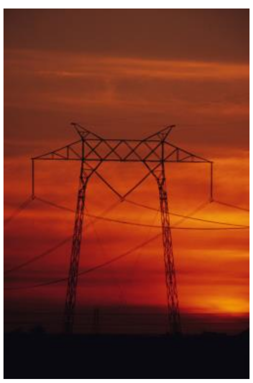
Technical Study Report

New York Control Area Installed Capacity Requirement

For the Period May 2017 to April 2018



Final Draft
Approved by ICS on 11/28/16

December 2, 2016

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.

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Note: Appendices A, B, C, and D are included in a separate document.

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,[1] 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 2017 through April 2018 (2017 Capability Year).

Results of the NYSRC technical study show that the required NYCA IRM for the 2017 Capability Year is 18.1% under base case conditions. This IRM satisfies the NYSRC and Northeast Power Coordinating Council (NPCC) reliability criterion of a Loss of Load Expectation (LOLE) of no greater than 0.1 days per year.

This study also determined corresponding *preliminary* Locational Capacity Requirements (LCRs) of 81.6% and 103.5% for New York City and Long Island, respectively. In accordance with its responsibility of setting the final LCRs, the New York Independent System Operator (NYISO) will later determine the applicable LCRs for the New York City and Long Island zones using a separate process in accordance with NYISO tariff and procedures, while adhering to NYSRC Reliability Rules and policies.

The 18.1% IRM base case value for the 2017 Capability Year represents a *0.7% increase* from the 2016 base case IRM of 17.4%. Table 6-1 shows the IRM impacts of individual updated study parameters that result in this change. There are seven parameter drivers that in combination *increased* the 2017 IRM from the 2016 base case. Of these, the three most significant drivers are (1) updated Ontario, New England, Quebec, and PJM Interconnection (PJM) interconnected external area models, which increased the IRM by 0.5%; (2) updated generating unit EFORds,[2] which increased the IRM by 0.4%; and (3) additional wind capacity, which increased the IRM by 0.4%.

Six other parameter drivers collectively *decreased* the IRM. Of these, the most significant driver is an updated load forecast for 2017, which decreased the IRM by 0.3%.

This study also evaluated IRM impacts of several sensitivity cases. The results of these sensitivity cases are summarized in Table 7-1, and in greater detail in Appendix B, Table B.1. In

[1] A Capability Year begins on May 1 and ends on April 30 of the following year.
[2] See Section 5.2.3.

addition, a confidence interval analysis was conducted to demonstrate that there is a high confidence that the base case 18.1% IRM will fully meet NYSRC and NPCC resource adequacy criteria that require a Loss of Load Expectation (LOLE) of no greater than 0.1 days/year.

Two new IRM study models were introduced for the 2017 IRM Study. First, a new multiple wind shape model, available in a new version of GE-MARS, was tested and accepted by ICS for use in the 2017 IRM Study. This model, which allows inputting of five (5) years of historical wind shape data, is an improvement over the previous wind shape model which could accept historical wind shape data from only one year. Second, the 2017 IRM Study includes a new five-zone PJM model, which was tested and accepted to replace the previous four-zone PJM model for use in the 2017 IRM Study. The five-zone model provides a more accurate representation of the PJM system. Another advantage of the new five-zone model is that data updates received from PJM will be consistent with that provided to NPCC, which also now uses a five-zone model.

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 2017 Capability Year is adopted. The 2017 IRM Study also evaluated Unforced Capacity (UCAP) trends. UCAP is the manner the NYISO values installed capacity – considering the forced outage ratings of individual generating units. This analysis shows (see Table 8-1) that required UCAP margins, which steadily decreased over the 2006-2012 period to 5%, have gradually increased to approximately 9% in the 2017 Capability Year.

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, 2017 through April 30, 2018 (2017 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:

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

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 2017 Capability Year.

The NYISO will implement the Final NYCA IRM as determined by the NYSRC, in accordance with the NYSRC Reliability Rules[3]; NYSRC Policy 5-11, *Procedure for Establishing New York Control Area Installed Capacity Requirement;*[4] the NYISO Market Services Tariff; and the NYISO Installed Capacity (ICAP) Manual.[5] The NYISO translates the required IRM to a UCAP basis. These values are also used in a Spot Market Auction based on FERC-approved Demand Curves. The schedule for conducting the 2017 IRM Study was based on meeting the NYISO's timetable for conducting this auction.

The study criteria, procedures, and types of assumptions used for the study for establishing the NYCA IRM for the 2017 Capability Year (2017 IRM Study) are set forth in NYSRC Policy 5-11. 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 the Northeast Power Coordinating Council (NPCC) resource adequacy criterion. IRM study procedures include the use of two study methodologies: the *Unified Methodology* and the *IRM Anchoring Methodology.* The NYSRC reliability criterion and IRM study methodologies are described in Policy 5-11 and discussed in detail later in this report.

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

In addition to calculating the NYCA IRM requirement, the above methodologies identify corresponding preliminary LCRs for New York City (NYC) and Long Island (LI). In its role of setting the final LCRs for 2017, the NYISO will utilize the 2017 IRM value approved by the NYSRC. The LCR values determined in this NYSRC study are considered *preliminary* because the NYISO, using a separate process – in accordance with NYSRC Reliability Rules, NYSRC Policy 5-11, and NYISO tariff and procedures – is responsible for setting the final LCRs.

The 2017 IRM Study was managed and conducted by the NYSRC Installed Capacity Subcommittee (ICS) and supported by technical assistance from NYISO staff.

