

New Brunswick System Operator
Exploitant du réseau du Nouveau-Brunswick



10-Year Outlook:

**An Assessment of the Adequacy of
Generation and Transmission Facilities**

In

New Brunswick

2006 - 2015

1.0 EXECUTIVE SUMMARY

On October 1, 2004 New Brunswick's *Electricity Act* restructured the electric utility industry in New Brunswick and created the New Brunswick System Operator (NBSO). It is an independent not-for-profit statutory corporation separate from the NB Power group of companies. The *Electricity Act* transferred the responsibility for the security and reliability of the integrated electricity system from NB Power to NBSO, and also made NBSO responsible for facilitating the development and operation of the New Brunswick Electricity Market. These responsibilities take the form of operation of the NBSO controlled grid and administration of the Open Access Transmission Tariff (OATT) and the Market Rules.

This document, *10-Year Outlook: An Assessment of the Adequacy of Generation and Transmission Facilities in New Brunswick 2006 – 2015*, is the second of an annual series of such reports from NBSO. The intent of this document is to inform existing and potential Market Participants of the current and future outlook for the market and for the adequacy of the electricity system. It includes committed generation and transmission plans for new projects and potential plans for other transmission upgrades that may be required. With this information, Market Participants will be able to assess potential market opportunities for themselves and their customers from a common base.

New Brunswick's electricity system faces both significant challenges and potential opportunities over the next 10 years. One of the challenges is the uncertainty regarding plans for new generation resources to support load growth. Some announcements regarding new generation projects in New Brunswick during the last year include:

- On July 29, 2005, the Province announced that it would proceed with the planned refurbishment of the Point Lepreau nuclear station, with Atomic Energy of Canada Limited (AECL) as the general contractor. This 18-month refurbishment is to begin in April 2008, and results in a 558 MW capacity reduction for the system during the refurbishment period. NB Power Distribution and Customer Service is in the process of identifying the capacity requirement for the refurbishment period, and is looking at ways to meet this requirement.
- On October 18, 2005, NB Power Distribution and Customer Service (DISCO) issued an Expression of Interest (EOI) for proposals to develop, own, and operate up to 400 MW of wind powered electricity for purchase by DISCO. The deadline for this EOI was December 16, 2005. DISCO's intent is to review each proposal to determine if any of the proposals warrant further negotiation and/or formal execution of a Power Purchase Agreement (PPA). This process is expected to conclude by the end of spring 2006.

Opportunities for the New Brunswick electricity system include the continued evolution of the Electricity Market that allows for participants to independently buy and sell power through bilateral contracts. Open access to the transmission system makes it attractive for developers to build power projects in New Brunswick, and the increased transfer

capability provided by the planned second 345 kV interconnection project with New England provides New Brunswick power producers with more opportunities to export power. The increase in import capability provided by the second interconnection also enhances the competitiveness of the Electricity Market by providing load serving Market Participants a greater choice of suppliers. Open access to the transmission system and the planned second interconnection project also provide opportunities for other areas in the northeast by increasing the potential for wheeling through New Brunswick.

The 10-year load forecast predicts that the electrical energy to be supplied to New Brunswick customers will increase from 15,913 GWh in 2006/07 to 18,074 GWh in 2014/15. This increase of 2,161 GWh represents an annual net energy growth rate of 1.4%. The load forecast for the hourly peak demand shows an increase from 3,207 MW in 2006/07 to 3,684 MW in 2015/16. This increase of 477 MW represents an annual peak demand growth rate of 1.6%.

The outlook on generation resources shows that the New Brunswick system requires an additional 222 MW in 2008/09 to meet the long term NBSO capacity based reserve criterion. The cause of this capacity shortage is the planned 18-month refurbishment of the Point Lepreau Generating Station that is scheduled for April 2008 to November 2009. The current net capability of this nuclear station is 581 MW, which will increase to 635 MW after refurbishment.

The only committed generation addition in this 10-year Outlook is the 20 MW Grand Manan Wind Project in 2006/07, New Brunswick's first commercial wind project. Generation retirements include 98 MW at Courtenay Bay in 2009/10, and 57 MW at Grand Lake in 2010/11. Beyond the refurbishment period, the outlook forecasts capacity deficits of 57 MW in 2014/15, and 143 MW in 2015/16. Deficits are expected to grow beyond 2016. Details of the load and resources review are provided in the table below for the planning period.

Load and Resources Review 2006/07 to 2015/16

		Fiscal Year Ending									
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
A	Load Forecast	3,207	3,250	3,240	3,290	3,350	3,406	3,470	3,538	3,612	3,684
B	Non-Firm Industrial	137	144	144	144	144	144	144	144	144	144
C	Required Reserve C = 20%*(A - B)	614	621	619	629	641	652	665	679	694	708
D	Interconnection Contracts (+Export/-Import)	237	236	210	240	240	50	50	50	50	50
E	Total Supply Resources	4,273	4,261	3,703	4,240	4,184	4,184	4,184	4,184	4,155	4,155
F	(+Surplus/-Deficit) F = E + B - D - C - A	352	298	-222	225	97	220	143	61	-57	-143

Major projects in the planning period that impact the bulk transmission system include:

- the building of a second 345 kV tie between New Brunswick and New England by 2007 that will increase the transfer capability to and from ISO New England by about 300 MW, and
- installation of the Newcastle Terminal 345/230 kV tie transformer in the 2010-2014 time period for system security and back-up to the Bathurst 345/138kV transformer.

In addition, several other projects are identified in this report to maintain supply reliability to customers served from the 138 kV and 69 kV systems.

This 10-Year Outlook fulfills NBSO's obligation under Market Rule 9.3 to publish an annual assessment of the potential need for investments in transmission facilities and other actions that may be required to maintain reliability of the SO-controlled grid, to improve performance of the market, and to reduce the costs associated with transmission constraints on the SO-controlled grid. Under Market Rule 9.4, third parties may contact NBSO to bid on the projects identified in this report, or they may propose alternative solutions to these projects that may include, but are not limited to, transmission, generation, distribution, and energy efficiency projects.

2.0	TABLE OF CONTENTS	
1.0	EXECUTIVE SUMMARY	2
2.0	TABLE OF CONTENTS	5
2.1	List of Tables	6
2.2	List of Figures	6
3.0	INTRODUCTION	7
4.0	LOAD FORECAST	8
4.1	Annual Requirements	8
4.2	Historical and Forecast Requirements	10
5.0	GENERATION RESOURCES	12
5.1	Existing Generation Resources	12
5.2	Changes in Capacity	13
5.3	The Need for New Resources	14
6.0	RESOURCE ADEQUACY	15
6.1	Operating Reserve Criterion	15
6.2	Planning Reserve Criterion	15
6.3	Load and Resources Review	16
6.4	Strengths and Weaknesses	17
7.0	TRANSMISSION SYSTEM	18
7.1	System Evolution	18
7.2	Interconnections to External Systems	18
8.0	TRANSMISSION PLAN	20
8.1	Transmission Planning Responsibilities	20
8.2	Transmission Planning Criteria	20
8.3	Transmission Planning Methodology	21
8.4	Determination of Regional Loads for Transmission Planning Studies	24
8.5	Transmission Development 2006 to 2015	25
8.6	Transmission Region Requirements	27
8.7	Life Extension of Transmission Lines	28
9.0	SUMMARY OF RESULTS	30
10.0	REFERENCES	33
APPENDIX A	SYSTEM DESIGN CRITERIA	34

2.1 List of Tables

Table 1	New Brunswick 10-year Load Forecast.....	9
Table 2	New Brunswick Generation Resources	12
Table 3	Summary of New Brunswick Generation Changes	14
Table 4	Load and Resources Review for New Brunswick 2006/07 to 2015/16.....	16
Table 5	Interconnection Transfer Capability	19
Table 6	Non-coincident Peak Loads by Region.....	25

2.2 List of Figures

Figure 1	Monthly Consumption of Annual System Net Energy	9
Figure 2	Monthly Peak Loads as a Percentage of Annual Peak Load	10
Figure 3	New Brunswick Annual Energy Consumption.....	11
Figure 4	New Brunswick Peak Hourly Load	11
Figure 5	Forecast of Remaining Service Life of New Brunswick Generators.....	14
Figure 6	Transmission Planning Process.....	22

3.0 INTRODUCTION

On October 1, 2004 New Brunswick's *Electricity Act* was proclaimed and the electric utility industry in New Brunswick was restructured. Competitive supplier choice for municipal utilities and large industrial customers served from the transmission system was provided; the Electricity Market under Market Rules issued by the Minister of Energy was opened; and a new corporation called New Brunswick System Operator (NBSO) was created.

NBSO is an independent not-for-profit statutory corporation separate from the NB Power group of companies. It is led by a CEO and governed by an independent Board of Directors. The primary responsibilities of NBSO are to ensure the security and reliability of the integrated electricity system, and to facilitate the development and operation of a competitive electricity market. These responsibilities take the form of operation of the SO controlled grid and administration of the Open Access Transmission Tariff (OATT) and the Market Rules. They also include contract and agreement development, market monitoring, system studies, accounting, settlement, interconnection issues, and Regional Transmission Organization (RTO) development.

