

**NYISO 2009 Comprehensive Review
of
Resource Adequacy**

**Covering the New York Control Area
For the period 2010 to 2014**

**Final Report
Approved by the
NPCC RCC**

March 10, 2010

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1.0 EXECUTIVE SUMMARY

The New York Independent System Operator's (NYISO) 2009 reliability planning cycle is known as the Comprehensive Reliability Planning Process (CRPP). The CRPP encompasses a ten-year planning horizon and evaluates the future reliability of the New York bulk power system. In the first step of this two part CRPP, the NYISO, in conjunction with its Market Participants, identifies reliability needs over the planning period and issues its findings in the Reliability Needs Assessment (RNA). The Comprehensive Reliability Plan (CRP) then evaluates a range of proposed solutions to address the needs identified in the RNA. The 2009 RNA¹ did not identify any reliability needs over the ten-year planning horizon, so therefore no solutions were evaluated in the 2009 CRP.

This Comprehensive Review relies upon the following elements of the NYISO 2009 CRPP as studied as part of its first five year planning horizon: 1) the most recent Annual Transmission Reliability Assessment (ATRA) Base Case; 2) input from NYISO Market Participants; and 3) the procedures set forth in the CRPP Manual. For the 2009 CRPP, load models were initially based on the econometric load forecast in the NYISO 2008 Load and Capacity Data (also known as the NYISO "Gold Book").

In early December, the 2009 RNA database was revised to include a new load forecast. This new load forecast began with the 2009 Gold Book and was modified: to account for the impact of the Energy Efficiency Portfolio Standard (EEPS)²; and, to incorporate the impact of the state's economic downturn.

While there were incremental changes to the data, the findings of this update to the 2009 RNA database were consistent with the 2009 CRP report in that no reliability needs were identified over the period 2010 through 2014. Thus, the NYCA, for each year of the study and under Base Case conditions, will meet the Northeast Power Coordinating Council (NPCC) Resource Adequacy criterion in which the probability of an unplanned disconnection of firm load will not exceed one occurrence in ten years.

1.1 Major Findings

The findings indicate that the anticipated capacity supply (42,536 MW) will exceed the forecasted peak load (34,309 MW) (this includes the required reserve margin of 18% for the 2010-2011 Capability Year) by 2,051 MWs in 2014. There are three major reasons why no reliability needs were identified:

- a) A reduction in peak load forecast due to both slower economic growth and projected energy efficiency gains;
- b) An increase in generation additions and Special Case Resource (SCR) participation;
- c) Fewer planned retirements.

¹ Final Report January 13, 2009,

http://www.nyiso.com/public/markets_operations/services/planning/planning_studies/index.jsp

² Order issued by New York State Public Service Commission June 23, 2008.

1.2 Major Assumptions and Results

This review covers the period from 2010 to 2014 inclusive. Major assumptions are summarized in Table 1.1 below.

Table 1.1 Major Assumptions

Assumption	Description
Adequacy Criterion	NPCC Loss Of Load Expectation (LOLE) requirement of not more than one unplanned disconnection of firm load in ten years or 0.1 days/year on average.
Reliability Model	GE's MARS program
Load Model	8,760 hourly loads – based on 2009 Load and Capacity Data Report adjusted to account for 30% of the Energy Efficiency Portfolio Standard load reduction goals. 11 Zones modeled Load shape for year 2002 utilized.
Load Uncertainty	Historical Basis. Weather and economic conditions are factored in the analysis.
Generating Capacity Additions	2169 MWs of nameplate capacity by 2014
Generating Capacity Retirements	983 MWs in 2010
Unit Availability	Based on NERC-GADs data (EFORd calculation) and 5 year unit history.
Topology	As defined per the 2009 RNA study with modifications dictated by the assessment of future transmission system conditions. Emergency transfer limits at transmission interfaces between zones modeled.
Emergency Operating Procedures (EOP)	EOPs that reduce load during emergency conditions to maintain operating reserves are modeled.
Operating Reserve	600 MWs of 10 minute synchronized reserves. 1800 MW total reserves modeled.
External Control Areas	Load and Capacity fixed for years 2010 through 2013 per the 2009 RNA study. For Year 2014, the peak load was adjusted to yield an LOLE of approximately 0.10 days/year in External Areas. External Control Areas provide generator, load, transfer limits, and forecast uncertainty data.

Table 1.2 Summarizes the LOLE results for this review.

Table 1.2 NYCA LOLE Results

Summary of LOLE (Days/Year) Results			
Year	Base Load Forecast (2009 Gold Book)	High Load Forecast (2009 Gold Book)	2009 Base Load Update (10/30/09) [Load Forecast reduced]
2010	<0.01	0.05	<0.01
2011	<0.01	0.03	<0.01
2012	<0.01	0.04	<0.01
2013	<0.01	0.06	<0.01
2014	<0.01	0.09	<0.01

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3.0 INTRODUCTION

The New York Independent System Operator (NYISO) was formed in 1999 as the successor to the New York Power Pool (NYPP). The NYPP was formed by a consortium of the eight investor owned utilities that served the state of New York during and after the 1965 statewide blackout. The NYISO is recognized by the Federal Energy Regulatory Commission (FERC) as operator of the New York Control Area (NYCA). The NYCA is comprised of the New York state transmission grid encompassing approximately 10,892 miles of transmission lines over 47,000 square miles and serving the electric needs of more than 19.2 million New Yorkers. New York experiences its peak load in the summer period with the current peak load of 33,939 MWs occurring in the summer of 2006. (<http://www.nyiso.com>).

This report represents the NYISO's comprehensive review of resource adequacy covering the time period: 2010 through 2014. This report was prepared for the Northeast Power Coordinating Council (NPCC) in accordance with NPCC's Documents B-8 and A-2.

3.1 Most Recent NPCC Comprehensive Review

The previous comprehensive review for the NYISO, titled "2006 Triennial Review of Resource Adequacy" was submitted on October 1, 2006, and approved by NPCC's Reliability Coordinating Committee (RCC) on November 28, 2006. The 2006 report covered the years 2007 through 2011.

3.2 Comparison with the 2006 Comprehensive Review

3.2.1 Demand Forecast – Base Case

The demand forecast for this 2009 review significantly differs from the 2006 review due to two primary factors: the adoption of a new Energy Efficiency Portfolio Standard (EEPS) by the New York State Public Service Commission (NYSPSC); and the persistent economic downturn experienced in the state, as well as the nation.

