10-Year Assessment of the Adequacy of Generation and Transmission Facilities In New Brunswick 2008 - 2017

1.0 EXECUTIVE SUMMARY

The New Brunswick System Operator (NBSO) is an independent not-for-profit statutory corporation created under New Brunswick's *Electricity Act* on October 1, 2004. The *Act* transferred the responsibility for the adequacy 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 Assessment of the Adequacy of Generation and Transmission Facilities in New Brunswick 2008 – 2017*, continues an annual series of such reports from NBSO. The intent of this report 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. This assessment consists of:

- A baseline plan showing the load forecast along with committed supply resources only.
- Recommended transmission plans for new projects and upgrades.
- A summary of projects for which NBSO is undertaking and coordinating studies and future scenario analyses, both independently or in partnership with other system operators and utilities. Because of the uncertainty associated with these projects, they are not included in the baseline plan.

This assessment does not deal with power costs, rate structures, economics, or business risks of the electric industry in New Brunswick, but focuses on adequacy and reliability of supply. 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. These challenges include the completion of a major nuclear refurbishment, and the integration of significant wind generation capacity onto the New Brunswick transmission system. Recent announcements regarding these projects 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 began on March 29, 2008, and results in a 558 MW capacity reduction for the system during the refurbishment period. To meet its capacity obligations during the 2008/09 peak winter season, NB Power Distribution and Customer Service has arranged for up to 200 MW of capacity purchased from Hydro Quebec. Completion of this refurbishment by October 2009 results in 658 MW of capacity returned to the system for a net increase of 100 MW.

- NB Power has announced the following wind projects for New Brunswick

Project Location	Size (MW)	Owner	In-service Date
Kent Hills	96	TransAlta	December 2008
Lamèque	49.5	Acciona	November 2009
Aulac	64.5	Acciona	November 2009
Caribou	99	SUEZ Energy	November 2009

Each of these wind projects are to be operated and maintained by their owners. NB Power has entered into 20 or 25 year Power Purchase Agreements with these projects to purchase all of their energy output plus any environmental attributes that they may produce such as renewable energy credits.

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 possible for developers to build power projects in New Brunswick, and the increased transfer capability provided by a new second 345 kV interconnection project, commissioned December 2007, 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 updated load forecast in this review is considerably lower compared to the previous review. Contributing significantly to this reduction are the announced mill closures at UPM Kymmene and Bowater, along with limited growth expectations in the pulp & paper and wood processing sectors whose export margins are under significant pressure due to a high Canadian dollar and rising energy costs.

A comparison of the updated load forecast compared to the previous load forecast is shown in the table below.

	Updated Forecast	Previous Forecast	Difference
2008/09 In-province Energy	14,558 GWh	15,884 GWh	(1,326 GWh)
2017/18 In-province Energy	15,905 GWh	17,931 GWh	(2,026 GWh)
Energy Increase	1,347 GWh	2,047 GWh	(700 GWh)
Energy Annual Growth Rate	1.0%	1.4%	(0.4%)
2008/09 In-province Demand	3,096 MW	3,275 MW	(179 MW)
2017/18 In-province Demand	3,418 MW	3,757 MW	(339 MW)
Demand Increase	322 MW	482 MW	(160 MW)
Demand Annual Growth Rate	1.1%	1.5%	(0.4%)

The committed generation additions in this 10-year assessment include 100 MW of incremental nuclear capacity by October 2009 due to refurbishment, and 309 MW of new

wind project capacity, with 96 MW targeted by December 2008 and 213 MW targeted for November 2009. Additional capacity also results from the termination of a 198 MW capacity export contract to Hydro Quebec in November 2011. The only generation retirement projected in this 10-year assessment is 57 MW at Grand Lake in 2010/11.

The assessment of committed generation resources shows that the New Brunswick system does not require additional capacity in the next 10 years to meet the long term NBSO capacity based reserve criterion of 20%. Details of the load and resources review are provided in the table below for the planning period.

Load and Resources Review 2008/09 to 2017/18

		Fiscal Year Ending									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
A	Load Forecast	3,096	3,115	3,133	3,170	3,210	3,256	3,300	3,341	3,380	3,418
B	Non-Firm Industrial	98	98	98	98	98	98	98	98	980	98
C	Required Reserve C = 20%*(A - B) or largest generator*	600	628	628	628	628	632	640	649	656	664
D	Interconnection Contracts (+Export/-Import)	18	248	248	50	50	50	50	50	50	50
E	Total Supply Resources excluding Wind	3,816	4,274	4,217	4,217	4,217	4,217	4,217	4,217	4,217	4,217
F	Committed Wind	96	309	309	309	309	309	309	309	309	309
G	Committed Wind (@ 30% capacity credit)**	29	93	93	93	93	93	93	93	93	93
H	Total Supply Resources including Wind H = E + G	3,845	4,367	4,310	4,310	4,310	4,310	4,310	4,310	4,310	4,310
I	(+Surplus/-Deficit) I = H + B – A – C – D	29	473	399	560	520	471	418	369	322	276
J	Projected Wind***	-	100	100	100	100	100	100	100	100	100
K	Projected Wind (@ 30% capacity credit)**	-	30	30	30	30	30	30	30	30	30
L	Projected (+Surplus/-Deficit) L = I + K	29	503	429	590	550	501	448	399	352	306

* From 2010 to 2012, the largest generator is calculated to be 628 MW, based upon the 658 MW Point Lepreau minus a 30 MW participation agreement with PEI (maritime Electric)

** Wind capacity values are derated according to the NB Energy Market Rules. Wind projects in New Brunswick have their capacity values derated to their seasonal (winter and summer) capacity factors. The purpose of derating wind capacity is to approximate its reliability contribution to the grid, and 30% is a conservative estimate of the expected capacity factor of a new wind project. Once a wind project is built and its seasonal capacity factors demonstrated, its accredited capacity is adjusted accordingly.

*** The projected wind capacity of 100 MW by 2009/10 is based upon information from NB Power that they are currently in negotiations for this capacity.

Projected demand side management (DSM) numbers from Efficiency NB are incorporated into the base load forecast. This projected efficiency results in a 96 MW

reduction in demand by 2017/18 and a 497 GWh reduction in energy by 2017/18. These estimates are related to the following programs:

- Existing Homes Energy Upgrades Program
- Energy Efficient New Homes Program
- Upgrades Program for Multi-Unit Residential Buildings
- Retrofit Program for low-income households

While this report identifies current generation emission standards it makes no assumptions regarding altered future environmental requirements and the effects that they could have on future generation resource adequacy. In particular regulations limiting greenhouse gas emissions are expected and could pose a risk for the future utilization of fossil fuelled generation. NBSO will be tracking such standards as they are implemented and may conduct analyses in the future regarding their impact on generation adequacy.

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

- Planning for the construction of a new 345 kV line between Coleson Cove and Salisbury is scheduled for 2009/10. This new line will mitigate the unacceptable post-contingency conditions associated with the loss of Line 3004 or Line 3013 during winter peak load levels.
- Refurbishment of the Eel River HVDC station (converter controls, synchronous condensers and various other station upgrades) is planned in 2010. The purpose of this project is to replace aging technology and extend the life of the HVDC station by 20 years. Two years will be needed to procure all necessary equipment, and the installation of the new equipment will require 8 weeks of station outage (4 weeks/circuit).

Several other transmission projects are identified in this report to maintain supply reliability to customers served from the 138 kV and 69 kV systems.

In addition to analysis of committed generation and planned transmission in New Brunswick, this 10-Year assessment report reviews the various regional development opportunities that are currently under study by ISO-New England, Newfoundland and Labrador Hydro, NB Power and Maine utilities. As part of its participation in these regional studies, NBSO is undertaking scenario analysis in order to determine the most efficient expansion of the New Brunswick transmission system interconnections with ISO-NE in order to accommodate increased exports of potential future generation from nuclear, wind, hydro, cogeneration and natural gas. It is anticipated that NBSO will complete this study during the 2008/09 year.

