5. Models and Key Input Assumptions

This section describes the models and related base case input assumptions for the ~~2023~~ 2024 IRM Study. The models represented in the GE-MARS analysis include a *Load Model, Capacity Model, Transmission Model, and Outside World Model*. A *Database Quality Assurance Review* of the ~~2022~~ 2024 base case assumptions is also addressed in this section. The input assumptions for the final base case were approved by the Executive Committee on October ~~15~~13, ~~2021~~2023~~, except for the transfer capability of the Neptune Cable[1] which was revised and made part of the final base case following a Special Sensitivity analysis as per Policy 5-15.~~ Appendix A, Section A.3 provides more details of these models and assumptions and comparisons of several key assumptions with those used for this ~~2022~~ 2024 IRM Study.

5.1 The Load Model

5.1.1 Peak Load Forecast

The NYCA peak load forecast is based upon a model that incorporates forecasts of economic drivers, end use and technology trends, and normal weather conditions. A ~~2023~~ 2024 NYCA summer peak load forecast of 31,765.6~~32,246~~ MW was assumed in the ~~2023~~ 2024 IRM Study, ~~an increase~~a decrease of ~~107~~ 480.4 MW from the forecast used in the ~~2022~~ 2023 IRM Study. This "Fall ~~2023~~ 2024 Summer Load Forecast" was prepared for the ~~2023~~ 2024 IRM Study by the NYISO staff in collaboration with the NYISO Load Forecasting Task Force and presented to the ICS on October ~~5~~4, ~~2022~~2023. The ~~2023~~ 2024 forecast considered actual 2023~~2~~ summer load conditions.

The peak load forecast changes are shown on Table 5-1 below.~~, indicates an increase in peak loads in Zone J, while the peak loads for upstate zones (zones A-I) decline. The Zone K forecast level is similar to that from the 2022 IRM forecast, with slight decrease. The decrease in Zone A to I peak load forecast level is driven by a combination of lower experienced summer 2022 levels in some upstate areas, lower regional load growth projections in some areas, and an aggregate decrease in projected load levels for large load facilities. The increase in the Zone J forecast level is driven by higher experienced load levels; along with strong peak load growth projections driven by increased electric vehicles and appliance electrification drivers, decreased energy efficiency and storage peak reduction impacts, strong commercial and residential load growth, and a continued load recovery from the COVID-19 pandemic.~~ Relative to the 2023 IRM forecast, the load forecast for the 2024 IRM study has decreased in Zones A ~~thought~~through I, Zone J, and Zone K. Actual experienced and weather normalized peak load

~~[1] *See* footnote 3 page 3~~

levels in summer 2023 were generally lower than in recent years. The primary factors behind year over year load declines are the continued strong load-reducing impact of state policy incented energy efficiency programs, and behind-the-meter (BTM) solar installations. A secondary factor is slower ~~recent and forecast~~ economic growth relative to projections used for prior forecasts. In future years, electrification of vehicles and building appliances is expected to add to summer peak load levels. At this point, these positive load impacts are generally smaller than the load-reducing impacts of energy efficiency and BTM solar generation.

Table 5-1: Comparison of 202~~2~~3 and 202~~3~~4 Actual and Forecast Coincident Peak Summer Loads (MW)

	Fall 2023~~2~~ Forecast	2023~~2~~ Actual	2023~~2~~ Normalized[2]	Fall 2024~~3~~ Forecast	Forecast Change
	(a)	(b)	(c)	(d)	= (d) – (a)
Zones A-I	~~16,037~~15,828	~~14,511~~13,703	~~15,608~~15,114	~~15,828~~15,515	~~-209~~ -313
Zones J&K	~~16,102~~16,418	~~15,981~~15,020	~~16,167~~16,284	~~16,418~~16,251	~~+316~~ -167
NYCA	~~32,139~~32,246	~~30,492~~28,723	~~31,775~~ 31,398	~~32,246~~31,766	~~+107~~ -480

Use of the Fall ~~2023~~ 2024 Load Forecast resulted in ~~an~~an increase to the IRM ~~XX~~ ~~increase~~ compared to the ~~2022~~ 2023 IRM Study (Table 6-1).

5.1.2 Load Forecast Uncertainty

As with all forecasting, 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 load forecast uncertainty (LFU) of individual NYCA areas, separate LFU models are prepared for five areas: New York City (Zone J), Long Island (Zone K), Westchester (Zones H and I), and two rest of New York State areas (Zones A-E and Zones F-G).