The current OATT was approved by the New Brunswick Board of Commissioners of Public Utilities (PUB) in its decision of March 13, 2003 and specifies the terms, conditions and rates for use of the NBSO controlled transmission system. Any future changes and additions to the OATT will be made by NBSO and submitted for regulatory approval to the PUB. The Market Rules govern the rights and obligations of entities participating in the Electricity Market (Market Participants). The initial Market Rules were issued by the Minister of Energy effective October 1, 2004 and are based on principles recommended by the Market Design Committee in April 2002 and accepted by government. Any future changes and additions to the Market Rules will be made by NBSO after consultation with stakeholders through the Market Advisory Committee (MAC). The MAC includes representatives from a wide range of interested parties (large industrial customers, municipal utilities, generators, transmission operators, transmission users, environmental groups, small consumers, etc.). The role of the MAC is to review and propose potential changes to the OATT and Market Rules and make appropriate recommendations to the NBSO Board of Directors regarding their implementation.

In addition to being the operating authority for the reliable operation of the New Brunswick electricity system, NBSO is responsible for its long-term planning and development. Under the Market Rules, NBSO is required to publish annually a 10-year outlook regarding the current and future adequacy of the NBSO controlled integrated electricity system. This is the second such report and it includes the most recent official 10-year load forecast, and the current outlook for new generation and transmission projects. The intent of this document is to inform existing and potential Market Participants of the current and future state of the electricity system so that they will be able to assess potential market opportunities for themselves and their customers from a common base.

4.0 LOAD FORECAST

The load forecast represents the current 10-year forecast of the electricity requirements of in-province customers for 2006/07 to 2015/16. It is prepared based on a cause and effect analysis of past loads, combined with data gathered through customer surveys and an assessment of economic, demographic, technological and other factors that affect the utilization of electrical energy. This forecast incorporates the effects of the availability of natural gas in New Brunswick, energy efficiency and conservation measures, and changes in industrial customer self-generation.

Energy requirements and peak hour demand are affected by weather conditions, the most significant being temperature. The energy forecast is based on 30-year average temperatures (1971-2000) with the annual peak hour demand determined for a design temperature of -24°C over a sustained 8-hour period.

4.1 Annual Requirements

The 10-year load forecast in this report is based on the NB Power document *Load Forecast 2005 – 2015*, with Perth Andover load added. The load forecast for 2016 was produced by escalating the 2015 load forecast by 2%. The inclusion of Perth Andover is required because on January 1, 2005 Perth Andover became part of the NBSO controlled grid whereas it had previously been part of the Northern Maine load. Perth Andover load represents about 0.2% of the New Brunswick total, and its energy and demand growth is assumed to be the same as the rest of the province. The 2006/07 numbers reflect the most recent 18-month assessment data for New Brunswick and Perth Andover load.

Table 1 shows the 10-year load forecast of annual energy and peak load requirements for New Brunswick. System net energy has a forecast growth rate of 1.4% per year, and the peak hourly demand is forecast to grow at 1.6% per year.

The highest months of energy consumption in New Brunswick are December through February due to the electric heating load in the province. The months with the lowest energy consumption are June through August due primarily to warmer temperatures.

Although January represents the peak month for energy consumption, the peak hourly demand in New Brunswick is forecast to occur in the first week of February. The forecast for a February peak hourly demand occurs because, historically, the January peak load has been lowered through curtailments of interruptible customers on the coldest days, and these curtailments have occurred more often in January than in February.

Figure 1 shows the forecast consumption of annual system net energy on a monthly basis.

Figure 2 shows how the monthly peak loads are forecast to vary as a percentage of the annual forecast peak load.

Table 1
New Brunswick 10-year Load Forecast

Year	System Net Energy (GWh)	Peak Hourly Demand (MW)
2006/07	15,913	3,207
2007/08	16,104	3,250
2008/09	16,102	3,240
2009/10	16,196	3,290
2010/11	16,473	3,349
2011/12	16,763	3,406
2012/13	17,064	3,470
2013/14	17,386	3,538
2014/15	17,719	3,612
2015/16	18,074	3,684
Overall Increase (from 2006/07)	2,161	477
Average Annual Growth Rate	1.4%	1.6%

Figure 1
Monthly Consumption of Annual System Net Energy

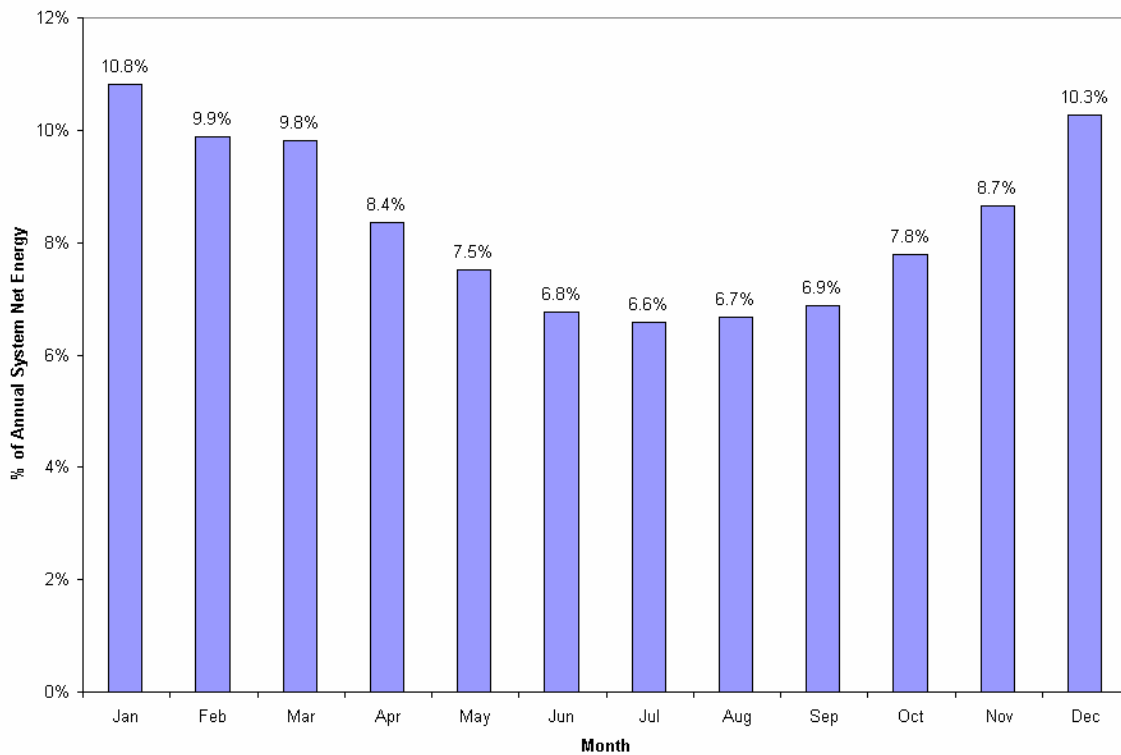
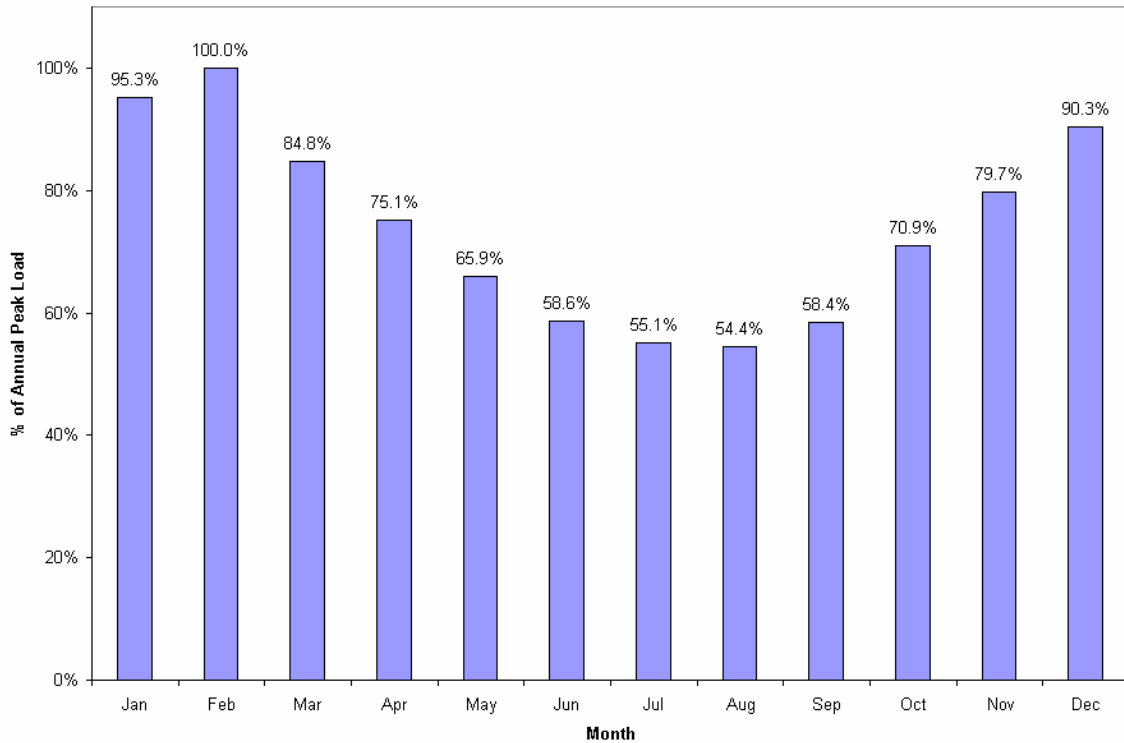


Figure 2
Monthly Peak Loads as a Percentage of Annual Peak Load



4.2 Historical and Forecast Requirements

NB Power Distribution and Customer Service (DISCO) currently serves all of New Brunswick except for Perth Andover. Each year DISCO prepares a load forecast that represents the long term projection of in-province customer requirements for demand and energy. This forecast reflects the fact that the New Brunswick economy is very electrically intensive, due in large measure to the forestry and mining industries. In 2004/05, large industrial loads accounted for 41% of NB Power’s in-province energy sales. Modernization efforts have increased industrial consumption in recent years, and that trend is expected to continue.

