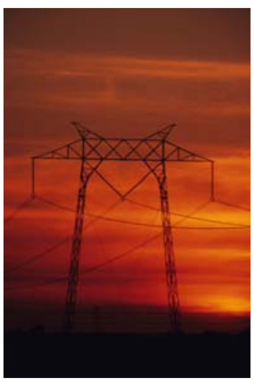
Attachment #4.2
Return to Agenda

Final Draft -- Approved by ICS on 11/28/17

Technical Study Report

New York Control Area Installed Capacity Requirement

For the Period May 2018 to April 2019



December 8, 2017

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 2018 through April 2019 (2018 Capability Year).

Results of the NYSRC technical study show that the required NYCA IRM for the 2018 Capability Year is 18.2% under base case conditions. This IRM satisfies the NYSRC and Northeast Power Coordinating Council (NPCC) reliability criteria 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 80.7% and 103.2% for New York City and Long Island, respectively. In accordance with its responsibility of setting the final LCRs, the New York Independent System Operator, Inc. (NYISO) will later determine the applicable LCRs for the New York City and Long Island localities using a separate process in accordance with NYISO tariffs and procedures, while adhering to NYSRC Reliability Rules and policies.

The 18.2% IRM base case value for the 2018 Capability Year represents a *0.1% increase* from the 2017 base case IRM of 18.1%. Table 6-1 shows the IRM impacts of individual updated study parameters that result in this change. There are six parameter drivers that in combination *increased* the 2018 IRM from the 2017 base case. Each of the following parameters increase the IRM by 0.1%; (1) new NYCA generating units; (2) NY topology updates; (3) new wind generation; (4) EFORd on UDR lines; (5) updated load forecast uncertainty; and (6) updated load forecast. One parameter driver—updated external control area models—*decreased* the IRM by 0.5%.

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 addition, a confidence interval analysis was conducted to demonstrate that there is a high confidence that the base case 18.2% 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 per year.

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

A new Emergency Assistance Model was introduced for the 2018 IRM Study. This model limits the amount of emergency capacity support that NYCA can receive from the four external control areas neighboring the NYCA. The value of this emergency assistance (EA) limit was based on an analysis of the total amount of excess ten-minute reserve above required operating reserve that has been historically available from the four external control areas. The analysis concluded that the appropriate value of the EA limit for the 2018 IRM Study is 3,500 MW.

The base case and sensitivity case IRM results, along with other relevant factors, will be considered in a separate NYSRC Executive Committee process, described in NYSRC Policy 5-12, in which the Final NYCA IRM requirement for the 2018 Capability Year is adopted. The 2018 IRM Study also evaluated Unforced Capacity (UCAP) trends. UCAP is the manner by which 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 2018 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, 2018 through April 30, 2019 (2018 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 2018 Capability Year.

The NYISO will implement the Final NYCA IRM as determined by the NYSRC, in accordance with the NYSRC Reliability Rules;[2] NYSRC Policy 5-12, *Procedure for Establishing New York Control Area Installed Capacity Requirement*;[3] the NYISO Market Administration and Control Area Services Tariff; and the NYISO Installed Capacity (ICAP) Manual.[4] 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 2018 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 2018 Capability Year (2018 IRM Study) are set forth in NYSRC Policy 5-12. The primary reliability criterion used in the IRM study requires a Loss of Load Expectation (LOLE) of no greater than 0.1 days per 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 5-12 and discussed in detail later in this report.

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[2] http://www.nysrc.org/NYSRCReliabilityRulesComplianceMonitoring.asp
[3] http://www.nysrc.org/policies.asp
[4] 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 the 2018 Capability Year, the NYISO will utilize the 2018 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 NYISO tariff and procedures, while adhering to NYSRC Reliability Rules and NYSRC Policy 5-12– is responsible for setting the final LCRs.

The 2018 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 2017, can be found on the NYSRC website.[5] Appendix C, Table C.1 provides a record of previous NYCA base case and final IRMs for the 2000 through 2017 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*.

[5] 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 2018 IRM Study are described in detail in NYSRC Policy 5-12, *Procedure for Establishing New York Control Area Installed Capacity Requirements*. Policy 5-12 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.