[2] The "normalized" ~~2022~~ 2023 peak load reflects an adjustment of the actual ~~2022~~ 2023 peak load to account for the load impact of actual weather conditions, demand response programs, and municipal utility self-generation.

These LFU models are intended to measure the load response to weather at high peak producing temperatures. The LFU is based on the slope of load versus temperature, or the weather response of load. If the weather response of load increases, the slope of load versus temperature will increase, and the upper-bin LFU multipliers (Bins 1-3) will increase.

~~The new LFU multipliers included summer 2021 data, which was not included in prior LFU models. With the exception of Zone K, the load response to weather in 2021 was lower in magnitude than it was in previous hot summers. The slope of load versus weather has recently decreased, resulting in smaller LFU multipliers in the upper bins. This change has resulted in lower LFU impacts on the IRM than in previous years.~~ The new LFU multipliers include summer 2022 data, which was not included in prior LFU models. Zone F-J's response to weather in 2022 was lower in magnitude than it was in previous hot summers, while the magnitude is great in Zone A-E, and Zone K. This change has resulted in lower LFU impacts on the IRM than previous years.

A sensitivity case shows that the modeling of LFU in the ~~2023~~ 2024 IRM Study has an effect of decreasing IRM requirements by ~~8.2%~~5.1% (Table 7-1, Case 3), as compared to a range of ~~7.2%~~7.6% to 9.1% in the previous five IRM studies. Also, the new LFU model resulted in a ~~0.6%~~0.14% reduction in the IRM – see Table 6-1: Parametric IRM Impact Comparison – ~~2022~~ 2023 IRM Study vs. ~~2023~~ 2024 IRM Study page 21.

Commented [BP1]: Note -might differ

5.1.3 Load Shape Model

The GE-MARS model allows for the representation of multiple load shapes. This feature has been utilized since the 2014 IRM study and was again utilized for the ~~2023~~ 2024 IRM Study. This multiple load shape feature enables a different load shape to be assigned to each of seven load forecast uncertainty bins.

~~For the 2023 2024~~Starting ~~in~~with the 2023 IRM study, a combination of load shape years 2013, 2017, and 2018 were selected by ICS as representative years, as recommended under the LFU Phase 2 Study.[3] ~~This is a change from the 2022 IRM study where 2002, 2006, and 2007 were utilized as representative years. The load shape curves were reviewed as part of the 2023 IRM Study to ensure that the curves being utilized most accurately represent the expected load shapes for the seven load forecast uncertainty bins moving forward. NYISO, as part of its load shape review,~~ The LFU Phase 2 Study recommended updating Bin 1 from 2006 to 2013, Bin 2

Commented [YH2]: To Gary: ensure to update all the foot note references.

[9] https://www.nysrc.org/wp-content/uploads/2023/05/A.I.10-LDC_Recommendation_ICS4098.pdf~~https://www.nysrc.org/PDF/MeetingMaterial/ICSMeetingMaterial/ICS%20Agenda%20259/A.I.10-LDC_Recommendation_ICS[4098].pdf~~

from 2002 to 2013, Bins 3 and 4 from 2007 to 2018, and Bins 5, 6, and 7 from 2007 to 2017. The recommendation ~~to change the bin structure was adopted by ICS and implemented for the final base case of the 2023 2024 IRM study~~~~has been~~ was adopted in the base case of the 2023 IRM study and is ~~consistently~~ also applied in the 2024 IRM study, with ~~.~~

~~The load shape for the year 2018 was selected to represent average summer peak day weather. The load shape for the year 2017 was selected to represent a flatter load shape typical of a cooler than normal summer. The load shape for the year 2013 was selected to represent a steeper load shape typical of a hotter than normal summer.~~ t~~T~~he 2013, 2017, and 2018 load shapes ~~were~~ being adjusted to account for the expected ~~2023~~ 2024 BTM Solar penetration level.

~~The load duration curve review was the second phase in a multiyear study that includes an extensive load shape and load forecast uncertainty review. The third phase in the load forecast uncertainty modeling review will focus on issues that should become more critical in the future, such as the NYISO trend toward a winter peaking system, increased focus on extreme weather assumptions and scenarios due to climate change, and increased load variability and evolving shapes due to increasing levels of BTM Solar. The third phase is anticipated to be completed prior to the 2024 IRM study.~~ The NYISO will focus on model-based synthetic load shapes reflecting expected load patterns in the future, as well as dynamic winter LFU development, and BTM Solar modeling improvement, with the goal of implementation in future IRM studies.

