New York ISO
Independent System Operator

IRM/LCR Overview

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3/18/2020 Carnegie Electricity Industry Center Lecture

Intro

- The following slides are an overview of the New York Control Area (NYCA) Installed Reserve Margin (IRM) study and Locational Minimum Installed Capacity (LCR) study
- The purpose of these annual studies is to determine the minimum Installed Capacity Requirements for New York State for the upcoming "capability year"

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Installed Capacity Market

- **Purpose: Ensures resource adequacy, recovers portion of fixed cost, and acts as market signal for investment**
  - Determines Amount of Installed Capacity Required: Peak load forecast/ Installed Reserve Margin/ Reliability Standards
  - Values Excess Installed Capacity available
  - Determines amount of Installed Capacity suppliers are qualified to offer: Unforced Capacity
  - Determines amount of minimum capacity obligation to be procured: Unforced Capacity/ Installed Capacity incorporating the forecasted peak load for each Load Serving Entity, Statewide Outage Rate
- **Components: The NYISO, Load Serving Entities, ICAP Suppliers**
- **Structure: Capability Period auctions (6 month strip), Monthly Auction, Spot Market Auction, and Bilateral Transactions**

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Resource Adequacy Annual Processes

- Conduct the IRM study (February – December)
- Conduct the LCR study (October – January)
- Conduct the Import Rights study (January – February)

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Installed Capacity Requirement

- Determined by the product of the reserve margin and the annual peak load
- Set annually in the year preceding the Capability Year
  - Example: Study performed in 2019 for 2020 Capability Year covering May 1, 2020 - April 30, 2021

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Installed Reserve Margin Study

Installed Reserve Margin (IRM) Study

- **Installed Capacity above firm system demand required to provide for equipment forced and scheduled outages and transmission capability limitations so that Loss of Load Expectation (LOLE) does not exceed more than 1 day in 10 years (0.1 days/year)**
- **Based on regulatory standards by:**
  - North America Electric Reliability Corporation (NERC)
  - Northeast Power Coordinating Council (NPCC)
  - Resource Adequacy Design Criteria
  - New York State Reliability Council (NYSRC) reliability rules
- **Established annually by New York State Reliability Council (NYSRC) for upcoming capability year (May 1 - April 30)**

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Procedures

- **Probabilistic approach: calculating the probabilities of generator unit outages in conjunction with load and transmission representations**
  - General Electric's Multi-Area Reliability Simulation (GE-MARS)
- **Result of calculation is Loss of Load Expectation (LOLE) in days/year and hours/year & Loss of Energy Expectation (LOEE in MWh/year)**

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MARS

- Includes detailed load, generation and transmission representation for 11 NYCA Load Zones and 4 external Control Areas (Ontario, New England, Quebec and PJM Interconnection)
- Basis formed by sequential Monte Carlo simulation
  - Sequential allows for calculation of time-correlated measures, e.g. Frequency (outages/year) & duration (hours/outage)

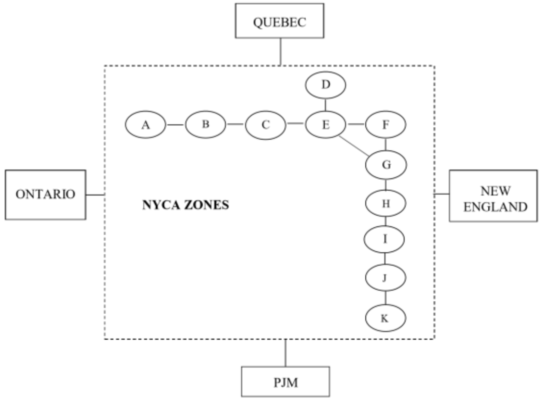

Figure 3-1: Simplified MARS Representation of NYCA Zones & External Control Areas

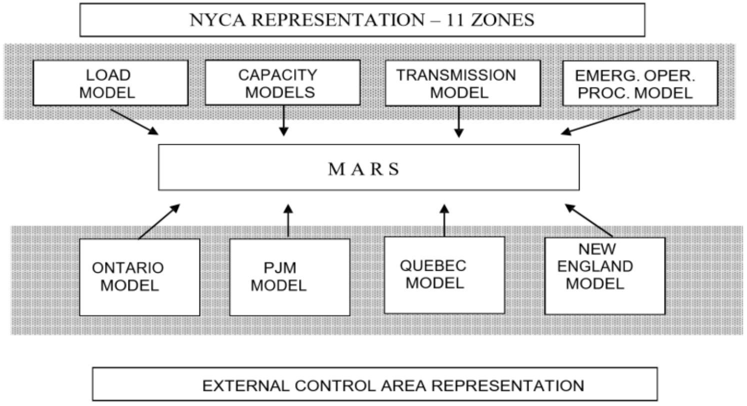

Figure 2-1: Relationship between MARS and the Models Used in the IRM Requirement Calculation Process

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Monte Carlo Simulation

- **Uses repeated sampling to obtain statistical properties of some phenomenon**
- **Technique used to understand the impact of risk and uncertainty in prediction and forecasting models**
  - Used in IRM calculations to produce the “Loss of Load Expectation” (LOLE) statistic → a measure of system reliability
    - Quantified by state transition rates to describe the random forced outages of thermal units; it is recognized that a unit’s capacity state in any given hour is dependent on a given state in previous hours and influences its future hours

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Analsis

- **Preliminary Base Case**
  - Starts with previous year's final base case
  - Inputs each parameter change one by one and reviews simulation to confirm reliability impact of each change is reasonable/ explainable ("parametric analysis")
    - Parametric results show incremental IRM change for each parameter
  - Incorporates preliminary peak load forecast
  - Used to conduct sensitivity studies
- **Final Base Case**
  - Used to calculate final IRM
  - Includes updates approved by ICS that have been added on since preliminary base case
  - Incorporates any sensitivity cases adopted by the NYSRC
  - Prepared following the NYISO's fall load forecast