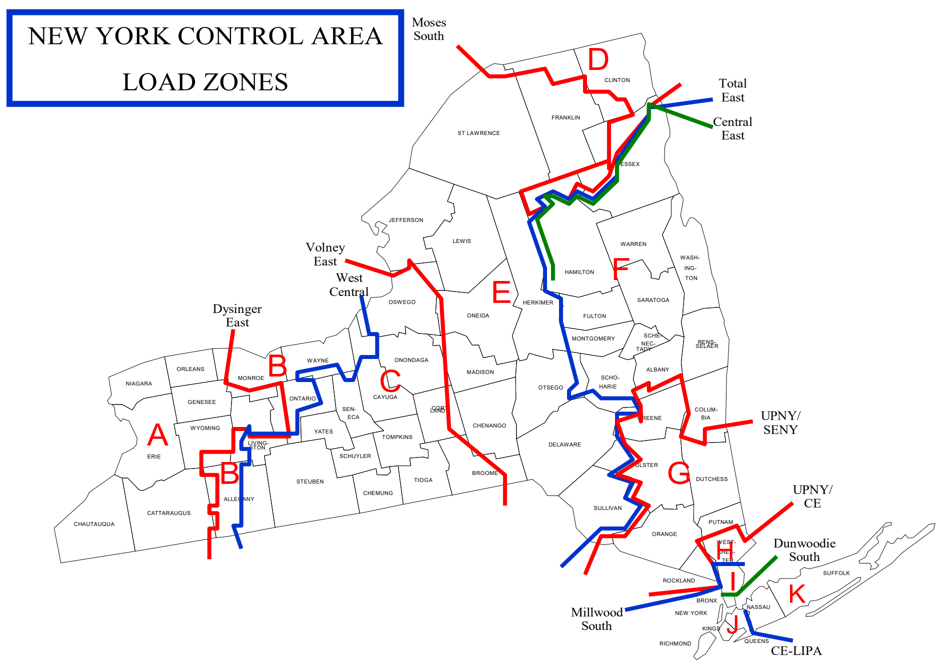
General Electric's Multi-Area Reliability Simulation (GE-MARS) is the primary computer program used for this probabilistic analysis. This program includes detailed load, generation, and transmission representation for eleven NYCA load zones — plus four external Control Areas (Outside World Areas) directly 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.[6] 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 all later studies, were simulated using all hours in the year.

[6] 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.

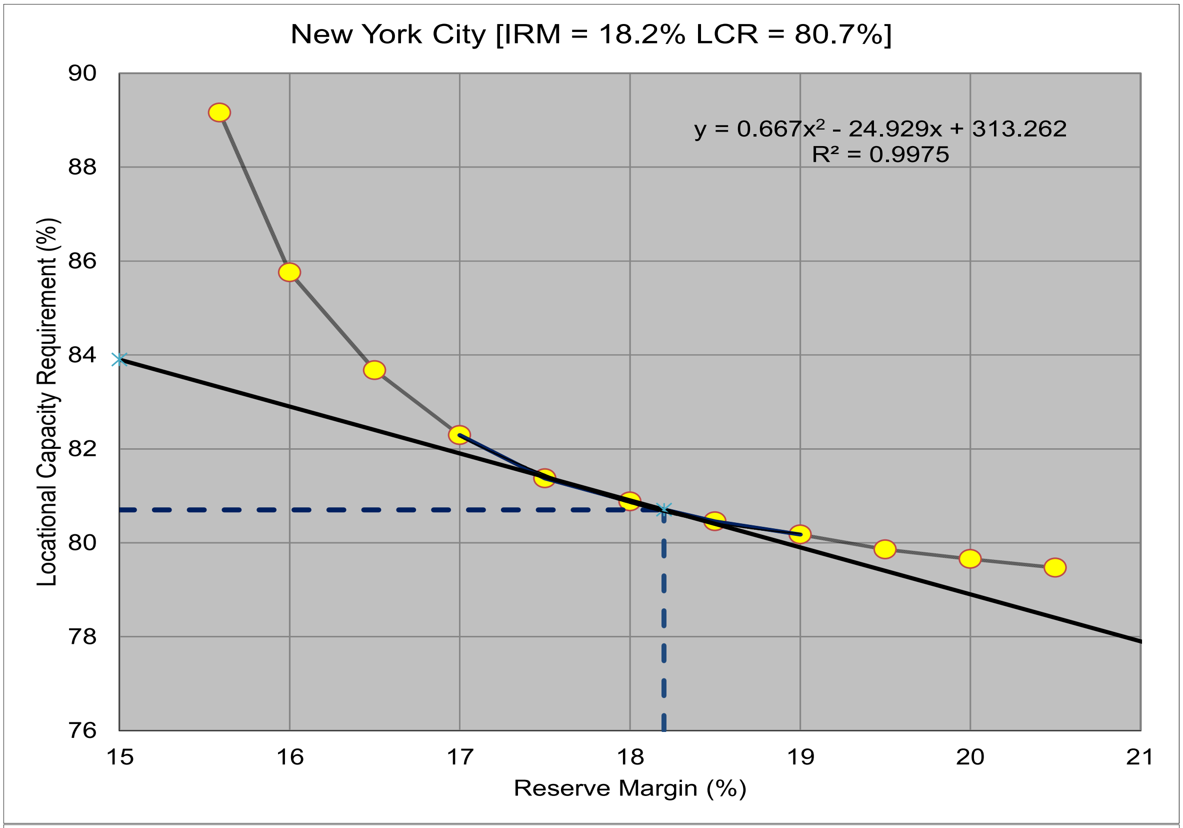
Using the GE-MARS program, a procedure is utilized for establishing NYCA IRM requirements (termed the *Unified Methodology*) which establishes a relationship between NYCA IRM and preliminary LCRs, as illustrated in Figure 3-2. All points on these curves meet the NYSRC 0.1 days/year LOLE reliability criterion described above. Note that the area above the curve is more reliable than the criterion, 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 5-12 provides a more detailed description of the Unified Methodology.