5.2 The Capacity Model

5.2.1 Conventional Resources: Planned New Capacity, Retirements, Deactivations, and Behind the Meter Generation

Planned conventional generation facilities that are represented in the ~~2023~~ 2024 IRM Study are shown in Appendix A, Section A.3~~.4~~. 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.

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There are no new thermal/conventional units planned in the 2024 IRM study. One wind unit~~,~~ (*i.e.*, Western New York Wind Power~~,~~) was previously modeled at 0 MW and is retired in study

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period for the 2024 IRM Study. No additional retirement is projected in the 2024 IRM study compared to the assumptions for the 2023 IRM Study. However, a number of units plannedthat were previously anticipated to be deactivateddeactivate due to the May 1, 2023 requirements of the 2023 Peaker Rules New York State Department of Environmental Conservation (DEC) regulations limiting NOx emissions for simple cycle turbines (Peaker Rule) hadhave confirmed their intent to continue their operations beyond June 2024. These units, totaling 140.1 MW, were removed from the 2023 IRM study and , but have been reinstated in the 2024 IRM sStudy., and 1205.2 MW of projected retirement. The significant amount of retirement is driven by the first phase of compliance obligations under the New York State Department of Environmental Conservation ("DEC") regulation to limit NOx emissions from simple cycle combustion turbines ("the Peaker Rules").

A behind-the-meter-net-generation ("BTM:NG") program resource, for the purpose of this study, contributes its full capacity while its entire host load is exposed to the electric system. Several BTM:NG resources with a total resource capacity of at least 220387.1 MW and a total host load of 157.5148.8 MW, are included in this 2023 2024 IRM sStudy. The full resource capacity of these BTM:NG facilities is included in the NYCA capacity model, while their host loads are included in the NYCA 2023 2024 summer peak load forecast used for this study.

The NYISO has identified several state and federal environmental regulatory programs that could potentially impact operation of NYS Bulk Power System. The NYISO analysis concluded that these environmental initiatives would not result in NYCA capacity reductions or retirements that would impact IRM requirements during the summer of 20232024. The analysis further identified those regulations that could potentially limit the availability of existing resources, and those that will require the addition of new non-emitting resources. For more details, see Appendix B, Section B.2.

5.2.2 Renewable Resources

Intermittent types of renewable resources, including wind and solar resources, are becoming an increasing component of the NYCA generation mix. These intermittent resources are included in the GE-MARS capacity model as described below. These resources, plus the existing 4,750 MW of hydro facilities, will account for a total of 7413 7,660 MW of NYCA renewable resources represented in the 2023 2024 IRM Study.

It is projected that during the 2023 2024 summer period there will be a total wind capacity of 2351.12,502.3 MW participating in the capacity market in New York State. This represents an increase in available wind resources of 539.3136 MW and reflects the addition of five two new offshore wind resources. ~~All wind farms are presently located in upstate New York in Zones A-E.~~

GE-MARS allows the input of multiple years of wind data. This multiple wind shape model randomly draws wind shapes from historical wind production data. The ~~2023~~ 2024 IRM Study used available wind production data covering the years ~~2017~~ 2018 through ~~2021~~2022. For any new wind facilities, zonal hourly wind shape averages or the wind shapes of nearby wind units will be modeled. As the offshore wind resources are new to the NYCA system, no historical production data is available. The NYISO obtained a consultant to develop synthesized historical offshore wind production profiles[4] based on the historical weather conditions in the areas along New York's shoreline. These synthesized production profiles covered the period between 2000-2021. The two new offshore wind resources in the 2024 IRM ~~s~~Study are modeled using the synthesized offshore wind production profiles for 2017 ~~to~~through 2021. In order capture the weather correlation between the offshore wind and the rest of the intermittent resources in GE-MARS simulation, the 2018-2021 offshore profiles are grouped with the same period as other intermittent resources, and the 2017 offshore profile is grouped with the 2022 intermittent profiles.

Overall, inclusion of the projected ~~2351.1~~2502.3 MW of wind capacity in the ~~2023~~ 2024 IRM Study accounts for ~~6.1~~7.2% of the ~~2023~~ 2024 IRM requirement (Table 7-1, Case 4). This relatively high IRM impact is a direct result of the wind facilities low-capacity factor 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." For wind units, a detailed summary of existing and planned wind resources is shown in Appendix A, Table A.9.