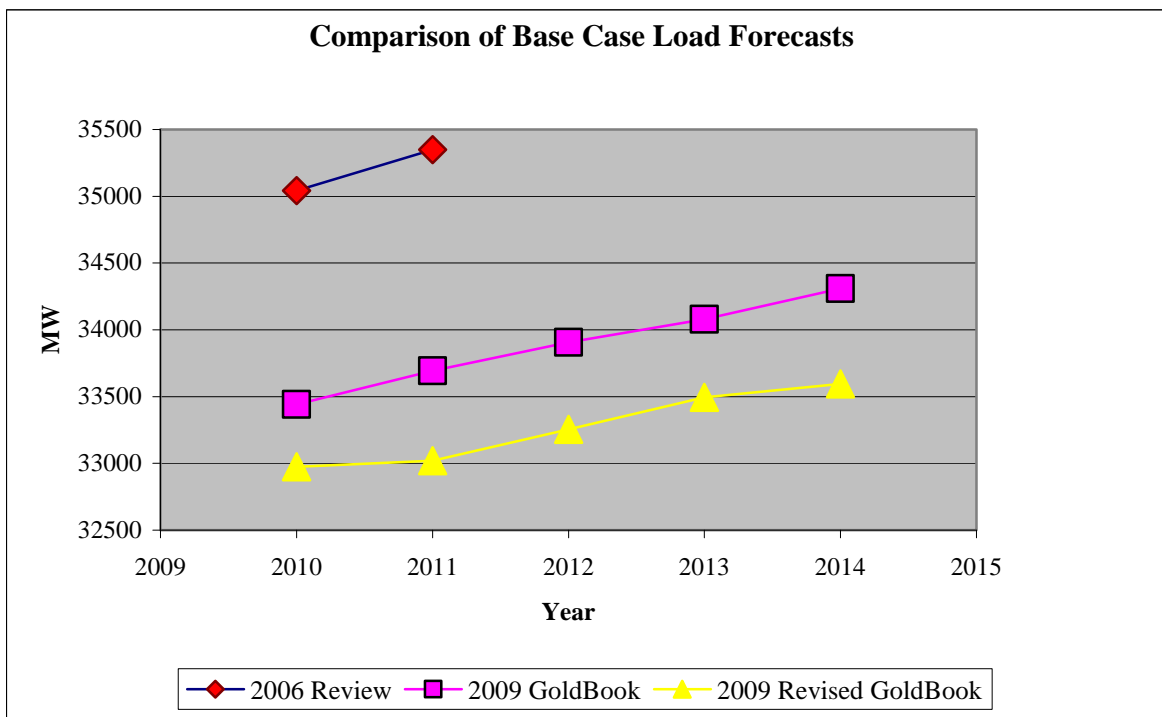
First, the NYSPSC adopted the EEPS Order on June 23, 2008 with the stated goal of reducing energy consumption by 15% of the 2007 forecasted levels, by 2015. The Order set short-term goals (for the entities over which it has jurisdiction) to adopt energy efficiency programs to be implemented in the 2008–2011 period. The Table 3.1 compares the Base Load forecasts of the 2006 Comprehensive Review with this current review. Table 3.1 also shows the cumulative impact of the EEPS over the term of the review.

The second factor significantly affecting the 2009 load forecast for the base case is the persisting state and federal economic downturn. The 2009 CRP captured the onset of reduced economic activity, but because of the duration of the economic downturn, a revised 2009 Gold Book forecast was completed on October 30, 2009. This revision lowered the forecast by an additional 800 MWs from the 2006 Comprehensive Review forecast for 2010 and 2011.

Table 3.1 Comparison of Demand Forecasts: Base Load

Comparison of Base Load Forecasts (MWs) with EEPS					
Year	2006 Review	2009 Gold Book	Difference	2009 Gold Book Revised 10/30/09	Difference
2010	35042	33441	-1601	32975	-2067
2011	35348	33693	-1655	33019	-2329
2012		33906		33254	
2013		34080		33494	
2014		34309		33594	

Figure 3.1 Comparison of Demand Forecasts: Base Load



3.2.2 Demand Forecast: High Load

The NYISO made a change in its methodology for constructing high and low load scenarios in 2007. In 2005 and 2006, the NYISO used high and low economic forecasts and weather projections to develop high and low energy and peak demand forecasts, using the same econometric models that were used to develop the base case forecasts. However, this led to

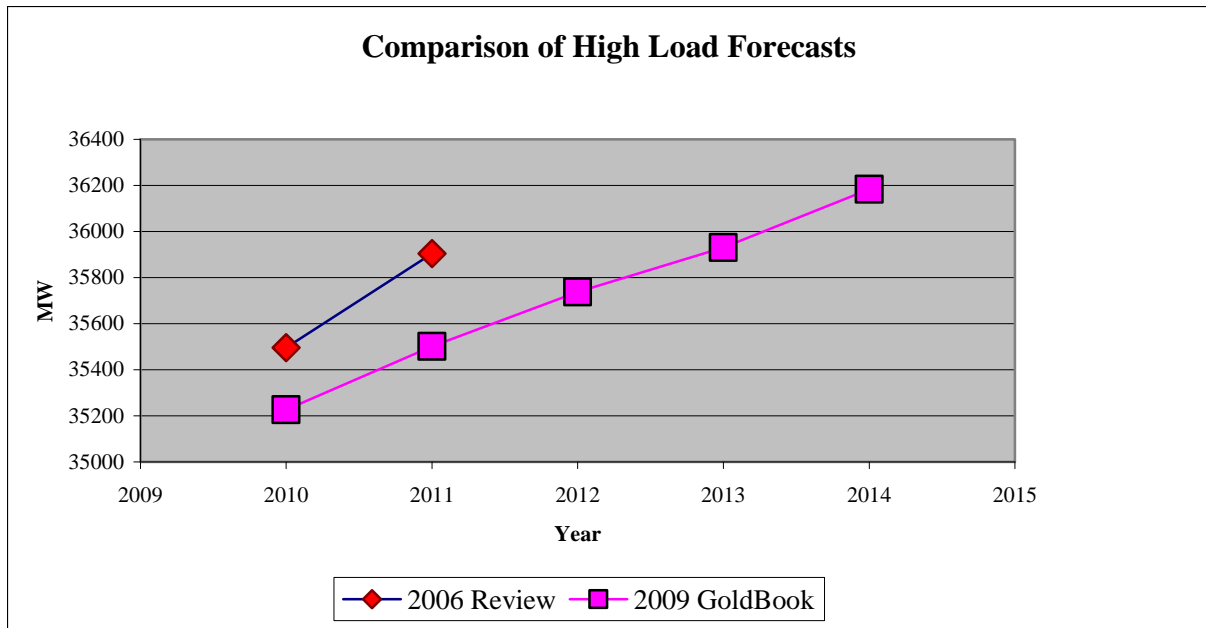
upper and lower bounds which, in percentage terms, appeared low in comparison to recent prior years. One drawback to the econometric-based method was that it was very difficult to determine how many standard deviations above or below the base case was implied by the economic data for the scenarios.

The method that has been in use since 2007 takes a univariate approach to developing the high and low bases cases. This method allows us to capture the combined effects of both weather variations and economic variations. It also allows us to be precise in stating the confidence level of the forecast, whether that be at the 80th percentile, or the 90th, or the 95th percentile.

Table 3.2 Comparison of Demand Forecasts: High Load

Comparison of High Load Forecasts (MWs)			
Year	2006 Review	2009 Gold Book	Difference
2010	35496	35227	-269
2011	35904	35502	-402
2012		35737	
2013		35931	
2014		36183	

Figure 3.2 Comparison of Demand Forecasts: High Load and Extreme Weather



3.3 Resources Forecast

Table 3.3 shows the resources forecast³ to be available to the New York Control Area system at the time of the seasonal peaks assumed for the 2006 Comprehensive Review and for the 2009 RNA.

Table 3.3 Comparison of Resources 2006 vs. 2009 Review

Comparison of Projected NYCA Resources (MWs)			
Year	2006 Review	2009 Gold Book	Difference
2010	41431	41741	310
2011	41431	42580	1149
2012		42580	
2013		42586	
2014		42536	

4.0 RESOURCE ADEQUACY CRITERION

4.1 Statement of Resource Adequacy Criterion

The NYISO adheres to the NPCC resource adequacy criterion⁴, which reads:

“The probability (or risk) of disconnecting firm load due to resource deficiencies shall be, on average, not more than one day in ten years as determined by studies conducted for each Resource and Planning Coordinator Area. Compliance with this criterion shall be evaluated probabilistically, such that the loss of load expectation (LOLE) of disconnecting firm load due to resource deficiencies shall be, on average, no more than 0.1 day per year. This evaluation shall make due allowance for demand uncertainty, scheduled outages and deratings, forced outages and deratings, assistance over interconnections with neighboring Planning Coordinator Areas, transmission transfer capabilities, and capacity and/or load relief from available operating procedures.”

