NEW ENGLAND POWER POOL
1999 TRIENNIAL REVIEW
OF
RESOURCE ADEQUACY

MARCH, 2000

1.0 EXECUTIVE SUMMARY

1.1 Major Findings

This report was prepared to satisfy the requirements for a Triennial Review of New England Power Pool's (NEPOOL) Resource Adequacy as established by the Northeast Power Coordinating Council (NPCC). The guidelines for the review are specified in the NPCC Document B-8 entitled, "*Guidelines for Area Review of Resource Adequacy"* (Revised: February 14,1996).

This review shows that NEPOOL will meet the NPCC Resource Adequacy Criterion of 1 day in 10 years Loss of Load Expectation (LOLE) for the period 2000 through 2009, inclusive, if future generating capacity additions are fully integrated into the New England transmission system. Of the 7157 MW of new capacity assumed, NEPOOL knows with certainty that 2,726 MW will be fully integrated. If partial integration is assumed for the remaining 4,431 MW, and a 50% derating of these new generating resources is modeled to reflect transmission constraints, NEPOOL system reliability could be below the 1 day in 10 years LOLE criterion by the year 2006.

This review also considered NEPOOL system reliability under a high load forecast. The results of the review based on the high load forecast show that NEPOOL has adequate resources to meet its reliability criterion through 2005. However, there are contingency plans available should this occur.

1.2 Summary of Major Assumptions and Results

Table1 shows the major assumptions used in this review.

Table 1
Major Assumptions

Assumption	Description
Reliability Criterion	LOLE of 1 day in 10 years
Load Model	Weekly daily peak load, mean and standard deviation
Reliability Model	Westinghouse/ABB Capacity Model
Unit Availability	Historic Averages: 2 year EFOR (1997 and 1998) 4 year Maintenance Factor (1995 through 1998)
Tie Benefits	Assumed 1,300 MW from the neighboring systems Tie Benefit assumption is year round and encompasses entire study period, 2000 - 2009 inclusive
Emergency Operating Procedures (Load Relief, Voltage Reduction)	Modeled
New Generating Capacity Additions	2726 MW – With Full Transmission Interconnection 4431 MW – Transmission Interconnection unknown at present

Tables 2 through 4 below show the results of the review. The Loss of Load Expectation (LOLE) values in these tables are expressed in days per year. An LOLE lower than 0.1 days per year is better than criterion.

Table 2
Results of Triennial Review based on Reference Summer Peak Load Forecast

Year	Summer Reference Peak Load (MW)	Installed Capability[1] (MW)	Installed Reserves (MW)	Installed Reserves %	LOLE (Days/Year)	Required Reserves[2] (MW)	Required Reserves %	Surplus/ (Shortfall) (MW)	Resource Need (MW)
2000	22,855	28,720	5,865	25.7	0.0073	3,985	17.4	1,880	0
2001	23,335	30,727	7,392	31.7	0.0010	4,365	18.7	3,027	0
2002	23,825	32,210	8,385	35.2	0.0002	4,395	18.4	3,990	0
2003	24,231	32,188	7,957	32.8	0.0005	4,418	18.2	3,539	0
2004	24,697	32,188	7,491	30.3	0.0013	4,447	18.0	3,044	0
2005	25,183	32,157	6,974	27.7	0.0037	4,496	17.9	2,478	0
2006	25,770	32,081	6,311	24.5	0.0104	4,499	17.5	1,812	0
2007	26,225	32,011	5,786	22.1	0.0223	4,524	17.3	1,262	0
2008	26,677	31,867	5,190	19.5	0.0490	4,559	17.1	631	0
2009	27,137	31,803	4,666	17.2	0.0943	4,614	17.0	52	0

[1] This is the sum of all supply resources available to NEPOOL(Internal Installed Capacity(including projected retirements and reratings) + Capacity From Ties + Capacity from New Unit Additions + Capacity from emergency operating procedures(OP4)). It includes the net interconnection credit of 1,500 MW associated with the Hydro-Québec Phase II Firm Energy Contract (Up to August 2001, inclusive).

[2] The required reserve margin shown here is not NEPOOL's planning criterion. Required reserve is a by-product of designing a system that meets an annual Loss Of Load Expectation(LOLE) of 1 day in ten years based on the assumptions used for installed capability, peak load and unit availability. This required reserve is the amount of capacity required over and above the peak load which gives exactly the required annual reliability of 1 day in ten years LOLE. The required reserve percentage is calculated with respect to the peak load and is considered to be the minimum amount needed to meet the annual LOLE. It must be noted that this required reserve has been calculated for the purposes of meeting the Triennial Review Requirements. NEPOOL sets required reserves through the Annual Objective Capability Process and, at this point in time, those required reserve levels have not been determined for 2000 and beyond.

Table 3

Results of Triennial Review based on High Peak Load Forecast

Year	High Peak Load (MW)	Installed Capability (MW)	Installed Reserves (MW)	Installed Reserves %	LOLE (Days/Year)	Required Reserves (MW)	Required Reserves %	Surplus/ (Shortfall) (MW)	Resource Need (MW)
2000	23,722	28,720	4,998	21.1	0.0305	4,057	17.1	941	0
2001	24,432	30,727	6,295	25.8	0.0087	4,452	18.2	1,843	0
2002	25,069	32,210	7,141	28.5	0.0027	4,489	17.9	2,652	0
2003	25,779	32,188	6,409	24.9	0.0095	4,535	17.6	1,874	0
2004	26,569	32,188	5,619	21.1	0.0304	4,594	17.3	1,025	0
2005	27,391	32,157	4,766	17.4	0.0901	4,675	17.1	91	0
2006	28,317	32,081	3,764	13.3	0.2564	4,714	16.7	(950)	950
2007	29,210	32,011	2,801	9.6	0.6667	4,787	16.4	(1,986)	1,986
2008	30,130	31,867	1,737	5.8	1.6667	4,877	16.2	(3,140)	3,140
2009	31,080	31,803	723	2.3	3.3333	4,985	16.0	(4,262)	4,262

The results of the review based on the high load forecast show that NEPOOL has adequate resources to meet its reliability criterion through 2005. From 2006 - 2009, NEPOOL will have capacity shortfalls ranging from 950 to 4,300 MW and will not be able to meet its reliability criterion if the high forecast materializes. However, there are contingency plans available should this occur.

