Constraint Specific Transmission Shortage Pricing

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ICAPWG/MIWG

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Agenda

- Background
- Comparison of Historic Base Case and Post-Contingency Constraint Costs
- Next Steps
- Appendix I: Current Transmission Constraint Pricing Logic
- Appendix II: Market Design Concept Proposal for Non-Zero CRM Facilities
- Appendix III: Market Design Concept Proposal for Zero CRM Facilities
- Appendix IV: Market Design Concept Proposal for External Interfaces

Previous Presentations

Date	Working Group	Discussion points and links to materials
November 5, 2019	Market Issues Working Group (MIWG)	Constraint Specific Transmission Shortage Pricing - Review of Market Design Concept Proposal
February 15, 2019	Market Issues Working Group (MIWG)	Constraint Specific Transmission Shortage Pricing - Market Design Concept Proposal
October 2, 2018	Market Issues Working Group (MIWG)	Constraint Specific Transmission Shortage Pricing – Study Review
August 7, 2018	Market Issues Working Group (MIWG)	Constraint Specific Transmission Shortage Pricing – High Level Design Considerations
June 25, 2018	Market Issues Working Group (MIWG)	Constraint Specific Transmission Shortage Pricing – Analysis Update
April 10, 2018	Market Issues Working Group (MIWG)	Constraint Specific Transmission Shortage Pricing – Study Approach

