Annual Planning Report 2004

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EXECUTIVE SUMMARY

Powerlink Queensland has been appointed by the Queensland Government to undertake transmission network planning in the State, and is the owner and operator of the Queensland electricity transmission network.

Powerlink has prepared this Annual Planning Report to document the annual planning review it has carried out, as required by the National Electricity Code.

The Annual Planning Report provides information about the electricity transmission network to Code participants and interested parties. It includes information on electricity demand forecasts, the existing electricity supply system including committed generation and network developments, estimates of grid capability and potential network developments.

As part of the Ministerial Council on Energy's (MCE's) recent reform program, the Annual Planning Reports of each jurisdictional planning body are being harmonised to ensure industry participants and interested parties can more easily understand and compare transmission planning information across the National Electricity Market (NEM). This report is presented in the new format.

Electricity usage in Queensland has grown strongly during the past ten years, and this trend is expected to continue. Summer maximum demand (weather corrected) delivered from the transmission grid is forecast to increase at an average annual rate of 3.2% p.a. from 6924MW in 2003/04 to 9490MW in 2013/14. However, this ten year average masks the accelerated summer demand increase forecast for the near future. This accelerated demand growth is attributable to the expected continuation of rapid increase in penetration and usage of domestic air conditioners and strong population growth, which have been evidenced in recent years, particularly in south east Queensland. Here the actual 2003/04 summer maximum demand jumped 13.2% over the previous summer, while the forecast summer weather corrected demand for the three year period up to 2005/06 will have an average growth rate of 6.6% per annum. Annual energy to be delivered by the Queensland transmission grid is forecast to increase at an average rate of 3.1% p.a. over the next ten years for the medium growth scenario. Similarly, an average energy growth of 3.4% p.a. is expected in south east Queensland.

This high level of load growth will require substantial augmentation of the capability of the Queensland transmission network to ensure grid capacity keeps pace with demand, particularly in the south eastern part of the state.

The most significant projects completed since the 2003 Annual Planning Report include the Blackwall to Belmont 275kV transmission line which has augmented transmission capacity into the south east part of Brisbane, and the establishment of the Molendinar 275/110kV substation which augments transmission to the northern parts of the Gold Coast. In addition, network support contracts continued with power stations in north Queensland to allow ongoing management of network limitations.

Following consultation with participants and interested parties, Powerlink is also carrying out major augmentations of its system supplying the Toowoomba and Darling Downs areas through construction of a 330kV transmission line between Millmerran and Toowoomba, and is constructing a 275kV line between Broadsound and Lilyvale to augment transmission capacity to the mining areas of inland central Queensland.

Work has also commenced on installation of a static var compensator at Woree in Cairns, and construction of a 275kV line between Belmont and Murarrie to augment transmission capacity into the Brisbane CBD area. Smaller augmentations such as the installation of capacitor banks and transformer upgrades are also underway to satisfy network reliability standards.

Development of new generating capacity in the Queensland region is continuing to occur with the conversion and upgrade of the Townsville power station to gas operation underway and recent announcement of a 750MW coal fired power station at Kogan Creek. These developments are following in the wake of commissioning of Millmerran, Tarong North and Swanbank E power stations in recent years.

These significant generation developments will alter flows on the Queensland transmission grid, as these generators compete in the wholesale electricity market to supply the forecast load in Queensland and the interconnected states of NSW, Victoria and South Australia.

Since the 2003 Annual Planning Report, the southward maximum transfer capacity of the Queensland-New South Wales Interconnection (QNI) has been increased from 750MW to 950MW. Powerlink is working closely with its NSW counterpart TransGrid, to design and implement controller tunings at various SVC's to improve this damping limit. Subject to further testing, it is expected that the maximum limit could be lifted to 1050MW in the coming year.

Powerlink and TransGrid have also carried out studies to identify market benefits associated with possible augmentations of QNI. The studies concluded that, under the current ACCC regulatory test which defines allowable benefits, no upgrade option was justified. An option which involved preservation of current limits by minor intra-regional works in NSW was found to be marginally economic and will be investigated further by TransGrid.

Within Queensland, Powerlink's transmission grid reached transfer limits at most grid sections for less than 1% of the time during the six months from October 2003 to March 2004, the period of highest loads. The CQ-NQ limit would have been exceeded for much longer durations, but this was managed by the network support arrangement between Powerlink and north Queensland generators.

Powerlink's expectation is that other grid sections, such as that between Tarong and Brisbane, and the grid supplying the Gold Coast, will continue to be heavily loaded relative to their capacity after considering committed generation and transmission developments, and network support arrangements. The Tarong limit experienced negligible binding over the 2003/04 summer due to the recently commissioned south Queensland power stations and recently completed reliability augmentation works near Brisbane and on the Gold Coast.

Not surprisingly, the predominant driver for augmentations to network capability will continue to be the need to maintain reliability standards. Reliability has long been the predominant driver for grid augmentation in Queensland.

Emerging needs are identified in this report. The areas of need include supply to north and far north Queensland area, supply to the Gold Coast/Tweed area, supply to Gladstone in the central Queensland area, supply to the Brisbane south and west, supply to Townsville, supply to Mackay, supply to Rockhampton and supply to the Moura and Blackwater areas of central west Queensland.

An Application Notice associated with addressing the Gold Coast/Tweed limitations has been issued. Work has also started on addressing the Gladstone area, and north and far north Queensland limitations. Powerlink has issued papers to inform market participants and interested parties about the emerging limitations, and to seek possible solutions. Powerlink expects to initiate consultation processes for a number of other limitations within the next twelve months so that corrective action can be implemented in a timely manner.

This Annual Planning Report also contains details of one proposed new small network augmentation. This proposal comprises the installation of shunt capacitor banks at Loganlea, Runcorn, Rocklea and Palmwoods in south east Queensland. Powerlink invites submissions on this proposed new small network augmentation by Wednesday 28 July 2004.

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2. INTRODUCTION

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Powerlink Queensland is a Transmission Network Service Provider (TNSP) in the National Electricity Market that owns, develops, operates and maintains Queensland's high-voltage electricity transmission network. It has also been appointed by the Queensland Government as the body responsible for transmission network planning within the state.

Powerlink has an obligation to undertake an annual planning review of the capability of its transmission network to meet forecast electricity demand requirements. Powerlink is required to inform industry participants and other interested parties of the findings of this review in its Annual Planning Report which is published in June each year.

This 2004 Annual Planning Report provides details of Powerlink's latest planning review. The report includes information on electricity demand forecasts, the existing electricity supply system including committed generation and transmission network developments, and forecasts of network capability. Emerging limitations in the capability of the network are identified and possible supply solutions to address these limitations are discussed. Interested parties are encouraged to provide input to facilitate identification of the most appropriate solution to ensure supply reliability can be maintained to customers in the face of continued strong growth in electricity demand.

Powerlink's annual planning review and report are an important part of the process of planning the Queensland transmission network to continue to meet the needs of participants in the National Electricity Market (NEM) and users of electricity in Queensland.

2.1 Context of the Annual Planning Report

All bodies with jurisdictional planning responsibilities in the NEM are required to undertake the annual planning review and reporting process prescribed in the National Electricity Code. These bodies currently comprise Powerlink (Queensland), TransGrid (New South Wales), VENCorp (Victoria), and the Electricity Supply Industry Planning Council (South Australia).

Information from this process is also provided to the National Electricity Market Management Company (NEMMCO) to assist it in preparing the Statement of Opportunities (SOO) and the new Annual National Transmission Statement (ANTS) in July each year. ANTS is part of new national transmission planning arrangements being implemented by the Ministerial Council on Energy (MCE), in conjunction with industry participants.

The SOO/ANTS is the primary document for examining electricity supply and demand issues across all regions in the NEM and covers the following issues –

- projections of demand and energy requirements for each region of the NEM;
- capabilities of existing and committed generating units;
- planned plant retirements;
- network capabilities and constraints, and information on potential solutions; and
- operational and economic information about the market.

Powerlink recommends that interested parties review its 2004 Annual Planning Report in conjunction with NEMMCO's 2004 SOO/ANTS, which is expected to be published by 31 July.

From 2004, the content and format of the Annual Planning Reports prepared by each jurisdictional planning body have been harmonised to ensure industry participants and interested parties can more easily understand and compare transmission planning information across the NEM. Powerlink's 2004 Annual Planning Report incorporates the new requirements.

2.2 Purpose of the Annual Planning Report

The purpose of Powerlink's Annual Planning Report is to provide information about the Queensland electricity transmission network to Code Participants and interested parties.

It aims to provide information that assists interested parties to:

- identify locations that would benefit from significant electricity supply capacity or demand side management (DSM) initiatives;
- identify locations where major industrial loads could be connected;
- understand how the electricity supply system impacts on their needs;
- consider the transmission network's capability to transfer quantities of bulk electrical energy; and
- provide input into the future development of the transmission grid.

Readers should note that this document is not intended to be relied upon or used for other purposes, such as for the evaluation of participants' investment decisions.

2.3 Role of Powerlink Queensland

As the owner and operator of the electricity transmission network in the state of Queensland, Powerlink Queensland is registered with NEMMCO as a Transmission Network Service Provider under the National Electricity Code. In this role, and in the context of this Annual Planning Report, Powerlink's transmission network planning and development responsibilities include the following:

1. Ensure that its network is operated with sufficient capacity, and augmented if necessary, to provide network services to customers.

2. Ensure that its network complies with technical and reliability standards contained in the National Electricity Code and jurisdictional obligations.

3. Conduct annual planning reviews with Transmission and Distribution Network Service Providers whose networks are connected to Powerlink's transmission grid (ie. – TransGrid, Energex, Ergon Energy and Country Energy).

4. Advise Code Participants and interested parties of emerging network limitations within the time required for corrective action.

5. Develop recommendations to address emerging network limitations through joint planning with Distributors and consultation with Code Participants and interested parties. Solutions may include network or non-network options. Options may be proposed by providers other than Powerlink, such as local generation, demand side management initiatives and alternatives involving other networks.

6. Undertake the role of proponent of regulated transmission augmentations in Queensland.

These responsibilities are described more fully in Powerlink's transmission licence and Chapter 5 of the National Electricity Code (NEC).

Powerlink has also been nominated by the Queensland Government as the entity having transmission network planning responsibility in the state, with respect to Clause 5.6.3(b) of the NEC. In this role, Powerlink represents the Queensland jurisdiction on the Inter-Regional Planning Committee (IRPC). Powerlink's role on the IRPC includes:

- providing information on the Queensland network to allow NEMMCO to carry out its obligations, such as publication of the Statement of Opportunities and preparation of the Annual National Transmission Statement;
- bringing forward, where necessary, proposed Queensland augmentations which have a material inter-network impact;
- participating in inter-regional system tests associated with new or augmented interconnections; and
- participating in the technical evaluation of proposals for network developments which have a material inter-network impact.

The role of the IRPC is described in Clause 5.6 of the NEC.

2.4 Overview of Planning Responsibilities

Planning the development of the Queensland regulated transmission grid comprises a number of different categories:

- the connection of a new participant, or alteration of an existing connection;
- the shared network within Queensland; and
- new interconnectors or augmentation to existing interconnectors between Powerlink's network and networks owned by other TNSPs.

2.4.1 Planning of Connections

Participants wishing to connect to the Queensland transmission network include new and existing generators, major loads and electricity distributors (DNSPs). Planning of new or augmentation of existing connections involves consultation between Powerlink and the connecting party, determination of technical requirements and completion of connection agreements.

2.4.2 Planning of the Shared Network Within Queensland

Powerlink is responsible for planning the shared transmission grid within Queensland. The National Electricity Code sets out the planning process and requires Powerlink to apply the Regulatory Test promulgated by the ACCC to new regulated network augmentation proposals. The planning process requires consultation with interested parties including customers, generators and DNSPs.

The significant inputs into the network planning process within Queensland are:

- the forecast of customer electricity demand (including demand side management) and its location;
- location, capacity and expected operation of generation;
- the assessment of future network capability;
- planning criteria for the network; and
- prediction of future loadings on the transmission network.

The ten-year forecasts of electrical demand and energy across Queensland are used together with forecast generation patterns to determine potential flows on transmission network elements. The location and capacity of existing and committed generation in Queensland is sourced from the NEMMCO Statement of Opportunities, unless modified based on advice from relevant participants. Information about existing and committed embedded generation and demand management within distribution systems is provided by the DNSPs.

Powerlink examines the capability of its existing network, and future capability following any changes resulting from committed augmentations. This involves consultation with the relevant DNSP where the performance of the transmission system may be impacted by the distribution system (for example, where the two systems operate in parallel).

Where potential flows on transmission system elements could exceed network capability, Powerlink is required to notify market participants of these emerging network limitations. If augmentation is considered necessary, joint planning investigations are carried out with the DNSPs (or TNSPs if relevant) in accordance with the provisions of Clause 5.6.2 of the NEC. The objective of this joint planning is to identify the most cost-effective network solution.

In addition to the requirement for joint planning, Powerlink has other obligations that govern how it should address emerging network limitations.

The *Electricity Act 1994 (Qld)* requires that Powerlink 'ensure as far as technically and economically practicable, that the transmission grid is operated with enough capacity (and if necessary, augmented or extended to provide enough capacity) to provide network services to persons authorised to connect to the grid or take electricity from the grid'.

It is a condition of Powerlink's transmission authority that Powerlink plan and develop its transmission grid in accordance with good electricity industry practice such that power quality and reliability standards in the NEC are met for intact and outage conditions, and the power transfer available through the power system will be adequate to supply the forecast peak demand during the most critical single network element outage, unless otherwise varied by agreement.

Powerlink also has legal obligations to evaluate and consider environmental impacts when developing its transmission network.

In addition, other obligations are contained in Schedule 5.1 of the NEC. The Code sets out minimum performance requirements of the network and connections, and requires that reliability standards at each connection point be included in the relevant connection agreement.

New network developments may be proposed to meet these legislative and Code obligations. Powerlink may also propose network augmentations that deliver a net market benefit when measured in accordance with the ACCC Regulatory Test.

The requirements for initiating new regulated network developments are set down in Clauses 5.6.2, 5.6.6A and 5.6.6 of the Code. These clauses apply to different types of proposed augmentations. While each of these clauses involves a slightly different process, particularly with respect to consultation with interested parties, the main steps in network planning can be summarised as follows:

- disclosure of information regarding the need for augmentation. This examines the load growth, generation and network capability to determine the time when corrective action is required – for example, when the technical standards can no longer be met in supplying the forecast load;
- consultation on assumptions made and potential solutions, which may include transmission or distribution network augmentation, local generation or demand side management;
- where a network development has a material inter-network impact, either the agreement of the entities responsible for those impacted networks must be obtained, or the development must be examined by the Inter Regional Planning Committee;
- analysis of the feasible options to determine the one that satisfies the ACCC's regulatory test. In the case of an augmentation required to meet reliability and quality standards, this involves a cost effectiveness analysis to determine the option that minimises net present value of costs. In all other cases, the regulatory test requires that the proposed development maximises the net market benefit as defined in the regulatory test; and
- consultation and publication of a recommended course of action to address the identified network limitation.

2.4.3 Planning Interconnectors

Development and assessment of new or augmented interconnections between Queensland and New South Wales (or other States) are the responsibility of the respective project proponents.

Powerlink will develop plans in association with connected networks to augment interconnection capacity where justified. Any plans to establish or augment interconnectors will be outlined in Powerlink's Annual Planning Report. The Code also provides a role to be carried out by the Inter Regional Planning Committee. This committee, convened by NEMMCO, includes a representative of the entity having transmission planning responsibility in each state jurisdiction. In summary, the inter-jurisdictional planning process involves the following main steps:

- NEMMCO publishes the annual Statement of Opportunities (SOO) which provides information on load and generation forecasts and committed network developments with an inter-regional impact.
- NEMMCO, with assistance from the jurisdictional planning bodies, prepares the Annual National Transmission Statement (ANTS). This document is being published for the first time in 2004 and will replace the existing Annual Interconnector Review.
- ANTS provides information relevant to the technical and economic need for augmentation of major national transmission flow paths. This includes information on the significance of forecast constraints on power transfers between regions. It also identifies options for the reduction or removal of future network constraints.
- The ANTS forms part of NEMMCO's SOO.

3. SUMMARY OF RELEVANT MAJOR NATIONAL TRANSMISSION FLOW PATH DEVELOPMENTS

CONTENTS

3.1 Purpose

The Australian National Transmission Statement (ANTS), which will form part of NEMMCO's Statement of Opportunities, is designed to provide information relating to potential augmentations of major national transmission paths.

Such information provided in ANTS is to be identified by the relevant Transmission Network Service Providers (TNSPs) in their Annual Planning Reports.

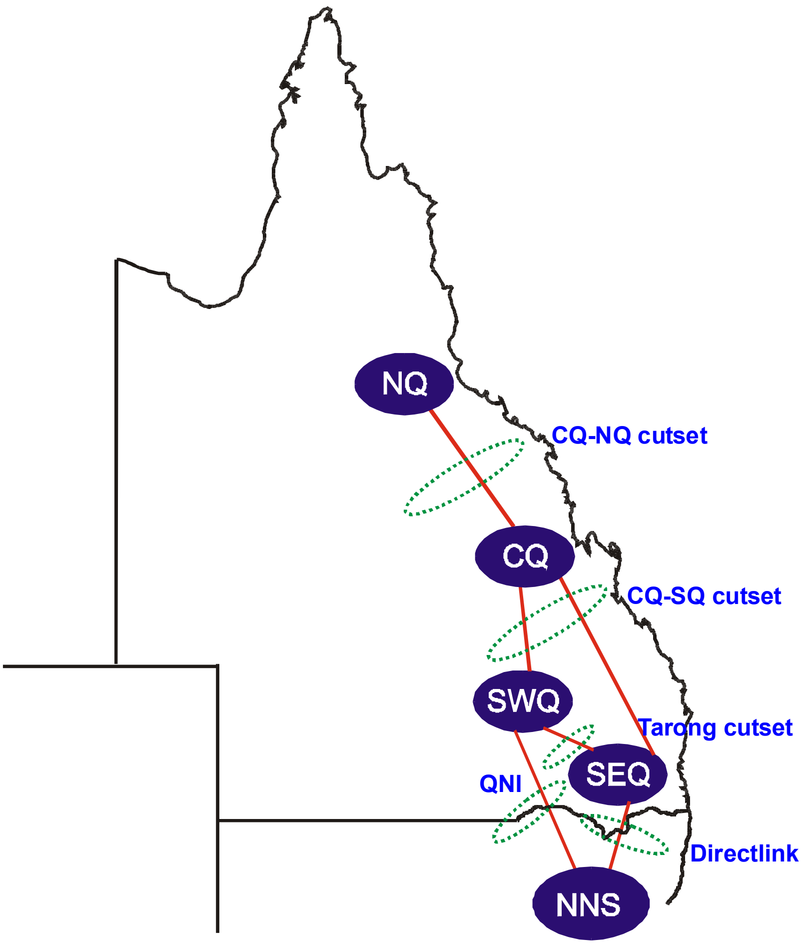
This section of the Annual Planning Report summarises potential Queensland intra-regional augmentations identified by Powerlink that may impact major national transmission paths.

3.2 Major National Transmission Paths

Major national transmission paths are those elements of the interconnected national transmission system used to transport significant amounts of electricity between generation centres and major electrical load centres (ie. – areas of customer electricity demand).

The major transmission flow paths in Queensland are shown in Figure 3.1.

Figure 3.1: Queensland Major Transmission Flow Paths



3.3 Status of Augmentations

Augmentation proposals outlined in this chapter fall under one of three categories:

- Committed augmentation – Project approved following completion of code process and project under construction at the time of writing this document.
- Recommended augmentation – Project identified as the recommended option under the ACCC "Regulatory Test" and undergoing the code consultation process at the time of writing this document
- Possible augmentation – Project identified as a potential option for future augmentation

Projects identified as "possible" augmentations must be considered preliminary and uncertain. These projects have not necessarily undergone rigorous technical or economic evaluation, and are included as indicative augmentations only. In some cases, several possible augmentation options are proposed. It should be noted that only network options are listed whereas at the time of evaluating options for approval purposes, non-network options will also be considered.

3.4 Summary of Potential Augmentations

Potential augmentations in the Queensland region, which may impact on major national flow paths, are summarised in Table 3.1. The augmentations are grouped under the relevant flow path. It should be noted that the CQ-SWQ and the CQ-SEQ flow paths are combined, as this aligns with the current representation of these flow paths (ie - limit equations) in NEMMCO's market dispatch system.

Powerlink and TransGrid have undertaken a study to examine the economics of upgrading the Queensland–New South Wales Interconnection (QNI). This study is outlined in Section 7.2.3 of the report. The options considered are summarised in Table 3.2.

Table 3.1: Potential Augmentations in the Queensland Region

Major National Flow Path	Limit Description	Basis for Augmentation	Potential Augmentation	Major National Flow Path Improvements	Status and Possible Date
CQ-SQ (combines CQ-SEQ and CQ-SWQ)	Constraints on transfer capacity between central and southern Queensland (CQ-SQ) are expected to occur under scenarios in which significant new base load generation is built in central or north Queensland	Market Benefit	Option 1: Addition of switching station on the Tarong-Calvale lines at Auburn River, and addition of series capacitors at Auburn River.	Increases maximum CQ-SQ transfer to 2200MW. (+300MW over present limit)	Possible 2008 or later
			Option 2: Construction of 275kV transmission line CQ to SQ.	Increases maximum CQ – SQ transfer to 2800MW. (+600MW, above limit with Option 1)	Possible 2008 or later
			Option 3: Construction of 500kV double circuit transmission line from CQ to SQ.	Increases maximum CQ – SQ transfer to 3500MW. (+700MW above limit with Options 1 and 2)	Possible 2008 or later
CQ-NQ	Central to north Queensland transfer capacity plus local generation may be insufficient to meet future load	Reliability requirement	Option 1: Construction of 275kV transmission line between Broadsound and Ross with associated capacitive compensation.	Increases maximum CQ – NQ transfer from present 985MW to 1300MW.	Possible 2008
SWQ-SEQ	South west Queensland to south east Queensland transfer capacity plus local generation may be insufficient to meet future load	Reliability requirement	Option 1 Construction of new 275kV double circuit transmission line from Middle Ridge to Greenbank and associated capacitive compensation to meet reliability need.	Increases to the present maximum Tarong limit by approximately 450MW.	Possible 2007 or later (scenario dependent)
			Option 2 Construction of new 500kV double circuit transmission line from SWQ to SEQ and associated capacitive compensation.	Increases the present maximum Tarong limit by up to 1000MW.	Possible 2007 or later (scenario dependent)

Major National Flow Path	Limit Description	Basis for Augmentation	Potential Augmentation	Major National Flow Path Improvements	Status and Possible Date
SWQ-NNS	Southerly transfer between south west Queensland (SWQ) and northern NSW (NNS) across the Queensland-New South Wales Interconnection (QNI) can be limited by the oscillatory stability of the interconnected power system.	Market Benefit	Project: Implement a Power Oscillation Damper Controller at Armidale SVC and upgrade the design of the existing Power Oscillation Damper Controller at the Blackwall SVC. (Extensive system performance testing will be required prior to release of this capacity).	These committed projects improve oscillatory stability such that under system normal conditions, damping will no longer limit the maximum secure power transfer on QNI. Increases flow path SWQ – NNS maximum capability to 1050MW (+100 MW above current limit) in relation to damping limit.	Committed 2004
	Northerly transfer between northern NSW (NNS) and south west Queensland (SWQ) across the Queensland-New South Wales Interconnection (QNI) can be constrained by an intra-regional limit at Braemar under some generation conditions. This limitation is not expected to emerge prior to new generation entering south west Queensland.	Reliability requirement	Project: Construction of 330kV double circuit transmission line between Millmerran and Middle Ridge.	This committed project addresses reliability requirements for supply to the Darling Downs area of south west Queensland. A consequential benefit of this augmentation is the unloading of the Braemar transformer by up to approximately 400MW. Hence, the augmentation will reduce the likelihood of SWQ-NNS constraint.	Committed December 2004
	Note: These proposals relate to intra-regional augmentations that may impact on the SWQ-NNS flow path	Market Benefit	Option 1: Construction of new 330/275kV transformer at Braemar and 275kV line between Braemar and Tarong.	Increases the present maximum Braemar limit by up to 500MW.	Possible 2006 (scenario dependent)

Major National Flow Path	Limit Description	Basis for Augmentation	Potential Augmentation	Major National Flow Path Improvements	Status and Possible Date
NNS-SEQ	Northward flow between northern NSW (NNS) and south east Queensland (SEQ) is currently limited by a reliability requirement associated with loss of a 132kV line at Lismore.	Reliability requirement	Proposal: DirectLink Grid Support to the Gold Coast + Lismore 132kV Transmission Line inter-trip scheme.	Augmentation recommended to address supply reliability requirements in Gold Coast/Tweed zone. Proposed inter-trip scheme would allow full 180MW flow north on DirectLink under system-normal conditions.	Recommended Summer 2005/06
SEQ-NNS	Southward flow between south east Queensland (SEQ) and northern NSW (NNS) may be limited by intra-regional transfer limit between Moreton South and Gold Coast/Tweed zones in south east Queensland Note: This proposal relates to an intra-regional augmentations that may impact on the SEQ-NNS flow path.	Reliability requirement	Proposal: Construction of 275kV transmission line between Greenbank and Maudsland.	Augmentation recommended to address supply reliability requirements in Gold Coast/Tweed zone. Proposed augmentation increases Gold Coast voltage stability limit by ~100MW depending on system conditions. This capacity increase will provide greater opportunity for southward flow on DirectLink. However, the maximum southward flow on DirectLink may also be constrained by 110kV connection limitations to NNS.	Recommended October 2006

Table 3.2: Potential Augmentations for Queensland-New South Wales Interconnection

Major National Flow Path	Limit Description	Basis for Augmentation	Potential Augmentation	Major National Flow Path Improvements	Status
QNI	Constraints on transfer capacity between Queensland and New South Wales are expected to occur under various dispatch and new generation entry scenarios	Market Benefit	Option 1: Works to alleviate future thermal limitations in northern NSW network.	Various southerly direction	Possible
			Option 2: Option 1 works + transient/oscillatory stability enhancements.	Nominal 50MW southerly direction	Possible
			Option 3: Option 1 and 2 works + further transient/oscillatory stability enhancements.	Nominal 100MW southerly direction	Possible
			Option 4: Option 1, 2 and 3 works + further transient/oscillatory stability enhancements. A 200MW upgrade will have wider impacts on connected systems, and will therefore require related intra-regional augmentations	Nominal 200MW both directions	Possible
			Option 5: An additional Queensland – New South Wales HVAC interconnection	Nominal 800MW in both directions	Possible
			Option 6: An additional Queensland – New South Wales HVDC connection.	Nominal 2000MW in both directions	Possible

4. INTRA-REGIONAL ENERGY AND DEMAND PROJECTIONS

CONTENTS

4.1 Background to Load Forecasts

4.1.1 Sources of Load Forecasts

In accordance with Clause 5.6.1 of the National Electricity Code, Powerlink has obtained summer and winter demand forecasts over a ten-year horizon from Distribution Network Service Providers (DNSPs) based on their post winter 2003 review, and from directly-connected customers, at each connection supply point in Powerlink's transmission network.

These individual connection supply point forecasts were aggregated into estimated demand forecasts for the total Queensland region and for ten geographical zones as defined in Table 4.10 in Section 4.5, using diversity factors observed from historical trends up to the end of March 2004.

Energy forecasts for each connection supply point were obtained from the DNSP's and directly connected customers, and these have also been aggregated for the Queensland region and for each of the ten geographical zones in Queensland.

The National Institute of Economic and Industrial Research (NIEIR) was also engaged by Powerlink to provide an independent assessment of energy and demand forecasts for the Queensland region and for the former DNSP[1] areas within Queensland in December 2003. These forecasts were based on a "top-down" economic growth perspective with high and low growth scenarios and predicted levels of generation from embedded co-generation and other renewable sources.

NEMMCO also engaged NIEIR to provide an updated independent assessment of economic outlook for all the regions of the NEM in April 2004, including high and low growth scenarios and embedded generation levels. These reports contained no significant changes to the economic outlooks previously provided, and accordingly the forecasts in this Chapter are consistent with the Queensland forecasts in NEMMCO's 2004 Statement of Opportunities.

4.1.2 Basis of Load Forecasts

Economic Activity:

Three forecast scenarios of economic activity in all NEM states were updated by NIEIR and provided to NEMMCO in April 2004. The three scenarios can be characterised as:

(i) Medium Growth Scenario (the base case), considered to be most probable
(ii) High Growth Scenario
(iii) Low Growth Scenario

The average economic growth for the High, Medium and Low Growth Scenarios developed by NIEIR, over the ten-year period 2004/05 to 2013/14 are:

	High	Medium	Low
Australian Gross Domestic Product (average growth p.a.)	3.9%	3.0%	2.1%
Queensland Gross State Product (average growth p.a.)	4.6%	3.7%	2.7%

[1] Prior to the amalgamations that formed Ergon Energy.

For Queensland, these growth rates are slightly higher for the medium and low growth scenarios, and slightly lower for the high growth scenario, compared to the previous NIEIR prediction outlined in the Powerlink 2003 Annual Planning Report. Consistent with the NIEIR outllook the revised energy growth rates in Queensland in this 2004 Annual Planning Report are slightly higher over the long term than in the previous forecast. However, peak demand forecast growth rates have increased significantly especially in the next three years (refer to Section 4.4).

Weather Conditions:
Within each of these three economic scenarios, three forecasts were also prepared to incorporate sensitivity of maximum summer and winter demands to prevailing ambient temperature weather conditions, namely:

(i) a 10% probability of exceedance (PoE), corresponding to one year in ten hot summer or cold winter conditions;

(ii) a 50% PoE, corresponding to one year in two (average summer or average winter) conditions; and

(iii) a 90% PoE corresponding to mild summer or mild winter conditions, which would be expected to be exceeded in nine years out of ten.

Cogeneration and Renewable Energy Source Generation:
The 2003 Annual Planning Report showed that the forecasts provided by NIEIR for cogeneration and renewable energy source generation projects in Queensland continued a trend of successive reductions from earlier predictions. In particular, fewer new projects were included in the period from 2008/09 and beyond due to the uncertain and less than favourable economic position of the sugar industry and delays in new gas pipeline projects.

The 2004 forecasts by NIEIR to NEMMCO yet again predict slightly lower levels of new projects than previously, this time across the whole ten year period, as can be seen from the year to year increases in Table 4.1 compared to previous Annual Planning Reports. It should be noted that Table 4.1 is not the total of all co-generation and renewable energy source generation in Queensland, as it excludes the output of the existing Roma and Barcaldine power stations.

Whilst being embedded in the distribution networks, Roma and Barcaldine power stations are scheduled market generators and as such their output is included within the “delivered from grid” forecasts in this Annual Planning Report. However, Table 4.1 does include the output of the existing Invicta Sugar Mill power station, which is non-scheduled despite being connected to the transmission grid. Accordingly, its output is included both within Table 4.1 and within the “delivered from grid” forecasts in this Annual Planning Report.

Table 4.1: Forecast of Cogeneration and Other Embedded Generation

NIEIR Forecasts of Queensland Total Cogeneration and Other Embedded (Renewable and Non-Renewable Energy Source) Annual Generation (GWh) (1) (2) (3)

Year	Cogeneration	Other Embedded Generation	Total
2003/04	2,251	238	2,489
2004/05	2,251	244	2,495
2005/06	2,251	254	2,505
2006/07	2,291	330	2,621
2007/08	2,291	339	2,630
2008/09	2,330	396	2,726
2009/10	2,457	406	2,863
2010/11	2,477	406	2,883
2011/12	2,603	423	3,026
2012/13	2,648	456	3,104
2013/14	2,694	465	3,159

Notes:
(1) These total generator outputs do not represent export to the distribution network as they include the energy required for the plant's own use.
(2) Invicta Mill bagasse cogeneration output is included in this table despite being connected to Powerlink's transmission grid.
(3) This Table excludes the output of Barcaldine and Roma power stations as these are scheduled market generators.

As in previous reports, the energy delivered to the Wivenhoe pumps is excluded from both the demand and energy forecasts in this report.

Other Loads:

Interconnector Loads
Energy flows across the Queensland-New South Wales Interconnection (QNI) and the DirectLink Market Network Service Provider (MNSP) are not included in the forecast loads in this Chapter, as they are not part of the Queensland customer load. These flows will increase or decrease the dispatch of generation within Queensland to meet the load demand.

New Queensland Loads
As reported in the 2003 Annual Planning Report, additional load is anticipated at Goondiwindi, a centre which has been historically supplied from the NSW network. This area is planned to be supplied by a new 132kV line from Bulli Creek substation in southern Queensland, to a new Waggamba (Goondiwindi) 132/66kV substation. The existing 66kV network from NSW will be retained for stand-by supply. This 2004 forecast includes this load from winter 2004 onwards.

New Large Loads – Committed
Since the 2003 Annual Planning Report, the Hail Creek Coal Mine (west of Nebo) has become operational, and the previously proposed Aluminium extrusion plant at Bundamba (north of Swanbank) has become committed.

The forecasts in this Chapter also include the committed new Comalco Alumina Refinery plant at Yarwun (near Gladstone), Morvale coal mine (near Coppabella), and Rolleston coal mine (south west of Blackwater). It also includes minor load increases at existing aluminium and zinc smelter plants, but at a slightly lower level than previously forecast.

New Large Loads – Uncommitted
Since the 2003 Annual Planning Report, development work on the AMC magnesium smelter project at Stanwell has been curtailed and a large chemical products plant at Yarwun (west of Gladstone) has been deferred. These potential loads were also not included in the previous forecasts.

There have been several other announced proposals for large metal processing or other industrial loads which are not yet considered to be committed and are therefore not included in the forecast.

These developments include:

- a new aluminium smelter west of Gladstone (Aldoga), possibly on a smaller scale than previously proposed;
- possible major expansions of an existing aluminium smelter (Gladstone) and an existing zinc smelter plant (Townsville);
- a zinc smelter plant at Yarwun (west of Gladstone); and
- a pulp and paper mill (between Swanbank and Abermain).

These developments could translate to the following additional loading on the network.

Zone	Type of Plant	Possible Load
Gladstone	Aluminium, zinc & chemical	0-1050MW
Ross	Zinc	0-130MW
Moreton South	A pulp and paper mill and other industries	0-100MW

Whilst the load forecast does not include the above uncommitted large loads, some consideration to the impacts of these potential developments is given in Chapter 6.

DNSP and NIEIR Forecast Reconciliation:
Powerlink also contracted NIEIR to provide economic outlook and embedded generation forecasts for Queensland. This enabled an independent check with the new DNSP and customer forecasts in Queensland and these again were found to be consistent.

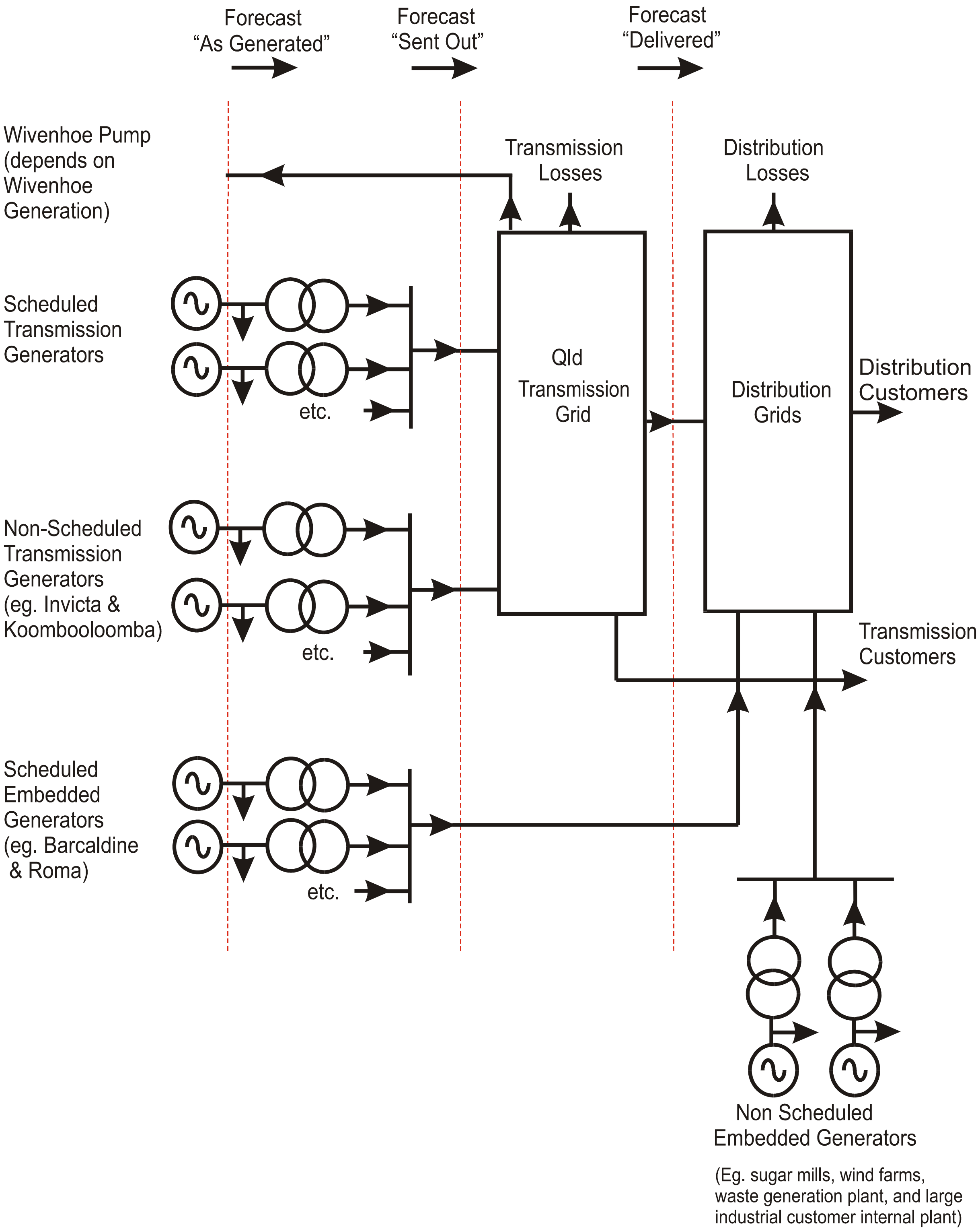
Reconciliation between the NIEIR forecast and the more detailed forecasts provided by DNSPs and customers was undertaken for the medium growth scenario and average weather conditions.

Overall, the customer and NIEIR demand and energy forecasts closely agreed over the ten-year period.

4.1.3 Load Forecast Definitions

The relationship between the classes of generation and the forecast quantities in this Report is shown in Figure 4.1.

Figure 4.1: Load Forecast Definitions



4.2 Recent Energy and Demands – Weather Correction

4.2.1 Recent Summers

The hotter than average 1997/98 Queensland summer initiated a substantial increase in the rate of domestic air-conditioning installations[2]. This increase accelerated further following the hotter than average 2001/02 summer. Air-conditioning installations during 2002 reached levels greater than five times the pre-1998 annual installation rate. However, the very hot weather in summer 2001/02 fell mostly within the Christmas to early January holiday period and consequently did not result in very high demand levels in south east Queensland.

The 2002/03 summer brought a return to more normal rainfall levels in south east Queensland and milder than average temperature conditions across all of Queensland. Despite this weather reversal, growth in actual summer demand and energy still occurred, indicating substantial underlying electricity growth after allowing for weather correction. Notwithstanding, the mild 2002/03 summer, installation rates of air-conditioning plant remained strong, at more than twice the pre-1998 levels[2].

Due to the popularity and relatively lower cost of domestic air-conditioners, continuing high levels of installation were forecast to continue for a further three years in the 2003 Annual Planning Report. It was then predicted that a saturation effect would reduce the installation rates to earlier levels.

The recent 2003/04 summer was mild in December but the January to early March period produced many very hot and extremely humid days. This period included twelve continuous days in south east Queensland where discomfort levels were generally more severe than during the hot summers of 1997/98 and 2001/02. This resulted in wide spread continuous use of domestic air-conditioning units. This drove very high electricity demands. Observations of demand sensitivity to ambient temperature conditions, suggest that these units struggled to cope with the extreme combined temperature and humidity levels day after day, resulting in maximum power draws and loss of typical load diversity between units. The observed sensitivities are shown in Table F.2 of Appendix F.

An increase in population migration to Queensland has also contributed to demand growth in recent years.

A summary of recent summer prevailing weather conditions, seasonal energy delivered and electricity demands is shown in Table 4.2.

[2] Based on estimates of air-conditioning sales outlined by NIEIR

Table 4.2: Comparison of Recent Queensland Summer Delivered Load

Summer	Energy GWh	Maximum Demand MW	Prevailing Queensland Weather Conditions	Brisbane Temperature (1) Summer Average °C	Peak Demand Day °C	No days >28.4°C
1997/98	8,746	5,234	Very hot	26.12	29.00	10
1998/99	8,796	5,386	Average	24.68	29.75	8
1999/00	9,285	5,685	Mild	22.62	31.95	2
2000/01	9,678	5,891	Average, dry	24.39	28.90	4
2001/02	10,434	6,259	Sustained hot and dry Extreme central to north	25.58	26.95	10
2002/03	10,530	6,462 (2)	Mild, late wet season in north	24.41	28.95	2
2003/04	11,330	7,103	Extremely hot and humid	26.01	30.60	17 (3)

Notes:

(1) In this report, Brisbane temperature is now measured at Archerfield – being more representative of general south east Queensland weather conditions than previous reference to Brisbane Airport. Day temperatures refer to average of daily minimum and daily maximum to represent the driver for cooling load.
The 28.4°C is the 50% PoE reference temperature which is expected to be exceeded 2 to 3 days per summer on average.

(2) A correction of 60MW was added to reflect an abnormal plant failure in a large industrial load.

(3) This included ten days from 12 February 2004 to 23 February 2004.

4.2.2 Recent Winters

The winter of 2003 was again milder than the long term historical average as was the case in five of the last six winters. However, during winter 2003 there was one eight day cold snap period which resulted in a peak demand more in line with an average winter.