Table 4

Results of Sensitivity Analysis on Possible Transmission Congestion associated with the remaining 4431 MW of New Generating Additions

Year	Peak Load	LOLE (Days/Year) at 100% Deration	LOLE (Days/Year) at 75% Deration	LOLE (Days/Year) at 50% Deration	LOLE (Days/Year) at 25% Deration	LOLE (Days/Year) at Full Capacity
2000	22,855	0.0073	0.0073	0.0073	0.0073	0.0073
2001	23,335	0.0471	0.0302	0.0111	0.0052	0.0010
2002	23,825	0.0952	0.0397	0.0085	0.0021	0.0002
2003	24,231	0.1637	0.0721	0.0170	0.0047	0.0005
2004	24,697	0.2833	0.1303	0.0347	0.0105	0.0013
2005	25,183	0.5128	0.245	0.0713	0.0238	0.0037
2006	25,770	0.9615	0.4808	0.1536	0.056	0.0104
2007	26,225	1.6129	0.8196	0.2732	0.100	0.0223
2008	26,677	2.7027	1.4493	0.5025	0.2087	0.0490
2009	27,137	3.8461	2.1739	0.8264	0.3649	0.0943

The results of the sensitivity analysis show that NEPOOL would not meet its reliability criterion from 2003 onwards if only 2,726 MW of new capacity is assumed. If 75 % deration is assumed on the remaining 4431 MW (i.e. a total of 3834 MW of new capacity to be in-service with full transmission interconnection) NEPOOL will not meet its reliability criterion from 2004 onwards. With 50% deration assumed (i.e. 4942 MW of new capacity to be in-service with full transmission interconnection), NEPOOL will not meet its reliability criterion from 2006. With 25% deration (6,049 MW of new capacity to be in-service with full transmission interconnection), NEPOOL will not meet its reliability criterion from 2008 onwards.

2.0 Table of Contents

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3.0 Introduction

The purpose of this report is to review the resource adequacy of NEPOOL as required by NPCC. As part of its Reliability Assessment Program, NPCC conducts resource adequacy reviews of its members' areas to ascertain whether or not each area plans enough resources to meet the NPCC resource reliability criterion. These resource adequacy reviews are currently done on a triennial basis.

This report compares current and previous resource plans and analyzes the adequacy of NEPOOL's planned resources based on the reference and high peak load forecasts for the period 2000 to 2009 inclusive.

3.1 Previous Triennial Review of NEPOOL's Resource Adequacy

The NPCC Reliability Coordinating Committee approved the previous NEPOOL Triennial Review of Resource Adequacy in June 1997. The findings of that review showed that NEPOOL had adequate resources to meet the NPCC Reliability Criterion for the period 1997 through 2006.

3.2 Comparison of Current and Previous Resource Plans

The previous Triennial Review of NEPOOL's Resource Adequacy was based on the 1996 Load Forecast, which projected a summer peak load[3] compound annual load growth rate of 1.1% for the period 1997 to 2006. The 1999 Load Forecast projects a summer peak load compound annual load growth rate of 1.94% for the period 2000 - 2009. The comparison of these two forecasts is shown in Figure 1 on the following page.

[3] Peak Load is adjusted to account for the impacts of Demand Side Management (DSM) Programs and the NEPOOL Participant recognized non-utility capacity which is netted from the load forecast. The reference load forecast used is found within the "*1999 Capacity, Energy, Loads and Transmission Report*", dated April 1, 1999(CELT). The high load forecast used is taken from the report entitled, *"Forecast of New England Electric Energy and Peak Load" (dated April,1998).* A description of the DSM components is given in Appendix 1.5

Figure 1
Summer Reference Peak Load Forecasts
1997 vs. 1999 Triennial Reviews
1996 vs. 1999 Load Forecasts

