NEW YORK STATE
NYSRC
RELIABILITY COUNCIL

NEW YORK INDEPENDENT SYSTEM OPERATOR

Resource Adequacy Workshop

Presented by the
New York State Reliability Council

June 7, 2007

AGENDA

2007 NYSRC Resource Adequacy Workshop

June 7, 2007

NYS Nurses Association, Latham, NY

	Topic	Time	Presenter
1	Welcome – Workshop Objectives	9:00 – 9:10 AM	Curt Dahl
2	Resource Adequacy Overview	9:10 – 9:30 AM	Curt Dahl
3	Background & NYSRC Criterion for Establishing the NYCA IRM Requirement	9:30 – 9:50 AM	Alan Adamson
4	Basics of Probability & Loss of Load Expectation (LOLE) Theory	9:50 – 10:10 AM	Glenn Haringa
	BREAK - 10:10 – 10:30		
5	GE-MARS: Our Primary Reliability Modeling Tool	10:30 – 11:10 AM	Glenn Haringa
6	IRM Modeling, Part I - Major Modeling Assumptions	11:10 AM – 12:10 PM	Frank Vitale William Lamanna
	LUNCH - 12:10 – 1:00		
7	IRM Modeling, Part II – Analysis, Establishing Base Case and Sensitivity Cases, Interpretation of Results	1:00 – 2:00 PM	Greg Drake
8	Establishing Locational Capacity Requirements (LCRs)	2:00 – 2:30 PM	John Adams
9	Questions & Answers	2:30 – 3:00 PM	Curt Dahl

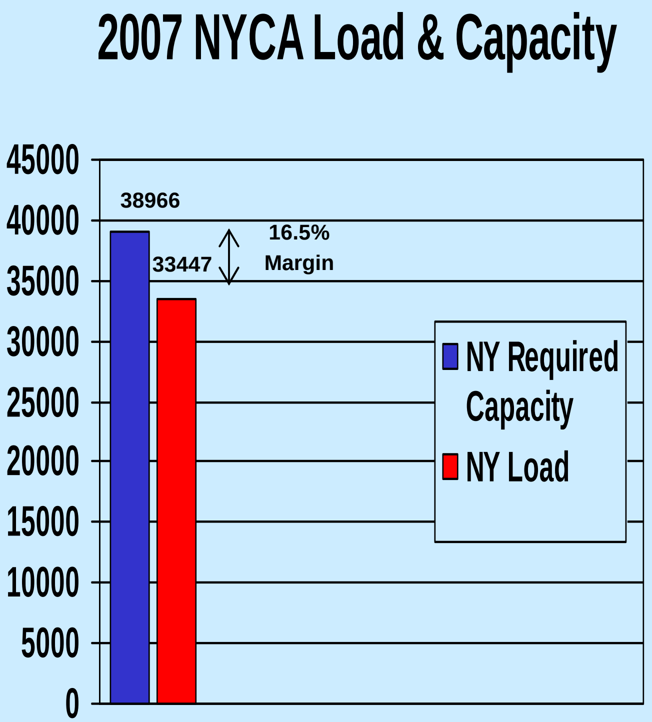
Workshop Objectives

- **Promote an understanding of the principals, methodologies, assumptions in the IRM study**
- **Increase the technical knowledge of the NYSRC and Market Participants regarding Multi-Area Reliability Simulation and Loss of Load Expectation**
- **Provide Open Forum to ask questions**

What is Resource Adequacy?

Resource Adequacy ***– The ability of the electric system to supply the aggregate electrical demand and energy requirements of the customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.***

NYSRC Reliability Rules address Resource Adequacy



http://www.nysrc.org/pdf/Documents/RRManualVer19_Final.pdf

Entities Involved in NYCA Resource Adequacy

NYSRC

NEW YORK INDEPENDENT SYSTEM OPERATOR
Building The Energy Markets Of Tomorrow...Today

Public Service Commission

	NYSRC	NYISO	PSC	MARKET PARTICIPANTS	NYISO/NYSRC CONSULTANTS
Primary Responsibility	Assist in maintenance of system reliability through promulgation of reliability standards and monitoring of compliance.	Reliable operation of power system and administration of market	Under NYS law responsible to ensure reliability of power system.	To comply with NYISO tariffs and procedures	
Role in ensuring Reliability	Set reliability standards	Under terms of NYSRC/NYISO agreement Responsible for its compliance and compliance of market participants with NYSRC reliability standards	Jurisdictional authority to establish reliability standards. Has adopted NYSRC reliability standards	Responsible to NYISO for compliance with NYSRC reliability standards. LSEs must secure ICAP to comply with IRM and LCRs	
Role in setting Resource Adequacy Requirement	Establishes IRM and reviews LCRs for consistency with IRM to ensure criteria is satisfied	Establishes LSE ICAP requirements, including LCRs, & amount of maximum ICAP located externally to NYCA	May adopt resource adequacy requirements if it chooses Has adopted 2007/08 IRM	Participate on NYSRC and NYISO committees and provide modeling information affecting resource adequacy	Assist NYSRC and NYISO in role of establishing IRM and LCR

Market Participants

Responsibilities of NYISO and NYSRC Committees

NYSRC Installed Capacity Subcommittee

- **Develop modeling assumptions**
- **Specify sensitivity tests to be run**
- **Manage MARS studies and prepare NYCA IRM report**

NYISO

- **Data Collection**
- **Provide technical and computer support for the IRM Study effort**
- **NYISO utilizes same assumptions from the IRM Study for LSE locational capacity requirements study**

NYSRC Executive Committee

- **Approve data and modeling assumptions and IRM Study**
- **Establish and approve the NYCA IRM requirement for the next capability year considering base case and sensitivity cases as well as any other issues that may impact NYCA IRM requirements**

Policy 5
Procedure for Establishing NYCA Installed Capacity Requirements

NEW YORK STATE RELIABILITY COUNCIL, L.L.C.
("NYSRC")
POLICY NO. 5–1

PROCEDURE FOR ESTABLISHING
NEW YORK CONTROL AREA
INSTALLED CAPACITY REQUIREMENTS

Approved by NYSRC Executive Committee – November 10, 2006
Date Issued: November 14, 2006

- Overview of Process
  - Timeline
- Details of Reliability Calculation
  - Criteria
  - Computer Model
  - Outside Representation
  - Input Data
- Responsibilities
- Last Revised 11/06

http://www.nysrc.org/pdf/Policies/Policy%205-1%20Final%2011-14-06.pdf

IRM Study Assumptions Matrix

Base Case Modeling Assumptions for
2007-08 NYCA IRM Requirement Study

Parameter	2006 Study Modeling Assumptions	Recommended 2007 Study Modeling Assumptions	Basis for Recommended 2007Assumptions	Possible Impact on IRM
NYCA Load Model				
Peak Load	32,400 MW	TBD on October 1st	NYISO forecast based on TO forecasts with NYISO estimate for National Grid and Con Ed zonal allocation (zones H, I, J). Top three external Area peak days aligned with NYCA.	Low (+)
Load Shape Model	2002 Load Shape	2002 Load Shape	After evaluating 2005 data, analysis indicates 2002 load shape remains an appropriate representation for this analysis.	None
Load Uncertainty Model	Statewide and zonal model updated to reflect current data.	Statewide and zonal model updated to reflect current data.	Updated data from LIPA, Con Ed, and NYISO.(see attachement A)	Low (+)
NYCA Capacity Model				
Generating Unit Capacities	2005 Gold Book	Updated DMNC test values.	2006 Gold Book plus SCS Astoria Energy unit (in service)	Low(-)
New Units	See 2006-07 IRM Study Report Page	Gold Book (table III) units plus: Prattsburgh Wind Park - 79.5 MW (10/06), Flat Rock Wind Power (phase 2) - 100 MW (12/06)	2006 Gold Book and those with Interconnection agreements signed by August 1st.(note the Neptune line will be introduced as a sensitivity since COD does not meet May 1 deadline)	Low(+)
Wind Resources	Derived from hourly wind data with summer peak hours	Derived from hourly wind data with average Summer Peak Hour	Based on collected hourly wind data. Summer Peak Hour capacity	Low (+)

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- Recommendations developed by NYSRC ICS in the Mar-Jul timeframe in conjunction with NYISO and GE
- Reflects NYSRC consensus on all MARS modeling and input data used for IRM/LCR calculations
- Where other opinions exist it may be appropriate to include alternate assumptions as Sensitivity Case
- Approved by the NYSRC Executive Committee

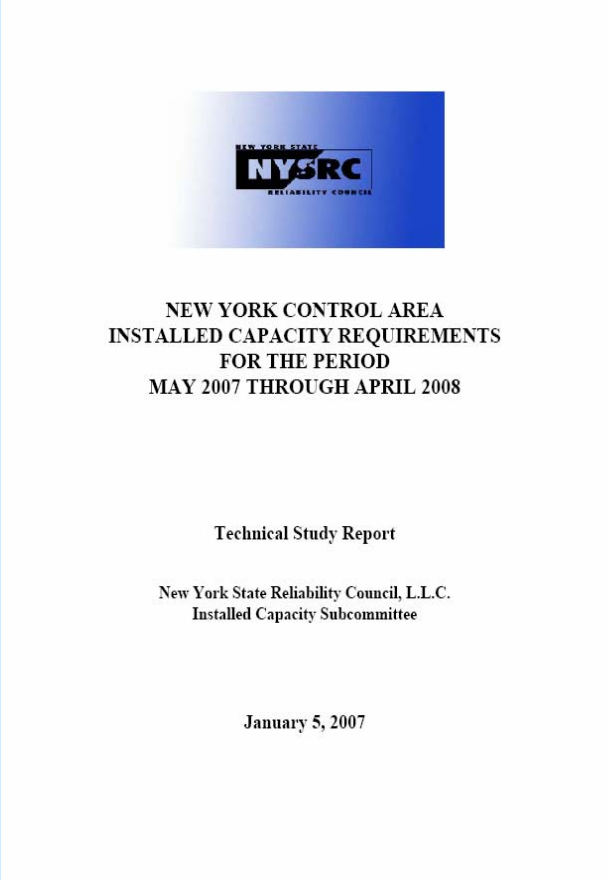
IRM Study Reporting Requirement

- Contents of Report

  Executive Summary, Main Body, Appendix, Sensitivity Results

- NYSRC to notify the NYISO of the NYCA IRM requirements and meet with NYISO management as required to review IRM Study results.

- NYSRC to make IRM requirement study results available to state and federal regulatory agencies and to the general public.



NYSRC

NEW YORK CONTROL AREA
INSTALLED CAPACITY REQUIREMENTS
FOR THE PERIOD
MAY 2007 THROUGH APRIL 2008

Technical Study Report

New York State Reliability Council, L.L.C.
Installed Capacity Subcommittee

January 5, 2007

http://www.nysrc.org/pdf/Reports/2007_08IRMReportFinal011707.pdf

IRM Study Workplan

Day	Year	Event/Deadline
Jan. 1	Y-1	
Mar. 1		ICS, with support from the NYISO and Market Participants, begin development of IRM Study database.
June1		NYISO completes transmission model. GE provides latest MARS executable for ICS benchmarking
July 1		NYISO completes benchmarking tests for new MARS version.
Aug. 1		ICS completes database assumption matrix and submits to the Executive Committee for review and approval.
Sept. 15		ICS completes preliminary base case.
Oct. 1		NYISO completes final NYCA load forecast and ICS identifies sensitivity tests to be examined.
Oct, 15		ICS completes final base case.
Nov. 1		ICS completes sensitivity testing and IRM Study draft, and submits to the Executive Committee for review and comment.
Dec. 15		Executive Committee approves final IRM Study and establishes the NYCA IRM requirement for Year Y.
Jan. 1	Y	

Y represents year for which NYCA ICR is established

Adherence to this schedule is required to support NYSRC annual filing with FERC to advise FERC of the annual state-wide IRM requirement for the New York control area for the following capability year and to seek FERC approval of any revision to the IRM requirement.