The very strong growth in installation of domestic air-conditioning over recent years was sparked mainly by hot summer weather. The majority of these units are reverse-cycle and were heavily utilised during cold periods in winter 2003. It is now expected that air-conditioning load will contribute more heavily to higher winter demands in future, even in average winter conditions.

A summary of recent winter electricity demands, seasonal energy delivered and prevailing weather conditions is shown in Table 4.3.

Table 4.3: Comparison of Recent Queensland Winter Delivered Load

Winter	Energy GWh	Max Demand MW	Prevailing Queensland Weather Conditions	Brisbane Temperature (1) Winter Average °C	Peak Demand Day °C	No days <10.9°C
1998	8,633	5,042	Mild to warm	16.45	11.85	0
1999	9,116	5,309	Mild	15.32	15.50	0
2000	9,668	5,691	Cooler than average	14.32	8.80	2
2001	9,912	5,811	Mild	14.99	10.10	3
2002	10,177	5,743	Average	14.57	12.85	1
2003	10,392	6,149	Mild but one 8 day cold snap	14.96	10.95	4

Notes:

(1) In this report, Brisbane temperature is now measured at Archerfield – being more representative of general south east Queensland weather conditions than previous reference to Brisbane Airport. Day temperatures refer to average of daily minimum and daily maximum to represent the driver for heating load.
The winter of 1997 was cooler than average based on Brisbane airport weather data.
The 10.9°C is the 50% PoE reference temperature which is expected to be exceeded 2 to 3 days per winter on average.

4.2.3 Seasonal Growth Patterns

The hot summers of 1997/98, 2001/02 and 2003/04 resulted in large increases in summer delivered energy. The relatively cooler than average winters of 1997 and 2000 also resulted in higher delivered energy. These effects can be seen in Figure 4.2 by comparison to the trend-line of summer and winter energy delivered to DNSPs over the last seven years. Figure 4.2 excludes the energy delivered to major industrial customers, connected directly to the transmission grid, so that it is indicative of the underlying trend of electricity consumption growth in Queensland.

4.2.4 Temperature Correction of Demands

Powerlink analyses the temperature dependence of demands for all ten zones across Queensland, with reference to weather station data from eight locations, as outlined in Appendix F.

Queensland is too large geographically to be accurately described as having a demand dependence on a single location's weather. The two recent very hot summers of 2001/02 and 2003/04 have shown that such an approach can be misleading. In summer 2001/02 the maximum Queensland region demands coincided with the hottest weather and highest demands in northern Queensland. However, in summer 2003/04 the northern Queensland demands and temperatures were relatively low at the times of hottest weather and highest demands in southern Queensland.

Accordingly, Powerlink has reviewed the methodology of weather correcting historical Queensland region demand, and now separates the analysis into five components for separate correction and combination according to average historical coincidence factors. The components are:

- south east Queensland area, corrected against Brisbane (Archerfield) temperature;
- major industrial loads which might exhibit fluctuating levels independent of temperature conditions, are corrected to typical levels coincident with time of Queensland region maximum demand;
- northern Queensland area, without its large industrial loads, corrected against Townsville temperature;
- central Queensland area without its large industrial loads, corrected against Rockhampton temperature; and
- south west Queensland area, corrected against Toowoomba temperature.

Queensland region corrected demands for all winters and summers from 1998, under the revised methodology, are shown on Figure 4.3. The methodology is further outlined in Appendix F. Powerlink will be conducting further research with independent bodies as to the appropriateness of also correcting demands against a temperature – humidity composite factor.

Figure 4.2: Recent Summer & Winter Energy Delivered to DNSPs in Qld (excluding energy to the major direct industrial customers)

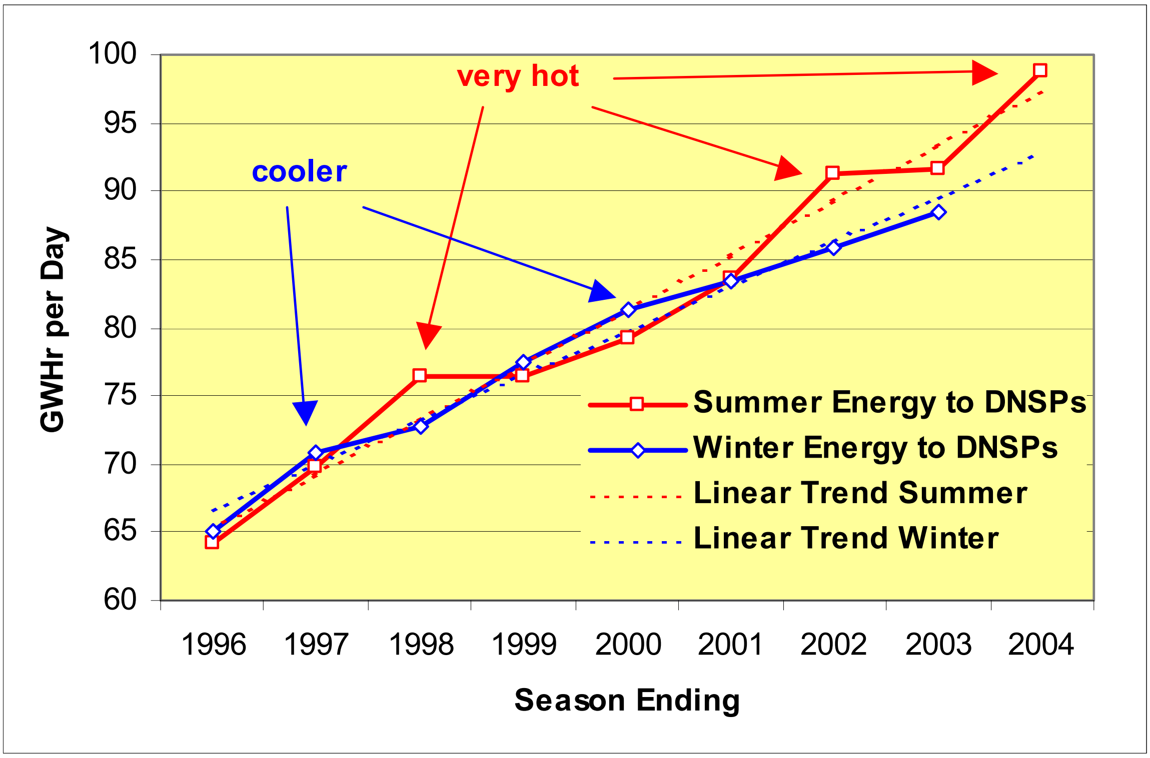
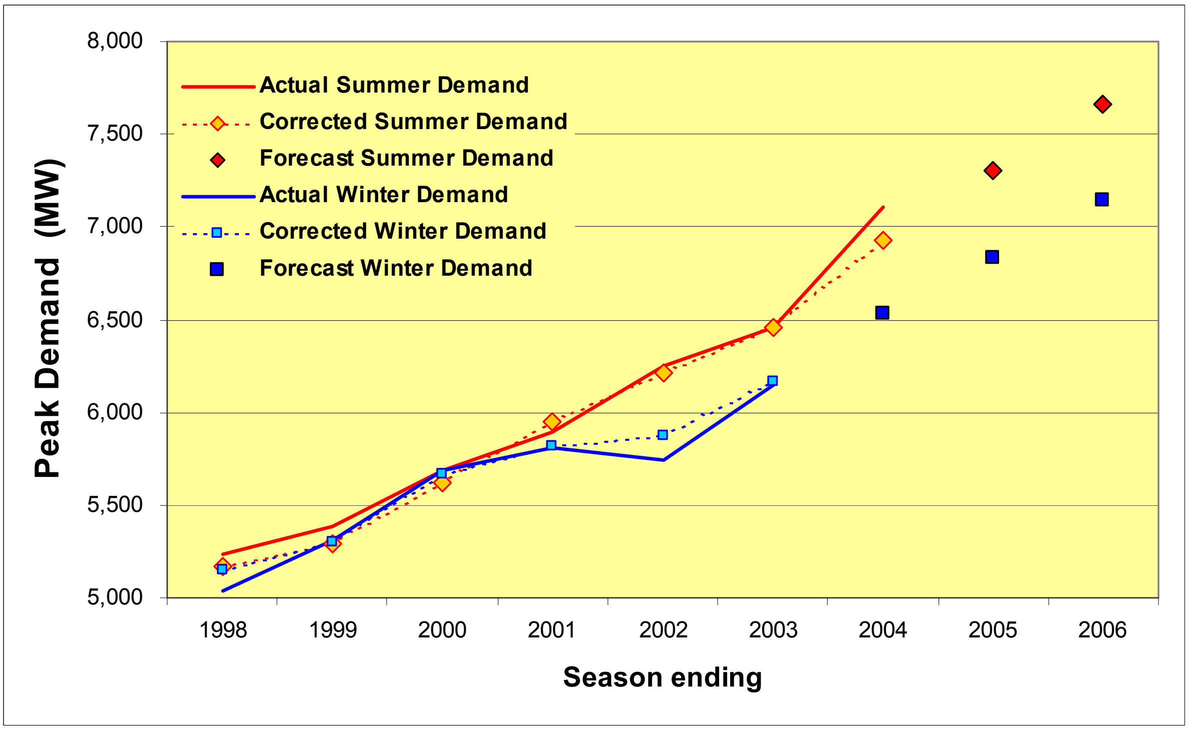


Figure 4.3: Recent Summer and Winter Actual and Temperature Corrected Demands MW Compared to Initial Values of New Forecast



4.3 Comparison with the 2003 Annual Planning Report

The new forecasts presented in this Annual Planning Report maintain the expectation of an expected initial three year burst of increased domestic air-conditioning load growth, which was incorporated into the forecasts in the 2003 Annual Planning Report.

That expectation had been based on greatly increased unit sales in response to the very hot summers of 1997/98 and 2001/02 and substantial improvements in appliance efficiency and affordability. It has been confirmed by a high 2003 winter demand more in line with average weather, ongoing very strong air-conditioning unit sales throughout 2003 and 2004, and very high utilisation of these units during the extreme prolonged hot and humid weather late in summer 2003/04.

In comparison with the 2003 forecast, the forecast in this report shows a small increase in summer demands and a substantial increase in winter demands. Initially, there is a small reduction in annual energy delivered from the transmission grid and from embedded scheduled generators, but a small increase over the ten year period. The main factors contributing to these changes are:

- commitment of an aluminium extrusion plant in the Swanbank-Abermain area;
- cancellation or deferment of some small energy intensive industrial load projects in the Gladstone area;
- deferment of minor expansion at the zinc smelter in Townsville;
- later timing of the Comalco Aluminium Refinery in the Gladstone area, and the Rolleston Coal Mine in the Blackwater area;
- small increases in some existing coal mines;

- recognition that air-conditioning sales and utilisation has been even greater over the last year than the high previous expectation;
- lower embedded non-scheduled generation forecasts, increasing the energy delivered from the transmission grid;
- an expectation that under future average winter weather conditions, utilisation of the expanding domestic air-conditioning installations in heating mode will increase;
- an expectation that, despite the higher air-conditioning growth over the last year, two more years of high growth in these loads will be maintained, as there is still substantial potential for expansion until penetration reaches levels at which saturation effects could reduce this growth; and
- air-conditioning load growth contributes less proportionally to energy growth than to summer and winter demands, and also causes a disproportionate increase in reactive power demands.

4.4 Forecast Data

The information pertaining to the forecasts are shown in tables and figures as follows:

- Figure 4.1 shows the relationship between the classes of generation and the definitions of forecast quantities used in this Report;
- Table 4.1 shows the NIEIR forecast of cogeneration and other embedded generation (both renewable and non-renewable energy source);
- Tables 4.2 and 4.3 show recent summer and winter demands, seasonal energy delivered and prevailing weather conditions for comparison purposes;
- Figure 4.2 shows recent growth in energy by seasons to illustrate the impact of the three very hot recent summers (1997/98, 2001/02 and 2003/04) but generally mild winters. Only 1997 and 2000 were slightly cooler than average winters;
- Figure 4.3 shows recent summer and winter demands and estimated temperature corrections to show consistency with initial values of the new forecast demands;
- Table 4.4 shows average growth rates of Queensland Gross State Produce (GSP), energy, summer and winter peak demands for the next ten years;
- Table 4.5 and Figures 4.4 and 4.5 show the historical and ten-year forecast of net **energy** supplied from the transmission grid together with embedded scheduled generators in the Queensland region for the Low, Medium and High Economic Growth scenarios;
- Table 4.6 and Figure 4.6 show the historical and ten-year Queensland region **summer demand** forecast (delivered from the grid and embedded scheduled generators) for each of the three economic scenarios and also for 10%, 50% and 90% PoE weather conditions;
- Table 4.7 and Figure 4.7 show the historical and ten-year Queensland region **winter demand** forecast (delivered from the grid and embedded scheduled generators) for each of the three economic scenarios and also for 10%, 50% and 90% PoE weather conditions;
- Table 4.8 shows the **Medium Growth** Scenario forecast of **average weather** winter and summer maximum coincident region electricity **demand** including estimates of Transmission Grid Losses, Power Station Sent Out and As Generated Demands;

- Table 4.9 shows the **Medium Growth** forecast of **one in ten year or 10% PoE** weather winter and summer maximum coincident region electricity **demand** including estimates of Transmission Grid Losses, Power Station Sent Out and As Generated Demands;
- Figure 4.8 shows the daily load profile on the days of the recent 2003 winter and 2003/04 summer Queensland region peak demand delivered from the transmission grid and from embedded scheduled generators;
- Figure 4.9 shows the cumulative load duration curve for the 2002/03 financial year; and
- The forecast loading at Powerlink Queensland 275kV substations at the time of the coincident Queensland region maximum demand, under a range of possible generation dispatch patterns and up to summer 2006/07 is shown in Table A2 of Appendix A. These loadings can be higher at the time of local area maximum demand, and can also vary under different generation dispatch patterns.

It should also be noted that the forecasts have been derived from information and historical revenue metering data up to and including April 2004, and are based on assumptions and third party predictions which may or may not prove to be correct. The 'projected actual' forecast for the 2003/04 year accounts for actual energy delivery in the first ten months of the financial year, ie. up to end of April 2004 plus forecast energy to end June based on statistical 'as generated' data.

In summary, the forecast average annual growth rates for the Queensland region over the next ten years under low, medium and high economic growth scenarios are shown in Table 4.4. These averages mask the accelerated summer demand growth (weather corrected) over the three year period up to 2005/06, which averages 6.6% p.a. in south east Queensland and 5.8% p.a. for the whole Queensland region.

Table 4.4: Average Annual Growth Rate Over Next Ten Years

	Economic Growth Scenario		
	High	Medium	Low
Queensland Gross State Product	4.6%	3.7%	2.7%
Energy Delivered (1)	5.4%	3.0%	2.2%
Summer Peak Demand (50% PoE) (2)	5.3%	3.2%	1.0%
Winter Peak Demand (50% PoE) (2)	5.6%	3.4%	1.2%

Notes:

(1) This is energy delivered from the transmission grid and from embedded scheduled generators, and is reduced by the forecast growth in embedded non-scheduled generation. If there were to be no increase in embedded non-scheduled generation above current levels the average forecast growth rate in energy delivered would be 3.1% p.a. under the medium growth scenario.

(2) This is the half-hour average power delivered from the transmission grid and from embedded scheduled generators.

Table 4.5: Annual Energy – Actual and Forecast

Year	Sent Out (1)			Transmission Losses (2)			Delivered		
94/95	29,240			1,427			27,813		
95/96	30,255			1,497			28,758		
96/97	31,375			1,506			29,869		
97/98	35,675			1,662			34,013		
98/99	36,555			1,556			34,999		
99/00	38,439			1,486			36,953		
00/01	40,203			1,642			38,561		
01/02	42,291			1,994			40,297		
02/03	43,120			1,855			41,264		
03/04 (3)	44,968			1,988			42,980		
Forecast	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
04/05	45,783	46,667	47,726	2,042	2,100	2,170	43,741	44,567	45,556
05/06	46,773	48,486	50,736	2,107	2,221	2,374	44,666	46,265	48,362
06/07	47,879	49,952	53,649	2,195	2,336	2,594	45,684	47,616	51,056
07/08	48,940	51,532	56,761	2,283	2,462	2,836	46,657	49,070	53,925
08/09	49,651	53,397	59,415	2,350	2,615	3,057	47,301	50,783	56,358
09/10	51,192	54,920	63,273	2,473	2,742	3,372	48,718	52,178	59,900
10/11	52,688	56,304	67,379	2,594	2,859	3,717	50,094	53,445	63,662
11/12	53,987	57,964	71,079	2,706	3,003	4,044	51,281	54,961	67,034
12/13	55,235	59,748	74,891	2,817	3,160	4,394	52,418	56,589	70,498
13/14	56,365	61,199	77,519	2,917	3,290	4,645	53,448	57,909	72,874

Notes

(1) This is the input energy that is sent into the Queensland Grid from Queensland Scheduled generators, Invicta Mill (transmission connected but non-scheduled), and Net Imports to Queensland. The energy to Wivenhoe Pumps is not included in this table, as it is not predictable and is accordingly assumed to be netted off any Wivenhoe generation.

(2) This includes the Queensland share of losses on the Queensland-New South Wales Interconnection. Increases in transmission losses have occurred since 2001/02, as power flows on QNI have reached increasingly higher levels for longer periods of time. Transmission losses can be reduced through network augmentation, as occurred in 1998/99 and 1999/2000 due to the commissioning of the major Calvale-Tarong and Tarong-Blackwall 275kV transmission lines. However, loss levels are also highly dependent on generation dispatch patterns that can create power flow changes in different parts of the state. For example, in 2001/02, higher summer central to northern Queensland power flows and losses occurred due to low hydro dispatch in far north Queensland. In 2002/03, loss levels decreased due to the substantial new generation in southern Queensland reducing the power flows from central to southern Queensland. Future generation dispatch pattern changes may both increase and decrease loss levels by creating power flow changes not related to normal growth-related escalation. This table assumes that the level of future transmission works, will only provide a partial check against the normal growth related power flow increases and associated loss levels.

(3) These projected end of financial year values are based on revenue metering data up to April 2004 and statistical metering up to May 2004.

Figure 4.4: History and Forecasts of Annual Energy Delivered for Medium Economic Growth Scenario

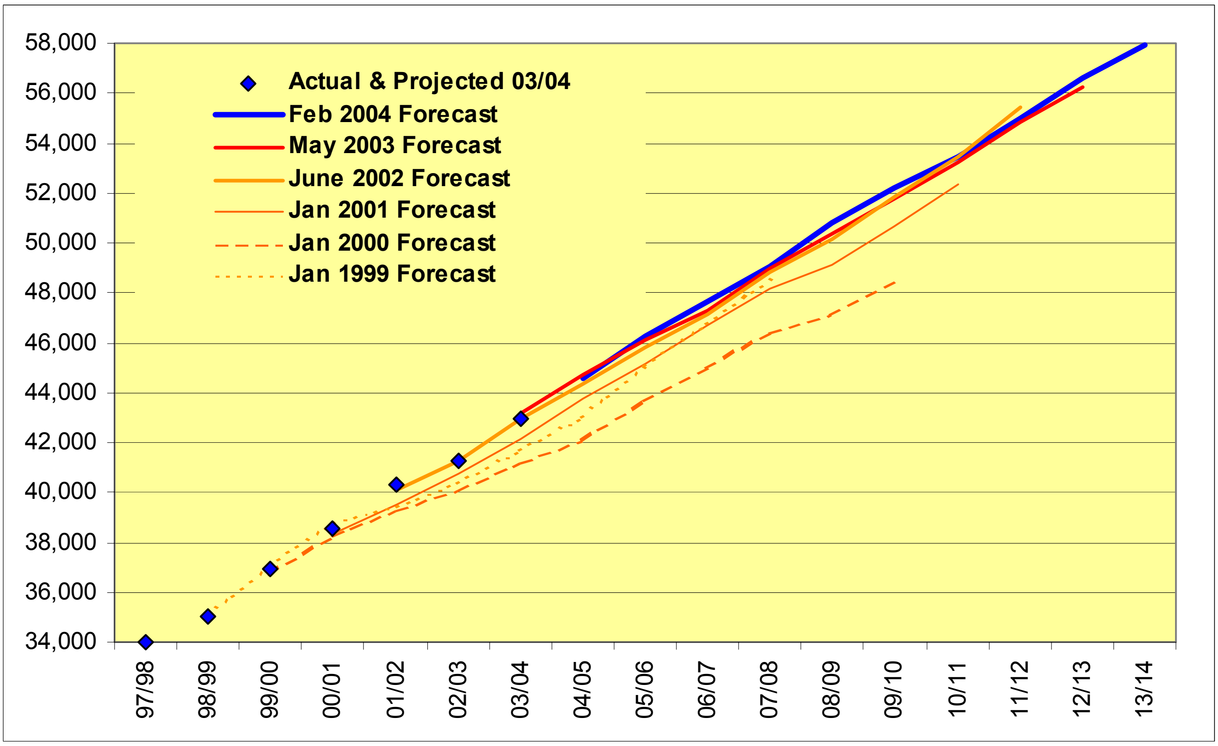


Figure 4.5: History and Forecast of Energy Delivered for Low, Medium and High Economic Growth Scenarios

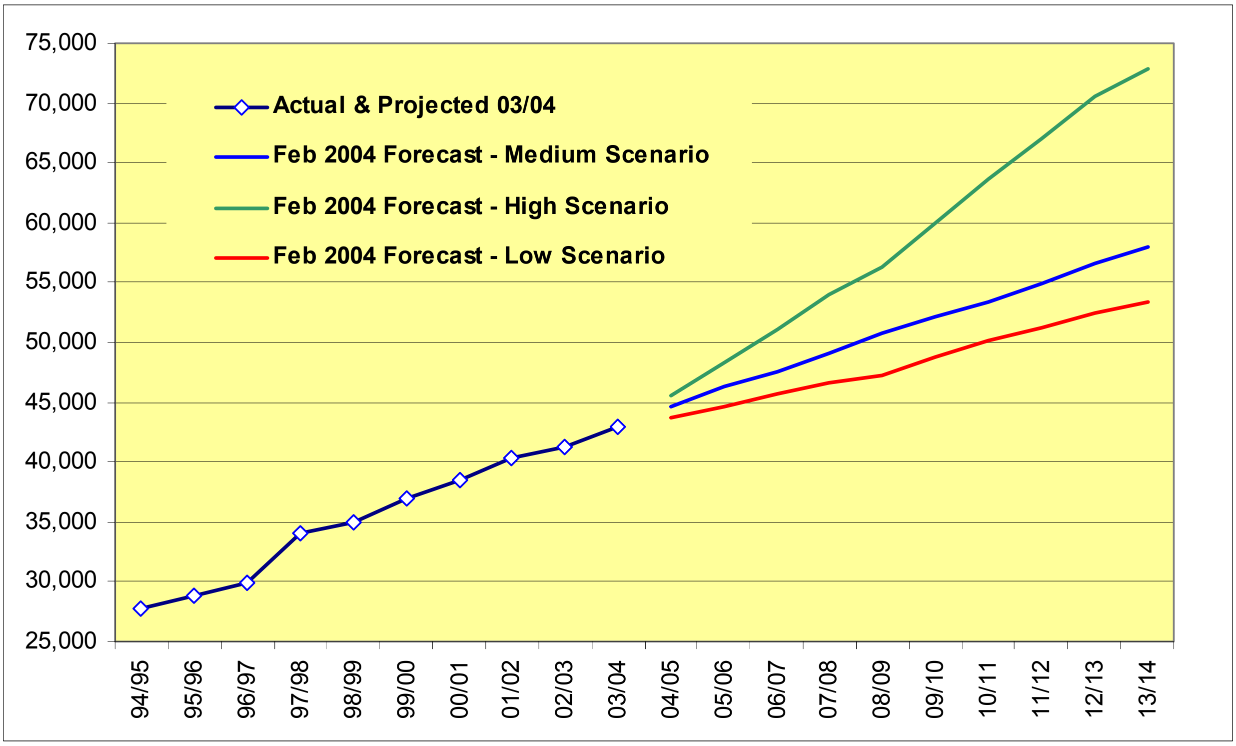


Table 4.6: Peak Summer Demand

Summer	Actual	50%PoE Temperature Corrected Peak Demand
97/98	5,161	**5,165**
98/99	5,386	**5,292**
99/00	5,685	**5,620**
00/01	5,891	**5,954**
01/02	6,246	**6,211**
02/03	6,462	**6,461**
03/04	7,103	**6,924**

Summer Forecasts	High Growth Scenario			Medium Growth Scenario			Low Growth Scenario		
	10%PoE	50%PoE	90%PoE	10%PoE	50%PoE	90%PoE	10%PoE	50%PoE	90%PoE
04/05	7,895	7,613	7,447	7,574	**7,303**	7,143	7,310	7,049	6,895
05/06	8,458	8,156	7,977	7,944	**7,660**	7,492	7,511	7,242	7,084
06/07	8,879	8,561	8,374	8,185	**7,892**	7,719	7,627	7,354	7,193
07/08	9,302	8,969	8,773	8,433	**8,131**	7,954	7,709	7,432	7,270
08/09	9,786	9,440	9,236	8,703	**8,395**	8,213	7,739	7,462	7,299
09/10	10,216	9,860	9,651	8,924	**8,613**	8,431	7,661	7,386	7,225
10/11	10,695	10,322	10,102	9,148	**8,829**	8,641	7,739	7,462	7,299
11/12	11,152	10,762	10,533	9,378	**9,050**	8,858	7,825	7,545	7,381
12/13	11,635	11,226	10,987	9,611	**9,274**	9,077	7,921	7,638	7,473
13/14	12,055	11,634	11,387	9,833	**9,490**	9,290	7,959	7,675	7,509

Figure 4.6: Queensland Region Summer Peak Demand

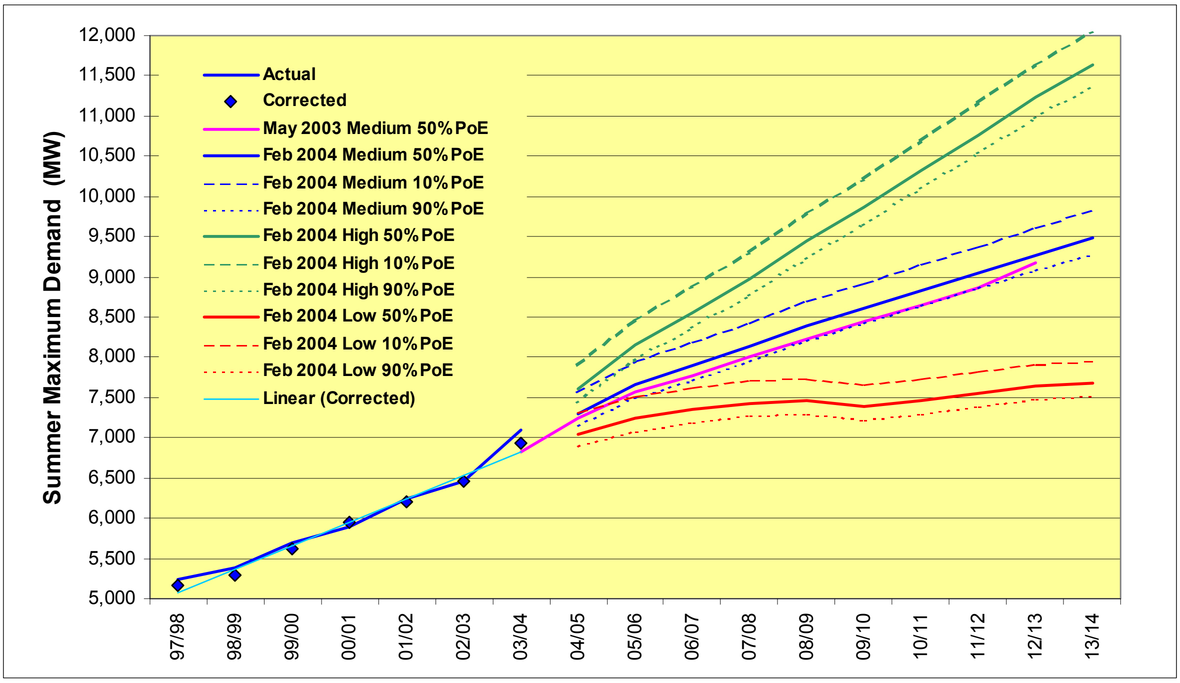


Table 4.7: Peak Winter Demand

Winter	Actual	50%PoE Temperature Corrected Peak Demand
1998	5,042	**5,152**
1999	5,309	**5,298**
2000	5,691	**5,672**
2001	5,811	**5,816**
2002	5,743	**5,875**
2003	6,149	**6,165**

Winter Forecasts	High Growth Scenario			Medium Growth Scenario			Low Growth Scenario		
	10%PoE	50%PoE	90%PoE	10%PoE	50%PoE	90%PoE	10%PoE	50%PoE	90%PoE
2004	6,833	6,708	6,582	6,658	**6,538**	6,417	6,531	6,415	6,298
2005	7,320	7,186	7,052	6,964	**6,838**	6,712	6,680	6,561	6,442
2006	7,813	7,671	7,528	7,278	**7,147**	7,016	6,870	6,748	6,626
2007	8,169	8,021	7,873	7,466	**7,332**	7,198	6,897	6,775	6,652
2008	8,589	8,436	8,283	7,683	**7,548**	7,412	6,875	6,753	6,631
2009	9,043	8,885	8,728	7,926	**7,789**	7,652	6,809	6,689	6,569
2010	9,492	9,327	9,162	8,126	**7,986**	7,846	6,869	6,748	6,627
2011	9,914	9,742	9,569	8,328	**8,184**	8,040	6,932	6,810	6,688
2012	10,370	10,190	10,010	8,540	**8,393**	8,246	7,011	6,889	6,765
2013	10,867	10,679	10,490	8,755	**8,604**	8,453	7,086	6,961	6,837

Figure 4.7: Queensland Region Winter Peak Demand

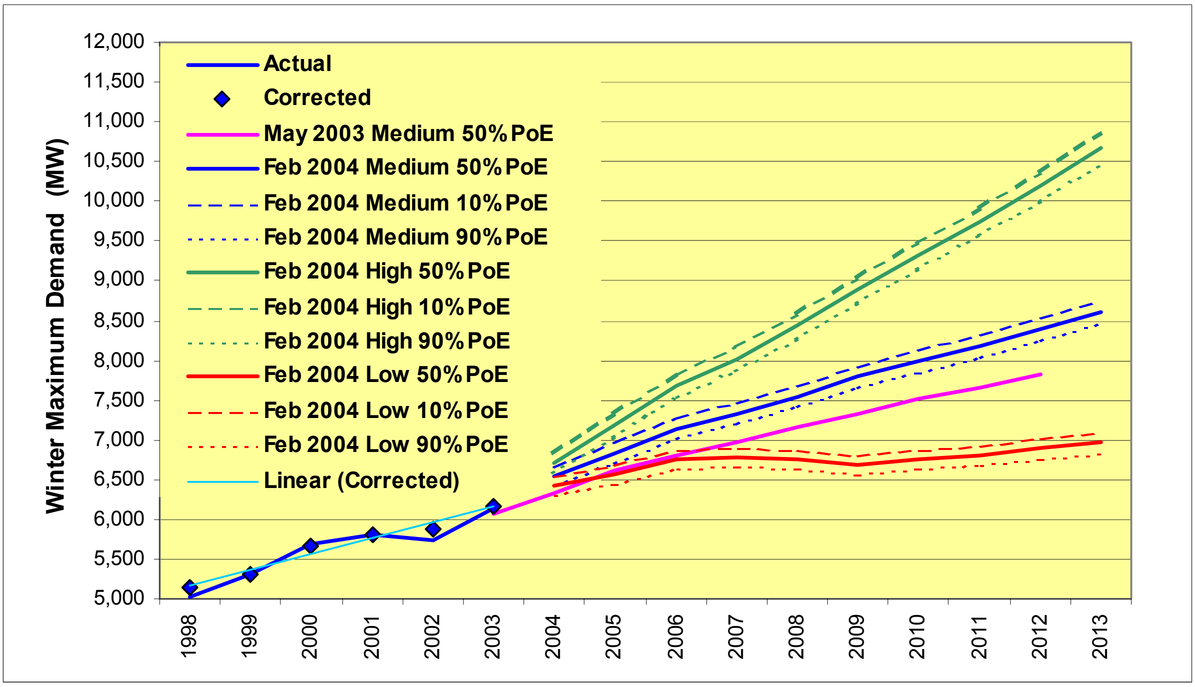


Table 4.8: Maximum Demand – 50% PoE Forecast

	Station "As Generated" Demand	Station Auxs & Losses (1)	Station "Sent Out" Demand	Transmission Losses	Delivered from Grid Demand (2)
Winter State Peak					
2004	7,305	420	6,885	347	6,538
2005	7,640	439	7,201	363	6,838
2006	7,986	459	7,527	379	7,147
2007	8,192	471	7,721	389	7,332
2008	8,433	485	7,948	401	7,548
2009	8,703	500	8,202	413	7,789
2010	8,923	513	8,410	424	7,986
2011	9,144	526	8,619	434	8,184
2012	9,378	539	8,838	445	8,383
2013	9,614	553	9,061	457	8,604
Summer State Peak					
04/05	8,187	471	7,716	413	7,303
05/06	8,587	494	8,094	434	7,660
06/07	8,847	509	8,338	447	7,892
07/08	9,116	524	8,592	460	8,131
08/09	9,411	541	8,870	475	8,395
09/10	9,656	555	9,101	488	8,613
10/11	9,898	569	9,329	500	8,829
11/12	10,146	583	9,562	512	9,050
12/13	10,397	598	9,799	525	9,274
13/14	10,639	612	10,027	591	9,490

Note:

(1) Station auxiliaries and generator transformer losses are now estimated at 5.75% of station "As Generated" dispatch at times of peak loading, lower than in previous years based on recent trends.

(2) "Delivered from Grid" includes the demand taken directly from the transmission grid as well as net power output from embedded scheduled generators (currently Barcaldine and Roma power stations)

Table 4.9: Maximum Demand – 10% PoE Forecast

	Station "As Generated" Demand	Station Auxs & Losses (1)	Station "Sent Out" Demand	Transmission Losses	Delivered from Grid Demand (2)
Peak State Winter					
2004	7,444	428	7,016	358	6,658
2005	7,786	448	7,338	375	6,963
2006	8,138	468	7,670	392	7,278
2007	8,348	480	7,868	402	7,466
2008	8,590	494	8,096	413	7,683
2009	8,862	510	8,352	426	7,926
2010	9,086	522	8,563	437	8,126
2011	9,311	535	8,776	448	8,328
2012	9,548	549	8,999	459	8,540
2013	9,789	563	9,226	471	8,755
Summer State Peak					
04/05	8,503	489	8,014	441	7,574
05/06	8,920	513	8,407	462	7,944
06/07	9,190	528	8,661	476	8,185
07/08	9,468	544	8,924	491	8,433
08/09	9,771	562	9,209	506	8,703
09/10	10,019	576	9,443	519	8,924
10/11	10,271	591	9,680	532	9,148
11/12	10,529	605	9,923	545	9,378
12/13	10,790	620	10,170	559	9,611
13/14	11,039	634	10,405	572	9,833

Note:

(1) Station auxiliaries and generator transformer losses are now estimated at 5.75% of station “As Generated” dispatch at times of peak loading, lower than in previous years based on recent trends.

(2) “Delivered from Grid” includes the demand taken directly from the transmission grid as well as net power output from embedded scheduled generators (currently Barcaldine and Roma power stations)

4.5 Zone Forecasts

The ten geographical zones referred to throughout this report are defined as follows:

Table 4.10: Zone Definitions

Zone	Area Covered
Far North	North of Tully including Chalumbin.
Ross	North of Proserpine and Collinsville, but excluding the Far North zone (includes Tully).
North	North of Broadsound and Dysart but excluding the Far North and Ross zones (includes Proserpine and Collinsville).
Central West	Collectively encompasses the area south of Nebo, Peak Downs and Mt McLaren, and north of Gin Gin, but excluding that part defined as the Gladstone zone.
Gladstone	Specifically covers the Powerlink transmission network connecting Gladstone power station, Callemondah (railway supply), Gladstone South, QAL supply, Wurdong and Boyne Smelter supply.
Wide Bay	Gin Gin and Woolooga 275kV substation loads excluding Gympie.
South West	Tarong and Middle Ridge load areas west of Postmans Ridge. From summer 2003/04 onwards, includes Goondiwindi (Waggamba) load.
Moreton North	South of Woolooga and east of Middle Ridge, but excluding the Moreton South and Gold Coast/Tweed zones.
Moreton South	Generally, south of the Brisbane River, but currently includes the Energex Victoria Park and Mayne 110kV substation load areas as supplied from Belmont 275/110kV substation, and excludes the Gold Coast/Tweed zone. From 2004 onwards some other parts of the Brisbane CBD area and inner suburbs will transfer from being in Moreton North to being in Moreton South, also supplied from Belmont and Murarrie.
Gold Coast/Tweed	Initially, south of Cades County to the Gold Coast and includes Tweed Shire of NSW. Energex's planned Coomera substation from summer 2005/06 onwards will cause a small net transfer of load to Moreton South, despite Cades County substation then shifting from Moreton South to the Gold Coast/Tweed zone.

Each zone normally experiences its own zone peak demand, which is usually greater than that shown in Tables 4.13 and 4.14, as it does not coincide with the time of Queensland region maximum demand.

Table 4.11 shows the average ratio of forecast zone peak demand to zone demand at the time of forecast Queensland region peak demands. These values can be used to multiply demands in Tables 4.13 and 4.14 to estimate each zone's individual peak demand, not necessarily coincident with the time of Queensland region peak demand. The ratios are based on historical trends.

Table 4.11: Average Ratio of Zone Peak Demand to Zone Demand at Time of Queensland Region Peak

Zone	Winter	Summer
Far North	1.200	1.060
Ross	1.150	1.065
North	1.140	1.130
Central West	1.050	1.080
Gladstone	1.020	1.020
Wide Bay	1.200	1.120
South West	1.010	1.035
Moreton North	1.007	1.010
Moreton South	1.008	1.010
Gold Coast / Tweed	1.023	1.050

Table 4.12 shows the forecast of energy supplied from the transmission grid and embedded scheduled generators for the Medium Growth Scenario for each of the ten zones in the Queensland region.

Table 4.13 shows the forecast of winter demand delivered from the transmission grid and embedded scheduled generators (coincident with the Queensland region winter peak) for each of the ten zones within Queensland. It is based on the Medium Growth scenario and average winter weather.

Table 4.14 shows the forecast of summer demand delivered from the transmission grid and embedded scheduled generators (coincident with the Queensland region summer peak) for each of the ten zones within Queensland. It is based on the Medium Growth scenario and average summer weather.

4.6 Daily and Annual Load Profiles

The daily load profiles for the Queensland region on the days of 2003 winter and 2003/04 summer peak demand delivered from the transmission grid and from embedded scheduled generators, are shown on Figure 4.8.

It should be noted that the delivered summer peak occurred on Monday 16 February 2004 which was not the same day as the recorded peak in Queensland as generated demand (Monday 23 February 2004). This occurrence on different days is not uncommon in Queensland. This results from the generation dispatch pattern and flow on QNI and the Directlink MNSP at the time, which can substantially vary the level of transmission losses across Queensland.

The annual cumulative load duration characteristic for the Queensland region demand delivered from the transmission grid and from embedded scheduled generators, is shown on Figure 4.9 for the 2002/03 financial year.