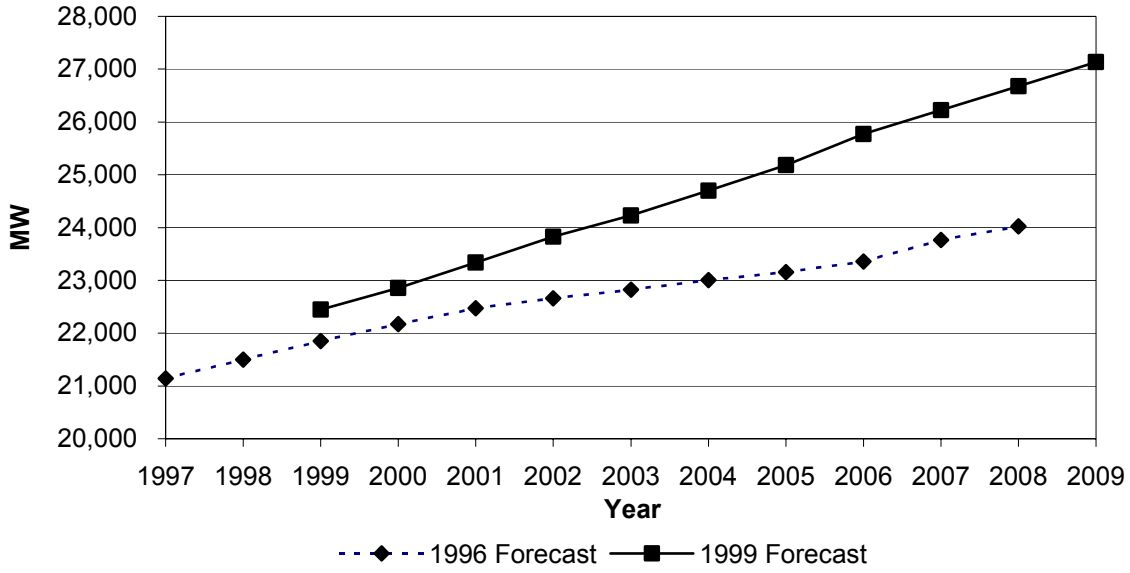

Figure 2
Projected Summer Capacity
1997 vs. 1999 Triennial Review

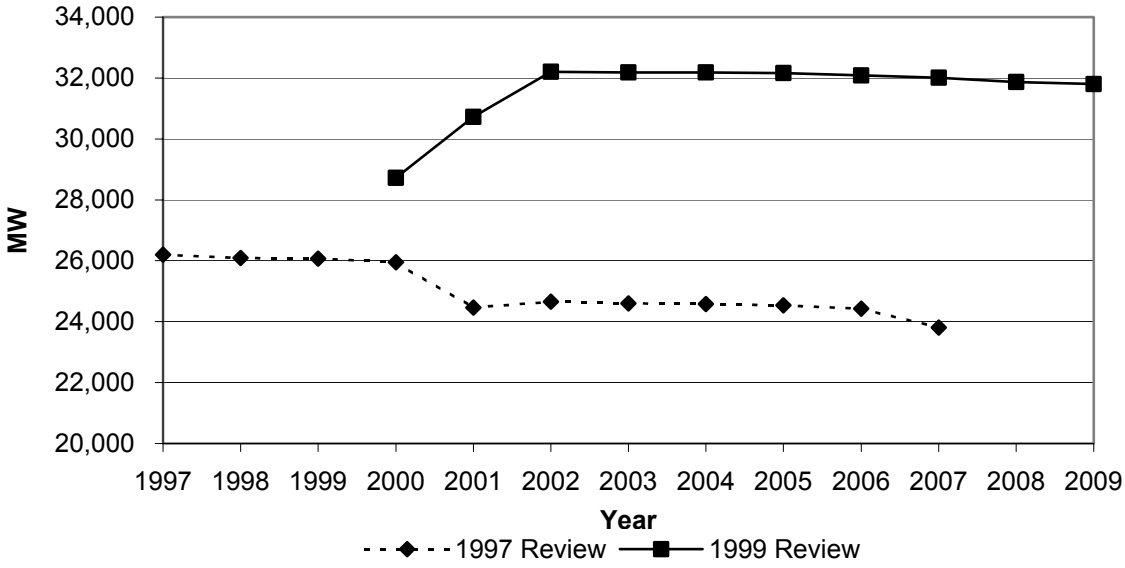

Table 5

Assumed New Capacity Additions (Winter Ratings)

Year	2000	2001	2002
New Capacity Additions (MW)	1,211	3,617	2,329
Cumulative New Capacity Additions (MW)	1,211	4,828	7,157

Since the 1996 Review, NEPOOL Participants, in response to Order 888 by the Federal Energy Regulatory Commission (FERC), have filed a request with FERC to create the ISO of New England (ISO-NE). ISO-NE was established on July 1, 1997 and immediately assumed responsibility for the management of NEPOOL's bulk power generation and transmission system and administering the Open Access Transmission Tariff (OATT).

ISO-NE and NEPOOL have identified more than 20,000 MW of proposed new capacity that could be added to the NEPOOL capability by 2002. For the purposes of this review the capacity additions shown in Table 5 have been assumed.

Figure 2 shows the comparison between the installed summer resources claimed for capability used in the 1997 Triennial Review and this year's review.

The assumptions on new capacity additions shown in Table 5 were based on the following:

- 1999 CELT[4] report assumptions for units with status codes TS, U and V.[5]
- Units which have either been approved or are pending approval via the NEPOOL 18.4 Application Process.
- Units which have received environmental and siting permits based on information available to ISO-NE.

This resource adequacy review was conducted under the assumption that all proposed new capacity additions would be deliverable anywhere in New England. When the approximately 20,000 MW in proposed new capacity additions were screened for inclusion in this report, only 7,157 MW of new additions were sufficiently advanced to warrant inclusion. While it is true that NEPOOL allows new capacity additions to be connected to the system under a "minimum interconnection standard," market pressures will influence the additions of capacity to locations where they will be able to deliver their output at the time of system peak. In addition, New England is working towards a method of specifically assessing the deliverability of capacity. ISO-NE and NEPOOL made a filing to FERC on December 30,

[4] The *Capacity, Energy, Loads and Transmission Report* (CELT) is a source of assumptions for use in planning and reliability studies, and fulfills in part the reporting requirements of DOE, NERC Reliability Assessment Subcommittee, NPCC, EEI, EFSB(MA) and NEPOOL. The CELT forecast assumptions do not constitute a "plan."

[5] TS – Construction complete, but not yet in commercial operation; U – Under Construction, less than or equal to approximately 50% of plant completed; V – Under Construction, more than approximately 50% of plant completed.

1999 to address the deliverability of installed capacity. The following paragraph is an excerpt from this filing:

> The ISO will perform an annual, independent "Regional Resource Adequacy Assessment" to determine that adequate resources are in place or are under development such as will assure that regional and subregional reliability objectives can be met. This assessment will also consider the extent that such resources can be delivered to loads in different reliability regions. NEPOOL will commence development of alternative, market based reliability assurance mechanisms and will file a status report with the Commission by January 1, 2001.

In conclusion, NEPOOL's use of a single bus model for resource requirements is appropriate for New England's existing system; and, ISO-NE will address the deliverability of capacity as additions are made to the system.