Previous IRM Study reports, from year 2000 to year 2016, can be found on the NYSRC website.[6] Appendix C, Table C.1 provides a record of previous NYCA base case and final IRMs for the 2000 through 2016 Capability Years. Figure 8-1 and Appendix C, Table C.2, 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 Requirement 1 of NYSRC Reliability Rule A.1, *Establishing NYCA 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 days per year. This evaluation shall make due allowance for demand uncertainty, scheduled outages and deratings, forced outages and deratings, assistance over interconnections with neighboring 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 Requirement 4 in Section 3.0 of NPCC Directory 1, *Design and Operation of the Bulk Power System*.

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

In accordance with NYSRC Reliability Rule A.2, *Establishing Load Serving Entity (LSE) Installed Capacity Requirements and Deliverable External Area Installed Capacity*, the NYISO is required to establish LSE installed capacity requirements, including LCRs, for meeting the statewide IRM requirement established by the NYSRC for complying with NYSRC Reliability Rule A.1 above.

3. IRM Study Procedures

The study procedures used for the 2017 IRM Study are described in detail in NYSRC Policy 5-11, *Procedure for Establishing New York Control Area Installed Capacity Requirements*. Policy 5-11 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.

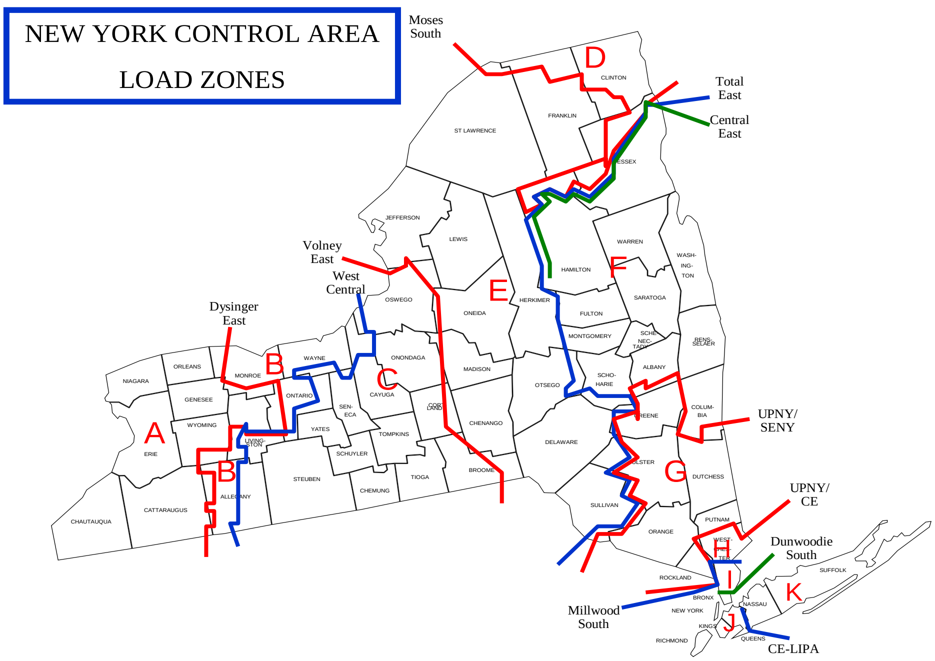
General Electric's Multi-Area Reliability Simulation (GE-MARS) is the primary computer program used for this probabilistic analysis. This program includes detailed load, generation, and transmission representation for eleven NYCA load zones — plus four external Control Areas (Outside World Areas) directly 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.[7] 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, Section A.1.

Prior to the 2016 IRM Study, IRM, base case and sensitivity analyses were simulated using only weekday peak loads rather than evaluating all 8,760 hours per year in order to reduce computational run times. However, the 2016 IRM Study determined that the difference between study results using the daily peak hour versus the 8,760 hour methodologies would be significant. Therefore, the base case and sensitivity cases in the 2016 IRM Study, and in this 2017 IRM Study, were simulated using all hours in the year.

[7] The Federal Energy Regulatory Commission has ordered the creation of a new capacity zone (NCZ) within the NYISO's ICAP market encompassing Load Zones G, H, I, and J (the "G-J Locality"). The creation of the G-J Locality did not impact the current Unified and IRM Anchoring Methodologies and NYSRC's calculation of the NYCA IRM that is discussed in this report. The NYISO establishes the LCR for the G-J Locality.

