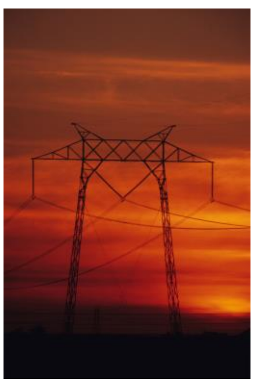
Technical Study Report

New York Control Area Installed Capacity Requirement

For the Period May 2015 to April 2016



December 5, 2014

New York State Reliability Council, LLC
Installed Capacity Subcommittee

About the New York State Reliability Council

The New York State Reliability Council (NYSRC) is a not-for-profit corporation responsible for promoting and preserving the reliability of the New York State power system by developing, maintaining and, from time to time, updating the reliability rules which must be complied with by the New York Independent System Operator and all entities engaging in electric power transactions on the New York State power system. One of the responsibilities of the NYSRC is the establishment of the annual statewide Installed Capacity Requirement for the New York Control Area.

Table of Contents

EXECUTIVE SUMMARY

A New York Control Area (NYCA) Installed Reserve Margin (IRM) Study is conducted annually by the New York State Reliability Council (NYSRC) Installed Capacity Subcommittee (ICS). ICS has the overall responsibility of managing studies for establishing NYCA IRM requirements for the following capability year, including the development and approval of all modeling and database assumptions to be used in the reliability calculation process. This year's report covers the period May 2015 through April 2016 (2015 Capability Year).

Results of the NYSRC technical study show that the required NYCA IRM for the 2015 Capability Year is 17.3% under base case conditions.

This study also determined Minimum Locational Capacity Requirements (MLCRs) of 83.4% and 103.7% for New York City (NYC) and Long Island (LI), respectively. In its role of setting the appropriate Locational Capacity Requirements (LCRs) pursuant to its tariff, the New York Independent System Operator (NYISO) will consider these MLCRs.

These study results satisfy and are consistent with NYSRC Reliability Rules, Northeast Power Coordinating Council (NPCC) reliability criteria, and North American Electric Reliability Corporation (NERC) reliability standards.

The 17.3% IRM base case value for 2015 represents a 0.3*% increase* from the 2014 base case IRM of 17.0%. Table 6-1 shows the IRM impacts of individual study parameters that result in this change. There are seven parameter drivers that in combination *increased* the 2015 IRM from the 2014 base case – they individually increased IRM in a range of +0.1% to +0.6%.

Six other parameter drivers collectively *decreased* the IRM. Of these, the most significant driver is an updated model representing NYCA's four interconnected areas, which decreased the IRM by approximately 0.9%. The major modeling change causing this decrease is the introduction in the 2015 IRM Study of about 5,600 MW of Demand Resources in the PJM control area. This change provides the benefit of permitting additional emergency assistance from PJM to NYCA that reduces the probability of load shedding, thereby reducing NYCA IRM requirements. A description of this PJM model change is located in Section 5.3.2.

This study also evaluated IRM impacts of several sensitivity cases. These results are summarized in Table 7-1 and in greater detail in Appendix B, Table B.1. In addition, a confidence interval analysis was conducted to demonstrate that there is a high confidence that the base case 17.3% IRM will fully meet NYSRC and NPCC resource adequacy criteria.

The base case and sensitivity case IRM results, along with other relevant factors, will be considered in a separate NYSRC Executive Committee process in which the Final NYCA IRM requirement for the 2015 Capability Year is adopted. The 2015 IRM Study also evaluated Unforced Capacity (UCAP) trends. This analysis shows that UCAP margins, having steadily decreased over the 2006-2010 period, have since stabilized. This UCAP trend is despite variations in IRM requirements and increases in low capacity factor wind generation.

1. Introduction

This report describes a technical study, conducted by the NYSRC Installed Capacity Subcommittee (ICS), for establishing the NYCA Installed Reserve Margin (IRM) for the period of May 1, 2015 through April 30, 2016 (2015 Capability Year). This study is conducted each year in compliance with Section 3.03 of the NYSRC Agreement which states that the NYSRC shall establish the annual statewide Installed Capacity Requirement (ICR) for the NYCA. The ICR relates to the IRM through the following equation:

$$\text{ICR} = \left(1 + \frac{\text{IRM Requirement (\%)}}{100}\right) * \text{Forecasted NYCA Peak Load}$$

The base case and sensitivity case study results, along with other relevant factors, will be considered by the NYSRC Executive Committee for its adoption of the Final NYCA IRM requirement for the 2015 Capability Year.

The NYISO will implement the final NYCA IRM as determined by the NYSRC, in accordance with the NYSRC Reliability Rules[1], the NYISO Market Services Tariff, and the NYISO Installed Capacity (ICAP) Manual.[2] The NYISO translates the required IRM to an Unforced Capacity (UCAP) basis. These values are also used in a Spot Market Auction based on FERC-approved Demand Curves. The schedule for conducting the 2015 IRM Study was based on meeting the NYISO's timetable for these actions.

The study criteria, procedures, and types of assumptions used for the study for establishing the NYCA IRM for the 2015 Capability Year (2015 IRM Study) are set forth in NYSRC Policy 5-8[3], *Procedure for Establishing New York Control Area Installed Capacity Requirement*. The primary reliability criterion used in the IRM study requires a Loss of Load Expectation (LOLE) of no greater than 0.1 days/year for the NYCA. This NYSRC resource adequacy criterion is consistent with NPCC reliability criteria and NERC reliability standards. IRM study procedures include the use of two study methodologies: the *Unified Methodology* and the *IRM Anchoring Methodology*. The above reliability criterion and methodologies are discussed in more detail later in the report. In addition to calculating the NYCA IRM requirement, these methodologies identify corresponding MLCRs for NYC and LI. In its role of setting the appropriate LCRs, the NYISO will utilize the IRM value approved by the NYSRC. The MLCR values determined in this study are indicative of the expected LCR values calculated by the NYISO. The 2015 IRM Study was managed and

[1] http://www.nysrc.org/NYSRCReliabilityRulesComplianceMonitoring.asp
[2] http://www.nyiso.com/public/markets_operations/market_data/icap/index.jsp
[3] http://www.nysrc.org/policies.asp

conducted by the NYSRC Installed Capacity Subcommittee (ICS) and supported by technical assistance from NYISO staff.

