Alternative Methods for Determining LCRs

Zachary Stines
Associate Market Design Specialist

New York State Reliability Council – Installed Capacity Subcommittee

June 28, 2017, NYISO

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Agenda

- Phase 1: Proof of Concept
- Phase 2: Refining Methodology
  - Phase 1 Follow-up
  - Cost curves
  - Transmission Security
- Next Steps
- Questions

Phase 1: Proof of Concept

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Optimized Base Case

Scenario	Zone J LCR (%)	Zone K LCR (%)	G-J LCR (%)	Cost (million)
Optimized Base Case (Updated)	77.5	107.0	91.0	$4,366.4
Base Case (Current LCR)	81.4	103.2	91.3	$4,407.7

- The NYISO final 2017-2018 Capability Year LCR base case was solved to a LOLE of 0.1 days/year with the NYSRC approved IRM of 18.0%
- The resulting base case will be used in order to compare the optimized methodology and the simplified version of the current LCR methodology

Initial Sensitivities

- **Entry/exit of Capacity**
  - Capacity addition/subtraction in Zone GHIJ
  - Capacity addition/subtraction in Zone J
  - Capacity addition/subtraction in Zone K
  - Capacity addition/subtraction in Rest of State
  - Capacity addition/subtraction in G with Lower Bound on Zone J
- **Changes in Net CONE**
  - Increase and decrease GHIJ Net CONE
  - Increase and decrease Zone J Net CONE
  - Increase and decrease Zone K Net CONE
  - Increase and decrease NYCA Net CONE
  - Increase in all Locality Net CONE
- **Changes in Transmission Capability**
  - Increase UPNY-SENY

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Changes in Capacity: Conclusions

- The optimized methodology reduces volatility in comparison to the current LCR methodology when there are changes in capacity
- Secondary effects observed in the optimization will be investigated in Phase 2

Changes in Transmission: Conclusions of Simple Analysis

- There are limitations to this simple analysis since changes in UPNY-SENY transmission would likely result in a change in the IRM
- The conclusions based on the simple analysis presently are:
  - UPNY-SENY reduces amount of optimal capacity required in GHIJ, but does not impact the amount for Zone J
  - The Zone J LCR is minimized to its optimal level in the Base Case (as a result of constraints south of UPNY-SENY)
  - Future sensitivity will seek to confirm that the optimal Zone J LCR is dependent on the downstream constraints by increasing Dunwoodie South limit to observe if the optimal Zone J LCR decreases

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Changes in Net CONE: Conclusions

- The sensitivities tested extreme changes (i.e., between 30% and 55% change in Net CONE)
- The optimized LCR responded intuitively to the changes in Net CONE (i.e., increase in Net CONE in most instances causes a reduction in LCR)
- The Net CONE can have an impact on the final optimized LCRs
- This places an emphasis on developing robust methodology for determining the cost curves

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Phase 1: Conclusions and Next Steps

- Perform sensitivities to assist in the understanding of any secondary effects observed in changes in generation sensitivities
- Work to potentially refine methodology to address these secondary effects
- Develop a robust methodology for determining cost curves that minimizes volatility
- Run a full Tan45 process for a few specific sensitivities to increase the understanding of how the current process and optimization responds
- While cost savings are only 1-2%, the process has numerous other benefits
  - Stability, more robust, intuitive, etc.

Phase 2: Refining the Methodology

Phase 2: Refining Methodology

- **Follow-up on Phase 1**
  - Seek to analyze and understand questions raised in Phase 1 and not yet addressed
- **Cost curves**
  - Seek to evaluate and understand how the cost curve shape impacts the optimization
  - Identify candidate cost curve methods and shapes
- **Transmission Security**
  - Incorporate transmission security limits into the optimization

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Phase 1 Follow-up

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Phase 1 Follow-up

- **Following the May 11th ICAPWG, GE:**
  - Finished remaining Phase 1 sensitivities
  - Reran specific cases in which the results had appeared to be potentially anomalous
  - Performed new sensitivities aimed at answering certain questions raised in Phase 1 (e.g., increase in transmission capability of Dunwoodie South)
  - Perform a complete Tan45 on select sensitivities

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Increase in Transmission Capability

- Phase 1 sensitivity showed that increasing the transmission capability of UPNY-SENY reduced the optimal amount of capacity required in GHIJ, yet minimally impacted Zone J
- It was hypothesized that Zone J LCR is minimized to its optimal level as a result of constraints south of UPNY-SENY
- Two new sensitivities sought to test this:
  - Dunwoodie South +1000 MW
  - UPNY-SENY +1000MW & Dunwoodie South +1000MW

Changes in Transmission Sensitivities Conclusions

- The optimization limits Zone J capacity requirement subject to the constraints south of UPNY-SENY
- Transmission changes can have an impact on the tradeoffs between capacity within each Locality
  - Increase in Dunwoody South capability results in the optimal requirements for Zone K to increase while Zone J decreases

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Cost Curves

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Cost Curves

- Phase 1 simple sensitivities only investigated how the magnitude of the cost curves impact the optimization
- Phase 2 will perform analysis and sensitivities to:
  - Investigate the impact of cost curves' shape on optimization
  - Develop a robust methodology for generating the curves
  - Seek to reduce any unnecessary volatility from cost curves

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Transmission Security

Transmission Security

- The NYISO continues to work to develop values for the lower bounds
- Sensitivities were performed to show how the optimization could incorporate lower bounds
    - Incorporated an arbitrary lower bound for Zone J of 80%

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Lower Bound Conclusions

- The optimization with a lower bound still results in a lower cost when compared to the current methodology
- The optimization still reduces volatility when a lower bound is incorporated

Next Steps

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Complete Tan45

- **Based upon stakeholder input, the following sensitivities were initialized using a complete Tan45**
  - Changes in capacity within G-J locality
  - Increase in the transmission capability of UPNY-SENY

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Phase 3: Market Simulations

- **Goal:** Simulate realistic market situations to demonstrate performance of methodology
  - Evaluate how the process would be performed with full Tan45 followed by optimization
  - Perform sensitivities that are expected to transpire within the coming years (e.g., capacity entry, capacity exit, transmission builds, etc.)

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Consumer Impact

- Consumer impact analysis will be provided for this project
- Methodology of the analysis will be provided and presented this summer
- Final analysis will be presented in the fall

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Other Next Steps

- The NYISO will consider input received during today's ICAP Working Group meeting
- Additional comments sent to deckels@nyiso.com will be considered
- The NYISO will return to a future ICAPWG meeting to discuss its progress and adjustments to the plan after considering comments or results

2017 Project Development

Stage	Objective	Specific Topics:
Proof of Concept	Demonstrate alternative methodology in relation to guiding principles (*i.e.*, least cost, stability, robust, predictability)	Generation +/- Unit net CONE +/- Transmission +/-
Refine Methodology	Modify the alternative method to ensure that all aspects have a purpose and are being performed as a result of sound market and engineering principles	Unit net CONE curves Potential Bounds Modeling methodology
Market Simulations	Simulate realistic market situations to demonstrate performance of methodology	Changes in resources Topological changes Locality configurations
Defining Process	Develop a process for the methodology that ensures guiding principles are being achieved over time	Develop process of method Process timeline Transition methods
Demonstrating Market Benefits	Demonstrate the methodology results in market benefits and resolve any issues that arise from its implementation	LOLE Criterion Consumer impact Multiyear simulation Cost allocation
Final Market Design	Summarize all findings and develop a final market design for implementation	Develop final market design

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Questions?