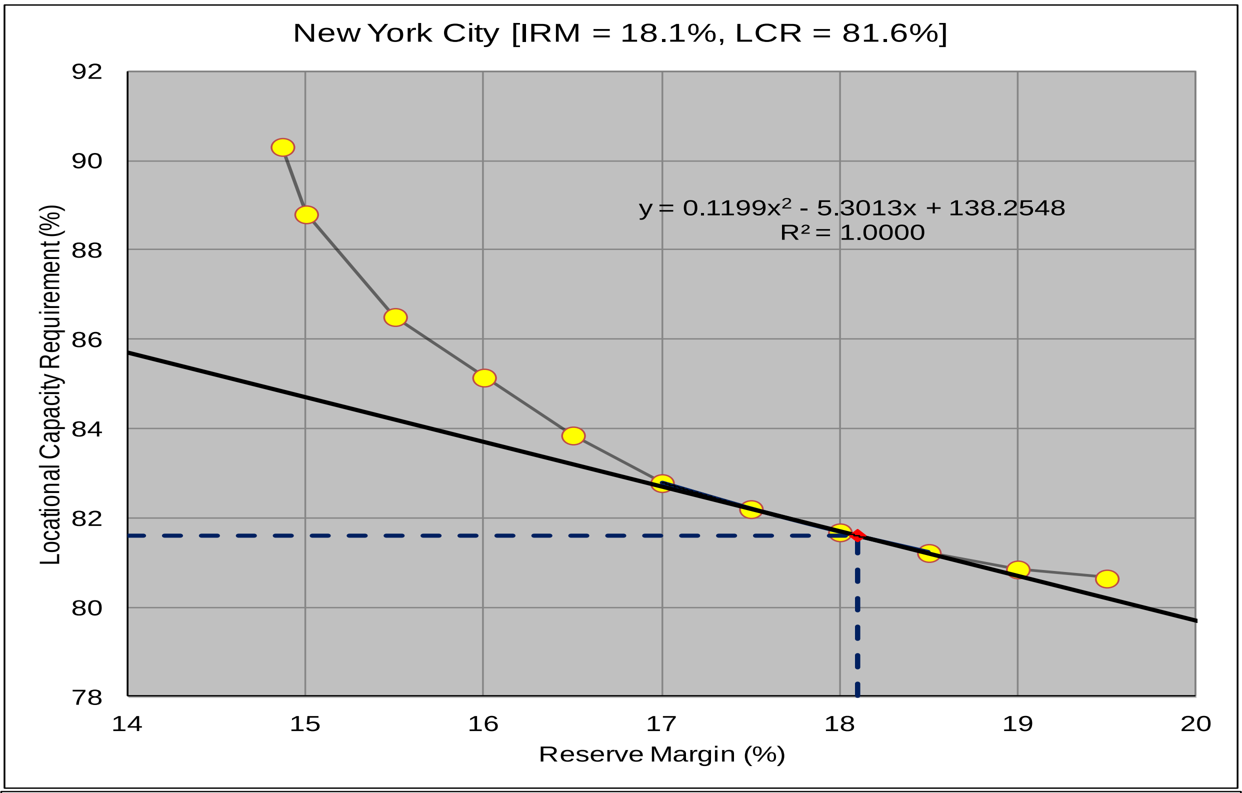
Using the GE-MARS program, a procedure is utilized for establishing NYCA IRM requirements (termed the *Unified Methodology)* which establishes a relationship between NYCA IRM and preliminary LCRs, as illustrated in Figure 3-2. All points on these curves meet the NYSRC 0.1 days/year LOLE reliability criterion 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 for two zones with locational capacity requirements, New York City (NYC), Zone J; and Long Island (LI), Zone K. Appendix A of NYSRC Policy 5-11 provides a more detailed description of the Unified Methodology.

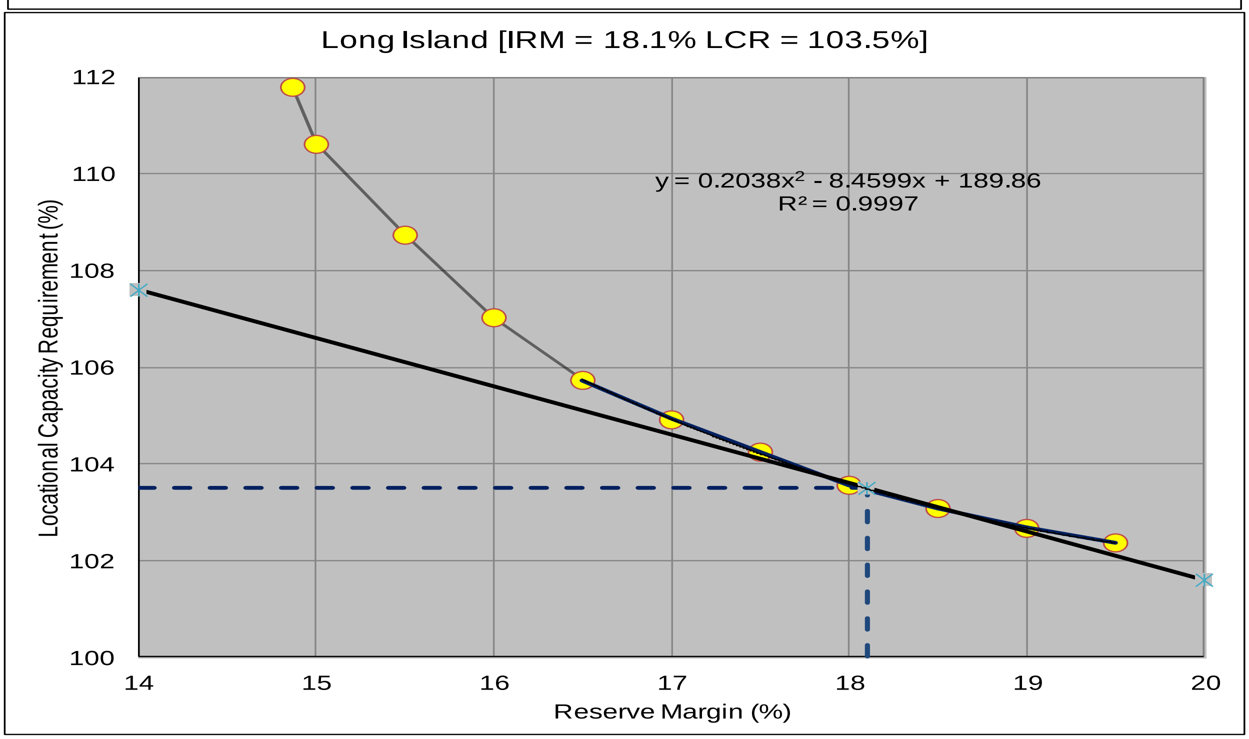
Figure 3-1 NYCA Load Zones



Base case NYCA IRM requirements and related preliminary LCRs for Zones J and K 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 NYSRC Policy 5-11 provides a more detailed description of the methodology for computing the Tan 45 inflection point.