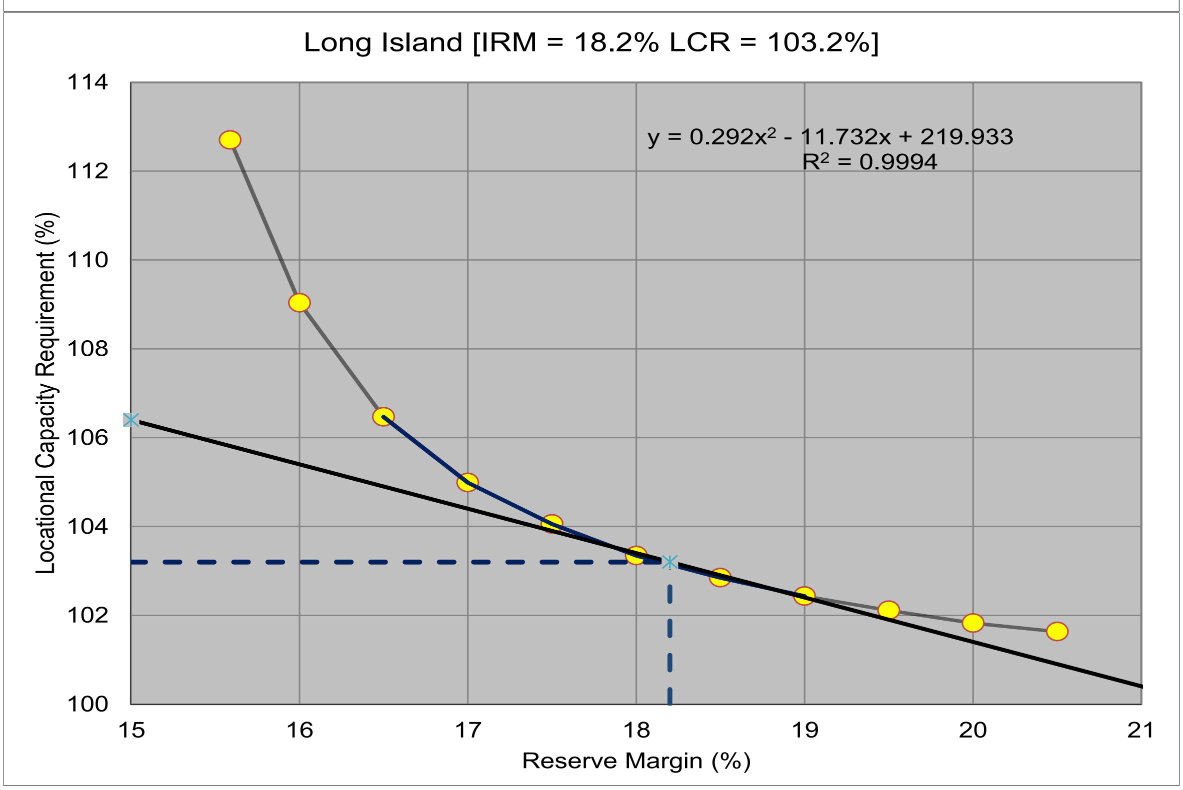
Figure 3-1 NYCA Load Zones



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 5-12 provides a more detailed description of the methodology for computing the Tan 45 inflection point.