The Mission of the New York Independent System Operator, in collaboration with its stakeholders, is to serve the public interest and provide benefits to consumers by:

- Maintaining and enhancing regional reliability
- Operating open, fair and competitive wholesale electricity markets
- Planning the power system for the future
- Providing factual information to policy makers, stakeholders and investors in the power system

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Appendix 1:
May 11th ICAPWG Presentation

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Associate Market Design Specialist

Installed Capacity Working Group

May 11, 2017, NYISO

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Agenda

- **Phase 1: Proof of Concept**
  - Updates to the Optimization
  - Initial Sensitivities Results
- **Phase 2: Refining Methodology**
  - Transmission Security
  - Cost curves
- **Next Steps**
  - 2017 Project Development
- **Questions**

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Phase 1: Proof of Concept

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Updates to Optimization

- Altered formulation of LOLE constraint within optimization tool
  - Linear versus Log-Linear
- Reset solver with a smaller initial step size after a low initial tolerance has been met

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Updates Impact on Optimized Base Case

Scenario	Zone J LCR (%)	Zone K LCR (%)	G-J LCR (%)	Cost (million)
Optimized Base Case (Old)	78.1	104.5	92.2	$4,370.8
Optimized Base Case (Updated)	77.5	107.0	91.0	$4,366.4
Δ in Base Cases	**0.6**	**-2.5**	**1.2**	**$4.4**

- Updated Base Case results in a lower cost, but slightly different LCRs for the localities

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Initial Sensitivities

- **Entry/exit of Capacity**
  - Capacity addition/subtraction in Zone GHIJ
  - Capacity addition/subtraction in Zone J
  - Capacity addition/subtraction in Zone K
  - Capacity addition/subtraction in Rest of State
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- **Changes in Net CONE**
  - Increase and decrease GHIJ Net CONE
  - Increase and decrease Zone J Net CONE
  - Increase and decrease Zone K Net CONE
  - Increase and decrease NYCA Net CONE
  - Increase in all Locality Net CONE
- **Changes in Transmission Capability**
  - Increase UPNY-SENY

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Methodologies used in Sensitivities

- **Optimization Methodology**
  - Uses GE Optimization tool and NYISO final 2017-2018 Capability Year LCR base case
  - Optimized the 3 Localities' LCRs while maintaining the 2017 NYSRC approved IRM of 18% subject to a LOLE constraint of 0.1 Days/year
- **Current LCR Methodology**
  - Uses NYISO LCR Calculation Process[1]
  - Not a full Unified Method (i.e., Tan45)
  - Maintains the NYSRC approved IRM of 18%
  - Used to provide a simple comparison

[1] This process is available at <http://www.nyiso.com/public/webdocs/markets_operations/market_data/icap/Reference_Documents/LCR_Calculation_Process/LCR%20Calculation%20Process%2012_13_13.pdf>.

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Current LCR Methodology Base Case

- The NYISO final 2017-2018 Capability Year LCR base case was solved to a LOLE of 0.1 days/year with the NYSRC approved IRM of 18.0%
- The resulting base case will allow for a direct comparison with the optimized methodology and the simplified current LCR methodology

Scenario	Zone J LCR (%)	Zone K LCR (%)	G-J LCR (%)	Cost (million)
Base Case (Current LCR)	81.4	103.2	91.3	$4,407.7

Changes in Capacity Sensitivities

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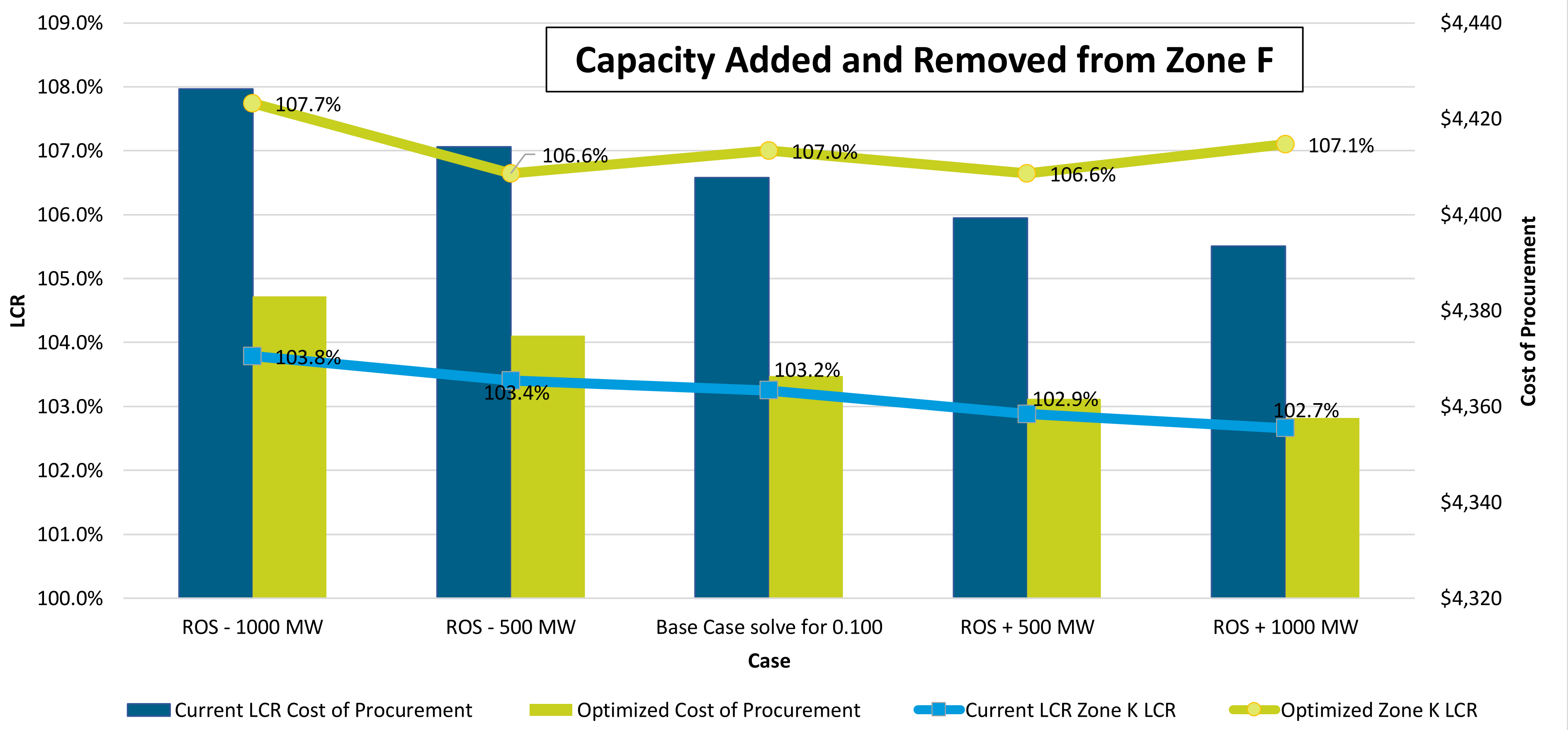
Changes to Capacity in ROS: Zone K LCR



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Changes in Capacity: Comparative Results

Scenario	Δ Optimized LCR from Optimized Base Case (%)			Δ Current LCR case from Current LCR Base Case (%)		
	Zone J	Zone K	G-J	Zone J	Zone K	G-J
+500 MW in GHIJ	0.2	0.7	0.1	-1.3	-0.5	2.3
- 500 MW in GHIJ	0.0	0.5	-1.0	1.6	0.6	-1.7
+500 MW in J	0.4	0.0	-0.6	0.5	-0.7	0.6
-500 MW in J	0.1	0.6	-0.5	-1.0	0.9	-0.6
+500 MW in K	0.6	-0.9	-0.4	-1.3	1.3	-0.8
-500 MW in K	0.1	-0.9	0.8	3.0	-2.5	2.5
+500 MW in ROS	0.1	-0.4	-0.5	-0.4	-0.3	-0.0
-500 MW in ROS	0.7	-0.4	-0.2	0.1	0.2	0.3
Average Absolute Δ from Base	**0.3**	**0.6**	**0.5**	**1.2**	**0.9**	**1.1**

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Changes in Capacity: Comparative Results

Scenario	Δ Optimized LCR from Optimized Base Case (%)			Δ Current LCR case from Current LCR Base Case (%)		
	Zone J	Zone K	G-J	Zone J	Zone K	G-J
+1000 MW in GHIJ	0.4	0.9	0.5	-1.5	-0.8	5.5
- 1000 MW in GHIJ	-0.5	0.2	-1.0	3.9	1.7	-3.3
+1000 MW in J	0.4	0.0	-0.6	1.1	-1.2	1.0
-1000 MW in J	0.2	-1.0	0.6	-2.2	3.0	-1.5
+1000 MW in K	0.2	-1.0	0.5	-1.7	1.8	-1.0
-1000 MW in K	0.5	-1.8	0.6	Cannot Solve	Cannot Solve	Cannot Solve
+1000 MW in ROS	-0.1	0.1	-0.8	-0.5	-0.5	-0.2
-1000 MW in ROS	0.6	0.7	0.1	0.6	0.6	0.5
Average Absolute Δ from Base	**0.4**	**0.7**	**0.6**	**1.6**	**1.4**	**1.9**