In 2008 NBSO, along with other transmission planners in the Maritimes Area, formed a Maritimes Area Technical Planning Committee (MATPC). The scope of the MATPC includes regular reviews of area plans of resource adequacy and transmission reliability. The MATPC may also undertake joint studies to assess the potential need for investments in transmission or other facilities in order to maintain the reliability of interconnections, improve performance of the market, or reduce the costs associated with transmission

constraints. Amongst the joint studies to be undertaken are transmission expansion between Nova Scotia and New Brunswick, transmission expansion between New Brunswick and Maine, and a possible third transmission line between PEI and New Brunswick.

According to its 2006 Environmental performance Report, NB Power's greenhouse gas (GHG) emissions for that year were 5.63 million tonnes. These emissions are 2.67 million tones below its 1990 level of 8.3 million tonnes.

A GHG reduction plan for Canada was released by the Federal Government in March 2008. Key points of this plan for the electricity sector include:

- Targeting an initial 18% intensity reduction using 2006 as a base year.
- Adding 2% intensity reduction per year for next 10 years to 2020.
- An additional requirement for the electricity sector is a 25 million tonne GHG reduction that could come from various new projects, including East-West transmission, Lower Churchill Project, Peace River, new nuclear, etc. Nothing has yet to be determined but opportunities for New Brunswick and Atlantic Canada are possible.
- No regulations are yet written so details of specific implementation, trading mechanisms, offset credits, etc. are still needed.
- There is also a long-term reference to 2050 that suggests the electricity sector will need to reduce 90% from its 2006 levels of GHG emissions.

Meeting the targets of this plan will be a major challenge for New Brunswick that will put pressure on its continued use of fossil generation. 2006 as a base year is especially challenging for New Brunswick because the nuclear and hydro generation for that year was well above average, and thus contributed significantly to below average annual GHG emissions. NBSO will track these GHG regulations as they are implemented in order to analyze their impact on system adequacy.

This 10-Year assessment fulfills NBSO's obligation under Market Rule 9.2 to develop and publish an annual baseline plan for the New Brunswick Electricity Market. It includes an 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.

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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 President & CEO and governed by an independent Board of Directors. The primary responsibilities of NBSO are to ensure the 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 NBSO-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 original OATT was approved by the New Brunswick Board of Commissioners of Public Utilities (PUB) in its decision of March 13, 2003, and was updated in its decision of April 26, 2005. It 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 newly created Energy and Utilities Board (EUB). 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. Several rule adjustments have been made in the last two years to improve pricing flexibility and market transparency, and also to allow demand bidding. Any future changes and additions to the Market Rules, similar to the past changes, 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 assessment regarding the current and future adequacy of the NBSO controlled integrated electricity system. This is the fourth such report and it includes:

- A baseline plan showing the load forecast along with committed supply resources only.
- Recommended transmission plans for new projects and upgrades.
- A summary of projects for which NBSO is undertaking and coordinating studies and future scenario analyses, both independently or in partnership with other system operators and utilities. Because of the uncertainty associated with these projects, they are not included in the baseline plan.

This assessment does not deal with power costs, rate structures, economics, or business risks of the electric industry in New Brunswick, but focuses on adequacy and reliability of supply. With this information, Market Participants 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 2008/09 to 2017/18. 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 2008 – 2017*. 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 1.0% per year, and the peak hourly demand is forecast to grow at 1.1% per year.

The highest months of energy consumption in New Brunswick are December through February due mainly 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.

Table 2 shows a summary of major assumptions built into the load forecast.

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 3 shows a summary of load forecast sensitivities for the year 2008/09.

Table 1: New Brunswick 10-year Load Forecast

Year	System Net Energy (GWh)	Peak Hourly Demand (MW)
2008/09	14,558	3,096
2009/10	14,728	3,115
2010/11	14,645	3,133
2011/12	14,830	3,170
2012/13	15,018	3,210
2013/14	15,197	3,256
2014/15	15,377	3,300
2015/16	15,552	3,341
2016/17	15,724	3,380
2017/18	15,905	3,418
Overall Increase (from 2008/09)	1,347	322
Average Annual Growth Rate	1.0%	1.1%

Table 2: Major Load Forecast Assumptions

Parameter	Description
GDP Growth	• 2.3% per year (from NB Dept of Finance)
Temperatures	• Temperature at peak of -24 degrees Celsius • Annual energy forecast is based on 30-year average temperatures
Residential Customers	• 3,171 new customers per year • Flat population growth • Declining household size from 1.0% to 0.9% in each of the forecast years. • Rate increase assumptions: - 6.4% in 2007/08 - 3.0% annually for 2008-12 - 2.0% annually for 2013-17
Large Industry Assumptions	• Continued operation of large customers during the forecast period, except for Bowater and UPM Kymmene mills that announced permanent closures in 2007/08. • Limited growth expectations in forestry , pulp and paper sectors.

Natural Gas Availability	• Gas territory forecast as available to 30% of NB population.
Energy Efficiency Assumptions	• 96 MW reduction in demand by 2017/18 • 497 GWh reduction in energy by 2017/18

