Request for Information:

Queensland
Transmission Network Constraints

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Powerlink Queensland
February 2001

1.0 Executive Summary

As foreshadowed in Powerlink's 2000 Annual Planning Statement, the electricity market in Queensland has in recent months been affected by material transmission network constraints.

This paper specifically addresses two constraints – the CQ-NQ limit and the Ross limit.

The transmission grid capacity at these locations has been exceeded for significant periods during the last few months. This has resulted in additional market costs as NEMMCO has needed to direct relatively high cost local generation to operate to ensure that electricity supplies are not interrupted and power flows across the network remain within grid capacity.

Due to the commercial implications for market participants, Powerlink considers it appropriate to investigate the benefits of ameliorating these network transfer limits.

The purpose of this paper is twofold:
(a) to inform participants and interested parties of the constraints, their impacts and possible future occurrence, and
(b) to seek information from those who could provide a solution which could be assessed in accordance with the ACCC's Regulatory Test.

Preliminary analysis indicates that there is a range of plausible scenarios where an augmentation (possibly ranging up to $90M) of the transmission system supplying the affected area would provide a net benefit to the market. Powerlink is issuing this paper as part of its obligations under the National Electricity Code (NEC) and its transmission licence.

Responses to this discussion paper are due by 19th March 2001. The consultation timetable is driven by the need to make a decision by mid 2001 if any option involving significant construction is to be in place by the summer of 2002/03. The constraints are already material, and, in the absence of an ameliorating action, this situation is likely to persist or worsen.

2.0 Incidence of Constraints

In its 2000 Annual Planning Statement, Powerlink advised that there were eight possible 'pinch-points' in the Queensland transmission network where, depending on the pattern of generation dispatch, constraints could arise.

The transfer capacity of Powerlink's transmission grid at the CQ-NQ limit and the Ross limit (see section 4.1) was reached for significant periods between October and December 2000. It is anticipated that further periods of constraint will be experienced in the remainder of the present (2000/01) summer and in subsequent summers.

Under normal conditions, such grid constraints do not pose a risk to the reliability and security of supply to the affected area due to the existence of local generation capacity. Notwithstanding this, there are certain circumstances (eg – if grid constraints coincide with fuel constraints on the local hydro and gas turbine generators) where the potential for impaired system reliability and security exists.

The primary consequence of reaching these transmission limits is the commercial impact on market participants and customers. For the periods that the transmission constraints occurred, local relatively high cost gas turbines were directed to operate by NEMMCO in order to meet customer demand within the transmission capability even though lower cost generators elsewhere were available.

Between October and December 2000, constraints on the CQ-NQ Limit totalled 80.5 hours, and constraints on the Ross limit totalled 68 hours. The latter was due largely to an extended outage of the Kareeya hydro generator.

The generators directed to operate by NEMMCO receive a payment from NEMMCO as compensation for their cost of operation above the market value of the energy supplied. Powerlink is not privy to information on the cost of running the local gas turbines but is aware of data provided to the South Australia – New South Wales Interconnector evaluation by an independent consultant which indicates operating costs in excess of $200/MWh[1].

Powerlink has a responsibility to investigate the magnitude and impacts of the constraints in future summers and to identify whether alternatives exist which might deliver greater market benefit (for example, access to more economic generation) in comparison to the future impact of those constraints.

[1] IRPC Stage 1 Report Update. Proposed SNI Interconnector. November 2000

3.0 Background –Supply and Demand

3.1 Geographic Zones

This document refers to three geographic zones. These zones were defined in Powerlink's 2000 Annual Planning Statement, and are delineated by sections of the 275kV transmission grid which are heavily loaded compared with their capacity.

Far North Zone:	north of Tully and Chalumbin (near Ravenshoe)
Ross Zone:	north of Proserpine and Collinsville, but excluding Far North Zone
North Zone:	north of Broadsound and Dysart but excluding the Far North and Ross Zones

In this document, the three zones are referred to collectively as 'the affected area'. The attached map (Fig 1) shows the relationship of these zones to the existing transmission network and major power generation sources.