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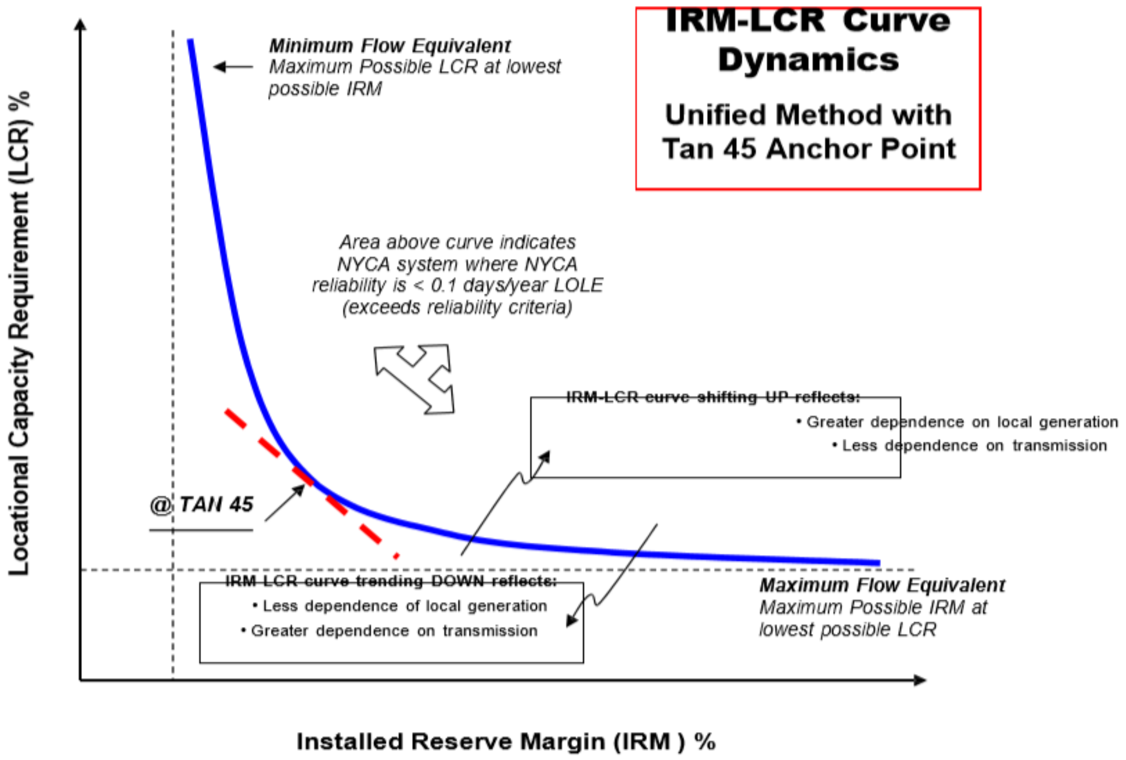
Analysis, *continued*

- **Unified Method**
  - Procedure to develop statewide IRM vs. LCR curves
  - 2 Zones for which this is applied: New York City & Long Island → capacity is removed from Zones with excess capacity; capacity shifted from Zones J & K into those ‘capacity removed’ zones until 0.1 LOLE criterion is no longer met
    - Various IRM points yield curve with LCR “point pairs” for NYC and LI that represent 0.1 LOLE solution for NYCA
- **Base Case IRM Anchoring**
  - Establishes base case IRM & LCRs from curves established by Unified Method
  - Anchor point on curve is selected by applying tangent of 45 degrees analysis at bend of curve
    - Balances the contribution of upstate and downstate ICAP towards meeting the resource adequacy criterion
  - Points on the curve on either side of the Tan 45 point may create disproportionate changes in LCR & IRM

Unified Method & Anchoring Method



IRM Input Data and Models

- **Load, Capacity and Transmission models are input to the MARS program to determine IRM**
  - NYCA Load Model
  - NYCA Capacity Model (Captures certain planned resource retirements and additions)
  - Emergency Operating Procedures
  - Transmission System Model
  - External Control Area Load & Capacity Models
  - External Control Area Capacity
  - Locational Capacity Requirements
- **An Assumptions Matrix is prepared early in study process to provide transparency into the study assumptions and identify year-over-year changes in assumptions**
- **Any changes to model(s) must be reviewed & tested, may include white paper**

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NYCA Load Model

Load Model

- **NYCA Load Model includes the forecast peak loads, load shape and load uncertainty models for the next capability year**
  - **(1) Peak Loads** – NYISO provides preliminary load forecast to ICS in preliminary base case which can be adjusted; then develops fall forecast based on actual Peak load conditions experienced during the summer → used for Final Base Case
  - **(2) Load Shape Model** – yearly load shapes consist of 8,760 hour chronologically; NYISO considers historical NYCA & zonal load shapes, weather conditions, and other characteristics to determine appropriate load shape used for IRM study
  - Load shapes capture parameters such as the duration of the peak, number of hours/days near the annual peak, and total energy served by the system

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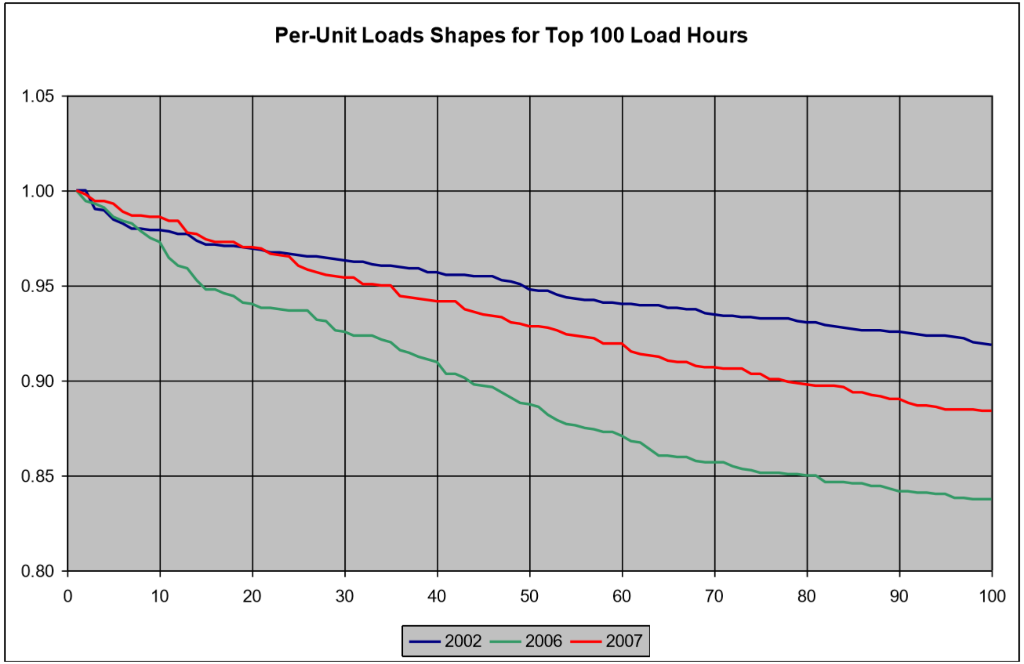
Load Shapes