For this Triennial Review, ISO-NE conducted a sensitivity analysis regarding possible transmission congestion related to the proposed new units. For the assumed 7157 MW of new capacity, it is known with certainty that 2,726 MW will be interconnected based on the Full Interconnection Standard. Some of the units in the remaining 4431 MW might be interconnected based on the minimum interconnection standard. Since it is not known with certainty which of these units will be interconnected fully or on the minimum standard, a sensitivity analysis has been done to determine the possible effects of transmission congestion on the output capacity of the units. In this regard the remaining 4431 MW of capacity have been modeled at varying levels of deration to identify the impact of the reduced capacity in meeting the NEPOOL Resource Planning Reliability Criterion. The units were modelled at derated levels of 100%, 75%, 50% and 25%. 100% deration is a worst case scenario which effectively means that only 2,726 MW will be available to fully serve the load. The results of the analysis are presented in Table 6 below.

Table 6

Results of Sensitivity Analysis on Possible Transmission Congestion associated with the remaining 4431 MW of New Generating Additions

Year	Peak Load	LOLE (Days/Year) at 100% Deration	LOLE (Days/Year) at 75% Deration	LOLE (Days/Year) at 50% Deration	LOLE (Days/Year) at 25% Deration	LOLE (Days/Year) at Full Capacity
2000	22,855	0.0073	0.0073	0.0073	0.0073	0.0073
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The results of the sensitivity analysis show that NEPOOL would not meet its reliability criterion from 2003 onwards if only 2,726 MW of new capacity is assumed. If 75 % deration is assumed on the remaining 4431 MW (i.e. a total of 3834 MW of new capacity to be in-service with full transmission interconnection) NEPOOL will not meet its reliability criterion from 2004 onwards. With 50% deration assumed (i.e. 4942 MW of new capacity to be in-service with full transmission interconnection), NEPOOL will not meet its reliability criterion from 2006. With 25% deration (6,049 MW of new capacity to be in-service with full transmission interconnection), NEPOOL will not meet its reliability criterion from 2008 onwards.

It is important to note that in the NEPOOL Triennial Review of Resource Adequacy, only 1300 MW of tie reliability benefits were assumed after 2001. NEPOOL has 2,800 MW of tie capability with its neighboring systems. It is expected that NEPOOL Participants will take advantage of this transfer capability for capacity contracts if needed to meet demand. This means that up to 1500 MW of capacity contracts could be obtained from neighbouring utilities.

4.0 Resource Adequacy Criterion

4.1 Statement of NEPOOL Resource Adequacy Criterion

The NEPOOL Resource Adequacy Criterion complies with the NPCC criterion and reads:

> "Resources will be planned and installed in such a manner that, after due allowance for the factors enumerated below, the probability of disconnecting non-interruptible customers due to resource deficiency, on the average, will be no more than once in ten years."

a. The possibility that load forecasts may be exceeded as a result of weather variations.
b. Immature and mature equivalent forced outage rates appropriate for generating units of various sizes and types, recognizing partial and full outages.
c. Seasonal adjustment of resource capability.
d. Proper maintenance requirements.
e. Available operating procedures.
f. The reliability benefits of interconnections with systems that are not NEPOOL participants.
g. Such other factors as may from time-to-time be appropriate.

4.2 Application of NEPOOL Resource Adequacy Criterion

For planning required resources the NEPOOL criterion translates to a LOLE of one day in ten years which is used to determine the amount of resources needed to reliably supply the system. The actual amount of capacity reserves required for the system is determined as a by-product of the probabilistic simulation of the system which takes into account the random nature of generating unit forced outages and the probability distribution of the load.

In calculating the amount of resources needed, NEPOOL also takes into account the tie benefits that are available from neighboring systems. The tie benefits are modeled as capacity available on a monthly basis. The Hydro-Québec, New York and New Brunswick ties have been modeled.

To properly capture the intended operation of the system, the emergency operating procedures that are implemented during periods of capacity deficiencies are also modeled in the form of the amount of load relief that is obtainable. It is assumed the system operators will always maintain at least some minimum level of operating reserve to ensure control over transmission loadings and maintain a minimum reliability level.

The amount of additional generation and load relief which may be obtained during a capacity deficiency are shown in Table 7. This table provides the different actions and their priority when implementing NEPOOL Operating Procedure No.4 (OP4) – Action During A Capacity Deficiency. In actual practice, these actions may be implemented in a different order to reflect the current situation and the magnitude of the expected deficiency faced at the time. OP4 Actions 14 to 16 were not modeled in the reliability assessment and are listed as contingency resources. Actions 1 to 13 were modeled in this review. The amount of OP4 load relief which was modeled in this Review is described in Appendix 1.7. The amount of load relief obtainable through OP4 Action 6 is modeled as tie reliability benefits and the assumed benefits are shown in Appendix 1.3.

For the purposes of this review it was assumed that the OP4 actions as modeled will be consistent in the future while taking into account the fact that the OP4 load relief associated with implementation of a voltage reduction varies with the peak load.