The NYISO also adheres to the New York State Reliability Council (NYSRC) resource adequacy criterion (A-R1), which reads:

“The NYSRC shall establish the Installed Reserve Margin (IRM) requirement for the NYCA such that the 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 these criteria shall be evaluated probabilistically, such that the loss of load expectation (LOLE) of disconnecting firm load due to resource deficiencies shall be, on average, no more than 0.1 day per year. This evaluation shall

³ Resources include internal NYCA generation, additions, ratings, retirements, purchases and sales, SCRs, and UDRs with Firm Capacity. Wind is included at full nameplate rating.

⁴ See NPCC Directory #1 at <http://www.npcc.org/documents/regStandards/Directories.aspx>

make due allowance for scheduled outages and deratings, forced outages and deratings, assistance over interconnections with neighboring control areas, NYS Transmission System transfer capability, and capacity and/or load relief from available operating procedures.”

The NYSRC criterion is consistent with the NPCC criterion. In addition, NYSRC imposes Installed Capacity Requirements on NYCA Load Serving Entities (LSE) (A-R2), as follows:

"LSEs shall be required to procure sufficient resource capacity for the entire NYISO defined obligation procurement period so as to meet the state-wide IRM requirement determined from A-R1. Further, this LSE capacity obligation shall be distributed so as to meet locational ICAP requirements, considering the availability and capability of the NYS Transmission System to maintain the A-R1 reliability requirements."

This means that NYS Transmission System capability limitations shall not prevent NYISO from meeting the NYSRC resource adequacy criterion.

4.2 Application of the criteria

NYSRC uses these criteria to establish the appropriate NYISO installed reserve requirements. According to these criteria, not more than one unplanned disconnection of firm load can occur in a ten year period. However, before a load disconnection will occur, a series of emergency operating procedures (EOP's) will be invoked. These are aimed at either reducing load or increasing capacity.

Table 4.1 Emergency Operating Procedures

STEP	Procedure	Effect	MW Value
1	Special Case Resource	Load Relief	2575 *
2	Emergency Demand Response Program	Load Relief	329 *
3	5% Manual Voltage Reduction	Load Relief	72
4	30 Minute Reserve to zero	Allow Operating Reserve to decrease to largest unit capacity	600
5	5% Remote Voltage Reduction	Load Relief	479
6	Voluntary Industrial Curtailment	Load Relief	61
7	General Public Appeals	Load Relief	88
8	Emergency Purchases	Increase Capacity	Varies
9	10-minute Reserve to zero	Allow 10-minute reserve to decrease to zero	1200
10	Customer Disconnection	Load Relief	As needed
* Effective Value 1875 and 148 respectively			

4.3 Resource Summary to Meet Criteria

Recently the NYSRC and FERC approved an 18.0 %⁵ Installed Reserve Margin requirement for the Capability Year 2010-2011. This value is based upon an annual study as referenced below. Should the reserve margin requirement remain constant for the review period, the NYCA would have in excess of 2000 MWs of available capacity to meet criteria under Base Case assumptions.

Table 4.2 Resources to meet a constant 18% Reserve Margin

Projected Resources (MWs) to Meet the Current 18.0% Reserve Margin				
Year	Base Forecast	Resources required to meet 18% Reserve Margin	Projected Capacity Resources	Excess Resources
2010	33441	39460	41741	2281
2011	33693	39758	42580	2822
2012	33906	40009	42580	2571
2013	34080	40214	42586	2372
2014	34309	40485	42536	2051

4.4 Planning Coordinator Criterion

The NYCA criterion is the same as the NPCC criterion.

4.5 Resource Adequacy Studies Since the 2006 Review

Additional resource adequacy studies conducted since the 2006 Comprehensive Review includes the 2007, 2008, and 2009 CRP/RNA studies, annual Installed Reserve Margin requirement studies, and annual Locational Installed Capacity Requirement studies. All cited NYISO studies are publicly available and are located on the NYISO website: www.nyiso.com.

5.0 RESOURCE ADEQUACY ASSESSMENT

5.1 Resources to meet criteria – Base Load Forecast

Table 5.1 shows that no violations of the NPCC criterion occur through the study period for the base case load forecast. Additionally, the calculated reserve margins exceed the required Installed Reserve Margin of 18.0% (2010-2011 Capability Year).

⁵ New York Control Area Installed Capacity Requirements for the Period May 2010 through April 2011, <http://www.nysrc.org/reports3.asp>

Table 5.1 Resources Available to meet criteria under Base Load condition

Projected Resources (MWs) to Meet Criteria - Base Load Forecast (MWs)				
Year	Capacity	Base Forecast	LOLE (days/year)	Reserve Margin
2010	41741	33441	<0.01	24.8%
2011	42580	33693	<0.01	26.4%
2012	42580	33906	<0.01	25.6%
2013	42586	34080	<0.01	25.0%
2014	42536	34309	<0.01	24.0%

5.2 Resources to meet criteria: High Load

The high load forecast accounts for extremes of weather and economic activity. The upper bound has a ten percent probability of being exceeded. This could only happen if very strong economic growth combined with extreme weather conditions in excess of typical peak-producing conditions were to occur. Current econometric models indicate that future economic growth is expected to be lower than in previous years. Table 5.2 shows a five year projection of capacity and peak demand at the 90th percentile. The loss of load expectation is never higher than 0.09, which is less than the 0.1 LOLE criteria. The table also shows the reserve margin in the forecast period, which ranges from 17% to 20%.

Table 5.2 Resources Available to meet criteria under High Load condition

Projected Resources (MWs) to Meet Criteria - High Load Forecast (MWs)				
Year	Capacity	High Load Forecast	LOLE (days/year)	Reserve Margin
2010	41741	35227	0.05	18.5%
2011	42580	35502	0.03	19.9%
2012	42580	35737	0.04	19.1%
2013	42586	35931	0.06	18.5%
2014	42536	36183	0.09	17.6%

5.3 Contingency Mechanisms for Managing Demand and Resource Uncertainties

NYISO has in place a comprehensive planning process to assess and identify solutions to reliability needs. In accordance with FERC Order #890, beginning with the 2010 planning cycle, the process will expand in scope to include economic planning (Congestion Assessment and Resource Integration Study (CARIS)), transmission planning (Local Transmission Owner Planning Process (LTPP)) and the current CRPP. This new planning process is detailed in Attachment Y of the OATT (Open Access Transmission Tariff) and will be conducted biennially. If market-based solutions are not available or are determined to not be available when

needed, the NYISO has the authority to implement the necessary regulated backstop solution(s) to mitigate the reliability need(s).

5.4 Impacts of Major Proposed Changes to Market Rules on Area Reliability

There are no proposed changes to the market rules at this time that will significantly impact reliability.

6.0 PROPOSED RESOURCE MIX

Figure 6.1 NYCA's resource capacity mix for the year 2009.

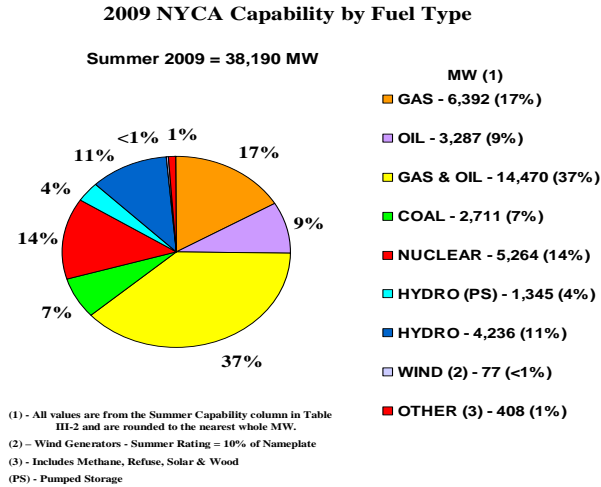


Table 6.1 Depicts NYCA resources by percentage of Capacity Mix by Year

Year	2010	2011	2012	2013	2014
Nuclear	13.7	14.1	14.1	14.1	14.1
Hydro	11.1	11.0	11.0	11.0	11.0
Pumped Storage	3.6	3.6	3.6	3.6	3.6
Biomass	1.1	1.1	1.1	1.1	1.1
Coal	7.1	7.0	7.0	7.0	7.0
Oil	8.6	8.6	8.6	8.6	8.6
Gas	19.3	19.2	19.2	19.2	19.2
Dual Fuel	35.3	35.2	35.2	35.2	35.2
Wind	0.2	0.2	0.2	0.2	0.2