New York Capacity Market

- The NYSRC sets the Installed Reserve Margins and the NYISO determines the NYCA Minimum Installed Capacity (ICAP) in accordance with criteria and standards of NYSRC, NPCC and NYPSC

- Load Serving Entities (LSE's) are required to procure sufficient resource capacity to meet NY and Locational Requirements

- Spot Price of Capacity Set by "Demand Curve"

NYSRC Criterion for Establishing the NYCA Installed Reserve Margin (IRM) Requirement

Alan Adamson, NYSRC Consultant

Topics to be Covered

- **Historical Perspective on Power Industry Reliability Indexes**
- **Regional Reliability Council Resource Adequacy Criteria**
- **The Process for Reviewing and Modifying the Resource Adequacy Criterion**
- **The Present Criterion and Its Elements**
- **How the Resource Adequacy Criterion and Its Application Has Evolved Over the Past 30 Years**

Historical Perspective on Power Industry Reliability Indexes

- Fixed Installed Reserve Margin
- Loss-of-Largest Generating Unit
- Loss of Load Expectation (LOLE) – NYSRC uses this index; it is the most widely used index used today in power industry
- Loss of Energy Expectation (LOEE) – predominately used by areas with a large percentage of hydro capacity

Loss of Load Index

- A probabilistic index.
- "The expected number of days per year for which available resource capacity is insufficient to serve the daily peak load."
- Measured in days per year.
- For NPCC and NYCA this index is 0.1 days per year, or one day in 10 years.

Regional Reliability Resource Adequacy Criteria

- Of the eight Regions, seven use a LOLE index – ERCOT, FRCC, MRO, NPCC, RFC, SERC, and SPP.
- The remaining Region, WECC, does not have a criterion; however, several of its sub-regions, including California, have initiated processes to develop one.

The Process for Reviewing and Modifying the Resource Adequacy Criterion

- Since formation of NYPP the criterion has been periodically re-examined as new reliability issues and system requirements have merged
- Comprehensive reviews since 1970 by the NYPP and NYSRC have led to several modifications of the criterion
- Improved computer models and databases have permitted these criterion changes
- NYPP and NYSRC have worked with NPCC to modify, when appropriate, the NPCC Resource Criterion to include requirements common to all NPCC Areas
- Since formation of the NYSRC there has been an open process for developing Reliability Rules, such as the Resource Adequacy Criterion. Under this process the Resource Adequacy Criterion has been modified with input from the NYISO and Market Participants

The Present Reliability Adequacy Criterion & Its Elements

"The NYSRC shall establish the IRM requirement for the NYCA such that the probability (or risk) of disconnecting any firm load due to resource deficiencies shall be, on average, not more than once in ten years. Compliance with this criterion shall be evaluated probabilistically, such that the loss of load expectation (LOLE) of disconnecting firm load due to resource deficiencies shall be, on average, no more than 0.1 day per year. This evaluation shall make due allowance for demand uncertainty, scheduled outages and deratings, forced outages and deratings, assistance over interconnections with neighboring control areas, NYS Transmission System emergency transfer capability, and capacity and/or load relief from available operating procedures."

Elements of NYSRC Criterion

- Once in 10 year LOLE index
- The factors that must be included in the Resource Capacity Requirement Analysis

This NYSRC Criterion is Consistent with NPCC Resource Adequacy Criterion

How the NYCA Resource Adequacy Criterion and Its Application Have Evolved Over the Past 35 Years

Criterion Factors That Must Be Considered in Reliability Evaluation							
	Forced Outages & Maintenance	Emergency Assistance From Other Areas	Emergency Load Relief Procedures	Load Forecast Uncertainty	NYS Transmission System	Locational Capacity Requirements	Reliability Program Applied
NYPP: Pre-1975	☯						Single-Area
NYPP: 1975-1990	☯	☯	☯				Two-Area
NYPP: 1990-1999	☯	☯	☯	☯			Two-Area
NYSRC: 1999-Present	☯	☯	☯	☯	☯	☯	MARS

GE Energy

Basics of Probability and Loss-of-Load Expectation (LOLE) Methods

New York State Reliability Council

June 7, 2007

Glenn Haringa

GE-Energy Consulting

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Probability

- **A number expressing the likelihood that a given event will occur**

$$\text{Probability} = \frac{\text{Number of “successful” outcomes}}{\text{Number of possible outcomes}}$$

- **Value ranges from 0 to 1**
- **Examples**

– ***Toss a balanced coin***	***Prob. of heads***	***1 / 2***
– ***Toss a coin twice***	***Prob. of 1 or more heads***	***3 / 4***
– ***Roll a balanced die***	***Prob. of 1 or 5***	***2 / 6***

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Expected Value

- **The average value for a random variable**

  Expected Value = Σ x * Prob(x)

- **Value range depends on event being considered**
  - ***Not necessarily one of the possible outcomes***
- **Example**
  - ***Toss 2 coins 20 times***
  - ***x = number of heads each toss (0, 1, or 2)***
  - ***Results: 0 – 5 times; 1 – 9 times; 2 – 6 times***
  - ***Expected Value (x) = 0 * (5/20) + 1 * (9/20) + 2 * (6/20)***

    = 1.05 heads

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Expected Value

Another Example

- **x = number of days per year that the high temperature exceeds 80° F**
- **Value could range from 0 to 365**
- **Review historical weather data**
  - ***Year 1 45 days***
  - ***Year 2 35 days***
  - ***Year 3 60 days***
  - ***Year 4 50 days***
  - ***Year 5 55 days***
- **Expected Value (x) = 49 days per year**

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Daily Loss-of-Load Expectation

- **The expected number of days per period that the system does not have sufficient generating capacity to meet the load at time of daily peak**
  - ***Measure of generation system reliability***
  - ***Considers generating unit unavailability***
- **Could review historical data and try to predict future reliability from it**
  - ***Conditions on the generation system changing too rapidly for this approach to be accurate***
- **Calculate for future time period based on assumptions for individual system parameters**

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Calculating LOLE – Analytical Method

- **From unit ratings and forced outage rates, construct a capacity outage table which shows the probability of having X MW or more on outage**
  - ***Enumerates all possible outage combinations with the corresponding MW on outage and probability of occurrence***
  - ***Table changes as units are installed, retired, or taken out for scheduled maintenance***
- **From the capacity outage table, determine the probability each day of not having sufficient capacity to meet the daily peak load**
- **Sum the daily probabilities over the year to compute the expected number of days per year**

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Calculating LOLE - Monte Carlo Simulation Method

- **"Roll the dice" to determine capacity available from each unit on the system based on unit's rating and forced outage rate**
- **Sum available capacity in each zone**
- **Count number of days per year that available capacity is less than daily peak load**
  - ***Gives daily LOLE for one set of random outages***
- **Simulate the year with additional sets of random outages**
  - ***Each simulation is also referred to as a "replication"***
- **Expected value is the average of the results for the individual replications**

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Simulation Convergence

- **Degree of statistical convergence of reliability index measured by standard deviation of estimate of reliability index calculated from simulation**

$$I_i = \text{Value of reliability index obtained from simulation data for year } i$$

$$N = \text{Number of times year has been simulated}$$

$$\bar{I} = \sum_{i=1}^{N} I_i / N = \text{Estimate of expected value of index } I$$

$$S^2 = \sum_{i=1}^{N} \left[\left(I_i - \bar{I} \right)^2 \right] / N = \text{Sample variance}$$

$$S_{\bar{I}} = \sqrt{\left(S^2 / N \right)} = \text{Standard deviation of estimate } \bar{I}$$

$$S_{\bar{I}} / \bar{I} = \text{Standard error of estimate } \bar{I}$$

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Factors Influencing Convergence

- **Number of units and size of units relative to load**
  - ***Many units small in comparison to load results in less year-to-year variation and faster convergence***
- **Strength of transmission network between interconnected zones**
  - ***Strong ties reduce yearly variations***
- **Level of reliability**
  - ***Highly reliable systems converge more slowly***

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Convergence - 2005 IRM Base Case Results

Replications	**1,500**	**10,000**
NYCA LOLE (days/year)	**0.100**	**0.093**
Standard Error (%)	**6.42**	**2.35**
Standard Error (days/yr)	**0.00642**	**0.00219**

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Confidence Intervals

		1,500		10,000	
%	Range (+/- Std. Dev.)	Lower Limit	Upper Limit	Lower Limit	Upper Limit
90	1.645	0.0894	0.1106	0.0894	0.0966
95	1.960	0.0874	0.1126	0.0887	0.0973
99	2.575	0.0835	0.1165	0.0874	0.0986

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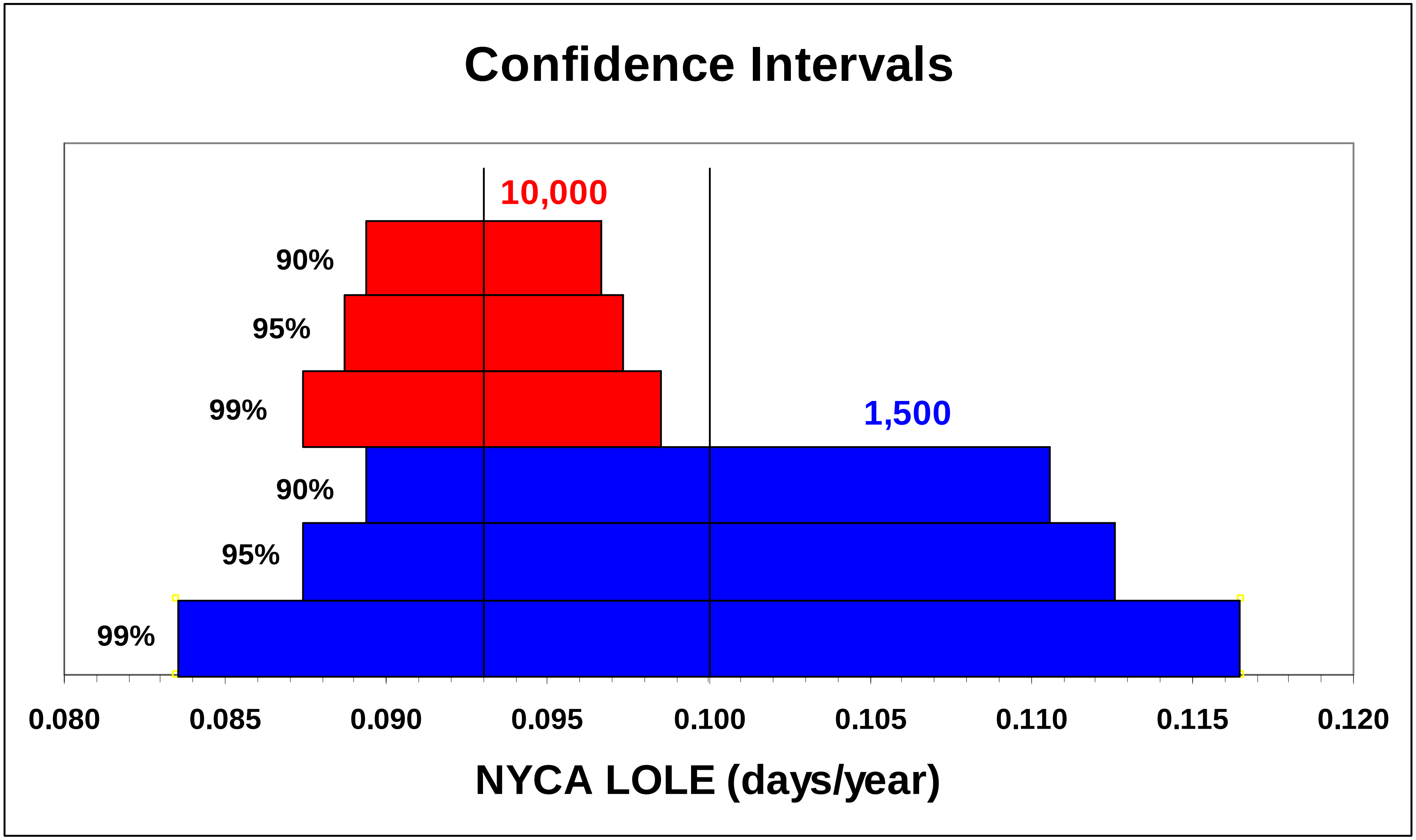
Confidence Intervals