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Changes in Capacity: Cost Comparison

Scenario	Current LCR Methodology Cost (million)	Optimized LCR Methodology Cost (million)	Δ Cost (million)
Base Case	$4,407.7	$4,366.4	$41.3
GHIJ + 500 MW	$4,406.0	$4,374.6	$31.4
GHIJ - 500 MW	$4,422.2	$4,359.8	$62.4
Zone J + 500 MW	$4,416.0	$4,367.2	$48.9
Zone J - 500 MW	$4,394.1	$4,366.7	$27.4
Zone K + 500 MW	$4,390.2	$4,367.6	$22.6
Zone K - 500 MW	$4,448.8	$4,370.3	$78.5
ROS + 500 MW	$4,399.4	$4,361.6	$37.7
ROS - 500 MW	$4,414.2	$4,374.8	$39.4

- Cost presented is the solution cost from the optimization objective function
- The objective function represents the cost of capacity procurement at the given requirement

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Changes in Capacity: Cost Comparison

Scenario	Current LCR Methodology Cost (million)	Optimized LCR Methodology Cost (million)	Δ Cost (million)
Base Case	$4,407.7	$4,366.4	$41.3
GHIJ + 1000 MW	$4,430.2	$4,383.5	$46.7
GHIJ - 1000 MW	$4,443.8	$4,350.4	$93.4
Zone J + 1000 MW	$4,423.5	$4,367.2	$56.3
Zone J - 1000 MW	$4,379.2	$4,368.5	$10.7
Zone K + 1000 MW	$4,385.3	$4,368.2	$17.1
Zone K - 1000 MW	Cannot solve	$4,369.4	N/A
ROS + 1000 MW	$4,393.4	$4,357.6	$35.8
ROS - 1000 MW	$4,426.3	$4,383.0	$43.3

Changes in Capacity: Conclusions

- The optimized methodology reduces volatility in comparison to the current LCR methodology when there are changes in capacity
- Secondary effects observed in the optimization will be investigated in Phase 2

Changes in Net CONE Sensitivities

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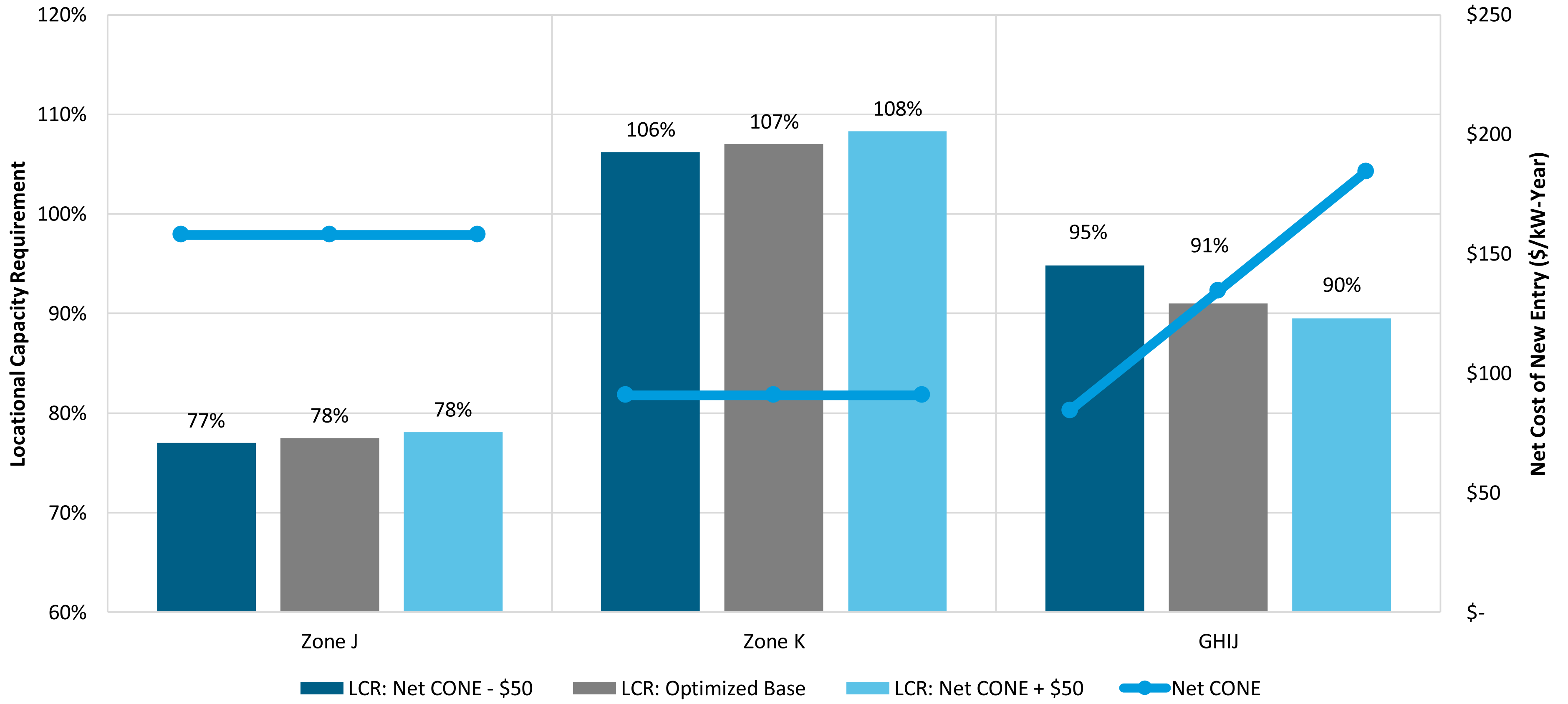
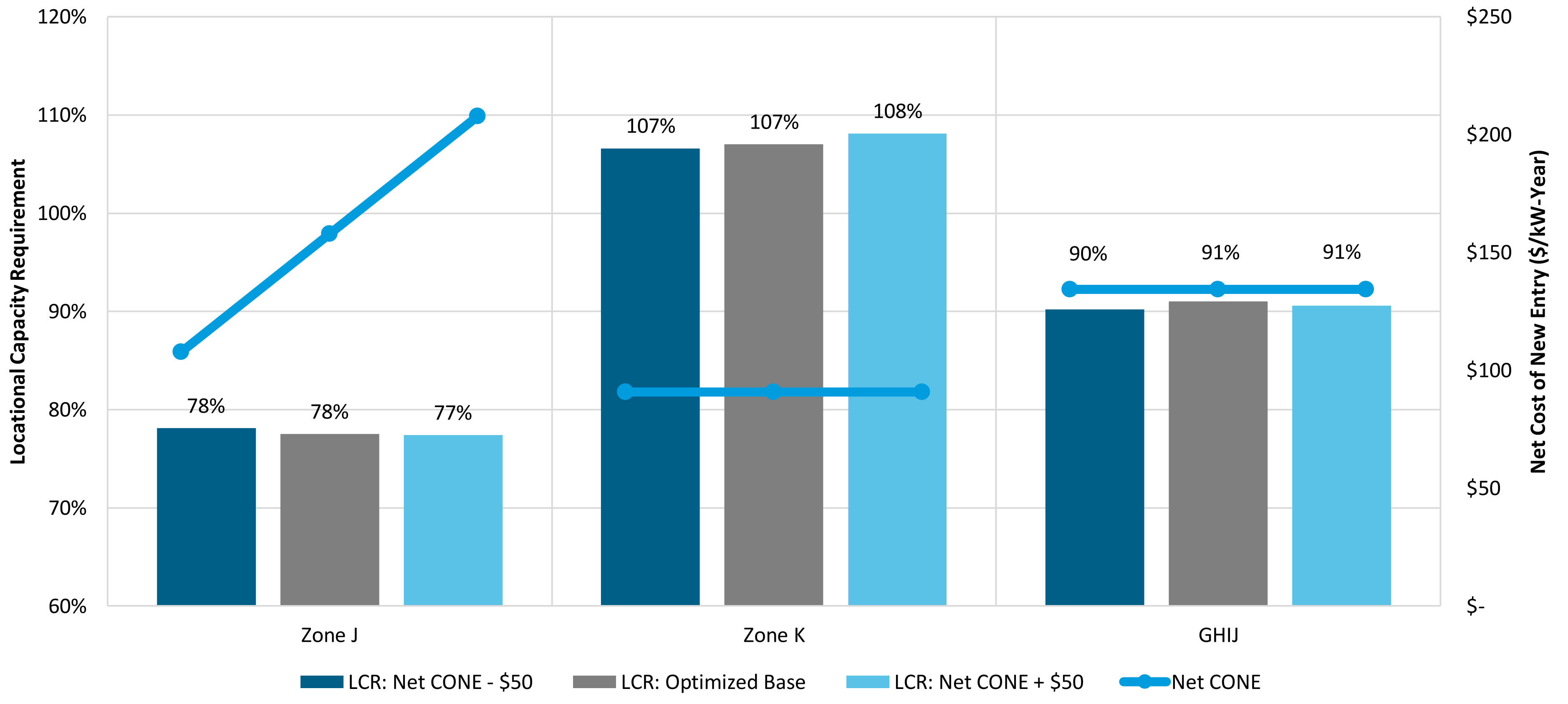
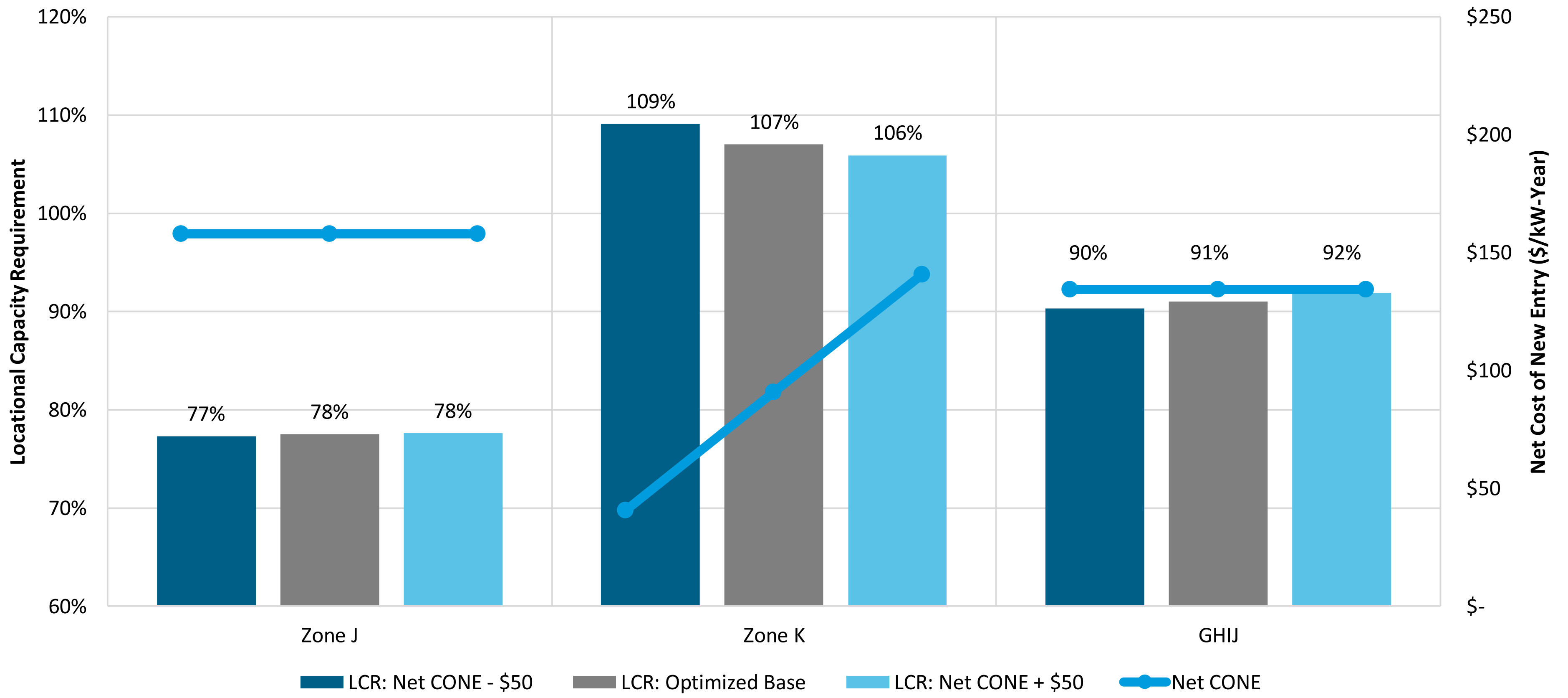
Net CONE Curves: +/- $50 GHIJ