Figure 4.8: Summer and Winter Peaks 2003/04

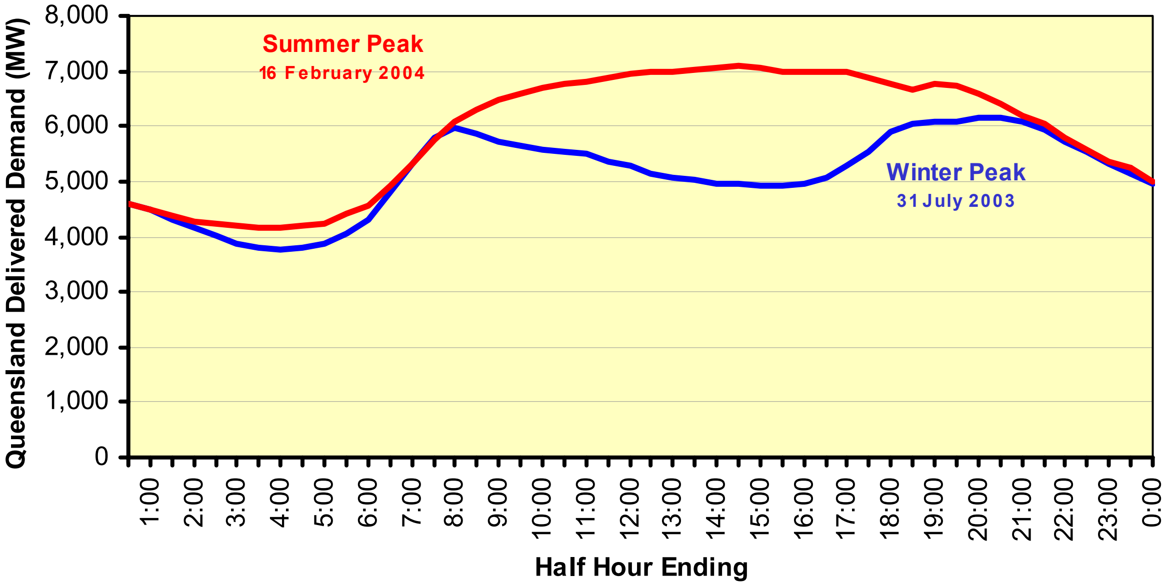


Figure 4.9: Cumulative Annual Load Duration 2002/03

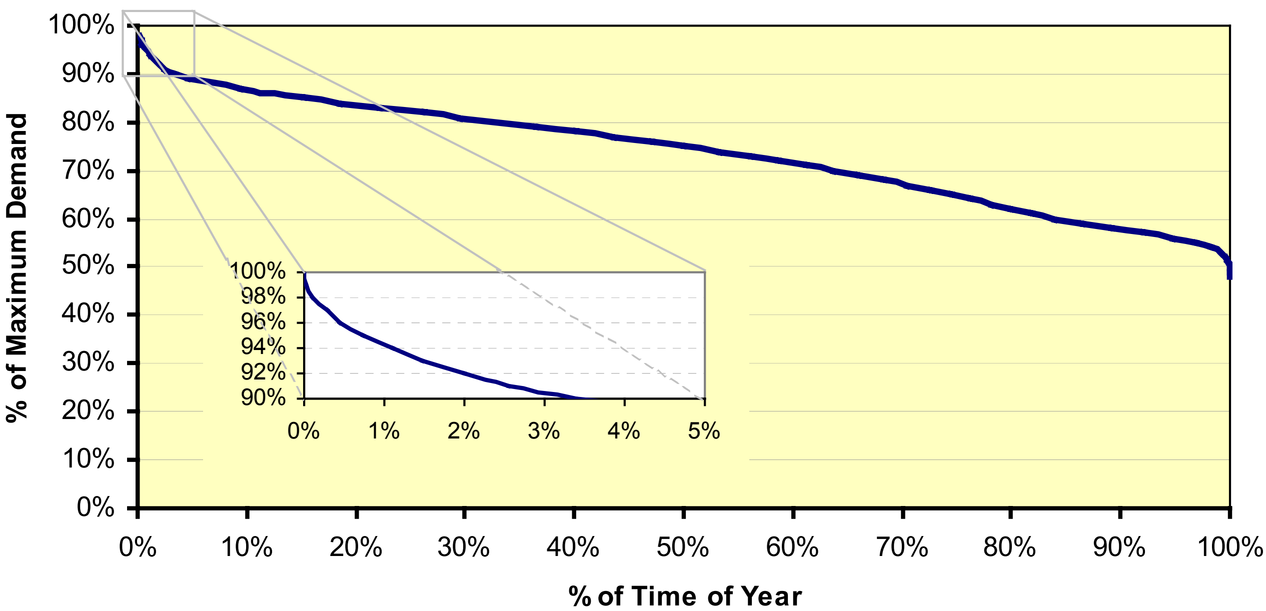


Table 4.12: Annual Energy by Zone

Actual and Forecast Annual Energy (GWh) Delivered from the Transmission Grid including from Embedded Scheduled Generators - In each zone - Medium Growth Scenario

Year	Far North	Ross	North	Central West	Gladstone	Wide Bay	South West	Moreton North	Moreton South	Gold Coast/ Tweed	Total
Actuals											
1997/98	1,364	1,967	1,844	2,638	7,925	1,051	1,482	5,530	7,684	2,529	**34,013**
1998/99	1,407	2,030	1,809	2,587	8,434	1,024	1,511	5,752	7,808	2,637	**34,999**
1999/00	1,430	2,454	1,963	2,789	8,660	1,088	1,575	6,101	8,116	2,777	**36,952**
2000/01	1,457	2,962	2,055	2,876	8,697	1,187	1,659	6,421	8,333	2,913	**38,561**
2001/02	1,536	2,971	2,219	3,069	8,948	1,257	1,717	6,769	8,746	3,064	**40,296**
2002/03	1,549	2,934	2,296	3,109	9,098	1,256	1,738	6,970	9,178	3,135	**41,264**
projected 2003/04	1,607	3,006	2,470	3,145	9,318	1,288	1,908	7,266	9,571	3,401	**42,980**
Forecasts											
2004/05	1,675	3,089	2,594	3,229	9,730	1,321	1,959	7,491 (1)	9,824 (1)	3,654	**44,567**
2005/06	1,718	3,209	2,659	3,354	10,009	1,355	2,009	7,714 (1)	10,323 (1)	3,915	**46,265**
2006/07	1,762	3,304	2,722	3,394	10,173	1,390	2,060	7,584 (1)	11,161 (1)	4,065	**47,616**
2007/08	1,807	3,377	2,782	3,507	10,259	1,426	2,112	7,930	11,613	4,255	**49,070**
2008/09	1,854	3,436	2,834	3,549	10,703	1,463	2,166	8,262	12,053	4,461	**50,783**
2009/10	1,902	3,501	2,905	3,603	10,802	1,501	2,220	8,577	12,537	4,632	**52,178**
2010/11	1,951	3,567	2,978	3,658	10,903	1,539	2,276	8,874	12,914	4,785	**53,445**
2011/12	2,001	3,635	3,054	3,714	11,005	1,579	2,333	9,293	13,377	4,971	**54,961**
2012/13	2,053	3,705	3,132	3,772	11,109	1,620	2,391	9,703	13,922	5,183	**56,589**
2013/14	2,101	3,770	3,204	3,827	11,208	1,658	2,446	10,029	14,321	5,345	**57,909**

Notes:

(1) Significant net transfer of load will occur from Moreton North to Moreton South zones due to the rearrangement of the 110kV network supplying the Brisbane CBD and inner suburbs area.

Table 4.13: State Winter Peak Demand by Zone

Actual and Forecast Demand (MW) on the Transmission Grid and Embedded Scheduled Generators in each zone at the time of Coincident State Winter Peak Demand - Average Weather Conditions

Year	Far North	Ross	North	Central West	Gladstone	Wide Bay	South West	Moreton North	Moreton South	Gold Coast/ Tweed	Total
Actuals											
1998	166	236	214	365	961	152	256	962	1,250	479	**5,042**
1999	173	238	229	377	994	165	278	1,022	1,315	517	**5,309**
2000	179	354	271	423	986	198	312	1,080	1,350	536	**5,691**
2001	184	378	255	442	1,019	189	301	1,110	1,365	567	**5,811**
2002	163	339	285	383	1,055	160	286	1,122	1,425	523	**5,743**
2003	177	348	295	412	1,009	181	318	1,251	1,574	583	**6,149**
Forecasts											
2004	197	374	293	435	1,121	193	347	1,289	1,669	621	**6,538**
2005	209	387	307	447	1,169	202	356	1,350 (1)	1,758 (1)	652	**6,838**
2006	216	411	319	479	1,201	208	367	1,401 (1)	1,874 (1)	671	**7,147**
2007	224	418	329	490	1,214	215	374	1,386	1,989	692	**7,332**
2008	232	435	339	513	1,229	222	383	1,429	2,049	716	**7,548**
2009	240	443	350	525	1,289	230	393	1,473	2,106	740	**7,789**
2010	248	452	359	537	1,302	237	401	1,519	2,167	765	**7,986**
2011	256	460	368	549	1,314	246	410	1,565	2,227	790	**8,184**
2012	265	470	377	560	1,327	254	418	1,621	2,287	814	**8,393**
2013	274	479	387	573	1,339	263	426	1,672	2,352	840	**8,605**

Notes:

(1) Significant net transfer of load will occur from Moreton North to Moreton South zones due to the rearrangement of the 110kV network supplying the Brisbane CBD and inner suburbs area.

Table 4.14: State Summer Peak Demand by Zone

Actual and Forecast Demand (MW) on the Transmission Grid and Embedded Scheduled Generators in each zone at the time of Coincident State Summer Peak Demand - Average Weather Conditions

Year	Far North	Ross	North	Central West	Gladstone	Wide Bay	South West	Moreton North	Moreton South	Gold Coast/ Tweed	Total
Actuals											
1998/99	244	292	271	372	959	189	242	992	1,381	444	**5,386**
1999/00	234	412	240	346	1,003	197	265	1,055	1,433	499	**5,685**
2000/01	252	458	294	391	993	195	270	1,068	1,472	498	**5,891**
2001/02	278	504	355	436	1,040	222	258	1,183	1,461	509	**6,246**
2002/03	264	470	307	426	1,048	200	298	1,243	1,653	554	**6,462**
2003/04	265	452	318	459	1,087	253	339	1,387	1,890	653	**7,103**
Forecasts											
2004/05	291	501	367	468	1,161	240	329	1,386	1,910	649	**7,303**
2005/06	302	529	380	501	1,184	247	339	1,416 (1)	2,085 (1)	677	**7,660**
2006/07	312	540	393	514	1,206	255	346	1,351 (1)	2,272 (1)	704	**7,892**
2007/08	323	560	405	538	1,220	263	354	1,390	2,350	729	**8,132**
2008/09	334	571	417	551	1,280	272	363	1,431	2,417	758	**8,395**
2009/10	345	583	428	564	1,292	281	371	1,475	2,489	785	**8,614**
2010/11	357	596	440	576	1,305	290	379	1,519	2,557	811	**8,830**
2011/12	368	609	452	589	1,317	300	387	1,570	2,623	836	**9,051**
2012/13	381	622	464	602	1,330	310	395	1,616	2,694	863	**9,275**
2013/14	392	635	475	615	1,341	319	402	1,661	2,761	889	**9,490**

Notes:

(1) Significant net transfer of load will occur from Moreton North to Moreton South zones due to the rearrangement of the 110kV network supplying the Brisbane CBD and inner suburbs area.

5. INTRA-REGIONAL COMMITTED NETWORK AUGMENTATIONS

CONTENTS

5.1 Transmission Network

The 1700km long Queensland transmission network comprises 275kV transmission from Cairns in the north to Mudgeeraba in the south, with 110kV and 132kV systems providing transmission in local zones, and providing limited backup to the 275kV grid. Also, 330kV lines forming part of the interconnection with New South Wales run from Braemar to the New South Wales border near Texas.

The single line diagrams of the Queensland network as shown in the 2003 APR have been updated to include recently completed augmentations outlined in this Chapter. Figures 5.1 and 5.2 show the updated single line diagram of the Queensland network.

Since a large proportion of the Queensland generating capacity is located in central Queensland, there are high power transfers from central to south Queensland and central to north Queensland. However, flows from central to south Queensland have decreased in recent times due to new generating plant in southern Queensland coming on-line.

The implications of this, together with forecast load growth, are:

- new generation capacity in central Queensland may again increase power flows from central Queensland to both north Queensland and south Queensland which may result in transmission limits being reached;
- new generation in north Queensland may reduce occurrences of transmission limits being reached from central to north Queensland, however, this alone may also increase flows from central to south Queensland which may result in transmission limits being reached in the south;
- additional new generation in south west Queensland may alleviate network constraints between central and south Queensland, however it may exacerbate constraints to the north. This may also tend to increase power flows into south east Queensland and increase the utilisation of the capacity across the Tarong grid section;
- additional new generation in south east Queensland may alleviate network constraints between central and south Queensland, however it may exacerbate constraints in the north. This will also tend to reduce total flows into south east Queensland and thus reduce utilisation of capacity across the Tarong grid section;
- new loads may be connected in central Queensland without significantly influencing transmission limits to the north or south; however network constraints may then arise within central Queensland;
- new loads in north Queensland may exacerbate constraints between central and north Queensland; and
- new loads in south east Queensland may exacerbate constraints associated with the Tarong limit and the CQ-SQ limit.

5.2 Committed Transmission Projects

Table 5.1 lists transmission grid developments commissioned since Powerlink's 2003 Annual Planning Report was published in July 2003.

Table 5.2 lists transmission grid developments which are committed and under construction at June 2004.

Table 5.3 lists connection works that have been commissioned since Powerlink's 2003 Annual Planning Report was published in July 2003.

Table 5.4 lists new transmission connections or connection works for supplying load which are committed and under construction at June 2004. These connection projects resulted from agreement reached with relevant connected customers, generators or distribution network service providers as applicable.

5.3 Possible Shared Grid and Connection Projects

Discussion of possible future developments of the shared transmission grid and connection points is presented in Chapter 6.

Table 5.1: Commissioned Transmission Developments

Commissioned Since June 2003 (1)

Project	Purpose	Zone Location (2)	Date Commissioned
Major Developments			
Belmont 275kV line reinforcement (3)	Increase supply capacity to maintain reliability to growing loads in southern areas of Brisbane	Moreton South	December 2003
Molendinar 275kV substation establishment (and transmission line from Maudsland) (4)	Increase 110kV supply capacity to maintain reliability to growing loads within Gold Coast and surrounding areas	Gold Coast/ Tweed	December 2003
Network support Arrangements			
Contract with local generators to provide network support in north Queensland	Part of solution to provide market benefits relating to supply to NQ	North	Ongoing from January 2002
Minor Developments			
Tarong to Blackwall circuit switching at Mt England	Provide voltage support	Moreton North	July 2003
Mt England 120MVAr, 275kV capacitor bank	Capacitive compensation to meet increasing reactive demand	Moreton North	December 2003
Palmwoods 120MVAr, 275kV capacitor bank	Capacitive compensation to meet increasing reactive demand	Moreton North	March 2004

Notes:
(1) Does not include new connections.
(2) Zone locations are defined in Table 4.10.
(3) Outstanding works between Swanbank and Blackwall sites to be completed by October 2004.
(4) Establishes a connection point (refer Table 5.3).

Table 5.2: Committed Transmission Developments

Committed and under construction at June 2004 (1)

Project	Purpose	Zone Location (2)	Planned Commissioning Date
Major Developments			
Lilyvale 275kV reinforcement	Increase supply capacity to maintain reliability to inland central Queensland mining area	Central West	October 2004
Darling Downs transmission reinforcement	Increase supply capacity to maintain reliability of supply to Darling Downs	South West	December 2004
Woree 132kV static var compensator	Increase supply capacity to maintain reliability to Cairns and far north Queensland	Far North	September 2005
Belmont-Murarrie 275kV reinforcement	Increase supply capacity to maintain reliability to Brisbane CBD and Trade Coast	Moreton South	October 2006
Minor Developments			
Wurdong 120MVAr, 275kV capacitor bank	Capacitive compensation to meet increasing reactive demand	Gladstone	August 2004
Ross and Chalumbin 275kV line switching	Provide improved switching arrangement	Far North	September 2004
Ross-Dan Gleeson 132kV transmission line retension	Increase thermal rating to maintain reliability to the north Townsville area	Ross	October 2004
Loganlea second 275/110kV transformer	Increase supply capacity to maintain reliability to Logan area	Moreton South	October 2004
Alligator Creek 20MVAr, 132kV capacitor bank	Provide voltage support	North	October 2004
Molendinar 50MVAr, 110kV capacitor bank	Capacitive compensation to meet increasing reactive demand	Gold Coast	October 2004
Rockhampton 40MVAr, 132kV capacitor bank	Increase supply capacity to maintain reliability to Rockhampton	Central West	October 2005
Ashgrove West 50MVAr, 110kV capacitor bank	Capacitive compensation to meet increasing reactive demand	Moreton North	October 2005
Murarrie 2 x 50MVAr, 110kV capacitor banks	Capacitive compensation to meet increasing reactive demand	Moreton South	October 2005
Nebo third 275/132kV transformer	Increase supply capacity to maintain reliability to the Mackay area and mining areas to the west	North	October 2005

Notes:
(1) Does not include new connections.
(2) Zone locations are defined in Table 4.10.

Table 5.3: Commissioned Connection Works since June 2003

Project	Purpose	Location	Commissioning Date
West End connection reinforcement	Increase capacity to West End and CBD	Moreton South	November 2003
Molendinar 275/110kV substation (1)	New connection point to Energex to augment 110kV capacity to parts of the Gold Coast and surrounding areas	Gold Coast	December 2003
Bulli Creek 330/132kV transformer (2)	Provide new 132kV connection point for Ergon supply to Goondiwindi (Waggamba)	South West	February 2004
Turkinje 132kV protection modifications	Increased capacity to Ergon's Craiglie network	Far North	February 2004

Notes

(1) Connection point created as a result of Molendinar project included in Table 5.1.

(2) Ergon works to Goondiwindi are still under construction.

Table 5.4: Committed Connection Works at June 2004

Project	Purpose	Location	Planned Commissioning Date
Biloela substation refurbishment and switching upgrade	Provide improved switching arrangement	Central West	October 2004
Pioneer Valley 132/66kV substation 2nd transformer	Provide reliable supply to growing load	Areas west of Mackay	October 2004
Edmonton 132/22kV substation	New connection point to Ergon to increase 22kV capacity to growing load south of Cairns	Areas between Cairns and Innisfail	October 2004
Bundamba(1) 110/11kV substation	New connection point to Energex	Moreton South	February 2005
Blackwater 132kV supply to Rolleston	New connection point for mining and other developments	Central West	May 2005
Ingham 132/66kV substation reconstruction and transformer replacement	Replace end of life assets and increase transformer capacity to meet load growth	North	June 2005
Mudgeeraba 110kV connections for Varsity Lakes	Provide supply to new Energex zone substation	Gold Coast areas near Bond University	October 2005
Dan Gleeson 132/66kV substation 2nd transformer	Increase 66kV capacity for reliable supply to growing load	South western areas of Townsville	October 2005
Rocklea 110kV 2nd connection for Archerfield	Increase capacity to Energex 33kV network to match load growth in Archerfield and surrounding areas	Moreton South	October 2005
New 110kV connection to Brisbane CBD and surrounding areas	New connection point to enable Energex to increase 110kV capacity to Brisbane CBD areas	Brisbane CBD and inner suburbs	October 2006

Notes:

(1) Was referred to as Ebbwvale in 2003 APR.

Figure 5.1 Existing 275/132/110kV Network June 2004 – North and Central Queensland

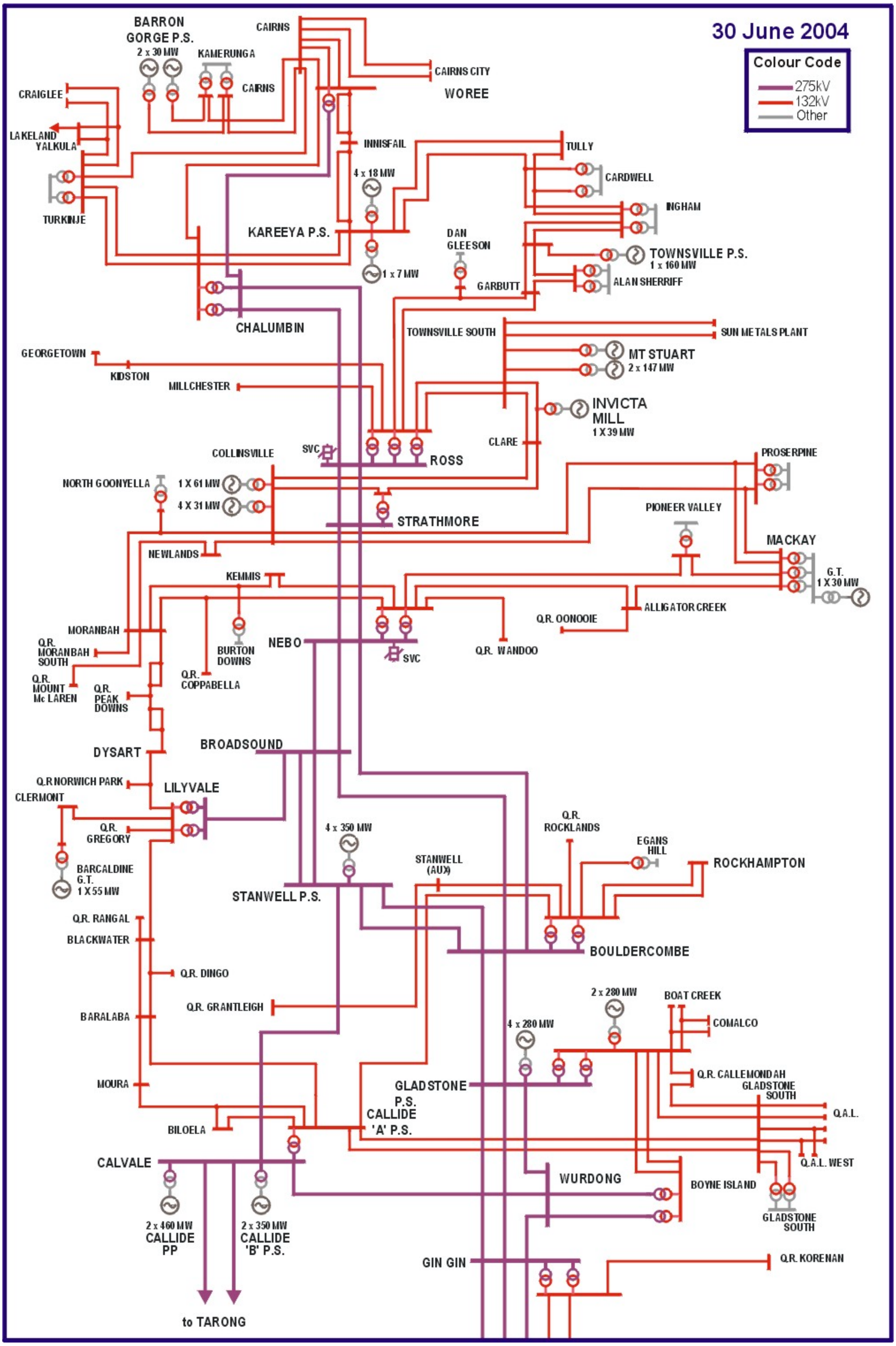
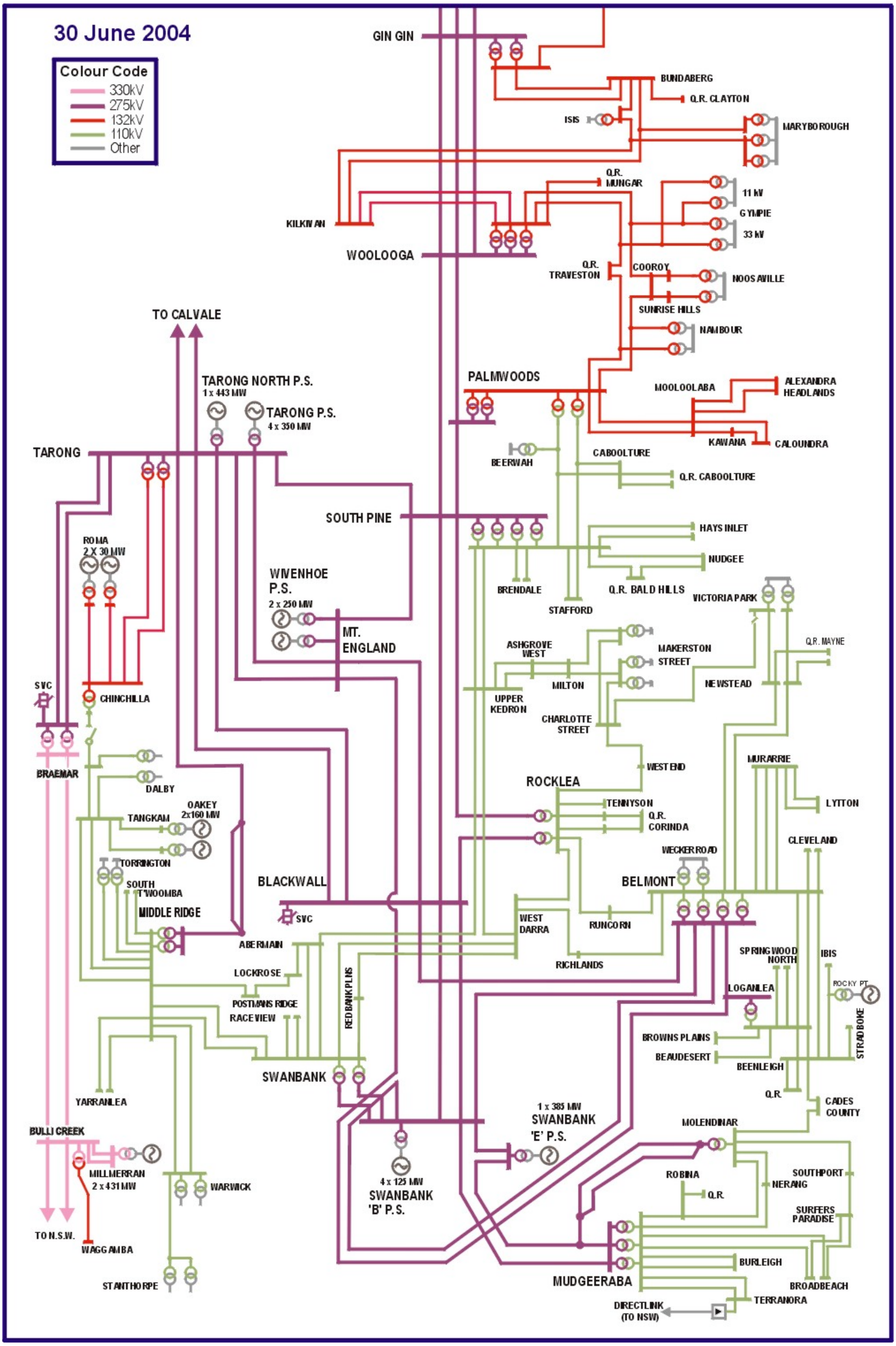


Figure 5.2 Existing 275/132/110kV Network June 2004 – South Queensland



6. INTRA-REGIONAL PROPOSED NETWORK DEVELOPMENTS WITHIN 5 YEARS

CONTENTS

6.1 Introduction

The National Electricity Code (Clause 5.6.2A(b)(3)) requires the Annual Planning Report to provide 'a forecast of constraints and inability to meet the network performance requirements set out in NEC Schedule 5.1 or relevant legislation or regulations of a participating jurisdiction over 1, 3 and 5 years'.

This Chapter on proposed network developments provides this and other related information. It contains:

- a background on the factors that influence network capability;
- sample grid power flows at times of forecast Queensland region maximum summer and winter demand under a range of interconnector flows and sample generation dispatch patterns within Queensland;
- a qualitative explanation of factors impacting power transfer capability at key grid sections on the Powerlink network;
- identification of emerging limitations with the potential to impact on supply reliability;
- a table summarising the outlook for grid constraints and network limitations over a five year horizon;
- details of those limitations for which Powerlink intends to implement corrective action or initiate consultation with market participants and interested parties; and
- a table summarising possible connection point proposals.

The capability of Powerlink's transmission grid to meet forecast demand is dependent on a number of factors that are subject to considerable uncertainty.

In general terms, the Queensland transmission grid is more highly loaded relative to its capacity during summer than during winter. The reactive power requirements are greater in summer than in winter and transmission plant has lower power carrying capacity in the higher summer temperatures. Also, high summer peak demands generally last for many hours, whereas winter peak demands are for short evening periods, as shown in Figure 4.8.

The location and pattern of power generation dispatch influence the power flows across most of the Queensland grid. Future generation dispatch patterns and interconnector flows are uncertain in the deregulated electricity market and can also vary substantially due to the impact of planned or unplanned outages of generation plant. Power flows on transmission grid elements can also vary substantially with planned or unplanned outages of transmission lines and transformers. Power flow levels can also be higher at times of local area or zone peak demands, as distinct from those at the time of Queensland region maximum demand. Power flows can also be higher when embedded generation levels are lower than forecast.

This chapter outlines some of these sensitivities using illustrative grid power flows over the next three years under a range of interconnector flows and sample generation dispatch patterns within Queensland. Qualitative explanation is also provided on the factors which impact power transfer capability at key grid sections on the Powerlink network, and on the cause of emerging limitations which may impact supply reliability.

6.2 Sample Winter and Summer Grid Power Flows

Powerlink has selected 18 sample scenarios to illustrate possible grid power flows for the forecast Queensland region summer and winter maximum demands over the period 2004 winter to 2006/07 summer.

Illustrative grid power flows at forecast Queensland region (50% PoE) winter and summer maximum demand over the next three years are shown in Appendix A for the Medium Economic Growth Scenario load forecast outlined in Chapter 4 of this report. These show possible grid power flows under a range of import and export conditions on the Queensland-New South Wales Interconnection (QNI) as indicated below. Grid power flows in Appendix A are based on existing network configuration, committed projects and proposed new network assets (as outlined in Section 6.7) only, and assume the grid is in its ‘normal’ or ‘intact’ state, that is, all network elements in service. Power flows can be higher than those levels during network or generation contingencies and/or during times of local area or zone peak demands.

This information is based on one possible sample generation dispatch and pattern with Queensland and load condition for each case and is provided only as an indication of network power flows. These can vary for different load conditions and generator bidding behaviour. In providing this information, Powerlink has not attempted to predict market outcomes.

Appendix A also indicates where grid flows are expected to exceed the relevant limit for the system conditions analysed.

Sample conditions in Appendix A include:

- Figure A1: Generation & Load Legend for Figures A3 to A20
- Figure A2: Power Flow & Limits Legend for Figures A3 to A20
- Figure A3: Winter 2004 Qld Peak 500MW Northerly QNI Flow
- Figure A4: Winter 2004 Qld Peak Zero QNI Flow
- Figure A5: Winter 2004 Qld Peak 500MW Southerly QNI Flow
- Figure A6: Winter 2005 Qld Peak 500MW Northerly QNI Flow
- Figure A7: Winter 2005 Qld Peak Zero QNI Flow
- Figure A8: Winter 2005 Qld Peak 500MW Southerly QNI Flow
- Figure A9: Winter 2006 Qld Peak 500MW Northerly QNI Flow
- Figure A10: Winter 2006 Qld Peak Zero QNI Flow
- Figure A11: Winter 2006 Qld Peak 500MW Southerly QNI Flow
- Figure A12: Summer 2004/05 Qld Peak 500MW Northerly QNI Flow
- Figure A13: Summer 2004/05 Qld Peak Zero QNI Flow
- Figure A14: Summer 2004/05 Qld Peak 500MW Southerly QNI Flow
- Figure A15: Summer 2005/06 Qld Peak 500MW Northerly QNI Flow
- Figure A16: Summer 2005/06 Qld Peak Zero QNI Flow
- Figure A17: Summer 2005/06 Qld Peak 400MW Southerly QNI Flow
- Figure A18: Summer 2006/07 Qld Peak 500MW Northerly QNI Flow
- Figure A19: Summer 2006/07 Qld Peak Zero QNI Flow
- Figure A20: Summer 2006/07 Qld Peak 350MW Southerly QNI Flow

The power flows shown in Figures A3 to A20 are a sample of possible generation dispatch and grid power flows for the forecast region peak demand conditions nominated. The dispatch assumed is broadly based on the relative outputs of generators since the commencement of the National Electricity Market but is not intended to imply a prediction of future market behaviour. Dispatch patterns have been adjusted at generators in north Queensland where Powerlink Queensland has a network support contract and where the power flow would have otherwise exceeded the CQ-NQ grid section limit.

The impact of DirectLink, between Mullumbimby and Terranora in NSW, is uncertain as the flows could vary in either direction in its role as a Market Network Service Provider. For the purposes of the sample power flows in Figures A3 to A20, the power flow on this link is assumed to be zero except for Figures A15 to A17 (summer 2005/06) where northerly flow on DirectLink has been assumed as under a possible network support agreement to the Gold Coast. In the simplified system representation in Appendix A, actual flows on DirectLink would have a similar impact to varying the generation level in the combined Moreton South and Gold Coast/Tweed zones, on flows across the CQ-SQ and Tarong limit grid sections.

6.3 Network Power Transfer Capability

6.3.1 Location of Network Grid Sections and Observation Points

Powerlink has identified a number of grid sections which allow grid capability and emerging limits of the whole grid to be assessed in a simplified manner. For the current system, limit equations have been derived for each of these grid sections. These limit equations quantify the maximum secure power transfer across these grid sections. NEMMCO has incorporated these limit equations as part of the constraint analyses within its market dispatch process (NEMDE).

In addition to these grid sections, Powerlink also monitors power flow over several ‘observation points’. These ‘observation points’ may be useful to define the maximum secure power transfer particularly under network outage conditions.

Figure A2 in Appendix A shows the location of grid sections (where limit equations apply) and ‘observation points’ on the Queensland network, where flows may encroach on transfer limits under some circumstances in the next three years. Potential limitations are summarised in Table 6.6.

The maximum power transfer across these grid sections may be limited by transient/dynamic stability, voltage stability, thermal plant ratings or protection relay load limits.

6.3.2 Determining Grid Transfer Capacities

The transfer capacity across each grid section varies with different system operating conditions. Transmission limits in the NEM are not generally amenable to definition by a single number. Instead, Transmission Network Service Providers define the capacity of their network using multi-term equations. These equations quantify the relationships between the system operating conditions and the network transfer limit, and are implemented into NEMMCO’s market systems for the optimal dispatch of generation. This is very relevant in Queensland as the grid transfer capacity is highly dependent on which generators are in service, and their dispatch level.

This 'limit equation' approach aims to maximise the transmission capacity available to electricity market participants at any point in time depending on the prevailing system conditions.

The trade-off for this maximisation of grid transfer capacity is the complexity of analysis required to define grid capacity. The process of developing transfer limit equations from multiple network analysis cases (using regression techniques) is very complicated and time consuming. It also involves a due diligence process by NEMMCO before these equations are implemented in the market dispatch processes.

The present limit equations applying to the Queensland transmission network grid sections, at the time of publication of this report, are provided in Appendix B. Readers should note that the limit equations will change over time with load, generation and network development.

Such detailed and extensive analysis has not been carried out for future network and generation developments for this Report. Instead, Figures A3 to A20 show if the flow on any grid section is expected to exceed the limit for that particular condition and generation dispatch. Section 6.4 gives a qualitative description of the main system conditions that impact on the capacity of each of the grid sections.

6.3.3 Grid Capacity Ranges

Grid capacity may vary depending on system conditions at the time. The grid capacity is the maximum power transfer for which the system will remain stable for any single credible contingency event.

Table A1 in Appendix A shows the power flows at each of these grid sections for intact operation (that is, with all network elements in service) at the time of peak demand in the Queensland region, corresponding to the sample generation dispatch shown in Figures A3 to A20. It also shows where grid flows are expected to exceed the relevant secure limit, and the mode of insecurity that determines the limit.

Forecast connection point demands coincident with Queensland (50% PoE) region maximum demands, as outlined in Chapter 4 and as detailed in Appendix E, were used to determine the grid flows shown in Figures A3 to A20. Grid power flows can be higher than shown in Table A1 at times of local area or zone peak demands, extreme weather conditions, lower embedded non-scheduled generation output or for different scheduled generation dispatch patterns.

The factors that influence the transfer capability and the impact of committed developments are discussed in Section 6.4.

6.4 Transmission Limits

This section is a qualitative summary of the main system conditions that impact on the transfer capability across key grid sections in the Queensland transmission network.

Powerlink has also provided a qualitative outlook for the likelihood that these grid sections will translate into restrictions on generator dispatch (ie. binding limits). This outlook is provided to assist readers to understand the information provided in Appendix A, and is in no way meant to imply that this outlook holds true for system conditions other than those in the sample power flows. Grid power flows and capability limits are highly sensitive to actual demand and generator dispatch patterns, and embedded non-scheduled generation output, and Powerlink makes no prediction of market outcomes in the information provided.

It should be noted that power flows across the grid sections can be higher than as shown in Figures A3 to A20 at times of local area or zone peak demands. However, the transmission capability may also be higher under such conditions depending on how generation or interconnector flow varies to meet the higher local load levels.

For each of the grid sections discussed below, the proportion of time that the limit equation has recently bound is provided for two periods, namely from April to September 2003 (winter) and from October 2003 to March 2004 (summer).

This information on binding limits sourced from the NEM Server includes all dispatch intervals in the relevant period. No attempt has been made to distinguish dispatch intervals when planned or forced outages may have affected network capability, or intervals when network flows may have been affected by network support contracts that Powerlink has in place with some generators.

This binding constraint information is provided for the information of readers and is not intended to imply that the historical information represents a prediction of constraints in the future.

6.4.1 Far North Grid Section

The maximum power transfer across the far north grid section is limited by the occurrence of unstable voltage levels following a transmission contingency. The critical contingency is an outage of either a Ross to Chalumbin 275kV transmission circuit or the 275kV transmission circuit into Woree (Cairns area).

The present limit equation, for each of these critical contingencies, is shown in Table B1 of Appendix B. The equations show that the following variables have the most significant effect on the limit:

- MW generation within the Far North zone;
- generators on-line within the Far North zone; and
- capacitor banks on-line within the Far North zone.

For these contingencies, the operation of local hydro generators (including operation as synchronous condensers) provides voltage support (reactive power) and increases the secure power transfer capability. However, the far north limit is also sensitive to the MW output from these hydro units. Local hydro MW output reduces the grid transfer limit, but more load can be securely supported in the Far North zone because the reduction in the grid transfer limit is more than offset by the increase in MW output by the local generators.

Information pertaining to the duration of constrained operation over the period April 2003 to March 2004, for the far north grid section is summarised in Table 6.1.

Table 6.1: Far North Limit Constraint for April 2003-March 2004

Far North Limit	Proportion of Time Constraint Equation Bound (%)	Equation Bound Hours
April to September 2003 (1)	0.02%	1 hour
October 2003 to March 2004 (1)	0.19%	8.2 hours

Note:
(1) Extended outage of both Barron Gorge hydro units (for penstock relining) from August 2003 to January 2004 contributed to higher constraints during this period.

The commissioning of a Static Var Compensator (SVC) at Woree by September 2005 should provide enough transfer capacity across this grid section for the period to 2008. This outlook is based on the assumed sample generation scenarios, and for average levels of embedded non-scheduled generators in the area.

However, power flows across this grid section can be higher than shown in Figures A3 to A20 at times of local area or north Queensland peak demands and during more severe weather than in typical 50% PoE conditions. Flows can also be higher during non-availability or low MW output of the hydro generators or if the output from embedded generators at sugar mills and wind farms in north Queensland is lower than forecast. Powerlink and NEMMCO have implemented operational arrangements to minimise the occurrence of binding limits during these conditions.

Beyond 2008, reliability of supply to the Far North zone may again become a limitation. This is addressed further in Section 6.5.1.

6.4.2 CQ-NQ Grid Section

The occurrence of dynamic instability, unstable voltage levels or thermal overload, following a transmission contingency, limits the maximum power transfer across the CQ-NQ grid section.

In recent years the maximum secure power transfer across this grid section has been significantly increased following the commissioning of the new 275kV transmission line from Stanwell to Broadsound and the 275/132kV transformer at the Strathmore 275kV switching station (approximately midway between Nebo and Ross).

These augmentations increased the maximum secure transfer across this grid section from 800MW to between 925MW and 985MW. These higher flows are mainly limited by dynamic stability following an outage of a 275kV transmission circuit between Nebo to Strathmore.

However, depending on prevailing ambient conditions, the maximum flow may be more limited by thermal overload following an outage of a 275kV transmission circuit between Broadsound to Nebo or Nebo to Strathmore substations. Powerlink and NEMMCO have implemented operational arrangements to avoid thermal limits being more restrictive than the dynamic stability limits.

Information pertaining to the duration of constrained operation over the period April 2003 to March 2004, for the CQ-NQ grid section is summarised in Table 6.2.

Table 6.2: CQ-NQ Limit Constraint for April 2003-March 2004

CQ-NQ Limit (1)(2)	Proportion of Time Constraint Equation Bound (%)	Equation Bound Hours
April to September 2003	0.13%	5.7 hours
October 2003 to March 2004 (3)	0.34%	15.1 hours

Note:

(1) Powerlink has entered into network support agreements with some generators in northern Queensland to manage the power flow across this grid section to within the limit.

(2) The figures do not include occurrences of binding constraints associated with these network support agreements. NEMMCO does not consider that periods of congestion that are managed through a network support agreement contribute to the total number of hours of a binding intra-regional constraint.

(3) During October 2003 to March 2004 the flow was controlled to avoid exceeding the CQ-NQ limit for 191.9 hours by generation management under the network support arrangements.

The transfer limit is currently described by a single equation. This limit equation for the CQ-NQ grid section is shown in Table B2 of Appendix B. The equation defines the dynamic stability limit and shows that the limit is a function of the number of local hydro generating units operating as synchronous condensers. Therefore, depending on the hydro generation, the CQ-NQ limit may vary between 925MW and 985MW.

The existing grid transfer capacity is now highly utilised, with limits reached at times of summer peak loads in north Queensland. This limitation is currently managed by network support contracts that Powerlink has with local NQ generators.

Power flows across this grid section can be higher than as shown in Figures A3 to A20 at times of local area or north Queensland peak demands and during more severe weather than in typical 50% PoE conditions. Flows can also be higher during non-availability or low MW output of the hydro generators or if the output from embedded generators in north Queensland is lower than forecast. Under these conditions, generators offering network support must run at higher levels of output to keep power transfers within the CQ-NQ limit.

The immediate outlook for the CQ-NQ limit is that it is likely that the power flow across this grid section will continue to regularly encroach on the limit particularly during summer load conditions in north Queensland. Powerlink has network support contracts with local generators to manage the CQ-NQ limit in these circumstances.

There are currently no transmission projects, either committed or under construction, which will further increase the transfer capacity between CQ-NQ. Therefore, the reliance on network support will increase steadily as load in north Queensland continues to grow. This trend could be modified with the conversion of the existing Townsville OCGT (Yabulu) power station to gas fired CCGT operation. The reliance on network support may be reduced if the Townsville power station operates regularly due to market dispatch over periods of northern Queensland summer peaks.

However, by the summer of 2008/09 the combination of local generation and grid transfer capacity (assuming an outage of the largest generator unit) is expected to be insufficient to maintain supply reliability to customers. As a result, Powerlink has initiated a consultation process to identify options to address this CQ-NQ transfer limitation. This is discussed further in Section 6.7.3.

Key factors which could influence the reliance on network support, and the timing of when the existing supply arrangements need to be augmented, include:

- non-availability or low MW output of the hydro generators in the Far North zone. Without this hydro generation, the CQ-NQ grid section is likely to be constrained over sustained summer load periods;
- availability and dispatch of Collinsville generation impacts on the reduction of flows across this grid section;
- development or expansion of large industrial loads in north Queensland not included in the load forecast, or lower levels of embedded generation than forecast, will result in increased power transfers across the CQ-NQ grid section, and lead to greater reliance on network support or other forms of capability augmentation; and
- development of additional generation capacity, which operates regularly due to market dispatch, could reduce the levels of constraint on the CQ-NQ grid section.

6.4.3 CQ-SQ Grid Section

The maximum power transfer across this grid section is limited by the occurrence of unstable voltage levels following an outage of a Calvale to Tarong 275kV transmission circuit. The limit results from an exhaustion of reactive power reserves in the Central West and Gladstone zones. As a result, the number of generating units on-line in these zones impacts on the limit. More generating units on-line increases the reactive power support, and therefore increases the limit.

The present voltage stability limit equations for the CQ-SQ limit are shown in Table B3 of Appendix B. The equations show that the following variables have the most significant effect on the limit:

- number of generating units on-line in Central West and Gladstone zones; and
- MW generation at the Gladstone power station.