Figure 3-2 Locational Requirements vs. Statewide Requirements


New York City [IRM = 18.2% LCR = 80.7%]
y = 0.667x² - 24.929x + 313.262
R² = 0.9975
Locational Capacity Requirement (%)
Reserve Margin (%)
90
88
86
84
82
80
78
76
15
16
17
18
19
20
21


Long Island [IRM = 18.2% LCR = 103.2%]
y = 0.292x² - 11.732x + 219.933
R² = 0.9994
Locational Capacity Requirement (%)
Reserve Margin (%)
114
112
110
108
106
104
102
100
15
16
17
18
19
20
21

4. Study Results – Base Case

Results of the NYSRC technical study show that the required NYCA IRM is 18.2% for the 2018 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 IRM of 18.2% for the 2018 Capability Year, together with corresponding preliminary LCRs of 80.7% and 103.2% 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 2018 IRM Study to 2017 IRM Study results (NYC LCR=81.6%, LI LCR=103.5%), the preliminary NYC LCR decreased by 0.9%, while the preliminary LI LCR decreased by 0.3%.

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,[7] dated January 13, 2017, determined that for the 2017 Capability Year, the final LCRs for NYC and LI were 81.5% and 103.5%, respectively. An LCR Study for the 2018 Capability Year is scheduled to be completed by the NYISO in January 2018.

A Monte Carlo simulation error analysis shows that there is a 95% probability that the above base case result is within a range of 18.0% and 18.4% (see Appendix A.1.1) when obtaining a standard error of 0.025 per unit at 2,500 simulated years. This analysis demonstrates that there is a high level of confidence that the base case IRM value of 18.2% 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 2018 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 Executive Committee on October 13, 2017. Appendix A, Section A.3 provides more details

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

of these models and assumptions and comparisons of several key assumptions with those used for the 2018 IRM Study.

5.1 Load Model

5.1.1 Peak Load Forecast

A 2018 NYCA summer peak load forecast of 32,868 MW was assumed in the 2018 IRM Study, a decrease of 405 MW from the 2017 summer peak forecast used in the 2017 IRM Study. This "Fall 2018 load forecast" – completed by the NYISO staff in collaboration with the NYISO Load Forecasting Task Force, and presented to ICS on October 4, 2017 – considered actual 2017 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 2017 summer was determined to be 32,857 MW.

Use of the 2018 peak load forecast in the 2018 IRM Study increased the IRM by 0.1% compared to the 2017 IRM Study due to the distribution of load (Table 6-1); whereby upstate load decreased more than downstate. The NYISO will prepare a final 2018 summer peak forecast by the end of 2017 for use in the NYISO's calculation of the 2018 LCRs.

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).

The LFU model for the 2018 IRM study was updated due to new extreme weather data becoming available. Appendix A, Section A.3.1 describes these models in more detail. Modeling of load forecast uncertainty in the 2018 IRM Study has an effect of increasing IRM requirements by 7.2% 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 2018 IRM Study. This multiple load shape feature enables a different load shape to be assigned to each of seven load forecast uncertainty bins. ICS has established criteria for selecting the appropriate historical load shapes to use for each of these load forecast uncertainty bins. For this purpose, a combination of load shape years 2002, 2006, and 2007 were selected as representative years. The load shape for the year 2007 was selected to represent a typical system load shape over the 1999 to 2017 period. The load shape for 2002 represents a flatter load shape, *i.e.*, 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 New Non-Wind Generation, Reratings, and Retirements

Planned new non-wind facilities and retirements that are represented in the 2018 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.

Two planned new generating units, having a total capacity of 784 MW, are included in the 2018 IRM Study: Greenidge Unit No. 4 and CPV Valley Energy Center. In addition, an increase of the rating of the existing Bethlehem Energy Center by 52 MW is included. Since the publication of the NYISO's 2017 Load and Capacity Report, three existing generators that noticed their intent to retire subsequently rescinded their notices to retire, and continue to be active in the New York markets.

The NYISO has identified several state and federal environmental regulatory programs that could potentially impact operation of NYS Bulk Power System. An analysis concluded that these environmental initiatives would not result in NYCA capacity reductions or retirements that would impact IRM requirements during the 2018 Capability Year. For more details see Appendix A, Section A.3.2.