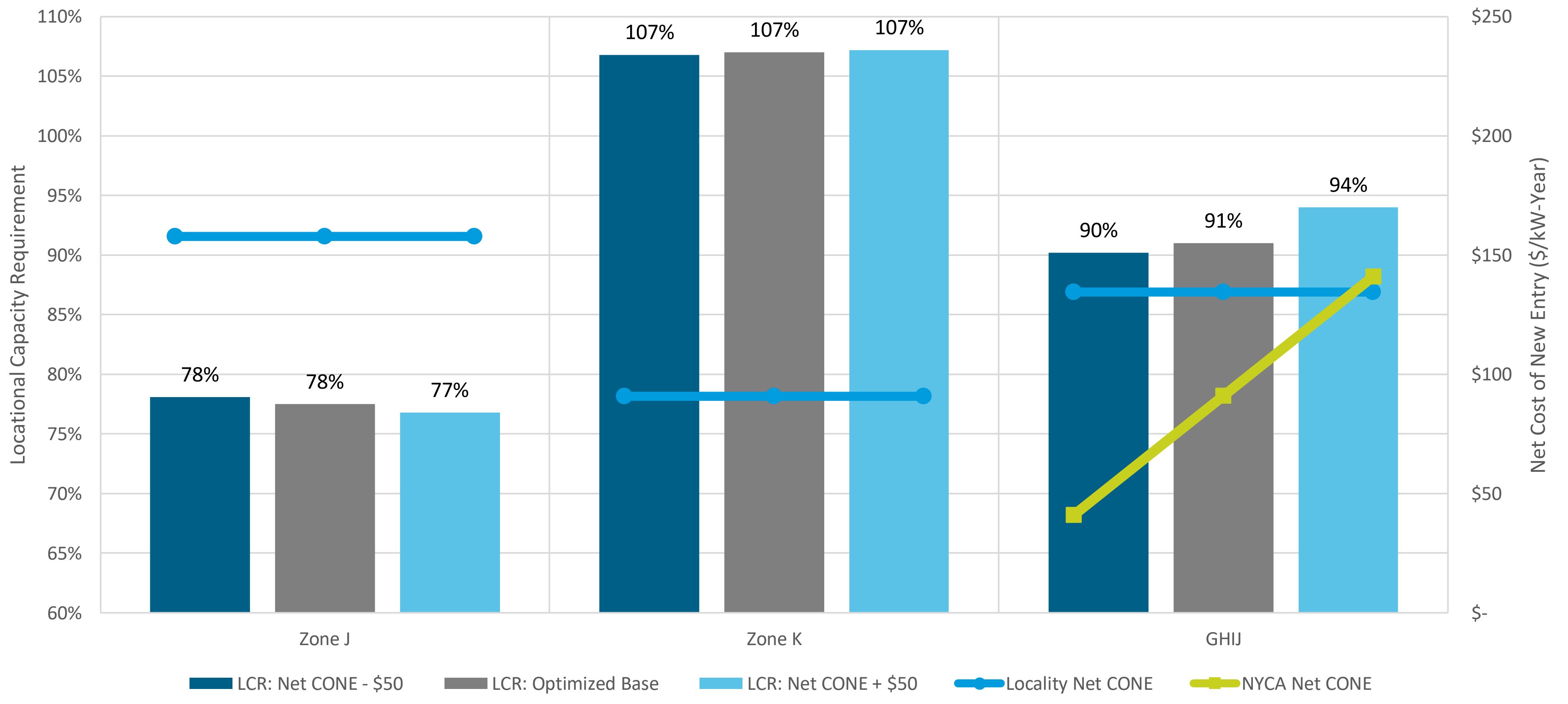
Net CONE Curves: +/- $50 Zone J



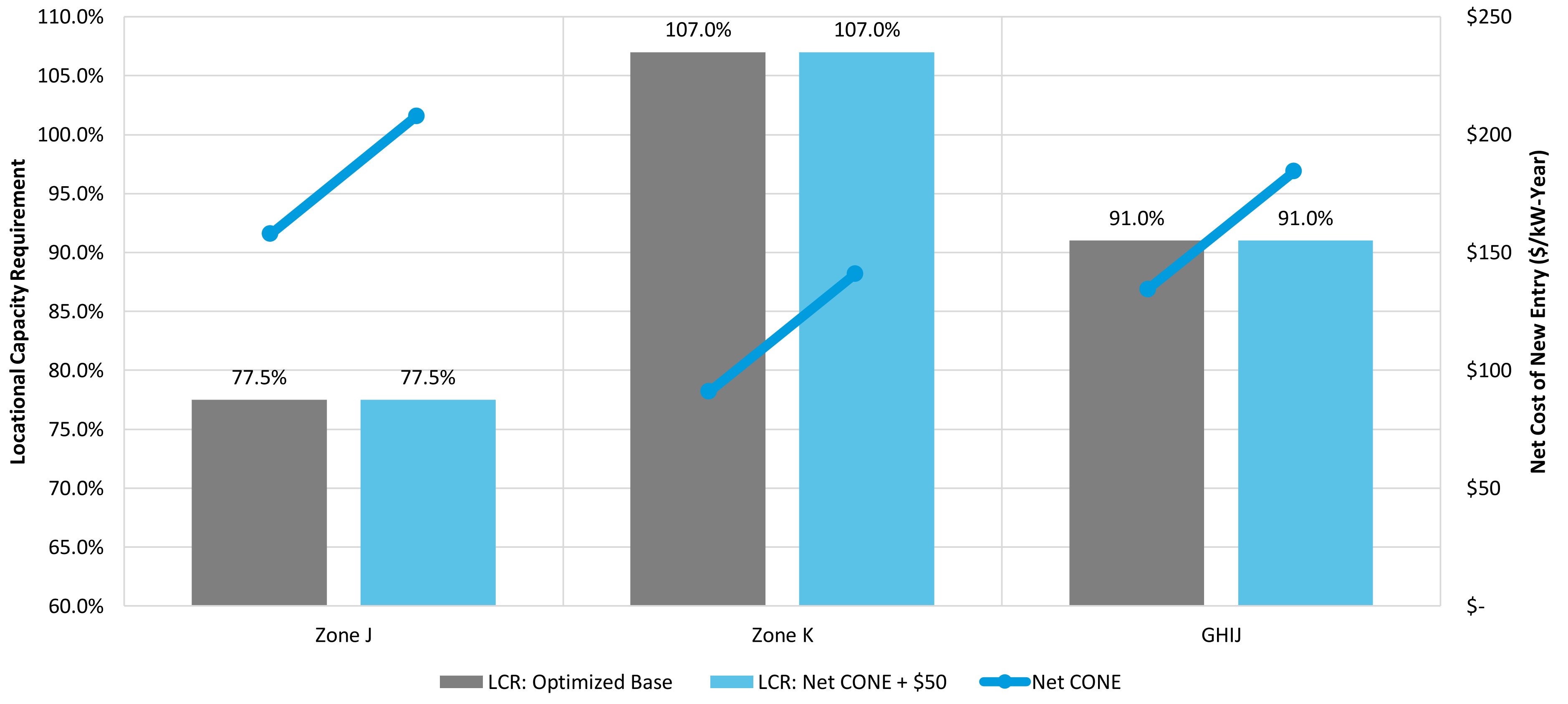
Net CONE Curves: +/- $50 Zone K



Net CONE Curves: +/- $50 NYCA



Net CONE Curves: +$50 All Zones



Changes in Net CONE: Cost Comparison

Scenario	Current LCR Methodology Cost (million)	Optimized LCR Methodology Cost (million)	Δ Cost (million)
Base Case	$4,407.7	$4,366.4	$41.3
GHIJ Net CONE + $50	$5,148.5	$5,090.3	$58.2
GHIJ Net CONE - $50	$4,154.4	$4,079.8	$74.6
Zone J Net CONE + $50	$4,889.3	$4,818.7	$70.6
Zone J Net CONE - $50	$3,938.1	$3,911.8	$26.3
Zone K Net CONE + $50	$5,170.1	$5,109.2	$60.9
Zone K Net CONE - $50	$4,132.8	$4,073.7	$59.1
NYCA Net CONE + $50	$5,831.1	$5,747.2	$83.9
NYCA Net CONE - $50	$3,471.9	$3,424.9	$47.0
All Net CONE + $50	$6,371.2	$6,323.9	$47.3

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Changes in Net CONE: Conclusions

- The sensitivities tested extreme changes (i.e., between 30% and 55% change in Net CONE)
- The optimized LCR responded intuitively to the changes in Net CONE (i.e., increase in Net CONE in most instances causes a reduction in LCR)
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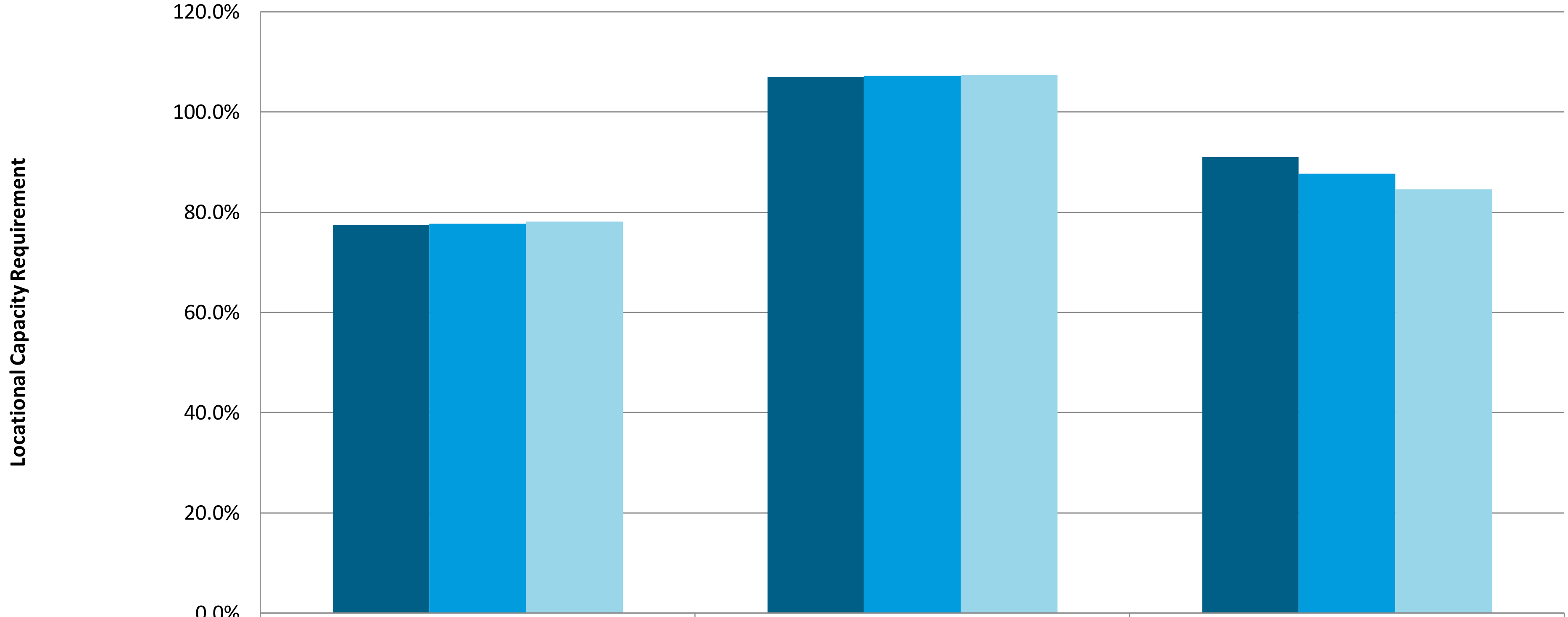
Changes in Transmission Sensitivities