- 3 Load Shapes are used in MARS for the IRM study: 2002, 2006, and 2007

2002: most representative of a year with many more high load days, though not the year with the highest peak
2006: most representative of a year with very hot weather, albeit a small number of high load days
2007: most representative of typical years



Load Forecast Uncertainty (LFU) Model

- Takes in to account impacts of weather conditions on future loads
- Gives MARS info on 7 Load levels (3 lower & 3 higher than median peak) and their probabilities of occurrence → MARS calculates resource adequacy for each hour and LOLE for the capability year of each load level
- LFU divided into 5 separate areas: Zone J, Zone K, Zones H&I, Zones F&G, Zones A-E
    - Model Built in 3 Steps:
        1. Creates relationship between a weather metric and the summer peak load for each zone using as many years of historical as possible
        2. Relates the same weather metric with the daily peak load historical data of selected years not older than 10-years
        3. Combines the correlations found to produce relationship of expected yearly peak load & its probability

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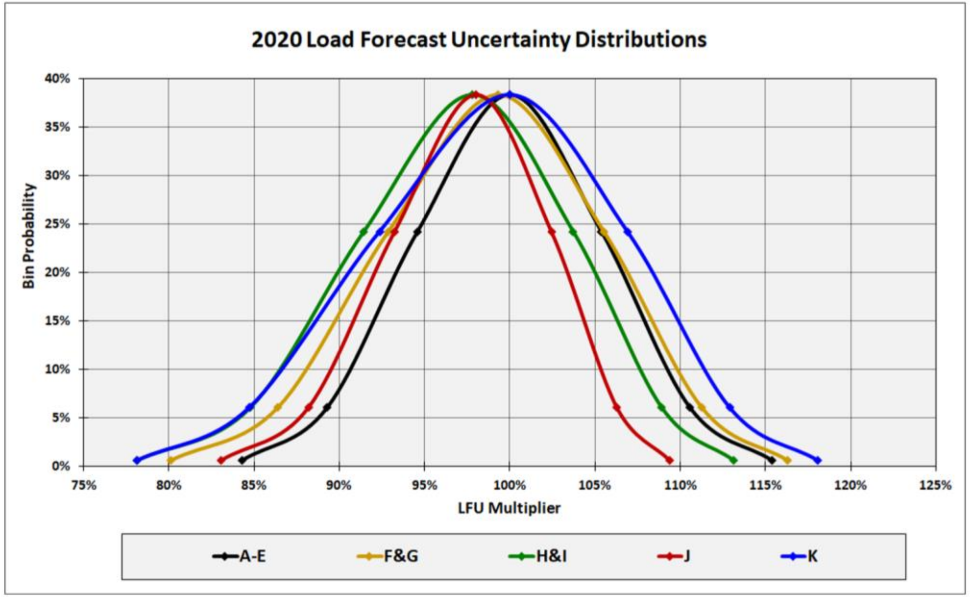
Load Forecast Uncertainty

2020 LFU Multipliers						
Bin	Probability	A-E	F&G	H&I	J	K
B7	0.62%	84.30%	80.12%	78.15%	83.07%	78.16%
B6	6.06%	89.29%	86.39%	84.79%	88.19%	84.73%
B5	24.17%	94.58%	92.86%	91.43%	93.24%	92.36%
B4	38.30%	100.00%	99.31%	97.82%	98.04%	100.00%
B3	24.17%	105.39%	105.52%	103.72%	102.45%	106.93%
B2	6.06%	110.57%	111.25%	108.90%	106.28%	112.92%
B1	0.62%	115.39%	116.28%	113.11%	109.38%	118.09%

Delta	A-E	F&G	H&I	J	K
Bin 7 - Bin 4	15.70%	19.19%	19.66%	14.97%	21.84%
Bin 4 - Bin 1	15.39%	16.97%	15.30%	11.34%	18.09%
Total Range	31.09%	36.16%	34.96%	26.31%	39.93%

Winter LFU Multipliers		
Bin	Probability	NYCA Winter LFU
B7	0.62%	91.28%
B6	6.06%	93.85%
B5	24.17%	96.75%
B4	38.30%	100.00%
B3	24.17%	103.59%
B2	6.06%	107.52%
B1	0.62%	111.80%

Delta	NYCA Winter LFU
Bin 7 - Bin 4	8.72%
Bin 4 - Bin 1	11.80%
Total Range	20.52%



Example of 2020 Load Forecast Uncertainty

NYCA Capacity Model

Generating Units

- Includes all generating units (new, planned to be in-service before the upcoming Capability Year, & physically outside of NYS); NYISO identifies units that are eligible to participate in the market and recommends to add or remove units in the IRM base case
- These are listed in the NYISO's Gold Book:

FUEL TYPE

BAT - Battery
BIT - Bituminous Coal
BUT - Butane
COL - Liquefied Coal
FO2 - No. 2 Fuel Oil
FO4 - No. 4 Fuel Oil
FO6 - No. 6 Fuel Oil
FW - Fly Wheel
JF - Jet Fuel
KER - Kerosene
MTE - Methane (Bio Gas)
NG - Natural Gas
OT - Other (Describe In Footnote)
REF - Refuse (Solid Waste)
SUN - Sunlight
UR - Uranium
WAT - Water
WD - Wood and/or Wood Waste
WND - Wind

