2020 Project:
Locational Marginal Pricing of Capacity
Concept Design Proposal

Pallas LeeVanSchaick
Potomac Economics
Market Monitoring Unit

Installed Capacity Working Group
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Overview of Presentation

- Scope, deliverables, and justification for the 2020 Project: *Locational Marginal Pricing of Capacity*
- Key capacity market design elements of proposed concept ("C-LMP")
- Overview of C-LMP market processes:
  - ✓ Quadrennial Demand Curve Reset
  - ✓ Annual adjustments
  - ✓ Monthly clearing of the spot capacity auction and market settlements
- Discussion of several issues regarding market performance
- Key questions to be answered
  - ✓ In the 2020 project
  - ✓ In future analyses

Scope and Deliverables of 2020 Project:
Locational Marginal Pricing of Capacity

Scope and Deliverables of 2020 Project: *Locational Marginal Pricing of Capacity*

The NYISO defined the *Locational Marginal Pricing of Capacity* project as part of the 2020 Market Project Candidate list. This project is scheduled for completion in Q1.

<u>NYISO's *2020 Market Project Candidates* document:</u>

- *Project Objective(s) & Anticipated Deliverable(s)*
  - ✓ *The objective for this project would be to consider a capacity pricing framework where the clearing price at each location is set in accordance with the* ***marginal reliability value of capacity at the location****.*
  - ✓ *The deliverable for 2020 is Issue Discovery.*

Scope and Deliverables of 2020 Project: *Locational Marginal Pricing of Capacity*

NYISO's *2020 Market Project Candidates* document:

- *Project Justification – This proposal* ***could****:*
  - ✓ *Reduce the costs of satisfying resource adequacy needs,*
  - ✓ *Facilitate more efficient investment and retirement decisions,*
  - ✓ *Be more adaptable to changes in resource mix (i.e., increasing penetration of wind, solar, and energy storage), and*
  - ✓ *Simplify market administration.*

Scope and Deliverables of 2020 Project: *Locational Marginal Pricing of Capacity*

<u>Project Schedule:</u>

- January 21 – Kickoff presentation
- February 6 – Presentation of proposed conceptual design
- February 19 and/or March 6 – Present example of market impact analysis based on 2019/20 LCR case at LOE conditions, including estimated prices and consumer payments for:
  - ✓ Generation and load in each zone
  - ✓ Transmission interfaces
  - ✓ Capacity imports
  - ✓ Compared to the current market framework
- March 26 – Sum-up proposal, results, conclusions, answers to outstanding questions, and list of unanswered questions.
- Schedule is tentative and dependent on other higher priority capacity market design efforts.

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Key Capacity Market Design Elements

Key Capacity Market Design Elements

1) The market should solve the "missing money problem"
   - ✓ A DCR is needed to estimate Net CONE in each location
   - ✓ Net CONEs are used with GE MARS to derive a system-level CRI ("Cost of Reliability Improvement")
   - ✓ C-LMP uses CRI as the current design uses Net CONE
2) The market should satisfy resource adequacy & other planning reliability and deliverability criteria to the extent possible
   - ✓ GE MARS topology should incorporate relevant planning and deliverability criteria to the extent possible
3) Efficient prices for different locations and technologies should be based on marginal reliability value
   - ✓ GE MARS is used to clear the spot capacity auction

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Key Capacity Market Design Elements

- Cost of Reliability Improvement ("CRI") –
  - ✓ The estimated capital investment cost of adding an amount of capacity to a zone that improves the LOLE by 0.001.
  - ✓ Based on estimated cost of new investment from DCR study and MRI of capacity in each area under LOE conditions.
- Marginal Reliability Impact ("MRI") –
  - ✓ The estimated reliability benefit (i.e., reduction in the annual loss of load expectation ("LOLE")) from adding 100 MW of UCAP to an area.
  - ✓ Measured by the MARS model for the "As-Cleared" system in each monthly auction.
- Clearing price$_{zt}$ = MRI$_{zt}$*CRI for each zone and technology

Overview of Market Processes

Market Processes

- Market processes that would be affected by the proposed concept (C-LMP):
  - ✓ Quadrennial DCR sets CRI
  - ✓ Annual update of MARS topology, IRM, TSLs
  - ✓ Annual update of CRI with summer/winter shaping
  - ✓ Monthly clearing and price determination in the capacity auction
  - ✓ Monthly settlement with LSEs, generators, imports, & NYTOs
- Other affected processes are discussed later:
  - ✓ Interconnection process
  - ✓ Buyer-side Mitigation evaluations

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Market Process – Quadrennial DCR

Demand Curve Determination	Current Framework	Concept Proposal
	• Estimate NetCONE at the LOE conditions for relevant zones • Set ZCP for relevant zones based on consultant recommendation	1. Estimate NetCONE curves for relevant zones 2. Estimate MRI in each zone using MARS for latest IRM/LCR case 3. Calculate CRI by shifting/ adding capacity in MARS until: (a) reaching LOLE that corresponds to LOE conditions (b) CRI equal in relevant zones 4. Determine SAF (Slope Adjustment Factor) based on consultant recommendation