Background

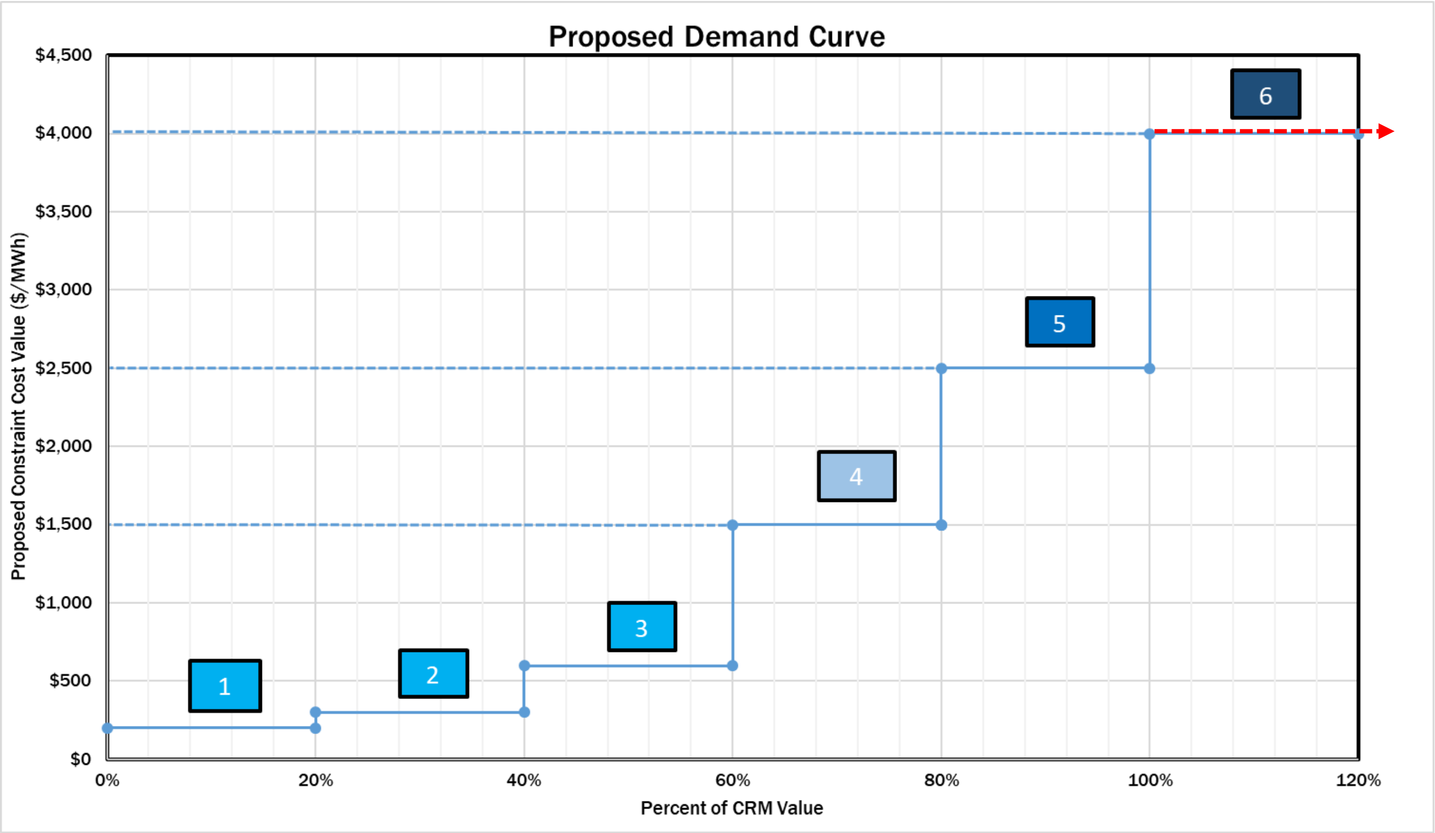
Background

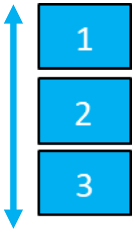
- **At the November 5, 2019 ICAPWG/MIWG meeting, the NYISO reviewed the market design concept proposal for Constraint Specific Transmission Shortage Pricing.**
  - In response to stakeholder requests, this presentation will provide further analysis of the historic constraint costs associated with base case (pre-contingency) and post-contingency constraints.

Market Design Concept Proposal

- **In its February 15, 2019 presentation, the NYISO proposed to implement a revised approach to the current transmission constraint pricing logic consisting of the following components:**
  1. Establish a revised six-step transmission demand curve mechanism for facilities currently assigned a non-zero constraint reliability margin (CRM) value.
  2. Apply a non-zero CRM value to internal facilities currently assigned a zero value CRM, with a separate demand curve mechanism for such facilities.
  3. Maintain the current single value $4,000 shadow price capping method for external interface facilities (zero value CRM) permitting the continued use of constraint relaxation.

Market Design Concept Proposal : Non Zero CRM Facilities





- Steps 1, 2 & 3 are priced at $200, $300 and $600 per MWh, respectively

- Step 4 is priced at $1,500 per MWh

- Step 5 is priced at $2,500 per MWh

- Step 6 is priced at $4,000 per MWh

Assessment of costs for Base Case and Contingency Constraints

Transmission Constraint Cost Analysis

- **Stakeholders have previously requested that the NYISO provide additional data comparing the historical constraint costs associated with base case and post-contingency transmission constraints.**
  - As previously discussed, the first three steps of the proposed 6 step transmission demand curve for non-zero value CRM facilities are intended to capture 99% of the historical cost of solving the transmission constraints through physical re-dispatch.

Transmission Constraint Cost Analysis

- **The analysis uses historic data for RTD binding constraints from July 2017 through February 2018**
  - Constraints with Shadow Prices equal to $350, $1,175, and $4,000 per MWh were removed from the dataset due to representing constraints resolved by capacity from the transmission demand curve mechanism rather than re-dispatch of physical resources
  - Constraints with a Shadow Price of less than $1/MWh were also removed from the dataset

- **Analysis performed includes a shadow price comparison across non-zero value CRM facilities using two distinct datasets:**
  - Dataset 1: Limited to facilities that had ***both*** binding base case and post-contingency constraints during the evaluation period.
  - Dataset 2: Includes all facilities that had ***either or both*** base case and post-contingency constraints during the evaluation period.
    - Distribution of shadow prices for base case and post-contingency constraints
    - Percentage of base case and post-contingency constraints resolved at a shadow price greater than $600/MWh (i.e., the proposed value for the third "step" of the proposed transmission demand curve for non-zero CRM value facilities)