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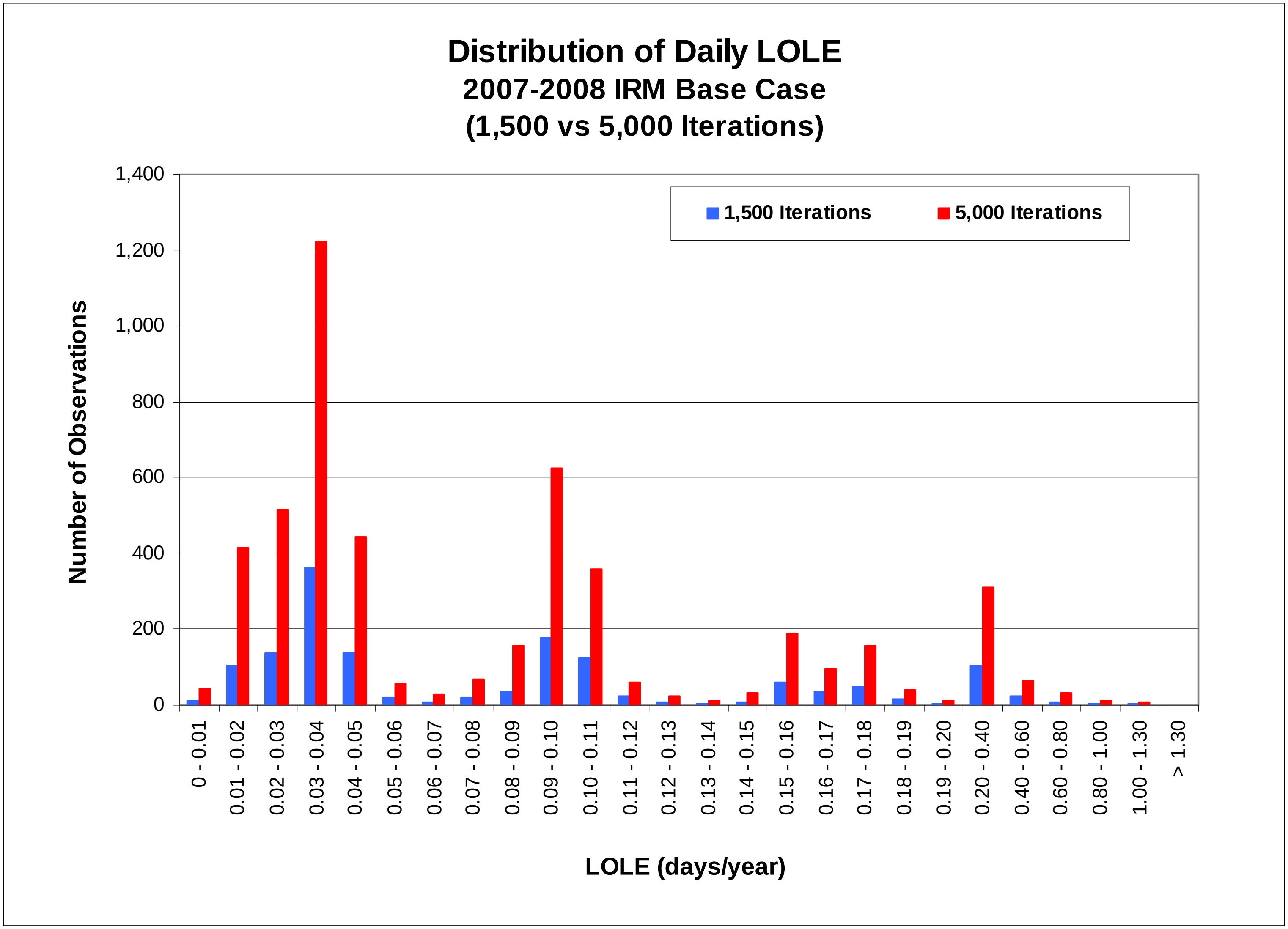
Distribution of Replication Results



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Distribution of Replication Results

- **Shape of distribution reflects load forecast uncertainty probabilities and the small number of outages each replication**
- **For a given level of load forecast uncertainty, integer number of days of outage will occur each replication**
- **Integer number of days combined with the seven discrete probabilities assumed gives rise to certain values for replication results that are much more likely to occur than others**
- **Spike of 1,222 replications at 0.03 - 0.04 days/year**
  - ***694 replications with 5 days at highest load level (0.0062) = 0.031***
  - ***528 replications with 6 days at highest load level (0.0062) = 0.037***
- **Spike of 626 replications at 0.09 - 0.10 days/year**
  - ***292 replications of 5 days at 0.0062 and 1 day at 0.0606 = 0.092***
  - ***334 replications of 6 days at 0.0062 and 1 day at 0.0606 = 0.098***

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GE Energy

MARS: The Primary Reliability Modeling Tool

New York State Reliability Council

June 7, 2007

Glenn Haringa

GE-Energy Consulting

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Multi-Area Reliability Simulation Program (MARS)

- **Developed for utilities of New York State**
- **Model any number of zones (areas) and Areas (pools)**
- **System modeled in considerable detail with accurate representation of random events and deterministic rules and policies**
- **Typical applications include:**
  - ***"As found" LOLE***
  - ***Locational capacity requirements***
  - ***Tie-line effectiveness***
  - ***Need for EOPs***

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MARS Methodology

- **Based on a full sequential Monte Carlo simulation**
- **Chronological system simulation performed by combining:**
  - ***Randomly generated operating histories of units through time***
  - ***Hourly chronological load cycles***
  - ***Transmission links***
- **Reliability indices determined for given scenario**
- **Year is simulated with different sets of random events until statistical convergence is obtained**

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Sequential Monte Carlo Simulation

Simulation Process

- **Determine capacity available each hour from each unit on the system based on:**
  - ***Unit rating and capacity states***
  - ***Scheduled planned outages***
  - ***Random forced outages***
- **Sum available capacity in each zone**
- **Determine zonal margins for each hour**
  - ***Margin = Capacity - Load***
- **Accumulate statistics for isolated indices**
- **Calculate flows between zones (if needed) and resulting zonal margins**
- **Accumulate statistics for interconnected indices**
- **Proceed to the next hour**

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Reliability Indices Calculated

- **Expected value and distribution of**
  - ***Daily LOLE (days/year)***
    - ***at time of daily peak for each zone, or***
    - ***at time of daily peak for specified zone or Area***
  - ***Hourly LOLE (hours/year)***
  - ***LOEE (MWh/year)***
  - ***Frequency (outages/year)***
  - ***Duration (hours/outage)***
- **Daily LOLE calculated for specified margin states**
- **Indices available by zone, Area, and zonal group on isolated and interconnected basis**

Calculation of Indices

- **Basic calculations are done at the zonal level**
  - ***Load is defined by zone, units are assigned to zones, and transfer limits are specified between zones***
  - ***Zonal load is compared to available zonal generation plus assistance from other zones***
  - ***If load exceeds generation plus assistance, zone is counted as being deficient***
- **Area (pool) indices are derived from the zones in that Area**
  - ***If one or more zones in the Area are deficient, the Area is counted as being deficient***
- **User can also define zonal groupings for calculating indices**
  - ***Calculations continue to be done at the zonal level***
  - ***If one or more zones in the zonal group are deficient, the zonal group is counted as being deficient***

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Load Data

- **Chronological hourly loads in EEI format for each zone**
- **Automatic load shape adjustment to meet specified monthly or annual peaks and energies**
- **Load forecast uncertainty modeled**
  - ***Input per unit multipliers on annual peak and corresponding probability of occurrence***
  - ***Reliability calculated for each load level***
  - ***Weighted-average value based on probabilities***

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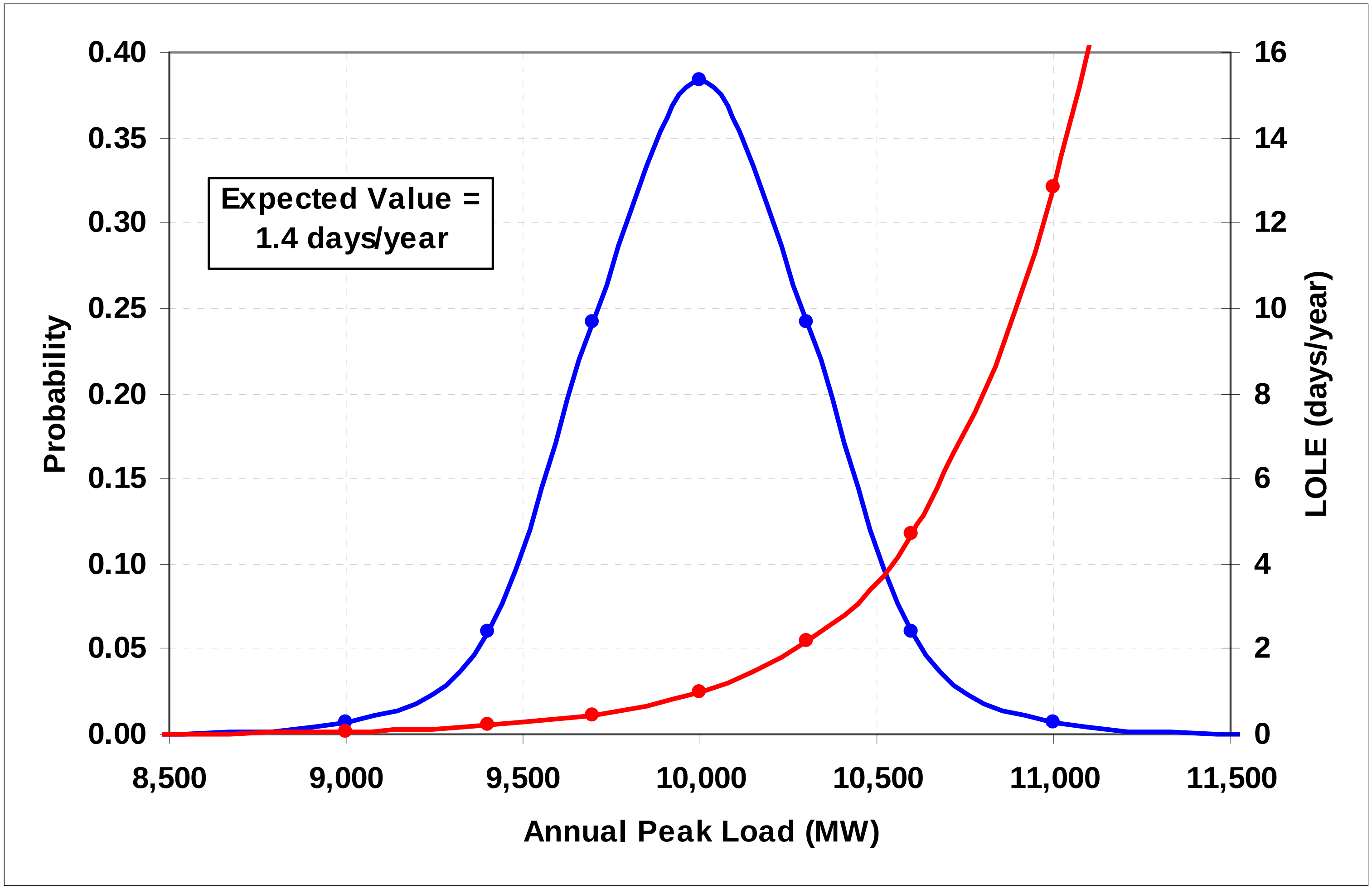
Load Forecast Uncertainty