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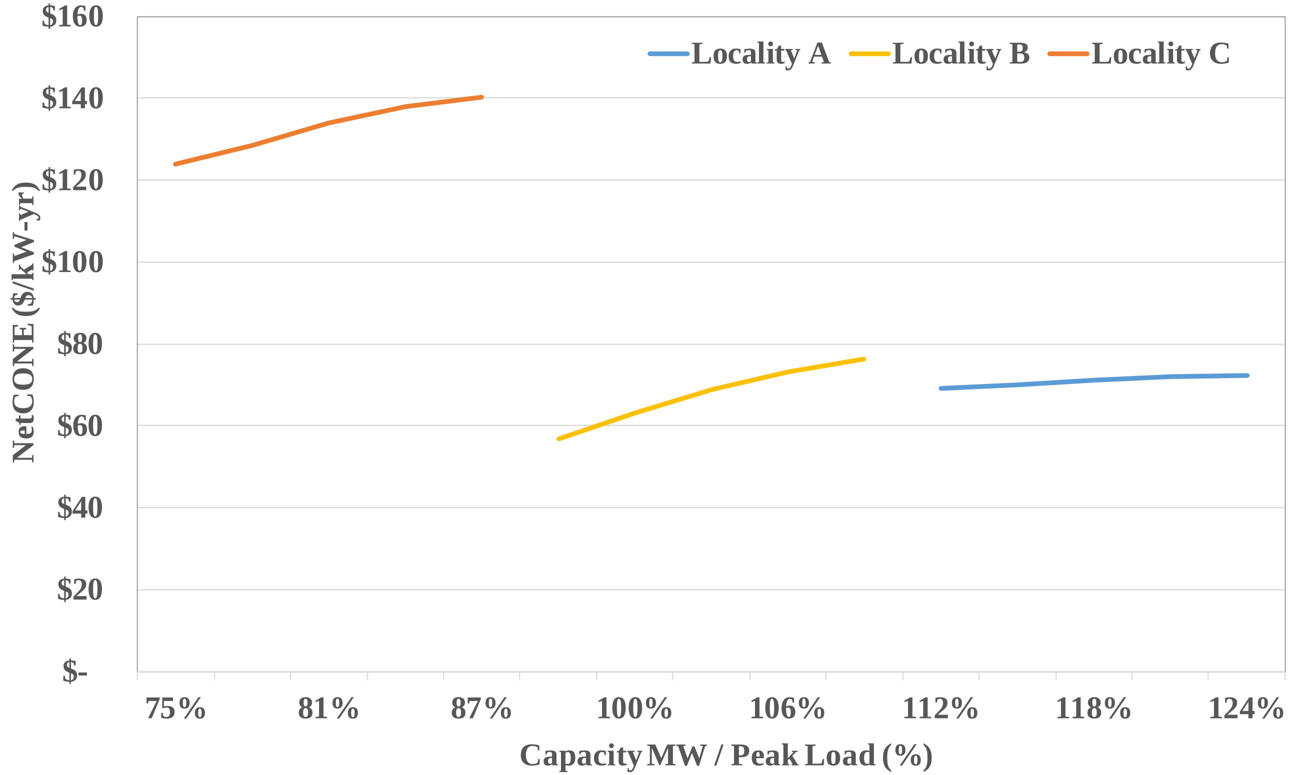
Market Process – Quadrennial DCR: (1) Estimate NetCONE Curves



- Estimate NetCONE curves relevant zones as is done in the DCR
  - ✓ These are the marginal cost of capacity at a particular margin level
  - ✓ Relevant zone determination is discussed under step (3)