The 2015 IRM Study included a major modeling change that introduced the addition of a significant amount of Demand Resources in the PJM model, which has the benefit of permitting additional emergency assistance to NYCA from PJM.

Previous IRM Study reports, from 2000 to 2014, can be found on the NYSRC website.[4] Table C-1 in Appendix C provides a record of previous NYCA base case and final IRMs for the 2000 through 2014 Capability Years. Table C-2 and Figure 8-1 show UCAP reserve margin trends over previous years. Definitions of certain terms in this report can be found in the Glossary (Appendix D).

2. NYSRC Resource Adequacy Reliability Criterion

The acceptable LOLE reliability level used for establishing NYCA IRM Requirements is dictated by the NYSRC Reliability Rule A-R1, *Statewide Installed Reserve Margin Requirements,* which states:

> *The NYSRC shall establish the 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 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 control areas, NYS Transmission System emergency transfer capability, and capacity and/or load relief from available operating procedures.*

This NYSRC Reliability Rule is consistent with NPCC Resource Adequacy Design Criteria in Section 5.2 of NPCC Directory 1, *Design and Operation of the Bulk Power System*.

In accordance with NYSRC Rule A-R2, *Load Serving Entity (LSE) Installed Capacity Requirements*, the NYISO is required to establish LSE installed capacity requirements, including locational capacity requirements, to meet the statewide IRM Requirement established by the NYSRC for maintaining NYSRC Rule A-R1 above.

[4] http://www.nysrc.org/reports3.asp

3. IRM Study Procedures

The study procedures used for the 2015 IRM Study are described in detail in NYSRC Policy 5-8, *Procedure for Establishing New York Control Area Installed Capacity Requirements*. Policy 5-8 also describes the computer program used for reliability calculations and the types of input data and models used for the IRM Study.

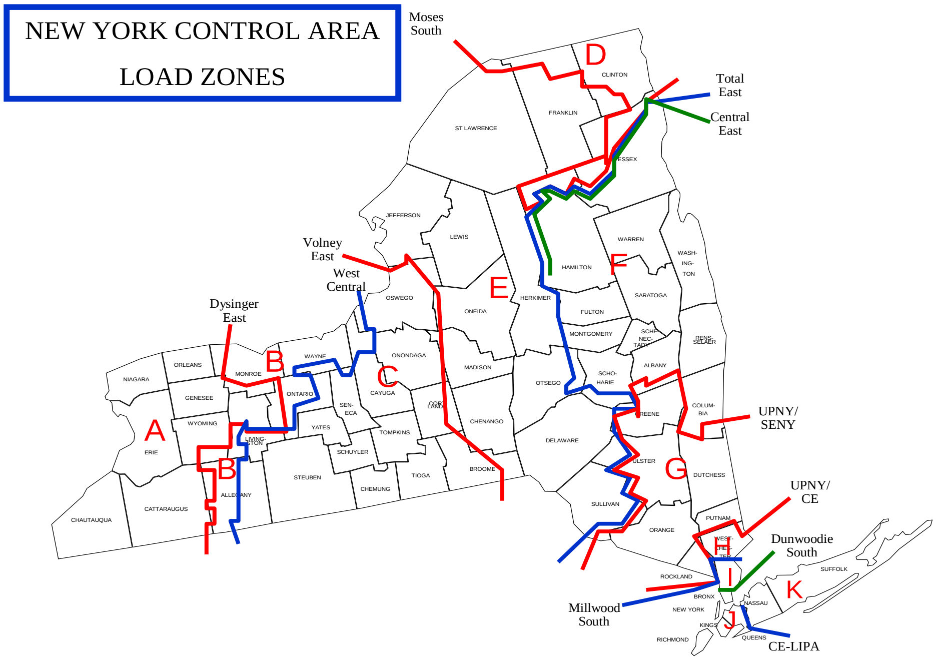
This study utilizes a *probabilistic approach* for determining NYCA IRM requirements. This technique calculates the probabilities of generator unit outages, in conjunction with load and transmission representations, to determine the days per year of expected resource capacity shortages.

General Electric's Multi-Area Reliability Simulation (GE-MARS) is the primary computer program used for this probabilistic analysis. This program includes detailed load, generation, and transmission representation for eleven NYCA load zones — plus four external Control Areas (Outside World Areas) directly interconnected to the NYCA. The external Control Areas are: Ontario, New England, Quebec, and the PJM Interconnection. The eleven NYCA zones are depicted in Figure 3-1[5]. GE-MARS calculates LOLE, expressed in days per year, to provide a consistent measure of system reliability. The GE-MARS program is described in detail in Appendix A.1.

Using the GE-MARS program, a procedure is utilized for establishing NYCA IRM requirements (termed the *Unified Methodology)* which establishes a graphical relationship between NYCA IRM and MLCRs, as illustrated in Figure 3-2. All points on these curves meet the NYSRC 0.1 days/year LOLE reliability criterion described above. Note that the area above the curve is more reliable than criteria, and the area below the curve is less reliable. This methodology develops a pair of curves, one for NYC (Zone J) and one for LI (Zone K). Appendix A of Policy 5-8 provides a more detailed description of the Unified Methodology.