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Unit Data

- **Name**
- **Unit type**
  - ***Thermal***
  - ***Energy-limited***
  - ***Cogeneration***
  - ***Energy storage***
  - ***Demand-side management***
- **Unit summary type**
- **Zonal location**
- **Installation and retirement dates**
- **Planned maintenance requirements**

Maintenance Scheduling

- **Fixed**
  - ***Specify starting/stopping month and day***
  - ***Thermal units limited to 2 periods per year***
- **Automatic**
  - ***Scheduled to levelize weekly MW reserves on zone, Area, or system basis***
  - ***Specify maintenance cycles (P.O.R. or weeks of maintenance) and maintenance windows***
- **Maintenance schedule from previous run**

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Thermal Units

- **Maximum capacity**
- **Scheduled maintenance requirements**
  - ***Fixed daily maintenance, or***
  - ***Automatically scheduled to levelize reserves***
- **Available capacity states**
- **Transition rates from each capacity state to each other capacity state**

State Transition Rates

- **Number of transitions from State A to State B per unit of time in State A**
- $$\mathbf{TR(A-B)} = \frac{\textbf{Number of transitions from A to B}}{\textbf{Total time in State A (hours)}}$$
- **Used to determine**
  - ***Mean time in each state***
  - ***Probability of transitioning from each state to each other state***
- **Option to approximate from partial forced outage rates and number of transitions**

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State Transition Rates

Example

State	MW	Hours
1	200	5000
2	100	2000
3	0	1000

Scheduled Outage Time 760 / 8760

Transition Matrix

From State	To State 1	To State 2	To State 3
1	0	10	5
2	6	0	12
3	9	8	0

Transition Rates

From State	To State 1	To State 2	To State 3
1	0.000	0.002	0.001
2	0.003	0.000	0.006
3	0.009	0.008	0.000

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Other Types of Generation Modeled

- **Energy - Limited Units**
  - ***Thermal unit with random outages***
    - *Specify energy probability distribution*
  - ***Deterministic load modifier***
    - *Peak-shave capacity scheduled deterministically or as needed*
- **Cogeneration**
  - ***Thermal unit with with associated hourly load demand***
- **Demand-Side Management and Energy Storage**
  - ***Specify net hourly load modification***
    - *for a typical week (168 hours)*
    - *for all hours in year*

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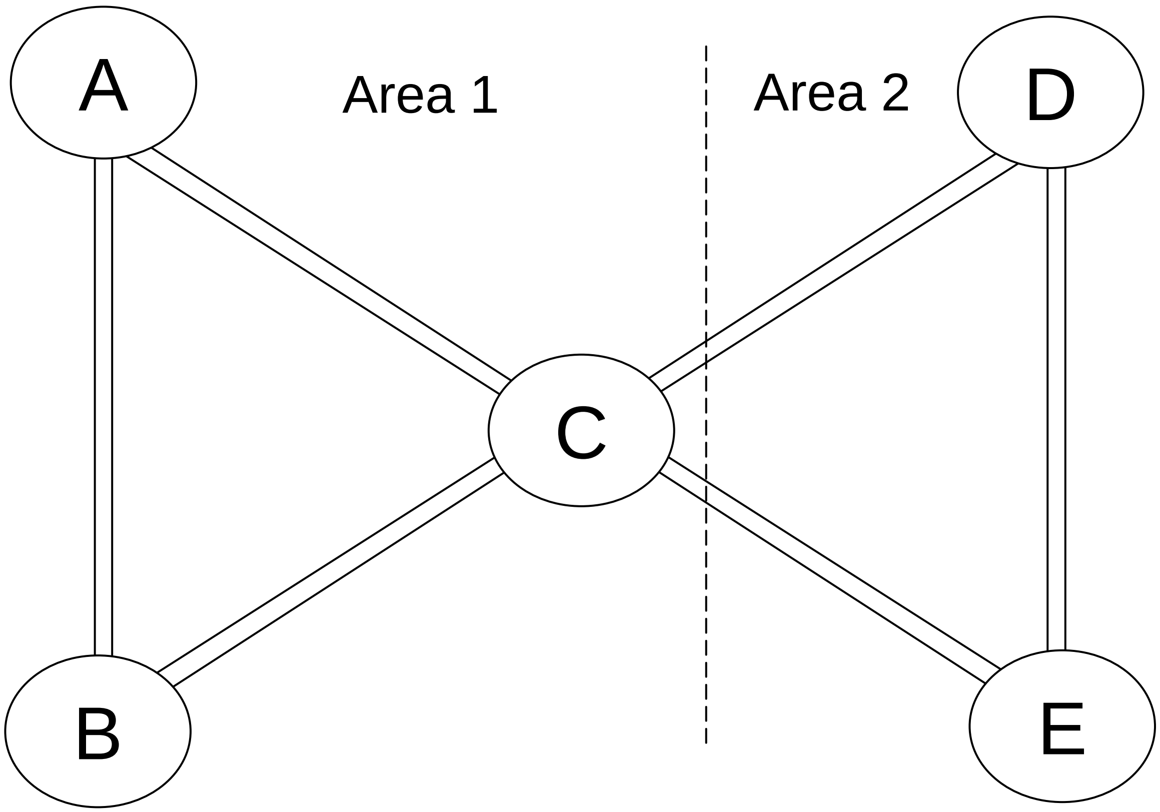
Transmission System Data

- **Define interfaces between zones**
  - ***Each interface consists of two ties***
- **Specify transfer limit of each tie**
  - ***Capacity states and interface transition rates***



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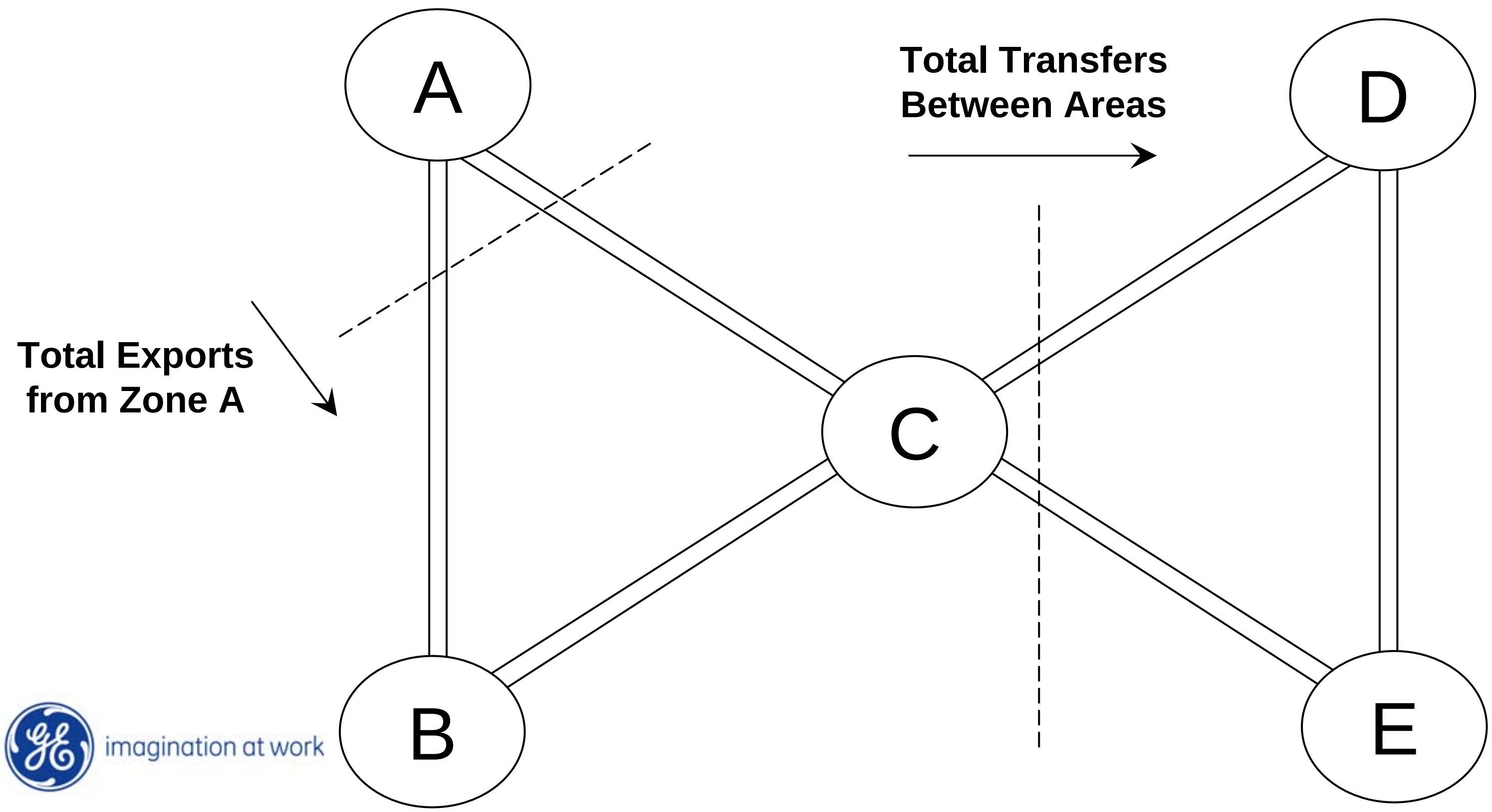
Transmission System Data

- **Limits on Simultaneous Interface Flows**
  - ***Limit Total Flow on Groups of Interfaces***
- **Dynamic Interface Transfer Limits**
  - ***Function of Available Units or Load Each Hour***



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Contracts (Firm or Curtailable)

- **Specify**
  - ***Hourly contract rating (type 2 energy-limited unit or DSM)***
  - ***Sending and receiving zones***
  - ***Interchange path for delivery***
- **Firm Contracts**
  - ***Scheduled regardless of available resources in the sending zones***
  - ***Curtailed only because of transfer limitations***
- **Curtailable contracts**
  - ***Scheduled to extent that sending zone has the necessary resources available from its own generation or assistance from other zones***
  - ***Curtailed due to insufficient resources or transfer limitations***
- **Summary of MWh and hours of curtailment**

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Resource Allocation Process

- **Reserve sharing**
  - ***Excess resources allocated among deficient zones in proportion to zonal shortfalls***
  - ***Iterative process to recognize interface transfer limits***
  - ***Undeliverable assistance reallocated to other zones***
- **Priority of assistance**
  - ***Assistance within Areas***
    - *Zones with excess assist other zones in the same Area*
    - *Option to allow flow through outside Areas*
  - ***Assistance between Areas***
    - *Specify arrangements between Area with excess and Area(s) receiving assistance*
    - *Option to allow flow through outside Areas*
  - ***System-wide assistance***