A former net generator located in Long Island delivering 9.6 MW of net capacity has become a new Behind-the-Meter Net Generation Resource (BTM:NG) facility. A BTM:NG resource, for this study's purpose, contributes its full capacity while its entire host load is exposed to the electric system. The 47 MW generating capacity of this BTM:NG Resource facility is included in the NYCA capacity model, while its host load of 39 MW is included in the NYCA 2018 summer peak load forecast used for this study.

5.2.2 Wind Generation

It is projected that during the 2018 summer period there will be a total wind capacity of 1,733 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 78 MW of planned new wind capacity.

GE-MARS includes a feature that allows input of multiple years of wind data. This multiple wind shape model randomly draws wind shapes from historical wind production data. The 2018 IRM Study used available wind production data covering the years 2012 through 2016. For new wind facilities, zonal hourly wind shape averages or the wind shapes of nearby wind units are modeled.

The 2018 IRM Study base case assumes that the projected 1,733 MW of wind capacity will operate at a 15.7% 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 2012 – 2016 summer month (June through August) period between the hours of 2:00 p.m. and 6:00 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 1,733 MW of wind capacity in the 2018 IRM Study accounts for 3.7% of the 2018 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 2018 IRM Study covered the 2012-2016 period.

Although the weighted average five-year EFORd for NYCA thermal and large hydro generating units calculated for this period is slightly lower than the 2011-2015 value used for the 2017 IRM Study, this decrease in forced outage rates had a negligible impact on the 2018 IRM (Table 6-1). Appendix A, Figure A.4 depicts NYCA EFORd trends from 2003 to 2016.

5.2.4 Emergency Operating Procedures (EOPs)

(1) <u>Special Case Resources (SCRs)</u>

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 represents 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 2017 registration. For the month of July, the forecast SCR value for the 2018 IRM Study base case assumes that 1,219 MW will be registered, with varying amounts during other months based on historical experience. The 2017 IRM Study had assumed a registered amount of 1,192 MW, 27 MW lower than that assumed for this 2018 IRM Study.

The SCR performance model is based on discounting registered SCR values to reflect historical availability. The SCR model used for the 2018 IRM Study is based on July 2017 performance data. SCR performance factors were determined from one-hour performance tests. The 2018 IRM Study used an Effective Capacity Value of 0.90 which resulted in a SCR model value of 867.6 MW with an overall effective performance of 71.2%. (refer to Appendix A, Section A.3.7 for more details). The number of SCR calls in the 2018 Capability Year for the 2018 IRM base case was limited to five (5) calls per month.

While the performance of the SCR program slightly increased from 70.6% in the 2017 IRM Study to 71.2% in this study, the amount of registered SCRs also increased. Downward pressure on the IRM, resulting from increased SCR performance, was outweighed by the upward IRM pressure caused by the increase in registrations. As a result, the updated SCR model had no impact on the IRM (Table 6-1).

The 2018 IRM Study determined that for the base case, approximately 8.6 SCR calls would be expected during the 2018 Capability 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 2018 IRM Study assumes that 16 MW of EDRP resources will be registered in 2018, 59 MW lower than the amount assumed in the 2017 IRM Study. The 2018 EDRP capacity was discounted to a base case value of only 3 MW to reflect past performance. This value is implemented in the study in July 2018 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 SCR and EDRP resources in the NYCA capacity model has the effect of increasing the IRM by 2.9% (Table 7-1, Case 5). This increase is 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, such as voltage reductions, as required, to avoid or minimize customer disconnections. Projected 2018 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 18.2% 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 2018 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 2018 IRM Study incorporates the confidential elections that these facility owners made for the 2018 Capability Year.

Updated UDR cable outage rates in the 2018 IRM Study increased the IRM by 0.1% compared to the 2017 IRM Study (Table 6-1).

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, Figure A.12. The transfer limits employed for the 2018 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 2018 IRM Study are listed in the Appendix A, Tables A.7 and A.8 and Figure A.13, 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 were 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 2018 IRM Study had no impact on the IRM compared to the 2017 IRM Study (Table 6-1).

As in all previous IRM studies, forced outage rates for overhead transmission lines were not represented in the 2018 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 2018 IRM could decrease by 2.0% (Table 7-1, Case 2).

The topology for the 2018 IRM Study features several changes from the topology used in the 2017 IRM Study. These changes fit into the following three general categories:

1. Changes to support the CPV Valley Energy Center.
2. Changes to support the NYISO-PJM Joint Operating Agreement.
3. Updates to certain interface limits throughout the Long Island Zone K.