3.2 Electricity Demand Forecasts

Underlying electricity demand from the transmission grid in the affected area (excluding load growth due to the Sun Metals Zinc Refinery) has been growing at approximately 3.8% per annum over the past 4 years. This represented a slowing of growth compared with previous years due to a steady increase in local generation output within the distribution networks (ie – embedded generation).

Growth in the transmission grid demand is expected to slow further over the next decade with underlying demand (again excluding Sun Metals) forecast to grow by 3.4%p.a.

Demand on Transmission Grid At State Summer Peak – Moderate Growth, Average Temperature (MW)[2]

	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11
Far North Zone	246	257	265	274	283	293	304	315	327	339	351
Ross Zone	467	457	457	488	501	515	529	544	559	576	592
North Zone	293	306	306	313	321	329	337	345	354	363	372

[2] The above forecasts show the forecast of the demand delivered from the Powerlink transmission grid (coincident with the statewide peak). Each zone normally experiences its own zone peak demand, which is usually greater than shown in the table and often occurs at a time other than the state peak. The transmission grid flows will need to supply transmission losses in addition to the demand forecast shown. The forecasts take account of forecast embedded non-scheduled generators. Effectively, any demand which is met by these embedded generators results in a reduction in the forecast demand to be delivered from Powerlink's grid as shown in this table.