Land Fill Gas (LFG) units account for ~~97.7~~103.3 MW and are included in the above total.

For the ~~2023~~ 2024 IRM study, ~~there were nowas~~ 90 MW of utility level solar generation additions are included. The total NYS Bulk Power System (BPS) solar capacity in the 2024 IRM Study is ~~214.4~~304.4 MW. Actual hourly solar plant output over the ~~2017-21~~2018-2022 period is used to represent the solar shape for existing units, while new solar units are represented by zonal hourly averages or nearby units.

5.2.3 Energy Limited Resources

~~In 2019, the NYISO filed, and in 2020 FERC approved tariff changes that became effective May 1, 2021 enhancing the ability of duration limited resources to participate in the NYISO markets.~~

[4] Offshore Production Profiles: https://www.nyiso.com/documents/20142/36079056/4%20NYISO_OffshoreWind_Hourly_NetCapacityFactor.xlsx/dc15cb6a-b6fc-6a6a-e1d0-467d5c964079

~~These rules allow output limited resources to participate in the markets consistent with those limitations and requires owners of those resources to inform the NYISO of their elected energy output duration limitations by August 1st for the upcoming capability year (i.e., August 1, 2021 for the Capability Year beginning on May 1, 2022).~~

~~To accommodate this new classification of resources, the 2021 IRM study adopted the simplified modeling approach by which Energy Limited Resources (ELR) units were dispatched at pre-determined output levels. Due to the lack of flexibility of the simplified approach, the NYISO and GE developed the dynamic ELR functionality within the GE-MARS program and recommended in the ELR Whitepaper[5] the TC-4C configuration which was tested with sensitivity cases in the 2022 IRM Study. In this 2023 IRM, an enhanced TC-4C configuration, which allowed more flexibility by modeling the energy limitation on a monthly basis, was tested in the Preliminary Base Case sensitivity and this dynamic ELR functionality was then adopted into the Final Base Case.~~

~~In general, the dynamic ELR functionality has an impact of lowering the IRM in a range between 0.8% and 0.5%, as compared to the simplified fixed-output approach. Compared to the simplified approach, the dynamic ELR functionality also has an impact on reducing the SCR calls during the emergency operating procedures (EOP), which will be discussed further in Section 5.2.5 – Emergency Operating Procedures.~~

~~x~~

Based on the FERC approved NYISO tariff, Energy Limited Resources (ELR) units started to participate in the NYISO markets in 2021. The NYSIO and GE developed the dynamic ELR functionality within the GE-MARS program and the recommended TC4C configuration in the ELR Whitepaper.[6]~~.~~ The recommended modeling would reduce the IRM and lower the Special Case Resource (SCR) program activation as compared to a fixed output profile modeling approach, and it was adopted in the Final Base Case in the 2023 IRM ~~s~~Study. The TC4C configuration contains a static time period limitation for the output from the ELR units. Starting with the 2024 IRM Study, a process is recommended to update the time period of the output limitation on an annual basis, based on the beginning of the 90% LOLE risk period from previous year's IRM Final Base Case (FBC). In the 2024 IRM ~~s~~Study, output from the ELRs will be available starting Hour Beginning 14, which is the beginning of the 90% LOLE risk window from the 2023

~~[5] The ELR Whitepaper can be found on the NYSRC website: https://www.nysrc.org/PDF/Reports/IRM%20White%20Papers/ELR%20Modeling%20White%20Paper%20May%202021%20FINAL.pdf~~

[6] The ELR Whitepaper can be found on the NYSRC we https://www.nysrc.org/wp-content/uploads/2023/03/ELR-Modeling-White-Paper-May-2021-FINAL.pdf

IRM FBC. This process aims to keep the ELR output limitation in close proximity to the period with the highest LOLE risk and the annual update process could have, if any, a small reduction on the IRM on a year-over-year basis.

5.2.4 Generating Unit Availability

Generating unit forced and partial outages are modeled in GE-MARS by inputting a multistate outage model that represents an equivalent demand forced outage rate ~~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 2024~~3~~ IRM Study covered the 2018~~7~~-2022~~1~~ period.