Figure 3-2 Locational Requirements vs. Statewide Requirements





4. Study Results – Base Case

Results of the NYSRC technical study show that the required NYCA IRM is 18.1% for the 2017 Capability Year under base case conditions. 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 18.1% for the 2017 Capability Year, together with corresponding preliminary LCRs of 81.6% and 103.5% 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 preliminary LCRs in this 2017 IRM Study to 2016 IRM Study results (NYC LCR=80.8%, LI LCR=102.4%), the preliminary NYC LCR increased by 0.8%, while the preliminary LI LCR increased by 1.1%.

In accordance with NYSRC Reliability Rule A.2, *Load Serving Entity ICAP Requirements,* the NYISO is required to separately calculate and establish final LCRs. The most recent NYISO LCR study,[8] dated January 14, 2016, determined that for the 2016 Capability Year, the final LCRs for NYC and LI to be 80.5% and 102.5%, respectively. An LCR Study for the 2017 Capability Year is scheduled to be completed by the NYISO in January 2017.

A Monte Carlo simulation error analysis shows that there is a 95% probability that the above base case result is within a range of 17.8% and 18.4% (see Appendix A.1.1) when obtaining a standard error of 0.025 per unit at 2,000 simulated years. This analysis demonstrates that there is a high level of confidence that the base case IRM value of 18.1% is in full compliance with the one day in 10 year LOLE criterion in NYSRC Reliability Rule A.1.

5. Models and Key Input Assumptions

This section describes the models and related input assumptions for the 2016 IRM Study. The models represented in the GE-MARS analysis include a *Load Model, Capacity Model, Transmission Model, and Outside World Model*. Potential IRM impacts of pending *Environmental Initiatives* and *Database Quality Assurance Review* are also addressed in this section. The input assumptions for the final base case were approved by the

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

Executive Committee on October 14, 2016. Appendix A, Section A.3 provides more details of these models and assumptions and comparisons of several key assumptions with those used for the 2017 IRM Study.

5.1 Load Model

5.1.1 Peak Load Forecast

A 2017 NYCA summer peak load forecast of 33,273 MW was assumed in the 2017 IRM Study, a decrease of 105 MW from the 2016 summer peak forecast used in the 2016 IRM Study. The 2017 load forecast, completed by the NYISO staff in collaboration with the NYISO Load Forecasting Task Force and presented to ICS on October 5, 2016, considered actual 2016 summer load conditions. After accounting for the peak load impacts of weather and demand response programs, the weather/demand response adjusted or normalized peak load during the 2016 summer was determined to be 33,263 MW.

Use of the 2017 peak load forecast in the 2017 IRM Study decreased the IRM by 0.3% compared to the 2016 IRM Study due to the distribution of load (Table 6-1); whereby downstate load decreased more than upstate. The NYISO will prepare a final 2017 summer forecast in early 2017 for use in the NYISO 2017 Locational Capacity Requirement (LCR) Study. It is expected that the 2017 summer peak load forecast used for this study and the NYISO final summer 2017 forecast will be similar.

5.1.2 Load Forecast Uncertainty (LFU)

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).

An NYISO examination of the LFU models used for the 2017 IRM Study indicated that, due to relatively cool summer weather in 2015 and 2016, the LFU models did not need to be updated because there is no new information to model extreme weather conditions. Appendix A, Section A.3.1 describes these models in more detail. Modeling of load forecast uncertainty in the 2017 IRM Study has an effect of increasing IRM requirements by 7.9% as demonstrated by a sensitivity case (Table 7-1, Case 3).

5.1.3 Load Shape Model

A feature in GE-MARS that allows for the representation of multiple load shapes was utilized for the 2017 IRM Study. This multiple load shape feature enables a different load shape to be assigned to each of seven 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 these 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 2016 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.

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 2017 IRM Study are shown in Appendix A, Section A.3.2. 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 its 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 reratings of existing generating units in 2017 will increase the planned NYCA resource capacity by 67 MW, while no new resource capacity is planned in 2017. The capability of anticipated retirements will total 261 MW.

Despite the owners of the FitzPatrick and Ginna nuclear units noticing proposed retirements of these units prior to the 2017 summer period, both units were modeled as in-service in the 2017 IRM Study base case. The NYSRC Executive Committee approved their inclusion due to the likelihood that these units will continue operating into the 2017 summer period because of new State regulatory policies and certain information received by the New York State Public Service Commission and the NYISO that they may continue operations past their scheduled retirement. If, however, FitzPatrick and Ginna were to retire before the 2017 summer, the IRM would increase by 0.5% (Table 7-1, Case 9). If only FitzPatrick were to retire, the IRM would also increase by 0.5% (Table 7-1, Case 9a).

5.2.2 Wind Generation

It is projected that during the 2017 summer period there will be a total wind capacity of 1,676 MW participating in the capacity market in New York State. All wind farms are located in upstate New York in Zones A-E. This includes 221 of planned new wind capacity.