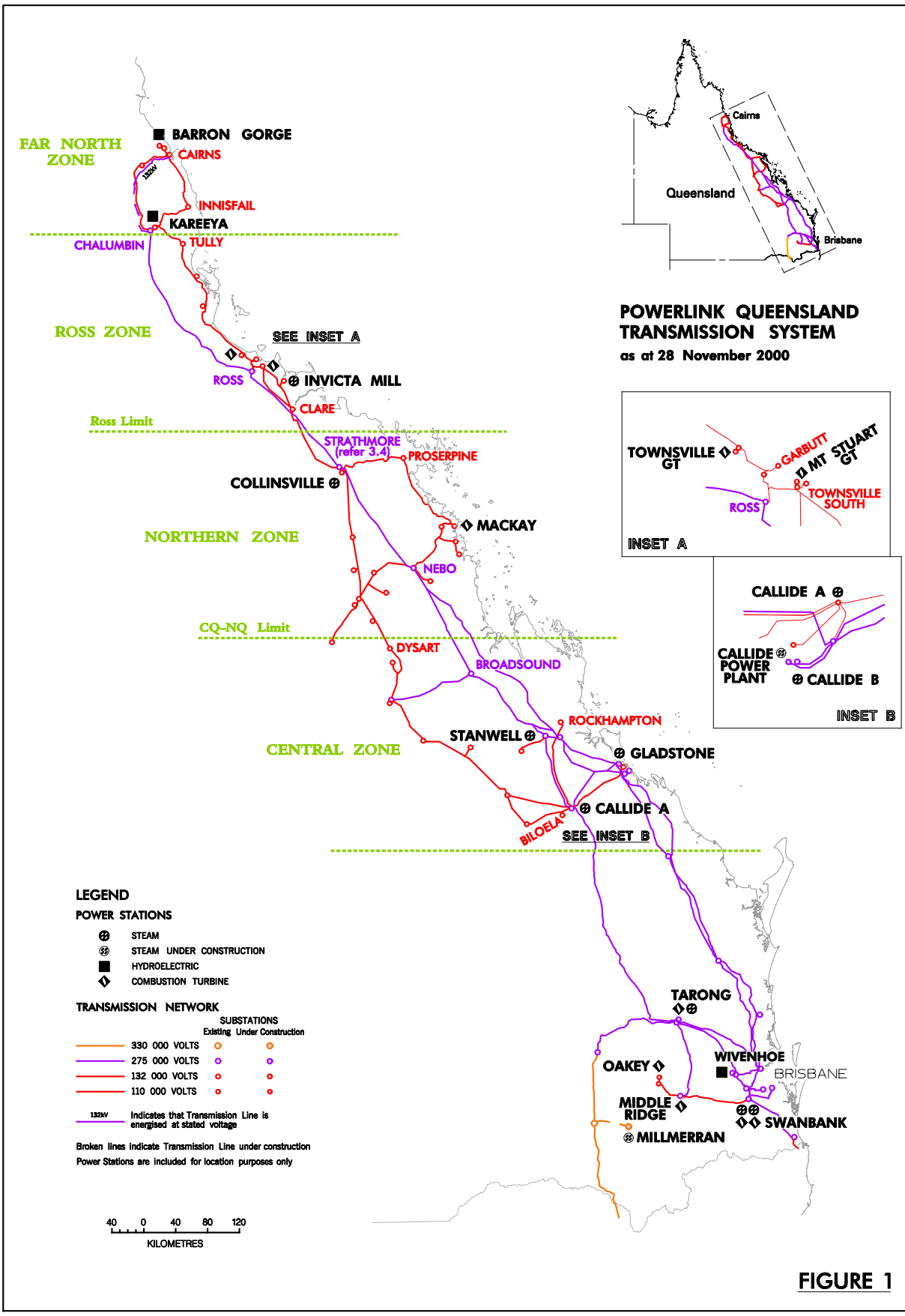

FAR NORTH ZONE
BARRON GORGE
CAIRNS
132kV
INNISFAIL
KAREEYA
CHALUMBIN
TULLY
ROSS ZONE
SEE INSET A
ROSS
INVICTA MILL
CLARE
Ross Limit
STRATHMORE (refer 3.4)
PROSERPINE
COLLINSVILLE
NORTHERN ZONE
MACKAY
NEBO
CQ-NQ Limit
DYSART
BROADSOUND
ROCKHAMPTON
STANWELL
CENTRAL ZONE
GLADSTONE
CALLIDE A
BILOELA
SEE INSET B
TARONG
OAKEY
WIVENHOE
BRISBANE
MIDDLE RIDGE
SWANBANK
MILLMERRAN
Cairns
Queensland
Brisbane
POWERLINK QUEENSLAND TRANSMISSION SYSTEM
as at 28 November 2000
TOWNSVILLE GT
GARBUTT
MT STUART GT
TOWNSVILLE SOUTH
ROSS
INSET A
CALLIDE A
CALLIDE POWER PLANT
CALLIDE B
INSET B
LEGEND
POWER STATIONS
STEAM
STEAM UNDER CONSTRUCTION
HYDROELECTRIC
COMBUSTION TURBINE
TRANSMISSION NETWORK
SUBSTATIONS
Existing Under Construction
330 000 VOLTS
275 000 VOLTS
132 000 VOLTS
110 000 VOLTS
132kV Indicates that Transmission Line is energised at stated voltage
Broken lines indicate Transmission Line under construction
Power Stations are included for location purposes only
40 0 40 80 120
KILOMETRES

FIGURE 1

The forecasts in the above table are the latest revision superseding those in Powerlink's 2000 Annual Planning Statement. Powerlink obtains electricity demand forecasts over a ten-year horizon from Distribution Network Service Providers and customers at each connection point in Powerlink's transmission system. These forecasts thus take account of demand management programs in place or foreseen by distributors, and also the presence of embedded generation which may reduce the forecast of demand which needs to be supplied via each transmission connection point.

Forecasts in the table were obtained by aligning the local distributor forecasts with an independent assessment of energy and demand forecasts for the Queensland region carried out by the National Institute of Economic and Industrial Research (NIEIR). This independent assessment included a review of the impact of new embedded generation.