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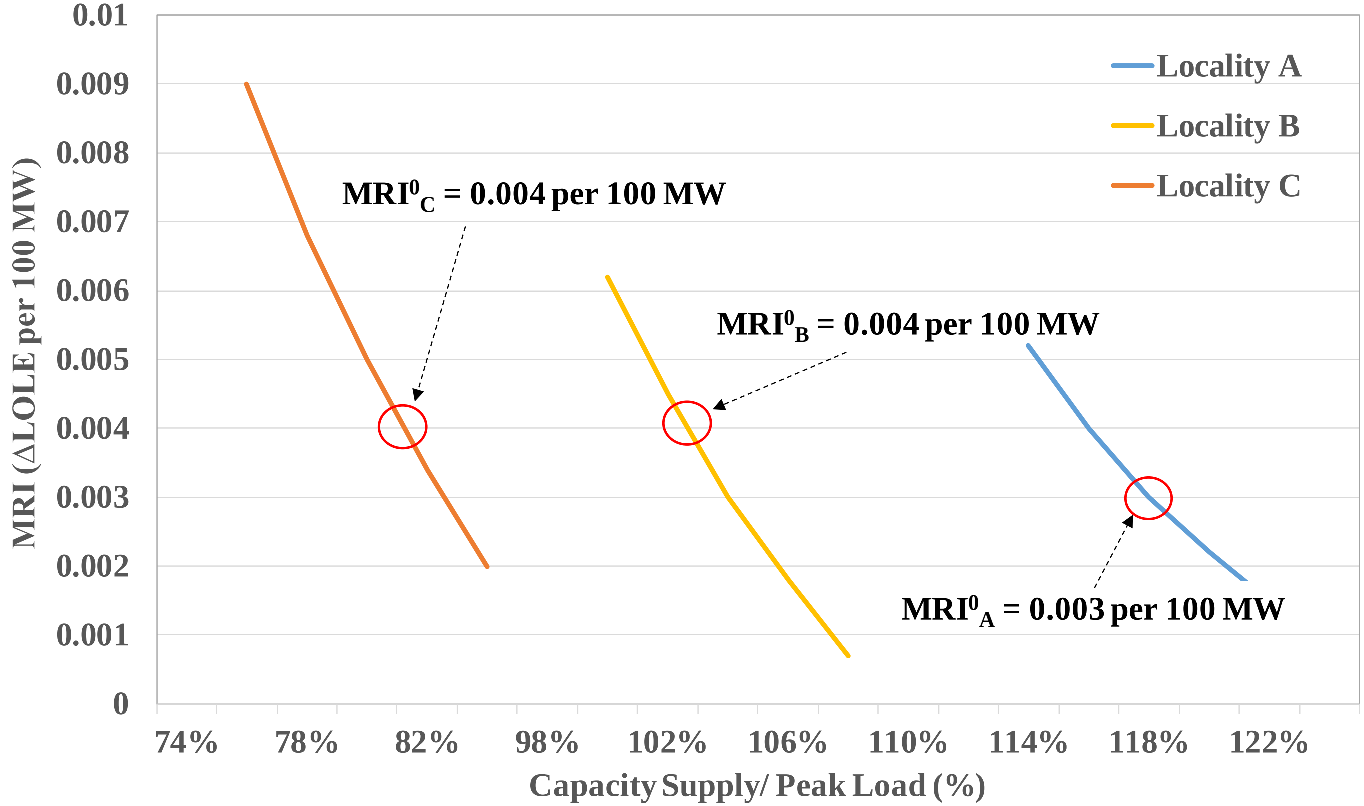
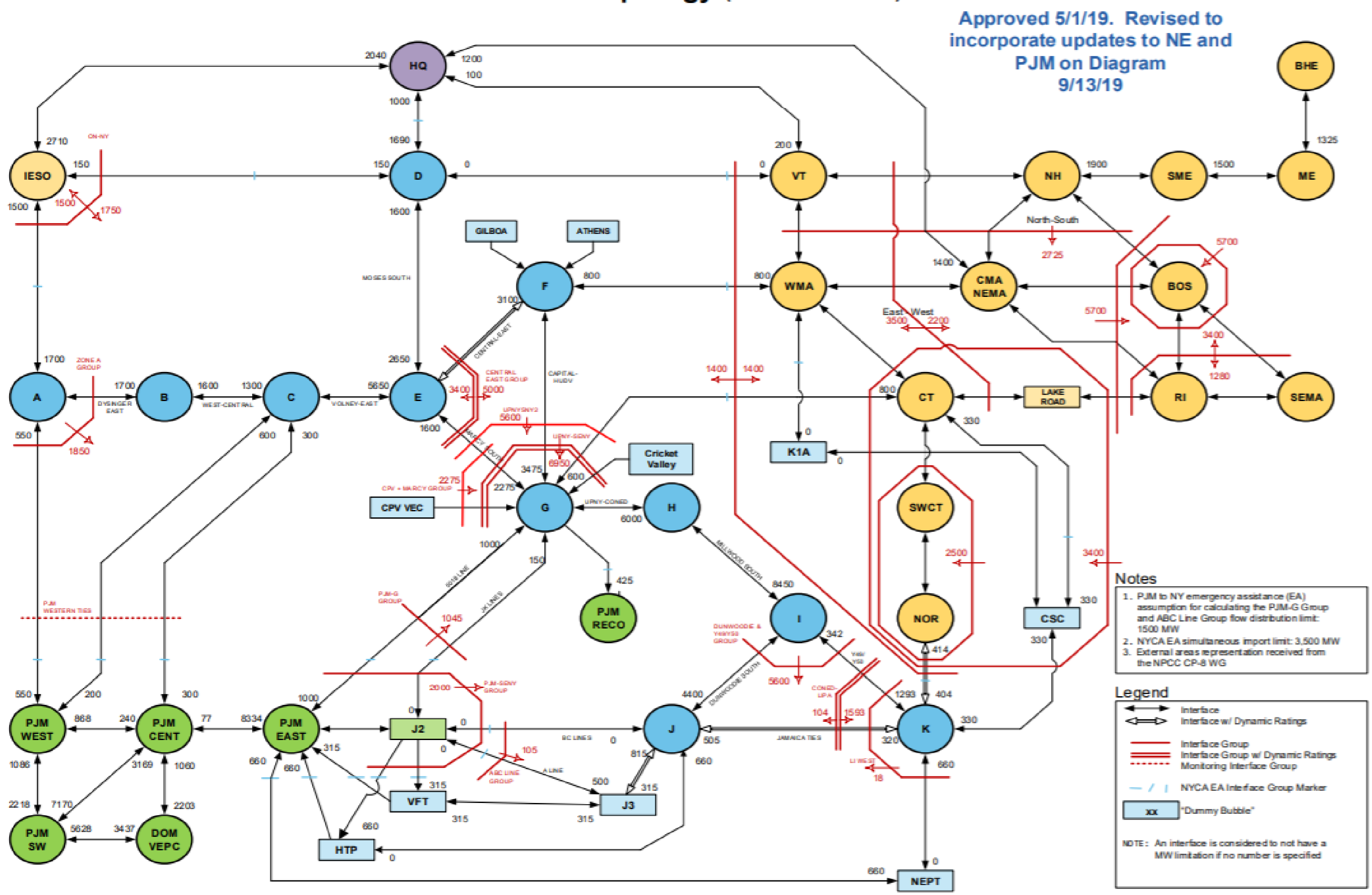
Market Process – Quadrennial DCR: (2) Estimate Marginal Reliability Impacts w/MARS