UNIT TYPE

CC - Combined Cycle
CG - Cogeneration
CT - Combustion Turbine Portion (CC)
CW - Waste Heat Only (CC)
ES - Energy Storage
FC - Fuel Cell
GT - Combustion Turbine
HY - Conventional Hydro
IC - Internal Combustion
IG - Integrated Coal Gasification (CC)
JE - Jet Engine
NB - Steam (BWR Nuclear)
NP - Steam (PWR Nuclear)
PS - Pumped Storage Hydro
PV - Photovoltaic
ST - Steam Turbine (Fossil)
WT - Wind Turbine

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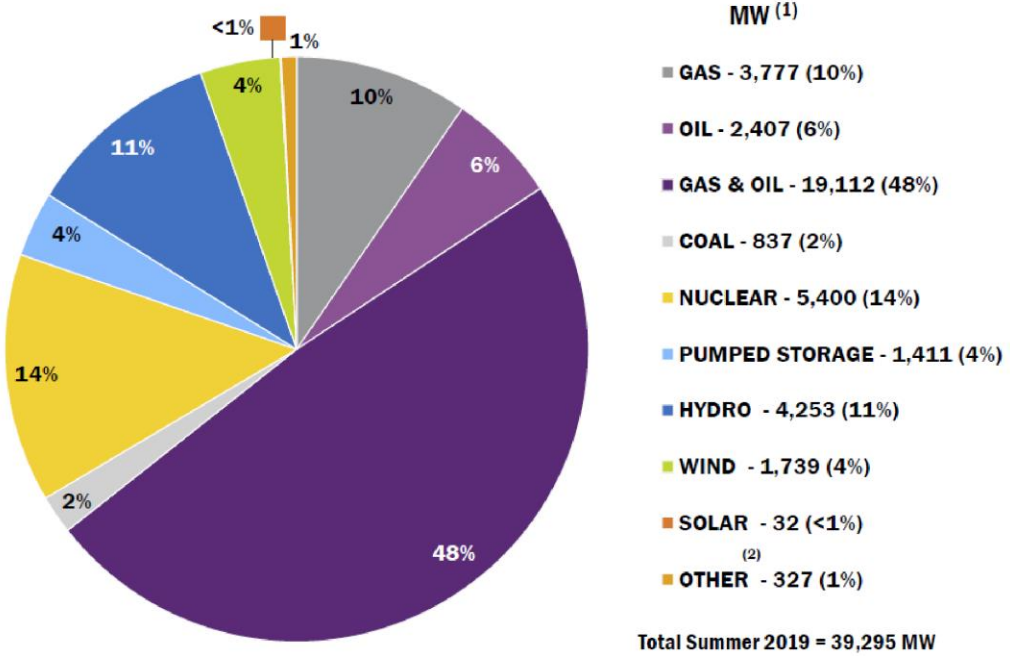
Generating Units

- Gold Book ICAP breakdown of the relative quantities of each resource type for 2019 Summer Capability
- 48% of capacity comes from Gas and Oil

Figure III-2: 2019 NYCA Summer Capability by Fuel Type



(1) All values are from the Summer Capability column in Table III-2 and are rounded to the nearest whole MW.

(2) Includes Methane, Refuse & Wood.

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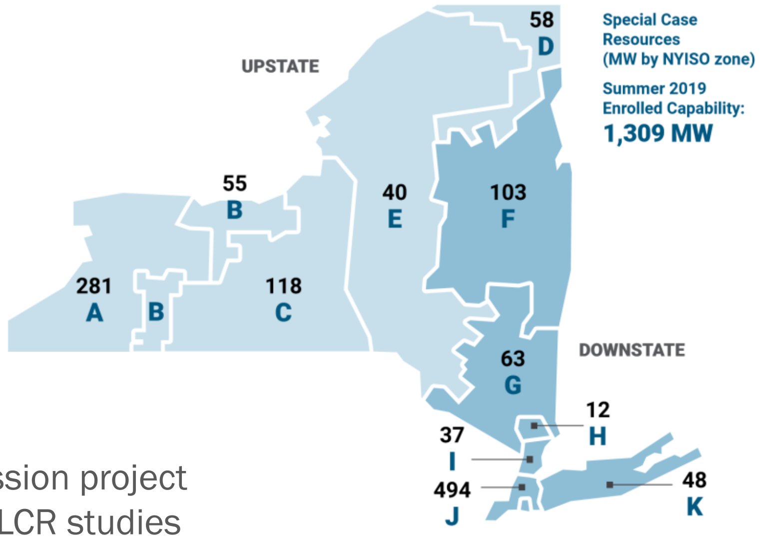
Additional Factors



- **Special Case Resources (SCRs)**
  - Loads able to be interrupted on demand rated at 100 kW or higher
  - Considered capacity resources when setting up IRM
- **Unforced Capacity Deliverability Rights (UDRs)**
  - Allow owner to receive Locational Capacity Benefits (*i.e.*, sell capacity) from the addition of a new transmission project
  - Owner must delegate how they will be treated in IRM/LCR studies for which NYISO calculates UDR award based on data
  - UDR Capacity sales are backed by a physical generating resource in the External Control Area
- **Behind the Meter: Net Generators**
- **Environmental Regulations**
  - The NYISO RNA is used to develop performance models for units while recognizing environmental impacts

Emergency Operating Procedures

Emergency Operating Procedures (EOPs)

- EOPs are modeled in IRM studies, and are used when reserve levels reach critical limits
- These steps and capacity values are recommended to ICS by the NYISO, and represent steps the NYISO would take to continue serving firm load under adverse operating conditions

EOP Example

Assumptions Model

Parameter	2019 Study Assumption	2020 Study Assumption	Explanation
Special Case Resources*	July 2018 –1309 MW based on registrations and modeled as 903 MW of effective capacity. Monthly variation based on historical experience*	July 2019 –1,282 MW based on registrations and modeled as 873 MW of effective capacity. Monthly variation based on historical experience*	SCRs sold for the program discounted to historic availability. Summer values calculated from July 2019 registrations. Performance calculation updated per ICS presentations on SCR performance.
Other EOPs	713.4 MW of non-SCR/non-EDRP resources	692 MW of non-SCR/non-EDRP resources	Based on TO information, measured data, and NYISO forecasts.
EOP Structure	10 EOP Steps Modeled	12 EOP Steps Modeled	Add one to separate EA from 10 min reserve. Add 2nd as placeholder for Policy 5

- The number of SCR calls is limited to 5/month when calculating LOLE based on all 8760 hours.