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Emergency Operating Procedures

- **Impact of EOPs modeled by evaluating daily LOLE at specified positive and negative margin states**
- **10 margin states available for each zone**
- **Specify margin states as**
  - ***Cumulative EOP benefit (MW), or***
  - ***Actual EOP benefit as sum of***
    - *fixed MW*
    - *per unit of zonal load*
    - *per unit of available zonal capacity*
- **Limit on number of days implemented each month**
- **Specify whether EOP benefits**
  - ***Zones only***
  - ***Other zones within same Area***
  - ***All zones in system***

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Emergency Operating Procedures

- **Zero specified ties during modeling of initial EOPs**
- **Staggered Implementation of EOPs**
  - ***Deficient zone must implement specified number of EOPs before other zones begin***
- **Isolated**
  - ***EOPs used by each zone as needed to meet load after dispatch of EL2 units***
- **Interconnected**
  - ***EOPs used as last resort after***
    - *dispatch of EL2 units*
    - *assistance from other zones*
    - *contract curtailments*

imagination at work

Emergency Operating Procedures

Example

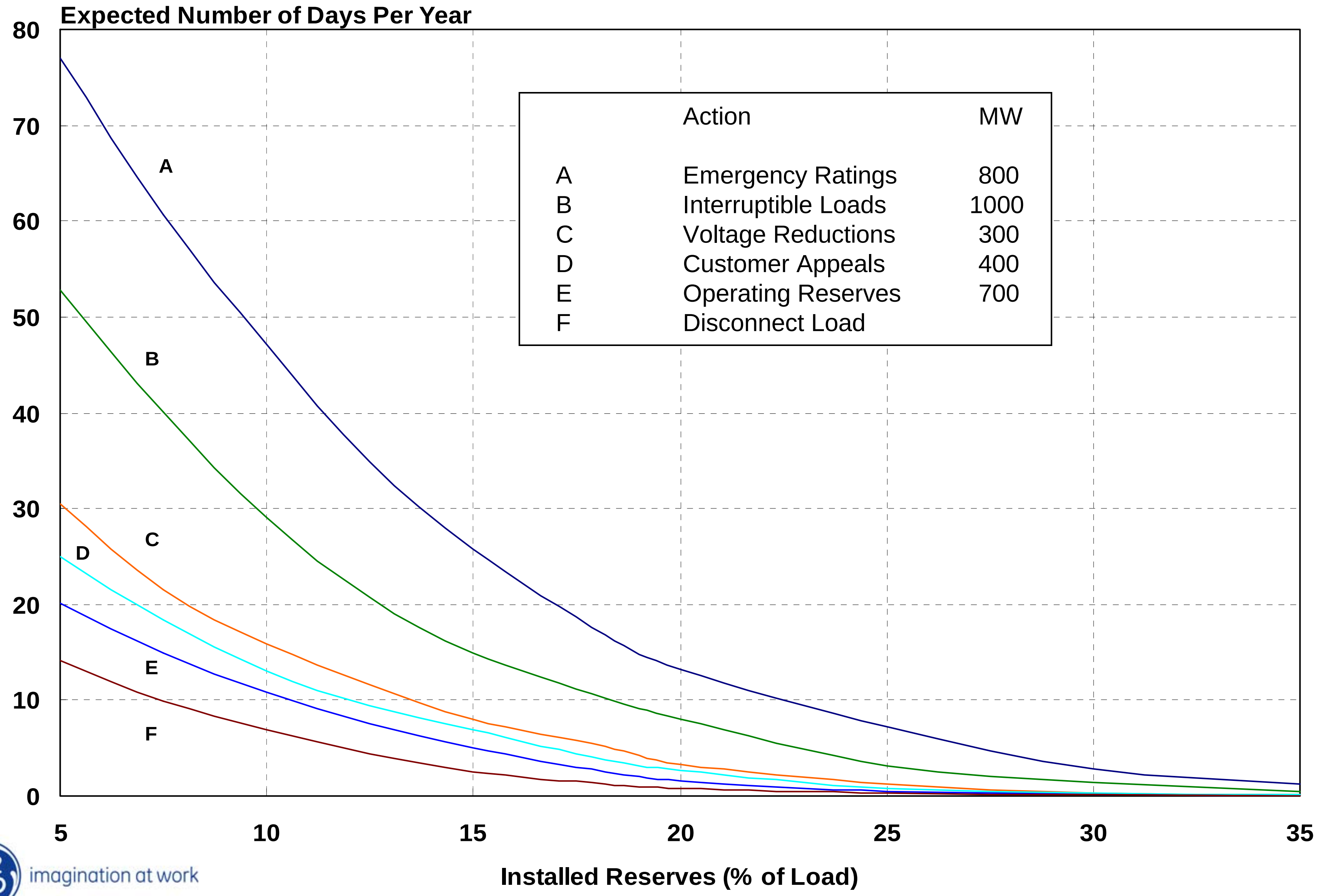
Operating Reserve Requirement = 1200 MW

EOP Procedure	MW Benefit
Emergency Ratings	800
Interruptible Loads	1000
Voltage Reductions	300
Customer Appeals	400
Reduce Operating Reserves	700

Margin State	MW
1	1200
2	400
3	-600
4	-900
5	-1300
6	-2000

imagination at work

Expected Need for EOPs



imagination at work

Output Summaries

- **Summary of input data**
  - ***Monthly load data***
  - ***Installed capacity by type by month***
  - ***Unit data***
- **Weekly maintenance schedule**
- **Calculated indices**
  - ***Zones, Areas, zonal groups***
  - ***Isolated and interconnected***
  - ***Load forecast uncertainty load levels***
  - ***Annual, monthly, and weekly***
- **Interface flow summary**
- **LOLE and LOEE for each replication year**
- **Detailed hourly output**

imagination at work

Major Modeling Assumptions
Their Source & Impacts

Frank Vitale, NYSRC Consultant
Bill Lamanna, NYISO

Topics to be Covered

- **NYCA Load Model**
- **NYCA Capacity Model**
- **Data Screening**
- **Emergency Operating Procedures**
- **Outside World Models**
- **Transmission System Model**

NYCA Load Model
Loads and Peaks

- **Sources**
  - 8760 hours of zonal data from the year 2002
  - Peak forecast was updated in October of 2006

- **Impacts**
  - More days near peak mean higher IRM Requirement
  - Trends - summer to winter peak ratio continues to increase.
  - Less diversity between Zones
  - Evaluating the impact of demand response programs

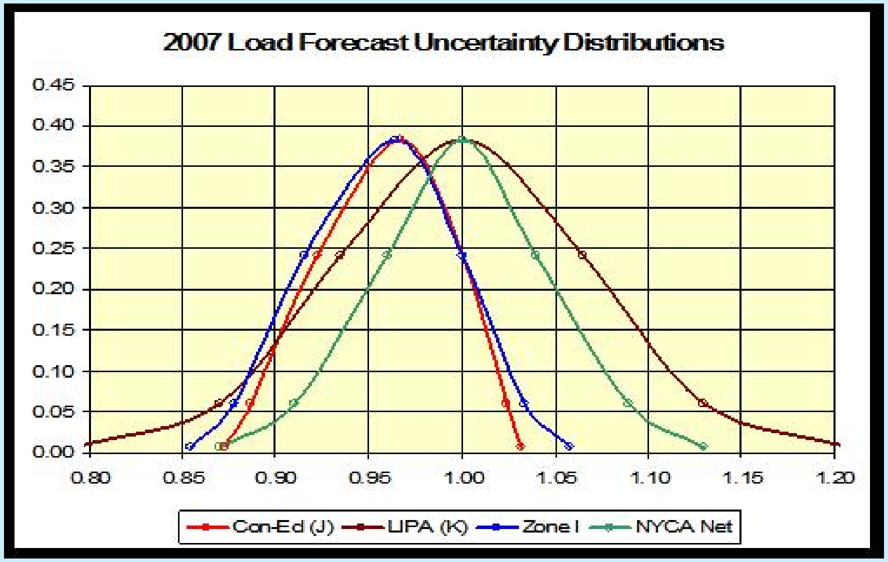
NYCA Load Model

Load Forecast Uncertainty

- Now incorporates separate uncertainty models for zones I, J, K and rest of state.
- Data is provided by Con Ed and LIPA.
- NYISO does rest of state.

2007 Load Forecast Uncertainty Models

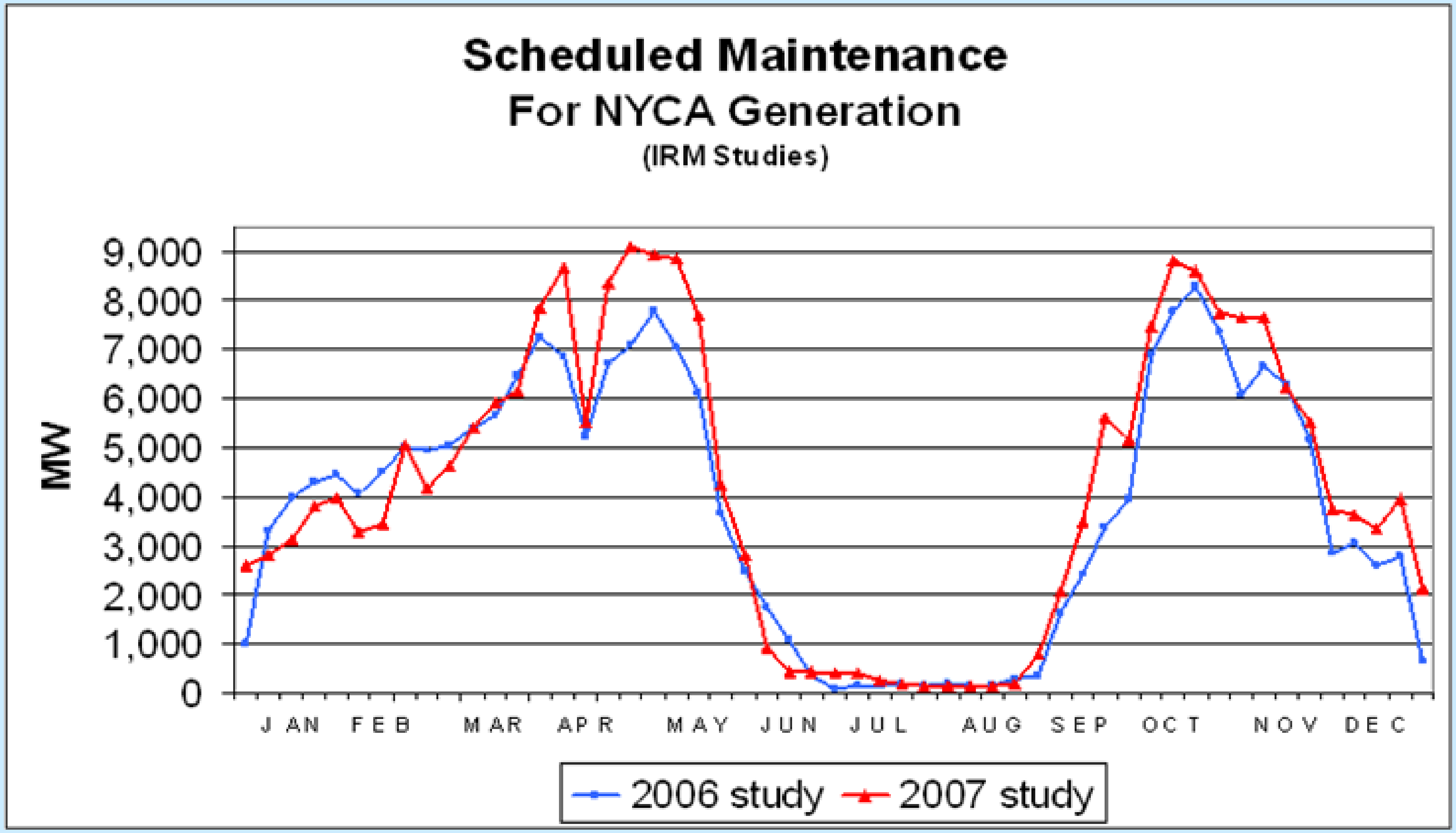
Multiplier	Zone I	Con Ed (J)	LIPA (K)	NYCA Net
0.0062	1.0580	1.0320	1.2075	1.1300
0.0606	1.0335	1.0245	1.1297	1.0900
0.2417	1.0000	1.0000	1.0648	1.0400
0.3830	0.9645	0.9673	1.0000	1.0000
0.2417	0.9156	0.9222	0.9352	0.9600
0.0606	0.8782	0.8869	0.8703	0.9100
0.0062	0.8539	0.8730	0.7925	0.8700



NYCA Capacity Model
Unit Size and Planned Outages

- **Sources**
  - Unit capacities are from the Gold Book based on semi-annual DMNC tests.
  - Planned outages from schedules, adjusted by history.
  - New units are given 4 weeks of planned outage.
- **Impacts**
  - Trend towards smaller units is continuing which reduces IRM Requirement.
  - No planned outages during peak periods.

