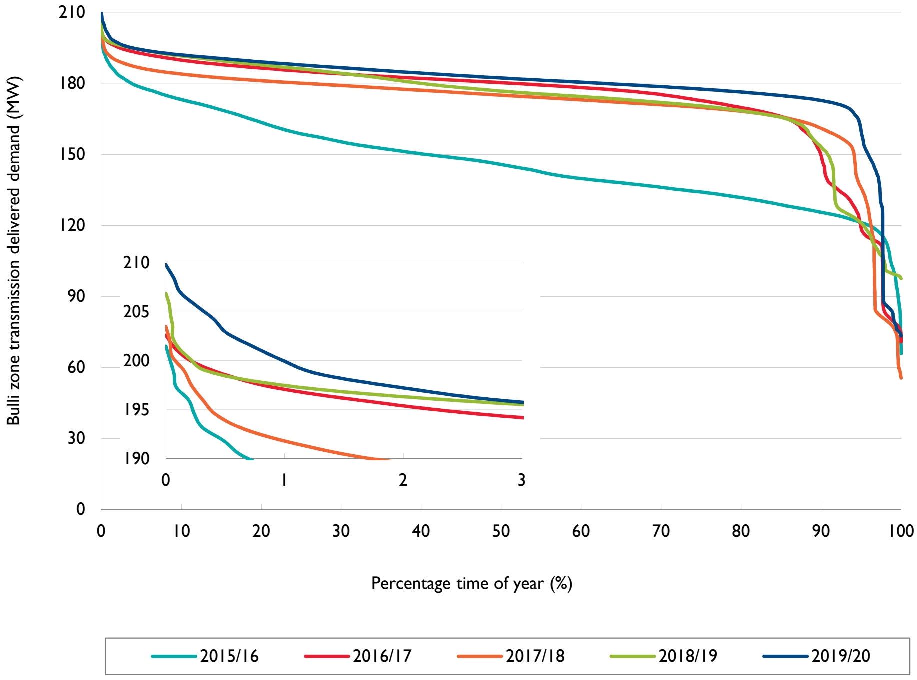
6.7.8 Bulli zone

The Bulli zone experienced no load loss for a single network element outage during 2019/20.

The Bulli zone contains no scheduled, semi-scheduled or significant non-scheduled embedded generators as defined in Figure 2.6.

Figure 6.35 provides historical transmission delivered load duration curves for the Bulli zone. Energy delivered from the transmission network has increased by approximately 4.0% between 2018/19 and 2019/20. The peak transmission delivered demand in the zone was 210MW, which is the highest maximum demand. The CSG load in the zone has now reached expected demand levels. The minimum transmission delivered demand in the zone was 73MW, which is above the lowest demand over the last five years of 56MW set in 2017/18.