Despite the availability of actual hourly wind generation output covering several past years, previous GE-MARS versions allowed only a single year's wind shape to be represented in IRM studies. ICS either used the previous calendar year's hourly plant output as the basis for the wind shape model, or selected a typical year from several years of actual wind data, as was assumed for the 2016 IRM Study.

A new GE-MARS version includes a feature that allows input of multiple years of wind data, an improvement over the present model. This multiple wind shape model randomly draws wind shapes from historical wind production data. After testing, this new wind shape model was accepted by ICS for use in the 2017 IRM Study. The 2017 IRM Study used available wind production data covering the years 2011 through 2015. Results of a parametric study showed that use of the new multiple wind shape model has the effect of lowering the IRM by 0.1% from the 2016 IRM Study (Table 6-1).

The 2017 IRM Study base case assumes that the projected 1,676 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 period during which virtually all of the annual NYCA LOLE occurrences are distributed.

Overall, inclusion of the projected 1,676 MW of wind capacity in the 2017 Study accounts for 3.9% of the 2017 IRM requirement (Table 7-1, Case 4). 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 Appendix A, Table A.6.

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 2017 IRM Study covered the 2011-2015 period.

The weighted average five-year EFORd for NYCA thermal and large hydro generating units calculated for this period is higher than the 2010-2014 value used for the 2016 IRM Study. This increase in forced outage rates caused the IRM to increase by 0.4% from the 2016 study (Table 6-1). Appendix A, Figure A.4 depicts NYCA EFORd trends from 2003 to 2015.

5.2.4 Emergency Operating Procedures (EOPs)

(1) Special Case Resources (SCRs)

SCRs are loads capable of being interrupted, and distributed generators that are rated at 100 kW or higher. SCRs are ICAP resources that provide load curtailment only when activated when as needed in accordance with NYISO emergency operating procedures. GE-MARS models SCRs as an EOP step which is activated to avoid or to minimize expected loss of load. SCRs are modeled with monthly values based on July 2016 registration. For the month of July, the forecast SCR value for the 2017 IRM Study base case assumes that

1,192 MW will be registered, with varying amounts during other months based on historical experience. The 2016 IRM Study had assumed a registered amount of 1,254 MW, 62 MW higher than assumed for the 2017 IRM Study.

The SCR performance model is based on discounting registered SCR values to reflect historical availability. The SCR model used for the 2017 IRM Study is based on July 2015 performance data. SCR performance factors were determined from one-hour performance tests. The 2017 IRM Study used an Effective Capacity Value of 0.90 which resulted in a SCR model value of 841 MW with an overall effective performance of 70.6%. (refer to Appendix A, Section A.3.7 for more details). The number of SCR calls in the 2017 Capability Year for the 2017 IRM base case is limited to five (5) calls per month.

Although the performance of the SCR program decreased from 76.6% in the 2016 IRM Study to 70.6% in this study, the amount of registered SCRs also decreased. Upward pressure on the IRM, resulting from decreased SCR performance, was outweighed by the downward IRM pressure caused by the reduction in registrations. With fewer poor performing resources, the fleet average EFORd decreased, resulting in a drop in the IRM value.

The updated SCR model used for the 2017 IRM Study as described above resulted in an IRM decrease of 0.1% from the 2016 IRM Study (Table 6-1). The 2017 IRM Study determined that for the 18.1% base case IRM, approximately seven (7) SCR calls would be expected during the June-August 2017 period.

(2) Emergency Demand Response Program (EDRP)

The EDRP is a separate EOP step from the SCR Program that 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 2017 IRM Study assumes 75 MW of EDRP resources will be registered in 2017, the same amount that was assumed in the 2016 IRM Study. The 2017 EDRP capacity was discounted to a base case value of 13 MW to reflect 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 resources are not ICAP suppliers and therefore are not required to respond when called upon to operate.

Incorporation of both SCR and EDRP resources in the NYCA capacity model has the effect of increasing IRM requirements by 2.8% (Table 7-1, Case 5) because the overall availability of SCRs and EDRP is lower than the average statewide resource fleet availability.

(3) Other Emergency Operating Procedures

In addition to SCRs and the EDRP, the NYISO will implement several other types of EOPs, as required, to avoid or minimize customer disconnections. Projected 2017 EOP capacity values are based on recent actual data and NYISO forecasts. Refer to Appendix B, Table B.2 for projected EOP frequencies for the 2017 Capability Year assuming the 18.1% base case IRM.

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 provide locational capacity benefits. Non-locational capacity, when coupled with a UDR to deliver capacity to a Locality, can be used to satisfy locational capacity requirements. The owners of the UDRs elect whether they will utilize their capacity deliverability rights. This decision determines how this transfer capability will be represented in the MARS model. 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 2017 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 they plan 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 2017 IRM Study incorporates the confidential elections that these facility owners made for the 2017 Capability Year.

5.3 Transmission Model

A detailed NYCA 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 A, Figures A.12, and A.13. The transfer limits employed for the 2017 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 2017 IRM Study are listed in the Appendix A, Tables A.7 and A.8, and described in detail in Appendix Section A.3.3.

Forced outages based on historic performance are represented in the GE-MARS model for the IRM study for the underground cables that connect New York City and Long Island to surrounding zones. 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 in the 2017 IRM Study had no impact on the IRM compared to the 2016 IRM Study (Table 6-1).

As in all previous IRM studies, forced outage rates for overhead transmission lines were not represented in the 2017 IRM Study. This was confirmed by a study conducted by ICS in 2015, *Evaluation of the Representation of Overhead Transmission Outages in IRM Studies*, which concluded that representing overhead transmission outages in IRM studies would have no material impact on the IRM (see www.nysrc.org/reports).