NYCA Capacity Model
Planned Outages



NYCA Capacity Model
External Capacity from Contracts

- **Sources**
  - Grandfathered contracts
  - Estimated values based on history
  - Limited to avoid impacting IRM Requirement

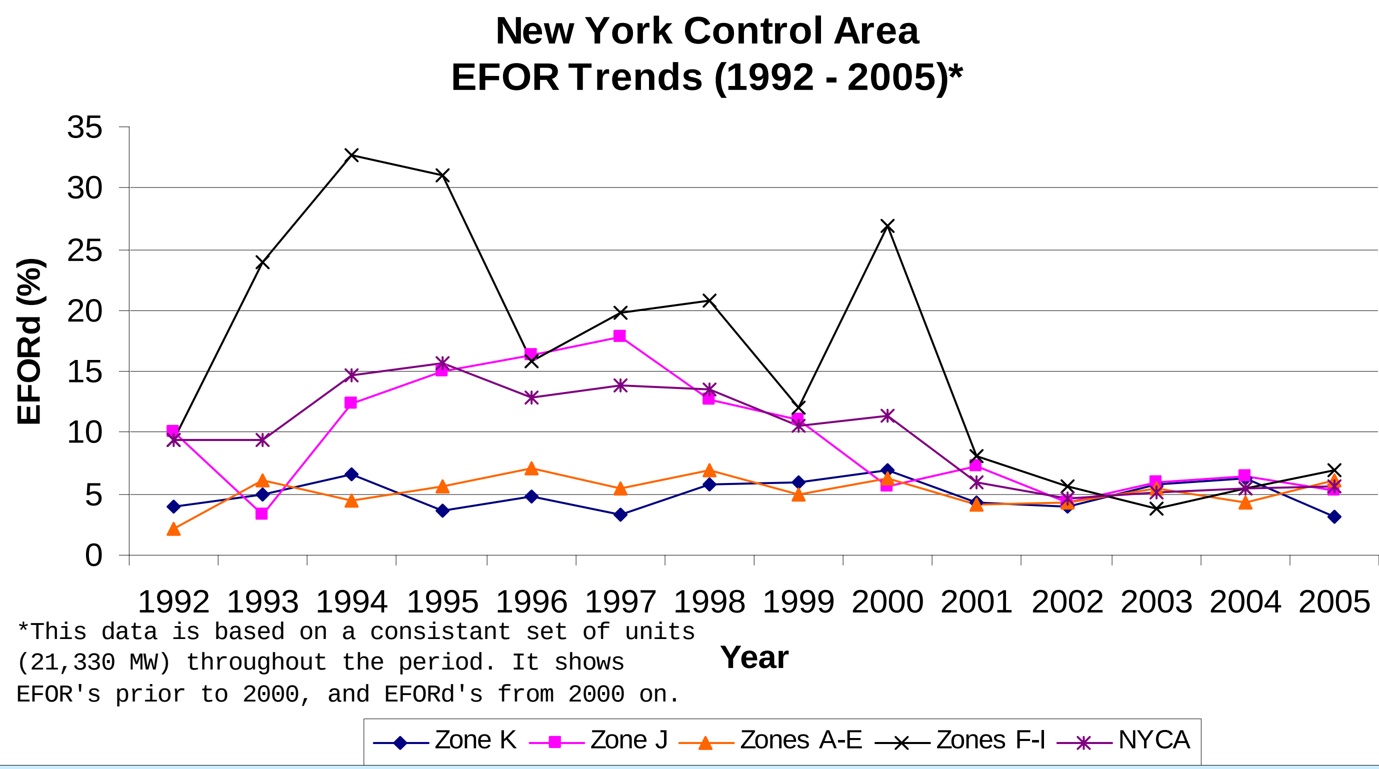
- **Impacts**
  - No capacity Impact – imports displace NYCA installed Capacity.

NYCA Capacity Model
Forced Outages

- **Sources**
  - Partial and full forced outages come from the Generator Availability Data System (GADS) reporting.
  - This data is converted into transition rates and emulates Equivalent Forced Outage Rates (EFORd).
  - New Units get either NERC class averages or NYCA fleet averages (for new GTs).
- **Impacts**
  - Use of EFORd instead of EFOR means lower IRM Requirement.
  - Trend towards higher availability means lower IRM Requirement.
  - Started using five year historical data in 2004 to predict future behavior.

NYCA Capacity Model

Forced Outage Rates - Trends



*This data is based on a consistant set of units (21,330 MW) throughout the period. It shows EFOR's prior to 2000, and EFORd's from 2000 on.

Emergency Operating Procedures

- **Sources**
  - NYISO Operations Group forecasts levels based on historic levels measured at the NYISO.
  - Order of EOPs based on NYISO procedures and experience.
  - Levels for Special Case Resources (SCRs) and Emergency Demand Response Program (EDRP) are adjusted to incorporate historical participation. The EDRPs are limited to 5 calls per month and some SCRs are emission limited.
- **Impacts**
  - SCR and EDRP programs continue to grow since their inception at the NYISO in 2001 and have led to reduced IRM Requirements.
  - There has been migration from voluntary programs towards the paid programs (SCR and EDRP).

Emergency Operating Procedures

Step	Procedure	Effect	MW Value
1	Special Case Resources	Load relief	1,080 MW*
2	Emergency Demand Response Prog.	Load relief	228 MW
3	5% manual voltage Reduction	Load relief	171 MW
4	Thirty-minute reserve to zero	Allow operating reserve to decrease to largest unit capacity (10-minute reserve)	600 MW
5	5% remote voltage Reduction	Load relief	465 MW**
6	Voluntary industrial curtailment	Load relief	156 MW**
7	General public appeals	Load relief	108 MW
8	Emergency Purchases	Load relief	Varies
9	Ten-minute reserve to zero	Allow 10-minute reserve to decrease to zero	1200 MW
10	Customer disconnections	Load relief	As needed

**   The SCR's are modeled as 1,080 MW, however they are discounted to 994 MW in July and August and further discounted in other months.*

** *   These EOPs are modeled in the program as a percentage. The associated MW value is based on a forecast 2007 peak load of 33,544 MW. Includes 11 MW of curtailed company use.*

nysrc.org New York State Reliability Council

Outside World Models

- **Sources**
  - The Northeast Power Coordinating Council's CP-8 working group.
  - Getting data directly from some of the Areas.
  - Outside Areas are modeled so they are not more reliable than their own or NYCA's criterion and their IRM is no higher than their design level.
- **Impact**
  - If external capacity contracts were not limited, they could reduce the amount of emergency assistance, thus raising the IRM.
  - Limits of the amount of firm capacity that can be bought from outside Areas is set by the NYISO.

Transmission System Model Components

- Topology
  - "Bubble Diagram" Construction and Interfaces
  - Transfer Capability Between the Zones (Bubbles)
  - Transmission Cable Outages – Cable EFORs
- Reconciliation of Transportation vs Network Model
  - Use of Interface Grouping to Capture Simultaneous Impacts and Flow Distributions (Shift Factors based on Network Impedance)
  - Use of Dynamic Transfer Limits to Capture Resource and Load Sensitivities

Transmission System Model

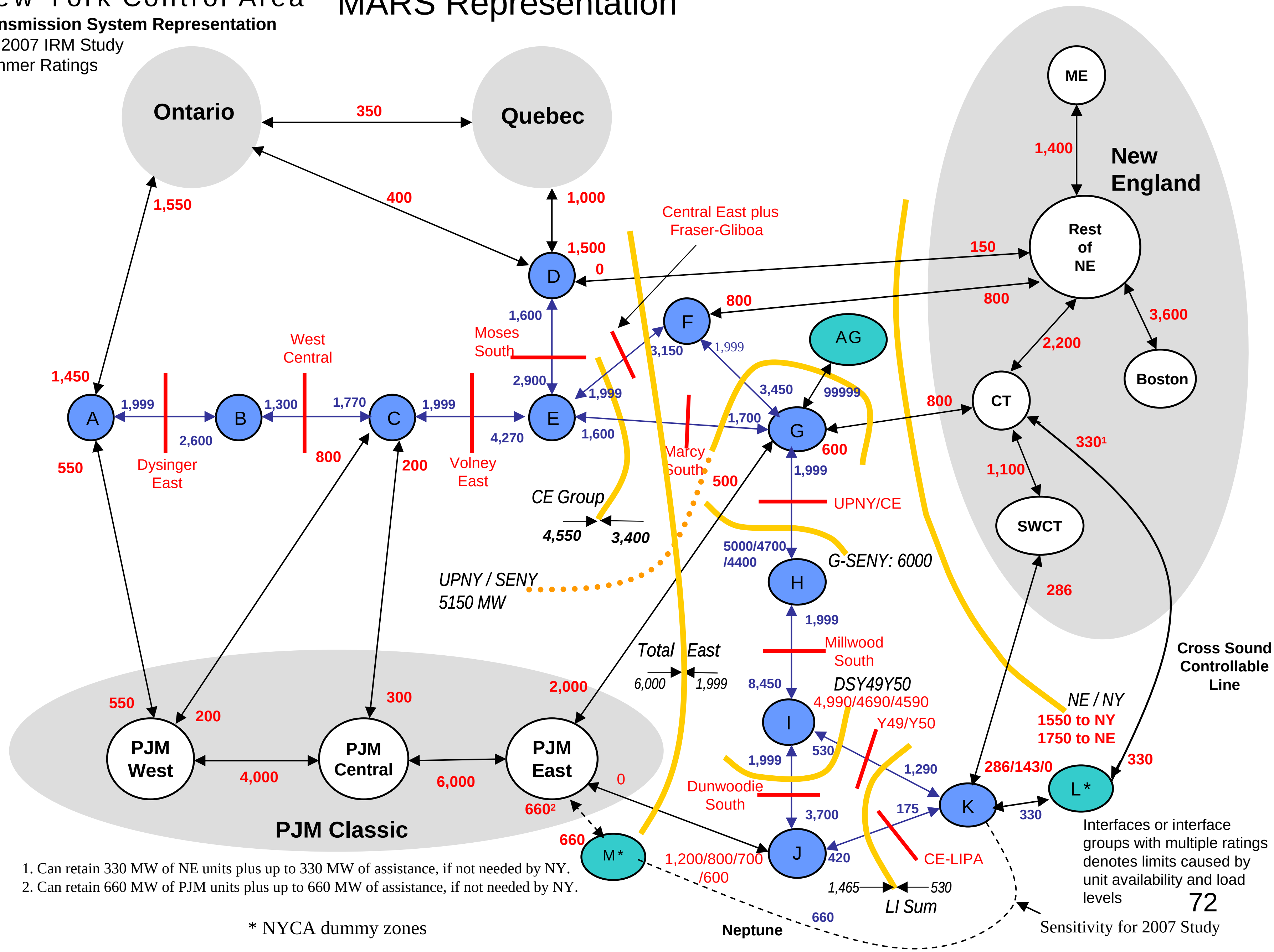
- Sources
  - NYISO Transmission Planning and Operations Studies
  - Regional Planning Studies
  - ICS members submit cable failure analysis so cable EFORs can be calculated.
- Impacts
  - The modeling of these potential constraints generally will increase the IRM and LCRs.