Figure 3 shows the actual annual energy consumption from 1973 to 2005, and the forecast annual energy consumption for 2006 to 2015.

Figure 4 shows the actual peak hourly demand from 1973 to 2005, and the forecast peak hourly demand for 2006 to 2015.

Figure 3
New Brunswick Annual Energy Consumption

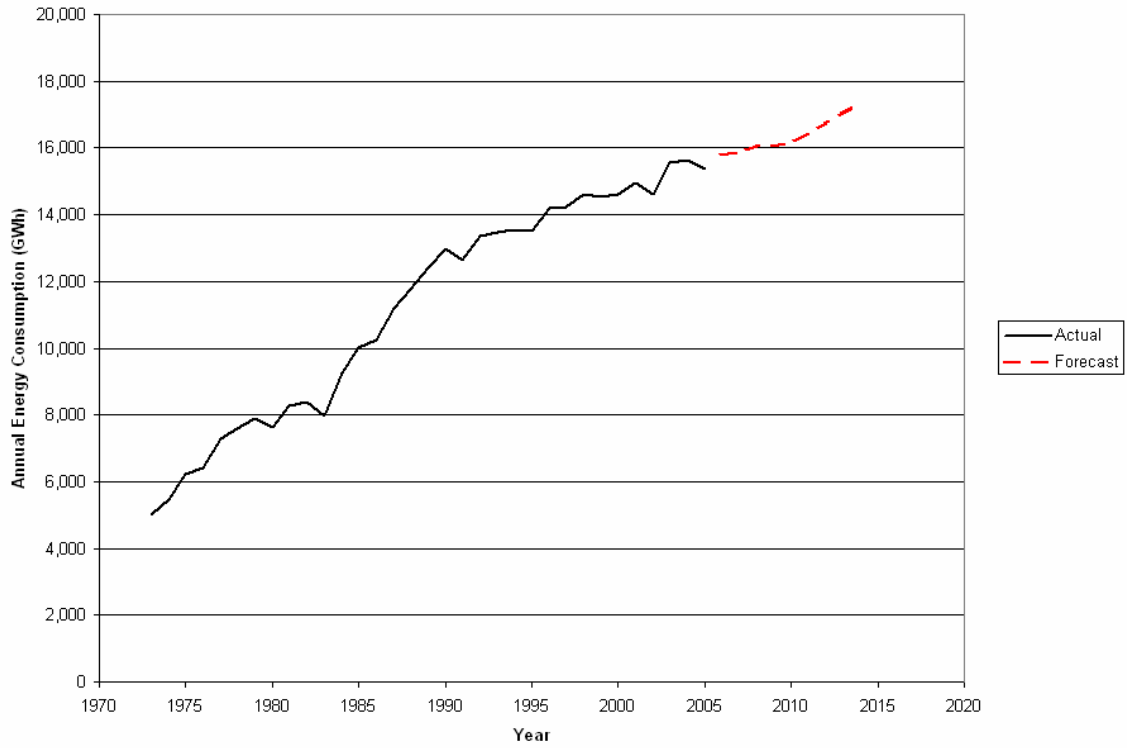
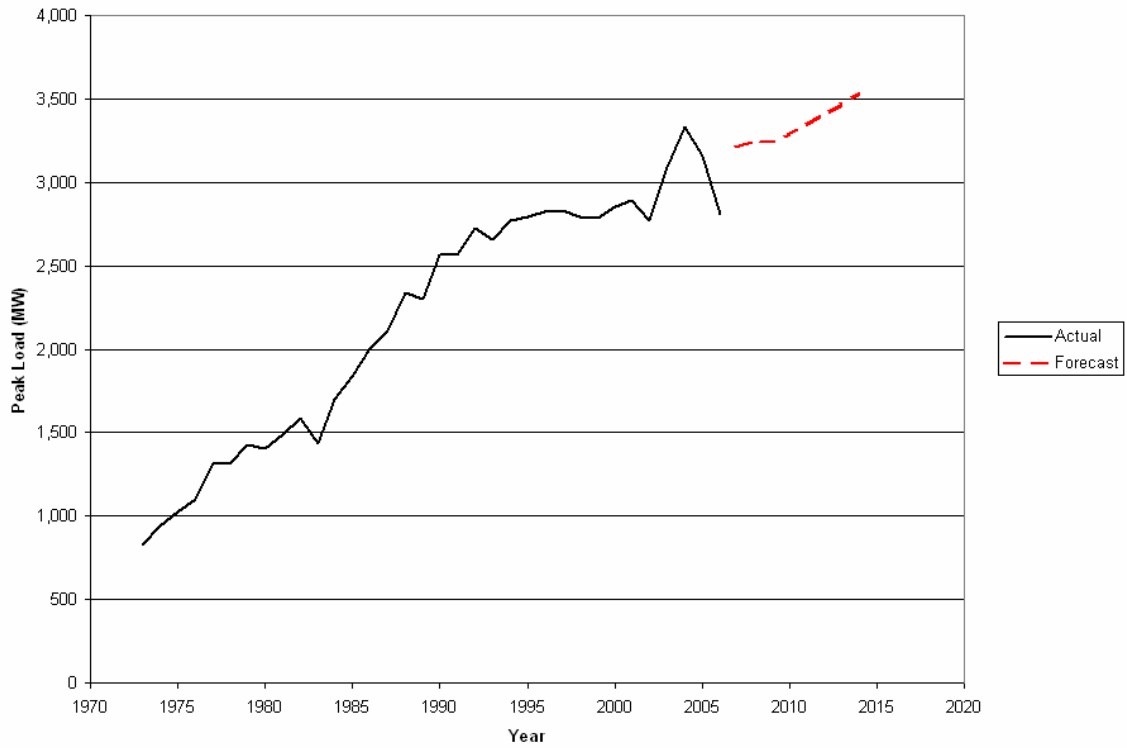


Figure 4
New Brunswick Peak Hourly Load



5.0 GENERATION RESOURCES

5.1 Existing Generation Resources

New Brunswick's generation plants comprise one of North America's most diverse generating systems. The mix of fuel types includes oil, hydro, nuclear, coal, natural gas, Orimulsion®, biomass, and diesel powered stations. Table 2 lists the New Brunswick generators along with their fuel types and capacities as of March 31, 2006.

Table 2
New Brunswick Generation Resources

Plant	Unit	Type	Net Capacity MW	Notes
Point Lepreau	1	Nuclear	581	Planned Refurbishment starting in April 2008
	SG1&2	Diesel	5	
Belledune	2	Coal	457	
Courtenay Bay	4	Oil	97	
Coleson Cove	1	Oil	324	
	2	Oil	324	
	3	Oil	324	
Dalhousie	1	Orimulsion® / Oil	96	
	2	Orimulsion® / Oil	203	
Bayside	6	Natural Gas	263	Capacity includes Combined Cycle Operation
Grand Lake	8	Coal	57	
Grand Manan	3	Diesel	28	
Millbank	1	Diesel	99	Tied to Sale Contract Until Nov 2011 Tied to Sale Contract Until Nov 2011
	2	Diesel	99	
	3	Diesel	99	
	4	Diesel	99	
Ste Rose	1	Diesel	99	
Grandview	1,2	Natural Gas	90	
Frasers	1	Biomass	38	
St. George	1,2	Hydro	15	
Musquash	1,2	Hydro	5	
Mactaquac	1	Hydro	110	
	2	Hydro	110	
	3	Hydro	110	
	4	Hydro	116	
	5	Hydro	113	
	6	Hydro	113	
Beechwood	1	Hydro	36	
	2	Hydro	36	
	3	Hydro	41	
Grand Falls	1	Hydro	16	
	2	Hydro	16	
	3	Hydro	16	
	4	Hydro	16	
Tobique	1	Hydro	10	
	2	Hydro	10	
Sisson	1	Hydro	9	
Milltown	1	Hydro	4	
TOTAL CAPACITY			4284	Total Capacity as of March 31, 2006

The bulk of the energy produced by hydro facilities usually comes during the spring run-off period when the snow melts in the watersheds in the upper reaches of the Saint John River. New Brunswick does not have major storage capability in its river system, and as a result, hydro facilities are not always fully available to supply at maximum power output on a continuous basis. The hydro system does serve a vital role in meeting short term peaking needs as well as providing immediate replacement power in the case of a sudden trip-off of another generating unit.