Emergency Operating Procedure

Step	Procedure	2019 MW Value	2020 MW Value
1,2	Special Case Resources –Load, Gen	1309 MW Enrolled/ 903 MW modeled	1282 MW Enrolled/ 873 MW modeled
3	Emergency Demand Response Program	6 MW Enrolled/1 MW Modeled	None Modeled
4	5% manual voltage Reduction	66 MW	57 MW
5	Thirty-minute reserve to zero	655 MW	655 MW
6	5% remote voltage reduction	401 MW	347 MW
7	Voluntary industrial curtailment	166 MW	207 MW
8	General public appeals	81 MW	80 MW
9	Emergency Purchases	Varies	Varies
10	Ten-minute reserve to zero	1,310 MW	1,310 MW
11	Customer disconnections	As needed	As needed

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Transmission System Model

Transmission System Model

- Based on emergency transfer limits in interfaces between NYCA zones and NYCA-external Control Areas
- Updated by the NYISO annually in coordination with the local transmission owners

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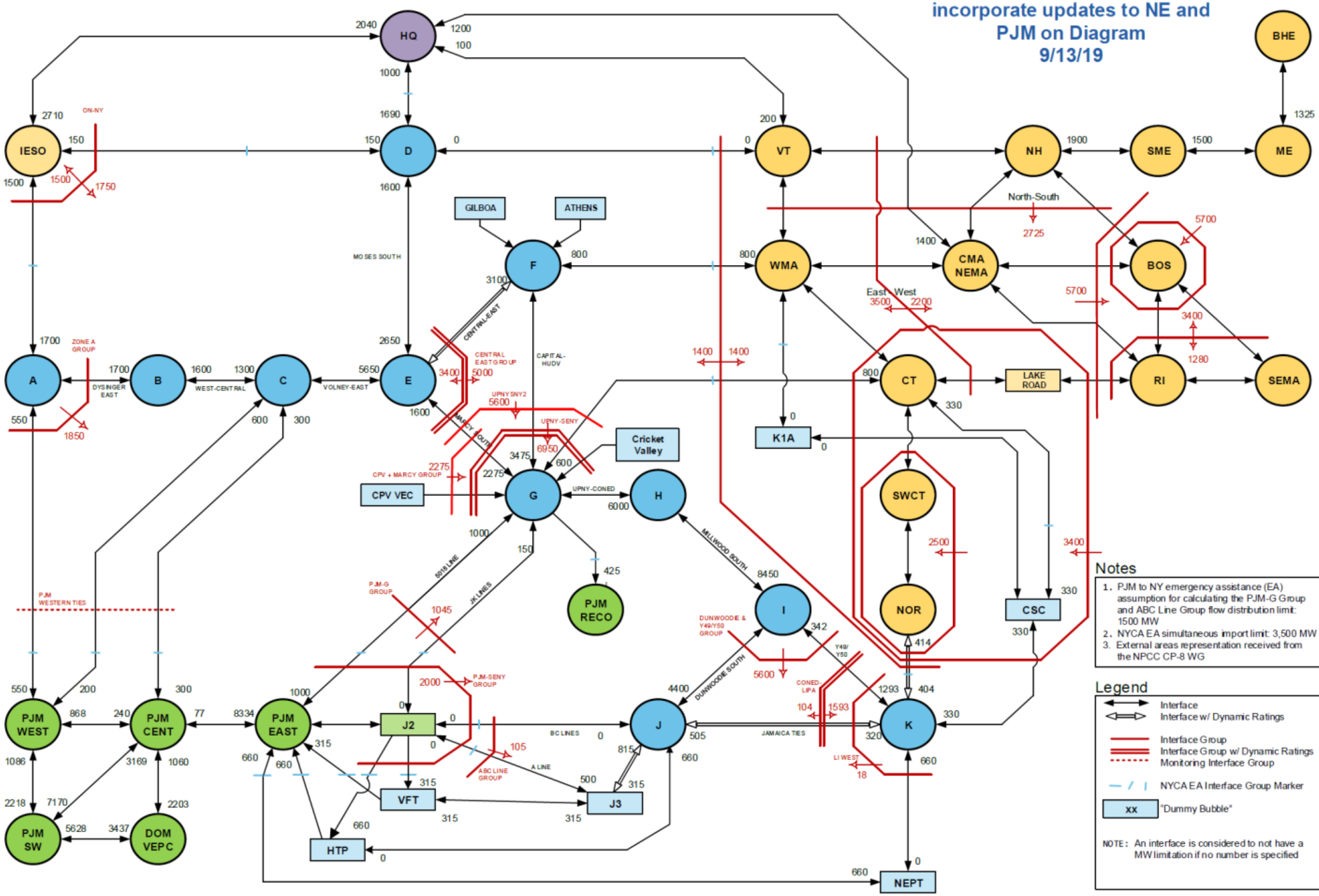
2020 IRM Topology (Summer Limits)

Approved 5/1/19. Revised to incorporate updates to NE and PJM on Diagram 9/13/19



Notes

1. PJM to NY emergency assistance (EA) assumption for calculating the PJM-G Group and ABC Line Group flow distribution limit: 1500 MW
2. NYCA EA simultaneous import limit: 3,500 MW
3. External areas representation received from the NPCC CP-8 WG

Legend

- Interface
- Interface w/ Dynamic Ratings
- Interface Group
- Interface Group w/ Dynamic Ratings
- Monitoring Interface Group
- NYCA EA Interface Group Marker
- xx "Dummy Bubble"

NOTE: An interface is considered to not have a MW limitation if no number is specified

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External Control Area

External Control Area Load and “ Capacity Models

- MARS analysis includes load and capacity from external areas such as New England, PJM-RTO, Ontario and Quebec, based on data received from these areas
- Modeling external control areas allows the NYSRC and NYISO to capture the interconnected nature of the electric grid and model potential emergency assistance (*e.g.,* flows into NY) when the NY grid requests assistance
- Various constraints on emergency assistance are used to avoid too much dependence on externals for emergency support
  - Limit is placed on maximum amount of capacity relied on from external control areas
  - External control areas are modeled at their minimum acceptable capacity levels instead of their as-found capacity levels

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IRM Summary

Timeline

- IRM Study for upcoming capability year is completed incrementally throughout a given year