Changes in Transmission: Optimized Methodology



	Zone J LCR	Zone K LCR	GHIJ LCR
Base Case	77.5%	107.0%	91.0%
UPNY-SENY + 500 MW	77.7%	107.2%	87.7%
UPNY-SENY + 1000 MW	78.1%	107.4%	84.6%

Changes in Transmission: Conclusions of Simple Analysis

- **There are limitations to this simple analysis since changes in UPNY-SENY transmission would likely result in a change in the IRM**
- **The conclusions based on the simple analysis presently are:**
  - UPNY-SENY reduces amount of optimal capacity required in GHIJ, but does not impact the amount for Zone J
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Phase 2: Refining Methodology

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Transmission Security

- The NYISO continues to work to develop values for the lower bounds
- Sensitivities were performed to show how the optimization could incorporate lower bounds
  - Incorporated an arbitrary lower bound for Zone J of 80%

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Lower Bound Comparison of Costs

Scenario	Optimized LCR with Lower Bound Cost (million)	Current LCR Methodology Cost (million)	Δ Cost (million)
Base Case	$4,366.4	$4,407.7	$41.30
Base Case – Lower Bound	$4,387.7	$4,407.7	$20.00
+500 MW in GHIJ – Lower Bound	$4,394.6	$4,406.0	$11.40
-500 MW in GHIJ – Lower Bound	$4,381.7	$4,422.2	$40.50

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Lower Bound Conclusions

- The optimization with a lower bound still results in a lower cost when compared to the current methodology
- The optimization still reduces volatility when a lower bound is incorporated

Cost Curves

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Next Steps

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2017 Project Development

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Appendix

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Changes in Capacity: 500 MW

Scenario	Optimized LCR (%)			Current LCR Methodology (%)			Optimized Cost (million)	Current LCR Cost (million)
	Zone J	Zone K	G-J	Zone J	Zone K	G-J		
Base Case	77.5	107.0	91.0	81.4	103.2	91.3	$4,366.4	$4,407.7
+500 MW in G	77.7	107.7	91.1	80.2	102.7	93.6	$4,374.6	$4,406.0
- 500 MW in G	77.5	107.5	90.0	83.0	103.8	89.6	$4,359.8	$4,422.2
+500 MW in J	77.9	107.0	90.4	81.9	102.5	91.9	$4,367.2	$4,416.1
-500 MW in J	77.6	107.6	90.5	80.4	104.1	90.7	$4,366.7	$4,394.1
+500 MW in K	78.1	106.1	90.6	80.1	104.5	90.5	$4,367.6	$4,390.2
-500 MW in K	77.6	106.1	91.8	84.4	100.7	93.8	$4,370.3	$4,448.8
+500 MW in ROS	77.6	106.6	90.5	81.0	102.9	91.3	$4,361.6	$4,399.4
-500 MW in ROS	78.2	106.6	90.8	81.5	103.4	91.6	$4,374.8	$4,414.2

Changes in Capacity: 1000 MW

Scenario	Optimized LCR (%)			Current LCR Methodology (%)			Optimized Cost (million)	Current LCR Cost (million)
	Zone J	Zone K	G-J	Zone J	Zone K	G-J		
Base Case	77.5	107.0	91.0	81.4	103.2	91.3	$4,366.4	$4,407.7
+1000 MW in G	77.9	107.9	91.5	79.9	102.4	96.8	$4,383.5	$4,430.2
- 1000 MW in G	77.0	107.2	90.0	85.3	104.9	88.0	$4,350.4	$4,443.8
+1000 MW in J	77.9	107.0	90.4	82.5	102.0	92.3	$4,367.2	$4,423.5
-1000 MW in J	77.7	106.0	91.6	79.2	106.2	89.8	$4,368.5	$4,379.2
+1000 MW in K	77.7	106.0	91.5	79.7	105.0	90.3	$4,368.2	$4,385.3
-1000 MW in K	78.0	105.2	91.6	Cannot solve	Cannot solve	Cannot solve	$4,369.4	Cannot solve
+1000 MW in ROS	77.4	107.1	90.2	80.9	102.7	91.1	$4,357.6	$4,393.4
-1000 MW in ROS	78.1	107.7	91.1	82.0	103.8	91.8	$4,383.0	$4,426.3

Changes in Net CONE

Scenario	Optimized LCR (%)			Current LCR Methodology (%)			Optimized Cost (million)	Current LCR Cost (million)
	Zone J	Zone K	G-J	Zone J	Zone K	G-J		
Base Case	77.5	107.0	91.0	81.5	103.5	91.5	$4,366.4	$4,413.7
+$50 GHIJ	78.1	108.3	89.5	81.5	103.5	91.5	$5,090.3	$5,148.5
-$50 GHIJ	77.0	106.2	94.8	81.5	103.5	91.5	$4,079.8	$4,154.4
+$50 Zone J	77.4	108.1	90.6	81.5	103.5	91.5	$4,818.7	$4,889.3
-$50 Zone J	78.1	106.6	90.2	81.5	103.5	91.5	$3,911.8	$3,938.1
+$50 Zone K	77.6	105.9	91.9	81.5	103.5	91.5	$5,109.2	$5,170.1
-$50 Zone K	77.3	109.1	90.3	81.5	103.5	91.5	$4,073.7	$4,132.8
+$50 NYCA	76.8	107.2	94.0	81.5	103.5	91.5	$5,747.2	$5,831.1
-$50 NYCA	78.1	106.8	90.2	81.5	103.5	91.5	$3,424.9	$3,471.9
+$50 All Zones	77.5	107.0	91.0	81.5	103.5	91.5	$6,323.9	$6,371.2

Changes in Transmission

Scenario	Optimized LCR (%)			Current LCR Methodology (%)			Optimized Cost (million)	Current LCR Cost (million)
	Zone J	Zone K	G-J	Zone J	Zone K	G-J		
Base Case	77.5	107.0	91.0	81.4	103.2	91.3	$4,366.4	$4,413.7
UPNY-SENY+500 MW	77.7	107.2	87.7	80.0	102.5	90.5	$4,342.1	$4,369.9
UPNY-SENY+1000 MW	78.1	107.4	84.6	79.7	102.3	90.3	$4,325.6	$4,362.4

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Appendix 2: June 1st ICAPWG Presentation

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Alternative Methods for Determining LCRs

Zachary Stines
Associate Market Design Specialist

Installed Capacity Working Group

June 1, 2017, NYISO

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Agenda

- **Phase 2: Refining the Methodology**
  - Follow-up from Phase 1
  - Cost curves
- **Phase 3: Market Simulations**
- **Next Steps**
- **Questions**

layed.

Phase 2: Refining the Methodology

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Phase 2: Refining Methodology

- **Follow-up on Phase 1**
  - Seek to analyze and understand questions raised in Phase 1 and not yet addressed
- **Cost curves**
  - Seek to evaluate and understand how the cost curve shape impacts the optimization
  - Identify candidate cost curve methods and shapes

Phase 1 Follow-up

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Phase 1 Follow-up

- **Following the May 11th ICAPWG, GE:**
  - Finished remaining Phase 1 sensitivities
  - Reran specific cases in which the results had appeared to be potentially anomalous
  - Performed new sensitivities aimed at answering certain questions raised in Phase 1 (e.g., increase in transmission capability of Dunwoodie South)
  - Perform a complete Tan45 on select sensitivities

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Finished Results: Zone K

- -1000 MW in Zone K case was finished since the May 11th ICAPWG presentation

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Increase in Transmission Capability

- Phase 1 sensitivity showed that increasing the transmission capability of UPNY-SENY reduced the optimal amount of capacity required in GHIJ, yet minimally impacted Zone J
- It was hypothesized that Zone J LCR is minimized to its optimal level as a result of constraints south of UPNY-SENY
- Two new sensitivities sought to test this:
  - Dunwoodie South +1000 MW
  - UPNY-SENY +1000MW & Dunwoodie South +1000MW