At transfers above about 1900MW, the CQ-SQ capability may be limited by transient instability also following a Calvale to Tarong 275kV circuit outage.

Information pertaining to the duration of constrained operation over the period from April 2003 to March 2004, for the CQ-SQ limit is summarised in Table 6.3.

Table 6.3: CQ-SQ Limit Constraint for April 2003-March 2004

CQ-SQ Limit	Proportion of Time Constraint Equation Bound (%)	Equation Bound Hours
April to September 2003	0.18%	7.9 hours
October 2003 to March 2004	0.07%	2.9 hours

Power flows across this grid section can be higher than shown in Figures A3 to A20. Based on the generation patterns in the sample power flows, the outlook for the CQ-SQ limit is that power flows are likely to increase across this grid section over the period to the summer of 2006/07. This outlook can be attributed to the expected increase in Gladstone generation as the system demand increases.

Other factors that could change this outlook include more severe weather than in typical 50% PoE conditions and/or generation patterns that result in higher power flows across the CQ-SQ grid section. The latter is the most variable and has the largest potential for producing transfers that encroach on the limit. One example is the anticipated return to service of the Callide A power station in 2006.

On the other hand, should any of the possible large metal processing load developments currently under investigation in central or north Queensland (but not included in the forecasts) proceed within the review period, CQ-SQ flows are likely to reduce significantly.

6.4.4 Tarong Grid Section

The maximum power transfer across this grid section is limited by the occurrence of unstable voltage levels. The critical contingency is the loss of a 275kV transmission circuit either between central and southern Queensland or between Tarong and the greater Brisbane load centre. Currently one of four contingencies can limit the maximum secure power transfer across this grid section. These critical contingencies are:

- Calvale to Tarong 275kV transmission circuit;
- Woolooga to Palmwoods 275kV transmission circuit;
- Tarong to Blackwall 275kV transmission circuit; and
- Mt. England to Loganlea 275kV transmission circuit.

The limit results from an exhaustion of reactive power reserves in southern Queensland.

The present limit equations for the Tarong limit are shown in Table B4 of Appendix B. The equations show that the following variables have the most significant effect on the limit:

- transfer on QNI;
- MW generation within the South West zone;
- number of generators on-line in the Moreton North and South zones; and
- MW generation within the Moreton North and South zones.

There is inter-dependence between the CQ-SQ transfer and the Tarong limit. High flows between central and southern Queensland reduce the Tarong limit. This reduction is due to the high reactive losses between central and southern Queensland eroding the reactive power reserves in southern Queensland. Therefore, reducing the CQ-SQ transfer by increasing generation west of the grid section increases the Tarong limit. Increasing the generation east of the grid section reduces the transfer limit, but increases the overall amount of secure supportable southern Queensland load. This is because the reduction in the power transfer limit is more than offset by the increase in MW output of the generators east of the grid section.

Information pertaining to the duration of constrained operation over the period April 2003 to March 2004, for the Tarong grid section is summarised in Table 6.4.

Table 6.4: Tarong Limit Constraint for April 2003-March 2004

Tarong Limit	Proportion of Time Constraint Equation Bound (%)	Equation Bound Hours
April to September 2003	-	-
October 2002 to March 2004	0.03%	1.2 hours

The advent of the Swanbank E, Millmerran and Tarong North generators has increased the amount of secure supportable load in southern Queensland. In addition, several completed, committed and proposed projects, aimed at addressing reliability limitations within the greater Brisbane area, contribute to incrementally increase this limit (refer Chapter 5 and Section 6.7). One such significant project completed since the 2003 APR has been the reliability augmentation between Blackwall and Belmont.

Based on the sample generation scenarios shown in Appendix A, and the 50% PoE load forecasts, the power flow across this grid section is not expected to encroach on the Tarong transfer capability over the period to the summer of 2006/07.

However, power flow across this grid section can be higher than shown in Figures A3 to A20 at times of local area or zone peak demands and during more severe weather than in typical 50% PoE conditions. Flows can also be higher during planned or unplanned outages of generating plant in the Moreton North and South zones. Combinations of these conditions may result in flows encroaching on the Tarong limit.

Powerlink and NEMMCO have implemented operational arrangements to minimise the occurrence of binding limits during these unusual conditions. However, as the load in SEQ continues to grow, additional action will be necessary to maintain reliability of supply to SEQ.

Powerlink will continue to investigate network support strategies and augmentations that will economically manage this limit. In later years a reliability limitation may emerge which is discussed in Section 6.5.1.

6.4.5 Gold Coast Grid Section

The maximum power transfer across this grid section is limited by the occurrence of unstable voltage levels during winter and potential 275kV and 110kV thermal overloads and unstable voltage levels during summer. The critical contingency is an outage of a 275kV transmission line between Swanbank and Mudgeeraba.

Several completed, committed and proposed projects within southern Queensland, aimed at addressing reliability limitations, contribute to increasing the Gold Coast limit. These projects include the installation by Energex of load compensation shunt capacitors at a number of locations in the distribution network, and a 110kV 50MVAr capacitor bank at Molendinar.

The present equation for the Gold Coast limit is shown in Table B5 of Appendix B. The equation shows that the following variables have the most significant effect on the limit:

- Number of generating units on-line in the Moreton North and South zones;
- MW and MVAr loading of DirectLink; and
- capacitive compensation levels on the Gold Coast, Moreton North and South zones.

The Gold Coast voltage stability limit is sensitive to the power factor of the load. As a result, the winter limits are higher than the corresponding limits during summer. The voltage limits are also higher if the Swanbank source voltage is stronger (ie. the more Swanbank B or E units on-line, the higher the reactive capability). The amount of secure supportable load also increases for northerly flow on DirectLink (however, under these conditions the limit reduces, but by less than the increase in DirectLink MW flow into the Gold Coast).

Information pertaining to the duration of constrained operation over the period April 2003 to March 2004, for the Gold Coast limit is summarised in Table 6.5.

Table 6.5: Gold Coast Limit Constraint for April 2003-March 2004

Gold Coast Limit (1) (2)	Proportion of Time Constraint Equation Bound (%)	Equation Bound Hours
April to September 2003	2.19%	96.1 hours
October 2003 to March 2004	0.40%	17.3 hours

Note:

(1) The transfer across this grid section is managed through an agreement whereby southerly flows on the DirectLink MNSP are runback during binding conditions. Although included in the duration in Table 6.5, NEMMCO does not consider that periods of congestion that are managed through this arrangement contribute to the total number of hours of a binding intra-regional constraint.

(2) The duration of binding events outlined in Table 6.5 include periods when spare capacity across this grid section was fully utilised by the DirectLink MNSP transferring power south into NSW.

For the winter system conditions considered, the flow across this grid section is unlikely to encroach on the limit. However, the situation may be different during summer. Critical to the summer outlook for this grid section was the completion by Energex of the uprating of the 110kV network between Beenleigh and Cades County. This work defers thermal ratings on the 110kV system being exceeded following the critical 275kV contingency until the summer of 2005/06. The installation of a 50MVAr 110kV shunt capacitor bank at Molendinar by October 2004, as a small network asset to address reactive requirements in south east Queensland will also assist in maintaining this limit with growing MVAr loads on the Gold Coast. Further details are provided in Chapter 5.

Power flows across this grid section can also be higher than shown in Figures A3 to A20 at times of local Gold Coast area peak demands (typically up to 5% higher). With such local peak demands the flows across this grid section may exceed the voltage stability limit from summer 2004/05 depending on the generation in the Moreton zones. These limitations can be managed by operational measures over the 2004/05 summer.

The immediate outlook for the Gold Coast grid section is that the flows in Figures A12 to A14 (summer 2004/05) will not exceed the voltage stability limit.

However, from the 2005/06 summer, the flows across this grid section may exceed the voltage stability limit (Figures A15 to A20) and the thermal capacity of the 110kV lines. In addition the 275kV circuits are forecast to reach emergency thermal rating under contingency conditions towards the end of this outlook. Powerlink has published a recommendation to address these limitations. This is also discussed in Section 6.7.2.

6.4.6 Braemar Grid Section

The maximum power transfer across this grid section is limited by a combination of the thermal rating of the Braemar 330/275kV transformers and unstable voltage levels following a 275kV circuit outage between Braemar and Tarong substations.

Power flow across this grid section can occur effectively in a northerly or southerly direction. With the commissioning of the Millmerran power station in 2002/03, southerly power flows from Tarong to Braemar have decreased. It is considered that southward flows from Tarong to Braemar will be well within the capability of this grid section.

However, with Millmerran generation, high northward flows can occur on this grid section. At times of northward flow on QNI these flows may reach the grid section capacity.

The capacity of this grid section is currently limited to 1125MW in NEMMCO's NEMDE. The present equation for the Braemar limit is shown in Table B6 of Appendix B. The current constraint implementation acts on the output of Millmerran. As a result, if this limit binds the Millmerran generation is reduced and the QNI transfer capability is unaffected. To date there have been no occurrences of binding limits across this grid section.

Any future limitation is likely to be impacted by the committed new large network asset to address the reliability limitations in supply to the Darling Downs area (discussed in Chapter 5). The approved network solution is to commission a 330kV double circuit transmission line between Millmerran and Middle Ridge in December 2004. This line provides an alternative path for power to flow within SWQ and hence off loads power flow across the Braemar grid section. The augmentation has consequential market benefits associated with alleviating potential congestion on the Braemar grid section during northward flows on QNI.

As a result, for the period up to summer 2006/07 flows across this grid section are not expected to encroach on this limit. Beyond this time the performance of this grid section will depend on the location and capacity of new generation entrants. Section 7.2 documents the announcement of the 750MW Kogan Creek coal fired power station and the proposed Wambo (up to 500MW) gas fired power stations. These new entrants will connect to the Braemar substation and as a result, may cause power flows to encroach on the limit of this grid section.

6.4.7 Gladstone Grid Section

The maximum power transfer across this grid section is limited by the thermal rating of the 275kV lines between the Central West and Gladstone zones, usually the circuit from Calvale to Wurdong, and potentially the thermal rating of the Calvale 275/132kV transformer. The highest loadings on the Calvale to Wurdong 275kV circuit generally occur following a contingency of the Calvale to Stanwell circuit.

Flows through the Calvale 275/132kV transformer are currently managed via a network switching strategy to ensure they do not exceed the transformer thermal rating. This strategy has been assumed to be in place for all of the 18 sample power flows shown in Figures A3 to A20 of Appendix A.

The present equation for the Gladstone grid section is shown in Table B7 of Appendix B. The current equation predicts the flow on the critical Calvale to Wurdong 275kV circuit following an outage of the Calvale to Stanwell circuit. In NEMDE this prediction is compared against the most current rating for the line, accounting for the prevailing ambient weather conditions. Powerlink updates these ratings as appropriate, and passes them to NEMMCO for their implementation in NEMDE. If the rating would otherwise be violated following the contingency then the generation is redispatched between Callide and Gladstone/ Stanwell.

Overload of this grid section is most likely under market dispatch scenarios that lead to high Callide but low Gladstone generation. For the sample power flows shown in Figures A3 to A20 the lowest Gladstone generation occurs for the northerly QNI flow cases. More specifically the highest flows, relative to the thermal rating of the Calvale to Wurdong circuit, occur in the QNI northerly flow cases for winter 2005, 2006 and summer 2004/05. For these cases, the post contingent flow on the Calvale to Wurdong line may exceed the emergency thermal rating. Under these conditions Powerlink has implemented network switching and support strategies to reduce the post contingent flow to within the line rating and hence minimise the impact on the NEM dispatch.

From the sample power flows, the flow on the Calvale to Wurdong circuit may reduce in subsequent years as more Gladstone generation is scheduled and the CQ-SQ transfer increases.

The power flow on these critical elements can vary considerably. Different generation schedules (particularly at Gladstone, Callide and Stanwell), than assumed for Figures A3 to A20, can change the outlook for this ‘observation point’. In recognition of this Powerlink and NEMMCO have implemented operational strategies and a constraint equation in NEMDE to manage this limitation.

Other action would be needed if potential major new industrial loads in the Gladstone area eventuate. In 2002, Powerlink initiated a consultation process related to these limitations. This is discussed further in Section 6.7.3.

6.4.8 QNI Limits

The Queensland–New South Wales Interconnection (QNI) was constructed of assets with plant ratings of at least 1000MW. However the actual transfer capability will vary from time to time depending on system conditions.

At the time of publication of this Annual Planning Report, the QNI southerly capacity has been capped at 950MW and the maximum northerly capacity of QNI and DirectLink combined limited to 700MW. Transfer capacity is limited by the following:

Southerly: (QNI)

- transient stability based on faults in Queensland;
- transient stability based on loss of largest load in Queensland;
- transient stability based on faults in the Hunter Valley;
- thermal rating limits of 132kV network in New South Wales;

- oscillatory stability based on contingencies within Queensland and of QNI plant; and
- oscillatory stability upper limit of 950MW.

Northerly: (combined QNI and DirectLink)

- transient stability based on loss of the largest generator in Queensland;
- transient stability based on faults in the Hunter Valley;
- transient stability based on faults on a Tarong to Braemar circuit;
- thermal rating limits of 330kV network in New South Wales; and
- oscillatory stability upper limit of 700 MW.

Following the commissioning of the Millmerran power station, higher secure southerly power transfers on QNI are possible. Transient stability limits are increased to at least 1050MW. However, oscillatory stability of the interconnected power system may limit southerly transfers on QNI to significantly less than this value. Powerlink, together with NEMMCO, TransGrid, VenCorp and ElectraNet, are addressing this by:

- undertaking research with the University of Adelaide to better quantify the differences between measured system damping and simulated levels of damping; and
- implementation of a Power Oscillation Damper Controller at the Armidale SVC and upgrading the design of the existing Power Oscillation Damper Controller at the Blackwall SVC.

These committed works should improve the oscillatory stability limits under system normal conditions such that damping should not limit southerly power transfer on QNI to less than 1050MW (with both Millmerran units on-line). Extensive system performance testing will be required prior to release of this capacity.

The 132kV network within NSW has been up-rated and as a result now imposes less of a thermal limitation at times of southerly flow on QNI.

The maximum combined northerly capacity of QNI and DirectLink is expected to be limited to between 400MW and 700MW (limited by either transient/oscillatory stability, northern NSW voltage stability or NSW thermal criteria).

6.5 Emerging 'Reliability' Limitations

It is a condition of Powerlink's transmission authority that it meet licence and Code requirements relating to technical performance standards during intact and contingency conditions. The transmission authority also requires Powerlink to plan and develop the network such that peak demand can be supplied during a single network element outage. The limitations described in this section can therefore be viewed as 'triggers' for action. Powerlink must ensure a solution is implemented to maintain a reliable power supply to customers.

In accordance with Code requirements, Powerlink will consult with market participants and interested parties on feasible solutions. Solutions may include local generation, provision of network support by existing generation, Demand Side Management (DSM) initiatives and network augmentations.

The information presented in this section provides advance notice of anticipated consultation processes, and extends the time available to interested parties to develop solutions. Further information will be provided during the relevant consultation process, if and when this is required (see Section 6.7 for current and anticipated consultation processes).

Solution providers should be aware that there is some uncertainty surrounding the timing that corrective action will be required to address some of the following emerging limitations. Timing is dependent on load growth and developments in the wholesale electricity market.

6.5.1 Emerging Reliability Limitations in the Queensland Grid

Far North Zone: Voltage Control/Transformer Capacity

By late 2005, depending on generation and load assumptions, an outage of one of the 275kV circuits between Chalumbin and Woree or Ross and Chalumbin, will result in severe voltage problems and the risk of voltage collapse at times of high demand. A 132kV Static Var Compensator at Woree substation will be commissioned to address this limitation by September 2005 (refer Table 5.2).

It is also anticipated that, depending on load growth, the 275/132kV transformer capacity in the Far North zone could be exceeded between 2008 and 2010.

Solutions to the transformer capacity limitation could include one or a combination of DSM initiatives, local generation and/or a network augmentation. An indicative network augmentation would be the installation of additional transformer capacity at Woree and uprating of the second Chalumbin to Woree circuit to 275kV operation, at an expected cost of $12-15M.

Far North Zone: Supply to Edmonton Area

Ergon Energy advised in 2002 that action was urgently required to address high load growth in coastal areas to the south of Cairns. Continued high demand growth will cause the capacity of the low voltage (22kV) system to be exceeded by late 2004. Establishment of a 132/22kV substation at Edmonton by October 2004 will address this limitation.

Ross Zone: Supply to Northern and Western Townsville Areas

Load in the Townsville area has grown consistently in recent years. Average demand growth is expected to be about 3 to 3.5% p.a. for the next several years, but may be much higher in specific areas due to new commercial, industrial and residential developments.

Northern and western areas of Townsville are presently supplied from the Dan Gleeson and Garbutt 132/66kV substations. Primary supply to these substations occurs via 132kV connections from Ross substation. These circuits may become overloaded during Townsville 132kV network contingencies from late 2004 onwards.

Re-tensioning of conductors and partial replacement of the existing line between Ross and Dan Gleeson by October 2004 will address these limitations (refer Table 5.2). However, network limitations across these circuits may re-emerge from the 2006/07 summer onwards.

The loading across these circuits may be impacted by possible network reinforcement of the Townsville CBD and Port areas from the Townsville South substation. This reinforcement may off-load the Garbutt 132/66kV substation, which could reduce the transfers across the Ross to Dan Gleeson circuits.

A feasible network solution may involve developing the 132kV or 275kV network between Ross substation and Townsville power station at an approximate cost of $20-40M. Non-network solutions may include local generation and/or DSM initiatives.

Ross Zone: Supply to Townsville CBD and Port Areas

The Townsville CBD and nearby areas continue to develop with steady increases in electricity demand. Potential industrial development is now also earmarked for the Townsville Port area particularly on the southern side of the river.

Studies indicate that the existing Ergon 66kV network with feasible upgrades could reach thermal capacity limits by about 2007/08 or earlier if new industrial loads emerge.

Initial joint planning studies indicate that a feasible network solution may involve developing the 132kV network from Townsville South to the Port area at an approximate cost of $10-25M. Non-network solutions may include new local generation and/or DSM initiatives.

Ross Zone: Supply to Townsville South Area

The Townsville South area includes the Sun Metals Zinc Smelter load and is supplied via a double circuit 132kV line from Ross 275/132kV substation and two longer single circuit 132kV lines from Collinsville via Clare.

With increasing loads at the zinc smelter, in the Townsville area 66kV distribution network and at Clare, together with potential new loads in the Townsville port area, the thermal capacity of the Ross to Townsville South 132kV circuits is being approached under contingency conditions. The loading on these circuits is dependent on generation at Mt Stuart power station, but can also vary to a lesser degree depending on generation at Townsville and Collinsville power stations.

Network limitations may arise from summer 2006/07 onwards. Indicative network solutions may involve a new 275kV or 132kV transmission line between Ross and Townsville South at an indicative cost of $8-25M. Non-network solutions may include DSM initiatives or local generation in the southern Townsville area.

North Zone: Supply to Mackay-Proserpine Area

Load in the Alligator Creek-Mackay-Pioneer Valley-Proserpine area continues to grow at relatively high rates of over 3% per annum. A point will soon be reached where the existing 132kV network from the Nebo and Strathmore substations will be unable to maintain a reliable supply following a 132kV network contingency.

Following an outage of a 132kV circuit between Nebo and Alligator Creek, or Nebo and Pioneer Valley, unacceptably low voltages are expected to occur by summer 2004/05 at times of high demand. Installation of a 20MVAr capacitor bank at Alligator Creek substation by October 2004, will address this limitation.

Further limitations in supply to the greater Mackay-Proserpine area are expected to arise in subsequent years. Following a 132kV outage of the above circuits, thermal ratings of the remaining circuits in service could be reached. The timing for this limitation is dependent on load growth and other network developments, but is anticipated to arise between 2007 and 2009.

Potential network solutions include the construction of a new line to the area costing $15-25M. Non-network solutions such as local generation and DSM initiatives may also be feasible.

North Zone: Nebo Transformer Limitations

Nebo substation is a major bulk supply point in north Queensland. Due to load growth in the Mackay and central Queensland areas, including increases in mining load, the existing Nebo 275/132kV transformers are expected to reach capacity limitations by late 2004. A third transformer at Nebo substation will be commissioned by October 2004 to address this limitation (refer Table 5.2).

North Zone: Supply to Pioneer Valley Substation

Pioneer Valley 132/66kV substation, which supplies areas to the west of Mackay, comprises only a single transformer. Alternative but limited supply is available to this area via Ergon's 33kV distribution network from Mackay and Alligator Creek 132/33kV substations and a small capacity 33/66kV step-up transformer substation.

Due to continuing relatively high load growth in the Mackay region, and in particular the western Mackay areas, the alternative supply capacity is becoming increasingly limited and is considered to be inadequate by the summer of 2004/05 onwards.

An additional 132/66kV transformer at Pioneer Valley substation will be commissioned by October 2004, to address this limitation (refer Table 5.4).

North Zone: CQ-NQ and Nebo-Ross Limitations

Summer peak electricity demand requirements in north and far north Queensland are currently met by the transmission system operating in conjunction with local generators. This combined supply capacity will be insufficient to reliably meet forecast electricity demand requirements from the summer of 2008/09.

Solutions which could fully or partially address this limitation include:

- Suitably located generation in NQ and FNQ of sufficient energy and capacity to meet the annual increase in load expected in these zones;
- Suitably located DSM initiatives in NQ and FNQ of sufficient energy and capacity to meet the annual increase in load expected in these zones; and
- A staged augmentation of the transmission network between Broadsound and Ross at a total cost in the range of $200-300M.

A consultation process to address these limitations is underway (refer Section 6.7).

Depending on the solution implemented, this limitation may re-emerge in subsequent years.

Central Zone: Supply to the Gladstone Area

The Gladstone area is one of the most heavily loaded areas of the Queensland region. The Boyne Island aluminium smelter dominates this load, but there is also significant demand at the Queensland Alumina plant and at the Gladstone and Gladstone South 132/66kV substations. There have also been announcements about significant new metal processing plants which could come into production in the next few years, other than those already included in the forecasts.

At the present time, there is a transmission limitation between the Callide and Gladstone areas and there are operational measures to manage the loading of the Calvale 275/132kV tie transformer. These measures include opening of the Callide to Gladstone South 132kV circuits. Thermal overloading of the Calvale-Wurdong 275kV line has also occurred infrequently and is managed through the application of dispatch constraints by NEMMCO.

Corrective action to alleviate this limitation is not able to be justified at this time under the ACCC Regulatory Test, however, major new industrial loads in the Gladstone area could trigger a requirement for augmentation to ensure supply reliability is maintained.

Central West Zone: Supply to the Rockhampton Area

Load growth in the Rockhampton area is forecast to grow at an average of 3% p.a. over the next five years. This area is supplied from Bouldercombe 275/132kV substation by a double circuit 132kV line to Rockhampton (Glenmore) 132/66kV substation and by a single circuit 132kV line to Egans Hill 132/66kV substation. By the summer of 2005/06 an outage of either Bouldercombe to Rockhampton circuit will cause an overload in the companion circuit. A committed project to install a 40MVAr 132kV capacitor bank at Rockhampton substation has been initiated to address this emerging limitation.

However, planning analysis indicates that this limitation is likely to re-occur from the summer of 2007/08 onwards. A possible network solution could be to establish a new 132/66kV substation north of Rockhampton at an initial cost of $15-20M. Non-network solutions such as local generation and DSM initiatives may also be feasible.

Central West Zone: Supply to Lilyvale

The western central Queensland area including the Bowen Basin mining area covering Blackwater, Moranbah etc, is supplied from a 132kV electricity network which operates in parallel to the main 275kV transmission grid.

The major injection of power into this 132kV network occurs via a 275kV single circuit line between Broadsound (on the main 275kV transmission grid north west of Rockhampton) and a 275/132kV substation at Lilyvale.

Following an outage of the 275kV line between Broadsound and Lilyvale, the capability to supply peak load in the area will be limited by unstable voltage levels and thermal overloads of local 132kV circuits. This limitation may arise from summer 2004/05 onwards.

A committed project to construct a second 275kV line between Broadsound and Lilyvale (and associated substation works) by October 2004, has been initiated to address these limitations (refer Table 5.2). The substation works includes the replacement of one Lilyvale 275/132kV 200MVA tranformer with a 375MVA unit enabling the replaced unit to be installed at Nebo (as outlined in Appendix D of the 2003 Annual Planning Report).

Central West Zone: Supply to the Blackwater/Moura Area

Blackwater 132/66/11kV substation, with 2 x 80MVA transformers, supplies the mining loads of the southern Bowen Basin as well as the domestic and commercial load associated with the towns in the area. One double circuit 132kV line and one single circuit 132kV line from Callide A supplies Biloela, Moura and Blackwater and a single circuit 132kV line from Lilyvale also supplies Blackwater.

Due to increasing mining loads in the area, thermal limitations are forecast to arise in the Blackwater transformers under contingency conditions from 2007/08 onwards (in summer peak demand periods). In the event that some potential mining load commits, thermal and voltage limitations may occur in the 132kV transmission lines between Lilyvale and Callide under contingency conditions.

Possible network solutions to address the forecast transformer limitation include the installation of a third transformer at Blackwater at a cost of around $6-8M. Possible network solutions to address the forecast line limitation include the construction of a second 132kV transmission line between Lilyvale and Blackwater at a cost of $10-15M.

Non-network solutions such as local generation and DSM initiatives may also be feasible.

Central West Zone: Supply to the Biloela Area

Biloela 132/66kV substation (2 x 34MVA transformers) provides electricity supply to the area immediately west of Gladstone in central Queensland, including the Callide and Boundary Hill Mines, and the townships of Biloela, Monto and Wowan.

Electricity demand in this area is growing steadily and by the summer of 2007/08, Biloela substation will be unable to supply the peak demand following the loss of one of its transformers.

This timing assumes that suitable load transfer arrangements will be determined with Ergon Energy for summer periods prior to 2007/08. Possible network options may include installation of a third transformer at Biloela (at a cost of around $5-7M) or replacement of the existing transformers with higher capacity units. Non-network solutions such as local generation and DSM initiatives may also be feasible.

Wide Bay Zone: Supply to Wide Bay Area

The eastern Wide Bay area is supplied from 275/132kV substations at Gin Gin (2 x 120 MVA) and Woolooga (2 x 120 MVA, 1 x 250 MVA). Electricity demand in this area is growing steadily and planning studies have forecast that by the summer of 2006/07, the 132kV network supplying the Gin Gin, Woolooga and Maryborough area will be unable to supply the peak demand under contingency conditions due to thermal overloads and low voltages.

Possible supply solutions could include construction of a new 275/132kV substation at a cost of $15-20M. Local generation or DSM initiatives could also be feasible.

South West Zone: Supply to South West Qld (Darling Downs Area)

Limitations are expected to arise from late 2004 in the transmission system supplying the Darling Downs area of south west Queensland. Voltage limitations and thermal overloads will occur during an outage of the 275kV single circuit line between Tarong and Middle Ridge substations.

A 330kV transmission line between Millmerran and Middle Ridge (and associated substation works) will be commissioned by December 2004, to address these limitations (refer Table 5.2).

Moreton North & South Zones: South East Queensland Voltage Control

Growing load in south east Queensland (SEQ) results in higher reactive power requirements and greater reactive losses in the system due to increased transmission and transformer loading.

The net effect is an annual increase in reactive demand above that already being supplied through existing reactive devices and ancillary service arrangements. Potential solutions include demand side management or a program of shunt capacitor installation in SEQ to keep pace with this growing requirement. The shunt capacitor option would cost around $4-7M per year. A proposed small network asset, consisting of new capacitor banks, to keep pace with reactive demand has been recommended (see Section 6.7.4). However, there is expected to be an ongoing requirement for additional reactive support as SEQ electricity demand continues to grow rapidly.

Moreton North & South Zones: Supply to Brisbane CBD and Inner Suburbs

The Brisbane CBD and inner suburbs are supplied by five 110kV circuits comprising a double-circuit 110kV line from Belmont to Newstead, a double-circuit 110kV line with cable sections from Upper Kedron to Ashgrove West and a 110kV overhead/underground cable single circuit from Rocklea/Tennyson to West End.

By 2005/06 and 2006/07, various thermal capacity limits on this 110kV network and in parts of the distribution network are expected to be reached under normal or single contingency conditions.

A committed Energex/Powerlink project has been initiated to address these limitations. The project comprises construction of a new 110kV underground connection to Charlotte Street substation teed from the existing Belmont to Murarrie transmission lines, upgrade of the existing 110kV network supplying the CBD area, construction of a 275kV line between Belmont and Murarrie, and carrying out of works to provide new substations within the CBD area.

Moreton North & South Zones: 275/110kV Transformer Limitations

Load in the Moreton North and Moreton South zones is forecast to grow at around 3% and 6% p.a. respectively, over the next five years. This load is supplied from the 110kV network, which receives supply via the 275kV system. The 275/110kV transformer capacity must at least keep pace with load growth or unacceptable overloads can occur following transformer outages.

The emergence of transformer capacity limitations is monitored closely by considering the impact of future load growth, and the loading of existing and committed future transformers.

Based on forecast load growth, 275/110kV transformer capacity limitations will occur at a number of existing locations within the Moreton North and Moreton South zones over a 5 year outlook period. The most immediate limitation is the loading on the Belmont and South Pine transformers, where the overload during single contingency conditions becomes unacceptable by summer 2004/05 and summer 2006/07 respectively. A committed project to install a second 275/110kV transformer at Loganlea substation by October 2004 and a committed project to install the first 275/110kV transformer at Murarrie substation by October 2006, have been initiated to address these limitations (refer Table 5.2). Further corrective action will be required in subsequent years.

Network solutions include transformer augmentation at existing 275/110kV substations, or establishing new 275/110kV injection points where necessary to also prevent overloading of the 110kV network. Indicative costs of such a network solution are in the range of $5-50M.

Non-network alternatives to transformer augmentation include new local generation connected at suitable 110kV or lower voltage locations, and/or DSM initiatives to maintain loadings within the capacity of existing transformers.

Moreton South Zone: Supply to South West Brisbane

Load growth in the south west area of Brisbane is forecast to increase rapidly at around 7-8% p.a. for the next three years – driven by significant residential, commercial and industrial development and further penetration of domestic air-conditioning. This area extends south from Runcorn to Browns Plains and west to Abermain and Raceview.

Given this level of growth, there are emerging limitations in the 275kV, 110kV and distribution networks supplying this area. From the summer of 2006/07 onwards, thermal capacity limitations are expected to arise in this network during a critical network outage.

Powerlink, in conjunction with Energex, expects to initiate a public consultation process on the emerging limitations in the near future. Joint planning studies indicate that network solutions involving augmentation of the existing transmission network could cost in the range of $25-60M. Non-network solutions such as local generation and DSM initiatives may also be feasible.

Moreton South Zone: Supply to Murarrie and Trade Coast Areas

Belmont 275/110kV substation supplies part of the Brisbane CBD, Murarrie and Trade Coast (Brisbane Port), Redlands Shire, coastal areas and part of the Richlands-Algester-Runcorn area.

Thermal capacity limitations in the 110kV network supplying Murarrie are expected by 2006 to 2008 under single contingency conditions.

These limitations are being addressed by the committed project to address supply limitations in the Brisbane CBD and inner suburbs (see earlier entry 'Moreton North and South zones: Supply to Brisbane CBD and Inner Suburbs').

Moreton South Zone: Load Growth South East Queensland (Logan)

Power in the Moreton South zone is supplied from local generation and transmission connections from adjacent zones. The majority of power used in the Moreton South area and other south east Queensland (SEQ) zones is transferred via five 275kV circuits between Tarong and SEQ.

Very high load growth in SEQ (including Moreton North, Moreton South and Gold Coast/Tweed zones) is expected to result in reliability of supply limitations to SEQ within the 5 year outlook for network limitations in this Chapter. Supply capability limitations are expected to arise due to a combination of full utilisation of existing local generation sources and the inability to transfer additional power into SEQ on the existing transmission network.

Feasible solutions will be required to meet the anticipated average increase in SEQ demand of approximately 170MW (5%) p.a. over the next five years. Local generation options may be feasible, however Powerlink is currently not aware of any such committed proposals.

This network limitation could be addressed by construction of a new transmission line from the South West zone to the Moreton zones. A possible network option involves a new 275kV double circuit transmission line between Middle Ridge and Greenbank (with associated capacitive compensation) at a cost in the range of $60-80M.

Gold Coast/Tweed Zone: Supply to South Coast

The South Coast (Gold Coast) area is one of the fastest-growing areas in the state, in terms of population, commercial development and load growth. Summer electricity demand growth is expected to average about 5.1% p.a. for the next five years.

Due to the high load growth, emerging limitations have been identified in the transmission and distribution system supplying the Gold Coast area. During summer peak demand periods from late 2005/06 onwards, voltage stability and thermal limitations are expected to arise following a critical 275kV contingency.

Powerlink has published a recommendation to address this emerging limitation (refer Section 6.7.2).

Gold Coast/Tweed Zone: 275/110kV Transformer Capacity

Depending on load growth, transfer through the Mudgeeraba 275/110kV transformers is forecast to exceed their capacity by late 2008 following an outage of the Molendinar 275/110kV transformer.

Solutions which could fully or partially address this limitation include:

- network support from local generation or the DirectLink MNSP of sufficient energy and capacity to meet the annual increase in load expected in these zones;
- suitably located DSM initiatives in the Gold Coast/Tweed zones of sufficient energy and capacity to meet the annual increase in load expected in these zones; and
- installation of a second Molendinar 375MVA, 275/110kV transformer estimated to cost $6-10 million.

6.6 Summary of Forecast Network Limitations

Limitations discussed in Section 6.4 and 6.5 have been summarised in Table 6.6. This table provides an outlook (based on load, generation and committed network development assumptions contained in Chapters 4, 5 and 6) for potential limitations in Powerlink's transmission network over a one, three and five year timeframe.

Table 6.6: Summary of Forecast Network Limitations

Refer Section 6.7 for information on corrective action to address future limitations

Anticipated Limitation	Reason for constraint or limitation	Time Limitation May Be Reached		
		1 Yr Outlook	3 Yr Outlook	5 Yr Outlook
FAR NORTH AND ROSS ZONES				
Far North Voltage Control/Transformer Capacity	A 275kV outage in far north Queensland may result in unacceptable voltage conditions. This condition is exacerbated when output from Barron Gorge power station is low. Continued load growth expected to result in 275/132kV transformer capacity being exceeded.		Corrective action in progress (2)	2008-2010 (1)
Supply to Edmonton	Future limitations in the 22kV distribution capability in meeting continued load growth in the areas south of Cairns.	Corrective action in progress (2)		
Supply to Northern and Western Townsville	Future 132kV network thermal capacity limitations in meeting load growth in northern and western Townsville.	Corrective action in progress (2)	2006/07 (1)	
Supply to Townsville CBD and Port Area	Future 66kV network thermal capacity limitations in meeting growing potential new loads in CBD and surrounding areas.			2007/08 (1) (4)
Supply to Townsville South Area	Future limitations in the thermal capacity of the Ross to Townsville South 132kV line to meet load growth in the zinc smelter, Clare, southern Townsville and/or Townsville port areas.		2006/07 (1)	
NORTH ZONE				
Supply to Mackay-Proserpine Area	Due to load growth, an outage of either the Nebo-Alligator Creek 132kV line or Nebo-Pioneer Valley 132kV line may result in unacceptable voltage conditions and thermal overloading of the remaining circuits in service.	Corrective action in progress (2)		2007-2009 (1)
Nebo Transformer Limitations	Due to load growth, Nebo 275/132kV transformers expected to reach thermal capacity limitations in the event of a single transformer outage.	Corrective action in progress (2)		
Supply to Pioneer Valley Substation	Due to load growth, limitations arise in alternative supply, via distribution networks, to the single Pioneer Valley transformer.	Corrective action in progress (2)		
CQ-NQ and Nebo-Ross Limitations	Voltage, dynamic instability, and thermal overloading may result from 275kV line outages during periods of high northern Qld load.	Corrective action in progress (3)		2008/09 (1)

Anticipated Limitation	Reason for constraint or limitation	Time Limitation May Be Reached		
		1 Yr Outlook	3 Yr Outlook	5 Yr Outlook
CENTRAL AND CENTRAL WEST ZONE				
Supply to Gladstone Area	Potential for overload of Calvale-Wurdong 275kV line and/or Calvale 275/132kV tie transformer.	Currently managed by switching and support arrangements (5)		
Supply to Rockhampton Area	Due to load growth, an outage of one of the Bouldercombe-Rockhampton 132kV circuits may result in thermal overloading of the remaining circuit in service.	Corrective action in progress (2)		2007/08
Supply to Lilyvale	Due to load growth, an outage of the existing Broadsound-Lilyvale 275kV line may result in unacceptable voltage levels and thermal overloading on the 132kV network	Corrective action in progress (2)		
Supply to Blackwater/Moura Area	Due to load growth, Blackwater 132/66kV transformers and 132kV network supplying Blackwater/Moura expected to reach thermal capacity limitations in the event of a single contingency.			2007/08
Supply to Biloela Area	Due to load growth, Biloela 132/66kV transformers expected to reach thermal capacity limitations in the event of a single transformer outage.			2007/08
Grid Transfer from Central Zone	Additional base load generation in CQ may result in transfer limits between CQ and SQ being reached.		2006-2008	
WIDE BAY AND SOUTH WEST ZONE				
Supply to Wide Bay Area	Load growth may result in voltage control and thermal limitations during an outage of the 132kV network between Bundaberg and Woolooga.		2006-2008 (1)	
Supply to South West Queensland	Load growth expected to cause voltage control and thermal limitations during 275kV Tarong-Middle Ridge contingency.	Corrective action in progress (2)		
Grid transfer limit: Braemar-Tarong	Some NEM generation dispatch scenarios may give rise to binding transfer limits for northerly flows.		2006-2008	
MORETON NORTH AND SOUTH ZONES				
South East Qld Voltage Control	Increasing reactive demand due to load growth likely to require program of corrective action to satisfy voltage control standards.	Corrective action in progress (2)	2005-2008 Corrective action in progress (2) (1)	

Anticipated Limitation	Reason for constraint or limitation	Time Limitation May Be Reached		
		1 Yr Outlook	3 Yr Outlook	5 Yr Outlook
Supply to Brisbane CBD and inner suburbs	Increasing loads in Brisbane CBD and inner suburbs leading to thermal capacity limits in the distribution and 110kV networks.		2005/06 and 2006/07 Corrective action in progress (2)	
275/110kV Transformer Capability	Due to load growth, future 275/110kV transformer capacity limitations are anticipated at multiple locations.	Corrective action in progress (2)	2005-2008	
Supply to South West Brisbane	Due to load growth, thermal capacity limitations are expected in the 275kV and 110kV network supplying this area.		2006/07 (1)	
Supply to Murarrie-Trade Coast Areas	Thermal capacity limitations of 110kV network to Murarrie in meeting growing and potential new Trade Coast area loads.		2006-2008 Corrective action in progress (2) (6)	
Load Growth South East Queensland (Logan)	High load growth expected to result in limitations in supply to entire south east area.			2007-2009
GOLD COAST/TWEED ZONE				
275kV Supply to South Coast	Expected power flows likely to exceed Gold Coast voltage stability limits. Thermal limits may also arise in Energex system.		2005/06 (1)	
Gold Coast/Tweed 275/110kV Transformer Capacity	Due to load growth, Mudgeeraba 275/110kV transformers expected to reach thermal capacity limitations in the event of an outage of the Molendinar 275/110kV transformer.			2008/09

Notes:
(1) Refer to Section 6.7 – Proposed Network Developments
(2) Refer Tables 5.2 and 5.4 – Committed Augmentations
(3) Network support arrangements in place
(4) Earlier timeframe if major new industrial loads proceed
(5) Other corrective action may be required if major new loads occur in the Gladstone area
(6) Works to address the forecast Brisbane CBD limitations also address this limitation.

6.7 Proposed Network Developments

As outlined in Chapter 4, electricity demand in Queensland is expected to grow strongly in the near term – driven by continued residential, commercial and industrial development. This growth will be particularly evident in the south east corner of the state where demand is forecast to increase by around 5% p.a. over the next five years.

Network development to meet forecast load depends on the location and capacity of generation developments and the pattern of generation dispatch in the competitive electricity market. Uncertainty about the generation pattern creates uncertainty about the power flows on the network, and subsequently which parts of the network will experience limitations. This uncertainty is a feature of the competitive electricity market, and has been particularly evident in the Queensland region where a significant amount of new large generation capacity has entered the market over the past few years. However, following the recent commissioning of major new generators, a new pattern of generation and power flows is becoming more evident although this may change again following the announcement of new generating plant.

The previous section of this report outlined forecast limitations that may arise in Powerlink's transmission network in the near future. The possible timing and severity of these limitations is dependent on load growth and market developments.

This section focuses on those limitations for which Powerlink intends to implement corrective action or initiate consultation with market participants and interested parties in the near future. Information is also provided on potential connection point proposals.

It should be noted that the information provided in this section regarding Powerlink's network development plans may change, and should therefore be confirmed with Powerlink before any action is taken based on this information.

6.7.1 Processes for Proposed Network Developments

Sections 6.4-6.6 of this report identified anticipated network limitations and constraints that may arise in the Queensland transmission network over the next 5 years. Where action is considered necessary, Powerlink will:

- Notify Code participants of anticipated limitations within the timeframe required for corrective action.
- Seek information from market participants and interested parties on feasible non-network solutions to address anticipated constraints.
  - Powerlink's general approach is to seek input, via the Annual Planning Report, on potential solutions to network limitations which may result in small network assets. Those that cannot be identified for inclusion in the Annual Planning Report will be the subject of separate consultation with market participants and interested parties;
  - For emerging network limitations which may result in large network assets, Powerlink's approach is to issue detailed information papers outlining the limitations to assist in identifying non-network solutions.
- Consult with Code Participants and interested parties on all feasible alternatives (network and non-network) and recommended solutions.
- Carry out detailed analysis to determine feasible network solutions that Powerlink may propose to address identified network constraints.

- In the event a regulated solution (network or network support) is found to satisfy the ACCC Regulatory Test, Powerlink will implement the recommended solution.