Transmission System Model Criteria

- Emergency Transfer Criteria is invoked.
- Allows for post contingency loading to Short Term Emergency (STE) Ratings.
- Allowance for loading above normal rating pre-contingency is not utilized.
- Voltage and Transient Stability Limits Used if More Limiting than Thermal
- Use NYISO guidelines for Transfer Limits
- Transfer limits are also assigned to interface groupings, not just between zones. These can have dynamic ratings as well.

New York Control Area MARS Representation

Transmission System Representation
For 2007 IRM Study
Summer Ratings



1. Can retain 330 MW of NE units plus up to 330 MW of assistance, if not needed by NY.
2. Can retain 660 MW of PJM units plus up to 660 MW of assistance, if not needed by NY.

* NYCA dummy zones

Study Analysis

Development of the
Base Case and Sensitivity Cases

Interpretation of Results

Development of Base Case

- The base case starts from the previous year's base case.
- An incremental process occurs whereby changes are made, one at a time, and results are calculated.
- Changes include incorporating new model functionality, altering assumptions, and updating data.
- Final database is arrived at when all changes have been made, based on Aug 1st assumptions.

Development of Base Case

Recent Functionality Improvements

- Dynamic interface ratings – allows interface values to change based on load levels and/or generation dispatch.
- Special Case Resource call limits – allows a finite number of times the SCRs are used.
- Emergency assistance from neighbors, at appropriate EOP level, is now automatically modeled.

Development of Base Case
Examples of potential assumption changes

- Reserve sharing order
- Use of outside pools to transport reserves
- The number of zones in outside control areas
- Modeling of wheeled contracts

ICS Assumption Matrix

Base Case Modeling Assumptions for 2008-09 NYCA IRM Requirement Study

Parameter	2007 Study Modeling Assumptions	Recommended 2008 Study Modeling Assumptions	Basis for Recommended 2008Assumptions	Possible Impact on IRM
NYCA Load Model				
Peak Load	33,544 MW for NYCA, 11,775 MW for zone J, and 5478 MW for zone K	To be provided by NYISO on October 1st.	Forecast based on examination of 2007 weather normalized peaks. Top three external Area peak days aligned with NYCA.	
Load Shape Model	2002 Load Shape	2002 Load Shape	After evaluating 2006 data, analysis indicates 2002 load shape is an appropriate representation for this analysis.	
Load Uncertainty Model	Statewide and zonal model updated to reflect current data.	Statewide and zonal model updated to reflect current data.	Updated data from LIPA, Con Ed, and NYISO.(see attachment A)	
Generating Unit Capacities	Updated DMNC test values.	Updated DMNC test values.	2007 Gold Book plus (list units that have come on line since GB).	

Development of Base Case
Examples of data changes

- Generating units are input based on their gold book ratings (summer and winter).
- Load Forecast Uncertainty is recalculated based on recent experience.
- Transition rates are developed based on unit events over last five year experience.
- Unit planned maintenance is directly input from schedules but may be adjusted if different from historical averages.

Running the Model

- The model is run whenever there is a planned data, model, or assumption update.
- Sensitivity cases show the impact of assumption variations of interest.
- The year of simulation repeats until the standard error of the index's cumulative average falls to 0.05.

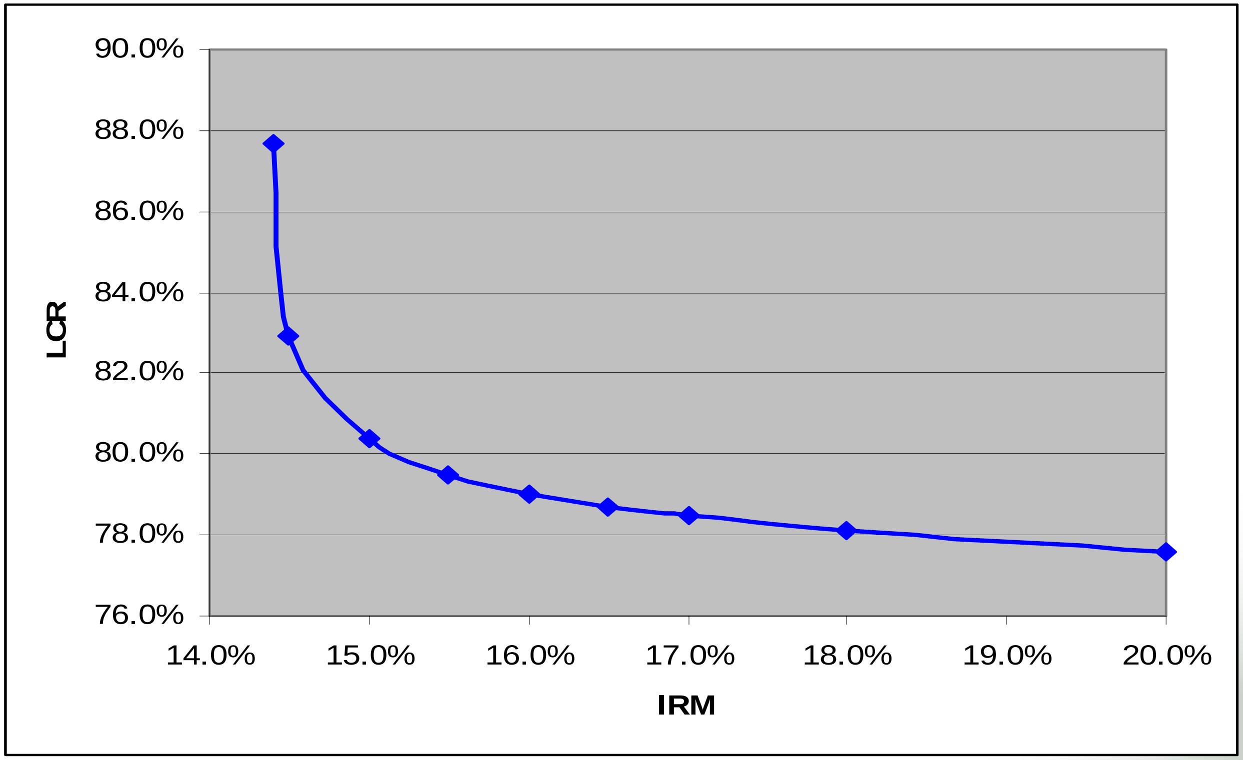
Unified Methodology
The LCR-IRM Curve

- The method for the ICS setting the statewide reserve margin and the NYISO setting the locational ICAP requirements is unified (the same).
- The procedure generates a curve showing the relationship between Installed Reserve Margins (IRMs) and Locational Capacity Requirements (LCRs).
- This procedure can be found in NYSRC's policy 5, appendix A.

Unified Methodology
The Procedure - simplified

- Capacity is removed from zones west of the Central East interface until a statewide IRM study point is achieved.
- Capacity is shifted from localities to the above zones until the 0.1 days/ year LOLE criteria is violated.
- The resulting capacity to load ratios in the localities form the LCRs

LCRs vs Statewide IRM Example

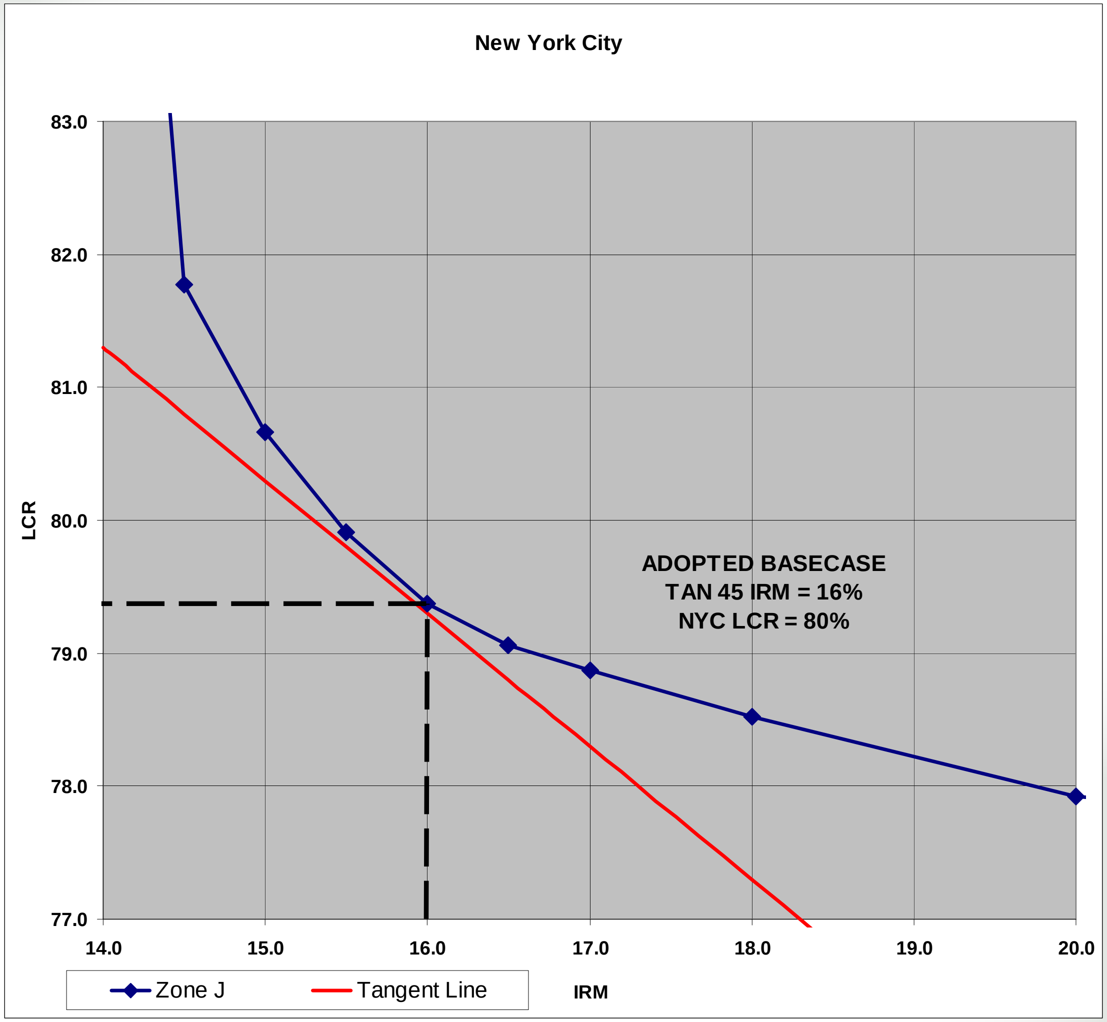


Anchoring Method

- Method shown in Appendix B of NYSRC's Policy 5.
- Uses multi-order polynomial regression analysis to fit the curve, maximizing R^2 value (R^2=1 is a perfect fit).
- Applies a tangent (-45 degree) line to find the base case point.