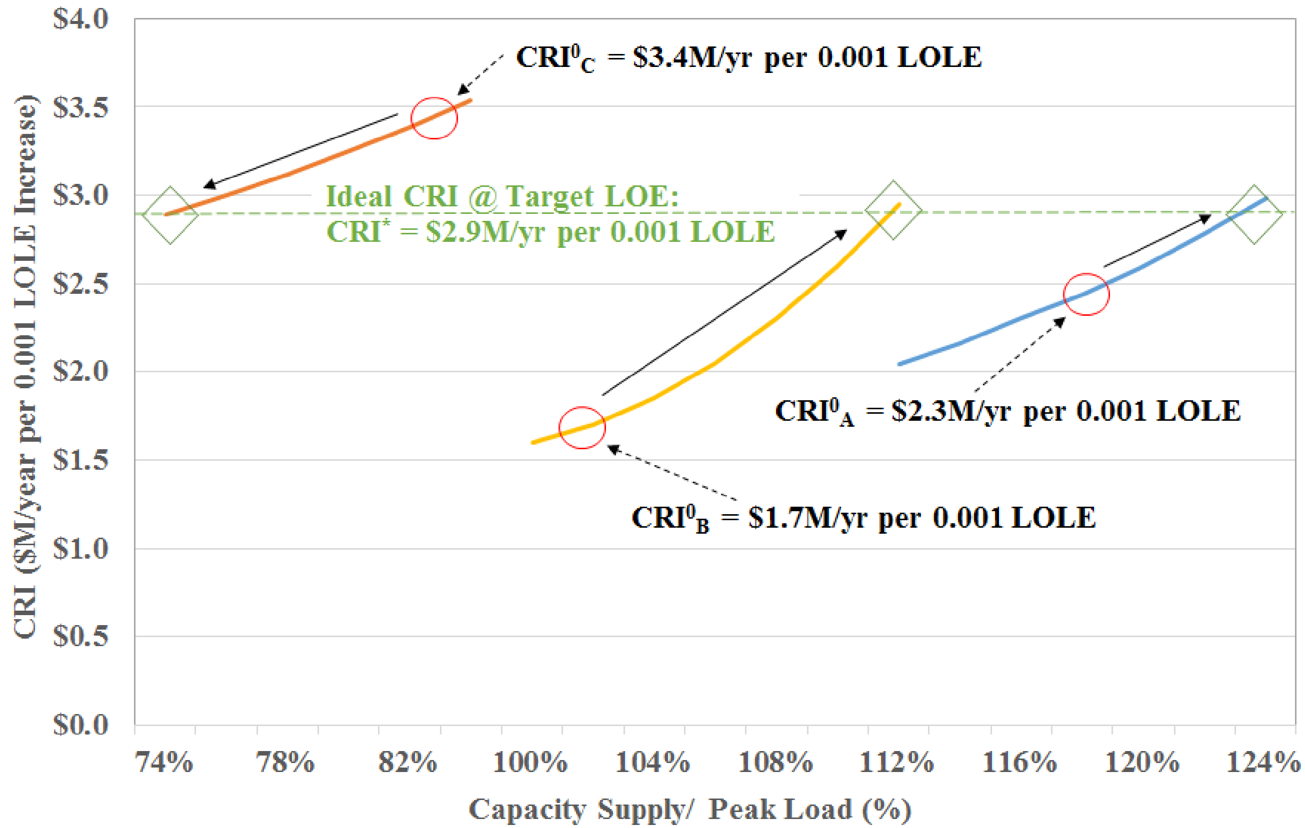
- Estimate MRI of supply in each relevant zone as MW are added
  - ✓ Start with the latest IRM or LCR case

Market Process – Quadrennial DCR: (2) Estimate Marginal Reliability Impacts w/MARS

2020 IRM Topology (Summer Limits)



Market Process – Quadrennial DCR: (3) Estimate Ideal Cost of Reliability Improvement



- Calculate initial CRI^0 in each location and then shift/add capacity in MARS until: (a) reaching LOLE that corresponds to LOE conditions and (b) CRI is ideal (i.e., equal in relevant zones).