3.3 Generation Capacity

3.3.1. Existing Generation Capacity

Existing transmission connected generation capacity in the affected area is as follows:

Location	Type	Rated Capacity (MW generated)
Collinsville	Coal Fired Steam	180
Mt Stuart (Townsville)	Combustion Turbine	288 Summer; 295 Winter
Townsville (Yabulu)	Combustion Turbine	160
Mackay	Combustion Turbine	30 Summer; 34 Winter
Barron Gorge	Hydro	60
Kareeya	Hydro	72
Koombooloomba	Hydro	7
Invicta	Sugar Mill	38.8
TOTAL		**835 Summer; 846 Winter**

There are also a number of existing small generators embedded in the distribution networks that effectively reduce the demand on the transmission system when they are generating. These include wind generators at Windy Hill and output from cogeneration at several sugar mills. Relevant characteristics of the generation in the affected area include:

- the sugar mill generation is largely unable to operate during summer peak periods as this is after the sugar cane crushing season.
- The three combustion turbine generators have significantly higher operational (fuel etc) costs than the other local generators, as they were designed as peak load generators. These high cost generators represent more than 50% of the available generation.
- Hydro-electric generators have limited water storage capacity, and are heavily dependent on local rainfall for water availability. This is particularly true in the early summer ahead of the traditional wet season.

3.3.2. Future Generation Capacity

Powerlink is aware that several proposals for additional generation capacity in the affected area are under investigation, including a proposal for the establishment of a baseload gas-fired generation facility in Townsville.

Powerlink is now seeking detailed information from participants on such proposed developments, regarding their ability to alleviate the identified transmission grid constraints. Participants should note that significant increases in embedded wind generator and sugar mill cogeneration have already been factored into the load forecasts as noted in section 3.2.

3.4 Transmission System

3.4.1. Existing Transmission Network

The 275kV and 132kV supply system to the affected area is shown in Fig 1.

Primary supply to the region is via a 275kV backbone transmission grid between generators in Central Queensland and Chalumbin in Far North Queensland. This is supported by a parallel 132kV network.

3.4.2. Committed Transmission Network Augmentations

In addition to the existing system, Powerlink has committed to the following 'incremental' network augmentations which will improve the transmission supply to the affected area:

Augmentation	Anticipated Commissioning Date
Strathmore 275kV substation establishment	Sept 2001
Nebo No. 2 120MVAr 275kV shunt capacitor bank	Dec 2001
Install 275/132kV transformer at Strathmore substation	Sept 2002

4.0 Network Transfer Capability

4.1 Network Transfer Limits

The Powerlink Annual Planning Statement 2000 defines the transmission capability for the two limits:

- 'CQ-NQ limit': defined as the sum of 275kV flows into Nebo and the 132kV flows from Dysart to Peak Downs
- 'Ross Limit': defined as the sum of 275kV flows into Ross and the 132kV flows from Collinsville to Clare.

The CQ-NQ and Ross limits are found to be mainly limited by dynamic and transient stability. Studies modelling system behaviour for very high power transfers suggest that the transmission system is nearing an 'absolute' theoretical limit, which cannot be extended by adding more shunt capacitors or other incremental augmentations.

For each of these limits, Powerlink estimates the grid capacity or power transfer below which there is a high probability that the system will remain stable for any credible single contingency. Powerlink's past practice has been to define the grid limits based on typical operation. Actual grid capacity varies from the defined limits depending on system conditions at the time – eg - the Ross and CQ-NQ limits are sensitive to the generation pattern, particularly in north Queensland.

Powerlink is presently developing complex constraint equations to recognise the sensitivity of the grid transfer capability to the interactions between variables such as generation at specific power stations, area demands and grid flows. These constraint equations, once finalised, will allow the capability of the grid under various system conditions to be predicted as accurately as possible and reflected in the dispatch by NEMMCO.

Transfer limits are utilised by NEMMCO in the affected area as follows:

- scheduled generators throughout Queensland are dispatched by NEMMCO according to competitive market bids
- when flows on the transmission grid resulting from this normal dispatch process would exceed the capacity defined either by the Ross or CQ-NQ Limit, NEMMCO will constrain on, or if necessary direct, local generators to run.
- These generators are required to generate at sufficient levels to ensure the power flows across the network remain within grid capacity. Lower cost generators south of the constraint are therefore unable to compete for this supply to customers because their power output cannot be transferred north.