6.1 Reliability Impacts from Fuel Supply

There is a potential for a natural gas shortage in New York State in the winter. This could cause natural gas fired units to burn other fuels or curtail operations. If unit operation curtailment due to fuel unavailability occurs in load pockets, generation from other areas would need to help meet demand, causing heavier loading on the existing transmission system. Many of the dual fired units are the larger older steam units located in load pockets and would impact reliability needs in multiple ways if retired. The real challenge on a going forward basis will be to maintain the benefits that fuel diversity, in particular dual fired fuel capability, provides today. This will be especially critical in New York City and Long Island which are entirely dependent on oil and gas fired units many of which have interruptible gas transportation contracts. In terms of operational strategy, the NYSRC has adopted the following local reliability rule where a single gas facility refers to a pipeline or storage facility:

I-R3. Loss of Generator Gas Supply (New York City & Long Island)

“The NYS Bulk Power System shall be operated so that the loss of a single gas facility does not result in the loss of electric load within the New York City and Long Island zones.”

The NYISO categorizes generation capacity fuel types into three supply risks: “Low”, “Moderate” and “High.”

The greatest risk to fuel supply interruption occurs during the winter months when both natural gas and heating fuel oils are competing to serve electrical and heating loads. Fortunately in New York, peak electrical loads occur during the summer months when demand is approximately 9,000 MWs greater than the winter peak. As such, New York can meet the winter peak of roughly 25,000 – 26,000 MW with sufficient generation without exposure to significant fuel risks. Even with a forced outage rate of 10%, there is sufficient generation in the low to moderate fuel risk categories to meet the winter electrical peak.

The New York Control Area also has a significant amount of Hydro resources. Many of these resources are located on rivers throughout the State. The output of these run-of-river resources are subject to water levels which may vary greatly on a month to month basis based upon weather conditions - snowfall amounts, temperature, rainfall amounts, etc. For reliability purposes these units are modeled with a 45% derate factor.

6.2 Mechanisms to Mitigate Risk

The most current project schedules are also incorporated into the studies to reflect any potential changes due to economics, permitting and cancellations for resources expected to come on line during the study period. There are no current impacts to reliability due to economic conditions expected.

The NYISO monitors, on a quarterly basis, projects identified in an RNA assessment to determine that those projects remain on schedule. The NYISO also monitors progress on the State energy efficiency program implementation, SCR program registration, transmission

owners' updated plans and other planned projects on the bulk power system. Should the NYISO determine that conditions have changed, it will determine whether market-based solutions that are currently progressing are sufficient to meet resource adequacy and system security needs of the New York bulk power system. If not, the NYISO will address any newly identified reliability need in the subsequent RNA or, if necessary, issue a request for a Gap solution.

Should extreme conditions result in unanticipated load levels, the NYISO will call on its SCR and EDRP programs and invoke coordinated system operations through NPCC Regional Reliability Reference Directory 2, "Emergency Operations."

6.3 Reliability Impacts due to State/Federal requirements

The State of New York is required to comply with the National Ambient Air Quality Standards (NAAQS) for criteria pollutants, including ozone, which have been established by the U.S. Environmental Protection Agency (EPA). New York State has not achieved compliance with the NAAQS for ozone. Ground level ozone is the product of hydrocarbons (HC) and nitrous oxide (NO_x) emissions, and sunlight. Fossil-powered generating stations are the fourth largest source of NO_x emission in New York, behind area sources, non-road sources and on road mobile sources, each of which are responsible for significantly higher NO_x emissions.

The State Implementation Plan (SIP) to achieve compliance with NAAQS is currently being reviewed by EPA. The SIP has three design elements that will affect fossil fuelled generators in New York. First is a federally initiated regional program to budget NO_x emissions and provide for tradable NO_x Allowances, known as the Clean Air Interstate Rule (CAIR). On July 11, 2008, the U.S. Court of Appeals for the D.C. Circuit issued an opinion vacating and remanding these rules. The CAIR rulings leave in place the CAIR trading programs until EPA issues a new rule to replace CAIR. Upon the July 2008 ruling the EPA informed the Court that development and finalization of a replacement rule could take about two years. The second element is the Ozone Transport Commission (OTC) High Electric Demand Day (HEDD) program to reduce emissions from older peaking units. Third, DEC has recently proposed (12/23/09) new standards for Reasonable Available Control Technology for the control of NO_x from all but the newest fossil fuelled generators in New York.

It is reasonable to evaluate the potential impact of significant new NO_x emission limitations on the bulk power system. The 2007 RNA analyzed the potential impact of the OTC-HEDD program on the targeted plants for the "design day" and determined that proposed program would lead to exceedances of reliability criteria. This year, the analysis reviewed the impact of the OTC-HEDD emission reductions on targeted units for all high ozone days during the period 2005 to 2007. In addition, potential impacts of DEC's preliminary proposal to update NO_x RACT standards for all units will need to be examined in a subsequent study.

A review of recent generation and air quality data should aid in the understanding of the nature of possible reduction requirements. According to DEC data, throughout the period of 2005-2007 there have been a total of 49 days when New York's air quality did not meet the existing NAAQS for ozone of 84 ppb. With the new standard of 75 ppb in place, it is reasonable to expect that additional exceedances would have been recorded with the current level of emissions. The

NYISO analyzed the same dataset to determine the potential impact of the OTC HEDD program. The analysis was conducted in two parts, looking first at the High Emitting Combustion Turbines (HECT), and then at the Load Following Boilers (LFB). The complete OTC HEDD analysis would include both HECT and LFB being limited in capacity simultaneously and would result in greater LOLEs than the sum of the single class evaluations. Retrofit emission reduction technologies may not be economically feasible or available at all for many of the HECTs and some of the LFBs. The analysis conducted assumed that the proposed emission reductions are achieved through capacity limitations. The impacts of those capacity limitations result in LOLEs >0.1 as shown in Table 6.2. This analysis shows a reduction in the magnitude of the LOLEs which can be attributed to the increased use of SCR resources. The analysis shows that these SCR resources will be called upon significantly more than current practice. Programs designed to reduce NOx emissions from the HECT units will require at a minimum, equivalent capacity replacement, to maintain resource adequacy.

Table 6.2 Environmental Impacts on LOLE

Environmental Impacts on LOLE (days/year)		
Year	Base Load w/OTC HEDD LFBs	Base Load w/OTC HEDD HECTs
2010	0.02	0.03
2011	0.01	0.02
2012	0.02	0.02
2013	0.03	0.03
2014	0.05	0.05

APPENDIX A

Description of Resource Reliability Model

The reliability calculation process for determining the NYCA IRM requirement utilizes a probabilistic approach. This technique calculates the probabilities of outages of generating units, in conjunction with load and transmission models, to determine the number of days per year of expected capacity shortages. The General Electric Multi-Area Reliability Simulation (GE-MARS) is the primary computer program used for this probabilistic analysis. The result of the calculation for “Loss of Load Expectation” (LOLE) provides a consistent measure of system reliability.

As the primary probabilistic analysis tool used by the NYCA for reliability studies, the GE-MARS program includes a detailed load, generation, and transmission representation for 11 NYCA Zones, as well as the four external Control Areas (Outside World Areas) interconnected to the NYCA

A sequential Monte Carlo simulation forms the basis for GE-MARS. The Monte Carlo method provides a fast, versatile, and easily expandable program that can be used to fully model many different types of generation, transmission, and demand-side options. GEMARS calculates the standard reliability indices of daily and hourly LOLE (days/year and hours/year) and Loss of Energy Expectation (LOEE in MWhrs/year). The use of sequential Monte Carlo simulation allows for the calculation of time-correlated measures such as frequency (outages/year) and duration (hours/outage). The program also calculates the need for initiating Emergency Operating Procedures (EOPs), expressed in days/year.