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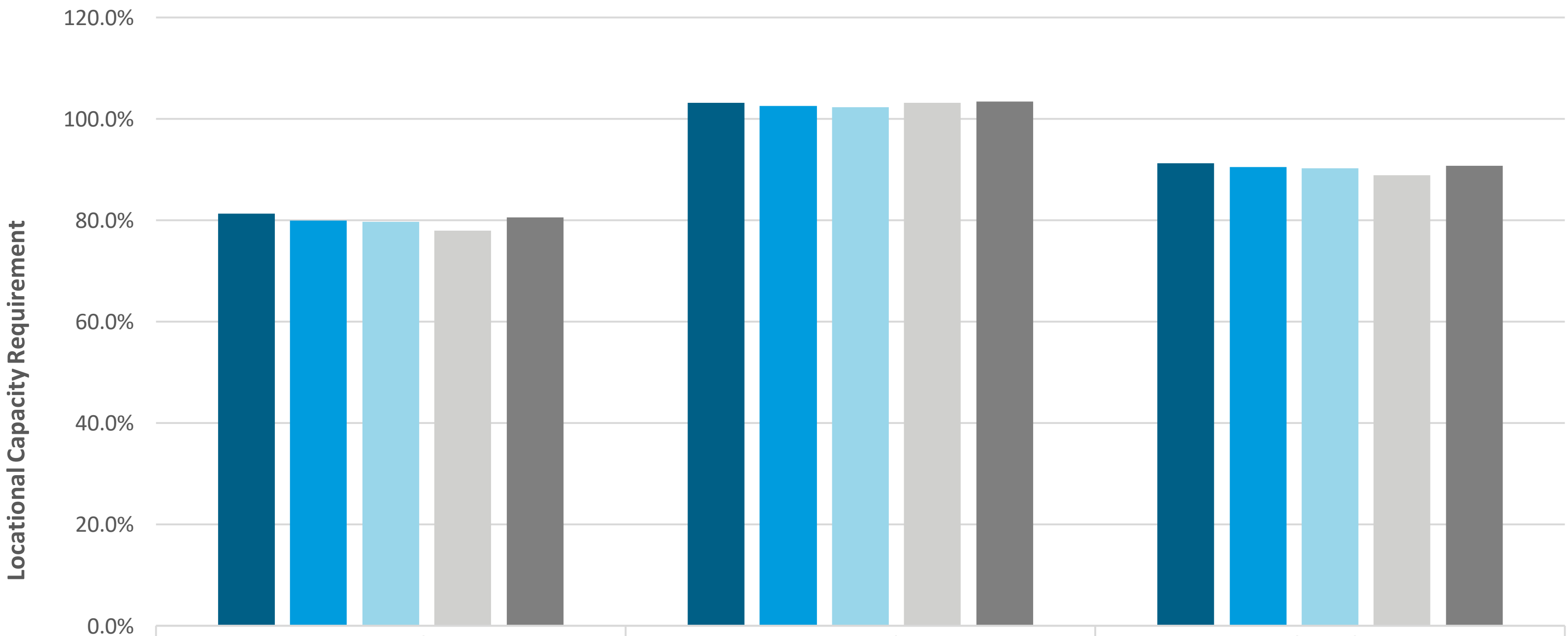
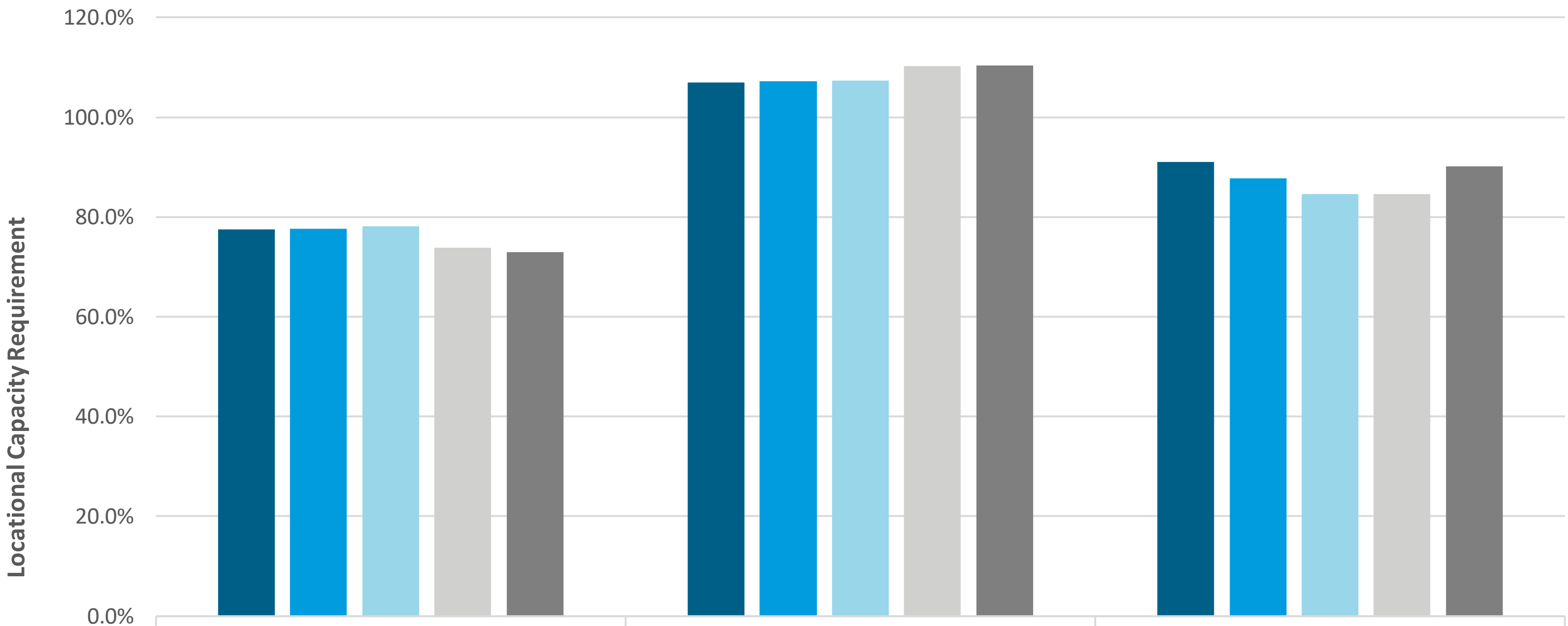
Changes in Transmission: Current LCR Methodology



	Zone J LCR	Zone K LCR	GHIJ LCR
Base Case solve for 0.100	81.4%	103.2%	91.3%
UPNY-SENY + 500 MW	80.0%	102.5%	90.5%
UPNY-SENY + 1000 MW	79.7%	102.3%	90.3%
Dunwoodie South, UPNY-SENY +1000 MW	78.0%	103.2%	89.0%
Dunwoodie South +1000 MW	80.6%	103.4%	90.8%

Changes in Transmission: Optimization Methodology



	Zone J LCR	Zone K LCR	GHIJ LCR
Base Case solve for 0.100	77.5%	107.0%	91.0%
UPNY-SENY + 500 MW	77.7%	107.2%	87.7%
UPNY-SENY + 1000 MW	78.1%	107.4%	84.6%
Dunwoodie South, UPNY-SENY +1000 MW	73.8%	110.3%	84.6%
Dunwoodie South +1000 MW	72.9%	110.4%	90.1%

Changes in Transmission Sensitivities Conclusions

- The optimization limits Zone J capacity requirement subject to the constraints south of UPNY-SENY
- Transmission changes can have an impact on the tradeoffs between capacity within each Locality
  - Increase in Dunwoody South capability results in the optimal requirements for Zone K to increase while Zone J decreases

Complete Tan45

- **Based upon stakeholder input, the following sensitivities were initialized using a complete Tan45**
  - Changes in capacity within G-J locality
  - Increase in the transmission capability of UPNY-SENY

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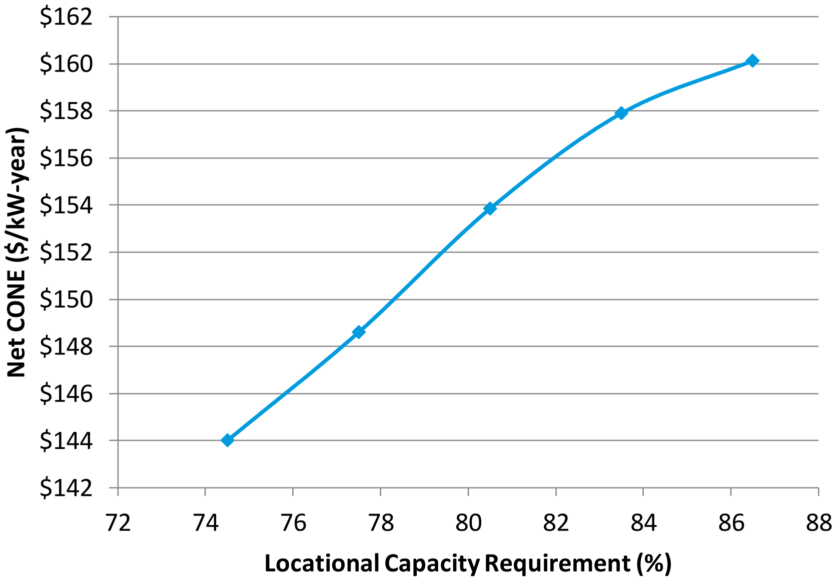
Cost Curves

What defines the cost curves?