5.2 Changes in Capacity

At this time, there are no firm plans for major conventional generation additions in New Brunswick. New Brunswick's first commercial wind power project, a 20 MW wind farm on Grand Manan Island, has a target in-service date of late 2006. Due to the intermittency of wind power, the capacity credit assigned to wind projects by NBSO is derated to the wind project's capacity factor averaged over the three most recent years of operation. However, because of existing Grand Manan thermal generation, light load on the island, and limited transmission from the island, there is no capacity value associated with the Grand Manan wind project.

On October 18, 2005, NB Power Distribution and Customer Service (DISCO) issued an Expression of Interest (EOI) for proposals to develop, own, and operate up to 400 MW of wind powered electricity for purchase by DISCO. The deadline for this EOI was December 16, 2005. DISCO's intent is to review each proposal to determine if any of the proposals warrant further negotiation and/or formal execution of a Power Purchase Agreement (PPA). This process is expected to conclude by the end of spring 2006.

Planned generation retirements in the next 10 years include 98 MW at Courtenay Bay in 2009/10, and 57 MW at Grand Lake in 2010/11. The replacement of some feeder tubes at Point Lepreau is expected to derate that facility by 11 MW in 2006/07, and an additional 12 MW in 2007/08.

A planned 18-month refurbishment of the Point Lepreau nuclear station is targeted for April 2008. The loss of this generator results in a 558 MW capacity decrease for the system during the refurbishment period. The scheduled completion date for the project is November 2009, and the refurbished net capability of the generator is to be 635 MW. Approval to proceed with this project was given by the Province in July 2005, with Atomic Energy of Canada Limited (AECL) as the general contractor. NB Power Distribution and Customer Service is in the process of identifying the capacity requirement for the refurbishment period, and is looking at ways to meet this requirement. Table 3 provides a summary of the generation capacity changes from January 2005 to December 2009.

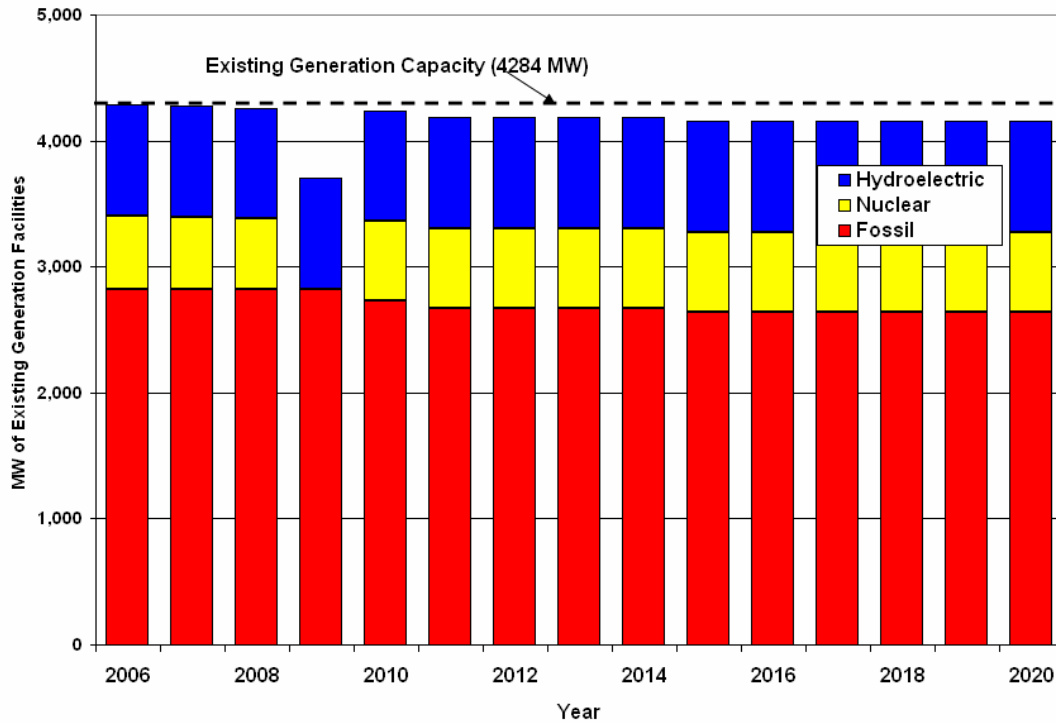
Table 3
Summary of New Brunswick Generation Changes

Year	January Capacity MW	December Capacity MW	Capacity Change MW	Explanation
2006	4284	4273	-11	Grand Manan Wind Project (+0 MW equiv. capacity), Point Lepreau derated (-11 MW)
2007	4273	4261	-12	Point Lepreau derated (-12 MW)
2008	4261	3703	-558	Point Lepreau refurbishment begins April 2008 (-558 MW)
2009	3703	4240	+537	Point Lepreau refurbishment ends October 2009 (+635 MW), Courtenay Bay 4 retired (-98 MW)
2010	4240	4184	-56	Grand Lake retired (-56 MW)

5.3 The Need for New Resources

Over time, the aging of the existing fleet of New Brunswick generators will result in additional retirements that will require either new generation resources or refurbishment of existing resources. Figure 5 illustrates the forecasted remaining service life of the existing generation facilities in New Brunswick over the next 20 years.

Figure 5
Forecast of Remaining Service Life of New Brunswick Generators



6.0 RESOURCE ADEQUACY

6.1 Operating Reserve Criterion

NBSO is responsible for determining the capacity needs of the integrated electricity system, and for ensuring that Market Participants procure and provide sufficient capacity to meet these needs. The capacity required by the system is the sum of the NBSO forecasts for load, required reserve, and firm capacity sales. The capacity available to the system is the sum of the installed capacity, firm capacity purchases, and interruptible load, minus any capacity that is derated or unavailable due to a planned maintenance outage.

NBSO regularly performs assessments of operational resource adequacy for each capability period and for the next 18 months (done each quarter). The main operational criterion is to have sufficient reserve capacity to meet 100% of the largest contingency plus 50% of the next largest contingency. The 18-month assessments by NBSO of the capacity and adequacy of the integrated electricity system are published quarterly at <http://www.nbso.ca> in the *Reports and Assessments* section.

The capability period assessment takes place 6 months prior to the start of each of two capability periods. The winter capability period starts November 1 and ends March 31. The summer capability period starts April 1 and ends October 31. NBSO forecasts the capacity requirements for the total system for the respective capability period and allocates those requirements to all load-serving Market Participants on the basis of their non-coincident peak demands. It is then the responsibility of the load-serving Market Participants to demonstrate to the satisfaction of NBSO that they have secured capacity equal to or in excess of their individual capacity obligations at least 4 months prior to the start of the capability period.

6.2 Planning Reserve Criterion

To assess the long-term generation resource adequacy of the system, NBSO applies a capacity based reserve criterion that is equal to the higher of the largest contingency or 20% of the firm load.

As a member of the Northeast Power Coordinating Council (NPCC), NBSO also reports its resource adequacy with respect to meeting the NPCC generation reliability criterion, which states:

Each Area's probability (or risk) of disconnecting any firm load due to resource deficiencies shall be, on average, not more than once in ten years. Compliance with this criterion shall be evaluated probabilistically, such that the loss of load expectation shall be, on average, no more than 0.1 days per year. This evaluation shall make due allowance for demand uncertainty, scheduled outages and deratings, forced outages and deratings, assistance over interconnections with

neighboring areas and regions, transmission transfer capabilities, and capacity and/or load relief from available operating procedures.

NBSO submits a comprehensive resource adequacy review to NPCC every three years, and interim reviews of resource adequacy are submitted in the years subsequent to completing the comprehensive review. In the most recent comprehensive review, the *2004 Maritimes Area Triennial Review of Resource Adequacy* [1], it was found that the 20% planning reserve criterion used by the Maritimes Area combined with 50 MW of additional capacity provided through interconnection support would meet the NPCC criterion for the existing system. This confirmed that the NBSO capacity based criterion is acceptable under the NPCC standard.

6.3 Load and Resources Review

The load and resources review looks at whether the sum of the generation resources and non-firm industrial load customers are adequate to meet the sum of the forecast requirements for peak load, firm interconnection contracts, and required planning reserve. A surplus indicates that the planned resources are adequate, whereas a deficit indicates that the planned resources are not adequate.

Table 4 summarizes the load and resources outlook from 2006/07 to 2015/16. It shows that the New Brunswick system will be short 222 MW of capacity in the 2008/09 fiscal year due to the planned refurbishment of Point Lepreau. Beyond the refurbishment period, the outlook forecasts capacity deficits of 57 MW in 2014/15, and 143 MW in 2015/16. Deficits are expected to grow beyond 2016.