In addition to calculating the expected values for the reliability indices, GE-MARS also produces probability distributions that show the actual yearly variations in reliability that the NYCA could be expected to experience. In determining NYCA reliability, there are several types of randomly occurring events that must be taken into consideration. Among these are the forced outages of generating units and transmission capacity. Monte Carlo simulation models the effects of such random events. Deviations from the forecasted loads are captured by the use of a load forecast uncertainty model.

Monte Carlo simulation approaches can be categorized as “non-sequential” and “sequential”. A non-sequential simulation process does not move through time chronologically or sequentially, but rather considers each hour independent of every other hour. Because of this, non-sequential simulation cannot accurately model issues that involve time correlations, such as maintenance outages, and cannot be used to calculate time-related indices such as frequency and duration.

Sequential Monte Carlo simulation (used by GE-MARS) steps through the year chronologically, recognizing the status of equipment is not independent of its status in adjacent hours. Equipment forced outages are modeled by taking the equipment out of service for contiguous hours, with the length of the outage period being determined from the equipment’s mean time to repair. Sequential simulation can model issues of concern that involve time correlations, and can be used to calculate indices such as frequency and duration. It also models transfer limitations between individual areas.

Because the GE-MARS Program is based on a sequential Monte Carlo simulation, it uses state transition rates, rather than state probabilities, to describe the random forced outages of the thermal units. State probabilities give the probability of a unit being in a given capacity state at any particular time, and can be used if one assumes that the unit’s capacity state for a given hour is independent of its state at any other hour. Sequential Monte Carlo simulation recognizes the fact that a unit’s capacity state in any given hour is dependent on a given state in previous hours and influences its state in future hours. It thus requires additional information that is contained in the transition rate data.

From the state transition rates for a unit, the program calculates the two important quantities that are needed to model the random forced outages on the unit: the average time that the unit resides in each capacity state, and the probability of the unit transitioning from each state to each other state. This time in state is added to the current simulation time to calculate when the next random state change will occur. The second random number is combined with the state transition probabilities to determine the state to which the unit will transition when it leaves its

current state. The program thus knows for every unit on the system, its current state, when it will be leaving that state, and the state to which it will go next.

Each time a unit changes state, because of random state changes, the beginning or ending of planned outages, or mid-year installations or retirements, the total capacity available in the unit's area is updated to reflect the change in the unit's available capacity. This total capacity is then used in computing the area margins each hour.

1. Load Model

NYCA is a summer peaking system. Both summer and winter peaks show considerable year-to-year variability due to the influence of extreme weather conditions on the seasonal peaks. Annual energy is influenced by weather conditions over an entire year, which is much less variable.

Average actual annual peak demand growth from 1999 through 2009 has been 0.68% per year, state-wide. This rate of growth is expected to decline to a rate of 0.47% over the years 2010 through 2014 and to decline further to 0.27% over the years 2014 through 2018. The decrease in peak demand growth is attributed to both a slower pace of economic growth and the increase in state-mandated energy efficiency programs.

Econometric forecasts of annual energy were developed for each of the 11 NYISO load zones using quarterly data from 1993 through the 3rd quarter of 2009. For each zone, an ensemble of econometric models was estimated using population, households, economic output, employment, cooling degree days and heating degree days and other economic variables. Each member of the ensemble was evaluated and compared to historic data. The zonal model chosen for the forecast was the one that best represented the recent history of load growth for that zone. The NYISO also received and evaluated forecasts from Con Edison and LIPA, which were used for Zones H, I, J and K.

The summer & winter non-coincident and coincident peak forecasts for Zones H, I, J and K were taken from the forecasts provided to the NYISO by Con Edison and LIPA. For the remaining zones A through G, summer and winter coincident peak demand were derived from the zonal energy forecasts by using average zonal weather-normalized load factors from 2001 through 2008. Non-coincident peaks were obtained by developing historic averages of diversity factors for each zone.

1.1 Description of Period Load Shapes

The 2002 load shape was compared to load shapes from 1999 through 2007. The conclusion was the same as in previous years - the 2002 load shape is best suited for this analysis.

1.2 Load Forecast Uncertainty

It is recognized that some uncertainty exists relative to forecasting NYCA loads for any given year. This uncertainty is incorporated in the base case model by using a load forecast probability distribution that is sensitive to different weather and economic conditions. Recognizing the unique LFU of individual NYCA areas, the LFU model is subdivided into four areas: Zones H and I, Zone J (NYC), Zone K (LI), and Zones A-G (the rest of New York State).

The process followed in this and previous years is for transmission owners of zones H, I, J, and K to provide Load Forecast Uncertainty (LFU) models to the Installed Capacity Subcommittee (ICS) for their respective Transmission Districts, and for the NYISO to develop an LFU model for the rest of the state. As a matter of practice, the NYISO develops its own estimates of LFU for the zones H, I, J, and K and compares its results to those of the Transmission Owners.

Table A.1 Load Forecast Uncertainty Models

Load Forecast Uncertainty Models (Summer Period)				
Multiplier	Zones H&I	Con Ed (J)	LIPA (K)	NYCA Net
0.0062	1.0457	1.0348	1.1584	1.1320
0.0606	1.0406	1.0297	1.1303	1.1070
0.2417	1.0215	1.0106	1.0651	1.0490
0.3830	0.9935	0.9765	1.0000	1.0000
0.2417	0.9517	0.9336	0.9349	0.9570
0.0606	0.9108	0.8926	0.8697	0.8970
0.0062	0.9014	0.8833	0.8416	0.8730

1.3 External Control Areas

NYCA reliability depends on emergency assistance from its interconnected Control Areas in NPCC and PJM, based on reserve sharing agreements with the Outside World Areas. Load and capacity models of the Outside World Areas are therefore represented in the GEMARS analyses. The load and capacity models for New England, Ontario, PJM, and Quebec are based on data received from the Outside World Areas, as well as NPCC sources.

The primary consideration for developing the final load and capacity models for the Outside World Areas is to avoid over-dependence on the Outside World Areas for emergency capacity support. For this purpose, a rule is applied whereby either an Outside World Area's LOLE cannot be lower than 0.100 days/year LOLE, or its isolated LOLE cannot be lower than that of the NYCA. In other words, the neighboring Areas are assumed to be equally or less reliable than NYCA. Another consideration for developing models for the Outside World Areas is to recognize internal transmission constraints within the Outside World Areas that may limit emergency assistance to the NYCA. This recognition is considered implicitly for those Areas that have not supplied internal transmission constraint data.

The year 2002 is used in this study for both the NYCA and the Outside World Area load shapes. In order to avoid over-dependence from emergency assistance, the three highest summer load peak days of the Outside World Areas' are modeled to match the same load sequence as NYCA.

For this study, both New England and PJM continue to be represented as multi-area models, based on data provided by these Control Areas.

The EOPs were removed from the Outside World Areas to avoid the difficulty in modeling the sequence and coordination of implementing them. This is a conservative measure.

The assistance from Reliability First Corporation (RFC), with the exception of PJM-Mid Atlantic, and the Maritime Provinces was not considered, therefore, limiting the emergency

assistance to the NYCA from the immediate neighboring control areas. This consideration is another measure of conservatism added to the analyses.

The load forecast uncertainty models for the outside world model were supplied by the external Control Areas.