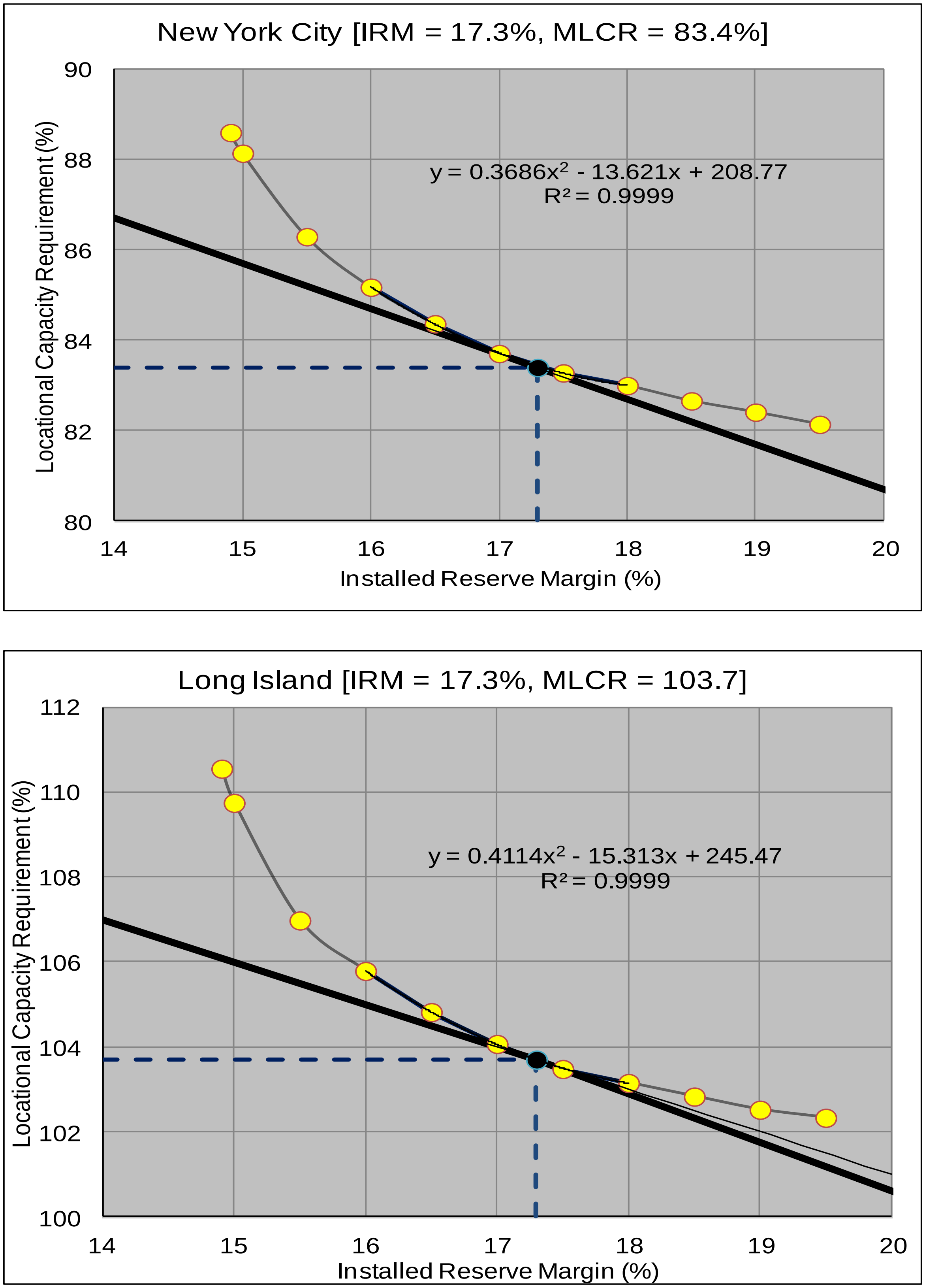
[5] The Federal Energy Regulatory Commission has ordered the creation of a new capacity zone (NCZ) within the NYISO's ICAP market starting in 2014. The NCZ encompasses Load Zones G, H, I, and J. The NCZ was triggered by a NYISO study that identified a deliverability constraint across the UPNY/SENY interface. The creation of the NCZ does not impact the current Unified and IRM Anchoring Methodologies and NYSRC's calculation of the NYCA IRM that is discussed in this report.

Figure 3-1 NYCA Load Zones



Base case NYCA IRM requirements and related MLCRs are established by a supplemental procedure (termed the *IRM Anchoring Methodology*) which is used to define an *inflection point* on each of these curves. These inflection points are selected by applying a tangent of 45 degrees (Tan 45) analysis at the bend (or “knee”) of each curve. Mathematically, each curve is fitted using a second order polynomial regression analysis. Setting the derivative of the resulting set of equations to minus one yields the points at which the curves achieve the Tan 45 degree inflection point. Appendix B of Policy 5-8 provides a more detailed description of the methodology for computing the Tan 45 inflection point.

Figure 3-2 NYCA Locational Requirements vs. Statewide Requirements



4. Study Results – Base Case

Results of the NYSRC technical study show that the required NYCA IRM is 17.3% for the 2015 Capability Year under base case conditions. As described above, Figure 3-2 depicts the relationship between NYCA IRM requirements and resource capacity in NYC and LI.

The tangent points on these curves were evaluated using the Tan 45 analysis. Accordingly, it can be concluded that maintaining a NYCA installed reserve of 17.3% for the 2015 Capability Year, together with MLCRs of 83.4% and 103.7% for NYC and LI, respectively, will achieve applicable NYSRC and NPCC reliability criteria for the base case study assumptions shown in Appendix A.3.

Comparing the MLCRs in this 2015 IRM study to the 2014 IRM Study results (NYC MLCR= 84.7%, LI MLCR=106.9%), the NYC MLCR decreased by 1.3%, while the LI MLCR decreased by 3.2%.

In accordance with NYSRC Reliability Rule A-R2, *Load Serving Entity ICAP Requirements,* the NYISO is required to calculate and establish appropriate LCRs. The most recent NYISO study[6] determined that for the 2014 Capability Year, the required LCRs for NYC and LI were 85% and 107%, respectively. A LCR Study for the 2015 Capability Year is scheduled to be completed by the NYISO in January 2015. The NYISO will consider the above MLCR results when developing the final NYC and LI LCR values for the 2015 Capability Year.