These changes are described in detail in Appendix A, Section A.3.3.

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 2018 IRM Study base case for permitting emergency assistance to NYCA reduces the NYCA IRM requirements by 8.0% (Table 7-1, Case 1). This “reserve value of NYCA interconnections” compares to 8.3% in the 2017 IRM Study. The representation of neighboring control areas in the 2018 IRM Study was similar to the representation used in previous IRM studies. Further, this study incorporates a new model that limits emergency assistance, which is discussed later in this section. The assumptions for the Outside World Model included in the 2018 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, a rule from NYSRC Policy 5-12 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 2018 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' IRM can be no higher than that Area's minimum requirement.

In addition, NYSRC Policy 5-12 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. These zonal representations align with these Control Areas' own models that they use for their reserve margin studies.

The existing PJM-SENY group transfer limit is imposed to reflect internal constraints in both the PJM and NYCA systems. The transmission model in IRM studies up through and including the 2016 IRM Study allowed for the contractual delivery of 1,000 MW at Waldwick and PJM re-delivery of 1,000 MW at the Hudson and Linden interface ("PJM wheel"). The PJM wheel was discontinued in 2017 and has been replaced with changes in the NYISO-PJM Joint Operating Agreement for the 2018 IRM study.

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. In 2016, a concern was raised that calculated emergency transfer levels from neighboring control areas in prior GE-MARS studies may have been overstated compared to actual operating conditions. The concern is that a portion of the excess generation in the neighboring control areas, as identified by MARS as available to potentially provide emergency assistance, could actually be unavailable at the time when emergency assistance is needed by NYCA. In consideration of this concern, a study to examine issues related to the amount of emergency assistance that can be reasonably relied on was conducted by the NYISO in 2016. Building on the results of this study, ICS reviewed alternate models for representing emergency assistance. ICS determined that limiting total emergency assistance to a maximum of 3,500 MW (EA Limit), based on an analysis of total actual excess ten-minute operating reserves above required operating reserves in the four neighboring external areas, is appropriate.[8] Use of the EA Limit increased the IRM by 0.4% (Table 7-1, Case 8).

5.5 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 two TOs for their review. Also, certain confidential data are reviewed by two independent NYSRC consultants as required.

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 for the 2018 IRM Study input data is shown in Appendix A, Section A.4.

6. Parametric Comparison with 2017 IRM Study Results

The results of this 2018 IRM Study show that the base case IRM result represents a 0.1% increase from the 2017 IRM Study base case value. Table 6-1 compares the estimated

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[8] For more information about this analysis, refer to the NYSRC white paper, "MARS Emergency Assistance Modeling" at http://www.nysrc.org/reports3.html.

IRM impacts of updating several key study assumptions and revising models from those used in the 2017 IRM 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 0.1% IRM increase from the 2017 IRM Study. Table 6-1 also provides the reason for the IRM change for each study parameter from the 2017 IRM Study.

There are six parameter drivers shown in Table 6-1 that *increased* the 2018 IRM from the 2017 base case. Each of the following parameters increase the IRM by 0.1%; (1) new NYCA generating units; (2) NY topology updates; (3) new wind generation; (4) EFORd on UDR lines; (5) updated load forecast uncertainty; and, (6) updated load forecast.

One parameter driver—updated external control area models—*decreased* the IRM by 0.5%. The parameters in Table 6-1 are discussed under *Models and Key Input Assumptions*.

Table 6-1: Parametric IRM Impact Comparison – 2017 IRM vs. 2018 IRM Study

Parameter	Estimated IRM Change (%)	IRM (%)	Reasons for IRM Changes
2017 IRM Study – Final Base Case		**18.1**	
2018 IRM Study Parameters that increased the IRM			
New NYCA Generating Units	+0.1		New generation has lower availability than zonal average.
NY Topology Updates	+0.1		Cumulative effect of topology changes.
New Wind Generation	+0.1		Wind generation has relativity low availability.
UDR elections and line EFORs	+0.1		Increased EFORs on cable interfaces.
Updated NYCA LFU Models	+0.1		Increased load uncertainty in downstate LFU model.
Updated Load Forecast	+0.1		Upstate/downstate load unbalance.
Total IRM Increase	**+0.6**		
2018 IRM Study Parameters that decreased the IRM			
Updated External Control Area Models	-0.5		Neighboring area interface availability improvements.
Total IRM Decrease	**-0.5**		
2018 IRM Study Parameters that did not change the IRM			
Updated DMNC Rates	0		
NYPA Sales	0		
Non-SCR/EDRP EOPs	0		
Updated SCRs & EDRPs	0		
Updated Maintenance	0		
Updated Run of River	0		
Updated Generating Unit EFORd's	0		
Updated Cable Outage Rates	0		
New Wind Shapes	0		