Table 7
NEPOOL Operating Procedure No. 4
Action During a Capacity Deficiency

Action #	Description	MW
1	Implement Power Caution and advise generators to prepare to provide emergency energy	0
2	Order on generation<5MW requiring special ISO treatment	0
3	Curtail Type 2 NEPOOL Interruptible Loads – Block E	0
4	Curtail Type 2 NEPOOL Interruptible Loads – Block D	0
5	Curtail Type 2 NEPOOL Interruptible Loads – Block C	22
6	Purchase Emergency Capacity and Energy	Variable, depending on system conditions (Could be between 0 and 1,000 MW)
7	Curtail Type 2 NEPOOL Interruptible Loads – Block B	94
8	Curtail Type 2 NEPOOL Interruptible Loads – Block A	66
9	Voluntary Load Curtailment of NEPOOL Participants' Facilities. Implement Power Watch.	40
10	Customer Generation Contractually Available to NEPOOL Participants During a Capacity Deficiency. Curtail Type 5 NEPOOL Interruptible Loads Total Action 10	5 2 7
11	Allow 30 Minute Reserve to go to Zero (0)	About 575 MW, depending on NE's 2nd contingency
12	Implementation of 5%Voltage Reduction (VR) requiring more than 10 minutes. *In later actions of OP4 the New England ten-minute reserve may be allowed to diminish to maintain an absolute minimum required level*.	5 *About 1,000 MW depending on system conditions and circumstances and on NE's largest contingency*.
13	Implementation of 5% VR requiring 10 minutes or less.	300
14	Customer Generation not contractually available to NEPOOL Participants Voluntary Load Curtailment by Large Industrial and Commercial Customers Total Action 14	5 200[6] 200-205
15	Radio and TV Appeals for Voluntary Load Curtailment. Implement Power Warning.	200
16	Request State Governors to Reinforce Appeals for Voluntary Load Curtailment and Declaration of Power Warning.	100
	Grand Total	**2,614-3,614**

[6] The actual load relief obtained is highly dependent on circumstances surrounding the appeals, including timing and the amount of advanced notice that can be given.

4.3 Statement of Required Installed Reserves

As mentioned earlier, the NEPOOL required reserve margin is not its planning criterion. It is a by-product of designing a system that meets the annual reliability criterion of no more than one day in ten years disconnection of non-interruptible customers. As a result, the reserve levels may vary from year to year depending on system characteristics.

Table 8 and Figure 3, that follow, show the projected NEPOOL installed and required reserves based on the projected installed capacity assumed for the 1999 Triennial Review. Based on the assumptions made, NEPOOL will have adequate reserves to meet its annual reliability criterion through 2009.

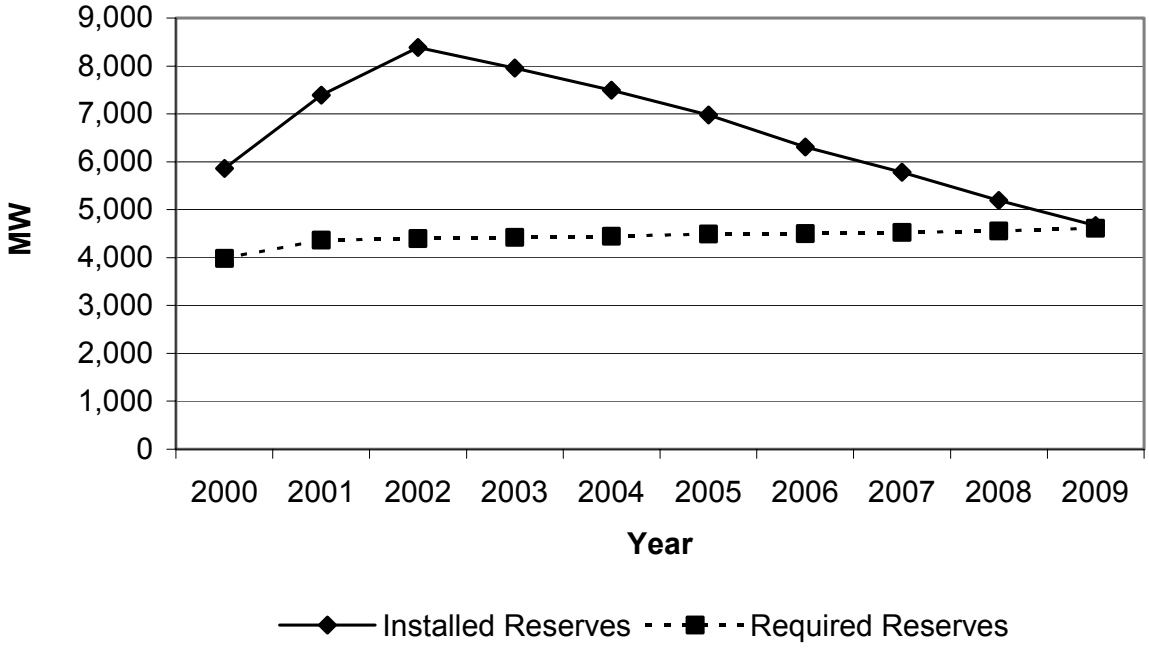
Table 8

NEPOOL Installed Reserves versus Required Reserves

Year	Installed Reserves (MW)	Required Reserves (MW)	Assumed Tie Benefits (MW)
2000	5,865	3,985	1300
2001	7,392	4,365	1300
2002	8,385	4,395	1300
2003	7,957	4,418	1300
2004	7,491	4,447	1300
2005	6,974	4,496	1300
2006	6,311	4,499	1300
2007	5,786	4,524	1300
2008	5,190	4,559	1300
2009	4,666	4,614	1300

Table 8 also shows the assumed tie benefits. Loss of the tie benefits would decrease the installed capability by 1300 MW which would result in an increase in required reserve levels by approximately 6% between 2000 and 2002 and by approximately 5% from 2003 to 2009 with respect to the summer reference peak load.

Figure 3
NEPOOL Installed Reserves versus Required Reserves



4.4 Comparison of NEPOOL and NPCC Resource Reliability Criterion

The NEPOOL's resource adequacy criterion as defined in Section 4.1 is the same as that established by NPCC.

4.5 Resource Adequacy Studies Done Since the 1997 Triennial Review

A study entitled,"*Review Of Interconnection Assistance Reliability Benefits"* was done by the NPCC CP-5 Working Group. The final report, dated May 12, 1999, concluded that the methodology and assumptions used by all NPCC areas for evaluating interconnection assistance in their reliability studies appear to be reasonable and do not overstate the assumed interconnection benefits.