A Monte Carlo simulation error analysis shows that there is a 95% probability that the above base case result is within a range of 17.1% and 17.5% (see Appendix A.1.1) when obtaining a standard error of 0.019 per unit at 1,500 simulated years. This analysis demonstrates that there is a high level of confidence that the base case IRM value of 17.3% is in full compliance with NYSRC and NPCC reliability rules and criteria.

5. Models and Key Input Assumptions

This section describes the models and related input assumptions for the 2015 IRM Study. The models represented in the GE-MARS analysis include a *Load Model, Capacity Model, Transmission System Model, and Outside World Model*. Potential IRM impacts of pending environmental initiatives are also addressed. The input assumptions for the base case were based on information available as of October 2014. Appendix A.3 provides more details of these models and assumptions and comparisons of several key assumptions with those used for the 2014 IRM Study.

---

[6] *Locational Installed Capacity Requirements Study, http://www.nyiso.com/public/markets_operations/services/planning/planning_studies*

5.1 Load Model

5.1.1 Peak Load Forecast

A 2015 NYCA summer peak load forecast of 33,587 MW was assumed in the 2015 IRM Study, a decrease of 68 MW from the 2014 summer peak forecast used in the 2014 IRM Study. The 2015 load forecast, completed by the NYISO staff in collaboration with the NYISO Load Forecasting Task Force and presented to ICS on October 1, 2014, considered actual 2014 summer load conditions. Use of this 2015 peak load forecast in the 2015 IRM study increased the IRM by 0.3% compared to the 2014 Study. This is because the downstate load growth increased compared to Upstate (Table 6-1). The NYISO will prepare a final 2015 summer forecast in early 2015 for use in the NYISO 2015 Locational Capacity Requirement Study. It is expected that the NYISO's October 2014 summer peak load forecast for 2015 and the final 2015 forecast will be similar.

5.1.2 Load Forecast Uncertainty (LFU)

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 conditions. Recognizing the unique LFU of individual NYCA areas, separate LFU models are prepared for four areas: New York City (Zone J), Long Island (Zone K), Westchester (Zones H and I), and the rest of New York State (Zones A-G).

The load forecast uncertainty models and data used for the 2015 IRM Study were updated by Consolidated Edison for Zones H, I, and J; Long Island Power Authority (LIPA) for Zone K; and the NYISO. Appendix Section A-3.1 describes these models in more detail. Modeling of load forecast uncertainty in the 2015 IRM Study has an effect of increasing IRM requirements by 10.0% as demonstrated in a sensitivity case (Table 7-1). Use of updated LFU models for the 2015 IRM Study increased the IRM requirement by 0.4% from the 2014 IRM Study (Table 6-1).

5.1.3 Load Shape Model

A feature in GE-MARS that allows for the representation of multiple load shapes, adopted for the 2014 IRM Study, was again utilized in the 2015 IRM Study. This multiple load shape feature enables a different load shape to be assigned to each of the load forecast uncertainty bins. Part of the effort of implementing this model was to establish criteria for selecting the appropriate historical load shapes to use for each of the seven load forecast uncertainty bins. ICS concluded that an acceptable approach would be to select a combination of load shape years 2002, 2006, and 2007. The load shape for the year 2007 was selected to represent a typical system load shape over the 1999 to 2012 period. The load shape for 2002 represents a flatter load shape, a shape that has numerous daily peaks that are close to the annual peak. The load shape for 2006 represents a load shape with a small number of days with peaks that are significantly above the remaining daily peak loads. The combination of these load shapes on a weighted basis represents an expected probabilistic LOLE result.

The GE-MARS version used for the 2015 IRM Study included a new daily peak load feature that enhances the logic for calculating the daily LOLE index. In the previous GE-MARS versions the LOLE index was calculated using the base load shape's daily peak hours for all bins. The enhanced MARS version instead calculates the LOLE index using the daily peak hour for each load shape in each bin. Use of this new GE-MARS feature as a default setting in the 2015 IRM Study base case increased the IRM by 0.6% from the 2014 IRM Study (Table 6-1). A sensitivity case that turned this new peak load logic feature off showed an IRM decrease of 0.7% (Table 7-1).

5.2 Capacity Model

5.2.1 Planned Non-Wind Facilities, Retirements and Reratings

Planned non-wind facilities and retirements that are represented in the 2015 IRM Study are shown in Appendix A.3. The rating for each existing and planned resource facility in the capacity model is based on its Dependable Maximum Net Capability (DMNC). In circumstances where the ability to deliver power to the grid is restricted, the value of the resource is limited to it Capacity Resource Interconnection Service (CRIS) value. The source of DMNC ratings for existing facilities is seasonal tests required by procedures in the NYISO Installed Capacity Manual. Planned non-wind facilities, retirements, and reratings, in combination, had the impact of increasing the IRM by 0.1% compared to the 2014 IRM Study. Appendix A.3.2 shows the ratings of all resource facilities that are included in the 2015 IRM Study capacity model.

5.2.2 Wind Generation

It is projected that during the 2015 summer period there will be a total wind capacity of 1,457 MW participating in the capacity market in New York State. All wind farms are located in upstate New York in Zones A-E. The 2015 summer period wind capacity projection is about 90 MW higher than the forecast 2014 wind capacity assumed for the 2014 IRM Study due to the addition of the Orangeville wind project.

The 2015 IRM Study base case assumes that the projected 1,457 MW of wind capacity will operate at a 14% capacity factor during the summer peak period. This assumed capacity factor is based on an analysis of actual hourly wind generation data collected for wind facilities in New York State during the June through August 2013 period between the hours of 2:00 p.m. and 5:00 p.m. This test period was chosen because it covers the time during which virtually all of the annual NYCA LOLE occurrences are distributed.

The increase in projected wind capacity from the value of 1,367 MW used in the 2014 IRM Study, to 1,457 MW forecast used for this 2015 IRM study, results in a 0.2% IRM increase (Table 6-1).