1.4 Demand Side Management

The NYISO Demand Side Management program consists of the Special Case Resources (SCR) program and the Emergency Demand Response Program (EDRP). These programs consist of loads that are capable of being interrupted and distributed generators that activate on demand, and which are not metered directly by the NYISO. SCR's receive a payment as ICAP providers for their capacity contribution. SCRs only provide energy/load curtailment when activated in accordance with the NYISO Emergency Operating Manual and are limited to four calls per month. EDRP resources participate on a voluntary basis, when called (maximum five times per month) in accordance with the NYISO Emergency Operating Manual, and are paid for their ability to restore operating reserves.

2. Supply-Side Representation

2.1 Resource Ratings

With the exception of wind units, the rating for each generating unit is based on its Dependable Maximum Net Capability (DMNC). The source of DMNC ratings are seasonal tests required by procedures in the NYISO Installed Capacity Manual. Wind units are rated at their nameplate, or full rated value, in the model. The NYCA Load and Capacity Report, issued by the NYISO, is the source of those generating units and their ratings included on the capacity model.

The procedure for verifying unit ratings through DMNC testing is detailed in Section 4.2 of the "NYISO Installed Capacity Manual."

2.2 Unavailability Factors

With the exception of wind units, performance data for generating units in the model includes forced and partial outages, which are modeled by inputting a multi-state outage model that is representative of the "equivalent demand forced outage rate" (EFORD) for each unit represented. Generation owners provide outage data to the NYISO using Generating Availability Data System (GADS) data in accordance with the NYISO Installed Capacity Manual. The NYSRC is continuing to use a five-year historical period as a basis for determining unavailability.

The multi-state model for each unit is derived from five years of historic events if it is available. For units with less than five years of historic events, the available years of event data collected since the inception of the NYISO is used if it appears to be reasonable. For the remaining units NERC class-average data is used. The unit forced outage states for the majority of the large steam units were obtained from the five-year average NERC-GADS outage data collected by the

NYISO for the years 2004 through 2008. This hourly data represents the availability of the units for all hours. From this, full and partial outage states and the frequency of occurrence were calculated and put in the required format for input to the GE-MARS program.

Table A-2 shows the NYCA 2008 weighted annual and five year rolling average EFORd's by fuel type, as compared to the NERC available data.

Table A.2 EFORds by Fuel NYCA vs. NERC⁶

EFORd Data NYCA vs NERC Experience				
	NYCA		NERC	
Year 2008	Annual	5 Year Rolling Average	Annual	5 Year Rolling Average
COAL	5.0%	6.0%	6.9%	6.6%
COMBUSTION TURBINES	12.5%	8.6%	9.0%	8.7%
NUCLEAR	0.9%	1.6%	2.1%	3.0%
OIL	11.1%	6.5%	21.3%	13.6%
GAS	6.7%	11.7%	11.1%	9.8%

A second performance parameter to be modeled for each unit is scheduled maintenance. This parameter includes both planned and maintenance outage components. The planned outage component is obtained from the generator owners, and where necessary, extended so that the scheduled maintenance period equals the historic average using the same five year period used to determine EFORd averages.

Wind generators are modeled as hourly load modifiers. The output of the unit varies between zero and the nameplate value based on wind data collected near the plant sites during 2002. The 2002 hourly wind data corresponds to the 2002 hourly load shape also used in the model. Characteristics of this data indicate an overall 30% capacity factor with a capacity factor of approximately 11% during the summer peak hours.

Operation of combustion turbine units at temperatures above DMNC test temperature results in reduction in output. These reductions in gas turbine and combined cycle capacity output are captured in the GE-MARS model using deratings based on ambient temperature correction curves. Based on the review of historical 2006 and 2007 data, the NYISO has concluded that the existing combined cycle temperature correction curves are still valid and appropriate. These temperature corrections curves, provided by the Market Monitoring Unit of the NYISO, show unit output versus ambient temperature conditions over a range starting at 60 degrees F to over 100 degrees F. Because generating units are required to report their DMNC output at peak or "design" conditions (an average of temperatures obtained at the time of the transmission district

⁶ NERC GADS data <http://www.nerc.com>

previous four like capability period load peaks), the temperature correction for the combustion turbine units is derived for and applied to temperatures above transmission district peak loads.

The derate does not affect all units because many of the new units are capable of generating up to 88 or 94 MW but are limited by permit to 79.9 MW, so they are not impacted by the temperature derating in obtaining an output of 79.9 MW. About one quarter of the existing 3,700 MW of simple cycle Combustion Turbines fall into this category.

The Niagara and St. Lawrence hydroelectric projects are modeled with a probability capacity model based on historic water flows and unit performance. The remaining 1,040 MW of hydro facilities are simulated in GE-MARS with a 45% hydro derate model for the summer capability period, representing deratings in accordance with recent historic hydro water conditions.

2.3 External Capacity Representation

An input to the study is the amount of NYCA installed capacity that is assumed located outside NYCA. Beginning with the study year 2010, only Grandfathered capacity will be modeled. This equates to 1130 MW of summer external capacity – 50 MW from New England, and 1080 MW from PJM.

The total TIE capability between New England and New York and between PJM and New York is 1400 MW and 1550 MWs respectively. Total TIE capability between Hydro Quebec and New York is 1667 MW, but only 1090 MWs were allowed to sink into New York for the 2009-2010 Import Rights period. The 2010-2011 capacity amounts for Hydro Quebec have not been determined yet. While the total tie transfer between Ontario and New York is 1725 MWs, Ontario does not meet the New York requirements to sell capacity into New York.

For each capability year, New York determines how much external capacity may sink into New York from the external control areas without violating the 0.1 day/year LOLE. Any additional TIE capability above those capacity limits would be available as emergency assistance.

The external capacity representation also includes Unforced Capacity Deliverability Rights (UDRs). These are rights that allow the owner of an incremental controllable transmission project to extract locational capacity benefit derived by the NYCA from the project. The owner of UDR facility rights designates how they will be treated by the NYISO in resource adequacy studies on an annual basis.

LIPA's 330 MW HVDC Cross Sound Cable, 660 MW HVDC Neptune Cable, and the 300 MW Linden VFT are facilities that are represented as having UDR rights. Any remaining capacity beyond that identified by the owners as in use for locational capacity benefit is available to support emergency assistance.

All firm sales are modeled as listed in the 2009 Gold Book.

2.4 Retirements

Only three units are scheduled for retirement during the period covered by this review – 1) Poletti, (891 MW) in Zone J, 2) Greenidge 3 (52 MW) in Zone C, and 3) Westover 7 (40.2 MW) in Zone C. Poletti will retire as of February 1, 2010 while both Greenidge 3 and Westover 7 retired as of December 31, 2009.

3. Representation of External Control Areas

Figure A-3 depicts the NYCA transmission system. Direct interface ties to New England, PJM, Hydro Quebec, and Ontario are modelled. Ontario and Quebec are modelled as single areas. New England's 14 zones are reduced to a five area representation. PJM is represented by three areas which represents the PJM-Mid Atlantic section of the PJM total area. The external areas provide load and capacity data, interface data, firm contracts, and other data as appropriate for inclusion in the MARS model.

4. Modeling of Variable and Limited Energy Sources

Modelling of these resources was discussed in section 2.2 above.

5. Modeling of Demand Side Resources

The values used for the SCR and EDRP resources in the MARS model are based upon the most current participation numbers and then applying the three year historic growth rates to those numbers. Those values for the SCR and EDRP programs are then held constant for the review period. Each resource registered is tested once per capability period to demonstrate that the resource is capable of responding to a demand call and to determine its level of load reduction attainable. Performance factors for each resource are then calculated from these tests and the results of actual events called. Performance factors by zone and an overall performance factor are also calculated. An additional derate amount is calculated as the percentage of demand resources to peak load for each zone monthly. Thus, as peak load decreases monthly, the amount of assistance provided by these resources decreases. The performance factors and derate factors are incorporated into the MARS model to provide the best possible representation of the effects on LOLE these resources provide.