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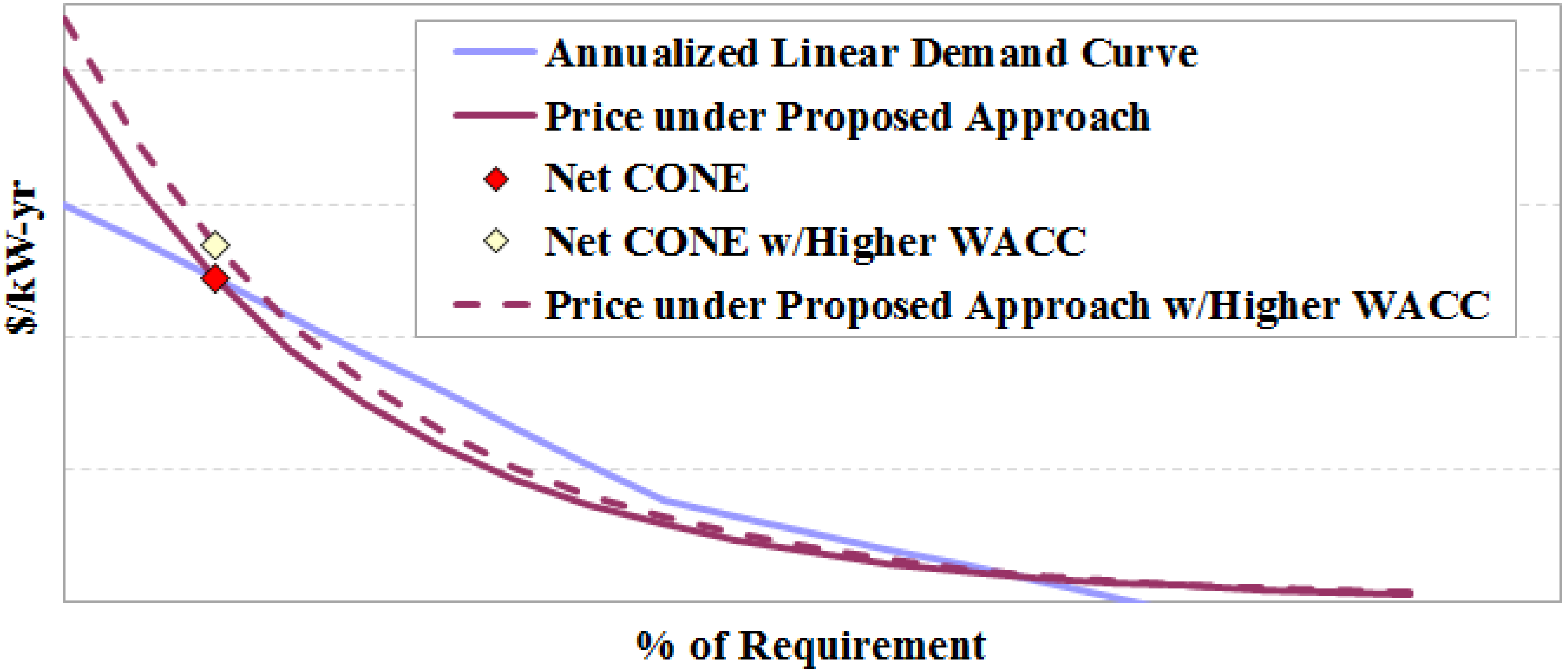
Market Process – Quadrennial DCR: (3) Estimate Ideal Cost of Reliability Improvement

- Calculate CRI by shifting/adding capacity in MARS until:
  - a) Reaching LOLE that corresponds to LOE conditions
    - – LOE conditions: where there is one peaking unit of surplus capacity in each capacity locality → Resulting LOLE is better than 0.1
  - b) CRI is equal in relevant zones
    - – This is where the ratio of NetCONE-to-MRI is equal in each zone
      - The previous slide shows an example where CRI is set to $2.9 million per 0.001 of LOLE improvement in each relevant zone
    - – Relevant zones are identified using the MARS case:
      - Identify import-constrained regions in NYCA
        - – For example: import-constrained regions B-K, G-K, H-K, J, K demarcate the relevant regions: BCDEF, G, HI, J, & K
      - Consultant identifies zone lowest NetCONE in each region

Market Process – Quadrennial DCR: (4) Determine Slope Adjustment Factor

- The proposed design concept would increase volatility because prices would decline more steeply than with current linear demand curves.
  - ✓ This is illustrated in the next slide.
- This reflects that MRI tends to fall more quickly than the current sloped demand curves as capacity is added to an area.
  - ✓ However, sloped demand curves were introduced for reasons other than just to reflect the diminishing MRI, including:
    - Reducing price volatility, and/or
    - Reducing market power.
  - ✓ Net CONE should reflect factors that increase investment risk.
- We will analyze factors that affect this issue, including (a) load distribution, (b) intermittent generation pattern, (c) use of LOLE objective versus LOEE objective, and (d) Level of Excess.

Market Process – Quadrennial DCR: (4) Determine Slope Adjustment Factor



- The DCR consultant could consider a slope-adjustment to optimize the trade-off between WACC and slope.
  - ✓ This Slope Adjustment Factor would be just below 1.0 for the system at criteria and just above 1.0 for moderate surplus levels.