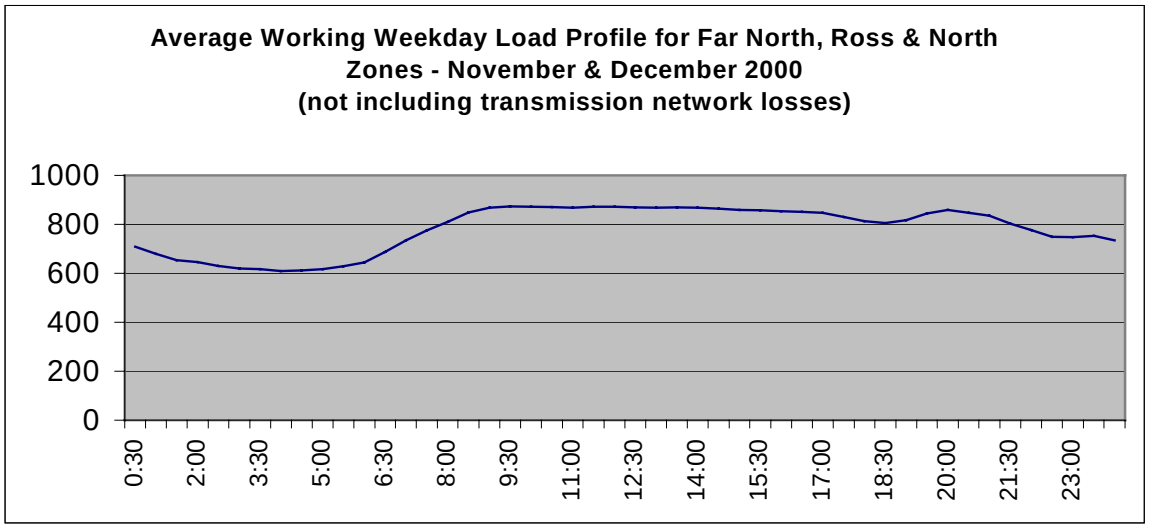
4.2 Factors impacting incidence of constraints

4.2.1. Summer Period

The summer months, October to March, are the critical period relevant to the grid constraints described in this paper.

4.2.2. Daily Load Profile

The strongest influence on the financial impact of constraints is the flat shape of the daily load profile. Summer weekday electricity demand in the affected area is relatively constant throughout the day, with little change in demand from 9am to 9pm (see diagram below). This means that, if the limits of the grid would otherwise be exceeded, local generators will be required to operate for long periods (ie – for most of the daytime period on weekdays). It also means that any demand side response which could be an alternative solution must be able to provide a sustained reduction in demand throughout all summer weekdays.



As shown by the graph above, this pattern was in evidence during late 2000. The Townsville gas turbines were required to operate for the majority of the day during the periods that binding grid constraints would otherwise have occurred – an atypical operating mode for peak load generators.

4.2.3. Generation Patterns

The level of constraint is also sensitive to the market bidding strategies of local generation. This may be influenced by factors other than the cost of generation, such as the market behaviour of other generators (particularly as committed new generation in central and southern Queensland begins commercial operation), the commercial contract market, the establishment of new local generation and, for the northern hydro stations, the availability of water.

4.3 Short-term Outlook for Constraints

Grid capacity limits into the affected area were reached in October, November and December 2000 as described in section 2.0, and the high cost Townsville gas turbines were required to operate to maintain power flows within grid capability.

Powerlink considers that there is a high likelihood that the constraints experienced during the current summer will continue during coming summer periods, due to the combination of transfer limits and growing load in the area. Due to the flat daily load profile, the period of time throughout any day that limits on transmission capacity will require local generation dispatch is also likely to be significant.

There are some factors which may offset a load growth-driven increase in the levels of constraints in the 2001/02 summer. For example, some of the constraints experienced in the current summer were due to a forced outage at Kareeya power station – this is arguably a one-off event, although the outcome is similar to that from a shortage of water. The committed incremental transmission augmentations should also assist to reduce the levels of constraints experienced as a result of the Ross limit.