Table 2: IRM Study Major Milestones

DAY	YEAR	EVENT/DEADLINE
Jan. 1	Y-1	
Mar. 1	Y-1	ICS, with support from the NYISO and Market Participants, begin development of IRM Study database.
June 1	Y-1	NYISO completes transmission model. GE provides latest MARS executable for ICS benchmarking.
July 1	Y-1	NYISO completes benchmarking tests for new MARS version. ICS completes preliminary assumption matrix and submits to the Executive Committee for review and approval.
Aug.1	Y-1	ICS lists sensitivities
Aug. 15	Y-1	ICS completes preliminary base case.
Oct. 1	Y-1	NYISO completes final NYCA load forecast, and ICS recommends sensitivity tests to run to the Executive Committee for approval. Completes final assumptions matrix for Executive Committee review and approval.
Oct. 15	Y-1	ICS completes final base case.
Nov. 1	Y-1	ICS completes sensitivity testing and IRM Study draft, and submits to the Executive Committee for review and comment.
Dec. 5	Y-1	Executive Committee approves final IRM Study and establishes the NYCA IRM requirement for Year Y.
Jan. 1	Y	

Y represents year for which the NYCA Installed Capacity Requirement (ICR) is established.

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Summary of Inputs for IRM

Table I: IRM Study Parameters/Data Inputs

Parameter	Source
Load Parameters	
Peak Load	NYISO Load Forecast Group with vetting at LFTF
Load Shapes Model	NYISO Load Forecast Group
Load Uncertainty Model	NYISO Load Forecast Group and TO input
Generator Parameters	
Existing Generating Unit Capacities	NYISO Gold Book
Proposed New Units	NYISO Gold Book, NYISO queue, TO projections, and RNA base case.
Solar Resource Modeling	NYISO Gold Book, TO projections, and RNA base case.
Wind Resource Modeling	DSS production data, NYISO Gold Book, NYISO queue, and PSC RPS data.
Retirements	NYISO Gold Book, PSC notification process, and needs assessments.
Forced & Partial Outage Rates	Latest 5-year GADS data.
Topology	
Interface Limits	From NYISO Long Term Planning. Based on Operating Studies, Operations Engineering Voltage Studies, Comprehensive Planning Process, and additional analysis.
New Transmission Capability	NYISO Gold Book, TO projections, and Planning forecast.
Transmission Cable Forced Outage Rates	TO and NYISO DSS data, examination of 5 year history.
Outside World Area Models	From CP-8 members including PJM.
Reserve Sharing between Areas	From CP-8 members.
Miscellaneous	
Model Version	From GE Consulting

Parameter	Source
Planned and Maintenance Outages and Derates	
Planned Outages	NYISO scheduling department and GADS data
Summer Maintenance	NYISO scheduling department and GADS data
Combustion Turbines Ambient Derate	Manufacturers Curves provided by Market Monitoring.
Non-NYPA Hydro Capacity Modeling	NYISO DSS data
Capacity Sales, Purchases, and UDRs	
Unforced Capacity Deliverability Rights (UDR)	NYISO Capacity Market Operations Group.
External Capacity - Purchases	NYISO Capacity Market Operations Group. Only Grandfathered Contracts are modeled.
Capacity - Sales	NYISO Gold Book, TO projections, and IMO forecast.
Capacity Wheels-through	TO projections and IMO forecast.
Environmental	
Environmental Impacts	NYISO environmental group.
Emergency Operating Procedures	
Special Case Resources	Distributed Resources Operations.
EDRP Resources	Distributed Resources Operations.
EOPs (other than SCR and EDRP)	NYISO Operations Engineering.

Resource Adequacy Studies Quality Assurance Procedure: 2019 IRM, LCR, and ECR Studies

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IRM Cycle

Reserve Margin that satisfies criterion

Public Procedures guide the development of study inputs

Stakeholders review study inputs at public meetings

Results presented to NYSRC's Executive Committee who vote on IRM value

Approved IRM value is filed with the New York State Public Service Commission (NYS PSC) and the Federal Energy Regulatory Commission (FERC)

Locational Minimum Installed Capacity Study

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Parties Involved

- NYSRC Executive Committee, NYSRC Installed Capacity Subcommittee (ICS), ICS stakeholders, NYISO stakeholder groups and committees, NYISO staff
- Highly technical inputs are often provided by subject matter experts and reviewed at specialized stakeholder meetings including:
  - **Peak Load forecasts and uncertainty:** Independently reviewed at the NYISO Load Forecasting Task Force comprised of NYISO Stakeholders
  - **Transmission Topology:** Independently reviewed at the NYISO Transmission Planning Advisory Subcommittee comprised of NYISO Stakeholders

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Locational Minimum Installed Capacity Requirement

Locational Minimum Installed Capacity Requirement (LCR)

- There are transmission constraints between certain load zones that have potential to impact the statewide LOLE
- To ensure sufficient capacity, these Zones require “locational ICAP requirements” that are expressed as a percentage of their respective peak load
- LCRs currently apply to Zone J (New York City), Zone K (Long Island) the G-J Locality
- Lower bounds exist to ensure transmission system flows remain reasonable (Transmission Security Limits)

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NYISO’s LCR Process

- For LCR calculation NYISO uses a LOLE that is the lesser of: 0.100 days/year and the resulting LOLE from the IRM → “target LOLE”
- LCR is optimized using equations such that:
  - The cost of capacity is minimized
  - Keeping NYSRC approved IRM
  - Maintaining LOLE ≤ 0.100 days/year
  - Maintaining capacity requirements ≥ the applicable Transmission Security Limit

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LCR Optimization

$$Minimize\ Cost\ of\ Capacity\ Procurement = [Q_J + LOE_J] \times P_J(Q_J + LOE_J) + [Q_K + LOE_K] \times P_K(Q_K + LOE_K) + [Q_{(G-J)} + LOE_{G-J} - Q_J - LOE_J] \times P_{(G-J)}(Q_{G-J)} + LOE_{(G-J)}) + [Q_{NYCA} + LOE_{NYCA} - Q_{G-J)} - LOE_{G-J} - Q_K - LOE_K] \times P_{NYCA}(Q_{NYCA} + LOE_{NYCA})$$

Subject to:

$$NYCA\ system\ LOLE \leq target\ LOLE$$

$$Q_{NYCA} = NYCA\ system\ peak\ load\ forecast \times (1 + NYSRC\ approved\ IRM)$$

$$Q_J \geq Q_{TSL(J)}$$

$$Q_K \geq Q_{TSL(K)}$$

$$Q_{G-J} \geq Q_{TSL(G-J)}$$

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LCR Optimization

Wherein-

"$Q_J, Q_K, Q_{G-J)}$ are the quantity of capacity, expressed in megawatts, required in J Locality, K Locality and G-J Locality respectively which is the product of the locality's non-coincident peak load forecast and the corresponding LCR values.