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Market Process – Annual Updates

	Current Framework	Proposed Approach
Demand Curve Determination	• Update key parameters from the DCR (e.g., Gross CONE)	• Update key parameters from the DCR (e.g., Gross CONE)
	• IRM is set using the Tan45 process to meet a target LOLE (=0.10)	• IRM is set using the Tan45 process to meet a target LOLE (if the IRM is required)
	• Calculate TSL for each region if necessary	• Calculate TSL for each region (if the TSL is required)
	• LCRs set using "Optimizer" to meet target LOLE at lower cost	• Update CRI using updated MARS topology and Net CONE (respecting IRM/TSL if req'd)
	• Do summer-winter shaping	• Do summer-winter shaping

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Market Process – Annual Updates Incorporating Minimum IRM or TSL

- Even if capacity resources are adequate to satisfy the 1-day-in-10-year planning criterion, planning reliability criteria may require the NYISO to satisfy the IRM and/or TSLs.
- If the IRM and/or TSLs will be mandatory criteria that might necessitate out-of-market actions (e.g., transmission solutions or capacity retention through a reliability agreement) when the NYCA LOLE < 0.1,
  - ✓ Then the IRM/TSL should be considered explicitly in the capacity market as described on the following slide.
- However, if this situation would <u>not</u> necessitate out-of-market actions:
  - ✓ Then the IRM/TSL should <u>not</u> be considered in the capacity market.

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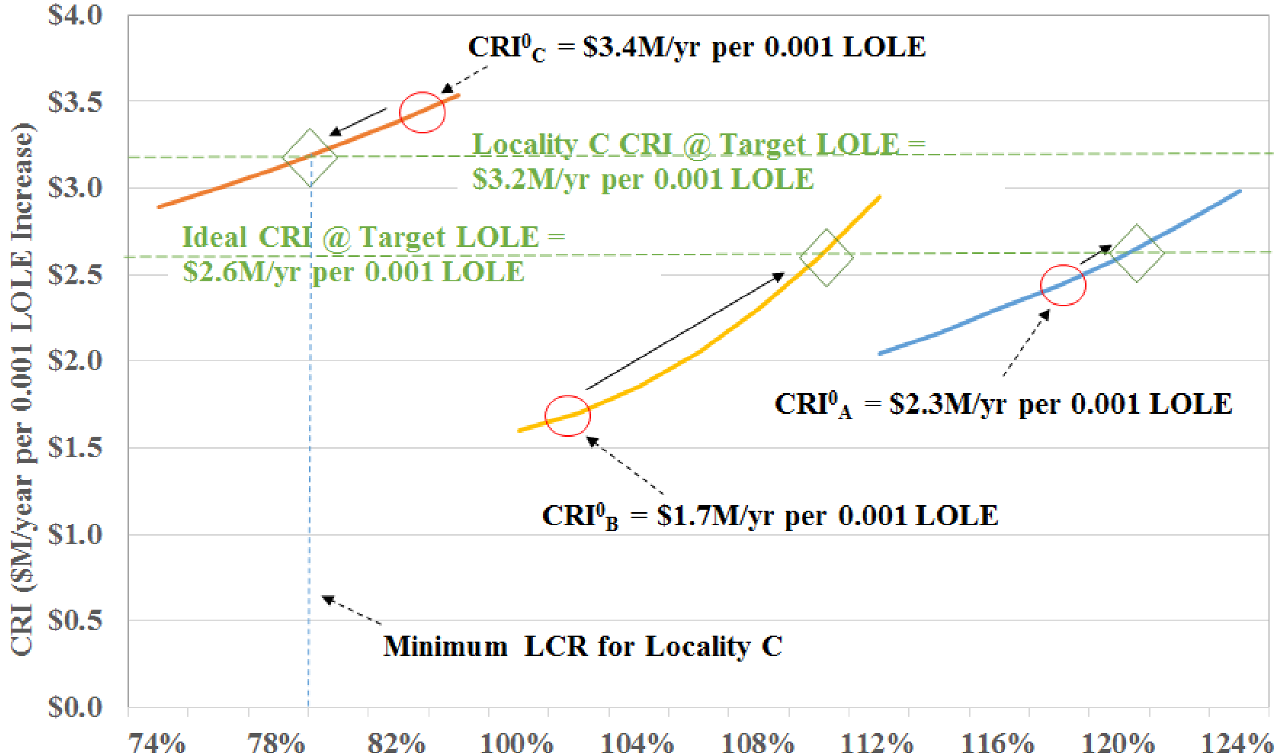
Market Process – Annual Updates Incorporating Minimum IRM or TSL



- Capacity for Zone C cannot fall because of IRM constraint and CRI is reduced relative to slide 16.
- If IRM is mandatory, the NYCA demand curve should be maintained.

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Market Process – Annual Updates
MARS Topology Update

- Each year, NYSRC and the NYISO update the MARS topology as part of the processes of setting the IRM and LCRs.
- These changes are made to reflect major transmission and/or generation additions and retirements. For example, the preliminary topology for the 2021/22 Capability Year includes:
  - ✓ Changes to the transmission limits across interfaces into Southeast New York partly because of the new entry of Cricket Valley; and
  - ✓ Changes to the UPNY-ConEd transmission limit that are related to the retirement of Indian Point 2.