- These curves define the cost used within the optimization of each Locality
- They are a function of the Locality's Minimum Installed Capacity Requirement



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Which cost to use?

- **Net CONE**
  - Net cost of new entry ("CONE") for the Demand Curve peaking unit
- **Reference Point Price**
  - The price on the Demand Curve at 100 % of the requirement and is a function of the Net CONE and level of excess
- **Gross CONE**
  - Total cost of new entry; i.e., without netting any revenues

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What is the shape of the curve?

- 6 point Cost Curves (currently being used in optimization)
  - Developed using GE MAPS in a process comparable to that used in the Demand Curve reset
  - Evaluate Net EAS at -6%, -3%, +3%, and +6% to develop curve
- Single value
  - Could potentially develop a single cost for the capacity that is not dependent on the quantity of Installed Capacity
- Other relationships (e.g., linear, 3-point, etc.)

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Different Cost Curves being Evaluated

- **Single value**
  - Net CONE
  - Gross CONE
  - Reference point price
- **6 point cost curve**
  - Net CONE curves based on MAPS
  - Reference point price

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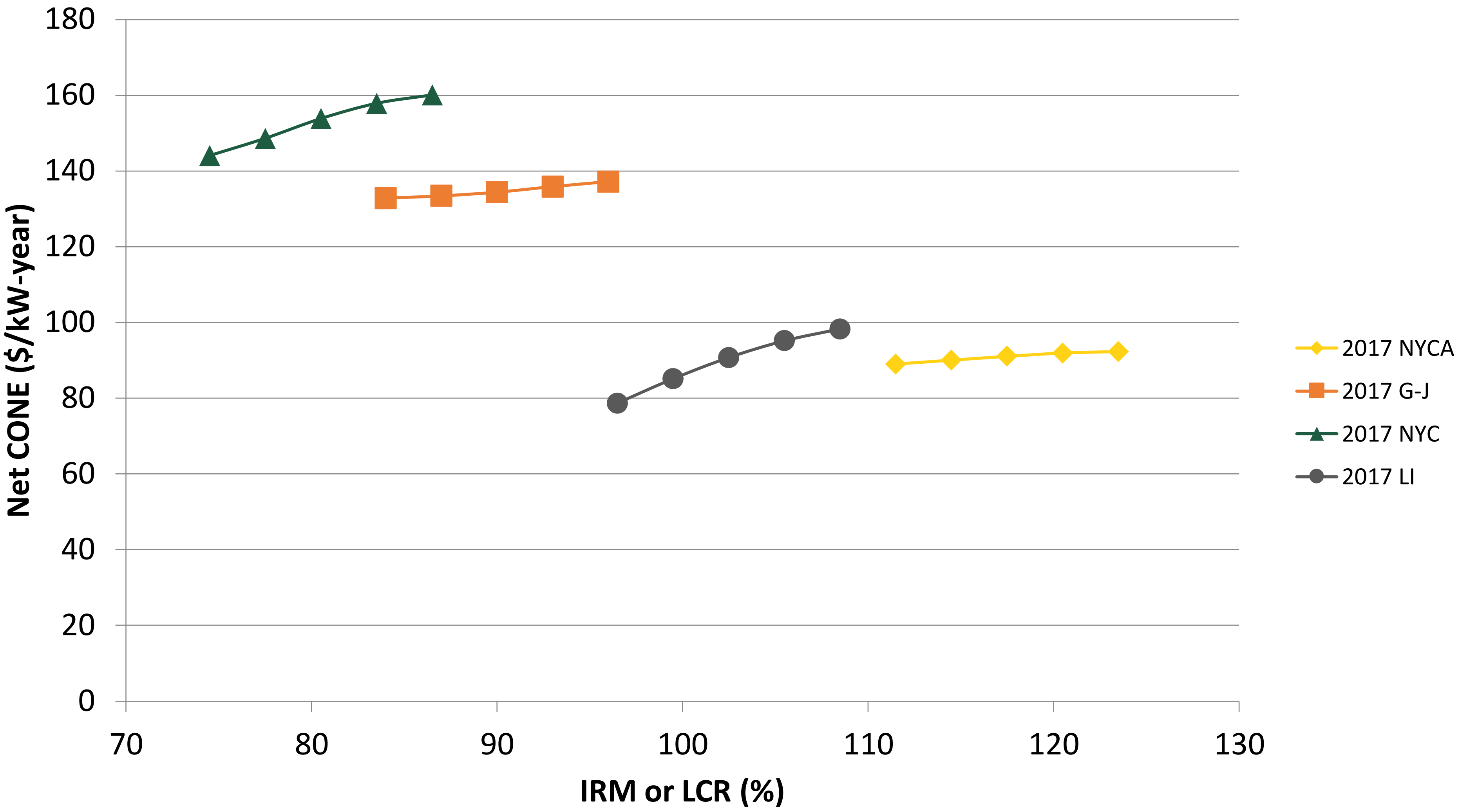
Net CONE ($/kW-year)
180
160
140
120
100
80
60
40
20
0
70
80
90
100
110
120
130
IRM or LCR (%)
2017 NYCA
2017 G-J
2017 NYC
2017 LI

How often will these cost curves change?

- Periodicity of cost curve
  - Understand the impacts of the cost curve periodicity
  - Annually updated or fixed for a set number of years?
- Time horizon used to develop cost curve
  - How many years should be evaluated to determine the cost curves?
  - 1 year, 3 years, >3 years, etc.

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Next Steps

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Phase 3: Market Simulations

- **Goal:** Simulate realistic market situations to demonstrate performance of methodology
  - Evaluate how the process would be performed with full Tan45 followed by optimization
  - Perform sensitivities that are expected to transpire within the coming years (e.g., capacity entry, capacity exit, transmission builds, etc.)

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Consumer Impact

- Consumer impact analysis will be provided for this project
- Methodology of the analysis will be provided and presented this summer
- Final analysis will be presented in the fall

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Other Next Steps

- The NYISO will consider input received during today's ICAP Working Group meeting
- Additional comments sent to deckels@nyiso.com will be considered
- The NYISO will return to a future ICAPWG meeting to discuss its progress and adjustments to the plan after considering comments or results

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2017 Project Development

Stage	Objective	Specific Topics:
Proof of Concept	Demonstrate alternative methodology in relation to guiding principles (*i.e.*, least cost, stability, robust, predictability)	Generation +/- Unit net CONE +/- Transmission +/-
Refine Methodology	Modify the alternative method to ensure that all aspects have a purpose and are being performed as a result of sound market and engineering principles	Unit net CONE curves Potential Bounds Modeling methodology
Market Simulations	Simulate realistic market situations to demonstrate performance of methodology	Changes in resources Topological changes Locality configurations
Defining Process	Develop a process for the methodology that ensures guiding principles are being achieved over time	Develop process of method Process timeline Transition methods
Demonstrating Market Benefits	Demonstrate the methodology results in market benefits and resolve any issues that arise from its implementation	LOLE Criterion Consumer impact Multiyear simulation Cost allocation
Final Market Design	Summarize all findings and develop a final market design for implementation	Develop final market design

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Questions?

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The Mission of the New York Independent System Operator, in collaboration with its stakeholders, is to serve the public interest and provide benefits to consumers by:

- Maintaining and enhancing regional reliability
- Operating open, fair and competitive wholesale electricity markets
- Planning the power system for the future
- Providing factual information to policy makers, stakeholders and investors in the power system

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