6. Modeling of All Resources

Generator resources are modelled as described in Section 2 above. The NYISO's Installed Capacity Manual provides further details on what resources qualify and how those resources may provide installed capacity in the NYISO's Installed Capacity Market pursuant to the NYISO's tariff.

Figure A-3 Study Topology

New York Control Area
Transmission System Representation
For 2010 IRM Study
Summer Ratings

Representation as of 8/14/2009

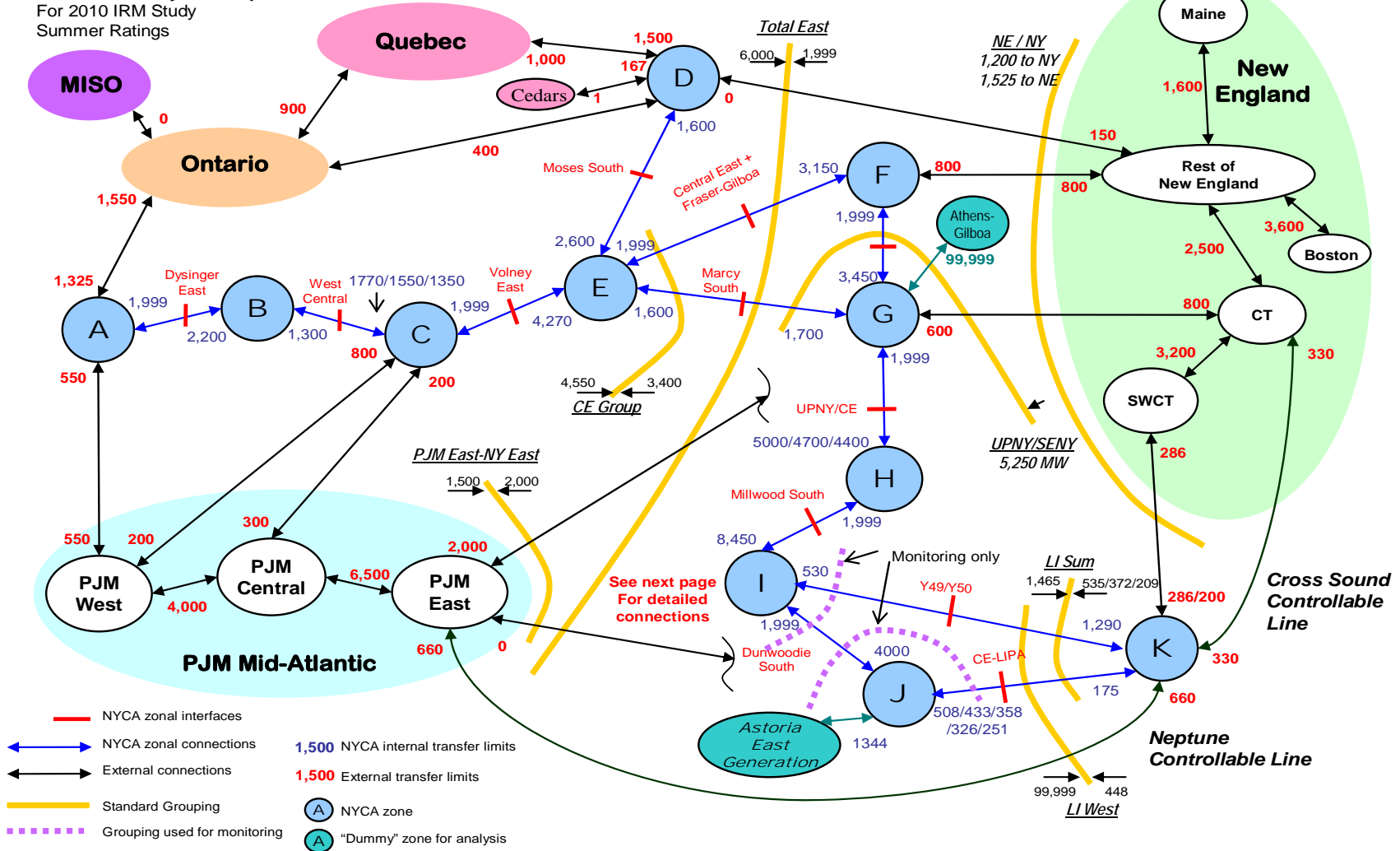
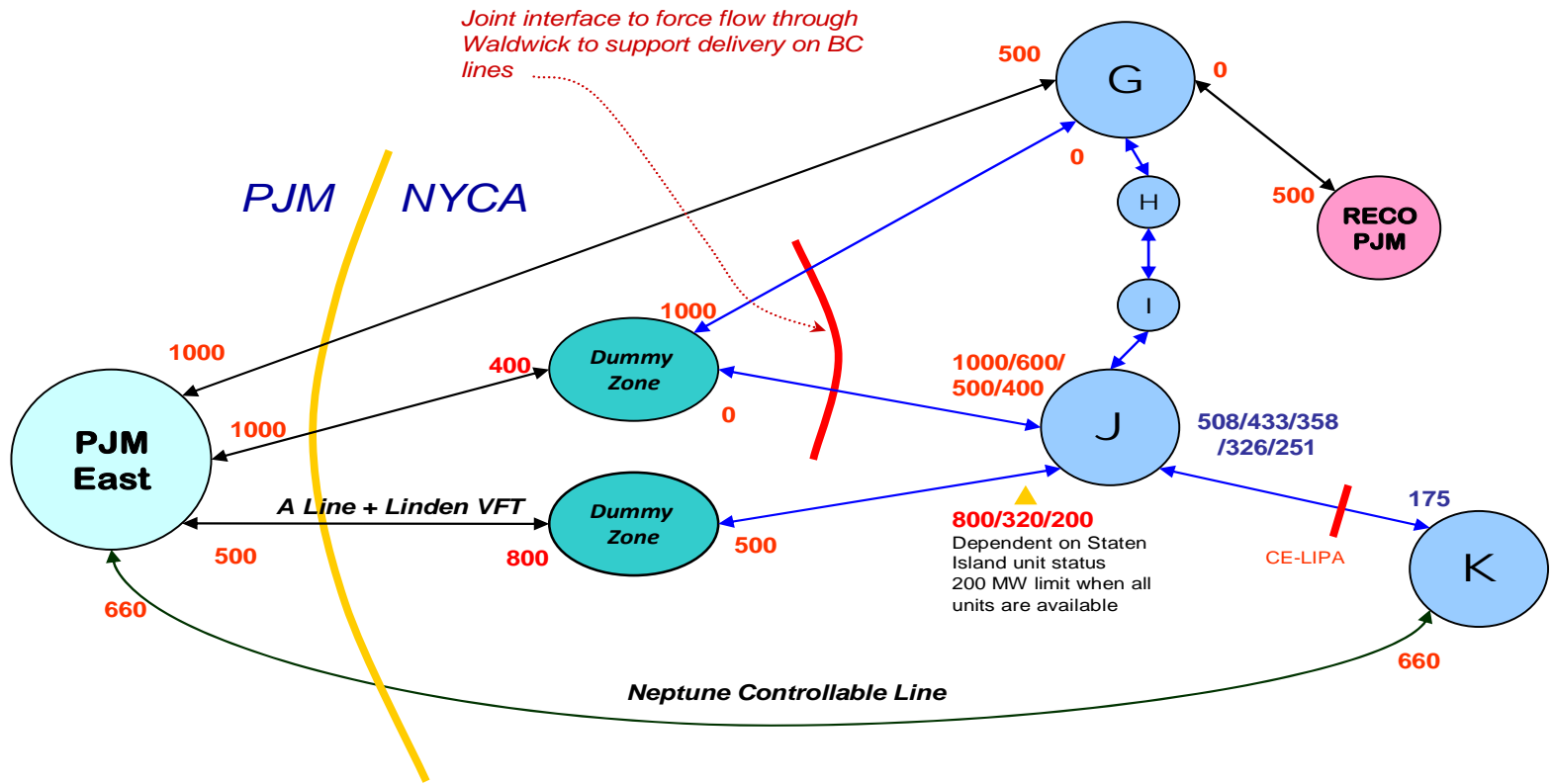


Figure A-3 Study Topology - continued

2009 PJM-NYCA GE-MARS Model - 8/14/2009



7. Other Assumptions

7.1 NYCA Topology

The NYCA is divided into 11 Zones. The boundaries between Zones and between adjacent control Areas are called interface ties. These ties are used in the GE-MARS model to allow and limit the assistance among NYCA Zones and adjacent control Areas.