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Market Process – Monthly Auction and Settlement

	Current Framework	Proposed Approach
Prices	• Calculate spot prices based on capacity margin in the "as-cleared" system relative to locality's demand curve.	• Calculate spot prices in a locality as product of CRI and the MRI for the "as-cleared" system. • If IRM/TSL must be respected, then incorporate corresponding locality demand curve as a minimum requirement.

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Market Process – Clear the Capacity Auction: The As-Cleared System

- Spot auction clearing begins with running MARS to calculate $LOLE^A$ for the "as-cleared" system.
  - ✓ The "as-cleared" system is similar to the "as-found" system, but it includes only offers that clear the auction
- Steps for finding $LOLE^A$ and accepted offers:
  1. Calculate Initial $LOLE^0$ – Run MARS including offers:
     a) Needed to satisfy IRM/TSL-based demand curve (if applicable), and
     b) From resources offered at prices less than a de minimis value (e.g., 20% of the clearing price for its location and technology in previous auction from same season)
        - Purpose: To identify a starting point from which additional offers can be added to the set of cleared offers

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Market Process – Clear the Capacity Auction: The As-Cleared System

2. Rank Uncleared Offers – Do this by the ratio of:
   a) Offer price to
   b) Estimated clearing price for its location and technology
      - This could be based on previous auction from the same season with an adjustment for any large new entrant or retirement.
3. Test Uncleared Offer – For the first-ranked uncleared offer:
   a) Find Impact of Addition – Add 20* MW to location z where the resource is located and run MARS to find $LOLE^{+20z}$
   b) Determine If Offer Is Economic:
      - Calculate: $MRI^{+20z} = LOLE^{0} - LOLE^{+20z}$
      - IF: Offer Price < CRI × MRI^{+20z} ÷ 20MW
      - THEN: Add up to 20 MW of offer to accepted case, set $LOLE^{0} = LOLE^{+20z}$ (or $LOLE^{+Xz}$ if offer X<20 MW), and return to Step 2
      - ELSE: Remove all offers in location z of the same technology and return to Step 3(a) after the first 2* occurrences
4. Finalize the As-Cleared system: $LOLE^{A} = LOLE^{0}$

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Market Process – Clear the Capacity Auction: Settlement for Internal Resources

- Clearing price determination for internal resources:
  - ✓ Run MARS to calculate $LOLE^{A+Xz}$ after X MW addition to capacity locality z
    - – We are still evaluating the appropriate value for "X"
  - ✓ Estimate MRI for generation in each locality:
    - – $GenMRI_z^A = (LOLE^{A+Xz} – LOLE^A) \div X\ MW$
  - ✓ Calculate price in each capacity locality:
    - – $GenPrice_z^A = GenMRI_z^A \times CRI$

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Market Process – Clear the Capacity Auction: Settlement for Intermittent Generators & ESRs

- Clearing price determination for intermittent gens & ESRs:
  - ✓ Run MARS to calculate:
    - $LOLE^{A+Xzt}$ after X MW addition of technology t to locality z
  - ✓ Estimate MRI for each type of resource in each locality:
    - $WindMRI_z^A = (LOLE^{A+XzW} - LOLE^A) \div X\ MW$
    - $SolarMRI_z^A = (LOLE^{A+XzS} - LOLE^A) \div X\ MW$
    - $ESRMRI_z^A = (LOLE^{A+XzE} - LOLE^A) \div X\ MW$
  - ✓ Calculate price in each capacity locality:
    - $WindPrice_z^A = WindMRI_z^A \times CRI$
    - $SolarPrice_z^A = SolarMRI_z^A \times CRI$
    - $ESRPrice_z^A = ESRMRI_z^A \times CRI$

Market Process – Clear the Capacity Auction: Settlement for External Resources

- Clearing price determination for external resources:
  - ✓ Run MARS to calculate $LOLE^{A+Xz}$ after X MW addition to:
    - External capacity bubble z, and
    - Contract over interface(s) along contract path
  - ✓ Estimate MRI for external resources in each bubble:
    - $ImpMRI_z^A = (LOLE^{A+Xz} - LOLE^A) \div X\ MW$
  - ✓ Calculate price for each import:
    - $ImpPrice_z^A = ImpMRI_z^A \times CRI$
- The ImpPrice will be lower than the GenPrice for the sink location because (a) the ImpPrice does not include the value of increasing transfer capability along the contract path, and (b) the import may reduce emergency assistance.

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Market Process – Clear the Capacity Auction: Settlement for External UDRs

- Clearing price determination for external UDRs:
  - ✓ Run MARS to calculate $LOLE^{A+Xu}$ after X MW additions to:
    - – External capacity bubble u,
    - – Contract over interface(s) along contract path, and
    - – Transmission interface corresponding to the UDR.
  - ✓ Estimate MRI for external resources in each bubble:
    - – $UDRMRI_u^A = (LOLE^{A+Xu} – LOLE^A) \div X\ MW$
  - ✓ Calculate price for each import:
    - – $UDRPrice_u^A = UDRMRI_u^A \times CRI$
- The UDRPrice will be higher than the ImpPrice for an external bubble because the UDRPrice includes the value of transfer capability associated with the UDR.