Figure 6.35 Historical Bulli zone transmission delivered load duration curves



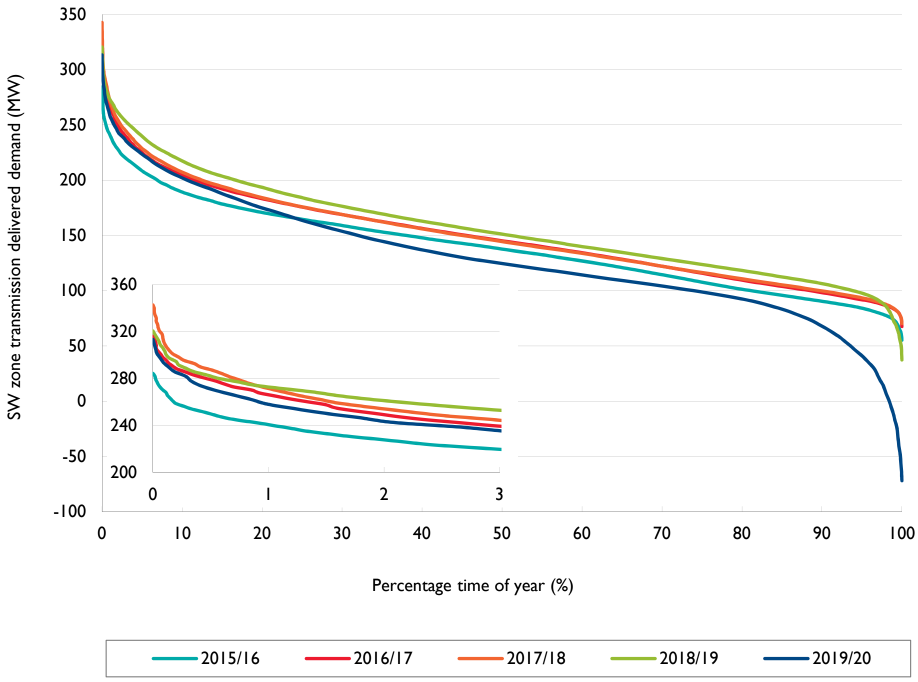
6.7.9 South West zone

The South West zone experienced no load loss for a single network element outage during 2019/20.

The South West zone includes the semi-scheduled embedded generators Oakey 1 Solar Farm, Oakey 2 Solar Farm, Yarranlea Solar Farm, Maryrorough Solar Farm and significant non-scheduled embedded generator Daandine Power Station as defined in Figure 2.6. These embedded generators provided approximately 338GWh during 2019/20.

Figure 6.36 provides historical transmission delivered load duration curves for the South West zone. The South West zone is one of two zones in Queensland where the delivered demand reaches negative values, meaning that the embedded generation exceeds the native load, the transmission network supplying the zone is often operated at zero and near zero loading, and the embedded generation makes use of the transmission network to feed loads in other zones. Energy delivered from the transmission network has reduced by 17.0% between 2018/19 and 2019/20. The reduction in energy delivered is due to the increase in energy from embedded generation. The peak transmission delivered demand in the zone was 313MW, which is below the highest maximum demand over the past five years of 343MW set in 2017/18. The minimum transmission delivered demand in the zone was -72MW, which is the lowest demand on record.

Figure 6.36 Historical South West zone transmission delivered load duration curves

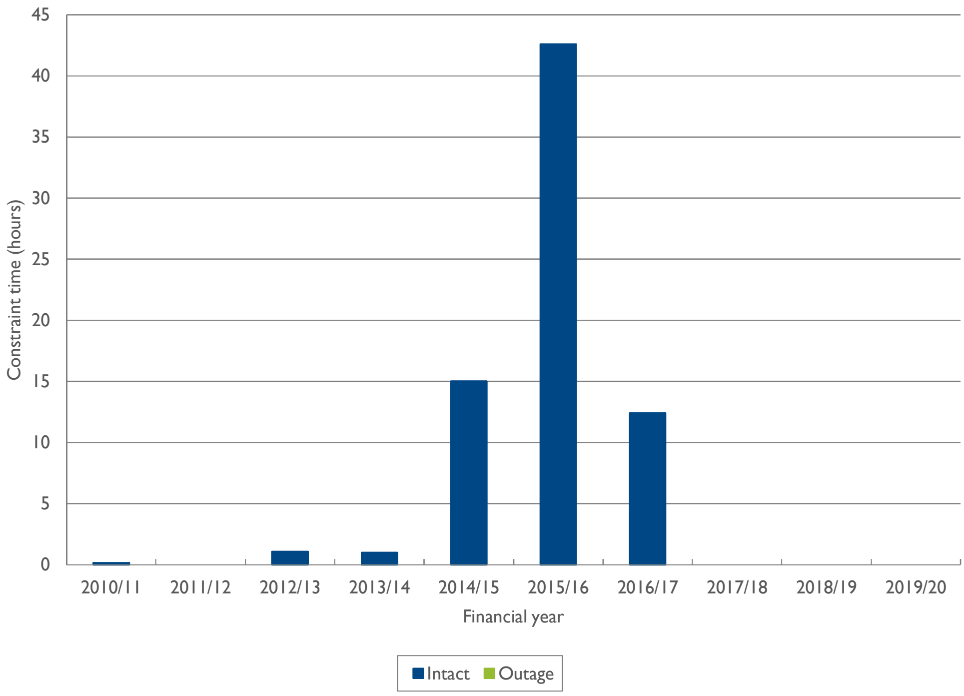


Constraints occur within the South West zone under intact network conditions. These constraints are associated with maintaining power flows of the 110kV transmission lines between Tangkam and Middle Ridge substations within the feeder's thermal ratings at times of high local generation. Powerlink maximises the allowable generation by applying dynamic line ratings to take account of real time prevailing ambient weather conditions. AEMO identifies these constraints with identifiers Q>NIL_MRTA_A and Q>NIL_MRTA_B. These constraints were implemented in AEMO's market system from April 2010. There were no constraints recorded against this constraint equations in 2019/20. Oakey Power Station's production reduced significantly since 2016/17, in line with other gas fired generators in South West Queensland.