Overall, inclusion of the projected 1,457 MW of wind capacity in the 2015 Study accounts for 3.7% of the 2015 IRM requirement (Table 7-1). This relatively high IRM impact is a direct result of the very low capacity factor of wind facilities during the summer peak period. The impact of wind capacity on *unforced capacity* is discussed in Appendix C.3, "Wind Resource Impact on the NYCA IRM and UCAP Markets." A detailed summary of existing and planned wind resources is shown in Figure A-7 of Appendix A.

Over the last several years, the NYISO has collected hourly wind generation output. This has allowed actual wind production data from NYCA generators to be compared to the simulated data. Functionality is included in the GE-MARS model which allows for the daily wind shape for each day during a simulation year to be modeled randomly. The GE-MARS model allows a single year wind shape to be input for this purpose. An actual hourly plant output of the 2013 calendar year was used as the basis for the wind shape for the 2015 IRM Study. Use of a 2013 wind shape for the 2015 IRM Study compared to using a 2012 wind shape for the 2014 IRM Study increased the IRM by 0.2% (Table 6-1).

5.2.3 Generating Unit Availability

Generating unit forced and partial outages are modeled in GE-MARS by inputting a multi-state outage model that represents an equivalent forced outage rate during demand periods (EFORd) for each unit represented. Outage data used to determine the EFORd is received by the NYISO from generator owners based on outage data reporting requirements established by the NYISO. Capacity unavailability is modeled by considering the average forced and partial outages for each generating unit that have occurred over the most recent five-year time period – the time span considered for the 2015 IRM Study covered the 2009-2013 period. The average NYCA five-year EFORd calculated for this period is slightly less than the 2008-2012 average value used for the 2012 IRM Study, causing the IRM to decrease by 0.1% (Table 6-1). Figure A-4 of Appendix A depicts NYCA 2004 to 2013 EFORd trends.

In 2010, ICS concluded that development of an improved EFORd model would provide a more accurate measure of generator performance then used in previously IRM studies, as well as providing a metric that was aligned with what is used in the capacity markets. An independent consulting firm was retained by the NYISO in 2011 to assist in developing this method. This methodology was applied for the 2013, 2014, and 2015 IRM Studies.

5.2.4 Emergency Operating Procedures (EOPs)

(1) Special Case Resources (SCRs)

SCRs are ICAP resources that include demand response (DR) resources that are capable of being interrupted as needed and distributed generators that may be activated also as needed. This study assumes a SCR base case value of 1,132 MW will be registered in July 2015, with varying amounts during other months based on historical experience.

The SCR performance model is based on an analysis of historical SCR load reduction performance which is described in Section A-3.7 of Appendix A. Due to the possibility that some of the potential SCR program capacity may not be available during peak periods, projections are discounted for the base case based on previous experience with these programs, as well as any operating limitations. The 2015 IRM Study assumed a 65.5% SCR effectiveness based on recent performance trends. This is slightly up from a 63% SCR effectiveness assumed for the 2014 IRM Study. The resulting effective SCR capacity that was modeled in the 2015 IRM Study is 742 MW.

The 2015 IRM Study determined that for the 17.3% base case IRM, nine SCR calls would be expected during the June-August 2015 period.

(2) Emergency Demand Response Program (EDRP)

The EDRP allows registered interruptible loads and standby generators to participate on a voluntary basis – and be paid for their ability to restore operating reserves after major emergencies have been declared. The 2015 IRM Study assumes 86 MW of EDRP capacity resources will be registered in 2015, a reduction from 2014. This EDRP capacity was discounted to a base case value of 14 MW reflecting past performance. This value is implemented in the study in July and proportional to monthly peaks loads in other months, while being limited to a maximum of five EDRP calls per month. Both SCRs and EDRP are included in the Emergency Operating Procedure (EOP) model. Unlike SCRs, EDRP are not ICAP suppliers and therefore are not required to respond when called upon to operate.

The updated SCR and EDRP models used for the 2015 IRM Study resulted in an IRM decrease of 0.1% from the 2014 IRM Study (Table 6-1). Incorporation of SCRs and EDRP resources in the NYCA capacity model has the combined effect of increasing IRM requirements by 1.3% (Table 7-1).

(3) Other Emergency Operating Procedures

In accordance with NYSRC criteria, the NYISO will implement EOPs as required to minimize customer disconnections. Projected 2015 EOP capacity values are based on recent actual data and NYISO forecasts. (Refer to Table B-5 of Appendix B for the expected use of SCRs, EDRP, voltage reductions, and other types of EOPs during 2015.). The updated EOP model, excluding the SCR and EDRP impact noted above, increased the IRM from the 2014 IRM study by 0.1% (Table 6-1).

5.2.5 Unforced Capacity Deliverability Rights (UDRs)

The capacity model includes UDRs which are capacity rights that allow the owner of an incremental controllable transmission project to extract the locational capacity benefit derived by the NYCA from the project. Non-locational capacity, when coupled with a UDR, can be used to satisfy locational capacity requirements. The owner of UDR facility rights designates how they will be treated by the NYSRC and NYISO for resource adequacy studies. The IRM modeling accounts for both the availability of the resource that is identified for each UDR line as well as the availability of the UDR facility itself.

LIPA's 330 MW High Voltage Direct Current (HVDC) Cross Sound Cable, LIPA's 660 MW HVDC Neptune Cable, Hudson Transmission Partners 660 MW HVDC Cable, and the 315 MW Linden Variable Frequency Transformer are facilities that are represented in the 2015 IRM Study as having UDR capacity rights. The owners of these facilities have the option, on an annual basis, of selecting the MW quantity of UDRs it plans on utilizing for capacity contracts over these facilities. Any remaining capability on the cable can be used to support emergency assistance which may reduce locational and IRM requirements. The 2015 IRM Study incorporates the confidential elections that these facility owners made for the 2015 Capability Year.