4.4 Future Outlook

If the current supply situation is not altered, significant constraints at the CQ-NQ and Ross limits are likely to continue beyond 2001/02 and the duration will increase markedly as electricity demand grows. This will mean a growing proportion of customer demand will have to be met by local generation – most likely the high-cost Townsville gas turbines - with material cost impacts for consumers. The options which may be available to reduce these impacts include grid augmentation, grid support arrangements with existing or new generators, or demand side measures.

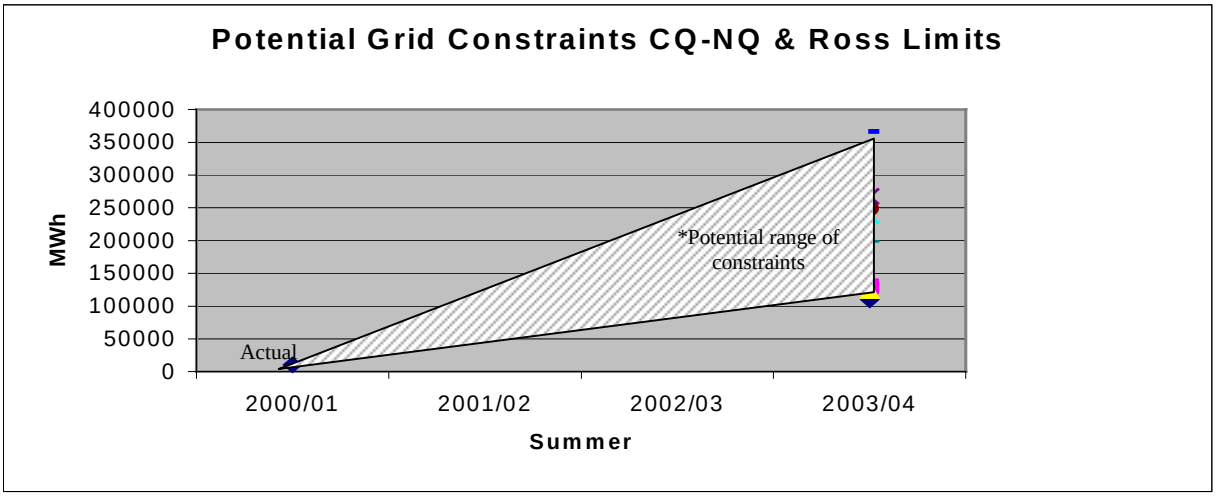
Forecasting the potential hours that grid limits may be reached, and the energy expected to be required from constrained or directed generation, is not a simple task. Because of the dependence of the limits on the pattern of generation, estimating future grid constraints involves first identifying plausible generation scenarios to determine the expected grid capacity for particular scenarios (system conditions).

As noted earlier, Powerlink is presently refining its methodology for determining potential grid capacity based constraints. Based on a preliminary constraint equation for the CQ-NQ Limit[4] , Powerlink has assessed the network capability for supply into the affected area as ranging between 780 and 900MW in the year 2003/04[5].

[4] At the present time, the Ross limit is likely to bind first (ie – as power flows increase, this limit will be reached first). The minor committed augmentations described in section 3.4 will increase the transmission capability into Ross to the extent that, in the short to medium term, Powerlink expects the CQ-NQ limit to bind first. Capacity in both areas is expected to remain tight until major augmentation occurs.

[5] Participants will be informed of any changes to this assessment during this consultation process. The formal definition of grid limits will be provided to and agreed with NEMMCO for operation of the market when the constraint equation is finalised.

The following graph shows the potential scale of total directed generation for the next few years on the CQ-NQ and Ross limits by extrapolating from the actual constraints experienced in summer 2000/01 to constraints estimated from market simulations of some plausible generation and load scenarios for the summer of 2003/04 (see 4.4.1).



**indicative range of potential constraints extrapolated from actual constraints in October-December 2001 to expected constraints under a range of scenarios outlined in section 4.4.1*

As can be seen in the graph, there are outcomes where the levels of constraint grow very rapidly and where resultant costs may be extremely high.