Figure 1: Monthly Consumption of Annual System Net Energy

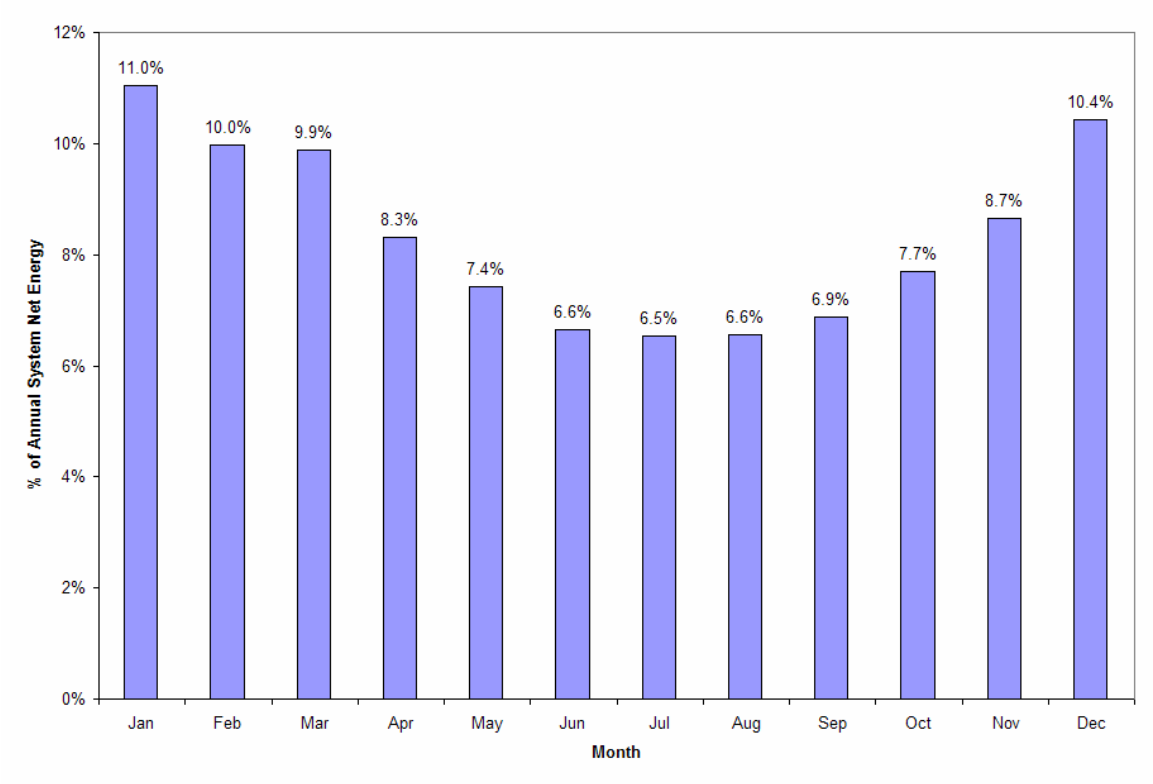


Figure 2: Monthly Peak Loads as a Percentage of Annual Peak Load

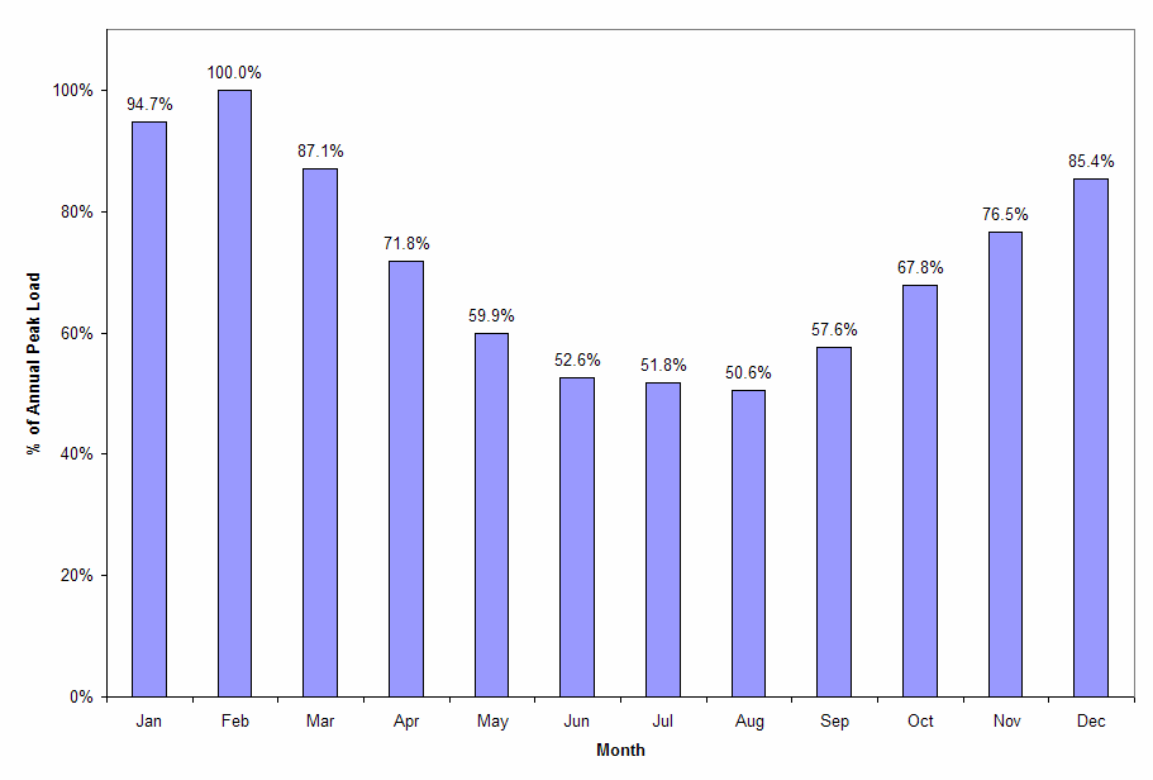


Table 3: Sensitivities of Load Forecast Assumptions

Sensitivity	Impact in year 2008/09	
	Energy GWh	**Demand MW**
Temperature colder by one degree Celsius at peak	n/a	+32
± 100 heating degree days per year	± 102	n/a
± 1000 residential customers per year	± 21	± 5
0.1% change in rate of GDP growth	± 1	± 2
±1%/Year change in real residential and general service rates	± 18	± 4

4.2 Historical and Forecast Requirements

NB Power Distribution and Customer Service (DISCO) currently serves 99.8% all of New Brunswick customer load, except for Perth Andover whose 0.2% of New Brunswick load is served by WPS Energy Services Inc. in Maine. 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 2006/07, large industrial loads accounted for 42% of NB Power's in-province energy sales.

Figure 3 shows the actual annual energy consumption from fiscal year ending 1973 to 2008, and the forecast annual energy consumption for 2009 to 2018.

Figure 4 shows the actual peak hourly demand from fiscal year ending 1973 to 2008, and the forecast peak hourly demand for 2009 to 2018.

Figure 3: New Brunswick Annual Energy Consumption

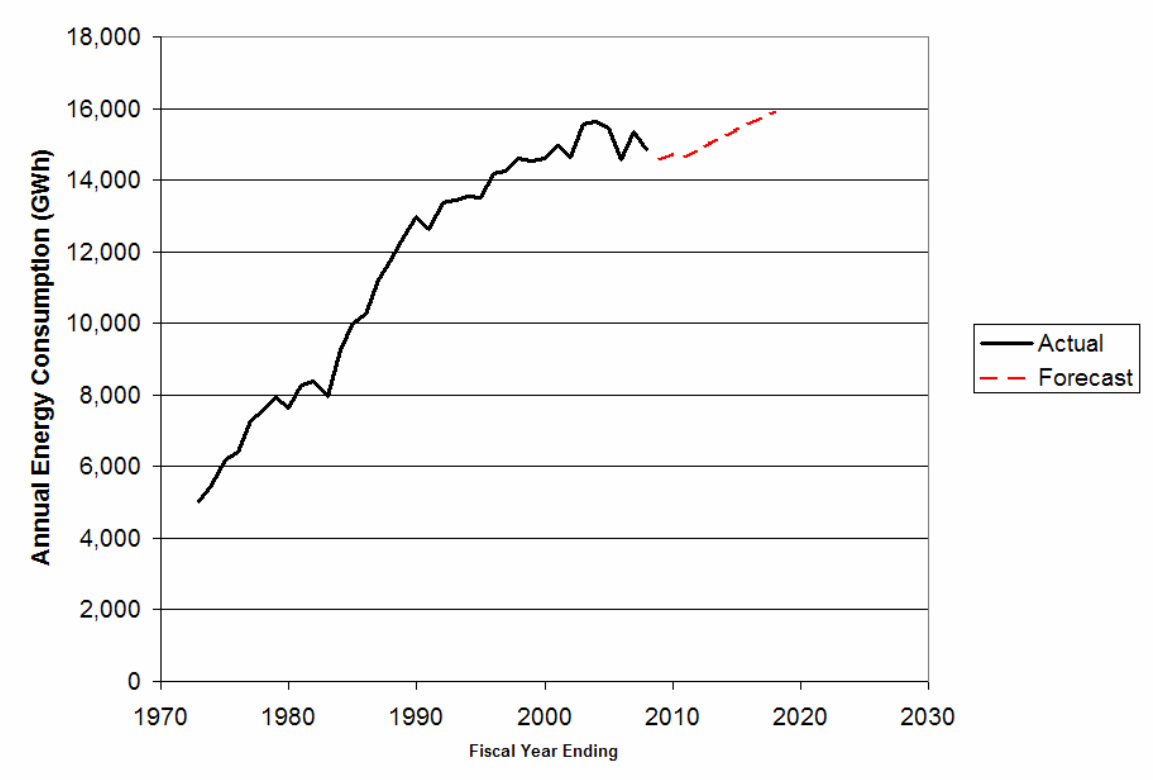


Figure 4: New Brunswick Peak Hourly Load

4.3 Demand Side Management Forecast

Efficiency NB is the New Brunswick energy efficiency and conservation agency. Its mission is to offer sound advice and practical solutions to help New Brunswickers use energy more efficiently, make better energy choices, manage energy expenses and lessen the impact of energy use on the environment.

Projected demand side management (DSM) numbers from Efficiency NB are incorporated into the base load forecast. This projected efficiency results in a 96 MW reduction in demand by 2017/18 and a 497 GWh reduction in energy by 2017/18. These estimates are related to the following programs:

- Existing Homes Energy Upgrades Program
- Energy Efficient New Homes Program
- Upgrades Program for Multi-Unit Residential Buildings
- Retrofit Program for low-income households

More information regarding Efficiency NB can be found at its website http://www.efficiencynb.ca.

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, biomass, and diesel powered stations. Table 4 lists the New Brunswick generators along with their fuel types and capacities as of Jan 1, 2008.