Emergency Assistance Limit at 3500 MW	0		.
Net Change from 2017 Study		**+0.1**	
2018 IRM Study – Preliminary Base Case		**18.2**	

7. Sensitivity Case Study

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 in Table 7-1 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 9 – show 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 2018 Capability Year[9] on December 8, 2017. Appendix B, Table B-1 includes a more detailed description and explanation of each sensitivity case.

Generally, 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[10] until the NYCA LOLE approaches 0.1 days/year. In Cases 4 and 9 however, the changes occur in the upstate zones (Zones A-F) and a better sensitivity method is to add or remove capacity in zones A-F in order to return the LOLE back to 0.1 days/year. Because of the lengthy computer run time and manpower needed to perform a Tan 45 analysis in IRM studies,[11] this method was applied for only Case 6 in Table 7-1 and Case F in Table 7-2. It

[9] See Section 5 of Policy 5-12 for a description of the process the NYSRC Executive Committee uses to establish the Final IRM.

[10] With the following exceptions: (1) the "No Wind or Solar Capacity" sensitivity in Table 7-2 in which wind replacement capacity only occurs in Zones A-F.,

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

should be recognized, therefore, that some accuracy is sacrificed when a Tan 45 analysis is not utilized. Also, Cases 1, 6, and 8 started with the final base case instead of the preliminary base case. The reason for this base case change is that there were significant changes made in the Outside World topology models in the final base case that would affect the sensitivity case results for these cases.

Table 7-1: Sensitivity Cases – 2018 IRM Study[12]

Case	Description	IRM (%)	% Change from Base Case
0	**2018 IRM Base Case**	18.2	0
1	NYCA isolated	26.2	+8.0
2	No internal NYCA transmission constraints	16.2	-2.0
3	No load forecast uncertainty	11.0	-7.2
4	No wind capacity	14.5	-3.7
5	No SCRs and EDRP	15.3	-2.9
6	Without CPV Valley Energy Center (tan 45)	18.3	+0.1
7	Limit Emergency Assistance from PJM to NYCA to 1500 MW	18.2	0
8	Remove 3,500 MW Emergency Assistance Limit into NYCA	17.8	-0.4
9	Retire Selkirk and Binghamton BOP	18.3	+0.1

7.1 Impact of Increases of Renewable Resource Capacity on IRM Requirements

A study was conducted by ICS as part of the 2018 IRM Study to analyze the effect of a range of renewable resource penetrations on NYCA IRM requirements. Initiatives such as the state's Clean Energy Standard call for significant increases in renewable resources. Wind and solar generation would likely make up a majority of these future renewable capacity additions. The average performance or availability of these options is lower that of the present fleet of NYCA generating units and, therefore, would likely

[12] Table 7-2 shows additional sensitivity cases.

increase the IRM requirement. Questions have arisen as to the extent of the increases on the IRM as more and more wind and solar capacity enters into service in the NYCA.

Several cases that evaluate the effect on the IRM requirement for a range of wind and solar penetration levels are examined in this analysis. The analysis starts with the 2018 IRM Study base case (Case B) and hypothetically adds or subtracts different levels of wind and solar capacity in the 2018 Capability Year on top of existing base case generating capacity.

Table 7-2 depicts the results of the study.

Table 7-2: NYCA IRM for a Range of Renewable Resource Penetration Levels

Case	Total Wind Capacity MW	Total Solar Capacity MW	Total Wind and Solar MW	Total Wind and Solar UCAP MW[13]	Wind & Solar as a % of Total Required Capacity	IRM %
A – No wind or solar	0	0	0	0	0	14.5
B – 2018 IRM Study base case wind and solar capacity	1,733	32	1,765	280	4.5	18.2
C -- Add 2,000 MW of wind	3,733	32	3,765	594	9.3	22.7
D – Add 2,000 MW of solar	1,733	2,032	3,765	754	9.3	22.8
E – Add 2,000 MW of wind and 2,000 Mw of solar	3,733	2,032	5,765	1068	13.7	28.2
F – Add 2,000 MW of wind and 2,000 Mw of solar (tan 45)	3,733	2,032	5,765	1068	13.9	26.3

Study assumptions for this analysis relative to assumed wind and solar performance and location are shown on the NYSRC web site at: http://www.nysrc.org/pdf/MeetingMaterial/ICSMeetingMaterial/ICS_Agenda%20195/ICS_mtg195_windsolar_final.pdf.

