IRM/LCR Overview

Nathaniel Gilbraith, PhD

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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”
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
Resource Adequacy Annual Processes

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

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
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

Minimum Flow Equivalent
Maximum Possible LCR at lowest possible IRM

Area above curve indicates NYCA system where NYCA reliability is < 0.1 days/year LOLE (exceeds reliability criteria)

IRM-LCR curve shifting UP reflects:
• Greater dependence on local generation
• Less dependence on transmission

IRM-LCR curve bending DOWN reflects:
• Less dependence of local generation
• Greater dependence on transmission

IRM-LCR Curve Dynamics
Unified Method with Tan 45 Anchor Point

Maximum Flow Equivalent
Maximum Possible IRM at lowest possible LCR

Installed Reserve Margin (IRM) %
Locational Capacity Requirement (LCR) %
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
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
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
  
  1. 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
# Load Forecast Uncertainty

## 2020 LFU Multipliers

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

## Delta LFU Multipliers

<table>
<thead>
<tr>
<th>Delta</th>
<th>A-E</th>
<th>F&amp;G</th>
<th>H&amp;I</th>
<th>J</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bin 7 - Bin 4</td>
<td>15.70%</td>
<td>19.19%</td>
<td>19.66%</td>
<td>14.97%</td>
<td>21.84%</td>
</tr>
<tr>
<td>Bin 4 - Bin 1</td>
<td>15.39%</td>
<td>16.97%</td>
<td>15.30%</td>
<td>11.34%</td>
<td>18.09%</td>
</tr>
<tr>
<td>Total Range</td>
<td>31.09%</td>
<td>36.16%</td>
<td>34.96%</td>
<td>26.31%</td>
<td>39.93%</td>
</tr>
</tbody>
</table>

## Winter LFU Multipliers

<table>
<thead>
<tr>
<th>Bin</th>
<th>Probability</th>
<th>NYCA Winter LFU</th>
</tr>
</thead>
<tbody>
<tr>
<td>B7</td>
<td>0.62%</td>
<td>91.28%</td>
</tr>
<tr>
<td>B6</td>
<td>6.06%</td>
<td>93.85%</td>
</tr>
<tr>
<td>B5</td>
<td>24.17%</td>
<td>96.75%</td>
</tr>
<tr>
<td>B4</td>
<td>38.30%</td>
<td>100.00%</td>
</tr>
<tr>
<td>B3</td>
<td>24.17%</td>
<td>103.59%</td>
</tr>
<tr>
<td>B2</td>
<td>6.06%</td>
<td>107.52%</td>
</tr>
<tr>
<td>B1</td>
<td>0.62%</td>
<td>111.80%</td>
</tr>
</tbody>
</table>

## Delta LFU Multipliers

<table>
<thead>
<tr>
<th>Delta</th>
<th>NYCA Winter LFU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bin 7 - Bin 4</td>
<td>8.72%</td>
</tr>
<tr>
<td>Bin 4 - Bin 1</td>
<td>11.80%</td>
</tr>
<tr>
<td>Total Range</td>
<td>20.52%</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>FUEL TYPE</th>
<th>UNIT TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAT - Battery</td>
<td>CC - Combined Cycle</td>
</tr>
<tr>
<td>BIT - Bituminous Coal</td>
<td>CG - Cogeneration</td>
</tr>
<tr>
<td>BUT - Butane</td>
<td>CT - Combustion Turbine Portion (CC)</td>
</tr>
<tr>
<td>COL - Liquefied Coal</td>
<td>OW - Waste Heat Only (CC)</td>
</tr>
<tr>
<td>FO2 - No. 2 Fuel Oil</td>
<td>ES - Energy Storage</td>
</tr>
<tr>
<td>FO4 - No. 4 Fuel Oil</td>
<td>FC - Fuel Cell</td>
</tr>
<tr>
<td>FO6 - No. 6 Fuel Oil</td>
<td>GT - Combustion Turbine</td>
</tr>
<tr>
<td>FW - Fly Wheel</td>
<td>HY - Conventional Hydro</td>
</tr>
<tr>
<td>JF - Jet Fuel</td>
<td>IC - Internal Combustion</td>
</tr>
<tr>
<td>KER - Kerosene</td>
<td>IG - Integrated Coal Gasification (CC)</td>
</tr>
<tr>
<td>MTE - Methane (Bio Gas)</td>
<td>JE - Jet Engine</td>
</tr>
<tr>
<td>NG - Natural Gas</td>
<td></td>
</tr>
<tr>
<td>OT - Other (Describe In Footnote)</td>
<td></td>
</tr>
<tr>
<td>REF - Refuse (Solid Waste)</td>
<td></td>
</tr>
<tr>
<td>SUN - Sunlight</td>
<td></td>
</tr>
<tr>
<td>UR - Uranium</td>
<td></td>
</tr>
<tr>
<td>WAT - Water</td>
<td></td>
</tr>
<tr>
<td>WD - Wood and/or Wood Waste</td>
<td></td>
</tr>
<tr>
<td>WND - Wind</td>
<td></td>
</tr>
</tbody>
</table>
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
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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2019 Study Assumption</th>
<th>2020 Study Assumption</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Case Resources*</td>
<td>July 2018 –1309 MW based on registrations and modeled as 903 MW of effective capacity. Monthly variation based on historical experience*</td>
<td>July 2019 –1,282 MW based on registrations and modeled as 873 MW of effective capacity. Monthly variation based on historical experience*</td>
<td>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.</td>
</tr>
<tr>
<td>Other EOPs</td>
<td>713.4 MW of non-SCR/non-EDRP resources</td>
<td>692 MW of non-SCR/non-EDRP resources</td>
<td>Based on TO information, measured data, and NYISO forecasts.</td>
</tr>
<tr>
<td>EOP Structure</td>
<td>10 EOP Steps Modeled</td>
<td>12 EOP Steps Modeled</td>
<td>Add one to separate EA from 10 min reserve. Add 2nd as placeholder for Policy 5</td>
</tr>
</tbody>
</table>