The impact of NYCA 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 on IRM, if there were no NYCA transmission constraints, the required 2017 IRM would decrease by 2.9% (Table 7-1, Case 2).

LIPA has revised its methodology for calculating its facility ratings. This change has resulted in reductions in the ratings of limiting facilities, which impacts the zones J to K, LI Sum, zones I to K, and LI West interface limits. Planned upgrades to mitigate the potential impacts of these reduced ratings are planned before the 2017 summer period. These updated Long Island-related interface limits were incorporated in the 2017 IRM Study, resulting in a 0.1% IRM increase from the 2016 IRM Study (Figure 6-1). If the above planned upgrades were delayed past the 2017 summer, the IRM would increase by 0.7% (Table 7-1, Case 13).

There is a reduction in the UPNY-SENY transfer limit in this study. This is caused by the change in how the Con Ed/PSEG wheel schedule is modeled. For the 2016 IRM Study, 1000 MW was modeled flowing to PJM on the South Mahwah to Waldwick ties, while 1000 MW was modeled flowing to NYCA on the A, B and C ties. For the 2017 IRM Study, because of the cancellation of the Con Edison/PJM wheel agreement, a 0 MW flow is modeled for these ties. This modeling change resulted in a 100 MW decrease in the UPNY-SENY limit and a 0.1% IRM increase from the 2016 IRM Study (Table 6-1).

Cancellation of the Con Edison/PSEG wheel agreement also resulted in an increase in the UPNY-Con Edison and zones I to J & K interface limits. Not modeling the 1000 MW withdrawal of power from Zone G to supply the wheel reduces the reactive power in SENY and increases voltage constraints in that area. The reduction in load growth also impacts these transfer limits.

5.4 Outside World Model

The Outside World Model consists of four interconnected external control areas contiguous with NYCA: Ontario, Quebec, New England, and the PJM Interconnection (PJM). NYCA reliability is 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 all such external interconnection support arrangements in the 2017 IRM Study base case for permitting emergency assistance to NYCA reduces the NYCA IRM requirements by 8.3% (Table 7-1, Case 2). This “reserve value of NYCA interconnections” compares to 8.5% in the 2016 IRM Study. The model for representing neighboring control areas in the 2017 IRM Study was similar that used in previous IRM studies. The assumptions for the Outside World Model included in the 2017 IRM Study are listed in Appendix A, Tables A.9 and A.10.

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 NYSRC Policy 5-11, a rule is applied whereby an Outside World Area's LOLE cannot be lower than its own LOLE criterion. Therefore, for each of the Ontario, Quebec and New England control areas, a minimum LOLE of 0.1 days/year is modeled in accordance with NPCC requirements and the Areas' own individual resource adequacy criteria. For PJM, the 2017 IRM Study assumed a minimum LOLE of 0.14 day/year, which PJM uses for its planning studies. This is based on PJM's LOLE or resource adequacy criterion of 0.10 days/year, plus a PJM internal transmission constraint risk adder of 0.04 days/year. Also, each of these control areas' 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 5-11 does not allow EOPs to be represented in Outside World Area models for providing emergency assistance to NYCA 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 can be explicitly considered through direct multi-area modeling of well-defined external area bubbles and their internal interface constraints. The model representation explicitly requires adequate data to accurately model transmission interfaces, load areas, resource and demand balances, load shape, and coincidence of peaks among the load zones within these Outside World Areas. If adequate data is unavailable, the area can also be modeled implicitly either by aggregating bubbles and associated interfaces and reflecting the constraint limits at the interfaces between aggregated bubbles and at the NYCA border, or by increasing the LOLE of the Outside World Areas.

For this study, two Outside World Areas, New England and PJM, are each represented as multi-area models, i.e., 13 zones for New England and five zones for the PJM Interconnection. The 13 zones for New England is an explicit representation that is reviewed by the ISONE staff and aligns with their own models for reserve margin studies.

In early 2016, the NYISO tested the impact of transitioning the PJM system representation, from a four-zone model used in previous IRM studies, to a five-zone representation. PJM has confirmed that a five-zone model is more accurate representation of the PJM system. Further, a five-zone model is currently utilized by NPCC. Given the NYISO's successful testing of a five zone PJM model, the NYSRC accepted transitioning from the previous four-zone model to a five-zone model for representing the PJM system in the 2017 IRM Study. Use of the five-zone model reduces the IRM by 0.1% compared to using the four-zone model in the 2016 IRM Study (Table 6-1).

The existing PJM-SENY group transfer limit is imposed to reflect internal constraints in both the PJM and NYCA systems. The transmission model in previous IRM studies allowed for the contractual delivery of 1000 MW at Waldwick and PJM re-delivery of 1000 MW at the Hudson and Linden interface ("PJM wheel"). The PJM wheel will be discontinued in 2017 and is not represented in the 2017 IRM Study. Removal of the PJM wheel increases the IRM by 0.1% (Table 6-1).