New York City LCRs vs Statewide IRM

From the 2007 IRM Study Report



Interpreting Results
Base case development

- As pointed out before, all changes to the model are done one at a time from the previous year’s base case.
- Note that all changes represent a potential departure from the LCR-IRM curve itself.
- An LCR-IRM curve takes two to three weeks to complete.
- It would be time prohibitive to create an LCR-IRM curve for each change.

Interpreting Results
Base case development- con't

- The starting point is the previous year's IRM/LCR base case point.
- Results for each change made is given in terms of LOLE change.
- Capacity is then either added or subtracted in all zones (except zone I because it has no major capacity) until the LOLE is back to 0.1 days/year.

Interpreting Results

Base case development- con't

- Verification runs may also be done at the Free Flowing Equivalent (FFE) point.
- This is the point at the left most portion of the IRM-LCR curve.
- The capacities and loads in the FFE for the localities are 'as forecast' for the upcoming study year.

Sensitivity Testing

- Once a base case is arrived at, a list of sensitivity cases is developed by ICS.
- Sensitivities can be used to determine the value of an assumption. For example in the 2007 IRM study, the impact of Load Forecast Uncertainty was worth 5.8 percentage points.
- Sensitivities can also be used to show a change in an assumption parameter. For example, lowering the reserve margins in neighboring CA's (by increasing their loads by 10%) raised the NYCA IRM by 0.9 percentage points.

2007-08 IRM Study Sensitivity Cases

1.	NYCA Isolated (no emergency assistance or non-UDR capacity from Outside World Areas)
2.	Use of 2006 Gold Book NYCA Peak Load Forecast (last year's input assumption)
3.	Load Forecast Uncertainty Model not Represented
4.	No SCR and EDRP Resources Available
5.	No Voltage Reductions
6.	No NYCA Transmission Constraints – Free Flow Case (i.e., infinite NYCA transfer limits)
7.	Peak Loads of all Outside World Areas Increased and Decreased by 10%
8.	Increased FORs – Represented by a GADf of 250 MW (doubled 2006 study value)
9.	Use NYISO 8/16/06 proposed SENY transfer limits (G-SENY, UPNY/CE, and DSY49Y50).
10.	Add Neptune Cable (660 MW of UDRs) with increased emergency assistance capability (750 MW) when units are unavailable.
11.	Cross Sound Cable as a free flowing tie.
12.	Run Free Flow Equivalent by removing capacity from Zones A-I, including Zone AG (instead of just A, C, and D).
13.	No transition rates (forced outage rates) on cable interfaces.

Sensitivity Methodology

- Start at the new base case point
- Make the parameter change
- Increase or decrease capacity in all zones (except zone I because it has no major capacity) until the LOLE is back to 0.1 days/year.
- Record results.

Other Analyses
One Year Studies

- The IRM study. Today's topic.
- The LCR Review. John Adams to talk about next on the agenda.
- External ICAP Analysis, performed by NYISO

External ICAP Analysis

- Is performed by NYISO after the completion of the IRM and LCR studies.
- Method employed does not interfere with the amount of emergency assistance that the IRM study relies on to reach 0.1 days/year LOLE.

External ICAP Analysis Method

- Contracts modeled in the IRM (except grandfathered contracts) are removed.
- Individual Control Area limits are arrived at by shifting capacity outside of NYCA until 0.1 LOLE criteria is violated.
- Total import limit is arrived at by shifting capacity simultaneously, at the above found ratios, until 0.1 criteria is violated.

Establishing Locational (Installed) Capacity Requirements (LCRs)

For the New York Control Area

Presented at the NYSRC Resource Adequacy Workshop

June 7, 2007

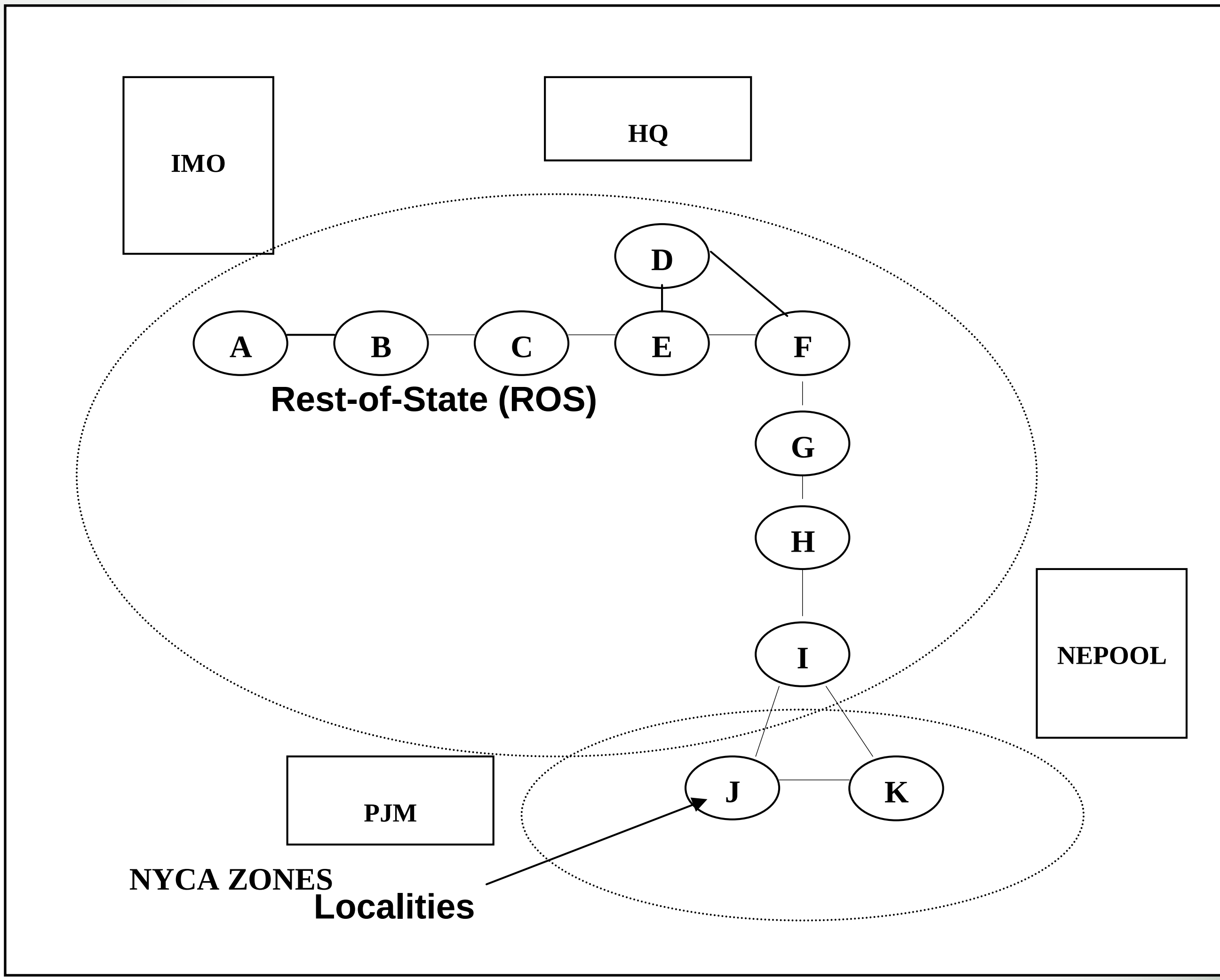
Locational Capacity Requirements - Introduction

- The purpose of this presentation is two fold:
  - *First is to describe how New York's locational capacity requirements are determined;*
  - *Second is to describe the market implementation of the IRM and LCRs*

- Tariff Definition of Locational Capacity
  - ***2.98 Locational Minimum Installed Capacity Requirement:***

The portion of the NYCA Minimum Installed Capacity Requirement that must be electrically located within a Locality, or possess an approved Unforced Capacity Deliverability Right, in order to ensure that sufficient Energy and Capacity are available in that Locality and that appropriate reliability criteria are met.

NYCA Load Zones, Localities and Neighboring Control Areas



NYISO Procedure for Determining LCRs

- The determination of the LCRs begins with IRM base case that approved each year by the NYSRC EC.
- Capacity is shifted out of each of the Localities independently until the reliability criteria is no longer being met.
- Capacity is shifted out of the Localities simultaneously based on the proportions determined above until criteria is violated.
- The capacity to peak load ratio that results from the previous step is the minimum or locational capacity requirement for the Locality that is needed to meet criteria.

Procedure for Determining LCRs (cont.)

- The minimum locational capacity required for the Locality to meet criteria is compared to the IRM base case or “tan 45” Locality capacity ratios

- Under the unified methodology the NYISO could ordinarily only recommend approval of an equal to or higher locational requirement than the IRM base case.

- Generally, the NYISO would adopt the IRM base case or “tan 45” results after the NYISO procedure confirmed the results.

NYISO Approval Process for LCRs

- The analytical work is documented in a report entitled: "LOCATIONAL INSTALLED CAPACITY REQUIREMENTS REVIEW". The review can be found on the NYISO web site at www.nyiso.com/services/planning/resourceadequacyplanning

- The results of the review along with a recommendation are presented to the NYISO Operating Committee usually at the February meeting.

- At the conclusion of the presentation, a motion containing the recommended LCRs is presented for a vote.

- LCRs need to be approved before the capacity auctions for the upcoming capability year can proceed.

- NYSRC reviews LCRs for consistency with IRM to ensure resource adequacy criteria is satisfied.

Market Implementation of IRM and LCRs

- Article 5 of the NYISO Market Services Tariff entitled: "CONTROL AREA SERVICES: RIGHTS AND OBLIGATIONS" set forth the following NYISO control area service requirements:
  - *(h) Defining the Installed Capacity requirements for LSEs[1], inclusive of individual customers taking services directly from the ISO, within the NYCA;*
  - *(i) Determining Locational Installed Capacity requirements for LSEs to ensure the reliable operation of the NYCA;*
  - *(j) Administering of an Installed Capacity Market;*

- Sections 5.10 through 5.16 of the Market Service Tariff implements the Installed Capacity market design, governs LSE Unforced Capacity Obligations, the qualification of Installed Capacity Suppliers, and the ISO's administration of Installed Capacity auctions.

1 Load Serving Entity (LSE) is any entity authorized to supply Energy, Capacity and/or Ancillary Services to retail customers located within the NYCA,

Market Implementation (Cont.)

- Each LSE must procure Unforced Capacity[1] in an amount equal to its LSE Unforced Capacity Obligation from any Installed Capacity Supplier through Bilateral Transactions with purchases in ISO-administered Installed Capacity auctions, by self supply from qualified sources, or by a combination of these methods.

- Each LSE must certify the amount of Unforced Capacity it has or has obtained prior to the beginning of each Obligation Procurement Period by submitting completed Installed Capacity certification forms to the ISO by the date specified in the ISO Procedures.

1) Unforced capacity is the installed capacity discounted by the EFORd.

Thank You

- Any Questions

Questions and Answers

Curt Dahl