Table 4
Load and Resources Review for New Brunswick 2006/07 to 2015/16

		Fiscal Year Ending									
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
A	Load Forecast	3,207	3,250	3,240	3,290	3,350	3,406	3,470	3,538	3,612	3,684
B	Non-Firm Industrial	137	144	144	144	144	144	144	144	144	144
C	Required Reserve $C = 20\% * (A - B)$	614	621	619	629	641	652	665	679	694	708
D	Interconnection Contracts (+Export/-Import)	237	236	210	240	240	50	50	50	50	50
E	Total Supply Resources	4,273	4,261	3,703	4,240	4,184	4,184	4,184	4,184	4,155	4,155
F	(+Surplus/-Deficit) $F = E + B - D - C - A$	352	298	-222	225	97	220	143	61	-57	-143

Other than DISCO's obligation to provide standard offer service, there is no prescribed requirement under the Market Rules for specific Market Participants to make up any deficit indicated by this long term review. The purpose of the 10-year load and resources review is to provide information to Market Participants and potential Market Participants of any forecasted deficiency. For example, the future need for replacement capacity during the planned Point Lepreau refurbishment outage to meet the planning criterion is indicated by the load and resources review, but action by specific Market Participants in that timeframe is not prescribed by the Market Rules. Similarly, the results of the 18-month assessments do not prescribe actions by specific Market Participants or trigger sanctions, but do provide important information to NBSO and the marketplace about impending deficits.

As noted in Section 6.1, both winter and summer capability periods are assessed. The Market Rules require Market Participants for load facilities to secure capacity resources equal to or greater than their obligation 4 months prior to each capability period. Non-compliance on the part of a Market Participant may lead to sanctions.

6.4 Strengths and Weaknesses

The geography of New Brunswick provides significant advantages towards the development of a vibrant energy market. An advantage for new thermal power projects is that they can be sited at many high quality coastal locations in the province that have access to low temperature cooling water. Another geographic advantage is that the strong interconnections between New Brunswick and neighbouring power systems in Quebec, New England, Nova Scotia, PEI, and Northern Maine enhance the opportunities for New Brunswick Market Participants to buy and sell power. These opportunities are also enhanced due to the seasonal diversity of the winter peaking New Brunswick load and the summer peaking New England load.

The cost of electrical supply in New Brunswick is stabilized with a diversified generation mix of hydro, nuclear, and thermal sources. However there is a weakness in the lack of indigenous power generation resources, especially hydro power reservoirs and low cost, low sulphur coal reserves. Extensive reliance on thermal generation leads to high dependency on thermal fuels that can be subject to disruption in supply, wide price swings and the need to meet stringent emission standards.

The geographic dispersion of the people of New Brunswick and the lack of population density makes for a complex and sophisticated transmission system connecting generating stations to substations distributing electricity to customers throughout the province.

7.0 TRANSMISSION SYSTEM

7.1 System Evolution

The existing transmission has evolved over the past century. It began mainly as 69 kV lines connecting small generating stations to municipal distribution systems in the first half of the 20th century. Following the Second World War as loads grew and additional stations were constructed, the 138 kV system was expanded to form a figure eight network around the province by the 1960's. Expansion continued into the early 1970's with completion of a 230 kV tree connecting from the northeast (Dalhousie-Bathurst-Newcastle) area to Keswick in the west and across the province past Grand Lake to Salisbury in the southeast. The main bulk system voltage increased to 345 kV with the completion of the New England interconnection and the Coleson Cove Generating Station in the late 1970's. Through the 1980s and 1990s the 345 kV system has expanded to encircle the province and extend into Nova Scotia.

Today the system is very robust with generation dispersed at different system locations and sufficient transmission capacity to economically dispatch generation for exports as well as all in province load levels. As a result congestion is rare except under extreme contingency conditions and power can be transferred in significant quantities in all directions.

7.2 Interconnections to External Systems

New Brunswick is interconnected to neighboring power systems in Quebec, New England, Nova Scotia, Prince Edward Island, Northern Maine, and Eastern Maine. Similar to the development of the internal transmission system these interconnections have evolved over time. The first interconnections were constructed at the 69 kV and 138 kV levels with the Maine Public Service Company in Northern Maine and Nova Scotia Power Inc in the 1950s. The initial interconnections with Quebec, New England and Prince Edward Island were completed as part of the major transmission expansions of the 1970s. Addition of the 345 kV interconnection to Nova Scotia and a second Quebec interconnection occurred in the 1980s. Further expansion of the New England interconnection with a second 345 kV transmission line is planned for 2006/07.

The two interconnections with Quebec are through High Voltage Direct Current (HVDC) stations and there is the ability at each to radially connect a portion of the New Brunswick load directly to the Quebec system. This enables increased transfer capability from Quebec to New Brunswick. All other interconnections are synchronous AC transmission lines and they connect the Maritimes Area systems as part of the very large Eastern Interconnection of North America.

Table 5 shows the transfer capability between New Brunswick and its neighboring systems.

Table 5
Interconnection Transfer Capability

Neighboring System	Transfer Capability to New Brunswick (MW)	Transfer Capability from New Brunswick (MW)
Quebec	1185	735
New England	100 [†]	700
Nova Scotia	350 ^{††}	300 ^{††}
Prince Edward Island	124	222
Northern Maine	90	100
Eastern Maine	15	15

[†] transfer capability from New England varies according to New Brunswick's largest contingency, load levels in Maine, status of area 345 kV MVAR resources, and the generating status of units near Orrington, Maine.

^{††} transfer capability to and from Nova Scotia is constrained by the import and export limits of the Nova Scotia electricity system.

8.0 TRANSMISSION PLAN

8.1 Transmission Planning Responsibilities

The Transmission Plan represents an analysis of the existing high voltage transmission network, and the development required to meet the forecast load in compliance with the established transmission planning criteria.

NBSO is responsible for ensuring that the integrated electricity system, at all times, has adequate capacity to satisfy all applicable reliability criterion. NBSO is also responsible for addressing congestion issues that impact the efficient operation of the Electricity Market.

NBSO, upon identifying a system adequacy issue or a congestion issue, will consult with Transmitters and Market Participants to develop technically feasible options for addressing the issue. These options will then be published on the NBSO website, along with a notice of intent by NBSO to request proposals to resolve the issue. Transmitters and Market Participants may then participate in a formal Request for Proposals (RFP) process leading to the final selection by NBSO of the preferred project.

8.2 Transmission Planning Criteria

The New Brunswick bulk transmission system is planned, designed and operated in accordance with single contingency criteria. The overall system quality of supply, as it relates to frequency and duration of interruption to customers and/or generation and voltage magnitude and waveform, is primarily a function of the accepted System Design Criteria in Appendix A.

NBSO policy is to use the transmission planning criteria widely accepted and used by North American utilities, and the system reliability criteria to which NBSO is obliged to conform through its participation in NPCC. NPCC's role in monitoring conformance with the *NPCC Basic Criteria for Design and Operation of Interconnected Power Systems* [2] is limited to those instances where non-conformance could result in adverse consequences to more than one Area.

These criteria can be summarized as follows:

1. Voltage Criterion

Under all normal (no contingency) heavy or light load operating conditions, there should be sufficient reactive support to enable the 230 kV and 138 kV load bus voltages to be held in the range of 95% to 105% of rated value. This includes the condition of peak load in combination with maximum hydro generating capability and also the condition of reduced load (50% variable +

100% industrial load) in combination with minimum hydro generating conditions.

2. Single Contingency Criterion

A single contingency is defined as an event leading to the loss of one or more system components. The most common interpretation of this definition is the assumption of the loss of one transformer or one transmission circuit or one generator. The loss of both circuits on a double circuit structure is considered a single contingency as required by NPCC for stability tests.

Each 138 kV area load should have less than one 1.0 hour/year expected outage on the loss of the most significant supply. For evaluation under this criterion, all transmission line loadings shall be within the limits where the CSA Code ground clearances can be maintained, and/or the conductor does not exceed 100 degree C, at 2 feet/sec. wind speed.

Under single contingencies, transformers can be loaded up to 119% of their forced cooled 65 degree C rating during the winter months when ambient temperatures does not exceed zero degree C.