$Q_{TSL(J)}, Q_{TSL(K)}, Q_{TSL(G-J)}$ are the quantity of LCR floor restriction, expressed in megawatts, due to transmission security limit for J Locality, K Locality and G-J Locality respectively.

Q_{NYCA} is the quantity of capacity, expressed in megawatts, required for NYCA, which is the product of NYCA system peak load forecast and the value of (1+ NYSRC approved IRM).

$LOE_J, LOE_K, LOE_{G-J}, LOE_{NYCA}$ are the quantity of level of excess condition, expressed in megawatts, for J Locality, K Locality, G-J Locality, and NYCA, respectively.

$P_J(Q_J + LOE_J), P_K(Q_K + LOE_K), P_{(G-J)}(Q_{G-J)} + LOE_{(G-J)}), P_{NYCA}(Q_{NYCA} + LOE_{NYCA})$ are the price of capacity for the given quantity of capacity in J Locality, K Locality, G-J Locality, and NYCA, respectively (noting that the ICAP Demand Curve reset process calculates Net CONE at the level of excess condition)"

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Transmission Security Requirements

- **Transmission security limits are designed to ensure the transmission system can be operated reliably under specified transmission and generation outage conditions**
  1. At a high level, resource adequacy ensures sufficient capacity exists to serve load in a reliable manner
  2. At a high level, transmission security ensures sufficient resources exist to operate the transmission system in a stable and reliable manner
- **Satisfying one of the reliability criteria does not ensure the satisfaction of both/all reliability criteria**
  - For example, resource adequacy studies typically allow transmission flows to reach emergency levels that are not sustainable over long periods of time

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LCR Formation

Establish LCRs that minimize total capacity market cost given defined inputs (approved IRM)

→

Stakeholders review at public meetings

→

Study results presented at the NYISO's Operating Committee who approve final LCR values for upcoming year

(Guided by NYISO Tariff and public procedures)

LCR report: https://www.nyiso.com/documents/20142/8583126/LCR2020-Report.pdf/4c9309b2-b13e-9b99-606a-7af426d93a47

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Installed Capacity Summary

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External ICAP Import Rights

- Once NYCA IRM and LCRs are complete the NYISO conducts separate study using the base case to determine if additional capacity imports might be made available to external control areas
- If such imports are available, eligible capacity suppliers in the external control area can use these rights to import installed capacity into the NYCA
  - External Installed Capacity Suppliers then take on the obligation to provide energy to the NYCA when called upon

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Review of Technical Aspects

- **Generation is added or removed:**
  - In the IRM study, generation is added/removed from upstate New York and downstate New York proportionately
  - In the LCR study, generation is added/removed from Localities with an LCR based on economics in order to minimize total cost
- **Monte Carlo simulation forms part of the requirement setting process (*i.e.,* produces the "Loss of Load Expectation" statistic, which is a measure of system reliability and is referenced in reliability rules)**
- **Transmission security requirements act as a lower bound on Locality capacity requirements**

Summary of Analysis

- Peak load and daily load shapes modeled using multiple representative load shapes
- Weather uncertainty modeled using Gaussian distribution of historically observed weather indices
- Generator capability from published data and probabilistic availability (*i.e.,* Markov Chains) from generator availability data
- Intermittent resources modeled using five years of historic data, then sampled randomly in the Monte Carlo simulation
- Transmission capability (and forced outages for certain facilities) modeled using a pipe and bubble transmission topology
- Neighboring regions modeled as providing emergency assistance to New York when such assistance is available
- Emergency operating procedures, utilized prior to load shedding, are modeled (*e.g.,* curtailing interruptible customers)
- Monte Carlo is run until results sufficiently converge
- Sensitivity analyses highlight uncertain or impactful model parameters
- Study parameters that change year-over-year are updated individually to identify impacts (*e.g.,* new generation resources entering the market)

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Installed Capacity Requirement Timeline

- Installed Capacity Requirement study for a given capability year is performed throughout the year prior
- Example: Study performed in 2019 for 2020 Capability Year covering May 1, 2020 - April 30, 2021

Table 2-1
Timeline for the Establishment of the NYCA Installed Capacity Requirements