Table 4: New Brunswick Generation Resources

Plant	Unit	Type	Net Capacity MW	Notes
Point Lepreau	1	Nuclear	558	18-month Refurbishment Apr'08 – Nov '09
	SG1&2	Diesel	5	
Belledune	2	Coal	457	
Coleson Cove	1	Oil	324	
	2	Oil	324	
	3	Oil	324	
Dalhousie	1	Oil	96	
	2	Oil	203	
Bayside	6	Natural Gas	263	Capacity includes Combined Cycle Operation
Grand Lake	8	Coal	57	
Grand Manan	3	Diesel	29	
Millbank	1	Diesel	99	
	2	Diesel	99	
	3	Diesel	99	Tied to Sale Contract Until Nov 2011
	4	Diesel	99	Tied to Sale Contract Until Nov 2011
Ste Rose	1	Diesel	99	
Grandview	1,2	Natural Gas	90	
Frasers	1	Biomass	39	
St. George	1,2	Hydro	15	
Musquash	1,2	Hydro	5	
Mactaquac	1	Hydro	110	
	2	Hydro	110	
	3	Hydro	110	
	4	Hydro	115	
	5	Hydro	112	
	6	Hydro	112	
Beechwood	1	Hydro	36	
	2	Hydro	36	
	3	Hydro	40	
Grand Falls	1	Hydro	16	
	2	Hydro	17	
	3	Hydro	16	
	4	Hydro	17	
Tobique	1	Hydro	10	
	2	Hydro	10	
Nepisiguit Falls	1,2,3	Hydro	11	
Sisson	1	Hydro	9	
Milltown	1	Hydro	4	
TOTAL CAPACITY			**4175**	Total Capacity as of Jan 1, 2008

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

The committed generation additions in this assessment include 100 MW of incremental nuclear capacity by October 2009 due to refurbishment, and 309 MW of new wind project capacity, with 96 MW targeted by December 2008 and 213 MW targeted for November 2009. Additional capacity also results from the termination of a 198 MW capacity export contract to Hydro Quebec in November 2011. The only generation retirement projected in this 10-year assessment is 57 MW at Grand Lake in 2010/11.

Recent announcements regarding committed generation additions include the following:

- 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 began on March 29, 2008, and results in a 558 MW capacity reduction for the system during the refurbishment period. To meet its capacity obligations during the 2008/09 peak winter season, NB Power Distribution and Customer Service has arranged for up to 200 MW of capacity purchased from Hydro Quebec. Completion of this refurbishment by October 2009 results in 658 MW of capacity returned to the system for a net increase of 100 MW.

- NB Power has announced the following wind projects for New Brunswick:

Project Location	Size (MW)	Owner	In-service Date
Kent Hills	96	TransAlta	December 2008
Lamèque	49.5	Acciona	November 2009
Aulac	64.5	Acciona	November 2009
Caribou	99	SUEZ Energy	November 2009

Table 5 provides a summary of the generation capacity changes from January 2008 to December 2012.

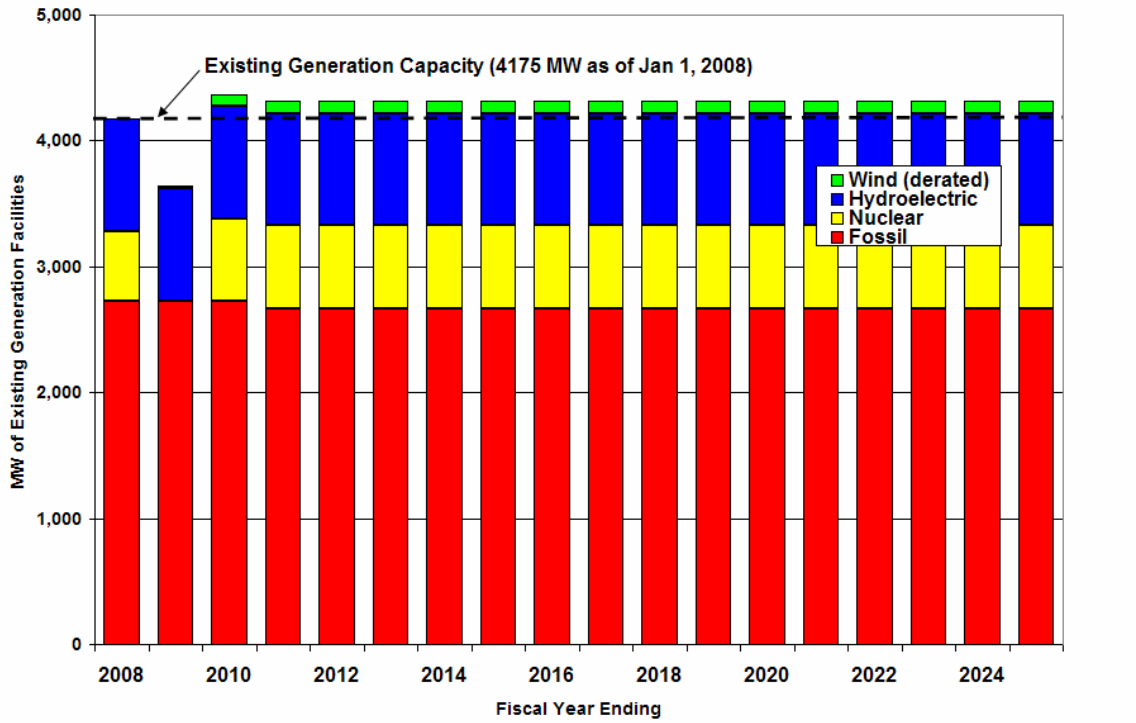
Table 5: Summary of New Brunswick Generation Changes

Year	January Capacity MW	December Capacity MW	Generation Capacity Change MW	Explanation
2008	4,175	3,646	-529	Point Lepreau refurbishment begins April 2008 (-558 MW), Wind capacity added (96 MW * 30% = 29 MW),
2009	3,646	4,367	+721	Point Lepreau refurbishment ends by October 2009 (+658 MW), Wind capacity added (213 MW * 30% = +64 MW)
2010	4,367	4,310	-57	Grand Lake retired (-57 MW)
2011	4,310	4,310	0	No changes forecast.

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 until 2025.

Figure 5: Forecast of Remaining Service Life of New Brunswick Generators



5.4 System Impact Studies

Under the Market Rules, NBSO is required to perform Connection Assessments for proposed projects that wish to connect to the SO-controlled grid at 69 kV or higher voltage. NBSO is required to conduct all System Impact Studies that are required for

such projects. A listing of completed and queued studies is available on the NBSO website at http://www.nbso.ca/Public/en/op/transmission/connecting/SIS.aspx

Connection Applications for System Impact Studies are placed into two separate queues; (i) the generation SIS queue, and (ii) the load and Point to Point SIS queue. The generation SIS queue will include all projects that involve the connection of new non-embedded generation to the SO-controlled transmission grid. The load and Point to Point SIS queue will include all other projects, including the connection of load projects, embedded generation projects, and assessments of new Point to Point transmission service.

Table 6 shows the System Impact Study list of queued projects as of April 2008.

Table 6: NBSO List of Queued System Impact Studies (April 2008)

Number	Project Name	Project Location	Project Size (MW)	Project Type	Company Name	SIS Initiation Date
1	Hopewell Cape Wind Farm	Hopewell Cape, NB	25	Generation	J.D. Irving, Limited	Jul 07, 2006
2	Upham Mountain Wind Farm	Upham Mountain, NB	60	Generation	J.D. Irving, Limited	Jul 07, 2006
3	Pokeshaw 37.5 MW Wind Farm	Pokeshaw, NB	37	Generation	Gale Force Energy	Jul 11, 2006
4	Burnt Church 27 MW Wind Farm	Burnt Church, NB	27	Generation	Atlantic Wind Power Corporation (2005) Ltd	Sep 05, 2006
5	Blue Mountain Wind Farm	Blue Mountain, NB	101	Generation	Invenergy Services Canada ULC	Dec 08, 2006
6	Aulac Wind Farm	Aulac, NB	64.5	Generation	Acciona Wind Energy Canada Inc.	May 28, 2007
7	Lamèque Wind Farm	Lamèque, NB	49.5	Generation	Acciona Wind Energy Canada Inc.	June 11, 2007
8	McAdam Wind Farm	McAdam, NB	52	Generation	FPLE Canadian Wind, ULC	Aug 3, 2007
9	St. George South Wind Farm	St. George, NB	204	Generation	FPLE Canadian Wind, ULC	Aug 3, 2007
10	Murray Corner	Murray Corner,	99	Generation	SkyPower	Aug 24, 2007