As earlier discussed, excess generation capacity is delivered as emergency assistance from neighboring control areas to NYCA, recognizing interconnection limits, to avoid load shedding. As a result, the modeling of emergency assistance permits NYCA to operate at an IRM lower than otherwise required. Recently, a concern has been raised that calculated emergency transfer levels from neighboring control areas in past GE-MARS studies may have been overstated in comparison to actual operating conditions. A reason for this concern is that a portion of excess generation in neighboring control areas as identified by MARS as available for potentially provide emergency assistance could actually be off-line at the time when emergency capacity is needed by NYCA. In consideration of this concern, a preliminary study to examine issues related to the amount of emergency assistance that can be reasonably relied on was conducted by the NYISO in early 2016. Recognizing the results of this study, ICS is currently reviewing alternate models for representing emergency assistance. Sensitivity Cases 6 and 6a in Table 7-1 depict IRM impacts for a range of emergency assistance limit scenarios (2250 to 2750 MW) based on a preliminary analysis of actual excess 10 and 30-minute operating reserves in neighboring external areas. From the Table 7-1 sensitivity case results, NYCA's reserve value of interconnections would be reduced from 8.3% in the 2017 IRM base case (Case 1) to a range of 7.6 to 8.0% (Cases 6 and 6a), assuming these emergency assistance limit scenarios. It is expected that a revised emergency assistance model will be available for use in the 2018 IRM Study after additional studies are completed.

5.5 Environmental Initiatives

The NYISO has identified environmental regulatory programs that could impact the operation of NYS Bulk Power System facilities. These state and federal regulatory initiatives cumulatively have required considerable investment by the owners of NYPA thermal power plants in order to comply. These programs are as follows:

NO_X RACT: Reasonably Available Control Technology (effective July 2014).

BART: Best Available Retrofit Technology for regional haze (effective January 2014).

MATS: Mercury and Air Toxics Standard for hazardous air pollutants (effective April 2015).

MRP: Mercury Reduction Program for Coal-Fired Electric Utility Steam Generating Units – Phase II reduces Mercury emissions from coal fired power plants in New York (effective January 2015).

CSAPR: Cross-State Air Pollution Rule for the reduction of SO_2 and NO_X emissions in 28 Eastern States. Additional Phase 2 ozone season NO_X emissions reductions were recently finalized in the CSAPR Update Rule to begin in 2017.

RGGI: Regional Greenhouse Gas Initiative Phase II cap reductions started January 2014. The program design is undergoing review by the RGGI states in 2016 for design changes expected to take effect in 2018-2020.

CO_2 Emission Standards: New Source Performance Standards would have become effective October 2015 with final emissions limits for existing units beginning in 2022. However, the Supreme Court of the United States stayed the effectiveness of the CPP pending resolution of judicial challenges to the regulation. New York State has issued its own CO_2 emission reduction goals in the Clean Energy Standard, which calls for 50% of all electric energy generation to come from renewable and carbon-free resources and a 40% reduction in CO_2 emissions by 2030.

RICE: NSPS and NESHAP – New Source Performance Standards and Maximum Achievable Control Technology for Reciprocating Internal Combustion Engines. (Effective July 2016, however, the exemption for use of non-compliant engines in energy markets has been removed from the regulatory text to address judicial remand.)

BTA**:** Best Technology Available for cooling water intake structures (Effective upon SPDES Permit Renewal).

NYC Residual Oil Elimination**:** Phase out of residual oil usage in New York City (NYC) utility boilers.

DG (Distributed Generation) Rule: New York State Department of Environmental Conservation (NYSDEC) Proposed announced a final rule on November 1, 2016 to lower carbon dioxide and nitrogen oxide emissions from small generators.

The NYISO has determined that as much as 27,500 MW in the existing fleet (72% of 2015 Summer Capacity) will have some level of exposure to environmental regulations. However, these initiatives are not expected to result in NYCA capacity reductions or retirements that would increase LOLE or IRM requirements during the 2017 Capability Year. For more details see the 2016 RNA Report.[9]

5.6 Database Quality Assurance Review

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. Also, certain confidential data were reviewed by two independent NYSRC consultants.

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

[9] NYISO Reliability Needs Assessment Report, dated 10/18/2016, at NYISO/planning/documents/

studies. A summary of these quality assurance reviews for the 2016 IRM Study input data is shown in Appendix A, Section A.4.

6. Comparison with 2016 IRM Study Results

The results of this 2017 IRM Study show that the base case IRM result represents a 0.7% increase from the 2016 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 2016 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 IRM impact of each parameter in this analysis was normalized such that the net sum of the -/+ % parameter changes total the 0.7% IRM increase from the 2016 Study. Table 6-1 also provides the reason for the IRM change for each study parameter from the 2016 Study.

The three principal drivers shown in Table 6-1 that *increased* the required IRM from the 2016 IRM base case are: (1) updated models for Quebec, Ontario, PJM, and New England, (2) updated generating unit EFORds, and (3) the addition of 221 MW of new wind capacity. These parameter changes increased the IRM by 0.5%, 0.4%, and 0.4%, respectively. The principal driver that *decreased* the required IRM from the 2016 IRM base case is the updated load forecast. This parameter change decreased the IRM by 0.3%. The parameters in Table 6-1 are discussed under *Models and Key Input Assumptions*.