Alternatively, Powerlink may undertake network augmentations under the 'funded augmentation' provisions of the Code.

6.7.2 Proposed New Large Network Assets

Proposals for new large network assets are required to be progressed under the provisions of Clause 5.6.6 of the NEC.

Powerlink is required to carry out separate consultation processes for each proposed new large network asset. Summary information is provided in this Annual Planning Report. Interested parties are referred to consultation documents published on Powerlink's website for further information.

Information on other network limitations that could result in a recommendation to implement a new large network asset, but where consultation on alternative solutions is still underway, is provided in Section 6.7.3.

Committed New Large Network Assets

Interested parties are advised that during 2003/04, Powerlink finalised regulatory processes associated with the following proposed new large network assets –

Table 6.7: New Large Network Assets Committed In 2003/04

Project Name	Description of works	Cost	Expected commissioning date
Darling Downs	Construct a 330kV double circuit transmission line between Millmerran and Middle Ridge, with associated substation works.	$71.3M	December 2004
Cairns and Far North Queensland	Install 132kV –80+150MVAr Static Var Compensator at Woree substation.	$16.9M	September 2005
Brisbane CBD Area	Upgrade and rearrange the Belmont-Newstead and Belmont-Murarrie 110kV lines and construct a 275kV reinforcement between Belmont-Murarrie. These works comprise the Powerlink component of a joint project with ENERGEX to meet reliability of supply obligations in the Brisbane CBD area.	$39.5M (Powerlink component) Total project cost $178.5M	October 2005 and October 2006

Proposed New Large Network Asset – Gold Coast/Tweed Zone

Joint planning studies undertaken by Powerlink and Energex have determined that by the summer of 2005/06, the capability of the existing network to supply the Gold Coast/Tweed zone will be exceeded during a single 275kV contingency (in summer peak demand periods). For supply to the Gold Coast/Tweed zone, the most critical contingency occurs when the 275kV Swanbank to Mudgeeraba circuit with the Maudsland to Molendinar tee connection is out of service. This circuit provides 275kV supply to both Molendinar and Mudgeeraba. Following an outage of the teed circuit from late 2005 onwards, unstable voltages are forecast to occur, and the 110kV lines between Beenleigh and Coomera will become overloaded. Action is required to address these future supply requirements before late 2005 to allow Powerlink and Energex to meet their respective reliability of supply obligations.

Powerlink and Energex have carried out consultation to identify and determine feasible options to address the future supply requirements. Analysis of options was carried out through joint planning (including with Country Energy and TransGrid) and in accordance with the ACCC Regulatory Test.

The recommended solution comprises:

- Provision of network support to the Gold Coast/Tweed zone by DirectLink for the summer of 2005/06 at an estimated total cost of $2.7M; and
- Establishment of a 275kV switchyard at Greenbank, and construction of a 275kV transmission line between Greenbank and Maudsland by late 2006. Construction of this proposed augmentation, estimated to cost $48.9M, is expected to begin in late 2004, for commissioning by late 2006.

An Application Notice for this proposed new large network asset was issued on 19 April 2004. This document can be accessed on the Powerlink website at www.powerlink.com.au. This proposed augmentation is being progressed under the relevant Code provisions. A Final Report is anticipated to be released in the near future and will be available for access on the Powerlink website.

6.7.3 Consultation – New Large Network Assets

Consultations Underway

Network limitations have been identified that could give rise to a requirement for a proposed new large network asset at a number of locations. This section provides a summary of the status of action to address future supply requirements in the Gladstone and north/far north Queensland areas. At this stage, Powerlink is consulting market participants regarding potential solutions or is in the process of evaluating potential solutions. No recommendation for a new large network asset has been made in either case.

Future Supply Requirements – Gladstone Area

An information paper outlining the system limitations anticipated in the Gladstone area was issued on 28 November 2002. No submissions regarding potential non-network solutions were received in response to this information paper.

Delays to the process have occurred due to ongoing discussions with potential industrial loads in the Gladstone area regarding their requirements and the revision of forecast demand by existing Gladstone area customers. The timing and extent of further investigations in the Gladstone area is therefore uncertain.

Powerlink will initiate regulatory processes as necessary to meet the future electricity supply needs of the Gladstone area.

Future Supply Requirements – North and Far North Queensland

An information paper outlining future supply requirements in north and far north Queensland was issued on 7 May 2004. A number of submissions regarding potential non-network solutions were received in response to this information paper. Powerlink is currently assessing these potential solutions, together with a range of network options, in accordance with the ACCC Regulatory Test. Publication of an Application Notice is anticipated by late 2004.

Anticipated Consultation Processes

Other consultation processes likely to be initiated in the next twelve months are summarised in Table 6.8:

Table 6.8: Consultation Likely Within 12 months

Location	Future Supply Requirement
Townsville area	Load growth expected to result in thermal capacity limitations being reached in the 132kV and 66kV networks.
Mackay area	Load growth expected to result in voltage stability and thermal limitations being reached in the 132kV network.
Rockhampton area	Load growth expected to result in thermal capacity limitations being reached in the 132kV network.
Wide Bay area	Load growth expected to result in 275/132kV transformer capacity being exceeded.
Brisbane South and West area	Load growth expected to result in thermal overload issues in the transmission network in the area.
Central Queensland mining area (Blackwater/Moura etc)	Load growth, particularly from coal mine projects, may result in limitations in the transmission network.
Supply to south east Queensland area	Transfer capacity to SEQ plus local generation may be insufficient to meet future load.

Emerging limitations other than those listed will be monitored, and Powerlink will initiate action, including consultation with interested parties, should this be required.

6.7.4 Outline of Proposed New Small Network Assets

This section outlines proposed network augmentations which are required to be progressed under the provision of Clause 5.6.6A of the NEC (new small network assets – capitalisation value between $1M and $10M). At the time of publication of this report, Powerlink has developed plans for the proposed new small network augmentations listed in Table 6.9 to the point where they can be consulted on through this document.

Table 6.9: Proposed New Small Network Assets

Proposed New Small Network Asset	Date to be Operational	Capital Cost
SEQ capacitor banks		
• Loganlea 50MVAr 110kV capacitor bank	October 2005	$1.1M
• Runcorn 50MVAr 110kV capacitor bank	October 2005	$1.2M
• Rocklea 50MVAr 110kV capacitor bank	October 2005	$1.0M
• Palmwoods 50MVAr 132kV capacitor bank	October 2006	$1.0M

Further details on each of these proposed new small network assets, including purpose, possible alternatives and the reasons that Powerlink is recommending these augmentations proceed, are in Appendix D.

Code Participants and interested parties are invited to make submissions regarding these proposed augmentations and any non-network options they consider to be an alternative. The closing date for submissions is 28 July 2004. Submissions should be addressed to:

Network Assessments Consultant
Powerlink Queensland
PO Box 1193
VIRGINIA QLD 4014
networkassessments@powerlink.com.au

If there are any material changes required following consideration of submissions, Powerlink will publish its conclusions and a revised recommendation. If no changes are required, Powerlink will proceed to implement these proposed new small network assets in the required timeframes.

Other proposed new small network assets will be subject to separate assessment and consultation as per Clause 5.6.6A of the Code, if commitment is required prior to the publication of the 2005 Annual Planning Report.

6.7.5 Connection Point Proposals

Table 6.10 lists connection works which may be required over the next few years. Regulatory approval of these projects is not required under the NEC. Planning of new or augmented connections involves consultation between Powerlink and the connecting party, determination of technical requirements and completion of connection agreements. New connections can be initiated by generators or customers, or result from joint planning with the relevant DNSP.

Table 6.10: Possible Connection Works

Project	Purpose	Location	Possible Commissioning Date
Algester 110/33kV substation	New connection point to Energex to increase 33kV capacity for load growth	Algester and surrounding areas	October 2006
Sumner 110/11kV substation	New connection point to Energex to increase 11kV capacity for load growth and new loads	Supply to industrial areas near Sumner Park	October 2006
Larcom Creek 275/132kV substation (connection point created as a result of possible Larcom Creek establishment)	New connection point to Ergon to augment CQ transformer capacity	Gladstone and central Queensland	October 2006
Goodna (Redbank) 110/33kV substation	New connection point to Energex	Redbank, Goodna and surrounding areas	October 2006
Blackwater 132/66kV substation 3rd transformer	Increase 66kV capacity for reliable supply to growing load	Bowen Basin mining area	October 2007
Biloela transformer augmentation	Increase transformer capacity to meet growing loads	Biloela	October 2007
Runcorn 110/33kV substation 3rd transformer	Increase 33kV capacity for reliable supply to growing load	South east areas of Brisbane	October 2008
Kogan power station 275kV connection	Connection of new power station	Braemar	Late 2007
Wambo power station 275kV connection	Connection of new power station	Braemar	2005 and later

7. OTHER RELEVANT INTRA-REGIONAL ISSUES

CONTENTS

7.1 Existing and Committed Generation Developments

7.1.1 Generation

The bulk of Queensland's electrical energy is generated by coal-fired power stations located in central and southern Queensland. Three relatively small hydro-electric power stations (with limited water storage) operate in far north Queensland. The remaining capacity is mostly pumped storage hydro in southern Queensland, coal fired at Collinsville and gas turbines at Swanbank, Townsville, Oakey and other locations.

Table 7.1 summarises the existing and committed power stations connected or to be connected to the Powerlink transmission network, including the non-scheduled market generators at Invicta and Koombooloomba, as well as the scheduled embedded generators at Barcaldine and Roma.

The following notes apply to Table 7.1:

(1) The 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 available rating depends on ambient conditions. Some additional overload capacity is available at some power stations depending on ambient conditions.

(2) Conversion of the Townsville power station from liquid fuelled open cycle gas turbine (OCGT) to gas fuelled combined cycle gas turbine (CCGT) in early 2005 has been included. Note that the steam turbo-alternator will be connected to the Ergon distribution network.

(3) 'Other various locations' comprise gas turbines at Mackay (33MW Winter/30MW Summer), Gladstone (14/13MW) and Tarong (15/14MW) – note that Tarong and Gladstone GTs are non-scheduled.

(4) Wivenhoe power station is shown at its full capacity (500MW), however output can be limited to lower levels of output depending on water storage in the upper dam.

Table 7.1: Generation Capacity

Connected to Queensland Transmission Network (Existing and Committed Plant only) including Embedded Market Scheduled Generators

Location	Capacity MW Generated (1)					
	Winter 2004	Summer 2004/05	Winter 2005	Summer 2005/06	Winter 2006	Summer 2006/07
Coal Fired						
Callide B	700	700	700	700	700	700
Tarong	1,400	1,400	1,400	1,400	1,400	1,400
Stanwell	1,400	1,400	1,400	1,400	1,400	1,400
Swanbank B	500	480	500	480	500	480
Callide A	0	0	0	0	120	120
Gladstone	1,680	1,680	1,680	1,680	1,680	1,680
Collinsville	185	185	185	185	185	185
Callide Power Plant	920	900	920	900	920	900
Millmerran	863	853	863	853	863	853
Tarong North	443	443	443	443	443	443
TOTAL – Coal Fired	8,091	8,041	8,091	8,041	8,211	8,161
Combustion Turbines						
Barcaldine	55	53	55	53	55	53
Mt Stuart (Townsville)	294	288	294	288	294	288
Townsville (Yabulu) (2)	160	160	223	223	223	223
Oakey	320	276	320	276	320	276
Swanbank D (37/32MW)	0	0	0	0	0	0
Swanbank E (CCGT)	385	355	385	355	385	355
Roma	60	50	60	50	60	50
Other (various locations) (3)	62	57	62	57	62	57
Hydro Electric						
Barron Gorge	60	60	60	60	60	60
Kareeya (including Koombooloomba)	80	84	88	88	88	88
Wivenhoe (pumped storage) (4)	500	500	500	500	500	500
Sugar Mills						
Invicta	39	39	39	39	39	39
TOTAL – Other Than Coal (rounded)	2,015	1,922	2,086	1,989	2,086	1,989
TOTAL – ALL STATIONS (rounded)	**10,106**	**9,963**	**10,177**	**10,030**	**10,297**	**10,150**
Interconnections Queensland – New South Wales **Import Capacity**	500	500	500	500	500	500

[Source: NEMMCO and Powerlink]

7.2 Changes to Supply Capacity

7.2.1 Generation

Since Powerlink's 2003 Annual Planning Report was published, there has been no change to generation connected to the transmission grid, other than the retirement of Swanbank D gas turbine generating unit.

Powerlink has been advised the conversion of the Townsville power station from liquid fuel to gas fuel, along with the addition of a steam turbine, is committed for completion by early 2005. The steam turbo-alternator (83MW) will be connected to the distribution network, while the output of the existing transmission connected generator will reduce from 160MW to 140MW.

Units at the Kareeya power station are undergoing refurbishment on a progressive basis, resulting in a slightly increased capacity of the station.

CS Energy announced during May 2004, that it has committed to construction of the proposed Kogan Creek 750MW coal fired power station. Expected connection date is late 2007, which is outside the timeframe of Table 7.1.

Wambo Power Ventures Pty Ltd has advised plans for 3 x 150MW and 50MW gas fired power stations in the Braemar area. It has indicated these units will be available by mid 2005 (2 x 150MW units), late 2005 (1 x 150MW unit) and mid 2006 (1 x 50MW unit). These units have not been included in Table 7.1

Swanbank D generating unit has been retired and disconnected from the grid. Accordingly the generator capacity has been nominated as zero for the purposes of Table 7.1.

The mothballed Callide A power station is planned to be returned to service in 2006, one year later than nominated in the 2003 Annual Planning Report.

Powerlink has not been advised of any other commitments to new generating capacity since the 2003 Annual Planning Report.

7.2.2 Interconnection

Table 7.1 also includes combined northerly flow capability for the Queensland-New South Wales Interconnection (QNI) and the market network service provider (DirectLink) between Mullumbimby and Terranora in New South Wales.

The combined QNI plus DirectLink maximum northerly capacity is limited by transient stability, oscillatory stability and the thermal capability of the 330kV network in New South Wales.

In addition, the combined QNI plus DirectLink maximum northerly capacity can also be constrained by intra-regional constraints in northern New South Wales and south western Queensland.

Based on the above network limits, the combined northerly capability of QNI plus DirectLink is nominated as 500MW for the purposes of the generation capacity schedule shown in Table 7.1.

7.2.3 Interconnection Upgrades

Following publication of the Annual Interconnector Review, which formed part of NEMMCO's 2003 SOO, Powerlink and TransGrid have undertaken a study to examine the economics of upgrading QNI.

The study identified augmentation options and examined the expected net market benefit from each option in relieving constraints over a range of generation entry scenarios. The options are listed in Table 7.2.

Table 7.2: QNI Upgrade Options

Option	Capacity Increase	Description	Estimated Cost
Option A	Maintain current southerly capacity over time	Works to alleviate future thermal limitations in northern NSW network	$15-20M
Option B	Nominal 50MW southerly direction	Option A works + transient/oscillatory stability enhancements	$35-45M
Option C	Nominal 100MW southerly direction	Option A & B works + further transient/oscillatory stability enhancements	$50-60M
Option D	Nominal 200MW both direction	Option A, B & C works + further transient/oscillatory stability enhancements. A 200MW upgrade will have wider impacts on connected systems, and will therefore require related intra-regional augmentations	$120-160M
Option E	Nominal 800MW in both directions	An additional Queensland – New South Wales HVAC interconnection	$600-800M
Option F	Nominal 2000MW in both directions	An additional Queensland – New South Wales HVDC connection	$1400-1800M

The study concluded that only Option A was likely to pass the current regulatory test evaluation. This option involves intra-regional upgrades with the NSW network and does not in itself involve constructing or upgrading the interconnector.

More information on the study can be found in the report on Powerlink's website.

7.3 Supply Demand Balance

The outlook for the supply demand balance for the Queensland region was published in NEMMCO's 2003 Statement of Opportunities in July 2003. A revised outlook is expected to be published by NEMMCO in the 2004 SOO (July 2004).

8. APPENDICES

CONTENTS

8.1 Appendix A – Estimated Network Power Flows

Appendix A illustrates the 18 sample grid power flows for the Queensland region for summer and winter over three years from 2004 to 2006/07.

These show possible grid power flows at the time of forecast winter or summer region peak demand, and with a range of import and export conditions on the Queensland-New South Wales Interconnection (QNI) as detailed in Section 6.2.

Table A.1: Summary of Figures A3 to A20 - Possible Grid Power Flows and Limit Stability States

Grid Section (1)		Illustrative Grid Power Flows (MW) and Limit Stability at Queensland Region Peak Load Time (2)(3)						Limit Due To (4)
		2004 WINTER Fig A3 / A4 / A5	2005 WINTER Fig A6 / A7 / A8	2006 WINTER Fig A9 / A10 / A11	2004/05 SUMMER Fig A12 / A13 / A14	2005/06 SUMMER Fig A15 / A16 / A17	2006/07 SUMMER Fig A18 / A19 / A20	
'Far North' Transfer								
Ross into Chalumbin 275kV (2 circuits)	Flow	150 / 150 / 150	162 / 162 / 162	170 / 170 / 170	232 / 232 / 232	243 / 243 / 226	253 / 253 / 235	V
Tully into Kareeya 132kV (2 circuits)	Stability	S / S / S	S / S / S	S / S / S	S / S / S	S / S / S	S / S / S	
'CQ-NQ' Transfer								
Broadsound into Nebo 275kV (2 circuits)	Flow	809 / 809 / 809	808 / 795 / 796	858 / 845 / 846	968 / 969 / 898	955 / 867 / 810	966 / 866 / 749	Dy, Th, V
Bouldercombe into Nebo 275kV (1 circuit)	Stability	S / S / S	S / S / S	S / S / S	S / S / S	S / S / S	S / S / S	
Dysart to Peak Downs 132kV (2 parallel circuits)								
'Gladstone' Transfer (5)								
Bouldercombe into Gladstone 275kV (2 circuits)	Flow	890 / 931 / 831	943 / 930 / 816	1009 / 871 / 701	802 / 708 / 736	719 / 670 / 697	748 / 734 / 774	Th
Calvale into Wurdong 275kV (1 circuit)	Stability	S / S / S	U / S / S	U / S / S	U / S / S	S / S / S	S / S / S	
Callide A into Gladstone South 132kV (2 circuits)								
'CQ-SQ' Transfer								
Wurdong into Gin Gin 275kV (1 circuit)	Flow	754 / 1037 / 1530	764 / 1241 / 1595	980 / 1311 / 1820	1117 / 1410 / 1494	1307 / 1699 / 1755	1409 / 1749 / 1905	Tr, V
Gladstone into Gin Gin 275kV (2 circuits)	Stability	S / S / S	S / S / S	S / S / S	S / S / S	S / S / S	S / S / S	
Calvale into Tarong 275kV (2 circuits)								
'Tarong' Transfer								
Tarong to South Pine, Mt England	Flow	2730 / 2595 / 2331	2948 / 2692 / 2351	3033 / 2703 / 2437	3118 / 2779 / 2428	3178 / 2881 / 2516	3216 / 2899 / 2634	V
and Blackwall 275kV (5 circuits)	Stability	S / S / S	S / S / S	S / S / S	S / S / S	S / S / S	S / S / S	
Middle Ridge to Swanbank and Postmans Ridge 110kV (3 circuits)								
'Gold Coast' Transfer (6)								
Swanbank into Mudgeeraba 275kV (2 circuits)	Flow	623 / 623 / 623	655 / 655 / 655	674 / 674 / 674	652 / 652 / 652	629 / 629/ 629	708 / 708 / 708	V, Th
Maudsland Tee into Molendinar 275kV (2 parallel circuits)	Stability	S / S / S	S / S / S	S / S / S	S / S / S	S / S / S	S / S / S	
Cades County into Molendinar 110kV (1 circuit)								
'Braemar' Transfer								
Braemar 330kV to Braemar 275kV	Flow	1113 / 771 / 273	583 / 272 / -41	577 / 268 / -47	590 / 281 / 5	584 / 274 / 24	582 / 272 / 53	Th, V
(2 transformers)	Stability	S / S / S	S / S / S	S / S / S	S / S / S	S / S / S	S / S / S	

Notes:

(1) X **into** Y – the MW flow between X and Y measured at the **Y end**; X **to** Y – the MW flow between X and Y measured at the **X end**.

(2) Grid power flows are derived from the assumed generation dispatch cases shown in Figures A3 to A20. The flows are estimated for system intact (ie, all network circuits in service), and are based on existing network configurations, committed projects, and proposed new assets in Chapter 6. Power flows within each grid section can be higher at times of local zone peak loading.

(3) S = Stable condition, U = Unstable condition.

(4) V = Voltage stability limit, Th = Thermal limit, Tr = Transient stability limit, and Dy = Dynamic stability limit.

(5) Calvale-Wurdong line loading exceeds emergency rating immediately following the critical contingency; however, the line loading will return to within rating following post contingent switching.

(6) The Gold Coast grid section is defined for the winter 2004 network configuration.
Following the establishment of Energex's Coomera substation by summer 2005/06, the grid section will be defined as:

- Swanbank into Mudgeeraba 275kV (2 circuits);
- Maudsland 'tee' into Molendinar 275kV (2 parallel circuits operated as one line);
- Coomera into Cades County 110kV (1 circuit).

Following the planned establishment of 275kV Greenbank substation by summer 2006/07, the grid section will be defined as:

- Greenbank into Mudgeeraba 275kV (2 circuits);
- Greenbank into Molendinar 275kV (2 parallel circuits operated as one line);
- Coomera into Cades County 110kV (1 circuit).

Table A.2: Transformer Capacity and Estimates of Loading of 275kV Substations

275kV Substation (1) (2)	Possible MVA at Queensland Region Peak (4)(5)						Dependence other than Local Load		Other Comments
Transformers No. x MVA Nameplate Rating (3)	Winter 2004	Winter 2005	Winter 2006	Summer 2004/05	Summer 2005/06	Summer 2006/07	Significant dependence on:	Minor dependence on:	
Woree 275/132 (1x375)	83	87	92	123	124	123	Barron Gorge generation	Kareeya generation	
Chalumbin 275/132 (2x200)	86	92	99	130	116	121	Barron Gorge and Kareeya generation	Townsville & Mt Stuart generation	
Ross 275/132 (2x250 and 1x200)	265	275	289	301	238	235	Mt Stuart, Townsville & Invicta generation	Collinsville generation	
Strathmore 275/132 (1x375)	86	67	54	51	99	86	Collinsville & Invicta generation	Townsville & Mt Stuart generation	
Nebo 275/132 (2x200)	251	251	274	281	317	317	Mackay GT generation	Collinsville generation	Summer 2005/06 (3rd Tx - 250MVA)
Lilyvale 275/132 (2x200)	207	249	261	271	285	249	Barcaldine generation	CQ-NQ flow	Summer 2004/05 (Tx's replaced by 2 x 375MVA)
Bouldercombe 275/132 (2x200)	137	142	144	160	155	161			
Calvale 275/132 (1x250)	182	174	136	178	185	128	Central Queensland Generation including Callide A re-entry in 2005		
Gin Gin 275/132 (2x120)	151	158	170	172	186	199	132kV transfers to/from Woolooga	CQ-SQ flow	
Woolooga 275/132 (2x120 and 1 x 200)	221	242	256	228	243	256	132kV transfers to/from Gin Gin	CQ-SQ flow	
Palmwoods 275/132 (2x375)	292	315	337	276	298	310	132/110kV transfers to/from South Pine & Woolooga	CQ-SQ flow	
South Pine 275/110 (1x375, 1x250 and 2x200)	710	730	760	843	883	839	110kV transfers to/from Rocklea & Palmwoods	CQ-SQ flow & Swanbank generation	

275kV Substation (1) (2)	Possible MVA at Queensland Region Peak (4)(5)						Dependence other than Local Load		Other Comments
Transformers No. x MVA Nameplate Rating (3)	Winter 2004	Winter 2005	Winter 2006	Summer 2004/05	Summer 2005/06	Summer 2006/07	Significant dependence on:	Minor dependence on:	
Rocklea 275/110 (2x375)	461	463	484	568	588	532	110kV transfers to/from South Pine and Belmont	110kV transfers to/from Swanbank & Swanbank generation	
Belmont 275/110 (2x250 and 2x200)	737	687	724	823	865	732	110kV transfers to/from Loganlea	110kV transfers to/from Rocklea	August 2004 (Loganlea 2nd Tx – 375 MVA) & October 2006 (Belmont-Murrarie 275kV line).
Swanbank 275/110 (1x250 and 1x240)	290	268	272	278	300	293	110kV transfers to/from South Pine & Oakey GT generation	110kV transfers to/from Rocklea & Swanbank generation	December 2004 (Millmerran-Middle Ridge 330kV re-enforcement).
Loganlea 275/110 (1x375)	291	420	446	441	477	476	110kV transfers to/from Belmont	110kV transfers to/from Molendinar & Mudgeeraba	Summer 2004/05 (2nd Tx - 375MVA)
Molendinar 275/110 (1x375)	238	232	234	266	262	248	110kV transfers to/from Loganlea & Mudgeeraba	DirectLink MNSP	
Mudgeeraba 275/110 (3x250)	419	433	443	425	411	475	110kV transfers to/from Molendinar & DirectLink MNSP	110kV transfers to/from Loganlea	
Tarong 275/132 (2x90)	62	63	65	60	62	64	Roma generation		
Tarong 275/66 (2x90)	40	41	43	40	42	43			
Middle Ridge 275/110 (2x250)	323	488	500	484	496	498	Oakey GT generation	Swanbank B generation	Summer 2004/05 (3rd Tx - 250MVA) & QNI transfer following commissioning of Millmerran-Middle Ridge 330kV line in Dec. 2004

Notes:

(1) Not included are the 275/132kV tie transformers within the Power Station switchyard at Gladstone. Loading on these transformers vary considerably with local generation.

(2) Also not included are 330/275kV transformers located at Braemar substation. Loading on these transformers are dependent on QNI transfer and Millmerran power station output.

(3) Nameplate based on present ratings. Cyclic overload capacities above nameplate ratings are assigned to transformers based on ambient temperature, load cycle patterns and transformer design.

(4) Substation loadings are derived from the assumed generation dispatch cases shown within Figures A3 to A20. The loadings are estimated for system normal (i.e. all network elements in service), and are based on existing network configurations, committed projects, and proposed new assets in Chapter 6. MVA loadings for transformers depend on power factor, and may be different under other generation patterns, outage conditions, local or zone peak demand times or different availability of local and down stream capacitor banks.

(5) Substation loadings are the maximum of each of the northerly/zero/southerly QNI scenarios for each year/season shown within the assumed generation dispatch cases in Figures A3 to A20.

Figure A.1: Generation and Load Legend for Figures A3 to A20

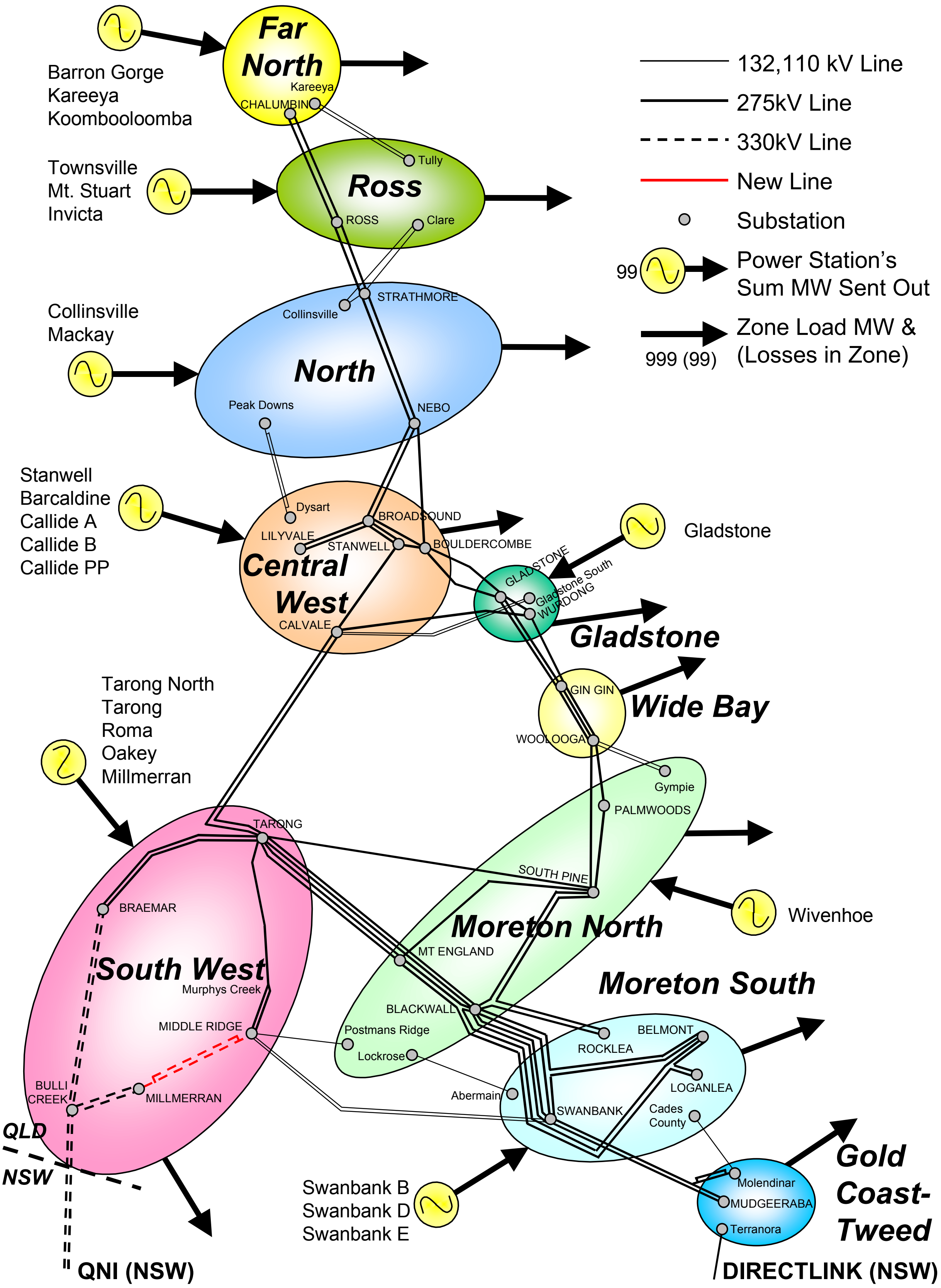


Figure A.2: Power Flow and Limits Legend for Figures A3 to A20

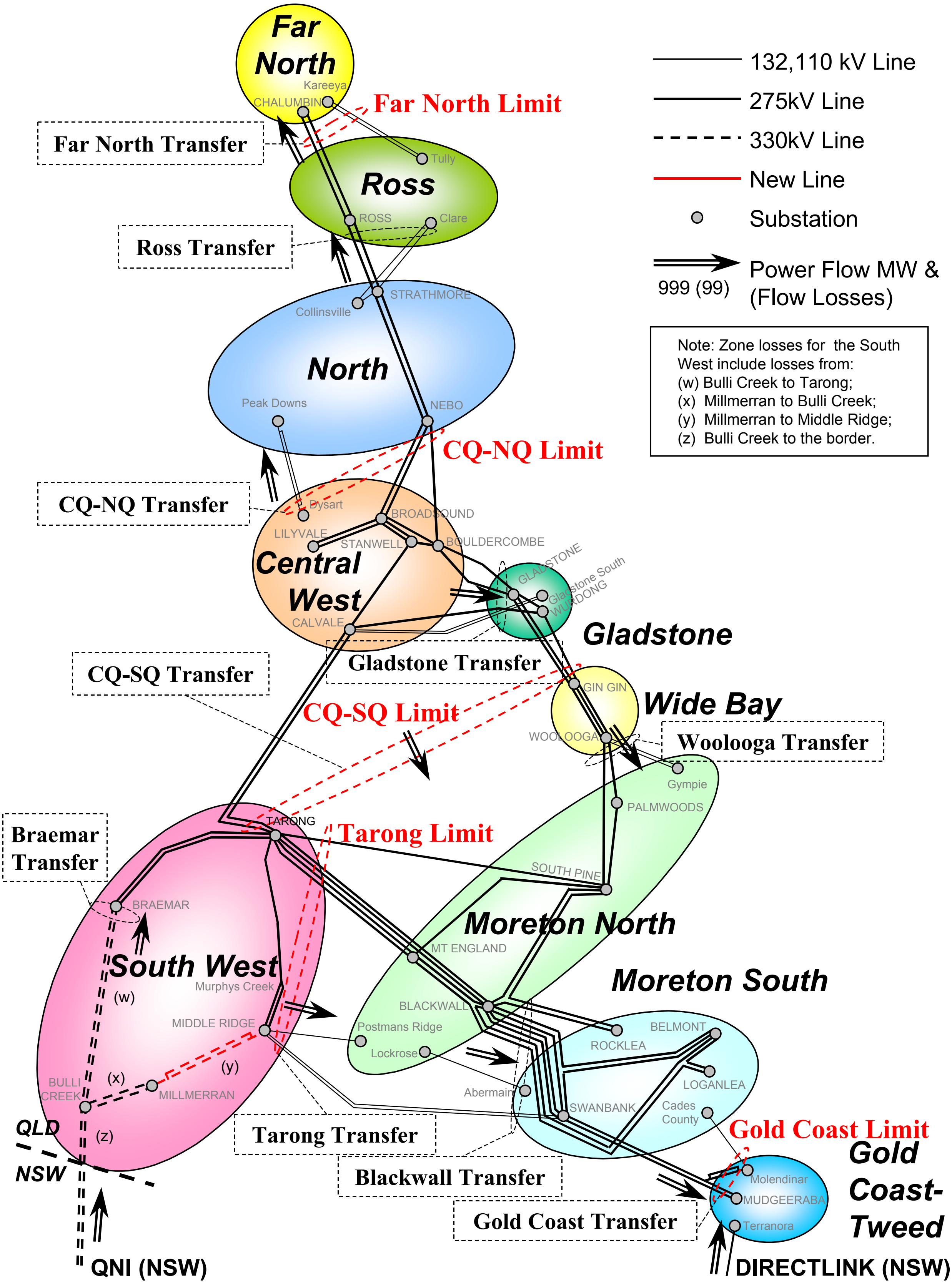


Figure A.3: Winter 2004 Qld Peak 500MW Northerly QNI Flow

Total Gen Sent-Out…	6344 MW
Total Load……………	6538 MW
Total Losses………..	306 MW
QNI Northerly……….	500 MW
DirectLink Import……	0 MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

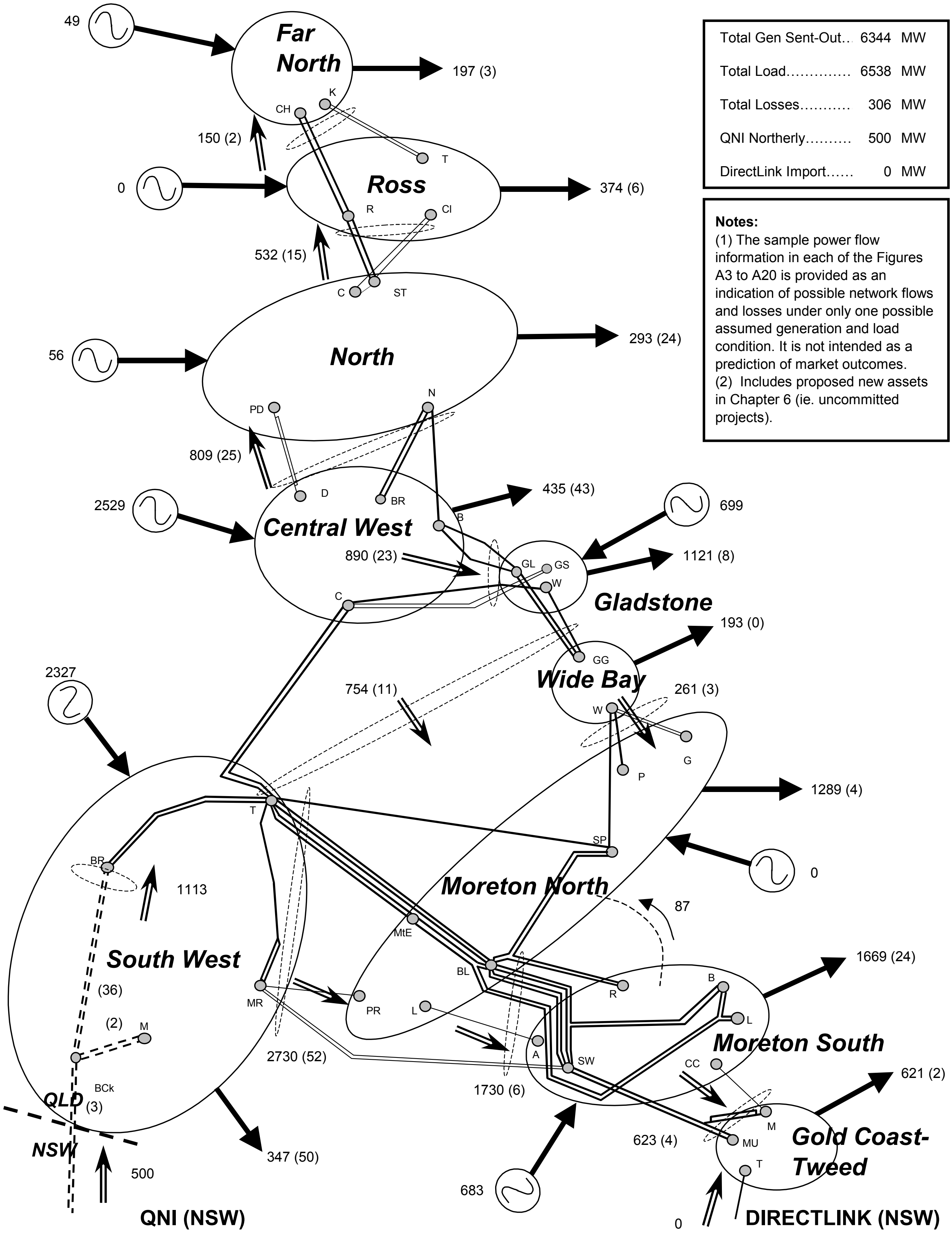
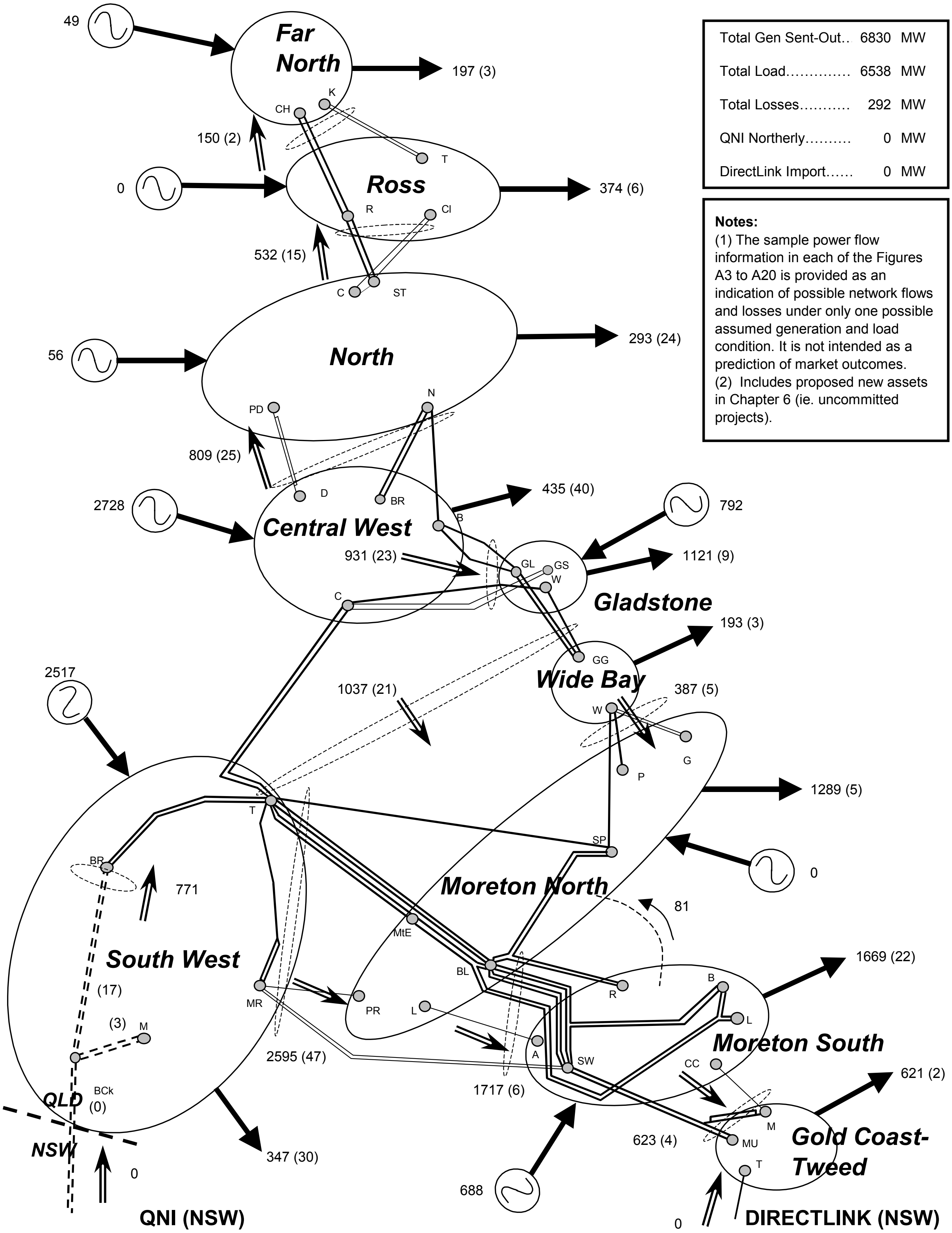