The weighted average five-year EFORd calculated for generating units ~~calculated for units~~ in Zones A~~G~~-I, ~~J~~ and K for the 2018~~7~~-22~~1~~ period is ~~lower~~higher than in the 2017~~6~~-2021~~0~~ ~~average value~~ period, which were used ~~for~~ in the 2023~~2~~ IRM Study. The~~is~~ ~~decrease~~ overall NYCA wide weighted average EFORd in the 2024 IRM ~~s~~Study is therefore higher than the 2023 study, and the increase in average forced outage rates ~~lowers~~ raises the IRM by 0.3% (Table 6-1). Appendix A, Figure A.5 depicts NYCA and Zonal five-year average EFORd trends from 2015~~4~~ ~~to~~through 2022~~1~~.

5.2.5 Emergency Operating Procedures (EOPs)

~~In modeling of duration limited resources for 2021 IRM Study, the need for SCR resources increased to 170.1 days (probabilistic expected value) from the 2020 value of 8.2 days.~~ In the 2022 IRM Study, the need for SCR resources was reduced to 38 days (probabilistic expected value) by redistributing the operating reserves and removing maintenance outside of the summer season. In the 2023 IRM Study, the need for SCR resources was further reduced to 6.9 days, due to the increased West Central Reverse Limit ~~was increased~~ from 1600 MW to 2275 MW based on the updated Summer 2022 Operating Study. The increased limit substantially reduced the need for SCR activation as more MW can flow into Zone A and B where most of the SCRs activations were triggered. In the 2024 IRM ~~s~~Study, the need for SCR resources has a slight increase to 8.1 days compared to the 2023 IRM Study, driven by the updated allocation of operating reserves, due to the in-service of the AC Transmission Project.

~~In addition, the adoption of the dynamic ELR modeling, which increases the flexibility in utilizing the energy limitations of the ELR units, further lowered the need for SCR resources. Therefore,~~

the updated West Central Reverse Limit and the adoption of the dynamic ELR modeling reduced the SCR activations to XX days per year, which is consistent with the historical level. (

(2) (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 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 2022 2023 registration. For the month of July, the forecast SCR value for the 2023 2024 IRM Study base case assumes that 1,2251,281 MW will be registered, with varying amounts during other months based on historical experience. This is 61 56 MW higher than that assumed for the 2022 2023 IRM Study.

As indicated above, the number of SCR calls in the 2023 2024-2025 Capability Year for the 2023 2024 IRM base case was limited to five calls per month.

The SCR performance model is based on discounting registered SCR values to reflect historical availability. The SCR model used for the 2023 2024 IRM Study is based on a recent analysis of performance data for the 2012-20212012-2022 period. This analysis determined a SCR overall performance factor of 69.970.0%. This is 0.30.1% higher than the performance factor used in the 2022 2023 IRM Study (refer to Appendix A, Section A.3.9 for more details). Although both the overall SCR participation and performance factor improved compared to the level assumed in the 2022 Study, an increase in participation level in Zone J and a decline in performance factor in Zone K had an offsetting effect and therefore the updated SCR model had a minor impact on system reliability. All areas saw an increase in participation level, but the performance factor decreased for Zone A-F and Zone G-I, and therefore the updated SCR model had a minor impact on system reliability.

Incorporation of SCR in the NYCA capacity model has the effect of increasing the IRM by 2.93.1% (Table 7-1, Case 5). This increase results from the lower overall availability of SCR compared to the average statewide resource fleet availability.

(2) Other Emergency Operating Procedures

In addition to SCR, the NYISO will implement several other types of EOP steps, such as voltage reductions, as required, to avoid or minimize customer disconnections. Projected 2023 2024 EOP capacity values are based on recent actual data and NYISO forecasts.

For the 2024 IRM sStudy, the NYISO implemented an additional set of topology limits to constrain Eemergency Aassistance in the IRM simulation, during severe and extreme

Formatted: Numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 2 + Alignment: Left + Aligned at: 0.5" + Indent at: 0.81" conditions. The limit has been updated to vary by LFU bin. The Recommendation from the NYISO considered the extra reserves that are available in the external control areas, and the areas' required reserve by load level (see section 5.4).

In the 2023 IRM Study, the The NYISO also implemented the modeling change to maintain 350 400 MW of 10-min operating reserve during any load shedding event. This modeling change reflects the need to protect the bulk power system against volatility during emergency operation at the time of load shedding.. [7] Maintaining 350 MW of 10-min operating reserve has the effect of increasing the IRM by 1.5% (Table 7-1, Case 7), as a reduced amount of 10-min operating reserve is made available during the EOP step.