While the NYCA transmission system is not explicitly modeled in the GE-MARS program, a transportation algorithm is utilized with limits on the interface ties between the Areas and Zones represented in the model. Interface tie groupings and dependent interface tie limits have been developed such that the transmission model closely resembles the standard eleven-Zone NYCA model. The interface tie limits employed are developed from emergency transfer limits calculated from various transfer limit studies performed at the NYISO and refined with additional analysis specifically for the GE-MARS representation. The study topology and interface limits are shown in Figure A-3.

The interface tie limits used in the study were reviewed to assess the need to update the transfer limits and topology resulting to reflect results from more recent studies. The following are the sources of the updated transfer limits:

- a) The Summer 2007 and 2008 and 2009 Operating Study Reports.
- b) The 2005 Comprehensive Area Transmission Review.
- c) The Reliability Needs Assessment (RNA) in the 2009 Comprehensive Reliability Planning Process.
- d) Transmission Owner input.
- e) Input from neighboring regions on internal constraints.

The transfer capability limits must be consistent with the requirements of the NERC Standards, NPCC Criteria and NYSRC Rules, and the NYISO Manuals and the NYISO OATT. The contingencies applicable to the determination of transfer capability limits as detailed within the Criteria and Rules include six types of contingencies, referred to as (a) through (g). The NYISO determines emergency transfer limits in the evaluation of thermal loading constraints only. In the Emergency Transfer Condition facility loadings must be within in normal ratings pre-contingency, and not exceed the short-time emergency rating (STE) for the (a) or (d) contingencies. Application of ETC is in accordance the provisions of the NYISO Transmission & Dispatch and the Emergency Operation Manuals. The NYISO determines transfer limits for the emergency transfer condition based on thermal constraints, but transient and voltage stability constraints are based on the entire set of contingencies. When a stability-based transfer limit is more constraining than the thermal limit, it is the controlling limit regardless of the transfer condition (normal or emergency).

Significant updates to the NYCA topology include:

- A. **PJM East to New York** – The PJM East bubble had been previously connected to NYCA Zones G, J and K. This interface was updated to reflect the installation of the Linden VFT, changes in modeling assumptions reflecting loop flow, and the improved treatment of the RECO load. The topology was modified as follows:
1. Linden VFT – Since this new interconnection is into Staten Island, the old Staten Island model was reviewed and updated with the VFT model. The existing limitations to the export of power from Staten Island to NYC were captured by a simplified model to approximate the limitation by derating the total 1500 MW interface limit of the PJM EAST to Zone J (or A,B, and C lines) to 1200 MW. This simplification was implemented versus a more detailed unit dependent nomogram or a separate Staten Island subzone as previous testing determined the three methods to be equivalent. The new model split the A line from this interface and combined it with the VFT into a new interface from PJM East to Zone J. With the VFT insertion, it was determined that the unit dependent limit on this interface would be implemented. To model the Staten Island Export, which is internal to Zone J, the impact of this internal limit was projected to the PJM East to Zone Interface by the use of a dynamic transfer limit with unit dependent model. When all generation on Staten Island is available (Arthur Kill 2&3 and Linden Cogen as two units), the A PAR controlled line and the VFT can not be utilized to their maximum rating of 800 MW, but is limited to 200 MW. This is captured in a unit nomogram that modifies the interface limit based on unit availability. If AK2 is unavailable the limit is 320 MW. If two or more of the units are unavailable, the limit is 800 MW.
 2. RECO Load – This load is served by PJM and is radial to the southern part of the Orange and Rockland system (in Zone G) and also connects to one of the 345 kV lines to New Jersey. The new model split the RECO load into its own bubble linked to Zone G.
 3. PSEG-Coned Wheel – Modifications to the interfaces and bubbles were made to more explicitly model the split of flows from Ramapo to RECO and the J and K lines to New Jersey.
- B. **Astoria East Generation** – Generation at Astoria East may be bottled when they are all available. Astoria 2, Astoria 5, Astoria Energy (SCS), Astoria GTs2-3-4, Hell Gate, North Queens GTs (approx. 1,714 MW) were placed in a separate bubble with an export limit of 1344 MW.
- C. **LI Sum DC Tie** – Implemented to capture limitations on flows from Western Long Island to Zones I and J when the PJM to LI DC tie is out of service or flows are limited to less than full rating. An interface grouping is constructed to represent this simultaneous limitation.

$$i. \text{ LI Sum DC Tie} = I \text{ to K} + J \text{ to K} + 0.13 \text{ K to PJM East}$$

- ii. Derivation of 0.13 coefficient: Analysis was performed to determine the transfer limit at the DC at full output and zero output and a linear relationship was assumed:

$$(535 \text{ MW} - 448 \text{ MW}) / 660 \text{ MW} = 0.13$$

- iii. Limits developed for this grouping are effective only for the Long Island west direction. When flows are from PJM to Long Island, the flows on K to J and K to I can be higher than 448, up to the present 535 MW limit.

D. Dynamic Transfer Limit for Western LI export limit that is dependent on Western Long Island Generation availability. Since there are over twenty units ranging in size from 14 MWs to 195 MWs in Western Long Island, only the large units are included in the Unit Status List (greater than 100 MW).

- i. From study results, reducing Barrett, Far Rockaway and Glenwood generation by 429 MWs leads to a 365 MW reduction in the Western LI export limit and a reduction in the K to J (Jamaica Export) limit of 168 MW, giving a ratio of approximately 0.851 and 0.39, respectively. The reduction occurs primarily with deliveries to Valley Stream and then to Jamaica, so the focus is on units affecting this area. Since Far Rockaway 4 (110 MW) is downstream of Valley stream, its impact is assumed to be one for one.

E. Impacts Interface K to J (Jamaica Export) and LISUM). Begin at 508 MW, LISUM 535 MW.

F. Grouping the Units to minimize number of dynamic transfer limit tables:

- a) Grouping: BARS01, BARS02
 - i. One Barrett Unavailable Reduce by 75 MW, 163 MW, Two Barrett Unavailable Reduce by 150 MW, 326 MW
- b) FROCS4 always Unavailable, then combined with:
 - i. BARS01, BARS02 Unavailability, Reduce Only K to J
 - ii. One Barrett Unavailable Reduce by 182 MW, Two Barrett units Unavailable Reduce by 257 MW

7.2 Locational Capacity Requirements

The GE-MARS model used in NYCA resource adequacy studies provides an assessment of the adequacy of the NYCA transmission system to deliver assistance from one Zone to another for meeting load requirements. Previous studies have identified transmission constraints into certain Zones that could impact the LOLE of these Zones, as well as the state-wide LOLE. To minimize these potential LOLE impacts, these Zones require a

minimum portion of their NYCA ICAP requirement, i.e., locational ICAP, which shall be electrically located within the Zone in order to ensure that sufficient energy and capacity are available in that Zone and that NYSRC Reliability Rules are met. Locational ICAP requirements are currently applicable to two transmission-constrained Zones, New York City and Long Island, and are normally expressed as a percentage of each Zone's annual peak load.

8. Impacts on Reliability due to Market Rules

No impacts on reliability due to market rules are anticipated.