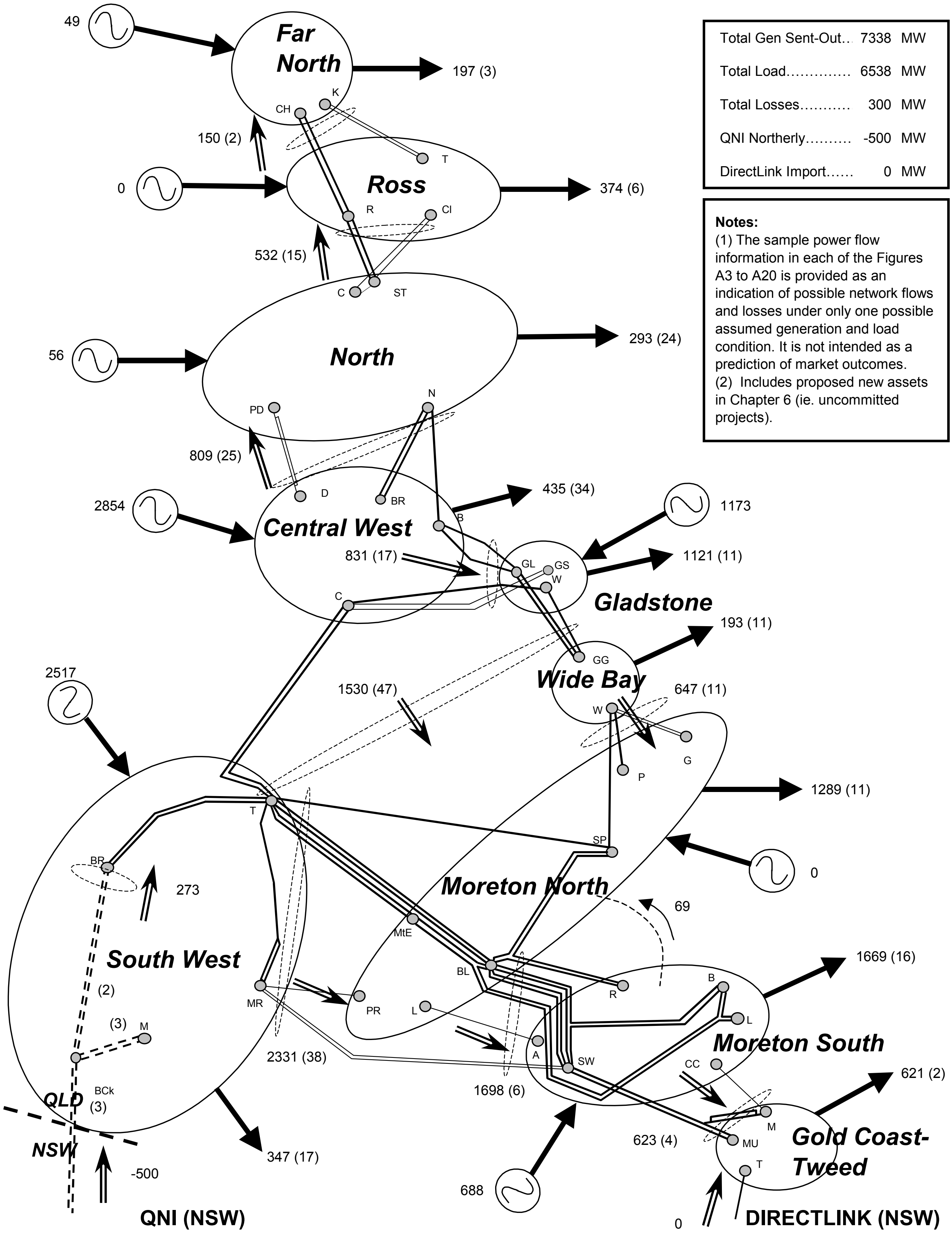
Figure A.4: Winter 2004 Qld Peak Zero QNI Flow



Total Gen Sent-Out..	6830	MW
Total Load..............	6538	MW
Total Losses...........	292	MW
QNI Northerly..........	0	MW
DirectLink Import......	0	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

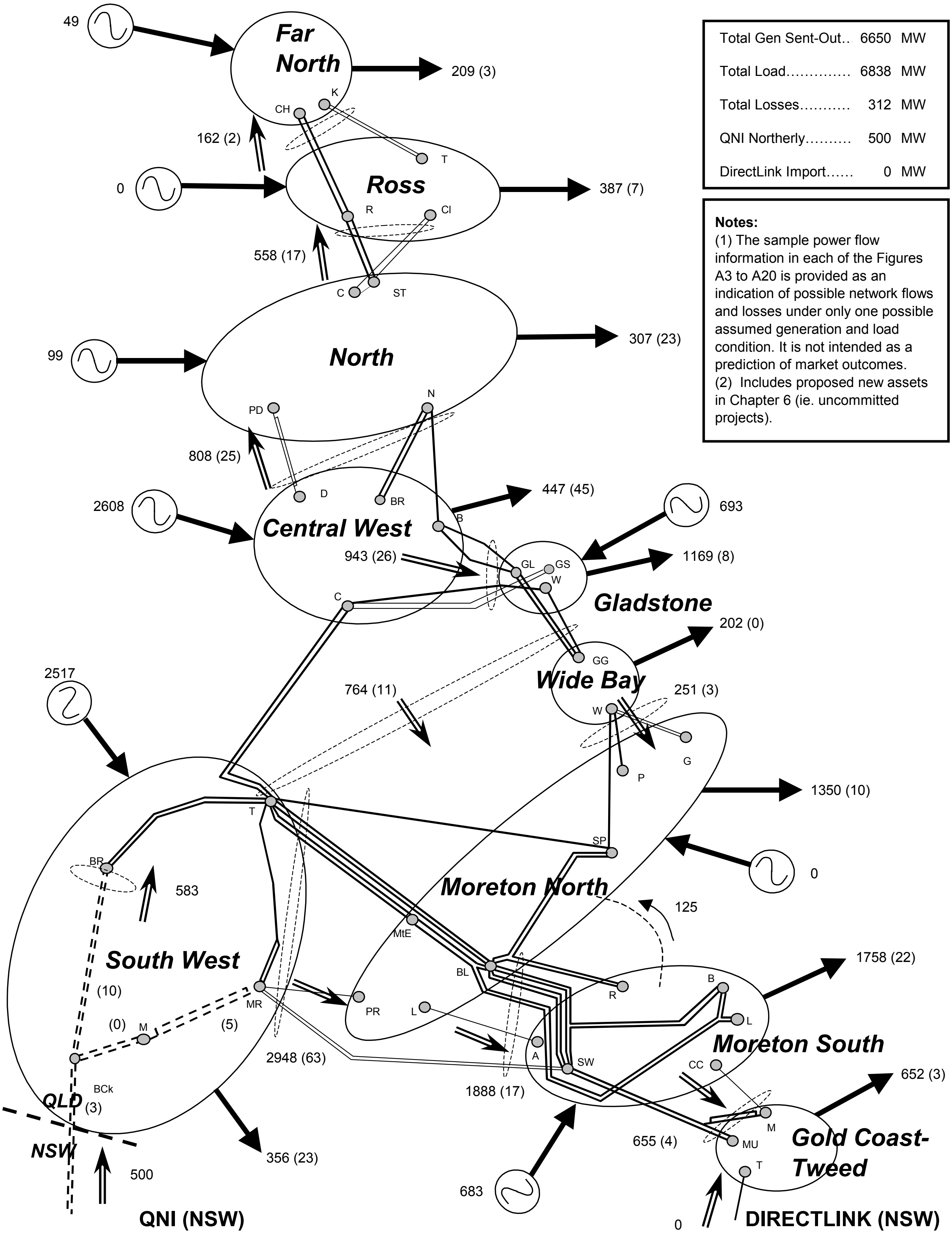
Figure A.5: Winter 2004 Qld Peak 500MW Southerly QNI Flow



Total Gen Sent-Out…	7338	MW
Total Load…………..	6538	MW
Total Losses………..	300	MW
QNI Northerly……….	-500	MW
DirectLink Import……	0	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

Figure A.6: Winter 2005 Qld Peak 500MW Northerly QNI Flow



Total Gen Sent-Out..	6650	MW
Total Load..............	6838	MW
Total Losses...........	312	MW
QNI Northerly..........	500	MW
DirectLink Import......	0	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

Figure A.7: Winter 2005 Qld Peak Zero QNI Flow

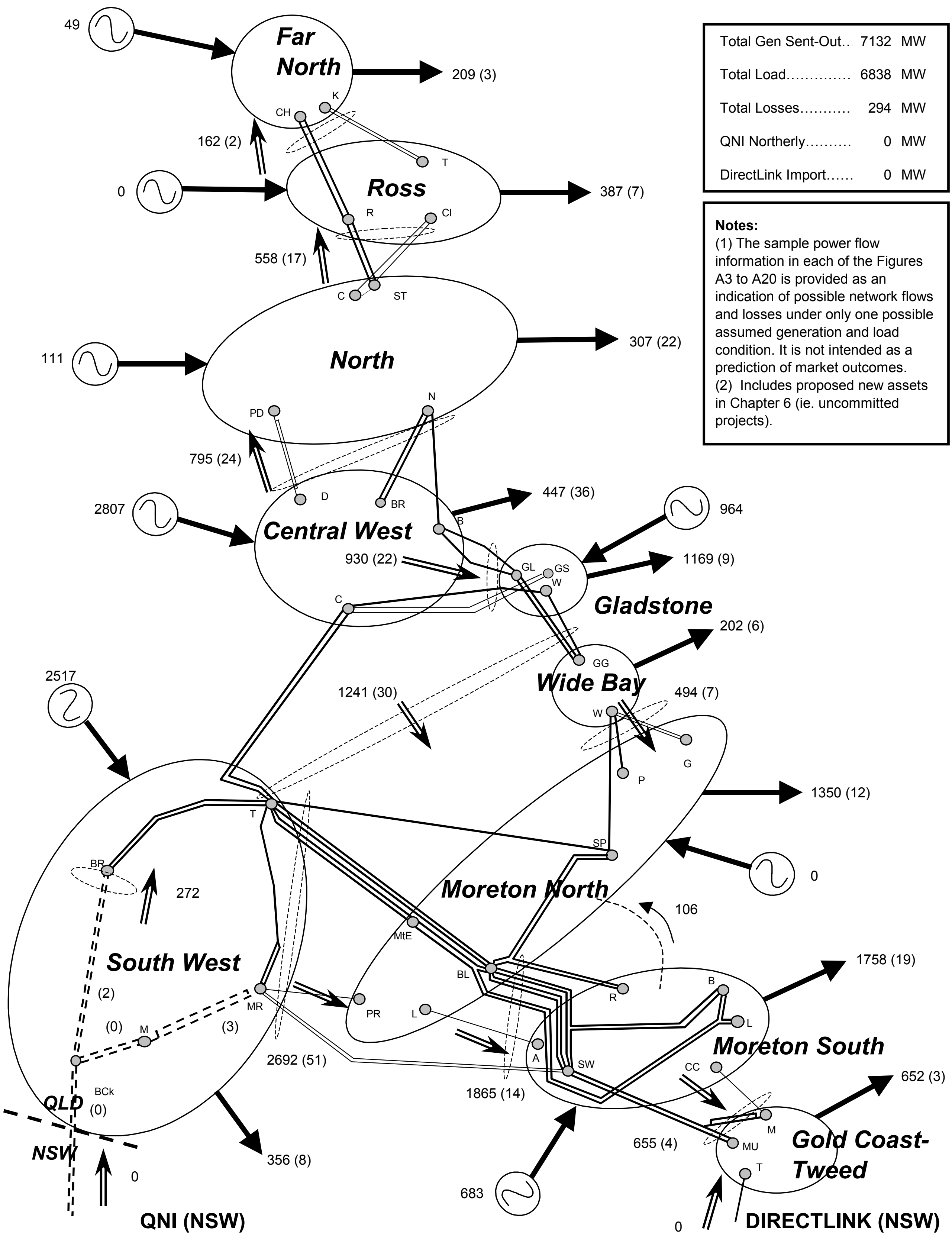
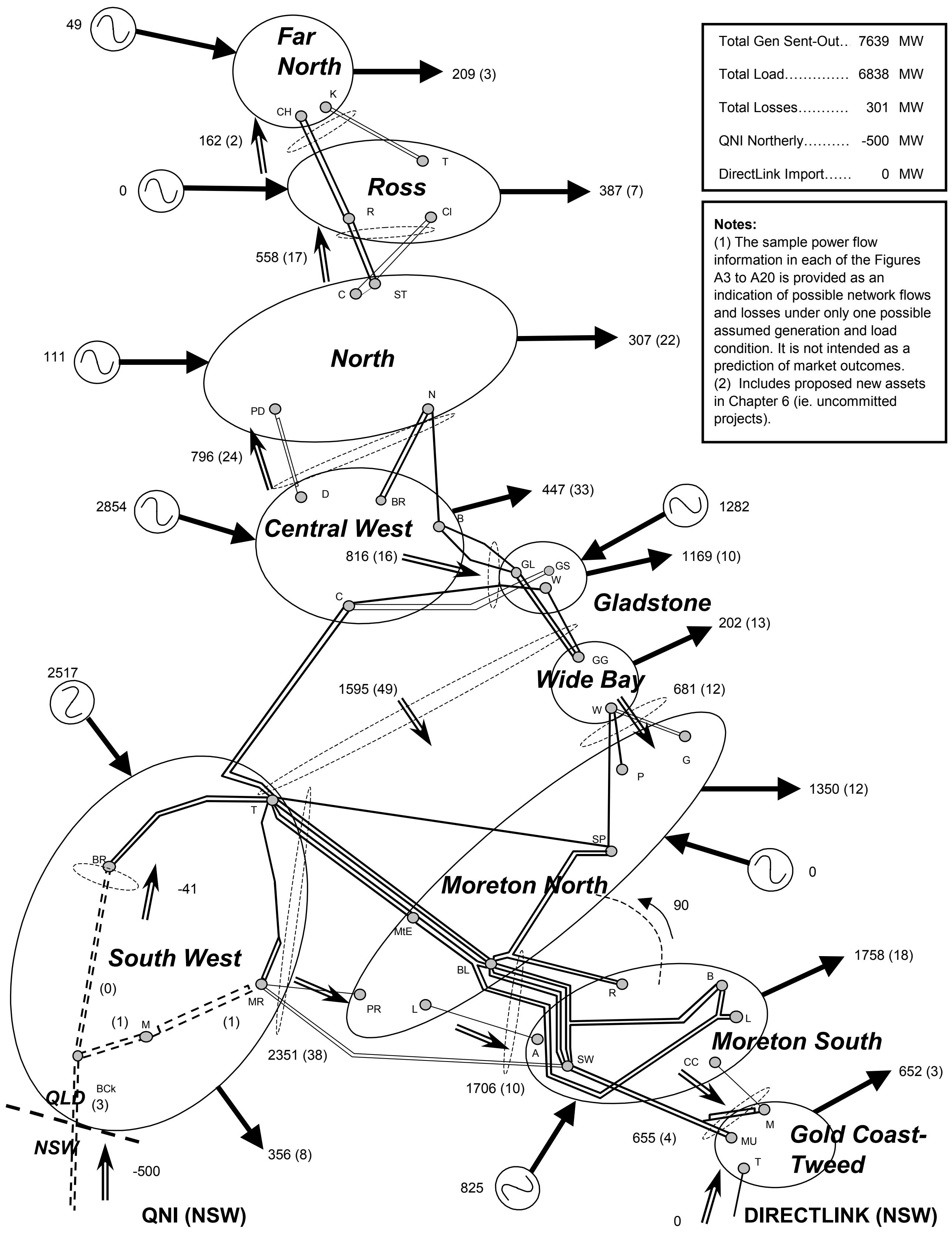


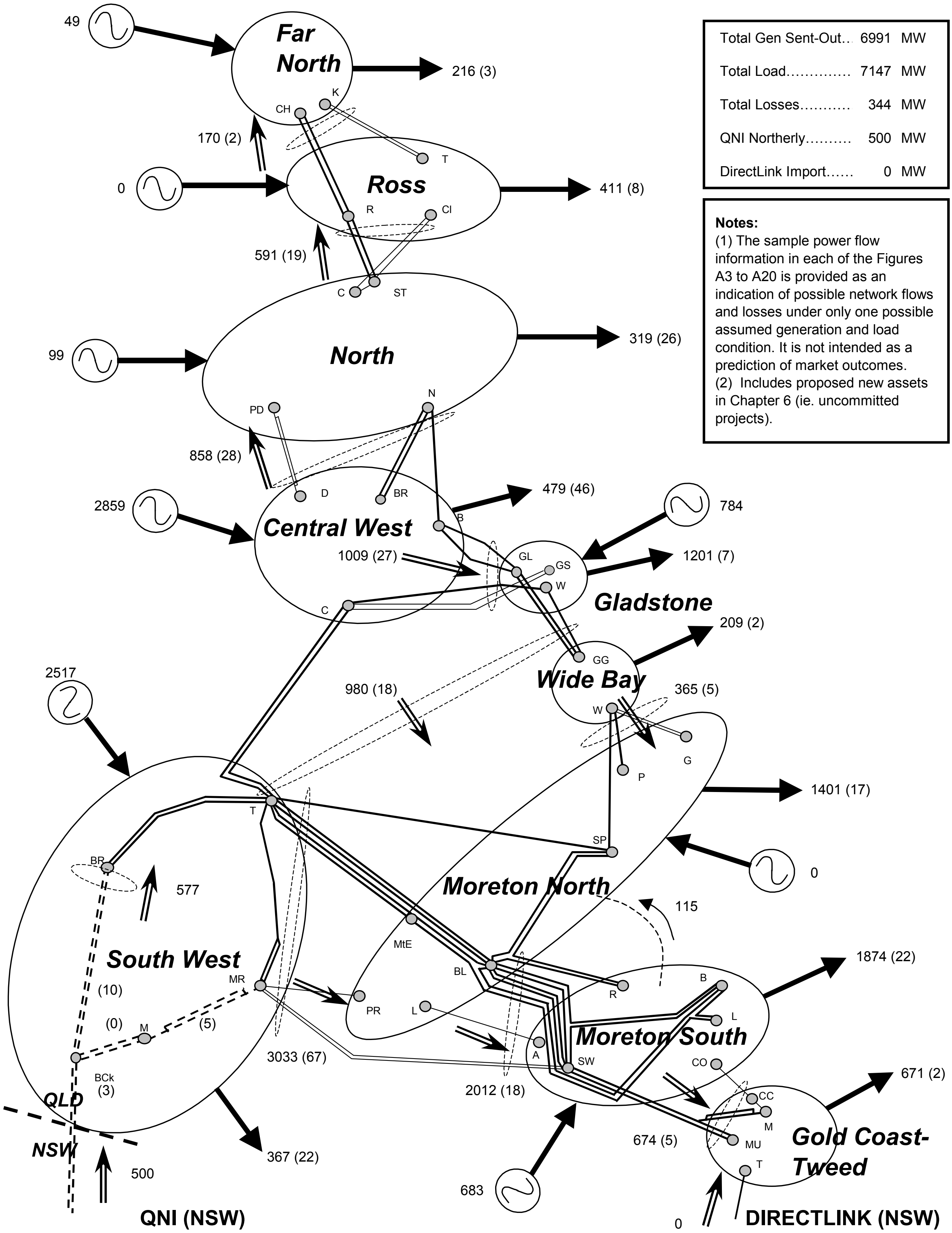
Figure A.8: Winter 2005 Qld Peak 500MW Southerly QNI Flow



Total Gen Sent-Out..	7639	MW
Total Load.............	6838	MW
Total Losses...........	301	MW
QNI Northerly..........	-500	MW
DirectLink Import......	0	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

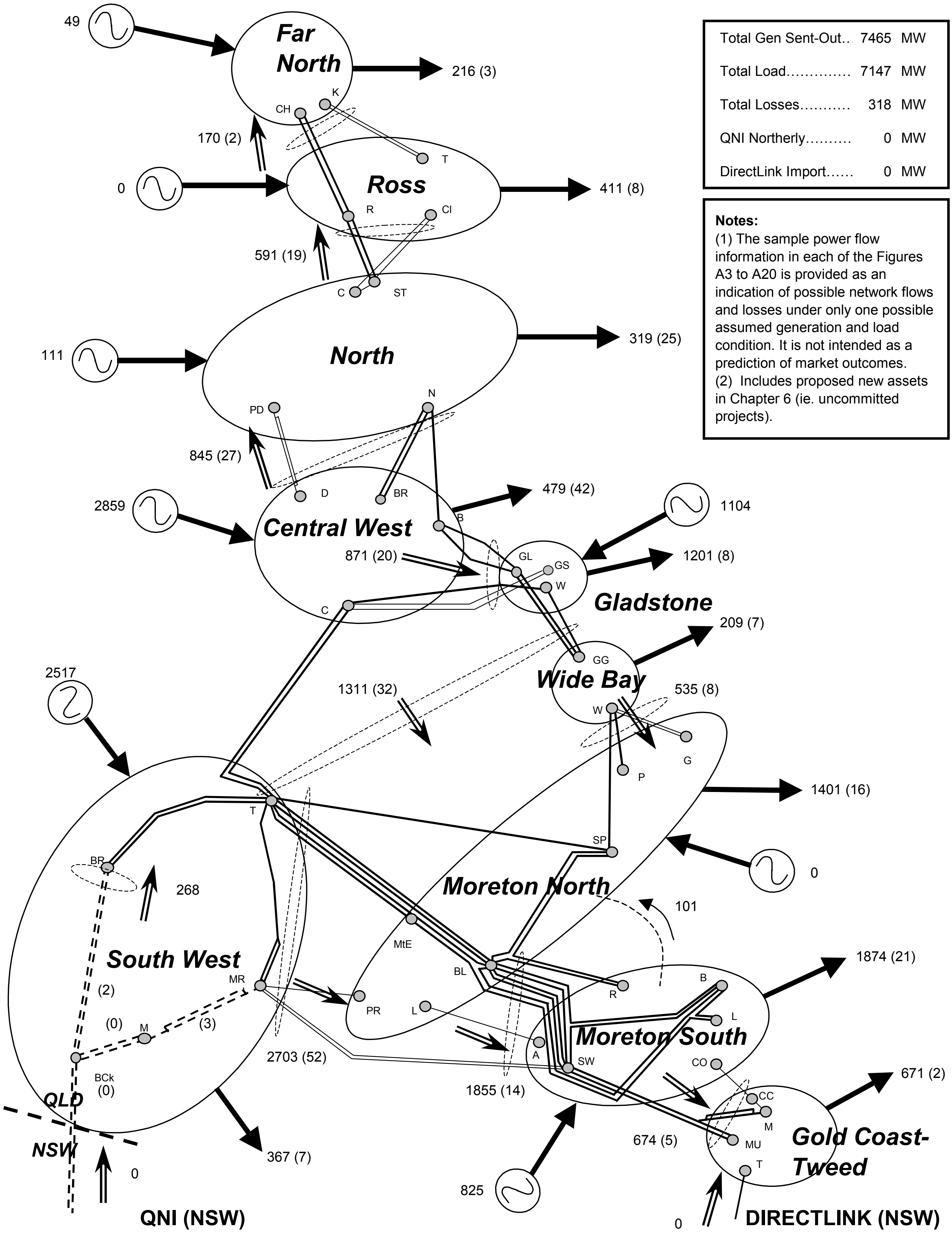
Figure A.9: Winter 2006 Qld Peak 500MW Northerly QNI Flow



Total Gen Sent-Out…	6991	MW
Total Load…………..	7147	MW
Total Losses………..	344	MW
QNI Northerly……….	500	MW
DirectLink Import……	0	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

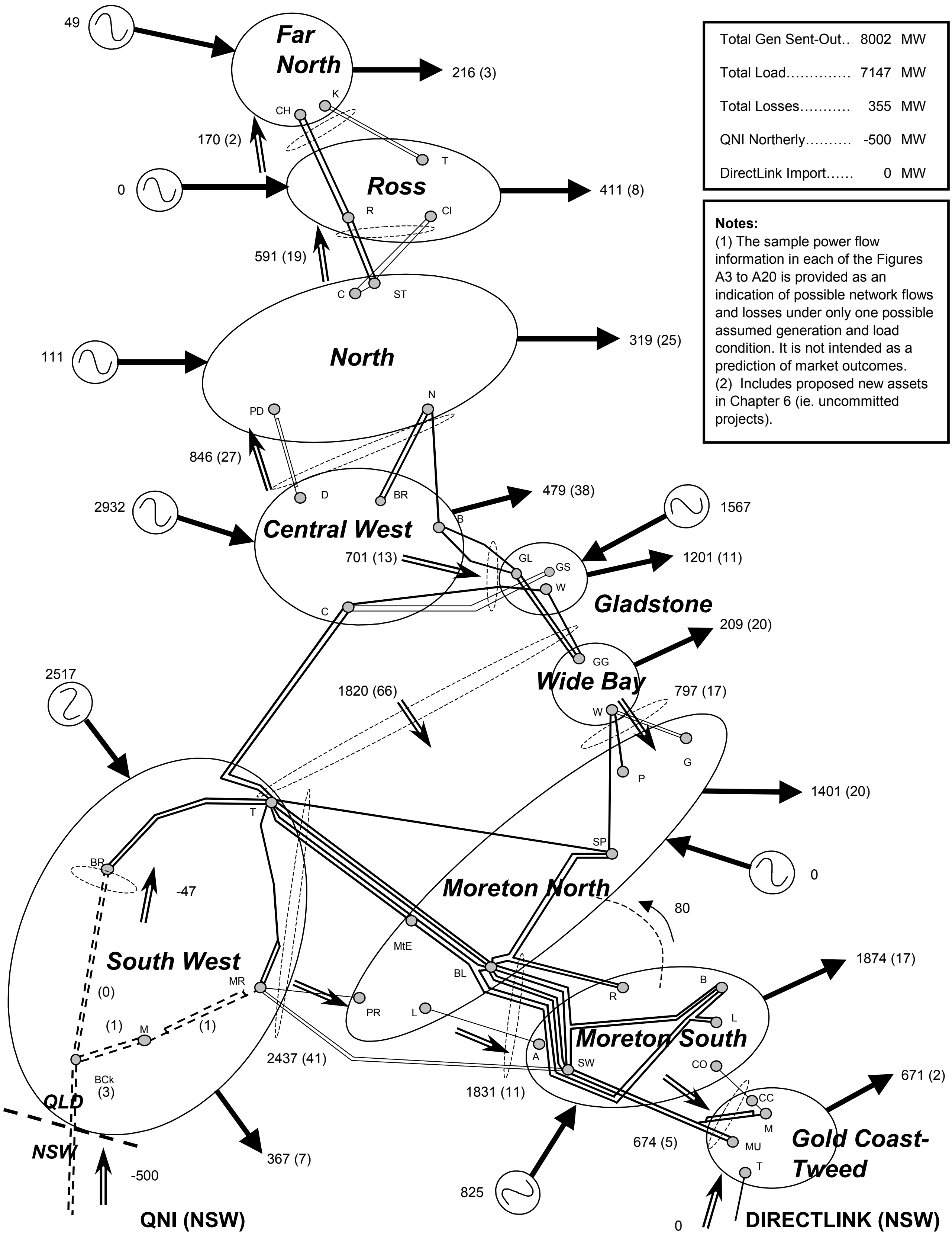
Figure A.10: Winter 2006 Qld Peak Zero QNI Flow



Total Gen Sent-Out…	7465	MW
Total Load…………..	7147	MW
Total Losses………..	318	MW
QNI Northerly……….	0	MW
DirectLink Import……	0	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

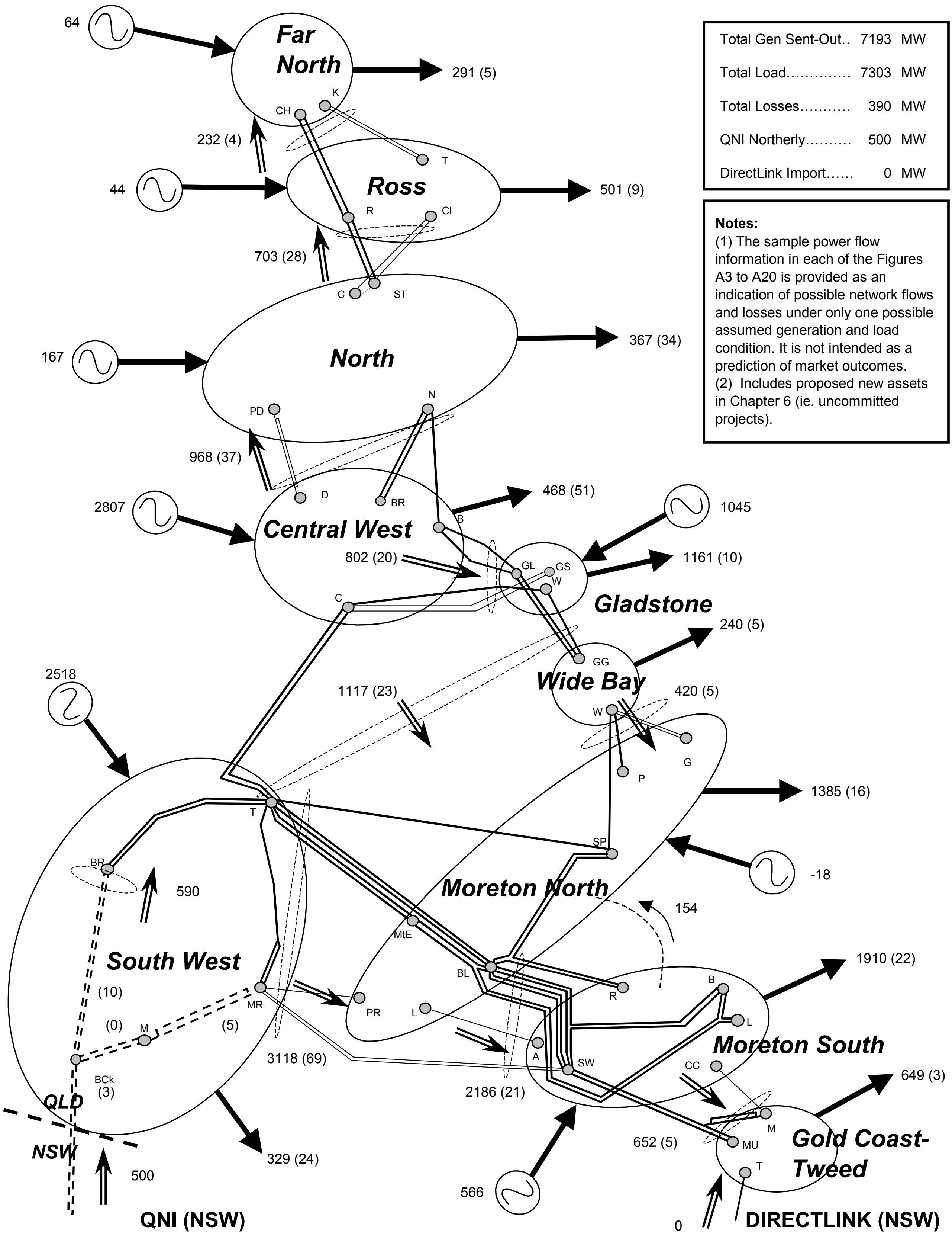
Figure A.11: Winter 2006 Qld Peak 500MW Southerly QNI Flow



Total Gen Sent-Out...	8002	MW
Total Load..............	7147	MW
Total Losses...........	355	MW
QNI Northerly..........	-500	MW
DirectLink Import......	0	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

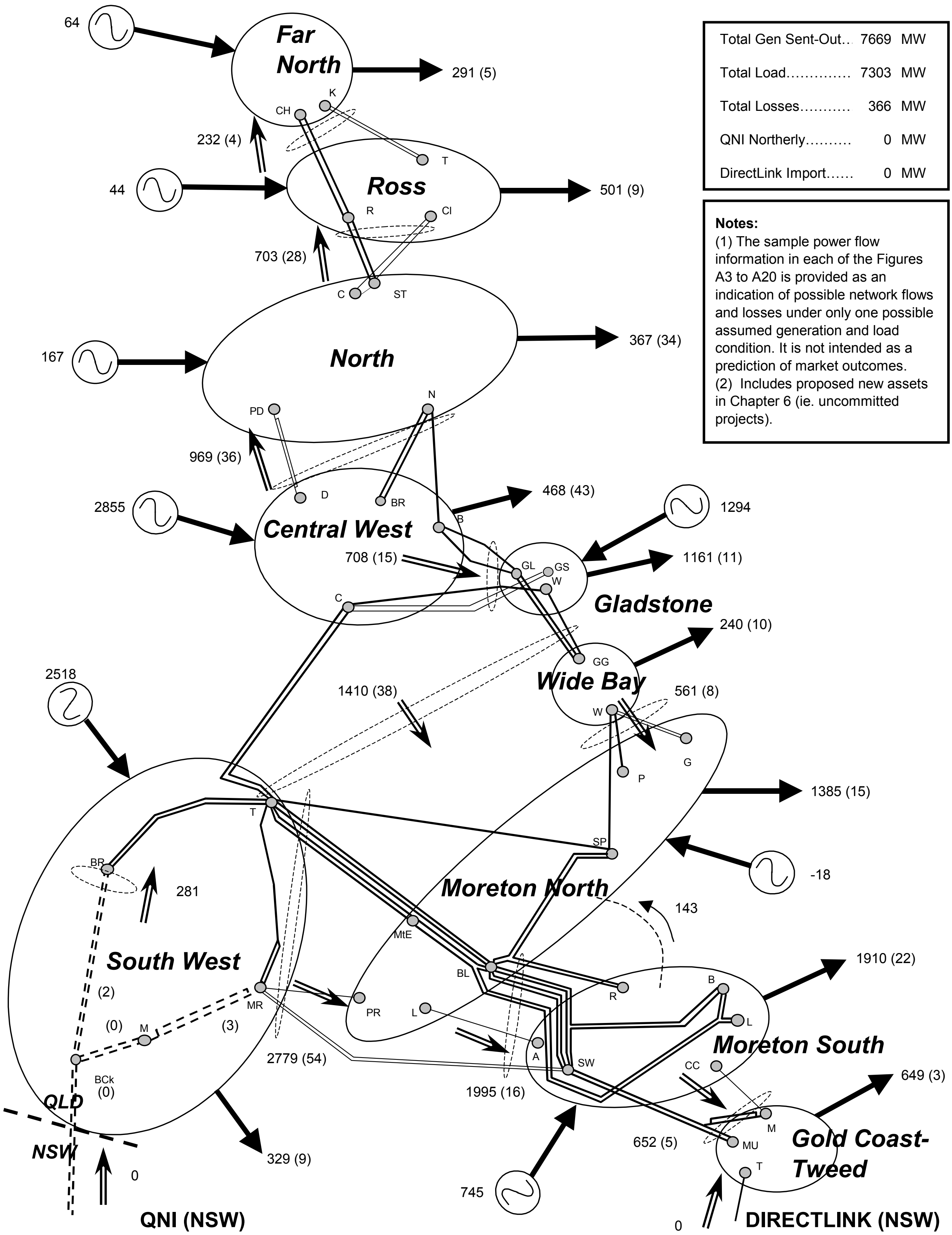
Figure A.12: Summer 2004/05 Qld Peak 500MW Northerly QNI Flow



Total Gen Sent-Out...	7193	MW
Total Load..............	7303	MW
Total Losses...........	390	MW
QNI Northerly..........	500	MW
DirectLink Import......	0	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

Figure A.13: Summer 2004/05 Qld Peak Zero QNI Flow



Total Gen Sent-Out…	7669	MW
Total Load………….	7303	MW
Total Losses………..	366	MW
QNI Northerly……….	0	MW
DirectLink Import……	0	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

Figure A.14: Summer 2004/05 Qld Peak 500MW Southerly QNI Flow

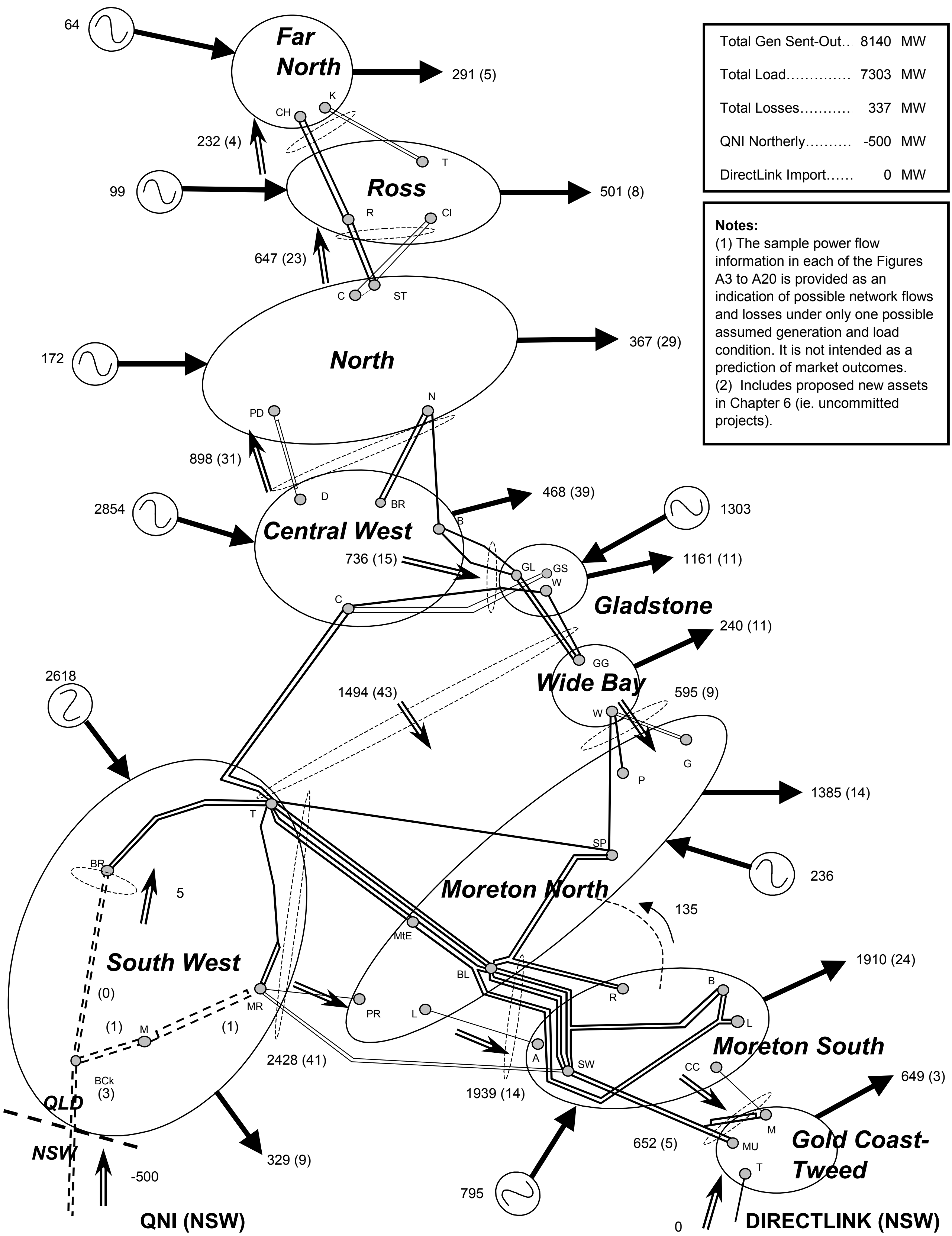
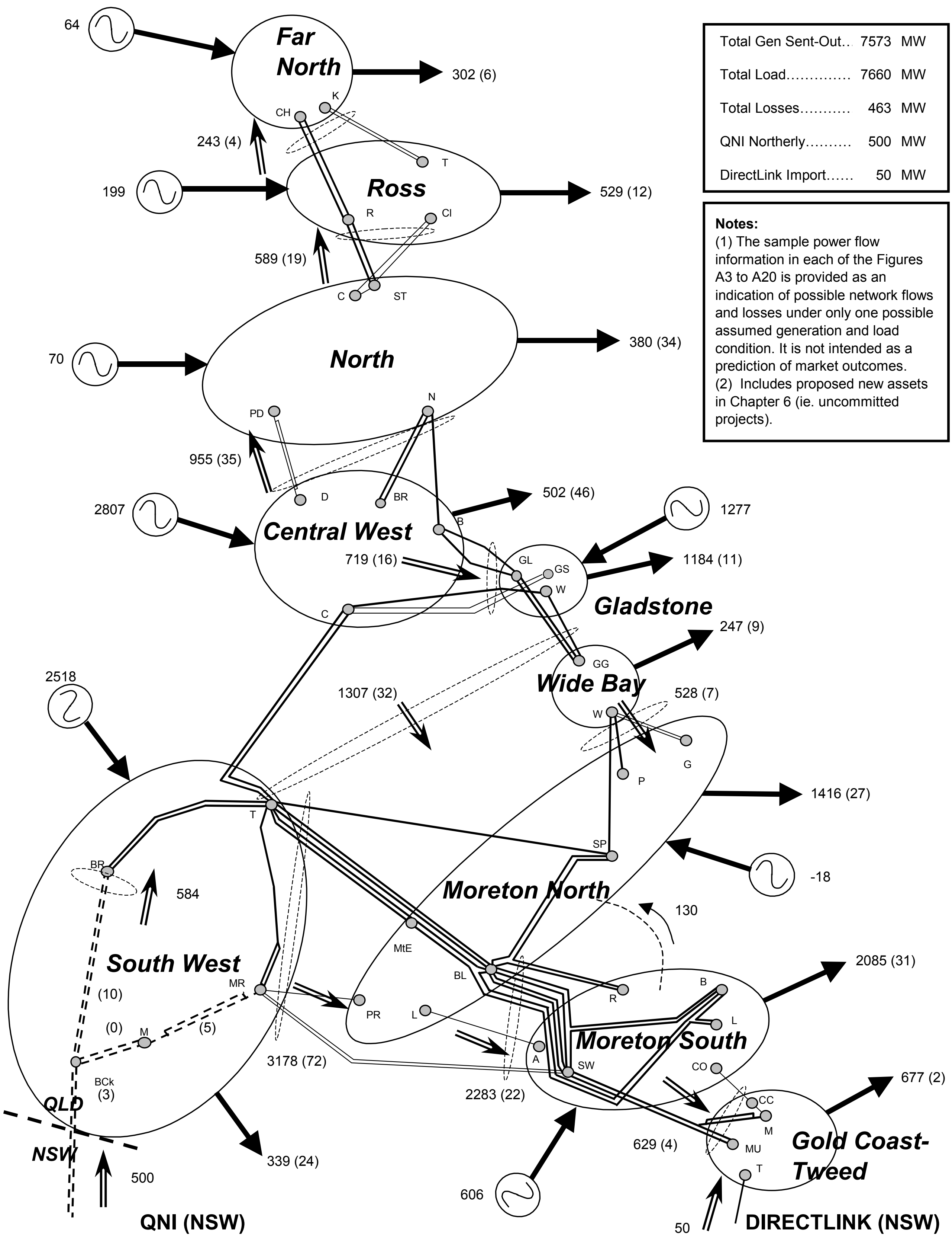