Refer to Appendix B, Table B.2 for projected EOP frequencies for the 2023 2024-2025 Capability Year assuming the xx23.1% base case IRM.

Commented [GB4]: Confirm value. Is this prior to the most recent updates to be presented at the 11/1 ICS?

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5.2.6 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 when coupled with a non-locational ICAP Supplier. The owners of the UDRs elect whether they will utilize their capacity deliverability rights. This decision determines how UDR 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.

The following facilities are represented in the 20243 IRM Study as having UDR capacity rights: LIPA's 330 MW High Voltage Direct Current (HVDC) Cross Sound Cable (CSC), LIPA's 660 MW HVDC Neptune Cable,[8]; and the 315 MW Linden Variable Frequency Transformer (VFT). 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 capacity requirements. The 20234 IRM Study incorporates the confidential elections that these facility owners made for the 20234-2025 Capability Year. The Hudson Transmission Partners 660 MW HVDC Cable (HTP) has been granted UDR rights but has lost its right to import capacity and therefore is modeled as being fully available to support emergency assistance.

UDRs, along with other cables captured in the IRM study are modeled with outage rate based on the average performance of their past 5-year's history. In the 2024 IRM sStudy, the cable

[7] The recommendation of maintaining OR at load shedding was presented at the 5/4 ICS meeting: https://www.nysrc.org/PDF/MeetingMaterial/ICSMeetingMaterial/ICS%20Agenda%20260/Operating_Reserve_Recommendation_ICS05042022_V4_Updated[4867].pdf

[8] *See* footnote 3 page 3

performance for 2018-2022 is used to develop the outage rate assumptions. Aggregated cable outage rate is reduced from 7% to 4.5% ~~this year~~for the 2024 IRM Study and the aggregated statistics cover the facilities of CSC, Neptune, VFT, HTP, Dunwoodie South, Y49/Y50, Norwalk Northport, A Line, and Jamaica Ties.

Commented [YH5]: I checked the calculation and these should be the complete list. Calculation spreadsheet is located here: \\hpcfs1.ad.aws1.nyiso.com\HPCCloud-Capacity\IRM\IRM24_data\PBC\Assumptions Matrix

I then notice that the original wording was from the AM - so we should keep in mind for updating AM in the future.

5.3 The Transmission Model[9]

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 relevant transfer limits, is depicted in Appendix A, Figure A-10. The transfer limits employed for the ~~2023~~ 2024 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 for this IRM Study topology.

The transmission model assumptions included in the ~~2023~~ 2024 IRM Study are listed in Table A.10 in the Appendix which reflects changes from the model used for the ~~2022~~ 2023 IRM Study. These topology changes are as follows:

In service of Segment B of AC Transmission Project, but with delay in the construction of Dover PAR

- Central East voltage collapse limit increases from 2654 MW to 3885 MW; dynamic limits are also increased by the similar amount.
- Central East + Marcy Group limit is increased from 4260 MW to 5590 MW; dynamic limits are also increased by similar amount.
- UPNY-ConED limit increases from 6675 MW to 7050 MW.
- UPNY/SENY limit increases from 5250 MW to 7150 MW and dynamic limits are removed. However, ~~D~~due to the delay of the construction of Dover PAR, a reduction to this limit increase is modeled. To account for this delay, ~~the UPNYSENY transfer limit will be impacted by~~ a conservative reduction of up to 750 MW~~,~~ from the 7150 MW limit for the UPNY/SENY is assumed for the 2024 IRM Study. Various scenarios of the UPNY/SENY transfer limit reduction have been tested and it was concluded that the transfer limit reduction on UPNY/SENY is not expected to impact the 2024 IRM ~~s~~Study results.

[9] The transmission model is discussed in Appendix A Section 3.5

Update to Dysinger East and Zone A Group Limits

- Dysinger East limit ~~is reduced~~decreased from 2200 MW to 2100 MW.
- Zone A group limit ~~is reduced~~decreased from 2650 MW to 2500 MW.

Update to various Zone K Transfer Limits:

- Jamaca Ties import limit decrease~~s~~d from 320 MW to 305 MW.
- ConEd-LIPA import limit decrease~~s~~d from 1613 MW to 1598 MW.
- ConEd-LIPA export limit increase~~s~~d from 135 MW to 170 MW.
- Y49/Y50 export limit increase~~s~~d from 420 MW to 460 MW.
- LI West export limit increase~~s~~d from 49 MW to 84 MW.