5.0 Resource Adequacy Assessment

5.1 Installed vs. Required Reserve for Reference Load Forecast

Table 9 shows that NEPOOL will have adequate capacity to meet its reliability criterion through 2009. The reference peak load forecast is characterized as having a '50/50' probability of occurring.

Table 9

Results of Triennial Review based on Summer Reference Peak Load Forecast

Year	Summer Reference Peak Load (MW)	Installed Capability (MW)	Installed Reserves (MW)	Installed Reserves %	LOLE (Days/Year)	Required Reserves (MW)	Required Reserves %	Surplus/ (Shortfall) (MW)	Resource Need (MW)
2000	22,855	28,720	5,865	25.7	0.0073	3,985	17.4	1,880	0
2001	23,335	30,727	7,392	31.7	0.0010	4,365	18.7	3,027	0
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2009	27,137	31,803	4,666	17.2	0.0943	4,614	17.0	52	0

Installed Capability is the sum of all supply resources available to NEPOOL which includes internal installed capacity(including projected retirements and reratings), capacity from ties, capacity from new unit additions and capacity from load relief obtainable through the emergency operating procedures(OP4) process.

The required reserve margin shown here is not NEPOOL's planning criterion. Required Reserve is a by-product of designing a system that meets an annual Loss Of Load Expectation (LOLE) of 1 day in ten years based on the assumptions used for installed capability, peak load and unit availability. As a result the required reserve levels may vary from year to year depending on system characteristics. This required reserve is the amount of capacity required over and above the peak load which gives exactly the required annual reliability of 1 day in ten years LOLE. The required reserve percentage is calculated with respect to the peak load and is considered to be the minimum amount needed to meet the annual LOLE. It must be noted that this required reserve has been calculated for the purposes of meeting the Triennial Review Requirements. NEPOOL sets required reserves through the Annual Objective Capability Process and, at this point in time, those required reserve levels have not been determined for 2000 and beyond.

5.2 High Load Forecast

Recognizing the impact of load uncertainty on resource capacity requirements, ISO-NE develops a high load forecast which is characterized as having a 10% chance of being exceeded. Table 10, below, shows the results of the resource adequacy review based on the high load forecast and the assumed new capacity additions.

Table 10
Results of Triennial Review based on High Peak Load Forecast

Year	High Peak Load (MW)	Installed Capability (MW)	Installed Reserves (MW)	Installed Reserves %	LOLE (Days/Year)	Required Reserves (MW)	Required Reserves %	Surplus/ (Shortfall) (MW)	Resource Need (MW)
2000	23,722	28,720	4,998	21.1	0.0305	4,057	17.1	941	0
2001	24,432	30,727	6,295	25.8	0.0087	4,452	18.2	1,843	0
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The results of the review based on the high load forecast show that NEPOOL has adequate resources to meet its reliability criterion through 2005. From 2006 - 2009, NEPOOL will have capacity shortfalls ranging from 950 to 4,300 MW and will not be able to meet its reliability criterion if the high forecast materializes. However, there are contingency plans available should this occur.

5.3 Contingency Plans

The NEPOOL Installed Capability Market (ICAP) will continue in its current form until December 31, 2001, at which time it is expected that it would be eliminated. Prior to the elimination of the ICAP Market, NEPOOL will commence development of alternative market based reliability assurance mechanisms and will file a status report regarding these mechanisms with FERC by January 1, 2001. As part of the reliability assurance mechanism, ISO-NE will perform an annual, independent "Regional Resource Adequacy Assessment" to determine that adequate resources are in place or are under development such as will assure that regional and sub-regional reliability objectives can be met.

At present, ISO-NE and NEPOOL have identified more than 20,000 MW of possible new generating capacity additions by 2002. Only 7,157 MW of that potential generating capacity has been used in this review. It is anticipated that market mechanisms will provide the capacity resources that will be needed in NEPOOL should the high load forecast materialize. There are also several transmission resources proposed for installation in the near future, totaling over 5,500 MW. These transmission resources are also supply options not modeled in this review. In addition, this review has not assumed that, upon the termination of the NEPOOL/HQ Firm Energy

Contract on September 1, 2001, additional capacity purchases could be obtained from Hydro-Quebec through the NEPOOL/Hydro-Quebec Phase II interconnection should capacity needs occur.