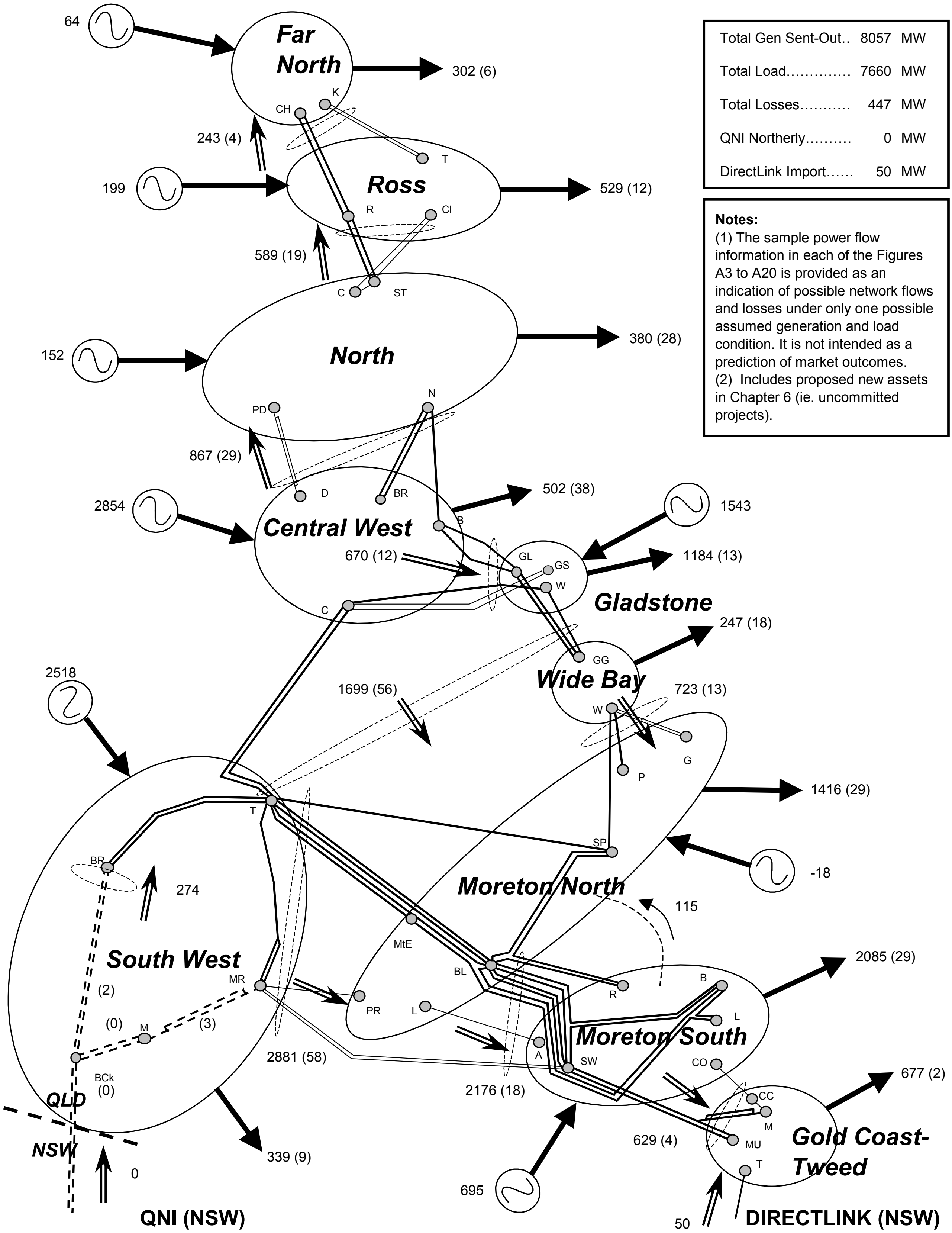
Figure A.15: Summer 2005/06 Qld Peak 500MW Northerly QNI Flow



Total Gen Sent-Out...	7573	MW
Total Load..............	7660	MW
Total Losses...........	463	MW
QNI Northerly..........	500	MW
DirectLink Import......	50	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

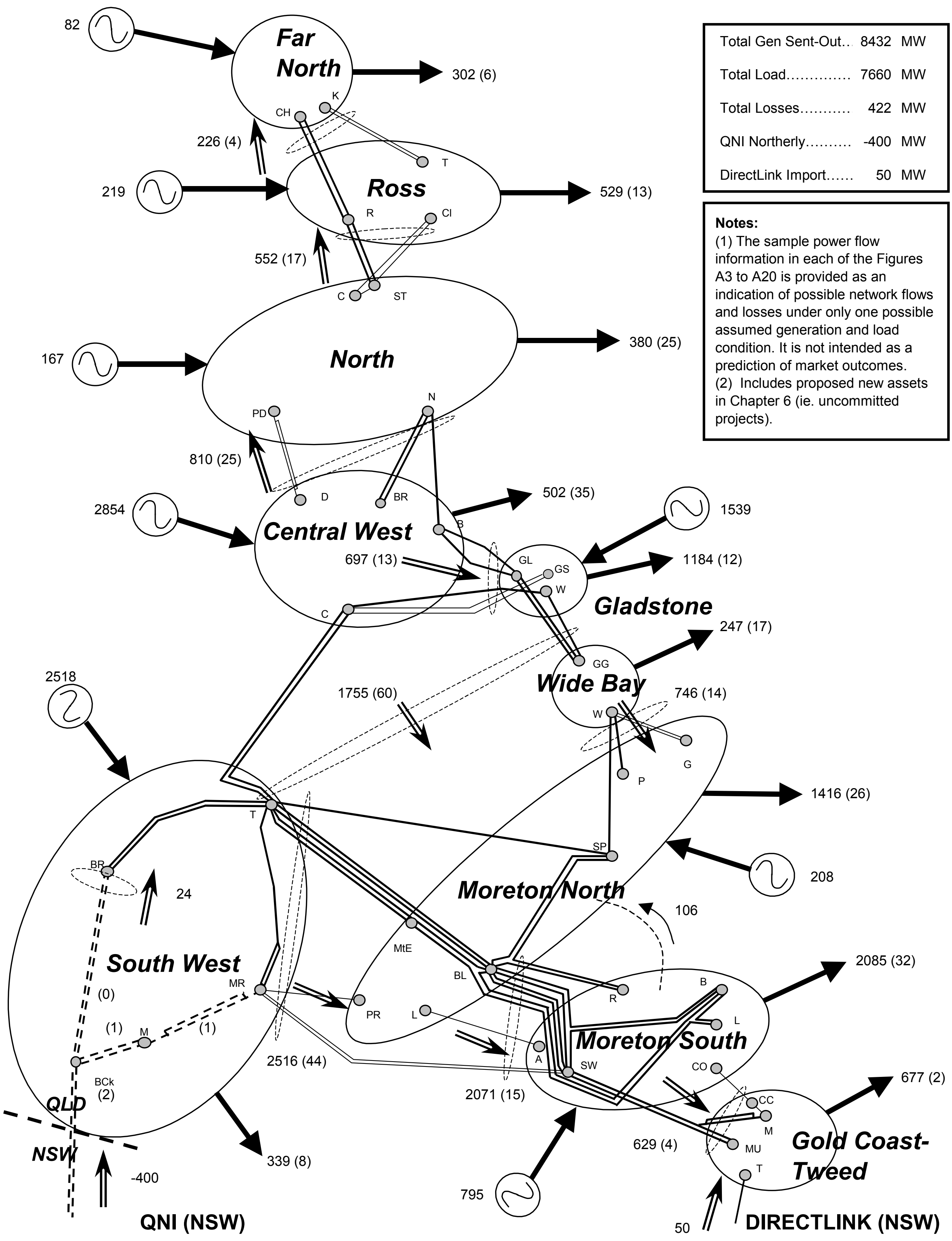
Figure A.16: Summer 2005/06 Qld Peak Zero QNI Flow



Total Gen Sent-Out…	8057 MW
Total Load……………	7660 MW
Total Losses………..	447 MW
QNI Northerly……….	0 MW
DirectLink Import……	50 MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

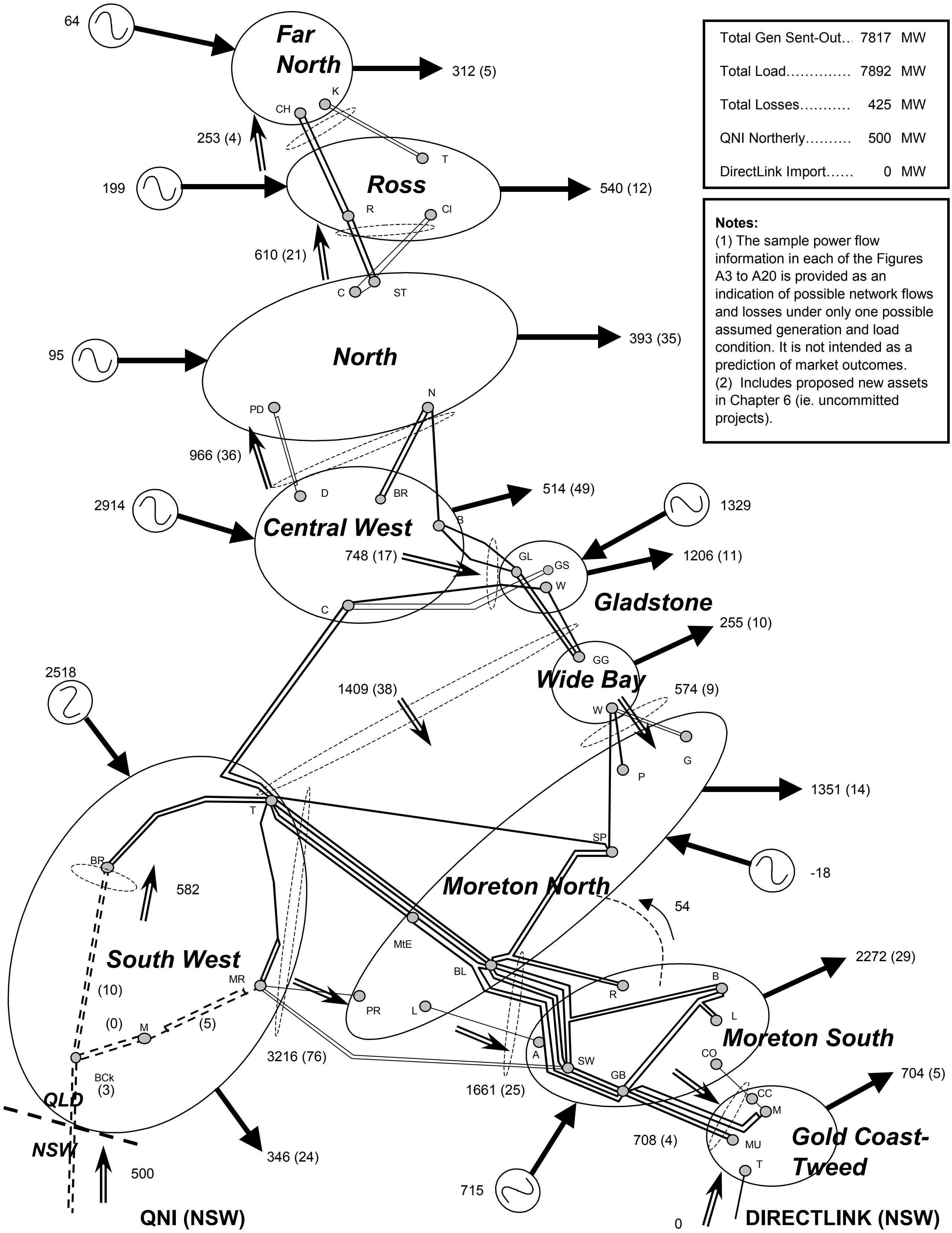
Figure A.17: Summer 2005/06 Qld Peak 400MW Southerly QNI Flow



Total Gen Sent-Out..	8432	MW
Total Load..............	7660	MW
Total Losses...........	422	MW
QNI Northerly..........	-400	MW
DirectLink Import......	50	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

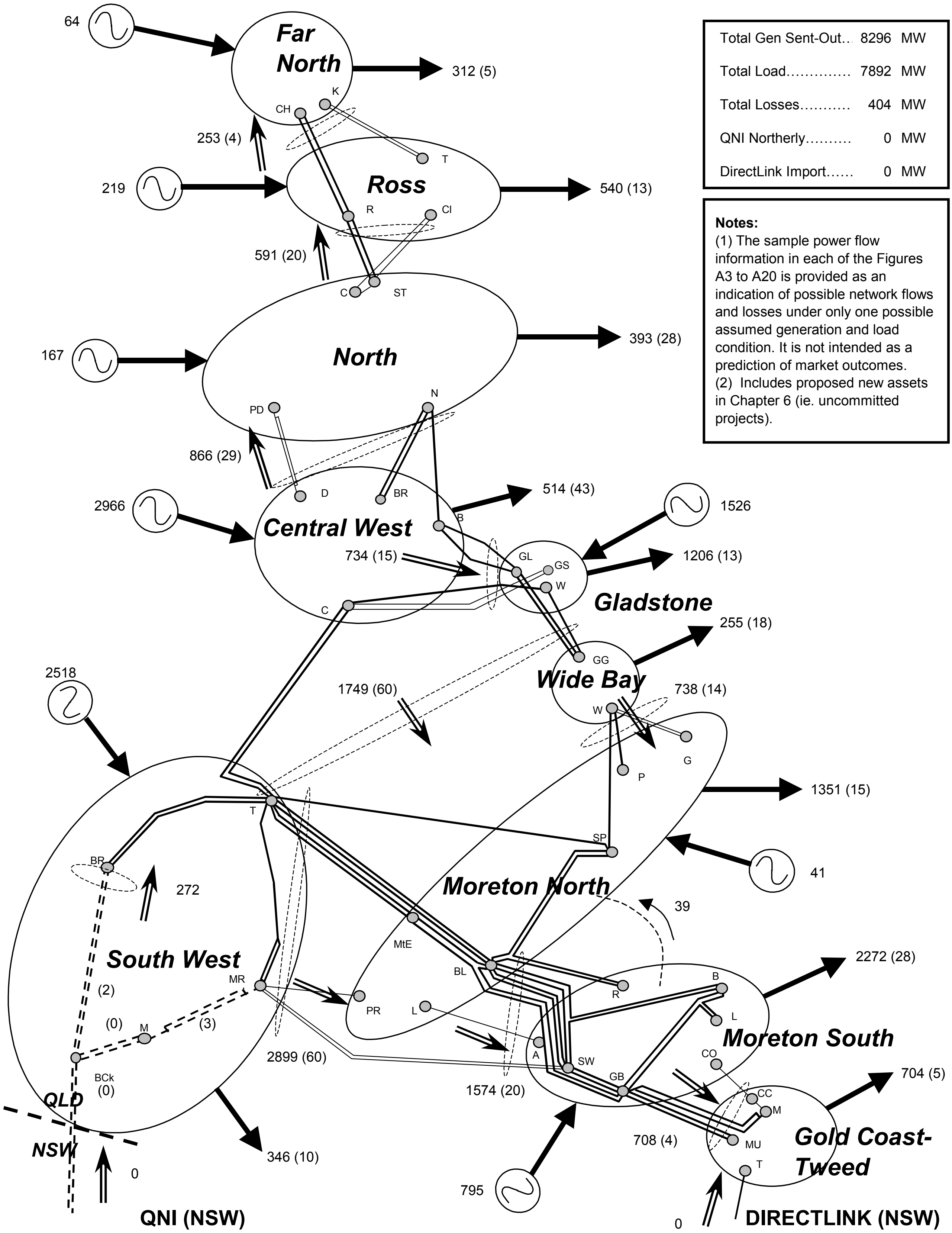
Figure A.18: Summer 2006/07 Qld Peak 500MW Northerly QNI Flow



Total Gen Sent-Out…	7817	MW
Total Load………….	7892	MW
Total Losses………..	425	MW
QNI Northerly……….	500	MW
DirectLink Import……	0	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

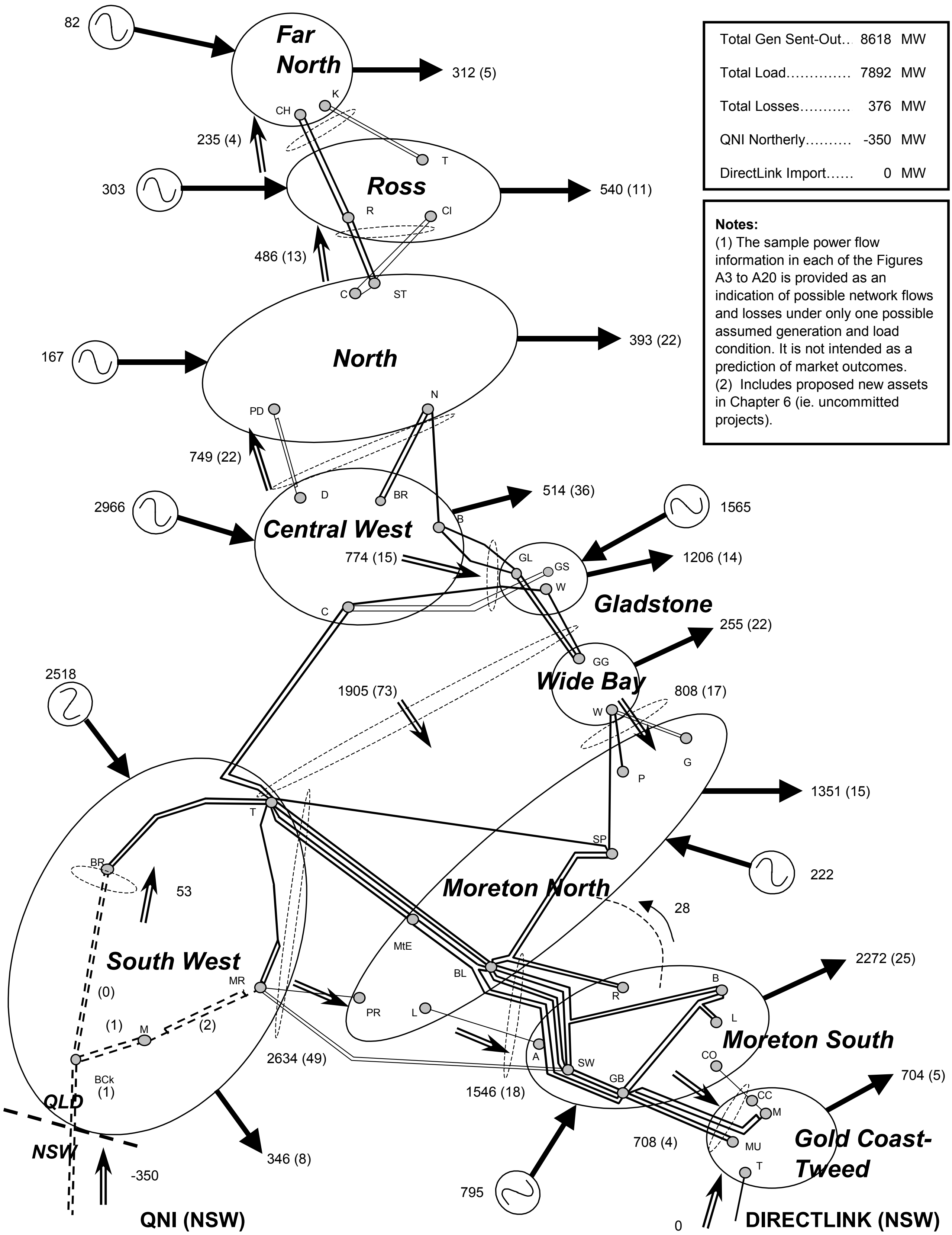
Figure A.19: Summer 2006/07 Qld Peak Zero QNI Flow



Total Gen Sent-Out...	8296	MW
Total Load..............	7892	MW
Total Losses...........	404	MW
QNI Northerly..........	0	MW
DirectLink Import......	0	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

Figure A.20: Summer 2006/07 Qld Peak 350MW Southerly QNI Flow



Total Gen Sent-Out...	8618	MW
Total Load..............	7892	MW
Total Losses...........	376	MW
QNI Northerly..........	-350	MW
DirectLink Import......	0	MW

Notes:
(1) The sample power flow information in each of the Figures A3 to A20 is provided as an indication of possible network flows and losses under only one possible assumed generation and load condition. It is not intended as a prediction of market outcomes.
(2) Includes proposed new assets in Chapter 6 (ie. uncommitted projects).

8.2 Appendix B – Limit Equations

Note: Limit Equations are valid at time of publication of this Annual Planning Report. The equations are continually under review and are revised from time to time to take account of changing market, climatic and network conditions.

Please contact Powerlink to confirm the latest form of the relevant limit equation.

Table B.1: Far North Queensland Voltage Stability Equations

Measured Variable	Coefficient	
	Equation 1 Chalumbin-Woree Contingency	Equation 2 Ross-Chalumbin Contingency
Constant Term (Intercept)	221.9	252.0
Total generation at Barron Gorge PS	-0.5941	-0.626
Number of Barron Gorge units on-line (generating)	14.2359	11.2428
Number of Barron Gorge units on-line (synchronous condenser)	24.5456	17.3656
Total MW generation at Kareeya PS (Units 1-5)	-1.0201	-0.7917
4 Kareeya units on-line (0 or 1) (excl K5)	28.69	26.9103
3 Kareeya units on-line (0 or 1) (excl K5)	21.51	18.2581
2 Kareeya units on-line (0 or 1) (excl K5)	14.20	9.4847
1 Kareeya unit on-line (0 or 1) (excl K5)	6.35	0
Total MW generation at Collinsville PS	0	0.0245
Total MW generation at Mt Stuart PS	0	0.0058
Number of Mt Stuart units on-line (0,1 or 2)	0	1.8413
Total MW generation at Townsville PS	0	0.0194
Number of Townsville units on-line	0	1.6650
Sum of Innisfail on-line nominal MVAr 132kV	0.2708	0.4219
Sum of Cairns on-line nominal MVAr 132kV	0.3732	0.4595
Availability of H32 Chalumbin 50MVAr Cap Bank to be switched (0 to 1)	0	18.305
Sum of Chalumbin reactors on-line nominal MVAr (0 to negative value)	0.0605	0

Table B.2: Central to North Queensland Dynamic Stability Equation

Measured Variable	Coefficient
Constant Term (Intercept)	985
Number of Barron and Kareeya units on-line in sync cond mode	-10

Note:
At the time of publication of this report the CQ-NQ transfer was limited to a maximum of 975MW due to disconnection of filter components at the Nebo SVC.

Table B.3: Central to South Queensland Voltage Stability Equations

Measured Variable	Coefficient	
	Equation 1 (1) Calvale-Tarong Contingency	**Equation 2** (2) Calvale-Tarong Contingency
Constant Term (Intercept)	1227.3	1217.2
Total generation at Gladstone 275kV PS	0.0731	0.0812
Number of Gladstone 275kV units on-line	72.2846	70.3649
Total generation at Gladstone 132kV PS	0.1062	0.1152
Number of Gladstone 132kV units on-line	75.8105	73.3362
Number of Callide B units on-line	47.7783	54.0629
Number of Callide C units on-line	74.2664	86.2947
(Calvale 275kV p.u. voltage – 1.07) x 1000	1.1843	0.8860
(Gladstone 275kV p.u. voltage – 1.07) x 1000	-1.5421	-1.5181
Equation Lower Limit	1750	1750
Equation Upper Limit (Transient instability threshold)	1900	1900

Note:
(1) Equation that preserves the required MVAr margin at Gladstone 275kV.
(2) Equation that preserves the required MVAr margin at Calvale 275kV.

Table B.4: Tarong Voltage Stability Equations

Measured Variable	Coefficient Equation 1 Calvale-Tarong Contingency	Equation 2 Woolooga-Palmwoods Contingency	Equation 3 Tarong-Blackwall Contingency	Equation 4 Mt England-Loganlea Contingency
Constant Term (Intercept)	1533.9	1648.0	1696.6	1704.6
Power transfer on QNI (MW – positive is into Qld)	0.5051	0.4611	0.4475	0.4528
DirectLink power transfer (MW – positive is into Qld)	-0.2064	-0.2218	-0.2172	-0.2189
DirectLink reactive power (MVAr – positive is into Qld)	0.2881	0.3277	0.3499	0.3897
DirectLink ancilliary service	55.000	55.000	55.000	55.000
Number of Swanbank B units on-line	11.8453	12.4719	13.6696	14.9573
Number of Swanbank E units on-line	41.1882	45.9784	48.3734	48.2347
Total generation at Roma PS	0.5102	0.4794	0.4682	0.4658
Total generation at Gladstone PS (H7 and T5)	-0.0496	-0.0517	-0.0494	-0.0497
Total generation at Tarong PS & Tarong North	0.5588	0.5186	0.4959	0.4952
Total generation at Wivenhoe PS	-0.3758	-0.4164	-0.4217	-0.4418
Total generation at Callide PS (A, B and C)	0.1024	0.1010	0.0951	0.0974
Total generation at Swanbank (B and E)	-0.3647	-0.3921	-0.4002	-0.4182
Total generation at Oakey PS	0.6185	0.5865	0.5614	0.5590
Total generation at Millmerran PS	0.4866	0.4435	0.4319	0.4359
Number of Wivenhoe synchronous condensors units on-line	33.2422	39.3679	39.3731	36.3414
Number of Wivenhoe units on-line as generators	27.4910	33.5073	32.3801	30.8037

Table B.5: Gold Coast Voltage Stability Equation

Measured Variable	Coefficient Swanbank-Mudgeeraba Contingency
Constant Term (Intercept)	455.32
Number of Wivenhoe units on-line	5.9757
Number of Swanbank B units on-line	5.5384
Number of Swanbank E units on-line	18.4529
DirectLink power transfer at Mullimbimby (MW positive is into Qld)	-0.7469
DirectLink reactive power at Bungalora (MVAr positive is into Qld)	0.3563
Number of Palmwoods 110kV Cap Banks available	1.6243
Number of South Pine 275kV Cap Banks available	4.6178
Number of South Pine 110kV Cap Banks available	2.6021
Number of Rocklea 110kV Cap Banks available	3.4356
Number of Belmont 275kV Cap Banks available	7.8884
Number of Belmont 110kV Cap Banks available	5.0531
Number of Blackwall 275kV Cap Banks available	7.8316
Number of Mudgeeraba 275kV Cap Banks available	22.3571
Number of Mudgeeraba 110kV Cap Banks available	12.6893
Number of Loganlea 110kV Cap Banks available	5.8353
Number of Mt England 275kV Cap Banks available	3.0938

Table B.6: Braemar Thermal and Voltage Stability Equation

Measured Variable	Coefficient
Constant Term (Intercept)	1125
Off-set If [total unavailability of southern Queensland capacitive support (including generator lagging capability and 275kV and 110kV capacitor banks)] $\geq$ 820MVAr	-100

Table B.7: Prediction of Post Contingent Flow on the Calvale-Wurdong Circuit

Measured Variable	Coefficient
System normal flow on Calvale-Wurdong (MVA)	1
System normal flow on Calvale-Stanwell (MW)	0.652

8.3 Appendix C – Estimated Maximum Short Circuit Levels

Tables C.1 to C.3 show estimates of the three phase and single phase to earth short circuit levels in the Powerlink transmission network in the period 2004 to 2006. They also show the short circuit interruption capacity of the lowest rated circuit breaker(s) at each location.

This information should be taken only as an approximate guide to conditions at each location. The impacts of some of the more significant embedded non-scheduled generators are included as noted in the tables. However, other embedded non-scheduled generators have been excluded. Some of these excluded generators are also noted in the tables. As a result, fault levels may be higher at some locations than shown. Interested parties needing to consider the effects of their proposals on system short circuit levels should consult Powerlink and/or the relevant Distribution Network Service Provider for detailed information.

The short circuit level calculations were determined:

- using a simple system model, in which generators are represented as a voltage source of 110% of nominal voltage behind sub-transient reactance; and
- with system loads and all shunt admittances not represented.

The short circuit levels shown in Tables C.1 to C.3 have been determined on the basis of the generation capacity shown in Table 7.1 (together with any noted embedded non-scheduled generators) and on the network development as at the end of each calendar year. These network models are based on the existing network configuration, committed projects and proposed new network assets (as proposed in Chapter 6).

The fault levels determined assume the grid is in its 'normal' or 'intact' state, that is, all network elements in service. Exceptions to this include potential open points at Belmont 110kV, South Pine 110kV, Swanbank 110kV and Gladstone South 132kV substations. These open points may be necessary to keep the maximum short circuit level below the critical circuit breaker ratings. These open points have been taken into account in the estimates in Tables C.1 to C.3.

At some locations where the short circuit level appears to be above the switchgear rating, the critical switchgear is required to interrupt only a portion of the total fault current, and that portion is less than the switchgear rating over the three year outlook period.

No account has been taken of short circuit interruption capability of switchgear in the distribution systems.

Table C.1: Estimated Maximum Short Circuit Levels – Southern Queensland

In Powerlink Transmission Network 2004 to 2006 (1)

Location	Voltage kV	Lowest Switchgear Rating (kA) (2)	3 Phase kA			Single Phase (kA)		
			2004	2005	2006	2004	2005	2006
Abermain	110.0	31.5	13.54	13.55	13.56	13.05	13.62	13.75
Algester	110.0	40.0	-	-	18.15	-	-	16.35
Ashgrove West	110.0	25.0	18.89	19.05	18.91	18.42	18.20	17.67
Belmont	275.0	31.5	14.86	14.87	15.66	15.09	15.07	16.48
Belmont (3) (4)	110.0	25.0	23.51	23.65	23.82	27.78	27.82	28.65
Blackwall	275.0	50.0	21.45	21.44	21.58	23.50	23.52	23.80
Braemar	330.0	50.0	10.51	10.49	10.49	10.06	10.05	10.06
Braemar	275.0	50.0	12.58	12.56	12.56	12.37	12.36	12.37
Bulli Creek	330.0	50.0	12.66	12.59	12.60	10.94	11.00	11.00
Bulli Creek	132.0	40.0	3.57	3.57	3.57	4.05	4.05	4.05
Bundamba	110.0	40.0	-	12.41	12.42	-	11.01	11.09
Goodna	110.0	40.0	-	-	13.88	-	-	11.47
Greenbank	275.0	40.0	-	-	18.25	-	-	18.50
Loganlea	275.0	50.0	12.06	12.07	13.65	11.94	11.94	13.64
Loganlea	110.0	25.0	20.05	20.11	20.94	22.68	22.74	23.73
Middle Ridge	330.0	NO CB	9.83	9.82	9.82	9.32	9.32	9.38
Middle Ridge	275.0	40.0	11.23	11.22	11.23	11.17	11.18	11.26
Middle Ridge	110.0	26.2	18.05	18.05	18.05	20.64	20.69	21.00
Millmerran Switch Yard	330.0	50.0	13.58	13.55	13.55	15.47	15.45	15.46
Molendinar	275.0	40.0	7.56	7.57	10.94	7.25	7.29	8.58
Mt England	275.0	31.5	20.66	20.65	20.96	20.85	20.89	21.20
Mudgeeraba	275.0	31.5	7.51	7.52	8.49	7.80	7.93	8.52
Mudgeeraba	110.0	19.3	13.26	13.30	15.08	16.19	16.62	18.43
Murarrie	275.0	40.0	-	-	10.48	-	-	10.90

Location	Voltage kV	Lowest Switchgear Rating (kA) (2)	3 Phase kA			Single Phase (kA)		
			2004	2005	2006	2004	2005	2006
Murarrie	110.0	25.0	15.50	18.43	21.64	15.05	17.24	22.75
Oakey	110.0	40.0	10.14	10.14	10.14	11.10	11.10	11.10
Palmwoods	275.0	31.5	8.07	8.07	8.07	7.99	7.99	8.02
Palmwoods	132.0	21.8	12.39	12.38	12.39	14.46	14.45	14.51
Palmwoods	110.0	NO CB	5.52	5.52	5.52	5.81	5.81	5.82
Redbank Plains	110.0	31.5	14.49	14.51	14.52	12.15	12.27	12.62
Richlands	110.0	18.3	11.33	11.32	13.42	11.53	11.53	13.52
Rocklea	275.0	40.0	12.60	12.59	12.63	11.38	11.38	11.46
Rocklea	110.0	40.0	21.77	21.74	21.86	24.86	24.80	24.94
Runcorn	110.0	21.9	14.50	14.52	16.85	14.17	14.18	16.44
South Pine	275.0	31.5	17.81	17.81	17.84	18.03	18.53	18.56
South Pine (3)(4)	110.0	25.0	22.82	23.84	23.82	25.83	27.67	27.64
Sumner	110.0	40.0	-	-	15.17	-	-	14.17
Swanbank A (3)	110.0	18.3	16.07	16.09	16.11	14.18	14.31	14.42
Swanbank B	275.0	31.5	20.39	20.38	20.84	23.59	23.60	24.15
Swanbank E	275.0	40.0	19.88	19.87	20.40	22.58	22.59	23.27
Tangkam	110.0	40.0	11.87	11.87	11.87	11.07	11.07	11.07
Tarong	275.0	31.5	27.58	27.55	27.60	29.88	29.86	29.91
Tarong	132.0	31.5	5.15	5.15	5.15	5.51	5.51	5.52
Tarong	66.0	21.9	13.84	13.84	13.84	15.20	15.20	15.20
Tennyson	110.0	40.0	14.51	14.49	14.55	14.18	14.16	14.26
Upper Kedron	110.0	40.0	21.13	21.37	21.28	17.50	17.55	17.41
West Darra	110.0	19.3	16.88	16.93	16.93	12.23	12.30	12.73
Woolooga	275.0	31.5	9.15	9.13	9.15	8.37	8.36	8.37
Woolooga	132.0	21.9	12.42	12.40	12.42	13.22	13.21	13.23

Notes:

(1) Short circuit levels are estimated maximum levels assuming 110% of nominal voltage behind sub-transient reactance, neglecting loads, shunt admittances and other passive elements.

(2) Powerlink switchgear ratings – no account taken of distribution switchgear.

(3) Analysis for these locations allows for operation with open points to keep short circuit levels below switchgear ratings.

(4) The lowest rated circuit breaker(s) at these locations are required to interrupt short circuit current which is less than the maximum fault current and below the circuit breaker rating.

Also note that:

(5) Fault level contributions to the Powerlink network from sugar mills, other than Invicta and Rocky Point, are not included in these tables.

(6) Fault level contributions to the Powerlink network from embedded non-scheduled generators, other than Bulwer Island (BIEP) and Queensland Nickel, are not included in these tables. Excluded generators include, but may not be limited to, Windy Hill wind generators, Wivenhoe small hydro generator, Stapylton biomass, and possible Moranbah coal seam methane gas turbines.

Table C.2: Estimated Maximum Short Circuit Levels – Central Queensland

In Powerlink Transmission Network 2004 to 2006 (1)

Location	Voltage (kV)	Lowest Switchgear Rating (kA) (2)	3 Phase (kA)			Single Phase (kA)		
			2004	2005	2006	2004	2005	2006
Baralaba	132.0	15.3	4.14	4.14	4.36	3.51	3.52	3.64
Biloela	132.0	12.3	7.55	7.55	8.72	6.49	6.49	7.33
Blackwater	132.0	12.3	3.47	3.47	3.52	4.06	4.12	4.32
Bouldercombe	275.0	31.5	16.23	16.24	16.41	15.85	15.86	15.97
Bouldercombe	132.0	25.0	10.11	10.11	10.21	11.50	11.50	11.58
Broadsound	275.0	31.5	9.09	9.10	9.16	7.04	7.06	7.08
Callemondah	132.0	31.5	20.46	20.46	20.82	20.59	20.59	20.84
Callide A Power Station (3)	132.0	12.3	10.64	10.64	10.05	10.45	10.45	11.14
Calvale	275.0	31.5	19.76	19.77	20.18	22.13	22.13	22.59
Calvale	132.0	NO CB	10.62	10.62	13.04	10.60	10.60	13.59
Dingo	132.0	31.5	2.26	2.26	2.30	2.48	2.48	2.52
Dysart	132.0	19.9	4.00	4.04	4.04	4.64	4.67	4.68
Egans Hill	132.0	NO CB	6.55	6.55	6.59	6.75	6.75	6.78
Gin Gin	275.0	31.5	10.25	10.25	10.29	8.19	8.19	8.21
Gin Gin	132.0	21.9	8.58	8.58	8.59	8.61	8.61	8.62
Gladstone	275.0	31.5	19.34	19.34	19.57	21.81	21.81	22.01
Gladstone (3)(4)	132.0	31.5	25.98	25.98	24.24	31.65	31.65	29.90
Gladstone South	132.0	40.0	16.95	16.95	17.39	16.72	16.73	17.02
Grantleigh	132.0	31.5	2.44	2.44	2.45	2.55	2.55	2.55
Gregory	132.0	31.5	7.54	7.54	7.58	8.83	8.83	8.87
Korenan	132.0	31.5	2.39	2.39	2.39	1.65	1.65	1.65
Lilyvale	275.0	40.0	4.87	4.87	4.90	4.97	4.97	4.99

Location	Voltage (kV)	Lowest Switchgear Rating (kA) (2)	3 Phase (kA)			Single Phase (kA)		
			2004	2005	2006	2004	2005	2006
Lilyvale	132.0	25.0	7.86	7.86	7.91	9.44	9.45	9.50
Moura	132.0	12.3	3.76	3.76	3.97	4.05	4.05	4.22
Norwich Park	132.0	40.0	3.25	3.26	3.27	2.50	2.50	2.50
Rockhampton	132.0	12.3	6.62	6.62	6.66	6.96	6.96	6.99
Rocklands	132.0	40.0	6.19	6.19	6.23	5.58	5.58	5.59
Stanwell Switch Yard	275.0	31.5	17.39	17.41	17.57	19.11	19.13	19.27
Stanwell Switch Yard	132.0	31.5	4.97	4.97	4.99	4.63	4.63	4.64
Wurdong	275.0	31.5	15.55	15.55	15.73	14.89	14.89	15.00

Notes:

(1) Short circuit levels are estimated maximum levels assuming 110% of nominal voltage behind sub-transient reactance, neglecting loads, shunt admittances and other passive elements.

(2) Powerlink switchgear ratings – no account taken of distribution switchgear.

(3) Analysis for these locations allows for operation with open points to keep short circuit levels below switchgear ratings.

(4) The lowest rated circuit breaker(s) at these locations are required to interrupt short circuit current which is less than the maximum fault current and below the circuit breaker rating.

Also note that:

(5) Fault level contributions to the Powerlink network from sugar mills, other than Invicta and Rocky Point, are not included in these tables.

(6) Fault level contributions to the Powerlink network from embedded non-scheduled generators, other than Bulwer Island (BIEP) and Queensland Nickel, are not included in these tables. Excluded generators include, but may not be limited to, Windy Hill wind generators, Wivenhoe small hydro generator, Stapylton biomass, and possible Moranbah coal seam methane gas turbines.

Table C.3: Estimated Maximum Short Circuit Levels – Northern Queensland

In Powerlink Transmission Network 2004 to 2006 (1)

Location	Voltage (kV)	Lowest Switchgear Rating (kA) (2)	3 Phase (kA)			Single Phase (kA)		
			2004	2005	2006	2004	2005	2006
Alan Sherriff	132.0	31.5	9.48	10.17	10.17	10.21	10.90	10.90
Alligator Creek	132.0	31.5	3.42	3.53	3.53	3.96	4.06	4.06
Burton Downs	132.0	19.3	4.31	4.46	4.46	4.31	4.41	4.41
Cairns	132.0	12.1	4.96	4.89	4.89	6.46	6.55	6.55
Cardwell	132.0	19.3	2.63	2.64	2.64	2.08	2.08	2.08
Chalumbin	275.0	21.9	3.23	3.27	3.27	3.51	3.55	3.55
Chalumbin	132.0	31.5	6.30	6.37	6.37	7.31	7.38	7.38
Clare	132.0	8.8	6.23	6.32	6.32	6.04	6.09	6.09
Collinsville	132.0	15.3	10.81	10.90	10.90	11.99	12.06	12.06
Coppabella	132.0	31.5	2.73	2.78	2.78	3.11	3.15	3.15
Dan Gleeson	132.0	31.5	9.05	10.61	10.61	9.70	11.62	11.62
Edmonton	132.0	31.5	4.60	4.81	4.81	5.56	6.06	6.06
Garbutt	132.0	NO CB	8.79	9.41	9.42	9.20	9.75	9.76
Ingham	132.0	15.7	2.76	2.78	2.78	2.28	2.28	2.28
Innisfail	132.0	40.0	4.14	4.20	4.20	4.57	4.62	4.62
Invicta	132.0	19.3	4.67	4.72	4.72	4.34	4.36	4.36
Kamerunga	132.0	15.3	3.83	3.94	3.94	4.59	4.79	4.79
Kareeya	132.0	10.9	6.28	6.35	6.35	7.38	7.45	7.45
Kemmis	132.0	31.5	4.74	4.98	4.99	5.47	5.70	5.70
Mackay	132.0	15.7	4.51	4.63	4.63	5.18	5.29	5.29
Moranbah	132.0	15.3	5.36	5.50	5.51	6.48	6.62	6.62
Moranbah South	132.0	40.0	4.24	4.32	4.33	4.18	4.23	4.23

Location	Voltage (kV)	Lowest Switchgear Rating (kA) (2)	3 Phase (kA)			Single Phase (kA)		
			2004	2005	2006	2004	2005	2006
MT McLaren	132.0	31.5	1.83	1.85	1.85	2.03	2.04	2.04
Nebo	275.0	31.5	6.53	6.58	6.60	7.03	7.23	7.25
Nebo	132.0	21.9	8.34	9.47	9.48	9.41	10.88	10.89
Newlands	132.0	31.5	3.03	3.04	3.04	3.05	3.06	3.06
North Goonyella	132.0	19.3	3.09	3.12	3.12	2.53	2.54	2.54
Oonooie	132.0	31.5	2.56	2.62	2.62	3.02	3.08	3.08
Peak Downs	132.0	40.0	4.24	4.30	4.30	3.86	3.89	3.90
Pioneer Valley	132.0	40.0	4.12	4.25	4.25	4.68	4.77	4.77
Proserpine	132.0	21.9	3.37	3.39	3.39	3.65	3.67	3.67
Ross	275.0	31.5	5.13	5.31	5.31	6.00	6.16	6.16
Ross	132.0	31.5	11.01	11.70	11.71	12.79	13.43	13.43
Strathmore	275.0	50.0	5.61	5.68	5.68	5.09	5.13	5.13
Strathmore	132.0	40.0	10.25	10.33	10.33	10.71	10.76	10.77
Townsville South	132.0	21.9	10.78	11.36	11.37	13.47	14.05	14.06
Townsville GT PS	132.0	31.5	8.43	8.82	8.82	9.31	9.62	9.62
Tully	132.0	31.5	3.17	3.18	3.18	2.95	2.95	2.95
Turkinje	132.0	15.7	3.73	3.78	3.78	4.24	4.31	4.31
Wandoo	132.0	40.0	3.74	3.94	3.94	2.77	2.88	2.88
Woree	275.0	50.0	2.34	2.36	2.36	2.71	2.82	2.82
Woree	132.0	40.0	4.98	5.04	5.04	6.47	6.90	6.90

Notes:

(1) Short circuit levels are estimated maximum levels assuming 110% of nominal voltage behind sub-transient reactance, neglecting loads, shunt admittances and other passive elements.