	Wind Farm	NB			Corp.	
11	Anse-Bleue Wind Farm	Anse-Bleue, NB	99	Generation	SkyPower Corp.	Aug 24, 2007
12	Escuminac Wind Farm	Escuminac, NB	104	Generation	SkyPower Corp.	Aug 29, 2007
13	Mann Siding Wind Farm	St. Quentin, NB	150	Generation	Shear Wind Inc.	Aug 30, 2007
14	Caribou Mines Wind Farm Phase II	Caribou, NB	101	Generation	Ventus Energy Inc.	Aug 31, 2007
15	Caribou 99 MW Wind Project	Caribou, NB	99	Generation	Ventus Energy Inc.	Nov 23, 2007
16	Grand Manan Wind Project	Grand Manan, NB	21	Generation	Dark Harbour Wind Inc.	Jan 28, 2008

5.5 Impact of Greenhouse Gas Emissions

On May 9, 1992, Canada was one of 150 world governments to adopt the United Nations Framework Convention on Climate Change. Building upon the climate change convention, in 1997, the world governments adopted the Kyoto Protocol with its legally binding constraints on greenhouse gas (GHG) emissions. Canada has ratified the Kyoto Protocol on climate change with a commitment to reduce greenhouse gas emissions by 6% of 1990 levels during the period between 2008 and 2012. Russia ratified the Kyoto Protocol in December, 2004, and it came into effect February 16, 2005.

While New Brunswick accounts for 3% of Canada's GHG, all jurisdictions will be called upon to address climate change. Approximately 90% of New Brunswick's 20 million tonnes of carbon dioxide emissions come from the combustion of fossil fuels with electricity generation accounting for 47% or nine million tonnes.

In addition to the Kyoto Protocol, the New England Governors and Eastern Canadian Premiers agreed in 2001 to a Climate Change Action Plan to reduce regional GHG in a manner that is cost effective while maintaining reliable energy supplies. That plan set regional reduction targets:

- Reduce regional GHG emissions to 1990 emission levels by 2010;
- Reduce regional GHG emissions by at least 10% below 1990 emissions by 2020 and establish a five-year process in 2005 to adjust or establish future emissions reductions goals; and
- Reduce regional rate of emissions by 20% per MWh by 2025 from 2000 rate.

According to its 2006 Environmental performance Report, NB Power's GHG emissions for that year were 5.63 million tonnes. These emissions are 2.67 million tones below its 1990 level of 8.3 million tonnes.

A GHG reduction plan for Canada was released by the Federal Government in March 2008. Key points of this plan for the electricity sector include:

- Targeting an initial 18% intensity reduction using 2006 as a base year.
- Adding 2% intensity reduction per year for next 10 years to 2020.
- An additional requirement for the electricity sector is a 25 million tonne GHG reduction that could come from various new projects, including East-West transmission, Lower Churchill Project, Peace River, new nuclear, etc. Nothing has yet to be determined but opportunities for New Brunswick and Atlantic Canada are possible.
- No regulations are yet written so details of specific implementation, trading mechanisms, offset credits, etc. are still needed.
- There is also a long-term reference to 2050 that suggests the electricity sector will need to reduce 90% from its 2006 levels of GHG emissions.

Meeting the targets of this plan will be a major challenge for New Brunswick that will put pressure on its continued use of fossil generation. 2006 as a base year is especially challenging for New Brunswick because the nuclear and hydro generation for that year was well above average, and thus contributed significantly to below average annual GHG emissions. NBSO will track these GHG regulations as they are implemented in order to analyze their impact on system adequacy.

5.6 Clean Air Initiative

A new federal initiative for clean air was released in 2007, but has yet to pass through Parliament and become law. It is intended to set new standards for particulate, acid rain gases (SO_2 and NO_X), volatile organic compounds (VOCs), mercury, and other heavy metals. These standards are not expected to pose any significant risk to the operating capability of fossil generators in New Brunswick. With the planned retirement of the Grand Lake plant in 2010, along with major environmental emissions controls already installed at other plants, New Brunswick's fossil generators are expected to perform well within these new standards.

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 semi-annually). 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 capability period assessment takes place six 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 four 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 *2007 Maritimes Area Comprehensive 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 criterion.

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 7 summarizes the load and committed resources from 2008/09 to 2017/18.

Table 7: Load and Resources Review for New Brunswick 2008/09 to 2017/18

		Fiscal Year Ending									
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
A	Load Forecast	3,096	3,115	3,133	3,170	3,210	3,256	3,300	3,341	3,380	3,418
B	Non-Firm Industrial	98	98	98	98	98	98	98	98	980	98
C	Required Reserve C = 20%*(A - B) or largest generator	600	628	628	628	628	632	640	649	656	664
D	Interconnection Contracts (+Export/-Import)	18	248	248	50	50	50	50	50	50	50
E	Total Supply Resources excluding Wind	3,816	4,274	4,217	4,217	4,217	4,217	4,217	4,217	4,217	4,217
F	Committed Wind	96	309	309	309	309	309	309	309	309	309
G	Committed Wind (@ 30% capacity credit)	29	93	93	93	93	93	93	93	93	93
H	Total Supply Resources including Wind H = E + G	3,845	4,367	4,310	4,310	4,310	4,310	4,310	4,310	4,310	4,310
I	(+Surplus/-Deficit) I = H + B – A – C – D	29	473	399	560	520	471	418	369	322	276
J	Projected Wind	0	100	100	100	100	100	100	100	100	100
K	Projected Wind (@ 30% capacity credit)	0	30	30	30	30	30	30	30	30	30
L	Projected (+Surplus/-Deficit) L = I + K	29	503	429	590	550	501	448	399	352	306

Projected demand side management (DSM) numbers from Efficiency NB are incorporated into the base load forecast. This projected efficiency results in a 96 MW

reduction in demand by 2017/18 and a 497 GWh reduction in energy by 2017/18. These estimates are related to the following programs:

- Existing Homes Energy Upgrades Program
- Energy Efficient New Homes Program
- Upgrades Program for Multi-Unit Residential Buildings
- Retrofit Program for low-income households

The projected wind capacity of 100 MW by 2009/10 is based upon information from NB Power that they are still in negotiations for this capacity.

Wind capacity values are derated according to the NB Energy Market Rules, where wind projects in New Brunswick have their capacity values derated to their seasonal (winter and summer) capacity factors. The purpose of derating wind capacity is to approximate its reliability contribution to the grid, and 30% is a conservative estimate of the expected capacity factor of a new wind project. Once a wind project is built and its seasonal capacity factors demonstrated, its accredited capacity is adjusted accordingly.

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. 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 four 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 1960s. Expansion continued into the early 1970s 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 1970s. 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 neighbouring 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 occurred in 2007/08.

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 8 shows the transfer capability between New Brunswick and its neighbouring systems.

Table 8: Interconnection Transfer Capability

Neighbouring System	Transfer Capability to New Brunswick (MW)	Transfer Capability from New Brunswick (MW)
Quebec	1000	720
New England	550†	1000
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