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

Emergency Operating Procedure

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

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

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### Table 2: IRM Study Major Milestones

<table>
<thead>
<tr>
<th>DAY</th>
<th>YEAR</th>
<th>EVENT/DEADLINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan. 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mar. 1</td>
<td></td>
<td>ICS, with support from the NYISO and Market Participants, begin development of IRM Study database.</td>
</tr>
<tr>
<td>June 1</td>
<td></td>
<td>NYISO completes transmission model. GE provides latest MARS executable for ICS benchmarking.</td>
</tr>
<tr>
<td>July 1</td>
<td></td>
<td>NYISO completes benchmarking tests for new MARS version. ICS completes preliminary assumption matrix and submits to the Executive Committee for review and approval.</td>
</tr>
<tr>
<td>Aug. 1</td>
<td>Y-1</td>
<td>ICS lists sensitivities</td>
</tr>
<tr>
<td>Aug. 15</td>
<td></td>
<td>ICS completes preliminary base case.</td>
</tr>
<tr>
<td>Oct. 1</td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Oct. 15</td>
<td></td>
<td>ICS completes final base case.</td>
</tr>
<tr>
<td>Nov. 1</td>
<td></td>
<td>ICS completes sensitivity testing and IRM Study draft, and submits to the Executive Committee for review and comment.</td>
</tr>
<tr>
<td>Dec. 5</td>
<td></td>
<td>Executive Committee approves final IRM Study and establishes the NYCA IRM requirement for Year Y.</td>
</tr>
<tr>
<td>Jan. 1</td>
<td>Y</td>
<td>Y represents year for which the NYCA Installed Capacity Requirement (ICR) is established.</td>
</tr>
</tbody>
</table>
# Summary of Inputs for IRM

## Table 1: IRM Study Parameters/Data Inputs

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

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

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

Reserve Margin that satisfies criterion

Locational Minimum Installed Capacity Study

Public Procedures guide the development of study inputs

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

Stakeholders review study inputs at public meetings

Results presented to NYSRC’s Executive Committee who vote on IRM value
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
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).
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
LCR Optimization

Minimize Cost of Capacity Procurement = \[ Q_J + \text{LOE}_J \times P_J (Q_J + \text{LOE}_J) + Q_K + \text{LOE}_K \times P_K (Q_K + \text{LOE}_K) + [Q_{(G-J)} + \text{LOE}_{G-J} - Q_J - \text{LOE}_J] \times P_{(G-J)} (Q_{G-J} + \text{LOE}_{(G-J)}) + \]
\[ [Q_{\text{NYCA}} + \text{LOE}_{\text{NYCA}} - Q_{G-J} - \text{LOE}_{G-J} - Q_K - \text{LOE}_K] \times P_{\text{NYCA}} (Q_{\text{NYCA}} + \text{LOE}_{\text{NYCA}}) \]

Subject to:

NYCA system LOLE \leq \text{target LOLE}

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

\[ Q_J \geq Q_{\text{TSL}(J)} \]
\[ Q_K \geq Q_{\text{TSL}(K)} \]
\[ Q_{G-J} \geq Q_{\text{TSL}(G-J)} \]
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 \((1+ NYSRC \text{ approved IRM})\).

\(LOE_J, LOE_K, LOE_{G-J}, LOE_{NYCA}\) 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)”
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
LCR Formation

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

(Guided by NYISO Tariff and public procedures)

Stakeholders review at public meetings

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

Installed Capacity Summary
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.
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)
Installed Capacity Requirement Timeline

- Installed Capacity Requirement study for a given capability year is performed throughout the year prior.

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 public procedure for calculating the IRM, which requires 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 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)

- 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
    - [Link](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
    - [Link](https://www.iso-ne.com/markets-operations/markets/forward-capacity-market/fcm-participation-guide/capacity-zone-development)
    - [Link](https://pjm.com/-/media/committees-groups/committees/pct/20171103-special/20171103-ceto-cetl-education-presentation.ashx)
Renewable Resources

- Clean Energy initiatives in New York State will lead to thousands 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.
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
Questions?