(2) Powerlink switchgear ratings – no account taken of distribution switchgear.

(3) Analysis for these locations allows for operation with open points to keep short circuit levels below switchgear ratings.

(4) The lowest rated circuit breaker(s) at these locations are required to interrupt short circuit current which is less than the maximum fault current and below the circuit breaker rating.

Also note that:

(5) Fault level contributions to the Powerlink network from sugar mills, other than Invicta and Rocky Point, are not included in these tables.

(6) Fault level contributions to the Powerlink network from embedded non-scheduled generators, other than Bulwer Island (BIEP) and Queensland Nickel, are not included in these tables. Excluded generators include, but may not be limited to, Windy Hill wind generators, Wivenhoe small hydro generator, Stapylton biomass, and possible Moranbah coal seam methane gas turbines.

8.4 Appendix D – Proposed Small Network Assets

8.4.1 Shunt Capacitor Banks for South East Queensland

Project Name: Shunt Capacitor Banks for South East Queensland
Proposed Timing: October 2005 and October 2006
Estimated Cost: $4.3 million

Background

In the recent 2003/04 summer period, the level of electricity demand in south east Queensland (SEQ) rose strongly in response to extremely hot weather conditions. This level of demand exceeded Powerlink's medium economic growth 10% Possibility of Exceedence (PoE) (very hot weather) forecast.

During this period, SEQ reactive power demand requirements also rose considerably in response to the significant demand growth, increased use of air-conditioners, and higher reactive power losses on the electricity transmission and distribution system (due to higher transformer and line loadings).

A subsequent review of future SEQ reactive demand requirements has identified that additional reactive support will be required in 2005/06, above the levels previously advised in the 2003 Annual Planning Report. An additional 150MVAr of reactive support will be needed in 2005/06 to ensure supply reliability can continue to be maintained to customers in SEQ during very hot summer weather conditions (10% PoE).

No new network assets have previously been proposed to address the reactive demand requirement in 2006/07. Detailed technical analysis to determine the total level of additional reactive support that will be required in 2006/07 is underway. At this time, it is proposed to install an additional 170MVAr of reactive support in 2006/07, with the total requirement for additional reactive support expected to be considerably higher.

It is assumed that existing levels of reactive support will continue to be provided by generators and the DirectLink Market Network Service Provider, either under their code obligations or as ancillary services under contract to NEMMCO.

Powerlink is required to take action to keep pace with growing reactive power demand. In particular, the voltage stability criteria outlined in Schedule 5.1.8 of the National Electricity Code requires "*that an adequate reactive power margin must be maintained at every connection point in a network with respect to the voltage stability limit as determined from the voltage/reactive load characteristic at that connection point*". In line with this requirement, a reactive margin of 1% of the maximum fault level (in MVA) at each connection point is required.

In addition, the Connection Agreement between Powerlink and Energex includes obligations regarding reliability of supply as required under Schedule 5.1.2.2 of the National Electricity Code. Powerlink's transmission authority also includes reliability of supply obligations. Voltage support must be provided in SEQ such that forecast peak demand can be supplied with the most critical element out of service, ie. N-1.

Without corrective action, Powerlink will be unable to meet these obligations. Therefore the proposed solution is classified as a reliability augmentation.

All regulated network augmentations are required to satisfy the Regulatory Test promulgated by the ACCC. For a reliability augmentation, this test requires that a proposed solution minimise the net present value cost of meeting objective performance standards compared with other feasible alternatives.

Network Options Considered

Option 1: Capacitor Banks

Option 1 is to install shunt capacitor banks throughout the SEQ network to meet the increased reactive power demand for 2005 and 2006. Sites have been chosen based on effectiveness in providing reactive support and the availability of space in the substations to accommodate a new capacitor bank.

2005 – Loganlea, Runcorn and Rocklea Capacitor Banks

Single 50MVAr, 110kV shunt capacitor banks are proposed to be installed at Loganlea, Runcorn and Rocklea substations by October 2005.

Construction of the capacitor banks would be scheduled to commence in August 2004 to meet the required commissioning date of October 2005.

2006 – Palmwoods Capacitor Bank

The initial 2006 reactive demand requirement is proposed to be met by the installation of a 50MVAr capacitor bank at Palmwoods substation and a 120MVAr capacitor bank at Greenbank substation. The capacitor bank at Greenbank is currently subject to a separate augmentation consultation process and application of the ACCC Regulatory Test.

Other proposals may be in the 2005 Annual Planning Report depending on the outcomes of further analysis being undertaken by Powerlink.

Construction of the capacitor bank at Palmwoods would be scheduled to commence in December 2004 to meet the required commissioning date of October 2006.

The total capital cost of the shunt capacitors to meet the reactive capacity demand in SEQ over 2005 and 2006, excluding the proposed Greenbank capacitor bank, is $4.3 million.

Option 2: SVC

The increased reactive demand could also be met by the installation of a static var compensator (SVC) in the SEQ network by late 2005. The SVC would need to have a capacity of 200MVAr to achieve the same result as the capacitor banks described in Option 1. This assumes the Greenbank capacitor bank project described in Option 1 is approved based on the separate regulatory process being undertaken.

The capital cost of Option 2 is $14 million.

Construction of this augmentation would be scheduled to commence immediately to meet the required commissioning date of October 2005.

Option 3: Customer Connected Capacitor Banks

It would be feasible that customers in the SEQ area could install capacitor banks to overcome the network loading limitations. However, Powerlink has no knowledge of any proposals for such customer-connected capacitor banks to be installed.

Non-Network Options Considered

Powerlink is not aware of any demand side management initiatives, local generation developments or other non-network solutions that could address the future supply requirements by the required timings of October 2005 and October 2006.

Summary of Options and Economic Analysis

There are two feasible options that are capable of supplying the additional reactive demand in SEQ by the required timings of October 2005 and October 2006. The net present value cost of each of these options was calculated over a period of 15 years. The results of this economic analysis are included in Table D.4. The costs and outcomes associated with these options for the medium growth forecast are summarised in Table D.1.

Table D.1: Summary of Economic Analysis for Medium Growth for Shunt Capacitor Banks for South East Queensland

Options	Net Present Value Cost (Medium Growth)	Ranking
1. Shunt capacitor banks	$2.53M	1
2. SVC	$8.49M	2
3. Customer connected capacitor bank	N/A	N/A
4. Non-network options	N/A	N/A

A range of market scenarios were also considered including demand growth at rates associated with high and low range estimates of economic growth rates in Australia. Economic analysis and the results of these scenarios are in Tables D.2 and D.4. The possible introduction of new generation in SEQ is expected to produce similar results as low demand growth rates. As a result, no generation investments were considered in formulating scenarios for the economic analysis.

Table D.2: Summary of Scenario Analysis for Shunt Capacitor Banks for South East Queensland

	Option One Capacitor Banks		Option Two SVC	
	NPV $M	Ranking	NPV $M	Ranking
Scenario A Medium Growth	2.53	1	8.49	2
Scenario B High Growth	2.61	1	8.49	2
Scenario C Low Growth	2.46	1	8.49	2

The sensitivity of the net present value calculations to key input variables such as the discount rate and capital costs (variation of +/- 10%) have been examined and the results are summarised in Table D.3. Sensitivity to the commissioning date was not examined, as both options are required to be in service from October 2005 to meet forecast peak load in the 2005/06 summer.

Table D.3: Results of Sensitivity Analysis for Shunt Capacitor Banks for South East Queensland

	Discount Rate					
	8%		10%		12%	
	Best ranked option	Frequency of wins	Best ranked option	Frequency of wins	Best ranked option	Frequency of wins
Scenario A Medium Growth	1	100%	1	100%	1	100%
Scenario B High Growth	1	100%	1	100%	1	100%
Scenario C Low Growth	1	100%	1	100%	1	100%

The result of the analysis is that Option 1, the installation of additional capacitor banks in SEQ, minimises the net present value cost of addressing the network limitation in all cases, and as such is considered to satisfy the Regulatory Test.

This project has no impact on other transmission networks.

Recommendation
It is recommended that 50MVAr capacitor banks be installed at Loganlea, Runcorn and Rocklea by October 2005. In addition, a single 50MVAr shunt capacitor bank should be installed at Palmwoods by October 2006, to meet the increased reactive demand in SEQ.

Table D.4: Cash Flow for Shunt Capacitor Banks for South East Queensland

		Medium Growth Forecast														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SCENARIO A		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
Option 1		**Capacitor Banks**														
2005 capacitor banks																
==> TUOS		0.000	0.000	0.364	0.359	0.354	0.349	0.344	0.340	0.335	0.330	0.325	0.320	0.315	0.310	0.306
==> NPV of TUOS	$2.00															
2006 capacitor banks																
==> TUOS		0.000	0.000	0.000	0.110	0.109	0.107	0.106	0.104	0.103	0.101	0.100	0.098	0.097	0.096	0.094
==> NPV of TUOS	$0.53															
Total for Option 1	**$2.53**															
Option 2		**SVC**														
SVC																
==> TUOS		0.000	0.000	1.544	1.523	1.502	1.482	1.461	1.441	1.420	1.399	1.379	1.358	1.338	1.317	1.297
==> NPV of TUOS	$8.49															
Total for Option 2	**$8.49**															

		High Growth Forecast														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SCENARIO B		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
Option 1		**Capacitor Banks**														
2005 capacitor banks																
==> TUOS		0.000	0.000	0.364	0.359	0.354	0.349	0.344	0.340	0.335	0.330	0.325	0.320	0.315	0.310	0.306
==> NPV of TUOS	$2.00															
2006 capacitor banks																
==> TUOS		0.000	0.000	0.110	0.109	0.107	0.106	0.104	0.103	0.101	0.100	0.098	0.097	0.096	0.094	0.093
==> NPV of TUOS	$0.61															
Total for Option 1	**$2.61**															
Option 2		**SVC**														
SVC																
==> TUOS		0.000	0.000	1.544	1.523	1.502	1.482	1.461	1.441	1.420	1.399	1.379	1.358	1.338	1.317	1.297
==> NPV of TUOS	$8.49															
Total for Option 2	**$8.49**															

		Low Growth Forecast														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SCENARIO C		04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19
Option 1		**Capacitor Banks**														
2005 capacitor banks																
==> TUOS		0.000	0.000	0.364	0.359	0.354	0.349	0.344	0.340	0.335	0.330	0.325	0.320	0.315	0.310	0.306
==> NPV of TUOS	$2.00															
2006 capacitor banks																
==> TUOS		0.000	0.000	0.000	0.000	0.110	0.109	0.107	0.106	0.104	0.103	0.101	0.100	0.098	0.097	0.096
==> NPV of TUOS	$0.46															
Total for Option 1	**$2.46**															
Option 2		**SVC**														
SVC																
==> TUOS		0.000	0.000	1.544	1.523	1.502	1.482	1.461	1.441	1.420	1.399	1.379	1.358	1.338	1.317	1.297
==> NPV of TUOS	$8.49															
Total for Option 2	**$8.49**															

8.5 Appendix E – Forecast of Connection Points

Tables E.1 and E.2 show the ten year forecasts of summer and winter demand at connection points, or groupings of connection points, coincident with the time of forecast total Queensland region summer and winter maximum demand.

Groupings of some connection points are used to protect the confidentiality of specific customer loadings.

It should be noted that generally connection points will have their own summer and winter maximum loadings at times other than coincident with Queensland region maximum and these may be significantly higher than as shown in the tables.

In Tables E.1 and E.2 the zones in which connection points are located are allocated by abbreviation as follows:

- FN Far North Zone
- Ross Ross Zone
- North North Zone
- CW Central West Zone
- Glad Gladstone Zone
- WB Wide Bay Zone
- SW South West Zone
- MN Moreton North Zone
- MS Moreton South Zone
- GCT Gold Coast/Tweed Zone

Table E.1: Forecasts of Connection Point Demands (MW) Coincident With State Summer Maximum Demand

Connection Points	Zone	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14
Abermain 110kV (Lockrose)	MN	48.86	51.76	38.48	39.74	41.10	42.55	43.91	45.30	46.77	48.15
Abermain 33kV	MS	125.83	119.05	110.44	91.40	93.18	95.12	96.90	98.63	100.49	102.30
Alan Sheriff 132kV	Ross	11.14	11.53	11.93	12.35	12.78	13.23	13.69	14.17	14.67	15.12
Algester 33kV (possible future)	MS			82.24	92.86	107.62	111.53	115.31	119.10	123.12	126.90
Alligator Creek 33kV	North	31.42	31.97	33.49	34.06	34.63	35.22	35.82	36.43	37.05	37.64
Ashgrove West 33kV	MN	65.43	69.08	70.48	72.45	74.54	76.81	78.96	81.10	83.38	85.55
Belmont 110kV (Cleveland and Murrarie)	MS	539.98	513.47	451.48	473.42	486.17	499.97	513.07	526.17	540.17	553.37
Biloela 66kV	CW	32.40	33.31	33.93	35.50	36.14	36.79	37.45	38.12	38.80	39.45
Blackwater 66kV	CW	76.42	83.61	85.83	88.12	90.47	92.89	95.38	97.94	100.57	103.02
Brisbane CBD 110kV (Ashgrove West)	MN	214.53	181.22	89.82	92.09	94.53	97.15	99.62	102.05	104.63	107.14
Brisbane CBD 110kV (Rocklea and Belmont)	MS	99.70	211.91	395.23	468.84	481.65	495.45	508.47	521.38	535.10	547.36
Cairns 22kV	FN	71.56	73.33	75.13	76.96	78.83	80.72	82.64	84.68	87.23	89.05
Cairns City 132kV	FN	63.79	65.91	68.11	70.39	72.73	75.16	77.67	80.26	82.94	85.40
Cardwell 22kV	Ross	3.29	3.39	3.48	3.58	3.68	3.79	3.90	4.01	4.12	4.23
Clare 66kV	Ross	76.52	77.36	78.21	79.06	79.93	80.80	81.68	82.58	83.48	84.36
Collinsville 33kV	North	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45	8.45
Dan Gleeson 66kV	Ross	44.46	45.69	47.08	48.51	49.98	51.49	53.04	54.64	56.27	57.81
Dysart 66kV	CW	38.94	39.06	39.19	39.32	39.45	39.58	39.70	39.83	39.96	40.09
Edmonton 22kV	FN	27.60	28.98	30.43	31.95	33.55	35.23	36.99	38.75	40.51	42.24
Egans Hill 66kV	CW	48.87	49.93	51.01	52.12	53.25	54.40	55.58	56.79	58.02	59.18
Garbutt 66kV	Ross	89.00	91.87	94.83	97.87	101.01	104.24	107.56	110.99	114.52	117.80
Gin Gin 132kV (Bundaberg)	WB	98.67	100.63	102.62	104.66	106.75	108.87	111.04	113.26	115.53	117.68
Gladstone 132kV (Boat Creek & Comalco)	Glad	92.03	93.59	95.16	96.17	147.81	148.87	149.95	151.05	152.18	153.25
Gladstone South 66kV	Glad	56.90	60.07	62.02	66.16	64.80	66.90	69.07	71.32	73.63	75.77
Goodna 33kV (possible future)	MS			81.56	89.08	88.86	94.07	98.79	102.29	106.06	110.80
Ingham 66kV	Ross	17.02	17.38	17.74	18.12	18.52	18.94	19.37	19.81	20.26	20.69
Innisfail 22kV	FN	27.30	28.13	28.95	29.77	30.59	31.44	32.29	33.14	33.99	34.84

Connection Points	Zone	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14
Kamerunga 22kV	FN	36.31	38.08	39.85	41.63	43.40	45.17	46.95	48.72	50.49	52.27
Lilyvale 66kV	CW	104.16	108.78	112.17	115.56	118.95	122.34	125.73	129.12	132.51	135.90
Lilyvale132kV (Barcaldine & Clermont)	CW	30.47	31.11	31.78	32.46	33.17	33.89	34.63	35.40	36.19	36.92
Loganlea 110kV	MS	293.33	321.40	345.96	347.55	349.14	360.15	370.63	381.12	392.25	402.81
Loganlea 33kV	MS	85.95	90.95	84.56	87.02	86.67	89.27	91.75	94.20	96.78	99.27
Mackay 33kV	North	96.56	99.99	103.53	107.21	111.01	114.94	119.02	123.24	127.61	131.62
Middle Ridge 110kV	SW	199.68	205.21	194.53	197.73	201.35	204.41	207.50	210.40	213.33	216.39
Middle Ridge 110kV (Postman's Ridge and possible future Gatton)	MN	26.38	27.29	45.30	46.17	47.10	48.07	48.92	49.74	50.58	51.47
Molendinar 110kV	GCT	253.58	258.42	273.94	284.31	267.08	276.27	285.11	293.97	303.35	312.23
Moranbah 66kV and 11kV	North	87.15	92.76	96.95	100.17	104.76	107.73	110.72	113.71	116.71	119.70
Moura 66kV	CW	32.07	36.36	36.79	37.24	38.67	39.12	39.58	40.05	40.52	40.98
Mudgeeraba 110kV	GCT	310.65	328.95	336.04	346.01	388.08	400.65	412.66	424.66	437.34	449.44
Nebo 11kV	North	1.76	1.82	1.89	1.95	2.02	2.08	2.15	2.22	2.28	2.35
Newlands 66kV (N)	North	21.39	21.88	22.39	22.91	23.44	24.00	24.56	25.14	25.74	26.30
Palmwoods 132kV and 110kV	MN	230.51	245.82	271.64	282.91	294.84	307.81	322.44	343.98	358.22	374.34
Pioneer Valley 66kV	North	6.79	6.99	7.19	7.40	7.62	7.84	8.07	8.30	8.55	8.77
Proserpine 66kV	North	52.71	54.67	56.41	58.21	60.06	61.97	63.95	65.99	68.10	70.05
Redbank Plains 11kV	MS	15.38	16.88	17.90	15.80	16.10	16.43	16.72	17.01	17.33	17.63
Richlands 33kV	MS	137.98	146.09	106.89	100.77	108.95	112.12	115.10	118.05	121.19	124.20
Richlands West 33kV (possible future)	MS				9.68	10.62	11.47	12.34	13.26	14.27	15.12
Rockhampton 66kV	CW	93.56	97.58	101.29	105.53	108.63	111.82	115.11	118.50	121.99	125.23
Rocklea 110kV (Archerfield)	MS	60.71	64.43	54.00	75.09	77.51	80.10	82.60	85.07	87.70	90.20
Ross 132kV (Kidston and Georgetown)	Ross	36.78	37.74	38.58	39.43	40.31	41.21	42.14	43.09	44.07	44.98
Runcorn 33kV	MS	138.76	146.46	125.02	128.61	132.43	136.53	140.40	144.27	148.33	152.26
South Pine 110kV	MN	689.29	724.93	739.01	758.61	778.60	800.16	820.50	840.72	862.25	882.80
Sumner 110kV (possible future)	MS			10.98	11.82	12.51	13.24	13.99	14.76	15.59	16.32
Swanbank 110kV (Raceview)	MS	100.96	109.37	76.12	77.77	79.55	81.47	83.25	85.00	86.84	88.65
Tangkam 110kV (Dalby and possible future Oakey)	SW	22.22	22.82	36.89	38.28	39.73	40.64	41.55	42.48	43.41	44.32

Connection Points	Zone	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14
Tarong 132kV (Chinchilla and Roma)	SW	58.78	60.67	62.57	64.48	66.39	68.31	70.23	72.16	74.09	76.01
Tarong 66kV (Wide Bay)	SW	32.80	34.00	35.25	36.55	37.89	39.28	40.72	42.21	43.76	45.18
Tennyson 33kV	MS	199.69	208.55	194.26	171.21	174.77	178.19	181.25	184.19	187.32	190.47
Terranora 110kV at State border	GCT	84.64	89.72	93.79	98.87	102.95	108.04	113.14	117.23	122.33	127.12
Townsville South 66kV	Ross	91.64	95.42	98.40	101.47	104.99	108.73	112.61	116.63	120.79	124.60
Tully 22kV	Ross	15.29	15.98	16.70	17.45	18.24	19.07	19.93	20.83	21.78	22.62
Turkinje 132kV (Craiglee and Lakeland)	FN	21.77	22.87	23.97	25.07	26.17	27.27	28.38	29.48	30.58	31.69
Turkinje 66kV	FN	43.12	44.44	45.80	47.20	48.66	50.15	51.70	53.30	55.00	56.51
Waggamba 132kV (Bulli Creek)	SW	15.83	16.36	16.88	17.41	17.94	18.47	18.99	19.52	20.05	20.57
Wecker Road 33kV (Belmont)	MS	98.46	104.29	104.15	77.28	79.59	82.07	84.44	86.80	89.28	91.67
Woolooga 132kV (Gympie)	MN	110.01	115.60	96.01	98.17	100.51	102.64	104.99	107.30	109.77	112.00
Woolooga 132kV (Kilkivan)	WB	140.05	145.71	151.65	157.86	164.37	171.20	178.36	185.87	193.75	200.74
Direct Connected Industrial Loads (SunMetals, QLD Nickel, Invicta Load - Ross, and BSL, QAL - Glad, and Bundamba - MN)		1127.04	1179.18	1197.25	1215.49	1225.76	1235.04	1244.28	1253.51	1262.76	1271.03
Transmission Grid Connected Mining Loads (Rolleston CW, Burton Downs N, Goonyella North N, Hail Creek N)		25.54	35.76	35.99	46.88	47.12	47.36	47.60	47.85	48.11	48.35
Transmission Grid Connected Queensland Rail Substations (Dingo, Grantleigh, Gregory, Norwich Park, Rangal, Rocklands - CW, and Coppabella, Moranbah South, Mt McLaren, Oonooie, Peak Downs, Wandoo - North, and Callemondah – Glad, and Korenan,Mungar WB, and Corinda - MS)		62.71	63.92	64.72	65.66	66.62	67.60	68.56	69.51	70.48	71.44
TOTAL QLD SUMMER PEAK		**7,303**	**7,660**	**7,892**	**8,131**	**8,395**	**8,613**	**8,829**	**9,050**	**9,274**	**9,490**

Table E.2: Forecasts of Connection Point Demands (MW) Coincident With State Winter Maximum Demand

Connection Points	Zone	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Abermain 110kV (Lockrose)	MN	46.52	48.59	51.28	36.67	37.92	39.21	40.55	41.91	43.29	44.76
Abermain 33kV	MS	120.71	117.02	122.02	91.96	93.73	95.52	97.41	99.27	101.15	103.19
Alan Sheriff 132kV	Ross	9.03	9.35	9.68	10.02	10.37	10.73	11.10	11.49	11.90	12.31
Algester 33kV (possible future)	MS				77.64	88.65	103.23	106.83	110.46	114.19	118.12
Alligator Creek 33kV	North	25.63	27.67	28.15	29.49	29.99	30.50	31.02	31.54	32.08	32.63
Ashgrove West 33kV	MN	70.14	73.23	77.16	78.42	80.79	83.23	85.78	88.33	90.93	93.70
Belmont 110kV (Cleveland and Murrarie)	MS	430.09	445.36	439.33	397.89	418.63	430.50	442.99	455.44	468.21	481.88
Biloela 66kV	CW	31.49	32.07	32.98	33.59	35.15	35.78	36.42	37.07	37.73	38.41
Blackwater 66kV	CW	69.99	71.97	78.74	80.84	82.99	85.20	87.48	89.83	92.24	94.71
Brisbane CBD 110kV (Ashgrove West)	MN	95.55	102.19	85.95	45.68	46.90	48.14	49.44	50.72	52.02	53.40
Brisbane CBD 110kV (Rocklea and Belmont)	MS	46.72	49.18	97.39	188.01	266.57	274.01	281.79	289.54	297.43	305.81
Cairns 22kV	FN	61.25	45.44	46.56	47.70	48.87	50.05	51.25	52.47	53.77	55.38
Cairns City 132kV	FN	34.60	35.75	36.95	38.18	39.45	40.77	42.13	43.53	44.99	46.49
Cardwell 22kV	Ross	2.88	2.96	3.04	3.13	3.22	3.31	3.40	3.50	3.60	3.70
Clare 66kV	Ross	46.18	46.69	47.20	47.71	48.23	48.76	49.29	49.83	50.38	50.93
Collinsville 33kV	North	7.72	7.72	7.72	7.72	7.72	7.72	7.72	7.72	7.72	7.72
Dan Gleeson 66kV	Ross	36.15	37.09	38.12	39.28	40.47	41.70	42.96	44.25	45.58	46.95
Dysart 66kV	CW	37.96	38.08	38.20	38.33	38.45	38.58	38.70	38.83	38.95	39.08
Edmonton 22kV	FN		18.30	19.22	20.18	21.18	22.24	23.36	24.52	25.69	26.86
Egans Hill 66kV	CW	41.84	42.75	43.68	44.62	45.59	46.58	47.59	48.62	49.68	50.75
Garbutt 66kV	Ross	72.63	74.98	77.40	79.88	82.45	85.09	87.81	90.62	93.50	96.48
Gin Gin 132kV (Bundaberg)	WB	71.04	72.42	73.83	75.27	76.74	78.24	79.77	81.33	82.92	84.55
Gladstone 132kV (Boat Creek & Comalco)	Glad	55.98	94.99	96.66	98.34	99.42	151.70	152.83	153.99	155.17	156.38
Gladstone South 66kV	Glad	55.94	57.76	60.98	62.96	67.16	65.77	67.91	70.12	72.39	74.75
Goodna 33kV (posible future)	MS				79.69	88.44	88.43	93.09	97.82	101.60	105.67
Ingham 66kV	Ross	13.24	13.51	13.80	14.09	14.38	14.70	15.03	15.38	15.73	16.08
Innisfail 22kV	FN	13.86	14.29	14.72	15.15	15.58	16.01	16.46	16.90	17.34	17.79

Connection Points	Zone	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Kamerunga 22kV	FN	31.76	33.39	35.02	36.65	38.28	39.91	41.54	43.18	44.81	46.44
Lilyvale 66kV	CW	92.32	96.54	100.83	103.97	107.11	110.26	113.40	116.54	119.68	122.83
Lilyvale132kV (Barcaldine & Clermont)	CW	28.43	29.01	29.61	30.22	30.85	31.49	32.16	32.84	33.54	34.26
Loganlea 110kV	MS	269.95	290.73	314.46	340.31	343.42	341.11	351.25	361.38	371.67	382.68
Loganlea 33kV	MS	98.22	103.20	108.71	103.26	103.19	106.09	109.10	112.08	115.10	118.31
Mackay 33kV	North	65.62	67.95	70.36	72.85	75.43	78.11	80.88	83.75	86.72	89.79
Middle Ridge 110kV	SW	215.84	221.20	227.35	215.57	219.14	223.19	226.60	230.05	233.29	236.57
Middle Ridge 110kV (Postman's Ridge and possible future Gatton)	MN	29.99	30.74	31.69	48.25	49.23	50.18	51.16	52.08	52.97	53.90
Molendinar 110kV	GCT	226.65	237.62	236.34	250.25	228.89	237.22	245.21	253.23	261.43	270.14
Moranbah 66kV and 11kV	North	84.28	85.94	91.52	95.66	98.83	103.37	106.30	109.23	112.18	115.12
Moura 66kV	CW	27.54	28.19	31.95	32.34	32.73	33.98	34.38	34.79	35.20	35.61
Mudgeeraba 110kV	GCT	304.15	320.60	337.23	339.45	380.65	392.94	405.58	418.26	431.21	444.94
Nebo 11kV	North	1.82	1.89	1.97	2.04	2.11	2.18	2.25	2.32	2.39	2.46
Newlands 66kV (N)	North	16.88	19.40	19.84	20.30	20.77	21.25	21.74	22.25	22.78	23.32
Palmwoods 132kV and 110kV	MN	259.12	273.29	314.13	322.92	336.34	350.35	365.15	380.17	404.60	421.52
Pioneer Valley 66kV	North	5.15	5.30	5.46	5.62	5.78	5.95	6.12	6.30	6.48	6.67
Proserpine 66kV	North	31.80	32.78	34.02	35.08	36.16	37.28	38.44	39.63	40.86	42.13
Redbank Plains 11kV	MS	15.34	16.88	18.61	19.78	15.90	16.18	16.49	16.78	17.07	17.39
Richlands 33kV	MS	114.82	120.57	127.10	90.21	85.23	92.24	94.76	97.25	99.80	102.49
Richlands West 33kV (possible future)	MS					8.37	9.18	9.89	10.64	11.44	12.32
Rockhampton 66kV	CW	78.99	81.67	85.17	88.42	92.12	94.82	97.60	100.48	103.44	106.48
Rocklea 110kV (Archerfield)	MS	37.18	39.03	41.25	36.68	49.53	51.07	52.71	54.33	55.99	57.74
Ross 132kV (Kidston and Georgetown)	Ross	28.66	31.64	32.47	33.19	33.93	34.69	35.46	36.26	37.08	37.92
Runcorn 33kV	MS	133.38	139.25	146.14	118.11	121.49	124.95	128.57	132.15	135.79	139.65
South Pine 110kV	MN	669.44	698.81	733.56	745.84	767.55	788.58	810.69	832.65	855.14	879.12
Sumner 110kV (possible future)	MS				9.78	10.53	11.14	11.77	12.42	13.12	13.86
Swanbank 110kV (Raceview)	MS	87.91	93.81	100.78	65.17	66.55	67.94	69.44	70.87	72.31	73.85
Tangkam 110kV (Dalby and possible future Oakey)	SW	18.88	19.40	19.92	35.32	36.71	38.17	39.03	39.90	40.78	41.67

Connection Points	Zone	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Tarong 132kV (Chinchilla and Roma)	SW	58.16	60.08	62.01	63.94	65.88	67.83	69.78	71.73	73.70	75.66
Tarong 66kV (Wide Bay)	SW	35.52	36.82	38.17	39.57	41.03	42.53	44.09	45.71	47.39	49.13
Tennyson 33kV	MS	186.62	192.63	200.26	213.75	169.40	172.63	175.77	178.76	181.77	184.98
Terranora 110kV at State border	GCT	89.72	93.79	97.86	101.93	106.00	110.08	114.16	118.25	121.31	125.40
Townsville South 66kV	Ross	48.02	49.53	51.57	53.18	54.84	56.74	58.77	60.86	63.03	65.29
Tully 22kV	Ross	4.50	4.70	4.91	5.14	5.37	5.61	5.87	6.13	6.41	6.70
Turkinje 132kV (Craiglee and Lakeland)	FN	13.17	21.37	22.45	23.53	24.60	25.68	26.76	27.85	28.93	30.01
Turkinje 66kV	FN	42.34	40.02	41.24	42.50	43.81	45.16	46.55	47.98	49.47	51.04
Waggamba 132kV (Bulli Creek)	SW	18.44	18.99	19.54	20.09	20.64	21.19	21.74	22.29	22.84	23.39
Wecker Road 33kV (Belmont)	MS	121.53	127.30	134.22	133.61	95.29	98.07	100.96	103.83	106.74	109.83
Woolooga 132kV (Gympie)	MN	118.17	122.76	107.02	107.92	110.58	113.29	116.39	119.20	122.10	125.17
Woolooga 132kV (Kilkivan)	WB	118.16	126.18	131.33	136.72	142.37	148.29	154.50	161.01	167.84	175.00
Direct Connected Industrial Loads (SunMetals, QLD Nickel, Invicta Load - Ross, and BSL, QAL - Glad, and Bundamba - MN)		1118.93	1147.07	1190.59	1199.59	1218.85	1228.11	1237.37	1246.62	1255.87	1265.13
Transmission Grid Connected Mining Loads (Rolleston CW, Burton Downs N, Goonyella North N, Hail Creek N)		18.96	23.19	33.41	33.63	44.42	44.65	44.88	45.12	45.36	45.61
Transmission Grid Connected Queensland Rail Substations (Dingo, Grantleigh, Gregory, Norwich Park, Rangal, Rocklands - CW, and Coppabella, Moranbah South, Mt McLaren, Oonooie, Peak Downs, Wandoo - North, and Callemondah – Glad, and Korenan,Mungar WB, and Corinda - MS)		74.12	75.28	76.51	77.55	78.70	79.85	81.02	82.18	83.36	84.54
TOTAL QLD WINTER PEAK		**6,538**	**6,838**	**7,147**	**7,332**	**7,548**	**7,789**	**7,986**	**8,184**	**8,393**	**8,604**

8.6 Appendix F – Temperature Corrected Area Demands

For analysis of the dependence of summer and winter daily maximum demands on ambient temperature conditions, across parts of Queensland, eight weather station records are used, as shown in Table F.1.

Table F.1: Reference Temperatures at Associated PoE Conditions

Weather Station	Average Daily Temperature Percentiles (1) °C					
	Summer			Winter		
	10% PoE	50% PoE	90% PoE	10% PoE	50% PoE	90% PoE
Cairns (2)	32.1	30.4	29.1	25.9	24.8	23.7
Townsville (2)	32.0	30.4	29.8	25.7	24.2	23.2
Mackay	30.9	29.3	28.3	11.3	12.4	13.5
Rockhampton	32.6	30.7	29.3	10.2	11.6	12.9
Bundaberg	30.2	28.8	27.7	10.5	11.7	13.0
Toowoomba	29.0	27.0	25.3	4.7	6.0	7.0
Archerfield (Brisbane)	30.5	28.4	27.3	9.6	10.9	12.3
Cooloongatta	29.0	27.1	24.5	9.3	10.6	12.2

Notes:

(1) Taken as the average of the maximum temperature on the day and the minimum temperature during the prior night/morning

(2) In these areas winter demand increases with higher ambient temperature

Graphs of daily maximum demands plotted against daily average temperatures on working week days, are used to determine observed estimates of sensitivity for parts of Queensland.

As shown in Table F.2, sensitivity of demand to ambient temperature is highest in summer across Queensland. Rapidly increasing summer sensitivity, at levels greater than in proportion to growth, is evident in all areas with the most dramatic change occurring in south east Queensland.

Table F.2: Observed Temperature Sensitivity of Daily Peak Demands

	Demand Change Dependence on Average Daily Temperature (MW per °C) (1)			
	South East	South West	Northern non-Industrial	Central Non-Industrial
Summer				
1997/98	39	4.9	22	9.9
1998/99	43	4.6	17	10.9
1999/00	50	4.9	23	11.6
2000/01	63	7.1	24	16.3
2001/02	67	5.0	28	14.3
2002/03	79	7.1	32	18.4
2003/04	126	8.6	39	17.1
Winter				
1998	-43	-6.4	4.2	
1999	-37	-6.1	6.0	
2000	-49	-7.0	(2)	(3)
2001	-39	-6.3	6.9	
2002	-41	-6.3	8.8	
2003	-47	-6.7	7.0	

Notes:

(1) Over summer, the period mid November to mid March is analysed and the holiday period from Christmas to the last week of January is excluded. Over winter, the period mid May to early September is analysed. In summer, if the previous day is hotter during a hot period, a 25% weighting of that day's average temperature is included, to capture higher remnant heat in buildings. Similarly, in winter, if the previous day is colder during a cold period, a 25% weighting of that day's average temperature is included.

(2) Poor correlation of data in this winter.

(3) Poor correlation of data over most winters. Accordingly, this area's demand is taken to be relatively insensitive to winter temperatures.

In order to determine temperature corrected demands for each of the four areas designated in Table F.3, correction techniques are applied to certain days. Only days which are both within the fifteen highest demands of a season, and within the fifteen most severe weather (hottest in summer, coolest in winter), are corrected to avoid distortions. The observed sensitivities, as shown in Table F.2, and difference to the reference 50% PoE temperature, are used to provide a correction to each of these day's demands. The highest corrected demands may not always correspond to the day of actual highest demand. These results are shown in Tables F.3 and F.4.

Table F.3: Area Summer Demand Temperature Corrections

	South East (1)	South West (2)	Northern Non-Industrial (3)	Central Non-Industrial (4)	Major Industrial (5)
Actual Peak Demands					
1997/98	2,648	244	842	686	893
1998/99	2,817	254	845	662	900
1999/00	3,011	268	887	704	1,017
2000/01	3,038	282	911	744	1,037
2001/02	3,187	284	1,044	801	1,062
2002/03	3,449	303	980	771	1,085
2003/04	3,929	340	1,080	831	1,108
Temperature Corrected Area Peak Demand					
1997/98	2,645	247	872	686	893
1998/99	2,768	267	872	662	900
1999/00	2,840	267	937	753	1,017
2000/01	3,058	304	947	813	1,037
2001/02	3,251	298	991	806	1,062
2002/03	3,444	315	1,009	820	1,085
2003/04	3,810	333	1,061	832	1,108
Historical average ratio of demand at time of Qld region peak to area corrected peak	100%	95.1%	91.8%	90.4%	96.8%

Notes:

(1) South east Queensland is taken here as Moreton North, Moreton South and Gold Coast Tweed zones and is compared to Archerfield (Brisbane) temperatures.

(2) South west Queensland is taken as the South West zone and is compared to Toowoomba temperatures.

(3) Northern Non-Industrial is taken as Far North, Ross and North zones less the SunMetals and Queensland Nickel industrial loads, and is compared to Townsville temperatures.

(4) Central Non-Industrial is taken as Central West, Gladstone and Wide Bay zones less the Boyne Island Smelter and QAL industrial loads, and is compared to Rockhampton temperatures.

(5) Industrial is taken here as the sum of SunMetals, Queensland Nickel, Boyne Island smelter and QAL direct connected industrial loads.

Table F.4: Area Winter 50% PoE Demand Temperature Corrections

	South East	South West	Northern Non-Industrial	Central Non-Industrial	Major Industrial
Actual Peak Demands					
1998	2,691	283	733	623	895
1999	2,854	297	731	665	921
2000	3,064	318	776	709	1,021
2001	3,052	313	779	735	1,052
2002	3,078	307	796	710	1,060
2003	3,408	322	806	739	1,068
Temperature Corrected Area Peak Demand					
1998	2,776	294	732	623	895
1999	2,855	302	725	665	921
2000	3,046	302	776	709	1,021
2001	3,104	329	782	735	1,052
2002	3,151	325	816	710	1,060
2003	3,411	329	808	739	1,068
Historical average ratio of demand at time of Qld region peak to area corrected peak	100%	92.2%	88.7%	94%	97.3%

The historical coincidence factor averages developed for each of these areas and for the major industrial loads, are then used to enable overall correction of Queensland Region summer and winter demands, as shown in Tables F.3, F.4 and F.5

Table F.5: Queensland Region Actual and 50% PoE Temperature Corrected Peak Demands

Summer	Actual	Corrected	Winter	Actual	Corrected
1997/98	5,161	5,165	1998	5,042	5,152
1998/99	5,386	5,292	1999	5,309	5,298
1999/00	5,685	5,620	2000	5,691	5,672
2000/01	5,891	5,954	2001	5,811	5,816
2001/02	6,246	6,211	2002	5,743	5,875
2002/03	6,462	6,461	2003	6,149	6,165
2003/04	7,103	6,924			

8.7 Appendix G – Commonly Used Abbreviations

ACCC	Australian Competition and Consumer Commission
ANTS	Annual National Transmission Statement
APR	Annual Planning Report
CB	Circuit Breaker
CBD	Central Business District
CCGT	Combined Cycle Gas Turbine
CQ	Central Queensland
DNSP	Distribution Network Service Provider
DSM	Demand Side Management
GSP	Gross State Product
GT	Gas Turbine
GWh	Gigawatt hour, one million kilowatt hours
IRPC	Inter Regional Planning Committee
kA	kiloamperes, one thousand amperes
kV	kilovolts, one thousand volts
MCE	Ministerial Council on Energy
MNSP	Market Network Service Provider
MVAr	Megavar, megavolt amperes reactive, one thousand kilovolt amperes reactive
MW	Megawatt, one thousand kilowatts
NEC	National Electricity Code
NEM	National Electricity Market
NEMMCO	National Electricity Market Management Company
NEMDE	National Electricity Market Dispatch Engine
NIEIR	National Institute of Economic and Industrial Research
NPV	Net Present Value
NQ	North Queensland
OCGT	Open Cycle Gas Turbine
PoE	Probability of Exceedance
PSS	Power System Stabiliser
QNI	Queensland-New South Wales Interconnection
SCADA	Supervisory Control and Data Acquisition
SEQ	South East Queensland
SOO	Statement of Opportunities, published annually by NEMMCO
SVC	Static Var Compensator
SWQ	South West Queensland
TNSP	Transmission Network Service Provider