6.0 Planned Resource Capacity and Energy Mix

Figure 4
NEPOOL's Resource Capacity Mix By Fuel Type

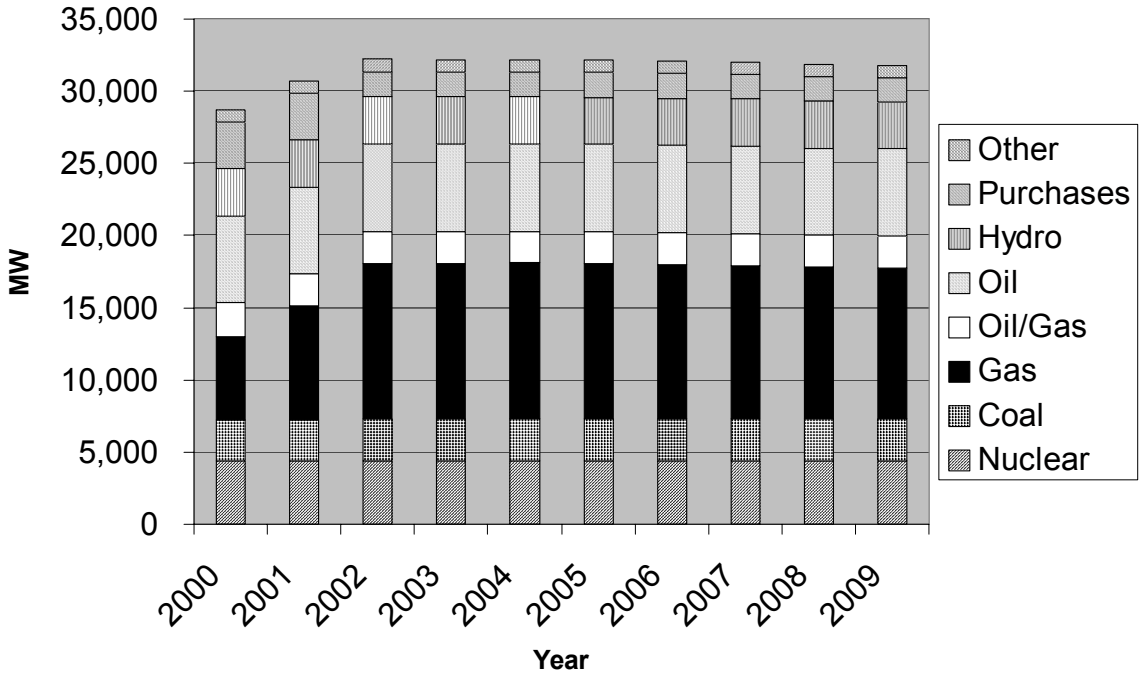

Figure 4 shows the projected NEPOOL's resource capacity mix by fuel type.

Figure 5
NEPOOL's Forecast Energy Production By Fuel Type

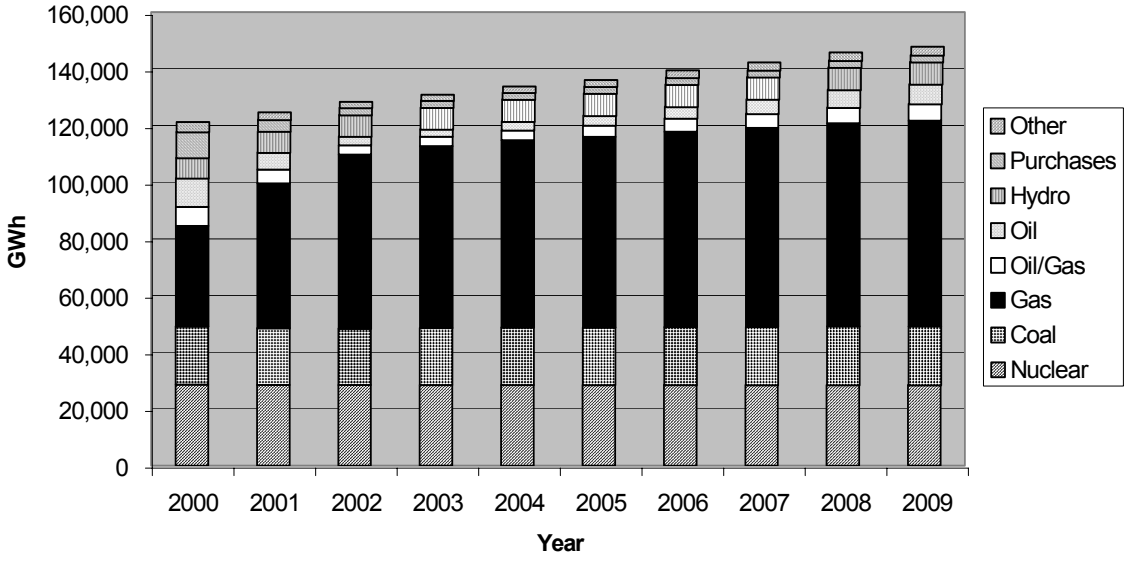

Figure 5 shows NEPOOL's Forecast Energy Production by fuel type.

Most of the future unit additions are projected to be fueled by natural gas. Figures 4 and 5 show that the projected use of natural gas as a fuel for electric generation will increase over time. ISO-NE is in the process of conducting an adequacy and reliability assessment of New England's natural gas pipeline infrastructure to serve the growing demand for natural gas from the electric power generation sector.

APPENDIX

A. DESCRIPTION OF RESOURCE RELIABILITY MODEL

For long-range resource adequacy studies, ISO-NE uses the Westinghouse/ABB Generation Capacity Model program (or reliability model). The reliability model utilizes probabilistic mathematics to simulate the uncertainty and random nature of future load and resource availabilities.

Specifically, the model calculates the reliability of the NEPOOL system taking the following parameters into account:

- A probability distribution of weekday peak loads of each week of the year.
- Expected weekly unavailability of generators due to planned maintenance, equivalent forced outages, and seasonal deratings.
- The expected level of capacity purchases and sales between NEPOOL (or its Participants) and neighboring utilities.
- The expected tie benefits from neighboring utilities.
- The expected amount of seasonal load relief obtainable through the implementation of emergency operating procedures.

The reliability model uses a cumulant method to represent the load and capacity distributions. The maintenance schedule is based on levelizing the risk over weeks in a year. The model calculates and reports the LOLE for the simulated period.

1.1 LOAD MODEL

1.1.1 ISO-NE uses a probabilistic load model in reliability calculations which assumes a distribution of daily peak loads for each week of the year (the weekend loads are omitted because they contribute negligibly to the system risk). The distribution is defined by three input parameters for each week of each year; the expected value of the highest daily peak in each week (weekly peak), the standard deviation, and skewness for the daily peaks within the month.

1.1.2 Reference and high load growth scenarios are used to identify the impact on system reliability of uncertainties associated with economic and demographic assumptions, as well as the impact of DSM programs. The NEPOOL Load Forecasting Model directly employs regional economic and demographic projections based on ISO-NE state-specific economic models and the Data Resources Inc.(DRI) long term economic forecast for the United States. The models forecast demand, employment, real output, value added, wages and relative production costs by industry as well as the more aggregate concepts of government employment, population, personal income, and gross regional product. The economic/demographic projections provide the NEPOOL Load Forecasting Model with the fundamental growth factors necessary to estimate future electric energy use and the resultant generation of a peak load and energy forecast. The forecast includes the impacts of NEPOOL Participant-sponsored DSM programs. The MW and MWh impacts of the DSM programs are subtracted from the load forecast.