5.3 Transmission Model

5.3.1 Internal Transmission Model

A detailed transmission system model is represented in the GE-MARS topology. The transmission system topology, which includes eleven NYCA zones and four Outside World Areas, along with transfer limits, is shown in Appendix Figures A-12, 13, and 14. The transfer limits employed for the 2015 IRM Study were developed from emergency transfer limit analysis included in various studies performed by the NYISO, and from input from Transmission Owners and neighboring regions. The transfer limits are further refined by additional assessments conducted specifically for this cycle of the development of the topology. The assumptions for the transmission model included in the 2015 IRM Study are listed in the Tables A-8 and A-9 of Appendix A and described in detail in Appendix A.3.3.

Forced outages based on historic performance are represented in the IRM study for the underground cables that connect New York City and Long Island to surrounding zones are represented in the GE-MARS model. The GE-MARS model uses transition rates between operating states for each interface, which are calculated based on the probability of occurrence from the failure rate and the time to repair. Transition rates into the different operating states for each interface are calculated based on the circuits comprising each interface, which includes failure rates and repair times for the individual cables, and for any transformer and/or phase angle regulator associated with that particular cable. Updated cable outage rates decreased the IRM from the 2014 IRM Study by 0.1% (Table 6-1).

The impact of transmission constraints on NYCA IRM requirements depends on the level of resource capacity in any of the downstream zones from a constraining interface, especially in the NYC and LI zones J and K. To illustrate the impact of transmission constraints, if there were no transmission constraints, the required IRM in 2015 would decrease by 2.6% (Table 7-1). The major changes to the NYCA 2015 IRM Study topology from the 2014 Study are:

- The Dysinger East transfer limit decreased. Thermal limitations on the 230 kV transmission path between Packard and Gardenville in Zone A became more constraining than previous voltage limitations.
- Transmission security analysis using the power flow system model identified the need for a new interface grouping (Zone A group) to set dynamic interface ratings based on unit availabilities in Zone A.
- Dynamic limits associated with the LIPA to Con Edison transfer limits and the Long Island Group interface were updated. This included the LIPA ties to Zone I and Zone J.

5.3.2 Outside World Model

The Outside World Model consists of those interconnected external control areas contiguous with NYCA: Ontario, Quebec, New England, and the PJM Interconnection (PJM). NYCA reliability can be improved and IRM requirements reduced by recognizing available emergency capacity assistance support from these neighboring interconnected control areas, in accordance with control area agreements governing emergency operating conditions. Representing such interconnection support arrangements in the 2015 IRM Study base case reduces the NYCA IRM requirements by 8.7% (Table 7-1). A model for representing neighboring control areas, similar to previous IRM studies, was utilized in this study. The assumptions for the Outside World Model included in the 2015 IRM Study are listed in Table A-9 of Appendix A. The 2015 IRM Study topology includes a 1,075 MW increase in the PJM to SENY interconnection capability from the 2014 IRM Study – from 2,000 MW to 3,075 MW – which permits additional emergency assistance from PJM (see Appendix Figure A-13, PJM-NY Interface Model). This 1,075 MW increase in transfer capability is primarily due to transmission upgrades in PJM that increase the ability to simultaneously utilize all paths into New York, including HTP (see Appendix Table A-9).

The primary consideration for developing the base case load and capacity assumptions for the Outside World Areas is to avoid overdependence on these Areas for emergency assistance support. For this purpose, from Policy 5, a rule is applied whereby an Outside World Area's LOLE cannot be lower than its own LOLE criterion, i.e., 0.1 days/year, its isolated LOLE cannot be lower than that of the NYCA, and its IRM can be no higher than that Area's minimum requirement. In addition, Policy 5 does not allow EOPs to be represented in Outside World Area models because of the uncertainties associated with the performance and availability of these resources.

Another consideration for developing models for the Outside World Areas is to recognize internal transmission constraints within those Areas that may limit emergency assistance into the NYCA. This recognition is considered either explicitly, or through direct multi-area modeling providing there is adequate data available to accurately model transmission interfaces and load areas within these Outside World Areas. For this study, two Outside World Areas – New England and the PJM Interconnection – are each represented as multi-areas, i.e., 13 zones for New England and four zones for the PJM Interconnection. Such granularity better captures the impacts of transmission constraints within these areas, particularly on their ability to provide emergency assistance to the NYCA.

Outside World Area Demand Resources

As with NYCA, Demand Resources (DR) are becoming a larger portion of the resource capacity mixes in the Outside World Areas. In the past, these resources have not been included in the Outside World models because they have been considered as EOPs, which are not permitted by Policy 5-8 to be represented in IRM studies. PJM, in particular, has a significant amount of DR capacity for meeting its installed capacity requirements and resource adequacy criteria. This has become an issue this year because approximately 6,000 MW of thermal generating capacity has retired. PJM refers to one part of its DR program as economic load response resources, as compared with emergency load response resources that are called upon when system emergencies are declared.

Table 5-1 depicts details of three types of PJM DR programs planned for 2015, which combined, provides approximately 15,500 MW of resource capacity.

Table 5-1
PJM 2015 Demand Resource Programs[7]

Characteristics	Limited	Extended	Annual
Load Response Program Type	Emergency (EOP)	Economic	Economic
DR Available	June-September	May-October	Year Round
Max. calls	10 calls/season	Unlimited	Unlimited
Max. hours/call	6	10	1-10
Min. hours	2	2	1
Lead time	1-2 hours	1-2 hours	Possibly Shorter
2015 Capacity (UCAP MW)	9,882	4,112	1,505

A MARS study shows that the PJM LOLE would increase to 0.88 if the NYSRC were to continue its policy of not representing DR in the PJM model, which has the impact of increasing the NYCA IRM by 1.5% because of a significant reduction of potential emergency support from PJM (Table 5-2).