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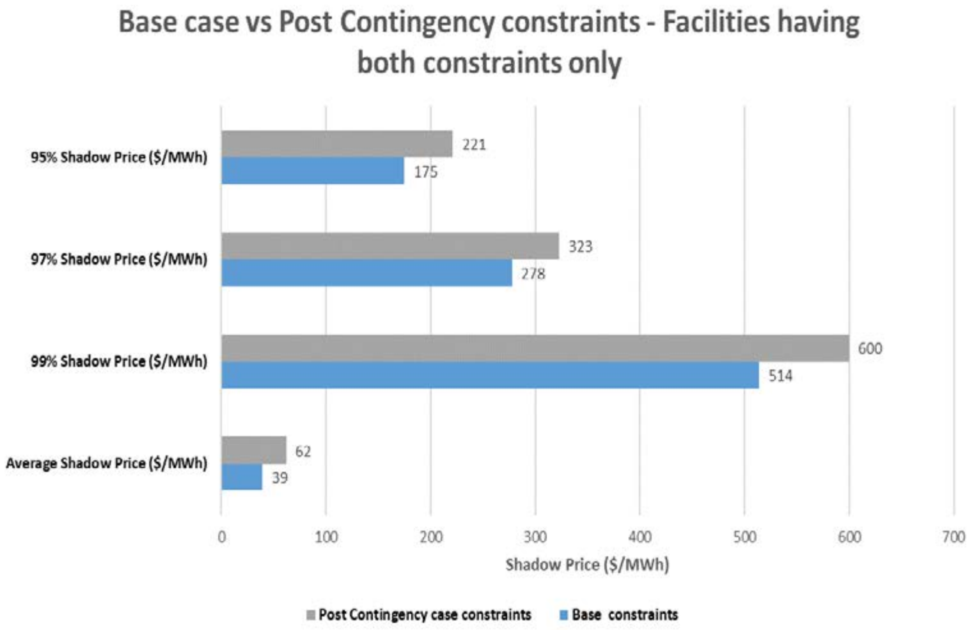
Non-zero value CRM facilities with both base case and post – contingency constraints

Transmission Constraint Cost Analysis

- **Shadow price comparison was performed for non-zero value CRM facilities that had *both* base case and post-contingency constraints binding during the period analyzed (total 22 unique facilities in the dataset).**
  - Analysis across the facilities that have both cases binding provides a fair basis for comparison of shadow costs associated with base case and post-contingency constraints.

Transmission Constraint Cost Analysis

- The chart shows that the Shadow Prices associated with base case and post-contingency constraints are similar.



- Total constraints = 47,342
  - 7,970 Base case constraints
  - 39,372 Post-contingency constraints

Non-zero value CRM facilities with either or both base case and post-contingency constraints

Transmission Constraint Cost Analysis

- Shadow Prices across all base case and post-contingency constraints associated with all non-zero value CRM facilities (total 92 unique facilities in the dataset) was also analyzed.
  - This analysis is intended to provide an additional means for evaluating relative Shadow Price differences between all base case and post-contingency constraints.

Transmission Constraint Cost Analysis

- **Shadow Price distributions are similar across both base case and post-contingency constraints**
  - Total constraints = 78,875; Base case constraints = 33,920; Post- contingency constraints = 44,955.

	Transmission Constraint Shadow Price Range ($/MWh)						
	1 - 101	101 - 201	201 - 301	301 - 401	401 - 501	501 - 600	>600
Base Case Constraints	89.4%	6.7%	2.5%	0.7%	0.2%	0.1%	0.3%
Post-Contingency Constraints	83.8%	10.0%	2.6%	1.1%	0.5%	0.9%	1.1%

- **The percentage of constraints that are resolved at a Shadow Price greater than $600/MWh is similar across both constraint types.**
  - 0.35% of base case constraints were resolved at a Shadow Price of greater than $600/MWh using re-dispatch of physical resources.
  - 1.14% of post-contingency constraints were resolved at a Shadow Price of greater than $600/MWh using re-dispatch of physical resources.

Conclusions

- **Analysis of shadow prices across base case and post-contingency constraints supports the NYISO's proposed market design.**
  - The analysis results do not support the need to differentiate transmission shortage pricing values by constraint type (base case vs post-contingency constraints).
- **The NYISO treats all thermal constraints equivalently.**
  - Differentiating the "value" assigned to resolving constraints by type does not align with the NYISO's overarching perspective that seeking to resolve all thermal constraints is of equal importance from a system reliability perspective.