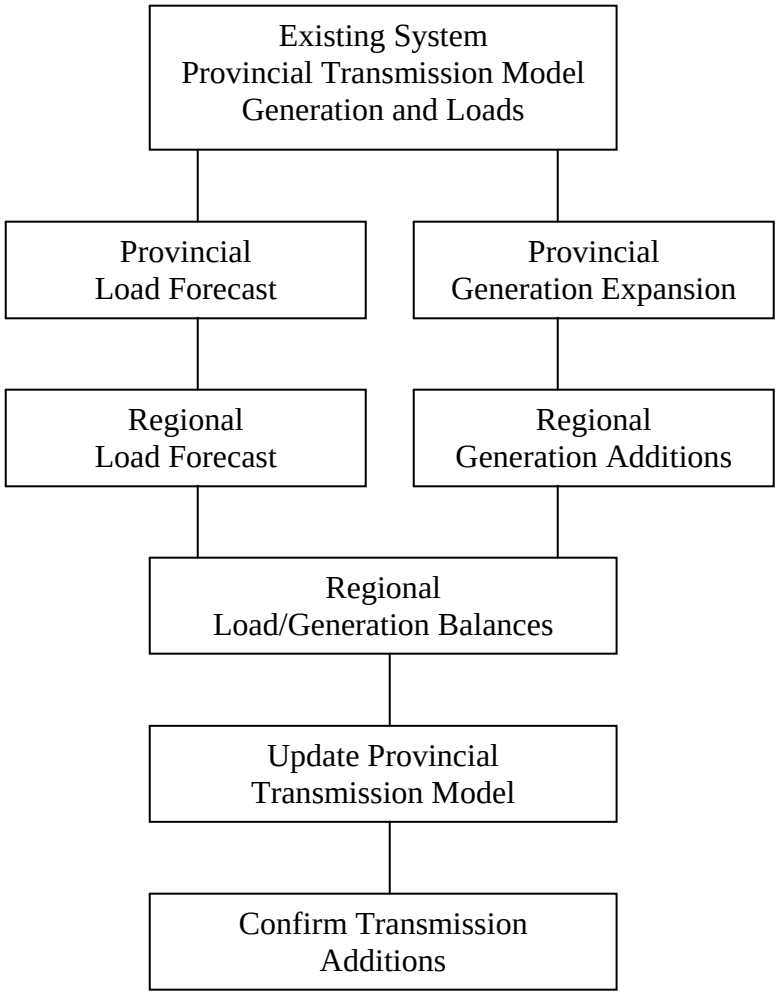
The System Design Criteria, upon which the needs for the recommended system reinforcements are based, are presented in Appendix A. The NPCC Basic Criteria for Design and Operation of Interconnected Power Systems, upon which are based the design of the 345 kV (Bulk) Transmission expansion, are available 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 2006/07. 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 9 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. While the average transmission losses are 2.5%, this value rises to approximately 4% at peak load levels. 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 2007/08, the diversity factor was found to be 90%.

Table 9: Non-coincident Peak Loads by Region

DISCO Region	2007/08 Non-Coincident Peak Load (MW)	Regional Percentage
Central		
Distribution	780	77%
Large Industrial	198	19%
Wholesale	41	4%
Eastern		
Distribution	880	64%
Large Industrial	276	20%
Wholesale	204	15%
Other Substation	11	1%
Northern		
Distribution	493	61%
Large Industrial	317	39%
Subtotal	3200	
Transmission Losses 4%	128	
Total Non-Coincident Peak	3328	
Total Coincident Peak (Jan 2007)	2998	
Diversity Factor	90%	

8.5 Transmission Development 2008 to 2017

This section summarizes the future project plans for the New Brunswick transmission system, and also highlights the major improvements of 2007/08. 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. Summary of the 2007/08 Additions

- Construction of a second 345 kV interconnection between New Brunswick and New England was completed on schedule in December 2007. This new line connects Point Lepreau Terminal to Orrington, Maine. As a result of this project, the maximum transfer capability between New Brunswick and New England is increased from 700 MW to 1000 MW. The firm import capability has been raised from zero to 300 MW, and the conditional firm import capability has been raised from 100 MW to 550 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 2007/08

- Construction of a 138 kV Line 1236 from Salisbury Terminal to Kent Hills is scheduled for completion in the fall of 2008. This line will connect New Brunswick's first commercial wind project, the 96 MW Kent Hills Wind Project, to the transmission grid.

- Two new 138/69 kV tie transformers (83/111/156 MVA) are planned for Bathurst Terminal to replace the existing transformers. Both are expected to be installed by the fall of 2008, and will be able to provide 100% backup support for each other.

- Transformer T1, a 138/69 kV tie transformer at Marysville Terminal, is to be replaced with a larger transformer capable of supporting 100% of the local area peak load. T1 is presently undersized (68 MVA peak at 0 degrees Celsius) and is past the normal life expectancy of a transformer (was built in 1957). The on-load tap changer is in poor shape and contains many 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. The installation of the new T1 is expected in the fall of 2008.

- The installation of a 75 MVAR reactor at Point Lepreau Terminal is required due to the addition of the International Power Line 3016. The reactor is necessary to absorb reactive power during times of low energy transfers with New England. This project is expected to be completed in the fall of 2008.

- A new 138 kV substation is being built in Deerwood Acres southeast of Fredericton. This new substation will be supplied by Line 1135, and is being built to relieve load from the Rainsford Lane Substation. The new substation will be completed in the fall of 2008.

- The Eel River HVDC Station is undergoing a study for a multi-year refurbishment project. The planning is underway for this project with a projected refurbishment completion date of 2010.

- Construction of 69 kV Line 0150 from Iroquois Terminal to East Edmundston Substation is planned for the 2008/10 time period because Line 0070 is nearing its normal operating winter rating. Line 0150 will offload over 30 MW of the current peak demand from Line 0070 and greatly assist future load growth in the Edmundston North, Baker Brook, Clair and St Francois areas of New Brunswick.

- The construction of a new 138 kV transmission Line 1237 from Salisbury to Memramcook is planned to relieve the high loading on Line 1156 and Line

1157. The initial activities include consultation with NB Power Distribution and Customer Service regarding line routing to supply present and future substations, undertaking the real-estate consultation process, and preliminary transmission line design. These activities will take at least two or more years to complete. Once a right of way has been selected with environmental approval, the real-estate can be secured and engineering and construction will begin. A 2012 completion date is expected.

- NB Power Transmission is planning for the construction of additional transmission lines to connect wind projects at Lamèque, Aulac, and Caribou. The details of these projects will be known once the negotiations with the individual developers are finalized.

3. Stage 2009 to 2012

- Planning for the construction of a new 345 kV line between Coleson Cove and Salisbury is scheduled for 2009/10. This new line will mitigate the unacceptable post-contingency conditions associated with the loss of Line 3004 or Line 3013 during winter peak load levels.

- The rebuilding of 69 kV Line 0013 from Six Roads to Line 0133 (near Shippegan) is planned at the earliest for 2009/10. 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 transmission line crews. The remaining portions of Line 0013 (Line 0133 to Lamèque) will be rebuilt in the future but no date has been set for this construction (+10 years).

- The addition of a 138 kV breaker in 2009/10 at the Newcastle Terminal will improve the reliability of the supply to T1 and T2 (138/69 kV transformers). These transformers supply all of the 69 kV substations in the Miramichi region.

- The Campbellton City Substation is planned to be converted from 69 kV to 138 kV in 2011. This conversion project will greatly relieve loading on the 138/69 kV transformer at Eel River Terminal. This project is also necessary due to the age and heavy loading of the existing transformers.

- A new substation on Claudie Road in Fredericton will be built in 2010/11. This substation will be built directly under the existing Line 0020. The purpose of this new distribution supply is load relief for the Nashwaaksis Substation and improved reliability and flexibility in operating the local distribution system.

- Nepisiquit Falls will have a new terminal and transmission line access by 2011. A short extension to Line 0112 will allow the energy generated at Nepisiquit Falls to be placed directly on the 69 kV transmission system.

- 345 kV breakers at Norton and Eel River will be installed in 2010/11 to provide increased reliability to the system. This improved breaker arrangement greatly reduces the possibility of losing two 345 kV lines due to breaker failure in the area.

- The replacement of the Brookville Switching Station with a 138/69 kV transformer at Norton is planned for 2010/11. The station will soon require a complete rebuild due to its poor condition. The development of a 69 kV supply at Norton Terminal provides greater economic value to the system than just replacing the existing breaker in Brookville.

- The third 345 kV breaker will be installed at Belledune terminal allowing for the completion of the ring bus breaker arrangement and improving the reliability of the transmission lines Line 3008 and line 3018 (lines interconnecting Belledune Generating Station to the system). Installation of this breaker is planned for 2011/12.

- The Grand Lake terminal line and breaker controls are presently located in the Grand Lake Plant. The long term plan is for the retirement of Grand Lake in 2010. NB Power Transmission is conducting a study for a multi-year terminal redevelopment project that will allow for the transmission line and breaker controls to be moved to a new terminal control building at Grand Lake. This project will be completed when the Grand Lake Plant is retired.

4. Stage 2012 to 2018

- The development of a 345 kV terminal north of the City of Moncton/Dieppe is being considered for the 2012 to 2018 time period. The purpose of this project will be to accommodate load growth and development in this area. The 345/138 kV transformation in the area will provide improved local operational flexibility and reliability.