During its preparation of the 2015 IRM Study, ICS re-evaluated the past NYSRC policy of considering all of PJM DR as an EOP as well as uncertainties surrounding the availability of these resources when needed to assist NYCA during emergencies. Discussions with PJM operating personnel and review of the NY-PJM Joint Operating Agreement concluded that PJM would activate its DR programs – to the extent that there is surplus capacity available above PJM needs – to provide emergency support to NYCA to avoid load shedding. Although PJM is committed to providing emergency support to NYCA from all of its DR resources, activation of the Limited DR Program (see Table 5-1) is restricted to a maximum number of 10 calls per year, beyond which requests to activate DR would be voluntary. Because of this constraint, ICS concluded that the PJM Limited DR Program is an EOP and therefore, should not be included in the 2015 IRM Study base case in accordance with Policy 5. ICS further concluded that there is sufficient confidence that PJM would make the Extended and Annual DR

[7] Based on information provided by PJM.

(totaling 5,617 MW) available for emergency support to NYCA, and therefore should be included in the 2015 IRM base case. ICS further concluded after its review that Extended and Annual DR programs be treated as PJM installed capacity resources (consistent with PJM policy) – not EOPs – and therefore their inclusion in the 2015 IRM Study would not violate Policy 5 EOP restrictions.

In addition to the base case and a sensitivity case without DR previously referenced, two additional sensitivity cases were prepared to test the IRM impacts of alternate DR representations – see Table 5-2. These sensitivity cases are also presented in Table 7-1.

Table 5-2
NYCA IRMs for Alternate PJM Demand Resource (DR) Scenarios

PJM DR Scenario	Table 7-1 Case No.	Available DR (MW)	PJM LOLE	NYCA IRM	Change from Base Case
Extended & Annual DR (Base Case)	0	5,617	0.23	17.3 %	0
No DR Programs Modeled	8	0	0.88	18.8%	+1.5%
Limited DR (EOP), Extended & Annual DR (Target PJM LOLE=0.15)	9	15,499	0.15	16.1%	-1.2%
Limited DR (EOP), Extended & Annual DR (Target PJM LOLE=0.10)	10	15,499	0.10	15.1%	-2.2%

The two last sensitivity scenarios in Table 5-2 assume that Limited DR is available as an EOP, recognizing that application of Outside World EOPs is presently not permitted by Policy 5-8[8]. Review of this table shows that there is a wide range of IRM requirements depending on the PJM DR assumed, from a low of 15.1% to a high of 18.8%. Next year ICS is planning to continue to evaluate the appropriate PJM DR for the 2016 IRM Study.

[8] One of these two cases, Case 10, was conducted to be consistent with a Policy 5 rule whereby the PJM LOLE cannot be lower than a 0.1 target. In the other case, Case 9, the target LOLE is set at 0.15. The purpose of setting this higher target LOLE is to restrict the amount of Limited DR that can be utilized to provide emergency support to NYCA.

5.4 Environmental Initiatives

Several environmental initiatives driven by the NYS and/or federal regulators are either presently in place or are pending that will affect the operation of most of the existing NYCA thermal generator fleet. These regulatory initiatives will require substantial investment and operating costs, in addition to changes in operating methods and emission levels for New York's existing thermal power plants in order to comply with these new regulatory requirements. However, these initiatives are not expected to result in NYCA capacity reductions or retirements that would increase LOLE or IRM requirements during the 2015 Capability Year.

5.5 Database Quality Assurance Reviews

It is critical that the data base used for IRM studies undergo sufficient review in order to verify its accuracy. The NYISO, General Electric (GE), and two New York Transmission Owners (TOs) conducted independent data quality assurance reviews after the preliminary base case assumptions were developed and prior to preparation of the final base case. Masked and encrypted input data was provided by the NYISO to the transmission owners for their reviews.

The NYISO, GE, and TO reviews found several minor data errors, none of which affected IRM requirements in the preliminary base case. The data found to be in error by these reviews were corrected before being used in the final base case studies. A summary of these quality assurance reviews is shown in Appendix A.4.

6. Comparison with 2014 IRM Study Results

The results of this 2015 IRM Study show that the base case IRM result represents a 0.3% increase from the 2014 IRM Study base case value. Table 6-1 compares the estimated IRM impacts of updating several key study assumptions and revising models from those used in the 2014 Study. The estimated percent IRM change for each parameter was calculated from the results of a parametric analysis in which a series of IRM studies were conducted to test the IRM impact of individual parameters. The results of this analysis were normalized such that the net sum of the -/+ % parameter changes total the 0.3% IRM increase from the 2014 Study. Table 6-1 also provides the reason for the IRM change for each study parameter from the 2014 Study.

The principal drivers shown in Table 6-1 that *increased* the required IRM from the 2014 IRM base case are a new daily peak logic feature in MARS and updated SCR data. These parameter changes increased the IRM by 0.6% and 0.4%, respectively. The principle driver that *decreased* the required IRM from the 2014 IRM base case is updated neighboring control area models, which results in a 0.9% IRM decrease from 2014. This large IRM decrease was primarily caused by the representation of 5,617 MW of demand resources (DR) in the PJM model as described in Section 5.3.2. No PJM DR was represented in the 2014 IRM Study. The parameters in Table 6-1 are discussed under *Models and Key Input Assumptions*. A more detailed description of these changes and their IRM impacts can be found in Table B-6 of Appendix B.