4.4.1. Scenario Analysis

To date, Powerlink has conducted analysis to determine potential grid constraints under a limited range of scenarios. Work has been carried out based on the existing supply system only, including plant which is under construction. No allowance has been made for uncommitted generation or transmission in the affected area. This is to allow solution providers to compare the constraint situation with and without proposed developments, and demonstrate the net benefits that would flow from their establishment.

There has also been no allowance made for potential regulated grid support payments to local generators, as this may be one of the potential solutions to the constraints. In other words, generation output levels are assumed to result from market bidding decisions.

Powerlink has estimated the expected grid constraints in the affected area in the summer of 2003/04 to be:

Demand Forecast	Energy to be supplied from local generation (except hydro & embedded)
Moderate growth	130 000MWh – 198 000MWh*
Moderate growth with 100MW step increase due to industrial expansion at Townsville	267 000MWh – 366 000MWh*

** range due to impacts of varying levels of local generation output*

These constraint forecasts are based on an assumption that demand is initially supplied by grid flows into the affected area from central and southern Queensland, and by output from local embedded generators and the northern hydro power stations (assumed to generate at the average output for the past five years[6]). Any demand in the affected area which cannot be supplied from these sources is assumed to have to be supplied by generators that are directed to operate due to limitations on the capacity of the transmission network.

There are naturally other plausible generation and load scenarios. Powerlink intends to conduct further analysis to examine the sensitivity of constraint levels to variables such as:

- different generating patterns by local scheduled and embedded generators
- unavailability of local generators
- extreme weather patterns
- different demand growth forecasts.

Powerlink would welcome input from market participants in their submissions to this discussion paper regarding other issues and sensitivities which may need to be addressed.

4.4.2. Discussion of Results

As noted in section 2.0, Powerlink is not privy to the costs of generation which might need to be directed to operate. It is therefore difficult at this point to accurately estimate the economic costs of the forecast levels of constraints. However, as an indication of the potential costs, if all constraints are met by output from the high cost gas turbines at an additional cost of $140/MWh[7], costs could range between $18M and $50M for the year 2003/04.

[6] It is assumed that, due to the inability to store large quantities of water, the hydro generators will operate whenever there is available water and are less impacted by market bidding than other generators.

[7] Based on cost figures provided by consultants for the SNI evaluation as per section 2.0, less an allowance for pool revenue which may be received by the generator through the market.

5.0 Addressing Grid Constraints

5.1 "Prima facie" case for augmentation

Powerlink's transmission licence requires it to ensure that, as far as technically and economically practicable, the transmission grid has sufficient capacity to meet demand[8].

This paper forms part of Powerlink's assessment of the economic practicality of overcoming the constraints due to the CQ – NQ limit and Ross limits from the summer of 2002/03. Plausible scenarios exist where the cost of the anticipated constraints in 2002/03 exceeds $12-14 million. All things being equal, this quantum would increase in subsequent years.

By way of comparison, a transmission augmentation with a capital cost of $90 million would result in an annual increase in transmission charges of around $11-12 million. There is, therefore, a prima facie case for transmission augmentation to relieve the constraints.

Of course, a transmission augmentation may not be the only ameliorative solution available, and may not necessarily be the most beneficial. The National Electricity Code requires that alternative solutions be assessed in accordance with the ACCC Regulatory Test.

5.2 Identifying Solutions

One of the purposes of this paper is to provide information to the market on the observed and predicted network limitations in the affected area. This is intended to enable interested parties to formulate and propose feasible and definitive options which may relieve grid constraints in the affected area.

As indicated, Powerlink considers that there are plausible scenarios where investment to augment the transmission system would deliver positive net market benefits, although this needs to be confirmed by further analysis and modelling of various market development scenarios.

Other options (eg – local generation or demand side management (DSM)) might also provide positive net market benefits compared to the existing supply system, and Powerlink is obliged to compare those options with network augmentation options to determine the option with the greatest net benefit.

This paper, and subsequent consultation, provides an opportunity for alternative solution providers to submit details of their proposals for consideration in this market benefit analysis.

[8] Powerlink's transmission authority includes a responsibility "….to 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." (Electricity Act 1994, S34.2).