8.3 Transmission Planning Methodology

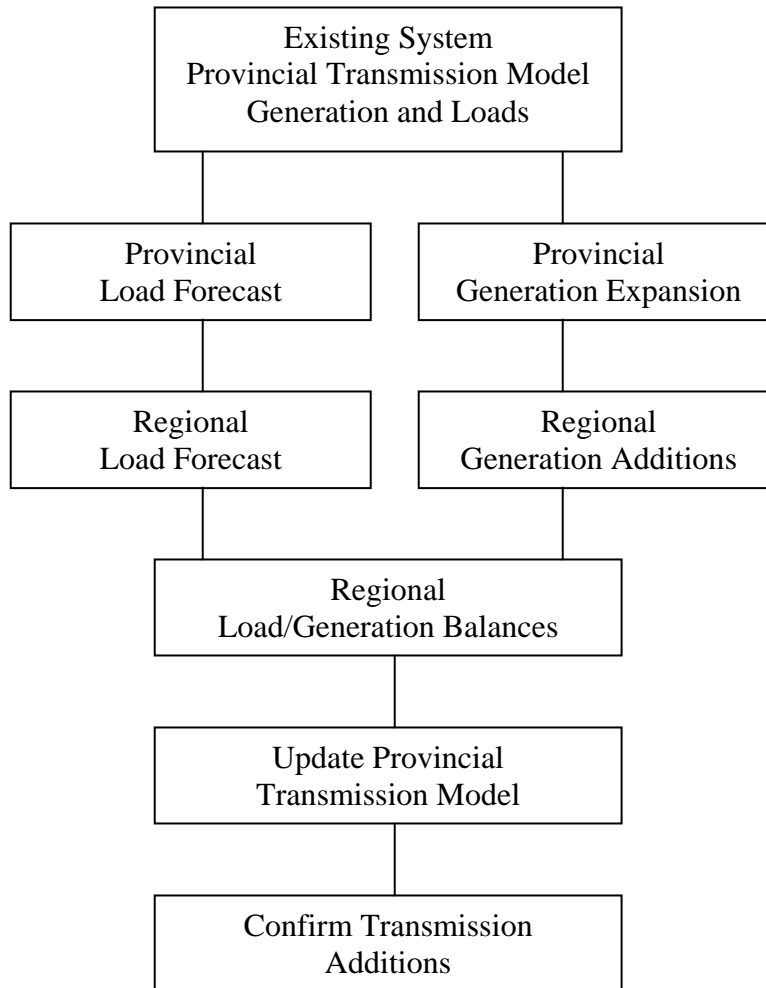
The System Design Criteria, upon which the needs for the recommended system reinforcements are based, are presented in Appendix A. The NPCC Basic Criteria for Design and Operation of Interconnected Power Systems, upon which are based the design of the 345 kV (Bulk) Transmission expansion, are available at <http://www.npcc.org/PublicFiles/Reliability/CriteriaGuidesProcedures/A-02.pdf>.

The planning of the major transmission system has to respond to the forecast load growth and the integration of new generating stations. The objective of transmission planning is, therefore, twofold. It has to satisfy the transmission of power from generating stations to load centres, and has to satisfy the interconnection and integration of generating stations to enable economic and reliable utilisation of the generating capability available to the market.

In the process of transmission planning, the geographic location of loads and generating stations play a role equally important to that of the magnitude of load and capacity of generating stations. Moreover, the planning methodology has to address imbalances between load and generation in any region as well as dynamics (e.g. fault conditions, stability) in order to provide reliable supply to customers.

Figure 6 illustrates the transmission planning process.

Figure 6
Transmission Planning Process



There are three inputs to the transmission planning process.

1. A computer model of the base year for the existing system is required that includes generation, loads, transmission lines and substations. This model simulates generating unit capacities, loads concentrated at load centres, transmission lines and transformers with their transmission characteristics and capabilities. This model, commonly referred to as the load flow model, is used to test the system for satisfactory transmission capability.
2. The second component is the load forecast. The in-province load forecast provides year by year prediction of loads at existing and future substations down to the 69 kV transmission level. Load information is compiled on individual substation peak loads that may or may not occur at the time of system peak. The prediction of sales to and purchases from neighbouring

utilities, based on actual contracts and expected sales or purchases is also an important aspect of the forecast.

3. The third component is the size and location of the present and proposed future generating units and stations.

As major transmission requirements are related to the balance of loads and generation in a geographic region, the first step in planning is to allocate loads and generation to regions. Such regions or transmission planning areas are defined on the basis of general load concentrations. The five regions in New Brunswick defined by NB Power Transmission for major transmission planning purposes are:

1. Northern including, Miramichi, Bathurst, Caraquet, Belledune, Eel River and Dalhousie
2. Western including Edmundston, Iroquois, Saint Andre, Grand Falls, Beechwood, and Woodstock
3. Central including Keswick, Fredericton, Millville, Grand Lake, Marysville, and Mactaquac
4. Southern including Saint John, Courtenay Bay, Pennfield, Oak Bay, Coleson Cove, Norton and Point Lepreau
5. Eastern including Salisbury, Moncton, Memramcook and Murray Corner

The loads and generating capabilities are allocated to the above regions annually during the planning period and the balance, positive or negative, is a measure of transmission capability required into the region to meet load demand or out of the region to transmit surplus generation. This balance is calculated not only for the annual peak hour demand, but also for intermediate load levels

The regional balances give an indication of the magnitude of transmission requirements and provide an appreciation of the long-term variation of such requirements.

To ensure an adequate level of reliability in the northeast part of the continent and across North America, criteria have been established to guide utilities in the design, operation and maintenance of their power systems. Member areas of NPCC agree to abide by guidelines and criteria that have been established by experience over the years. It is these guidelines that form the basis for operation and maintenance of the bulk power system in New Brunswick.

The essential requirement is to provide service continuity to customers, and to avoid jeopardising the reliability of neighbouring power systems in the event of loss of a major

transmission component, line or transformer, or loss of a generating unit. This is commonly referred to as the 'single contingency' planning criterion.

8.4 Determination of Regional Loads for Transmission Planning Studies

Consistent with the overall planning methodology, this section presents the regional non-coincident peak loads for 2005/06. In 2005/06, NB Power Distribution and Customer Service (DISCO) switched from NB Power Transmission's five region structure to its own three region structure as follows:

- Central – headquartered in Fredericton (Marysville) with operating centres in Fredericton, Miramichi, Woodstock, Grand Falls and St. Stephen
- Eastern – headquartered in Moncton with operating centres in Moncton, Bouctouche, Shediac, Sackville, Sussex and Rothesay
- Northern – headquartered in Bathurst with operating centres in Bathurst, Tracadie and Eel River

Table 6 shows the in-province firm loads for the DISCO regions. The total system load as seen by the generating units is the sum of the area loads plus the transmission losses. The peak system losses have been found to be approximately 4%, including the losses in the 345 kV, 230 kV, 138 kV and 69 kV networks. The sum of the loads and losses is the total system load. As the area peak loads may not occur exactly at the same time, the coincident system load as seen by the generation is less than the total load determined by the summation of non-coincident area loads and losses. The diversity factor is calculated by dividing the coincident peak by the sum of the non-coincident peak substation loads. For 2005/06, the diversity factor was found to be 87%.

**Table 6
Non-coincident Peak Loads by Region**

DISCO Region	2005/06 Non-Coincident Peak Load (MW)	Regional Percentage
Central		
Distribution	732	76%
Large Industrial	187	19%
Wholesale	42	4%
Eastern		
Distribution	826	62%
Large Industrial	296	22%
Wholesale	208	16%
Northern		
Distribution	475	60%
Large Industrial	321	40%
Subtotal		
	3087	
Transmission Losses 4%	123	
Total Non-Coincident Peak	3210	
Total Coincident Peak (Dec 2005)	2805	
Diversity Factor	87%	

8.5 Transmission Development 2006 to 2015

This section summarizes the project plans for the 345 kV transmission system, and the 345/230 kV and 345/138 kV transformer projects that impact the development of the 345 kV transmission system. It also lists the plans for 138 kV lines, 69 kV lines, and the 138/69 kV transformation additions connecting into bulk transmission terminal stations. Under Market Rule 9.4, third parties may contact NBSO to bid on the projects identified in this report, or they may propose alternative solutions to these projects that may include, but are not limited to, transmission, generation, distribution, and energy efficiency projects.

1. Stage 2006/07

Construction of a second 345 kV interconnection between New Brunswick and New England is scheduled to begin in 2006/07. This new line will connect Point Lepreau, New Brunswick to Orrington, Maine, and it has a targeted in-service date of December 2007. As a result of this project (including series and shunt capacitors in Maine), the maximum transfer capability between New Brunswick and New England is increased from 700 MW to 1000 MW, and the import capacity from New England to New Brunswick is expected to be raised from 100 MW to 400 MW. This second interconnection also significantly improves the reliability of the Maritimes system since loss of either of the two interconnections to

New England will no longer result in the separation of the Maritimes from the interconnected New England power system.

2. Stage 2006/08

Construction of 69 kV Line 0150 from Iroquois Terminal to East Edmundston Substation is planned for the 2006/08 time period. Loading on the existing Line 0070 supplying the East Edmundston Substation and the neighbouring substations is increasing, and this new line is necessary to accommodate this load growth.

3. Stage 2007/08

Rebuilding of 69 kV Line 0013 from Six Roads to Line 0133 (near Shippigan) is planned for 2007/08. This project is a restoration of a 50+ year old existing 69 kV line that has been exposed to some of New Brunswick's harshest weather conditions. The existing line also requires some portions to have new right-of-ways. For safety and reliability reasons the line will be rebuilt to 138 kV standards allowing proper spacing and safer working conditions for the crews.

4. Stage 2007/08

A new 10.7 MVAR capacitor bank is to be installed on the Grand Lake 69 kV bus in order to provide back-up voltage support to that area. During peak conditions, an outage of the Grand Lake 138/69 kV tie transformer causes the 69 kV voltage in the area to dip below the 0.9 per unit acceptable level. With the addition the new capacitor bank, the voltage problem due to a loss of this transformer is corrected.

5. Stage 2007/08

A third 138/69 kV tie transformer (83/111/156 MVA) is planned for the Bathurst Terminal to provide back-up support for the existing transformers. The loss of either of the existing transformers causes overloading of the transformer remaining in service. The third transformer will correct this potential overloading problem.

6. Stage 2006 to 2012

A new 138 kV transmission line from Salisbury to Memramcook is planned to relieve loading on Line 1156 and Line 1157. Consultation with Customer Services on substation location, route planning and design, environmental requirements will take many years to complete. Therefore, a 6-year completion date is expected.