Table 6-1: Parametric IRM Impact Comparison (2014 vs. 2015 IRM Study)

Parameter	Estimated IRM Change (%)	IRM (%)	Reasons for IRM Changes
2014 IRM Study – Final Base Case		**17.0**	
2015 IRM Study Parameters that Increased the IRM			
New MARS Daily Peak Logic	+0.6		This new MARS feature captures more multiple load shape LOLE events.
Updated LFU	+0.4		Greater variance in load distributions due to weather.
Updated Load Forecast	+0.3		Higher Downstate load growth relative to Upstate load growth.
New Orangeville Wind	+0.2		This new wind unit increases the system average EFORd.
2013 Wind Shape	+0.2		Poorer 2013 wind performance relative to the 2012 performance data used for the 2014 IRM Study.
Non-SCR EOPs	+0.1		Less capacity projected from non-SCR EOPs.
Total IRM Increase	**+1.8**		
2015 IRM Study Parameters that Decreased the IRM			
Updated Outside Area Models	-0.9		Inclusion of 5,600 MW of PJM demand resources.
Updated Topology	-0.2		Lower Upstate interface limits outweighed by the impact of increased downstate interface limits. Increase in PJM to SENY interface limit.
Updated DMNC Ratings	-0.1		Downstate DMNC ratings increased relative to Upstate ratings.
Updated Cable Outage Rates	-0.1		Five-year average performance improved.
Updated SCRs	-0.1		Fewer SCRs reduced the average system EFORd.
Updated Generating Unit EFORd's	-0.1		Five-year average EFORd performance improved.
Total IRM Decrease	**-1.5**		
2015 IRM Study Parameters that do not change the IRM			
Ravenswood and Danskammer Returned to Service	0		
Dunkirk 2 Retired from Service	0		
Updated Study Year	0		
Updated Maintenance	0		
Net Change from 2014 Study		**+0.3**	
2015 IRM Study – Final Base Case		**17.3**	

7. Sensitivity Case Study Results

Determining the appropriate IRM requirement to meet NYSRC reliability criteria depends upon many factors. Variations from the base case will, of course, yield different results. Table 7-1 shows IRM requirement results and related NYC and LI locational capacities for selected sensitivity cases. NYSRC Executive Committee members may consider one or more of these sensitivity case results, in addition to the base case IRM, when the Committee develops the Final NYCA IRM for 2015. A complete summary of the twelve sensitivity case results shown in Table 7-1 is depicted in Table B-1 of Appendix B. Table B-1 also includes a description and explanation of each sensitivity case. Because of the lengthy computer run time and manpower needed to utilize the Tan 45 method in IRM studies (see Section 3), this method was not applied for the sensitivity studies in Table 7-1.

Table 6-1: Sensitivity Cases – 2015 IRM Study

Case	Description	IRM (%)	% Change from Base Case	NYC MLCR (%)	LI MLCR (%)
0	Base Case	17.3	0	83.4	103.7
	Impacts of Major MARS Parameters				
1	NYCA isolated	26.0	+8.7	89.6	111.6
2	No internal NYCA transmission constraints	14.7	-2.6	N.A	N.A.
3	No load forecast uncertainty	7.3	-10.0	76.3	94.6
4	No wind capacity	13.6	-3.7	83.4	103.7
5	No SCRs and EDRPs	16.0	-1.3	81.8	104.3
	Impacts of Base Case Assumption and Model Changes from Base Case				
6	New MARS peak logic feature turned off	16.6	-0.7	82.9	103.1
7	2002 load shape without multiple load shape model	18.4	+1.1	84.2	104.7
8	No PJM DR Programs represented	18.8	+1.5	84.2	104.8
9	Add Limited PJM DR (Target PJM LOLE = 0.15)	16.1	-1.2	82.6	102.6
10	Add Limited PJM DR (Target PJM LOLE = 0.1)	15.1	-2.2	81.8	101.7
11	Remove Danskammer	17.3	0.0	85.4	106.3
12	Retire Indian Point 2 and 3[9]	N.A.	N.A.	N.A	N.A.

[9] See the Section 7, "Sensitivity Case Study Results" section for details of this case.

Sensitivity Cases 1-11 determined the IRM and LCRs required for meeting the 0.1 days/year LOLE criterion for the sensitivity condition assumed. However, for Sensitivity12, Indian Point 2 and 3 were assumed to shut down in 2015 when the NYCA IRM is 17.3% (the base case IRM for the 2015 Capability Year). The LOLE for this sensitivity increased from 0.1, with both Indian Point both units in service, to 0.712 with both units shut down. Therefore, if Indian Point was to close, New York customers would be expected to experience service interruptions at a rate seven times that permitted by the NYSRC Resource Adequacy Reliability Criterion.

A multiple load shape model was used for the first time for the 2014 IRM study. An enhanced MARS peak logic feature was used for the first time for the 2015 IRM base case. Both features are described in Section 5.1.3. Case 6 shows the IRM impact of turning the new peak logic feature off, while Case 7 shows the IRM impact of replacing the multiple load shape model with a 2002 load shape model that was used for IRM studies prior to development of the multiple load shape model.

Cases 8-10 compare the IRM impacts of assuming a range of alternate PJM DR program types and capacities with PJM DR base case assumptions. A detailed discussion of the PJM DR considerations for the 2015 IRM Study is described in Section 5.3.2, including a more detailed description of Cases 8-10.

8. NYISO Implementation of the NYCA Capacity Requirement

The NYISO values capacity sold and purchased in the market in a manner that considers the forced outage ratings (UCAP) of individual units. To maintain consistency between the DMNC rating of a unit translated to UCAP and the statewide ICR, the ICR must also be translated to an unforced capacity basis. In the NYCA, these translations occur twice during the course of each capability year, prior to the start of the summer and winter capability periods.

Additionally, any LCRs in place are also translated to equivalent UCAP values during these periods. The conversion to UCAP essentially translates from one index to another; it is not a reduction of actual installed resources. Therefore, no degradation in reliability is expected. The NYISO employs a translation methodology that converts ICAP requirements to UCAP in a manner that ensures compliance with NYSRC Resource Adequacy Rule A-R1. The conversion to UCAP provides financial incentives to decrease the forced outage rates while improving reliability.

The increase in wind resources increases the IRM because wind capacity has a much lower peak period capacity factor than traditional resources. On the other hand, there is a negligible impact on the need for UCAP. Figure 8-1 below illustrates that UCAP reserve margins, having trended downward during the 2006-2010 period, has since stabilized. This indicates a generally lower burden on New York loads over the 2006 to 2014 time period. Appendix C provides details of the ICAP to UCAP conversion process used for this analysis.

Figure 8-1 NYCA Reserve Margins