Table 6-1: Parametric IRM Impact Comparison – 2016 IRM vs. 2017 IRM Study

Parameter	Estimated IRM Change (%)	IRM (%)	Reasons for IRM Changes
2016 IRM Study – Final Base Case		**17.4**	
2017 IRM Study Parameters that Increased the IRM			
Updated PJM, Ontario, NE and Quebec Models	+0.5		Less assistance available from NE, Ontario, and Quebec.
Updated Generating Unit EFORd's	+0.4		Dropped a good performance year (2010) and added a poor performance year (2015).
New Wind Capacity	+0.4		Wind performance is less than the existing fleet performance.
Retirements	+0.1		Downstate retirements can raise IRM requirements because of their location.
PJM Wheel Removed	+0.1		Loss of PSEG wheel redirects some assistance to localities outside of zones J and K.
Updated DMNC Ratings	+0.1		DMNC ratings of downstate units decreased when compared to upstate units.
Long Island topology change	+0.1		Lower tie ratings on some of the interfaces surrounding Long Island.
Total IRM Increase	**+1.7**		
2017 IRM Study Parameters that Decreased the IRM			
Updated Load Forecast	-0.3		Lower load levels overall, particularly downstate.
Updated Non-SCR EOPs	-0.2		MWs available in EOP programs declined.
Rest of State Units Modeled as Load Modifiers	-0.2		Loss of poor performing capacity with resulting reduction of peak load.
Replace PJM 4-Bubble with 5-Bubble Model	-0.1		Small amount of increased transfer capability with 5-bubble representation.
Updated SCRs	-0.1		SCRs registered were less, improving the fleet average despite worse SCR performance.
Multiple Wind Shape Model Update	-0.1		Past five-year wind performance was better than the previously used 2013 wind shape.
Total IRM Decrease	**-1.0**		
2017 IRM Study Parameters that do not change the IRM			
Multiple Solar Shapes	0		
Updated Maintenance Schedules	0		
Updated Cable Outage Rates	0		
Updated Topology	0		Excludes Long Island topology change above.
Net Change from 2016 Study		**+0.7**	
2017 IRM Study – Final Base Case		**18.1**	

7. Sensitivity Case Study Results

Determining the appropriate IRM requirement to meet NYSRC reliability criteria depends upon many factors. Variations from base case assumptions will, of course, yield different results. Table 7-1 shows IRM requirement results for selected sensitivity cases.

Sensitivity Cases 1 through 5 illustrate how the IRM would be impacted if certain major IRM study parameters were not represented in the IRM base case. The remaining group of cases – Cases 6 through 13 – shows IRM impacts assuming selected base case assumptions are changed to reasonable alternative levels, some of which are referenced in Section 5. NYSRC Executive Committee members will consider one or more of these latter sensitivity case results, in addition to the base case IRM and other factors, when the Committee develops the Final IRM for 2017[10] on December 2, 2016. Appendix B, Table B-1 includes a more detailed description and explanation of each sensitivity case.

The methodology used to conduct the sensitivity cases starts with the preliminary base case IRM results, and adds or removes capacity from all NYCA zones[11] until the NYCA LOLE approaches 0.1 days/year. Because of the lengthy computer run time and manpower needed to perform a Tan 45 analysis in IRM studies,[12] this method was applied for only Cases 9, 9a, and 11 in Table 7-1.

All of the sensitivity cases, except Case 7, determined the IRM required for meeting the 0.1 days/year LOLE criterion for the sensitivity condition assumed. However, for Case 7, Indian Point 2 and 3 were assumed to be shut down in 2017, without being replaced, assuming the 2017 base case IRM value of 18.1%. The LOLE for this sensitivity increased from 0.1 days/year with both Indian Point both units in service, to 0.87 days/year 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 about nine times that permitted by the NYSRC Resource Adequacy Reliability Criterion.

The NYISO has proposed a market change to the way that NYCA capacity exports are treated from a locational capacity zone in relation to a NYISO/NE-ISO filing with FERC in which resources are qualified to participate in reconfiguration auctions for the 2017

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[10] See Section 5 of Policy 5 for a description of the process the NYSRC Executive Committee uses to establish the Final IRM.

[11] With the exception of the "No Wind Capacity" sensitivity in which replacement capacity only occurs in Zones A-F.

[12] See Section 3 for a description of a Tan 45 analysis.

Capability Year. The 2017 IRM Study does not include analysis or sensitivity studies to evaluate the potential 2017 IRM impact from such exports because there are still ongoing discussions between the NYISO and its stakeholders, as well as the ICS, on the appropriate way to model these transactions. It is anticipated that such studies will be included in the 2018 IRM Study after these issues are resolved.

Table 7-1: Sensitivity Cases – 2017 IRM Study

Case	Description	IRM (%)	% Change from Base Case
0	Final Base Case	18.1	0
1	NYCA isolated	26.4	+8.3
2	No internal NYCA transmission constraints	15.2	-2.9
3	No load forecast uncertainty	10.2	-7.9
4	No wind capacity	14.2	-3.9
5	No SCRs and EDRP	15.3	-2.8
6	New emergency assistance (EA) model under development: 2750 MW EA limit scenario	18.4	+0.3
6a	New emergency assistance model under development: 2250 MW EA limit scenario	18.8	+0.7
7	Retire Indian Point 2 and 3, w/o replacing capacity (LOLE)	N.A.	LOLE = 0.87 d/y
8	Long Island topology changes: planned upgrades delayed beyond 6/1/17	18.8	+0.7
9	Ginna and FitzPatrick retired *(Tan 45 analysis)*	18.7	+0.6
9a	Only FitzPatrick retired *(Tan 45 analysis)*	18.6	+0.5
10	One Ramapo PAR out of service	18.4	+0.3
11	Cayuga Units 1&2 retirement (300 MW)	17.7	-0.4

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.1 (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 required UCAP margins, which steadily decreased over the 2006-2012 period to 5%, have gradually increased to approximately 9% since then. Appendix C provides details of the ICAP to UCAP conversion process used for this analysis.

Figure 8-1 NYCA Reserve Margins