- Conversion of the Aberdeen Substation from 69 kV to 138 kV is planned for 2012/13. This substation supplies most of the load in the downtown Fredericton area. This conversion project will greatly relieve loading on the 138/69 kV transformer at Marysville Terminal. The mature age and heavy loading of Aberdeen Street Substation's transformers justify this conversion project. The line supplying the substation today was built to 138 kV standards, allowing for a convenient conversion of this transmission supply.

- NB Power Distribution and Customer Service are planning to build a 69 kV substation in St Francois in the next 5 to 10 years. This would require the construction of an extension to Line 0070.

- Line 0045 underwater cable from St. George to Grand Manan is to be replaced in 2018. The cable will be 40 years old at that time and will have reached its maximum life expectancy.

8.6 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 1363 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 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.

9.0 REGIONAL SYSTEM DEVELOPMENT

Under the Electricity Act and the Market Rules, NBSO is responsible for undertaking and coordinating power system planning and development responsibilities to maintain and ensure the adequacy and reliability of the integrated electricity system for present and future needs, and for the efficient operation of the market. Studies and future scenario analyses are regularly conducted by NBSO to assess possible system and market impacts of potential local New Brunswick projects as well as potential major projects in neighbouring areas affecting the NBSO system.

Some of the scenarios studied by NBSO include the potential for greater energy exports from New Brunswick. The Province announced in its 2007 throne speech that it intends to grow the energy sector in New Brunswick, and it will examine opportunities to sell more energy to markets in Atlantic Canada and the New England states. The Province has announced that it is also studying the feasibility of a second nuclear reactor at Point Lepreau, and the potential of sending natural gas to the northern area of New Brunswick.

Projects for which NBSO is undertaking and coordinating studies and future scenario analyses, both independently or in partnership with other system operators and utilities, include the following:

9.1 2nd Tie Project Studies

The new 345 kV interconnection between New Brunswick and New England was commissioned in December 2007. Studies involving this project that were completed in 2007/08 include:

- Final determination of the import/export transfer capabilities between New Brunswick and New England.
- A comprehensive area transmission review of the New Brunswick Bulk Power System.
- Revision of all operating procedures concerning the NBSO/ISO-NE interface.

9.2 Possible Generation and Transmission Expansion Projects

In conjunction with studying the possibility of greater electricity exports from New Brunswick, possible new sources of generation must be modelled to provide the increased exports. The possible generation projects that NBSO includes in these studies are publicly known to be under some degree of consideration, but NBSO makes no representation that its analysis of these projects shows that they have been committed to in any respect.

The following are possible generation expansion projects that NBSO is considering in its studies of greater electricity exports:

- Wind development in the Maritimes Area (500 to thousands of MW)
- Second nuclear facility at Point Lepreau (700 to 1000 MW)

- Second generator at Belledune (500 MW)
- Liquefied natural gas co-generation in Saint John (500 to 750 MW)
- 2nd Refinery co-generation in Saint John (200 MW)
- Lower Churchill Project import from Quebec and export to new England (740 MW)
- Lower Churchill Project interconnection at Salisbury, NB and export to New England (740 MW)

In 2008 NBSO, along with other transmission planners in the Maritimes Area, formed a Maritimes Area Technical Planning Committee (MATPC). The scope of the MATPC includes regular reviews of area plans of resource adequacy and transmission reliability. The MATPC may also undertake joint studies to assess the potential need for investments in transmission or other facilities in order to maintain the reliability of interconnections, improve performance of the market, or reduce the costs associated with transmission constraints. Amongst the joint studies to be undertaken are transmission expansion between Nova Scotia and New Brunswick, transmission expansion between New Brunswick and Maine, and a possible third transmission line between PEI and New Brunswick.

9.3 Maine/NB MOU to Enhance the Mutual Benefits of the Maine/NB Electrical Interconnections

On February 9, 2007 the Governor of Maine and the Premier of New Brunswick announced that they had signed a Memorandum of Understanding (MOU) to explore and set forth actions enhancing cross-border cooperation on electrical interconnections. This agreement directs Maine and New Brunswick to explore expansions of generation capacity, including renewables, and transmission opportunities by agreeing to jointly undertake the following tasks:

- Study the feasibility of expanding generation capacity and transmission infrastructure to increase electrical flows across borders;

- Identify processes and systems to provide transparency and efficiency in Maine and New Brunswick markets;

- Study the feasibility of developing common market rules that could be applied in Maine and New Brunswick;

- Explore the potential benefits and technical and legal impediments to the common provisioning of control area services (including balancing, dispatch and reserve sharing);

- Explore the tariff and governance structures required for a regional transmission organization for Maine and New Brunswick; and

- Examine the opportunities for compatible greenhouse gas emissions reduction regimes in the electricity sector.

NBSO will be participating in these undertakings, and it is anticipated that complete detailed assessments of all tasks will be presented to the respective governments in a final report in 2008/09.

9.4 Northern Maine Interconnection Study

In early 2007, Central Maine Power (CMP) and Maine Public Service (MPS) commissioned a study to analyse the Northern Maine transmission system and develop alternative transmission interconnections to the MEPCO and New England transmission systems to improve MPS system reliability without adversely affecting the New Brunswick – Maine transmission interface transfer capability. This study will examine the goal of connecting Northern Maine to the New England market, as Northern Maine is presently interconnected only with the New Brunswick transmission system. Some issues that will impact the scenarios considered in this study include:

- Aroostook Wind Energy, Inc. has submitted a request to connect a 500 to 800 MW wind project to the MPS system; and
- The recent Maine-New Brunswick MOU requires the parties to study the feasibility of expanding the transmission infrastructure to increase electrical flows across borders.

NBSO is participating in this study work, and it is anticipated that it will be completed in 2008/09.

9.5 NBSO Study Regarding Transfer Capability Expansion

As part of its participation in various studies, NBSO is undertaking scenario analysis in order to determine the most efficient expansion of the New Brunswick transmission system in order to accommodate increased exports to neighbouring markets. These scenarios include the possible generation expansion projects identified in section 9.2, and this work will complement NBSO's participation in the studies identified in sections 9.3 and 9.4. It is anticipated that NBSO will complete this study during the 2008/09 year.

10.0 SUMMARY OF RESULTS

Load Forecast

- The New Brunswick load forecast for the 10-year planning period has an average growth rate of 1.0% per year for system net energy. This equates to an overall increase of 1,347 GWh for the planning period.

- The load forecast has an average growth rate of 1.1% per year for the peak hour demand, an increase of 322 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 69% 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 98% higher than it is for August, the month with the lowest forecast for peak hour demand.

Generation Resources

- As of January 1, 2008 the total capacity of New Brunswick generation resources was 4,175 MW. The only current plan for additional conventional generation is an incremental 100 MW of nuclear capacity that results in October 2009 from the refurbishment of the Point Lepreau Generation Station

- 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 began on March 29, 2008, and results in a 558 MW capacity reduction for the system during the refurbishment period. To meet its capacity obligations during the 2008/09 peak winter season, NB Power Distribution and Customer Service has arranged for up to 200 MW of capacity purchased from Hydro Quebec. Completion of this refurbishment by October 2009 results in 658 MW of capacity returned to the system for a net increase of 100 MW.

- NB Power has announced the following wind projects for New Brunswick

Project Location	Size (MW)	Owner	In-service Date
Kent Hills	96	TransAlta	December 2008
Lamèque	49.5	Acciona	November 2009

Aulac	64.5	Acciona	November 2009
Caribou	99	SUEZ Energy	November 2009

- The only planned generation retirement is 57 MW at Grand Lake in 2010/11.

Load and Resource Balance

- The load and resources review shows that the New Brunswick system will have sufficient generation resources to meet the in-province load obligations throughout the forecast period.

Transmission Projects

- Construction of a 138 kV Line 1236 from Salisbury Terminal to Kent Hills is scheduled for completion in the fall of 2008. This line will connect New Brunswick's first commercial wind project, the 96 MW Kent Hills Wind Project, to the transmission grid.

- Two new 138/69 kV tie transformers (83/111/156 MVA) are planned for Bathurst Terminal to replace the existing transformers. Both are expected to be installed by the fall of 2008, and will be able to provide 100% backup support for each other.