5.3 Assessment of Solutions

The ACCC's Regulatory Test and Chapter 5 of the Code require Powerlink to consider local generation, DSM, transmission and any other augmentation options equally.

Where the augmentation is not required to meet reliability standards in the Code (as is the case for the CQ-NQ Limit and Ross Limit constraints), augmentations satisfy the Regulatory Test if they "maximise the net present value of the market benefit having regard to a number of alternative projects, timings and market development scenarios".

For the purposes of the Regulatory Test, market benefit of a proposed solution means the total net benefit (net of project costs) to all those who produce, distribute and consume electricity in the National Electricity Market (NEM). Assuming reliability standards can be met by the existing supply system for the foreseeable future, new augmentations might result in such benefits as reduced ancillary service requirements and reductions in the total fuel and variable operating costs in the NEM.

The Regulatory Test requires a public process, with disclosure of project costs. As the outcome of the economic analysis could be a recommendation to proceed with a regulated solution, it is important that all feasible options are considered in the process. If a non-network option satisfies technical requirements, is committed and delivers greater market benefits than a transmission augmentation, it may be necessary for Powerlink to enter into a grid support contract with the proponents of the alternative project to ensure the problem is overcome. If regulated funding is required from Powerlink, it is necessary that support payment arrangements satisfy the Regulatory Test in terms of both economics and disclosure to the market.

6.0 Request for Information

Powerlink invites submissions and comments in response to this discussion paper from national electricity market participants, solution providers and any other interested parties.

Submissions should be presented in a written form and should clearly identify the author of the submission including contact details for subsequent follow-up if required. If parties prefer, they may request to meet with Powerlink ahead of providing a written response.

6.1 Submissions from Solution Providers

This is not a tender process – submissions are requested so that Powerlink can fulfil its regulatory obligations to compare the net present value market benefit of alternatives to the option of augmenting the transmission supply system to ameliorate the identified constraint.

If your submission proposes a solution that may have a positive net market benefit compared with the existing supply situation, it should contain the following information:

- Details of the party making the submission (or proposing the solution)
- Technical details of the project (capacity, proposed connection point if relevant etc) to allow Powerlink to assess the likely impacts on grid constraints
- Sufficient information to allow the costs of the solution to be incorporated in a cost-benefit comparison in accordance with ACCC Regulatory Test guidelines.
- An assessment of the ability of the proposed solution to meet the technical requirements of the National Electricity Code
- Timing of the availability of the option, and whether it is a committed project
- Other material that would be relevant in the assessment of the proposed solution

As the submissions may be made public, any commercially sensitive material, or material that the party making the submission does not want to be made public, should be clearly identified. It should be noted that Powerlink is required to publish the outcomes of the Regulatory Test analysis. If solution providers elect not to provide specific project cost data for commercial-in-confidence reasons, Powerlink would rely on cost estimates from independent sources.

6.2 Timetable for Submissions

Please provide information by Monday 19th March to:

Alison Gray
Manager Network Assessments
Powerlink Queensland
PO Box 1193
Virginia QLD 4014

6.3 Assessment and Decision Process

Powerlink intends to carry out the following process to assess what action, if any, should be taken to address the identified network limitations:

Part 1	Initial Information Request (this paper). Submissions (responses to this paper).	Issued mid Feb 2001 Due by 19th March 2001
Part 2	Review and analysis. Likely to involve further consultation with Code participants and interested parties. Additional data may be requested to allow Powerlink to carry out the economic assessment process as required by the National Electricity Code and the ACCC Regulatory Test.	April 2001
Part 3	Presentation of draft report and recommendation of solution, if any, which satisfies the Regulatory Test Submissions on draft report Presentation of final report and recommendation	May 2001
Powerlink Queensland reserves the right to amend the timetable at any time. Amendments to the timetable will be made available on the Powerlink website (www.powerlink.com.au)		

The consultation timetable is driven by the need to make a decision by mid 2001 if any option involving significant construction is to be in place by the summer of 2002/03. The constraints are already material, and, in the absence of an ameliorating action, this situation is likely to persist or worsen.