The reference load forecast is characterized as having a ‘50/50’ probability of occurring, whereas the high load forecast is characterized as having a 10% chance of being exceeded.

1.2 Resource Unit Representation

1.2.1 Unit Ratings

1.2.1.1 Definition

Existing capacity data was based on the "*October, 1999 NEPOOL Seasonal Claimed Capability (SCC) Report"*. Seasonal Claimed Capability (SCC) represents the Summer (SCC-S) and Winter (SCC-W) Claimed Capability of a generating unit submitted by NEPOOL Participants. The summer period runs from June 1 through September 30, and the Winter period runs from October 1 through May 31. Claimed capability is the demonstrated maximum dependable load carrying capability, in megawatts, of such unit, excluding capacity required for station use.

NEPOOL SCC reports are published on ISO-NE's website.

1.2.1.2 Procedure for verifying ratings

ISO-NE has the right to initiate audits of all standard generating units to verify Claimed Capability. Audits are initiated by ISO-NE by ordering the generator output to be increased from its current operating level (if that level is below SCC) to its SCC. The required duration for a claimed capability audit is at least two hours and no more than eight hours, depending on the Capability Period and type of unit. In order to pass a claimed capability audit, a unit must demonstrate it can achieve average output greater than or equal to Claimed Capability. Full details of the audit process can be found in the NEPOOL Market Rules and Procedures, Appendix 11D(Rating and Auditing NEPOOL Resources).

1.2.2 Unit Unavailability Factors Represented

1.2.2.1 Each unit was modeled with its two year (1997 and 1998) average Equivalent Forced Outage Rate (EFOR) and four year (1995 through 1998) average Maintenance Factor.

1.2.2.2 The unit outage data was based on actual history.

1.2.2.3 Unit maturity was not considered in this review

1.2.2.4 Table 11 below shows the ranges of the EFOR's used in the review.

Table 11
NEPOOL Typical Forced Outage Rates By Unit Type

Unit Type	EFOR(%)
Nuclear	10 - 12
Coal	4 - 17
Gas	5 – 15
Oil/Gas	5 – 15
Oil	4 –16

1.2.3 Purchases and Sales Representation

The external contracts NEPOOL has with neighboring systems were modeled. The following capacity purchases were included in the Westinghouse/ABB Capacity Model:

- NYPA contracts
- HQ contracts through the Highgate interconnection
- Vermont's synchronous block loading on the Hydro-Québec system.

The values of these purchases are shown in the 1999 CELT Report.

1.2.4 Retirements

Retirements, re-ratings, deactivated reserve status of generating capacity and changes to purchases and sales are based on the "*1999 Capacity, Energy, Loads and Transmission Report (CELT)".* The CELT Report is a source of assumptions for use in planning and reliability studies, and fulfills in part the reporting requirements of DOE, NERC Reliability Assessment Subcommittee, NPCC, EEI, EFSB(MA) and NEPOOL. The CELT forecast assumptions do not constitute a "plan." The unit retirements as shown in the 1999 CELT report were modeled.

1.3 Representation Of Interconnected Systems

Tie benefits from Hydro-Québec, New York and New Brunswick were modeled. A total of 1300 MW of tie benefits was assumed year round and through the study period 2000 - 2009 inclusive. This 1,300 MW amount is higher than the zero to 1,000 MW range of emergency assistance assumed obtainable in Table 7 which details NEPOOL's Operating Procedure No. 4 - "Action During a Capacity Deficiency". Table 7 assumed a lower amount of emergency purchase because it reflects possible short-term capacity purchases over the interconnections which are not modeled in this review.

The net interconnection credit of 1,500 MW associated with the Hydro-Québec Phase II Firm Energy Contract was modeled (Up to August 2001, inclusive).

1.4 Modeling of Limited Energy Sources

NEPOOL's pumped storage and hydro units were considered available to meet daily and monthly peak loads except when they are on planned or forced outages.

1.5 Modeling of Demand Side Management(DSM)

NEPOOL models DSM as a load adjustment to forecasted monthly NEPOOL loads as shown in the 1999 CELT Report. The values used in this review are shown in Table 12 below.

Table 12
NEPOOL's DSM Load Adjustment

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total DSM (MW)	1,497	1,513	1,530	1,546	1,538	1,513	1,463	1,445	1,374	1,374

The total DSM value is made up of the following categories:

Non-OP4 Interruptible Contracts:
This is the amount of customer load that is under contract with a utility that can be controlled at the time of system peak in response to a signal by a dispatcher and generally achieved within 10 to 30 minutes.

Peak Load Management:
This is the amount of customer load reduced from or shifted off system peak with only a minimum or no change in energy consumption.

Conservation on Peak:
This is the amount of customer load reduction at the time of system peak due to utility programs, which reduce customer load during many hours of the year.

Loss Adjustment:
This is the estimated reduction in transmission and distribution losses due to the implementation of DSM programs.

1.6 Modeling of Non-Utility Resources

There are two types of non-utility generation modeled. The first type is non-utility generation that is Participant controlled and not considered NEPOOL dispatchable. This type of resource is netted from the load forecast and is not claimed for capacity. The second type is non-utility generation that is considered Pool controlled and claimed for capacity. This second type is modelled just like the other NEPOOL units.

1.7 Assumed Load Relief from OP4 Actions

For this Triennial Review, the following assumptions were made for modeling OP4 actions

Dispatchable Loads(Type 2 Loads)	182 MW
Voluntary Curtailment by Participants	40 MW
Utilization of Customer Generation	7 MW
5% Voltage Reduction	2.1% of Monthy Peak Load
Minimum Reasonable Operating Reserve	-200 MW
Total Load Relief in OP4 Model	**29 MW + 2.1% of Monthly Peak Load**

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