~~***UPNY-ConED Interface Limits***~~

- ~~Series reactors M51 & M52 and Dunwoodie 71 and 72 will change from bypassed to in service starting 2023~~
- ~~Zone G to Zone H transfer limit decreases to 6675 MW from 7000 MW~~

~~***West Central Reverse Limit***~~

- ~~The thermal ratings on the limiting circuit segments are increased due to the local upgrades by the Transmission Owners~~
- ~~Zone C to Zone B transfer limit increases to 2275 MW from 1600 MW~~

~~***Central East and Central East + Marcy Group Limits***~~

- ~~Updated Central East Voltage Collapse Limit captures the impact from the construction of Segment A Project (of AC Transmission Project)~~
- ~~Central East forward limits (Zone E to Zone F) are reduced based on the associated dynamic limit conditions as shown in Table A.10 in Appendix A~~
- ~~Proportional derates are applied to Central East + Marcy Group forward limits (Zone E to Zone G) as shown in Table A.10 in Appendix A~~
- ~~Associated decreases are also applied to Zone E to Zone F dynamic limits~~
- ~~Zone E to Zone G normal transfer limit decreases to 4260 MW from 4515 MW~~

- Associated decreases are also applied to Zone E to Zone G dynamic limits

Restoration of Neptune UDR Import Limit

- The import limit from the Neptune UDR was reduced to 330 MW in the 2022 IRM study due to the extended outage on the transformer named "NEWBRDGE_345_138_BK_1". The transformer is expected to return to service during the 2023 Capability Year and therefore the import limit from the Neptune UDR is restored to the full 660 MW in the 2023 IRM study.

Update to Zone K export limits

- Export limits from Zone K (Y49/Y50, ConED-LIPA and LI-WEST) are reduced due to the anticipated retirement of Trigen and the derate on 138-291
- Y49/Y50 forward limit reduced to 420 MW from 515 MW
- ConED-LIPA forward limit reduced to 135 MW from 220 MW
- LI-WEST forward limit reduced to 49 MW from 134 MW

Update to Ontario import limits

- The outage impacting phase shifters L33/34P is expected to end by summer 2023, restoring the transfer limits between IESO and NYCA. See Table A.10 in Appendix A

Forced transmission outages based on historical performance are represented in the GE-MARS model 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 were calculated based on the probability of occurrence from the historic failure rates and the time to repair. Transition rates into the different operating states for each interface were calculated based on the circuits comprising each interface, including failure rates and repair times for the individual cables, and for any transformer and/or phase angle regulator associated with that cable.

The Transmission Owners (TOs) provided updated transition rates for their associated cable interfaces. Updated cable outage rates assumed in the 2023 2024 IRM Study resulted in a 0.6% increase in the IRM compared with the 2022 2023 IRM Study (Table 6-1).

As in all previous IRM studies, forced outage rates for overhead transmission lines were not represented in the 2023 2024 IRM Study. Historical overhead transmission availability was evaluated in 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 NYC (Zone J) and LI (Zone K). To illustrate the impact of transmission constraints on the IRM, if internal NYCA transmission constraints were eliminated, the required ~~2023~~ 2024 IRM could decrease by 2% (Table 7-1, Case 2).

The 2024 IRM ~~s~~Study included a modeling change to limit ~~E~~emergency ~~A~~assistance during severe and extreme conditions from neighboring jurisdictions by implementing additional topology limitations between each of the external areas and NYCA. Such topology limitations do not reflect the real constraints on the transmission system, but rather, represent a means to reduce potential MW flow into NYCA at EOP steps during the GE MARS simulation. More details on this modeling change are discussed in section 5.2.5.

5.4 The Outside World Model

The Outside World Model consists of four interconnected Outside World Areas contiguous with NYCA: Ontario, Quebec, New England, and the PJM Interconnection (PJM). NYCA reliability is improved and IRM requirements can be reduced by recognizing available emergency assistance (EA) from these neighboring interconnected control areas, in accordance with control area agreements governing emergency operating conditions.