7. Stage 2008/09

Transformer T1, a 138/69 kV tie transformer at Marysville Terminal, is to be replaced with a larger transformer capable of supporting the area load on peak. T1 is undersized (68 MVA peak at 0 degrees Celsius) and was built in 1957. The on-

load tap changer is in poor shape with parts that are no longer available. The larger transformer replacing T1 will also serve to reduce loading on Marysville transformer T4, which has almost reached its maximum design (134 MVA on peak) under normal peak operating conditions.

8. Stage 2010 to 2014

A 345/230 kV, 450 MVA, transformer will be required at Newcastle terminal for system security and backup of the contingency loss of the Bathurst 345/138 kV transformer. The timing of this project is dependent on the load growth rate in the Bathurst and Newcastle areas, and it is projected to become necessary within the 2010 to 2014 time period.

8.6 Transmission Region Requirements

This section gives a summary of transmission adequacy issues and options at the subtransmission level (138 kV and below) to service area loads.

1. Western Region

This region, along with the Northern region, has the highest percentage of distribution substations supplied at 69 kV (approximately 90%). Limitation of the load growth on a few of the 69 kV transmission lines will be required in order to prevent future 138/69 kV tie transformer additions and construction of new 69 kV lines.

Conversion of existing 69 kV substations to 138 kV is required in order to prevent some transmission line over-loading. Line 0020 supplying the Woodstock area is becoming heavily loaded, and this loading has increased with the new 69 kV substation supplying the new Regional Hospital located very close to the Woodstock terminal.

The option to supply more loads from 138 kV substations instead of 69 kV substations would result in lower transmission losses for the region and would relieve loading on the area's 138/69 kV tie transformers.

NB Power Transmission is planning the construction of Line 0150 to supply East Edmundston Substation. The new line will be built to 138 kV standards for the possible future conversion of East Edmundston Substation to 138 kV.

2. Central Region

Fredericton Area - The single contingency loss of the Grand Lake 138/69 kV tie-transformer will soon require subtransmission reinforcement. The new tie transformer planned for Marysville and the addition of the capacitor bank at Grand Lake will help provide the area with voltage support and improved reliability.

Miramichi Area - The conversion of some 69 kV substations to 138 kV substations will soon be required to alleviate the loading on the local 69 kV transmission lines. The East Chatham Substation is a candidate for such a conversion, but there are no plans for converting any of this area's substations at this time.

3. Eastern Region (Moncton - Memramcook Area)

The Eastern Region has had significant 69 kV to 138 kV substation conversions in the past 5 years. These improvements were necessary in order to prevent serious 69 kV transmission deficiencies. Current plans to expand the 69 kV Shediac substation will increase the loading on the 69 kV transmission lines.

An additional 138 kV transmission line from Salisbury to Memramcook is recommended to relieve loading on Line 1156 and Line 1157.

4. Northern Region (Bathurst - Eel River Area)

The 138 kV Line 1194 to Tracadie and the development of the 138/69 kV terminal in Tracadie in 2002 has improved the reliability in the region. These improvements provided the necessary back-up for single contingency outages of the Caraquet transformers and deferred the major 345/230 kV transformation in Newcastle (required as back-up for contingency loss of the Bathurst 345/138 kV transformer). The addition of a third 138/69 kV tie transformer in Bathurst Terminal is required due to the heavy 69 kV loading on the existing transformers.

5. Southern Region

There are no subtransmission upgrades currently planned for this region.

8.7 Life Extension of Transmission Lines

Once designed and constructed, transmission lines are inevitably affected by the effects of time, the environment, repeated mechanical and electrical loading, etc. Transmission system reliability incorporates dependability and security. Dependability relates to the continuity of electricity to customers. In the event of equipment failure, system security ensures that system failures are localized and long-term damage is minimized. As would be expected, older systems normally provide less reliability and security.

The New Brunswick transmission system uses four different voltage levels. Higher voltage transmission lines provide greater power carrying capacity and lower losses.

1. 345 kV for "bulk" transmission delivery
2. 230 kV and 138 kV for "underlay" transmission
3. 138 kV for "underlay" support as well as transmission delivery to local areas

4. 69 kV for transmission delivery to local distribution areas

The 345 kV transmission system is comprised of 1267 km of steel tower transmission lines that are relatively new and are forecast to provide sufficient capacity to ensure reliable, economic delivery of electricity for the current planning period. The second interconnection between New Brunswick and New England is the only planned expansion for this system.

The 230 kV transmission system has 540 km of transmission lines (wood poles) and the 138 kV transmission system comprises some 2404 km of transmission lines (majority wood poles) that are generally near the midpoint of their estimated 45-year useful life.

The 69 kV transmission system has 2497 km of transmission lines and transmits power to the majority of in-province loads. These facilities have an average age of 39 years.

The average age of the 138 kV and 69 kV facilities has created the need for a comprehensive maintenance program. NB Power Transmission has recognized this need and is in the middle of an eight year program designed to improve reliability and extend the useful life of the 69 kV lines. This program includes preventive maintenance activities, such as:

- pole replacement
- cross arm and guy wire replacement
- capping and butt treatment of older poles
- using the latest methodology to determine the remaining useful life

Plans have been implemented to carry out a similar program for the 138 kV and 230 kV transmission lines.

Contingency plans are in place in the event of the loss of any single element of the bulk transmission system. This requires the 230 kV and 138 kV underlay system to be maintained in top form.

To further emphasize the need for a strong maintenance program for the 69 kV, 138 kV and 230 kV transmission lines; the single source radial supplied substation load within New Brunswick totals some 83% of the total system load. Percentage breakdowns are: 48% at the 69 kV level, 33% at the 138 kV level and 2% at the 230 kV level.

9.0 SUMMARY OF RESULTS

Load Forecast

- The New Brunswick load forecast for the 10-year planning period has an average growth rate of 1.4% per year for system net energy. This equates to an overall increase of 2,161 GWh for the planning period.
- The load forecast has an average growth rate of 1.6% per year for the peak hour demand, and this equates to an increase of 477 MW for the planning period.
- Energy consumption in New Brunswick is much higher in the winter versus the summer due to the electric heating load in the province. January is the month with the highest forecast for energy consumption. It is 64% higher than it is for July, the month with the lowest forecast for energy consumption.
- The month with the highest forecast for peak hour demand is February. It is 84% higher than it is for August, the month with the lowest forecast for peak hour demand.

Generation Resources

- As of March 31, 2006 the total capacity of New Brunswick generation resources was 4,284 MW, and at this time there are no plans for new major conventional generation additions to the New Brunswick system.
- Planned generation retirements 98 MW at Courtenay Bay in 2009/10, and 57 MW at Grand Lake in 2010/11.
- New Brunswick's first commercial wind power project, a 20 MW wind farm in Grand Manan, has a target in-service date of late 2006. Due to existing generation capacity on the island of Grand Manan, light load in the local area, and limited transmission from the island, there is no capacity value associated with this wind project. In circumstances where wind project capacity is not constrained by other generation capacity and limited transfer capability, the NBSO policy is to assign a capacity value to the wind project that is equal to its demonstrated capacity factor.
- On October 18, 2005, NB Power Distribution and Customer Service (DISCO) issued an Expression of Interest (EOI) for proposals to develop, own, and operate up to 400 MW of wind powered electricity for purchase by DISCO. The deadline for this EOI was December 16, 2005. DISCO's intent is to review each proposal to determine if any of the proposals warrant further

negotiation and/or formal execution of a Power Purchase Agreement (PPA). This process is expected to conclude by the end of spring 2006.

- There is a planned 18-month refurbishment of the Point Lepreau nuclear station for April 2008. This project was approved by the Province in July 2005, with Atomic Energy of Canada Limited (AECL) as the general contractor. NB Power Distribution and Customer Service is in the process of identifying the capacity requirement for the refurbishment period, and is looking at ways to meet this requirement. The anticipated replacement of some feeder tubes at Point Lepreau in the next few years is expected to derate its 581 MW capacity by 11 MW in 2006/07, and an additional 12 MW in 2007/08. The scheduled completion date for the refurbishment project is November 2009, and the refurbished net capability of the generator is to be 635 MW.

Load and Resource Balance

- The load and resources review shows that the New Brunswick system will be short 222 MW of capacity in the 2008/09 fiscal year due to the planned refurbishment of Point Lepreau. Beyond the refurbishment period, the outlook forecasts capacity deficits of 57 MW in 2014/15, and 143 MW in 2015/16. Deficits are expected to grow beyond 2016.

Transmission Projects

- Construction of a second 345 kV interconnection between New Brunswick and New England is scheduled to begin in 2006/07, with a targeted completion by December 2007. This interconnection will connect Point Lepreau, New Brunswick to Orrington, Maine, and it is expected to increase the transfer capability to and from New England by about 300 MW.
- Construction of Line 0150 from Iroquois Terminal to East Edmundston Substation is scheduled for the 2006/08 time period. This project will support local load growth at East Edmundston Substation.
- The rebuilding of Line 0013 from Six Roads to Line 0133 (near Shippigan) is a project planned for 2007/08. This project is necessary to extend the life of a 50+ year old existing line.
- A 10.7 MVAR capacity bank is to be added to the Grand Lake 69 kV bus in 2007/08 to provide additional voltage support.
- In 2007/08 a third 138/69kV tie transformer is planned for the Bathurst Terminal to provide back-up support for the existing transformers.