7.2 Indian Point Reliability Assessment

[13] See Section 8 for UCAP discussion.

The NYISO is presently conducting an assessment that will determine whether there is a reliability need as a result of the currently planned retirement of Indian Point Energy Center Units 2 and 3 in 2020 and 2021, respectively. It is expected that the results of this assessment will be available by the end of December 2017.

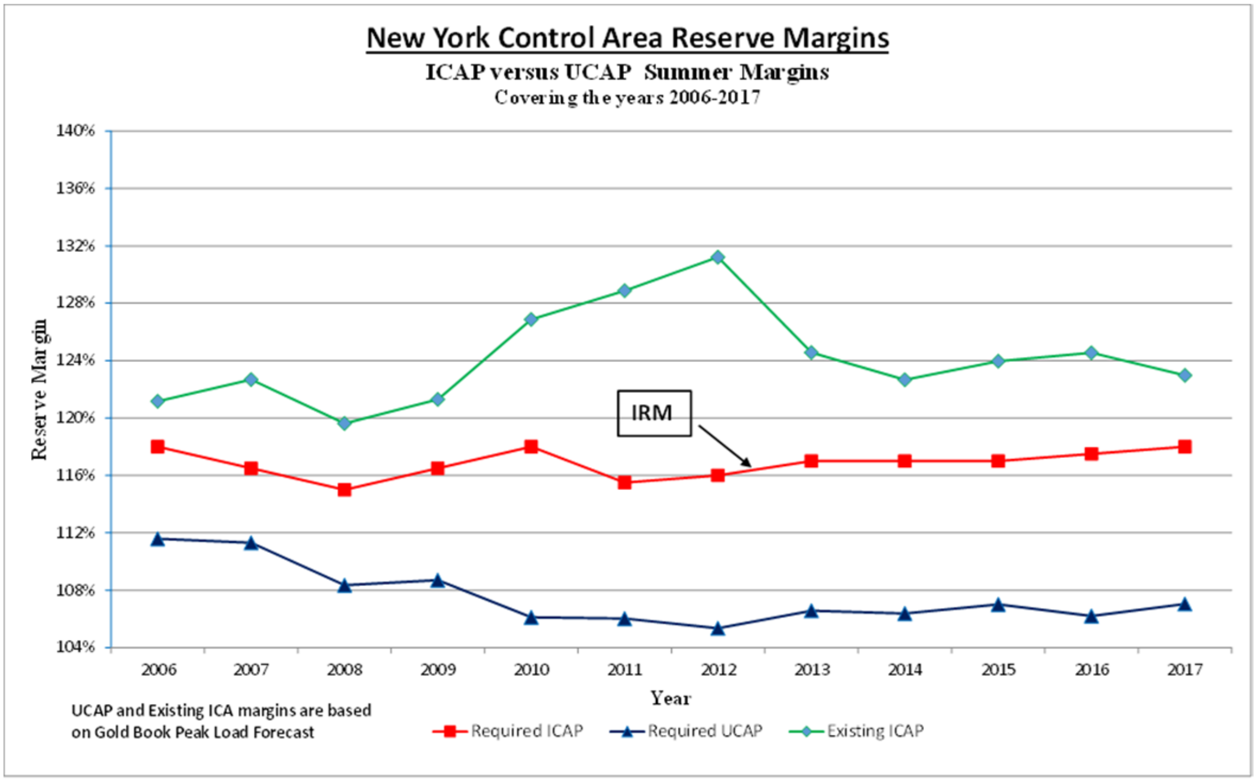
8. NYISO Implementation of the NYCA Capacity Requirement

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 7% since then. Appendix C provides details of the ICAP to UCAP conversion process used for this analysis.

Figure 8-1 NYCA Reserve Margins


New York Control Area Reserve Margins
ICAP versus UCAP Summer Margins
Covering the years 2006-2017
140%
136%
132%
128%
124%
120%
116%
112%
108%
104%
Reserve Margin
IRM
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
UCAP and Existing ICA margins are based
on Gold Book Peak Load Forecast
Required ICAP
Required UCAP
Existing ICAP