For the ~~2023~~ 2024 IRM Study, two Outside World Areas, New England and PJM, are each represented as multi-area models—*i.e.,* 14 zones for New England and five zones for the PJM Interconnection. Another consideration for developing models for the four Outside World Areas is to recognize internal transmission constraints within those areas that may limit EA into the NYCA. This recognition is explicitly considered through direct multi-area modeling of well-defined Outside World Area "bubbles" and their internal interface constraints. The model's representation explicitly requires adequate data in order to accurately model transmission interfaces, load areas, resource and demand balances, load shapes, and coincidence of peaks, among the load zones within these Outside World Areas.

In 2019, the ICS conducted an analysis[10] of the IRM study's Outside World Area Model to review its compliance with a NYSRC Policy 5 objective that "interconnected Outside World Areas shall be modeled to avoid NYCA's overdependence on Outside World Areas for emergency

[10] *See Evaluation of External Area Modeling in NYCA IRM Studies*, for a description of this analysis, at http://www.nysrc.org/reports3.html

assistance.". This analysis resulted in a change in the methodology to scale loads proportional to excess capacities in each load zone of each Outside World Area to meet the LOLE criterion and the Control Area's minimum IRM requirement, as well as the implementation of global Emergency Assistance (EA) limit of 3500 MW. For the past IRM studies, such EA assumption hasve reduced IRM requirements by aboutapproximately 6.2% (Table 7-1, Case 1).

Commented [BP6]: Based on the PBC without the new EA model

Commented [BP7R6]: 6.2% is without the EA model. It would be 7 with the new model

For the 2024 IRM sStudy, an EOP whitepaper[11] was conducted and the whitepaper concluded that further refinement of the that the previous EA assumptions were too optimistic would improve the reasonableness of expectations for availability of EA. Additional topology limits to constraint EabyEA by LFU bins in the IRM study were recommended. In the 2024 IRM sStudy, the 3,500 MW EA limit was modified as follows: LFU Bin 1: 1,470 MW; LFU Bin 2: 2,600 MW; LFU Bin 3-7: 3,500 MW. These limits were also implemented on each of the external Control Areas, based on historical extra reserves available in these Contral Areas during NYCA peak load periods, which to better reflect potential support that external Control Areas can provide when New York is in need. Utilizing these new limits would for the 2024 IRM Study increases the IRM by 2% (Table 7-1, Case 6a). These EA limits will be reviewed and updated on an annual basis, withincluded updated extra reserves data from the external Control Areas.

Representing Outside World Area interconnection support in IRM studies significantly reduces IRM requirements. For the previous seven IRM studies, EA has reduced IRM requirements in the range of 6.9 to 8.7%.[12]

In 2019, the ICS conducted an analysis of the IRM study's Outside Area Model to review its compliance with a NYSRC Policy 5 objective that "interconnected Outside World Areas shall be modeled to avoid NYCA's overdependence on Outside World Areas for emergency assistance." This analysis resulted in a change in the methodology to scale loads proportional to excess capacities in each load zone of each Outside World Area to meet the LOLE criterion and the Control Area's minimum IRM requirement. The ICS used this new model in the current study (2022) as well as in the 2021 IRM Study.[13]

During the 2023 Capability Year, Hydro-Quebec is expected to wheel 300 MW of capacity through NYCA to New England. In addition, the 2023 IRM study continues to limit the EA assistance to a maximum of 3,500 MW as applied in the previous four IRM Studies[14].

[11] EOP Whitepaper: *****LINK****

[12] *See* 2015 to 2022 IRM Study reports at www.nysrc.org/reports3.html.

[13] *See Evaluation of External Area Modeling in NYCA IRM Studies*, for a description of this analysis, at http://www.nysrc.org/reports3.html

[14] The 2018 IRM Study report, pages 17-18, describes this EA limit and its derivation. See www.nysrc.org/reports3.html.

Utilizing the improved Outside Area Model, while including the Hydro-Quebec wheel to New England and continuing to represent the 3,500 MW EA limit described above, reduces the NYCA IRM by 7.6% (Table 7-1, Case 1). This is 1% less than the impact determined in the 2022 IRM Study.

5.5 Database Quality Assurance Review

It is critical that the database used for IRM studies undergo sufficient review in order to verify its accuracy. The NYISO, General Electric (GE), and two New York Transmission Owners 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 Transmission Owners for their review. Also, certain confidential data are reviewed by two of the NYSRC consultants as required.

The NYISO, GE, and Transmission Owner reviews found a few minor data errors, with no material effect on IRM requirements no errors with the data 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 2023 2024 IRM Study input data is shown in Appendix A, Section A.4.