- A new 138 kV transmission line is planned from Salisbury to Memramcook in order to relieve loading on Line 1156 and Line 1157. Consultation on substation location, route planning and design, and environmental requirements will take many years to complete. This project is planned to begin in 2006/07, with a targeted completion in 2012/13.
- In 2008/09, a 138/69 kV transformer at Marysville Terminal is to be replaced with a larger transformer in order to support increased load growth in the Fredericton area.
- A 345/230 kV, 450 MVA transformer is planned for the Newcastle Terminal for system security and back-up in the event of the contingency loss of the Bathurst 345/138 kV transformer. The necessity of this project is dependent on continued load growth in the Bathurst and Newcastle areas, and it is currently targeted for sometime in the 2010 to 2014 timeframe.

10.0 REFERENCES

[1] *2004 Maritimes Area Triennial Review of Resource Adequacy*, Report approved by NPCC Reliability Coordinating Council March 9, 2005.

[2] *Basic Criteria for Design and Operation of Interconnected Power Systems*, Northeast Power Coordinating Council Document A-2, May 6, 2004

APPENDIX A

SYSTEM DESIGN CRITERIA

INTRODUCTION

The interconnected New Brunswick system is divided into several classifications, each of which is governed by different design criteria.

These classifications are as follows:

- Bulk Power System (BPS) Transmission
- Transmission
- Subtransmission
- Transformation

To provide the reader a better opportunity to understand the criteria and their application a set of definitions are also provided.

DEFINITIONS

1. Bulk Power System (BPS) Transmission

According to NPCC Criteria Document A-07 (revised Feb 6, 2006), the BPS transmission is "...transmission facilities on which faults or disturbances can have a significant adverse impact outside of the local area. In this context, local areas are determined by the Council members." By this definition, the New Brunswick BPS transmission encompasses most of the 345 kV transmission system with some dependence on the 230 kV and 138 kV transmission grids. The 345 kV transmission system rings the province. The 230 kV transmission system extends from Keswick to Salisbury, Keswick to Newcastle and extends to Bathurst and Eel River.

2. Transmission

Transmission is defined to be that part of the system, which serves mainly to interconnect generation with subtransmission at major load centres.

This definition encompasses the BPS Transmission; however, the lesser importance of some transmission relative to the BPS Transmission permits a relaxation of the design criteria from that required for the BPS. This definition then governs most of the 138 kV development plus certain 69 kV transmission.

3. Subtransmission

Subtransmission is defined to be that part of the system, which primarily serves as a source for transformation to the distribution level. This type of system is primarily characterised by radial feeds although looped subtransmission exists.

4. Normal System

Normal system conditions which are defined to include all of the following:

- a) Any load condition - this includes the full range of annually forecasted loads.
- b) All transmission facilities in service - no line or transformer maintenance.
- c) Economically scheduled and dispatched generation allowing for planned generator maintenance outages - non-firm generation not included as economically dispatched generation.
- c) All system voltages within 0.95 and 1.05% of nominal.
- e) All system elements within thermally limited ratings.

5. A System Element

A system element is defined to be any one generator, transmission line, transformer or transformer feeder.

6. Prime Time Clearance

Prime time clearance is defined to be the time to clear an in-zone fault. Actual clearance times for bulk transmission are in the 4 to 6 cycles (67 to 100 milliseconds) range for both three-phase and line-to-ground faults.

7. Back-up Clearance

Back-up clearance is defined to be the time to clear an out-of-zone fault. Actual clearance times are in the 15 to 18 cycles (250 to 300 milliseconds) range for both three-phase and line-to-ground faults for bulk transmission.

8. Breaker Back-up

Breaker back up is defined to be protection against local breaker failure to trip for any reason. Breaker back up will be applied to all BPS Transmission and most of the Transmission system.

BULK POWER SYSTEM (BPS) TRANSMISSION

Prime time clearances are in the range of 4 to 6 cycles (67 to 100 milliseconds) for both three-phase and line-to-ground faults.

Back-up clearance times are in the range of 15 to 18 cycles (250 to 300 milliseconds) for both three-phase and line-to-ground faults. Times of 20 to 30 cycles (333 to 500 milliseconds) will be permitted under certain instances.

The Design Criteria are:

1. From normal systems conditions, the BPS Transmission shall be able to withstand the loss of any one-system element following a three-phase fault cleared in prime time.
2. From normal systems conditions, the BPS Transmission shall be able to withstand the loss of any one system element following a line-to-ground fault cleared in delayed time.
3. From normal system conditions following loss of any one-system element, all system elements shall be within their thermally limited ratings.
4. From normal system conditions, for the loss of any one system element, as a general guideline no BPS Transmission system voltage shall be less than 90% following a steady state settling out of the system nor shall any bus experience a voltage change from pre-fault to post-fault condition greater than 10%.
5. As far as possible, provision should be made to ensure that no fault is left permanently on the system in case of failure of a primary protective device.

TRANSMISSION SYSTEM

Prime time clearances are in the range of 6 to 9 cycles (100 to 150 milliseconds) for both three-phase and line-to-ground faults.

Back-up clearances are in the range of 20 to 30 cycles (333 to 500 milliseconds) for both three-phase and line-to-ground faults.

The Design Criteria are:

1. From normal systems conditions, the Transmission system shall be able to withstand the loss of any one-system element following a three-phase fault cleared in prime time.

2. From normal systems conditions, the Transmission system shall be able to withstand the loss of any one system element following a line-to-ground fault cleared in delayed time.
3. From normal system conditions following loss of any one-system element, all system elements shall be within their thermally limited ratings.
4. From normal system conditions, for the loss of any one system element, as a general guideline no Transmission system voltage shall be less than 90% following a steady state settling out of the system nor shall any bus experience a voltage change from pre-fault to post-fault condition greater than 10%.
5. As far as possible, provision should be made to ensure that no fault is left permanently on the system in case of failure of a primary protective device.

SUBTRANSMISSION SYSTEM

The Design Criteria are:

1. Subtransmission system loading shall be within the thermally limited ratings.
2. The subtransmission system voltages shall not be less than 95% or greater than 105% of nominal.
3. From normal system conditions, for the loss of any one subtransmission system element which is part of a section of the system which remains collected, no transmission system bus voltage shall be less than 92.5% following a steady state settling out of the system nor shall any bus experience a voltage change from pre-fault to post-fault condition greater than 10%.
4. As far as possible provision, should be made to ensure that no fault is left permanently on the system.

The application of the above criteria does not guarantee a continuity of supply for any single contingency. In the case of a line, a lengthy outage is considered to be a very remote possibility. Time to repair is considered adequate for restoration of service. However, in the case of transformation, an outage is generally a prolonged one. The use of an available mobile transformer for a short-term replacement or the installation of a spare transformer and interconnections with adjacent substations at the distribution level, are considered in decisions concerning the guaranteeing, after outage, of an alternate supply.

TRANSFORMATION

Design Criterion

Reinforcement is required in all cases when for single contingency there will result either, thermal damage to equipment in attempting to continue to supply the load or, inability to meet the daily load requirements in whole or in part after due consideration is given to the following:

1. The capacity of the underlying interconnections with another supply points) when applicable.
2. Out-of-merit running of generation when applicable.
3. Loading of remaining station(s) transformer(s) to their (or their associated equipment) thermally limited rating as per Note 4. (This is in conjunction with 1 and 2 above as applicable).
4. Largest available suitable mobile transformer loaded to its nameplate rating. (This is in conjunction with 1 and 2 above as applicable).

Notes:

1. Reinforcement may be the economic choice even if 1, 2 and 3 or 4 result in satisfaction of the load supply criterion because "expected" out-of-merit costs may significantly exceed the cost of capital advancement.
2. The BPS Transmission system may require additional transformation in certain instances. Although the above 1, 2 and 3 may result in satisfaction of this particular criterion, any other of several possible contingencies (transmission lines, generators or transformers) will result in an "expectation" of either frequent or prolonged outages to a widespread part of the system.
3. The result of application of this criterion may not be installation of additional transformation.
4. Generally in accordance with universally accepted methods and particularly with reference to NEMA Publication No. TR98-1964 "Guide for Loading Oil Immersed Power Transformers with 65 C Average Winding Rise" and USASI Publication C57-92, 1962 "Guide for Loading Oil Immersed Distribution and Power Transformers with 65 C Average Winding Temperature Rise", it is NB Power practice to permit the loading of transformers to exceed the nominal or nameplate value such that thermal limits calculated in accordance with the above references are not regularly exceeded.

In special circumstances, such as single contingency situations where some means of reducing the overload exists, a thermal rating based on a loss of life of 2 1/2% may be applied, in accordance with the above and engineering judgement. The loss of life permitted is measured over the time required to reduce the loading on the transformers. This may be done by switching low voltage circuits or relieving load by use of a mobile transformer.

When no means of reducing the overload exists, a 0% loss of life is used.