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Market Process – Clear the Capacity Auction: Settlement for Transmission

- Use transfer limit analysis to set each Limit_i for interface i
  - ✓ Note, i specifies direction (i.e., A→B and B→A are different)
- Clearing price determination for transmission interfaces:
  - ✓ Run MARS to calculate:
    - – LOLE^{A+Xi} after Limit_i is increased by X MW
  - ✓ Estimate MRI and Price of interface i as:
    - – $\text{TxMRI}_i^A = (\text{LOLE}^{A+Xi} - \text{LOLE}^A) \div X$ MW
    - – $\text{TxPrice}_i^A = \text{TxMRI}_i^A \times \text{CRI}$
- NYTOs have Financial Capacity Transfer Rights:
  - ✓ $\text{Revenue}_i^A = \text{TxPrice}_i^A \times \text{Limit}_i$
- It is only necessary to calculate for interfaces constrained in the As-cleared case.

Market Process – Clear the Capacity Auction: Settlement for LSEs

- A MW of load and a MW of supply do not have the same effect on system reliability
  - ✓ Hence, they should not settle at the same price
  - ✓ Bilateral capacity purchases would no longer be perfect hedge
- Clearing price determination for LSEs:
  - ✓ Run MARS to calculate:
    - – $LOLE^{A–Xz}$ after X MW addition to load in locality z
  - ✓ Estimate MRI for load in each locality:
    - – $LoadMRI_z^A = (LOLE^{A–Xz} – LOLE^A) \div X\ MW$
  - ✓ Calculate price for load in each locality:
    - – $LoadPrice_z^A = LoadMRI_z^A \times CRI$

Issues Affecting Market Performance

Issues Affecting Market Performance: Effect of Uncertainty in Estimated Net CONE

- Under the current framework, large and unforeseen shifts in LCR/IRM can occur, which lead to large price changes.
- Under the NYISO proposal, LCRs depend on NetCONE
  - ✓ Under(over)-estimating NetCONE_z → Inflates(reduces) LCR_z
  - ✓ Thus, NetCONE estimation error leads to inefficient allocation
  - ✓ However, NYISO simulations suggest the effect is not large
- Under our proposed approach:
  - ✓ In the DCR: NetCONEs are used to set one CRI for NYCA
  - ✓ In the capacity auction: Price_z depends on the MRI_z and CRI
    - – Therefore, errors in estimated NetCONE (a) do not bias the *distribution* of capacity across NYCA and (b) do not have a large effect on regional cost allocation.

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Issues Affecting Market Performance: Price-Setting and Non-Convexities

- MARS uses a Monte Carlo analysis and a simplified transmission model to forecast load shedding that might occur under certain conditions.
- This requires millions of iterations of a linear optimization that minimizes load shedding. Therefore:
  - ✓ MWh of load shed is a convex function of supply in each area.
  - ✓ If MRI (Marginal Reliability Impact) was in MWhs, it would be a monotonic function of supply in each area.
- However, LOLE and the MRI are based on probability, which is not the sum of many linear optimizations. Thus:
  - ✓ MRI (and price) would not be fully monotonic in supply MWs.
  - ✓ An adjustment would be needed to make the MRIs and the clearing prices monotonic.

Issues Affecting Market Performance: Revenue Adequacy

- Revenue adequacy is where: Buyer Payments ≥ Seller Revenues
- MC pricing markets with only linear constraints are revenue adequate.
- But, nodal markets with MC pricing are not strictly revenue adequate.
  - ✓ Non-convex supply costs (e.g., start-up) require BPCG uplift.
  - ✓ Non-linear transmission losses result in revenue surpluses.
  - ✓ TCC v DA and DA v RT differences lead to surpluses/shortfalls.
- As discussed on the previous slide, LOLE is expressed as a probability rather than as the sum of MWhs of load shedding. Consequently:
  - ✓ LOLE is not fully convex and MRI is not strictly monotonic, so this could lead to uplift (depending on the adjustment in the previous slide).
    - – ISO-NE addressed this particular issue by setting its MRI based on load shedding MWhs rather than the probability of load shedding.
  - ✓ However, surpluses will result from EOPs and congestion outside NYCA in the MARS model.

Key Questions to Be Evaluated

Key Questions to Be Evaluated 2020-Q1

- What additional NYISO processes may be affected?
- How would C-LMP affect prices, consumer costs (including congestion revenue adequacy), and other market outcomes compared to the current rules?
  - ✓ Under LOE conditions
  - ✓ One-off scenarios (as time & resources permit)
- How much could the step size be reduced while ensuring prices are monotonic as supply is increased?
- What algorithm could be used to perform iterations necessary to calculate LOLE[A] for as-cleared system in each monthly capacity auction?

Key Questions to Be Evaluated Future

- Future projects could estimate how the design would change prices, consumer costs, and other market outcomes:
  - ✓ Under high renewable penetration, high battery storage penetration, and other changes in resource mix
  - ✓ Under a broad set of conditions (e.g., capacity surplus, inaccurate Net CONE, if SAF is utilized, etc.)
- Future efforts would be needed to assess:
  - ✓ The overall impact on the NYISO's administration of planning and market processes
  - ✓ Impact on the BSM process
  - ✓ Speed and efficiency of the Interconnection process