Monthly Meeting	Event/Deadline	Section References
February	➢ Approve list of tasks needed for preparation of 2020 IRM study (ICS). ➢ Approve scopes of potential new models (ICS). ➢ Review initial 2020 IRM Study Assumptions Matrix (ICS). ➢ Begin preparation of preliminary transmission topology (NYISO).	4.1 4.2 3.5.4
April	➢ Review draft white papers for new models (ICS). ➢ Review updated 2020 IRM Study Assumptions Matrix (ICS). ➢ Review GADS data (NYISO). ➢ Update new MARS software and benchmarks as necessary (NYISO). ➢ Begin base case build-up used for parametric analysis (NYISO).	4.1 3.5 3.2 3.4
May	➢ Approve new model white papers (ICS). ➢ Review updated 2020 IRM Study Assumptions Matrix (ICS). ➢ If applicable, approve use of new MARS version (ICS).	4.1 3.2
June	➢ Review updated 2020 IRM Study Assumptions Matrix, including preliminary transmission topology (ICS). ➢ Complete draft of any Policy 5 revisions for EC approval (ICS).	3.5 4.1
July	➢ Approve preliminary 2020 IRM Study Assumptions Matrix (ICS/EC). ➢ Perform parametric study to be used as the basis for Table 6-1 of IRM Study report (NYISO). ➢ Conduct preliminary IRM tan 45 study following parametric study (NYISO).	3.5 4.4 3.4
August	➢ Approve list of sensitivity cases (ICS/EC) ➢ Review parametric study results and preliminary tan 45 analysis (ICS). ➢ Send the completed initial master input file to GE by 8/21(NYISO)	3.6 3.4 3.9
September	➢ Approve parametric results for Table 6-1 (ICS). ➢ Approve preliminary 2020 base case IRM (ICS). ➢ Begins sensitivity testing (NYISO).	3.4 3.6
October	➢ Fall NYCA load forecast approved (ICS) ➢ Base Case assumptions lock-down (ICS) ➢ Approve Final base case assumptions matrix (ICS/EC) ➢ Begin preparation of base case study (NYISO). ➢ Begins preparation of draft IRM report including tables 6-1 and 7-1 (ICS). ➢ Report data quality assurance reviews (NYISO/GE/TOs). ➢ Review and approve sensitivity results and forward to EC (ICS).	3.5.1 3.6 3.5 3.4 2.3 3.8 3.6
November	➢ Complete Draft IRM study report (ICS). ➢ Approve Base case IRM (ICS/EC). ➢ If required prepare Special Sensitivity Case (includes all assumption changes after assumption lock-down) (ICS/NYISO)	2.3 3.4 3.6
December	➢ Complete Final IRM study report (ICS). ➢ Approve sensitivity results (ICS/EC). ➢ Approve Final IRM Study (EC). ➢ Final IRM adopted (EC) ➢ Issue letter to the NYISO CEO, press release, and IRM filing to FERC (if needed) announcing final IRM (EC) ➢ Complete base case alignment study (ICS)	2.3 3.6 3.4 5.0 4.4 3.5.5 App. C

New York ISO

Enhancements to Capacity Requirements Studies

- NYISO, NYSRC, and stakeholders may all propose changes to capacity requirement studies
- The New York State Reliability Council and NYISO work together to continually enhance the IRM
  - Recent examples include enhanced modeling of intermittent resources and energy storage resources
- NYSRC Installed Capacity Subcommittee (ICS) is the public forum where stakeholders can review the IRM modeling work (including recommending study enhancements)
  - Enhancements are developed and vetted prior to adoption in the IRM study
  - Enhancements may require updating the pubic procedure for calculating the IRM, which requirements supplemental review and approval by the NYSRC
- NYISO stakeholder meetings are the public forum where stakeholders can review the LCR modeling work (including recommending study enhancements)
  - Enhancements may require updating the NYISO Tariffs, which requires a successful stakeholder vote, approval by the NYISO Board of Directors, and acceptance by the Federal Energy Regulatory Commission

New York ISO

New York vs. Other Control Areas

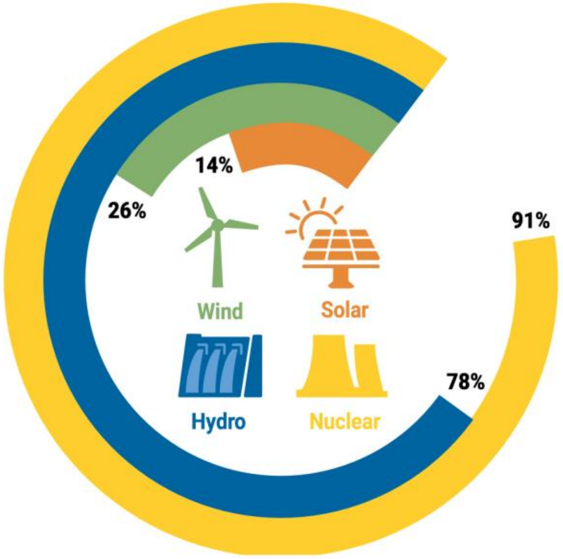
- **New York's capacity requirement setting studies generally build a bottom up model using extensive, detailed data**
  - New York's internal transmission model (i.e., NY's model of itself) is more complex than neighboring control areas
  - New York's external transmission model (e.g., NY's model of PJM) is more complex than neighbors models' of NY
- **New York's IRM and LCR studies model (and report) all resources based on their "Installed Capacity", akin to nameplate resource rating**
  - Some studies (including NERC's Long Term Reliability Assessment) report some resources based on Installed Capacity and others based on a de-rated capacity value (e.g., a lower value for wind due to its intermittency)
  - For example, California de-rates solar capacity when evaluating compliance with its 15% planning reserve margin (i.e., Effective Load Carrying Capacity)
    - https://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy/Energy_Programs/Electric_Power_Procurement_and_Generation/Procurement_and_RA/RA/2018%20RA%20Report%20rev.pdf
- **New York's IRM and LCR studies set capacity requirements in an "Installed Capacity" basis**
  - Some studies (including ERCOT's reserve margin study) report capacity requirements (or reserve margins) based on a mix of Installed Capacity and de-rated capacity
    - http://www.ercot.com/news/releases/show/195806
- **New York's LCR study uses Transmission Security Limits as a lower bound on locational capacity requirements**
  - ISO-NE and PJM capacity markets contain similar concepts
    - https://www.iso-ne.com/markets-operations/markets/forward-capacity-market/fcm-participation-guide/capacity-zone-development
    - https://pjm.com/-/media/committees-groups/committees/pc/20171103-special/20171103-ceto-cetl-education-presentation.ashx

New York ISO

Renewable Resources

- **Clean Energy initiatives in New York State will lead to thousand of megawatts of additional generation in Front of the Meter photovoltaic (FTM PV), onshore wind, and offshore wind**
- **Analyses ongoing based on hypothetical amounts of intermittent renewable resources and the impact on the IRM and LCRs**
  - "Impacts of High Intermittent Renewable Resources On the Installed Reserve Margin for New York" study shows that adding 12k MW of renewable resources leads to significant increases in New York IRM and LCRs
- **Projected shift in IRM & LCRs driven by intermittent characteristics of weather dependent resources**
  - Lower availability of intermittent generators reducing average availability of NYCA suppliers

Annual Capacity Factors for Clean Energy Resources



New York ISO

Renewable Resources

- Resources that have an availability that is less than the system average availability increase capacity requirements
- The intermittency of many renewable resources requires the system to carry a greater amount of nameplate capacity to meet a given resource adequacy reliability criterion
  - The NYSRC and NYISO are actively studying this question

New York ISO

Questions?