- Transformer T1, a 138/69 kV tie transformer at Marysville Terminal, is to be replaced with a larger transformer capable of supporting 100% of the local area peak load. T1 is presently undersized (68 MVA peak at 0 degrees Celsius) and is past the normal life expectancy of a transformer (was built in 1957). The on-load tap changer is in poor shape and contains many 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. The installation of the new T1 is expected in the fall of 2008.

- The installation of a 75 MVAR reactor at Point Lepreau Terminal is required due to the addition of the International Power Line 3016. The reactor is necessary to absorb reactive power during times of low energy transfers with New England. This project is expected to be completed in the fall of 2008.

- A new 138 kV substation is being built in Deerwood Acres southeast of Fredericton. This new substation will be supplied by Line 1135, and is being built to relieve load from the Rainsford Lane Substation. The new substation will be completed in the fall of 2008.

- The Eel River HVDC Station is undergoing a study for a multi-year refurbishment project. The planning is underway for this project with a projected refurbishment completion date of 2010.

- Construction of 69 kV Line 0150 from Iroquois Terminal to East Edmundston Substation is planned for the 2008/10 time period because Line 0070 is nearing its normal operating winter rating. Line 0150 will offload over 30 MW of the current peak demand from Line 0070 and greatly assist future load growth in the Edmundston North, Baker Brook, Clair and St Francois areas of New Brunswick.

- The construction of a new 138 kV transmission Line 1237 from Salisbury to Memramcook is planned to relieve the high loading on Line 1156 and Line 1157. The initial activities include consultation with NB Power Distribution and Customer Service regarding line routing to supply present and future substations, undertaking the real-estate consultation process, and preliminary transmission line design. These activities will take at least two or more years to complete. Once a right of way has been selected with environmental approval, the real-estate can be secured and engineering and construction will begin. A 2012 completion date is expected.

- NB Power Transmission is planning for the construction of additional transmission lines to connect wind projects at Lamèque, Aulac, and Caribou. The details of these projects will be known once the negotiations with the individual developers are finalized.

- Planning for the construction of a new 345 kV line between Coleson Cove and Salisbury is scheduled for 2009/10. This new line will mitigate the unacceptable post-contingency conditions associated with the loss of Line 3004 or Line 3013 during winter peak load levels.

- The rebuilding of 69 kV Line 0013 from Six Roads to Line 0133 (near Shippegan) is planned at the earliest for 2009/10. 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 transmission line crews. The remaining portions of Line 0013 (Line 0133 to Lamèque) will be rebuilt in the future but no date has been set for this construction (+10 years).

- The addition of a 138 kV breaker in 2009/10 at the Newcastle Terminal will improve the reliability of the supply to T1 and T2 (138/69 kV transformers). These transformers supply all of the 69 kV substations in the Miramichi region.

- The Campbellton City Substation is planned to be converted from 69 kV to 138 kV in 2011. This conversion project will greatly relieve loading on the 138/69 kV transformer at Eel River Terminal. This project is also necessary due to the age and heavy loading of the existing transformers.

- A new substation on Claudie Road in Fredericton will be built in 2010/11. This substation will be built directly under the existing Line 0020. The purpose of this new distribution supply is load relief for the Nashwaaksis Substation and improved reliability and flexibility in operating the local distribution system.

- Nepisiquit Falls will have a new terminal and transmission line access by 2011. A short extension to Line 0112 will allow the energy generated at Nepisiquit Falls to be placed directly on the 69 kV transmission system.

- 345 kV breakers at Norton and Eel River will be installed in 2010/11 to provide increased reliability to the system. This improved breaker arrangement greatly reduces the possibility of losing two 345 kV lines due to breaker failure in the area.

- The replacement of the Brookville Switching Station with a 138/69 kV transformer at Norton is planned for 2010/11. The station will soon require a complete rebuild due to its poor condition. The development of a 69 kV supply at Norton Terminal provides greater economic value to the system then just replacing the existing breaker in Brookville.

- The third 345 kV breaker will be installed at Belledune terminal allowing for the completion of the ring bus breaker arrangement and improving the reliability of the transmission lines Line 3008 and line 3018 (lines interconnecting Belledune Generating Station to the system). Installation of this breaker is planned for 2011/12.

- The Grand Lake terminal line and breaker controls are presently located in the Grand Lake Plant. The long term plan is for the retirement of Grand Lake in 2010. NB Power Transmission will be is undergoing a study for a multi-year terminal redevelopment project that will allow for the transmission line and breaker controls to be moved to a new terminal control building at Grand Lake. This project will be completed when the Grand Lake Plant is retired.

- The development of a 345 kV terminal north of the City of Moncton/Dieppe is being considered for the 2012 to 2018 time period. The purpose of this project will be to accommodate load growth and development in this area. The 345/138 kV transformation in the area would improve local operational flexibility and reliability.

- Conversion of the Aberdeen Substation from 69 kV to 138 kV is planned for 2012/13. This substation supplies most of the load in downtown Fredericton area. This conversion project will greatly relieve loading on the 138/69 kV transformer at Marysville Terminal. The mature age and heavy loading of Aberdeen Street Substation's transformers justify this conversion project. The line supplying the substation today was built to 138 kV standards, allowing for a convenient conversion of this transmission supply.

- NB Power Distribution and Customer Service are planning to build a 69 kV substation in St Francois in the next 5 to 10 years. This would require the construction of an extension to Line 0070.

- Line 0045 underwater cable from St. George to Grand Manan is to be replaced in 2018. The cable will be 40 years old at that time and will have reached its maximum life expectancy.

Regional Studies

- The following are possible generation expansion projects that NBSO is considering in its studies of greater electricity exports:
  - Wind development in the Maritimes Area (500 to thousands of MW)
  - Second nuclear facility at Point Lepreau (700 to 1000 MW)
  - Second generator at Belledune (500 MW)
  - Liquefied natural gas co-generation in Saint John (500 to 750 MW)
  - 2nd Refinery co-generation in Saint John (200 MW)
  - Lower Churchill Project import from Quebec and export to new England (740 MW)
  - Lower Churchill Project interconnection at Salisbury, NB and export to New England (740 MW)

- In 2008 NBSO, along with other transmission planners in the Maritimes Area, formed a Maritimes Area Technical Planning Committee (MATPC). The scope of the MATPC includes regular reviews of area plans of resource adequacy and transmission reliability. The MATPC may also undertake joint studies to assess the potential need for investments in transmission or other facilities in order to maintain the reliability of interconnections, improve performance of the market, or reduce the costs associated with transmission constraints. Amongst the joint studies to be undertaken are transmission expansion between Nova Scotia and New Brunswick, transmission expansion between New Brunswick and Maine, and a possible third transmission line between PEI and New Brunswick.

- On February 9, 2007 the Governor of Maine and the Premier of New Brunswick announced that they had sign a Memorandum of Understanding (MOU) to explore and set forth actions enhancing cross-border cooperation on electrical interconnections. This agreement directs Maine and New Brunswick to explore expansions of generation capacity, including renewables, and transmission opportunities. NBSO will be participating in these undertakings, and it is anticipated that complete detailed assessments of all tasks will be presented to the respective governments in a final report in 2008/09.

- In early 2007, Central Maine Power (CMP) and Maine Public Service (MPS) commissioned a study to analyse the Northern Maine transmission system and develop alternative transmission interconnections to the MEPCO and New England transmission systems to improve MPS system reliability without adversely affecting the New Brunswick – Maine transmission interface transfer capability. This study will examine the goal of connecting Northern Maine to the New England market, as Northern Maine is presently interconnected only with the New Brunswick transmission system. NBSO is participating in this study, and it is anticipated that it will be completed during 2008/09.

- As part of its participation in various studies, NBSO is undertaking scenario analysis in order to determine the most efficient expansion of the New Brunswick transmission system in order to accommodate increased exports to neighbouring markets. It is anticipated that NBSO will complete this study during the 2008/09 year.

11.0 REFERENCES

[1] *2007 Maritimes Area Comprehensive Review of Resource Adequacy*, Report approved by NPCC Reliability Coordinating Council March 5, 2008.

[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

Substransmission 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 prefault to postfault 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 prefault to postfault 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 prefault 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.