Energy Infrastructure Investments (EII) has advised AEMO of its intention to retire Daandine Power Station in June 2022.

Information pertaining to the historical duration of constrained operation due to these constraints is summarised in Figure 6.37.

Figure 6.37 Historical Q>NIL_MRTA_A and Q>NIL_MRTA_B constraint times



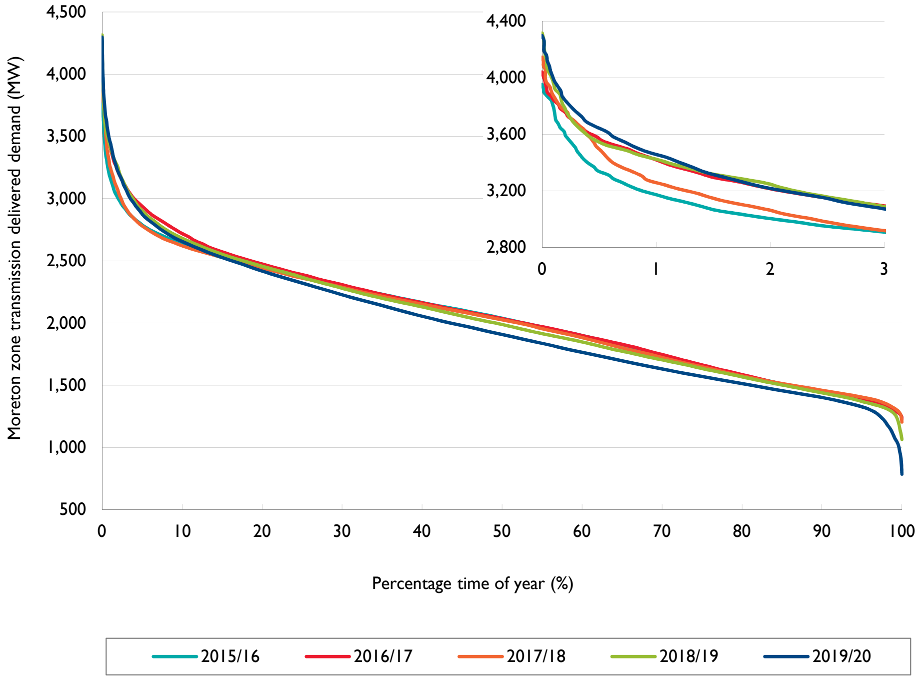
6.7.10 Moreton zone

The Moreton zone experienced no load loss for a single network element outage during 2019/20.

The Moreton zone includes the significant non-scheduled embedded generators Sunshine Coast Solar Farm, Bromelton and Rocky Point as defined in Figure 2.6. These embedded generators provided approximately 69GWh during 2019/20.

Figure 6.38 provides historical transmission delivered load duration curves for the Moreton zone. Energy delivered from the transmission network has reduced by 2.5% between 2018/19 and 2019/20. The peak transmission delivered demand in the zone was 4,298W, which is below the highest maximum demand over the past five years of 4,316MW set in 2018/19. The minimum transmission delivered demand in the zone was 786MW which is the lowest demand on record.

Figure 6.38 Historical Moreton zone transmission delivered load duration curves



High voltages associated with these light load conditions are currently managed with existing reactive sources. However, voltage control within Powerlink's and Energex's network is forecast to become increasingly challenging for longer durations. This is discussed in Section 5.7.10.

6.7.11 Gold Coast zone

The Gold Coast zone experienced no load loss for a single network element outage during 2019/20.

The Gold Coast zone contains no scheduled, semi-scheduled or significant non-scheduled embedded generators as defined in Figure 2.6.

Figure 6.39 provides historical transmission delivered load duration curves for the Gold Coast zone. Energy delivered from the transmission network has reduced by 3.1% between 2018/19 and 2019/20. The peak transmission delivered demand in the zone was 731MW, which is below the highest maximum demand over the last five years of 732MW set in 2018/19. The minimum transmission delivered demand in the zone was 167MW which is the lowest demand on record.

Figure 6.39 Historical Gold Coast zone transmission delivered load duration curves