Next Steps

Next Steps

- **At this time, the NYISO has planned for the implementation of this effort to take place in the 2022/2023 timeframe.**
- **Based on this, the following are the anticipated next steps for this effort**
  - Consider alternative approaches to congestion pricing of multiple line segments for the same facility.
    - This topic was discussed on September 10, 2019.
  - Revisit historical analysis with more recent data.
    - Update dataset near the end of 2020/early 2021.
  - Consider approaches to tariff changes.
  - Complete Consumer Impact Analysis.

Feedback/Questions?

- Email additional feedback to:
  Debbie Eckels, deckels@nyiso.com

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- 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 I: Current Transmission Constraint Pricing Logic

Current Transmission Constraint Pricing Logic

- **The NYISO assigns a CRM to facilities and interfaces to help manage transmission modeling uncertainty.**
  - The CRM value represents a reduction to the appropriate transmission facility rating or interface limit that is used to set the effective limit in the market software
  - Non-zero CRM values are applied to facilities to account for Generation and Load uncertainty, and unscheduled loop flows in the Real-Time Dispatch scheduling horizon.
  - Zero-CRM values are applied to facilities that are generally located within a generation pocket or at an external interface and therefore are not able to provide a significant amount of margin on a transmission limit.

Current Transmission Constraint Pricing Logic

- The following limits on Shadow Prices are applied in instances of transmission shortages (implemented on June 20, 2017)

Facility Type	Demand (MW)	Demand Curve Price ($)	Price Cap
Non-Zero CRM	Up to 5 >5 to 20	$350 $1,175	$4,000
Zero-CRM	N/A	N/A	$4,000

- For facilities with a non-zero value CRM, the software will seek redispatch at a shadow price up to $4,000 per MW, with consideration of the 20 MW of relief afforded by the two-step demand curve mechanism.
- For zero value CRM facilities, the software will seek redispatch at a shadow price up to $4,000 per MW, without consideration of any demand curve mechanism.
- In situations where insufficient resource capacity is available to fully resolve a constraint, "relaxation" is applied (see next slide for additional details).

Current Transmission Constraint Pricing Logic

- **In situations where insufficient resource capacity is available to fully resolve a constraint, "relaxation" is applied.**
  - To determine the applicable shadow cost for the transmission constraint, the applicable limit for the facility is increased to a value equal to the flow that can be achieved on the constraint by the available resources (including the 20 MW of relief from the demand curve mechanism, if applicable), plus 0.2 MW.

Appendix II: Market Design Concept Proposal for Non-Zero CRM Facilities

Market Design Concept Proposal

- **Non-Zero CRM Facilities: The NYISO proposes to implement a revised, six-step transmission demand curve mechanism for facilities currently assigned a non-zero CRM value**
  - Expressly accommodates the various non-zero CRM values currently utilized in the market.
  - Establishes consistent cost values for shortages based on specified percentage values of the CRM.
  - The final "step" of the revised demand curve mechanism will price all shortages in excess of the CRM, thereby eliminating reliance on constraint relaxation for resolving facilities assigned a non-zero CRM value.

Summary of Transmission Demand Curve Structure

1 2 3

- **The first three steps of the curve should capture 99% of the historical cost of solving the transmission system through physical re-dispatch.**
  - Supporting analysis determined that 99% of transmission constraints are resolved at approximately $588 per MWh or less for the historic study period (July 2017 – February 2018)

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- **The fourth step should be established at a value that facilitates appropriate trade-offs between products/services.**
  - For example, supporting analysis determined that $1,500 per MWh would facilitate trading off SENY 30-minute reserves to secure certain SENY transmission constraints

5

- **The value of the fifth step is intended to provide for continued pricing increases for worsening levels of shortage between steps 4 and 6.**

6

- **The sixth and final step on the curve is set at $4,000 per MWh.**
  - This value would be used to price all shortages in excess of the CRM value, replacing reliance on relaxation for facilities assigned a non-zero CRM value

Proposed Transmission Demand Curve Structure

- The table below represents the proposed six-step transmission demand curve mechanism MW/pricing structure applied to the non-zero CRM values currently used in the market:

	Proposed Demand Curve Steps											
CRM Value	1 (20% of CRM Value in MW)	1 Cost Value ($/MWh)	2 (40% of CRM Value in MW)	2 Cost Value ($/MWh)	3 (60% of CRM Value in MW)	3 Cost Value ($/MWh)	4 (80% of CRM Value in MW)	4 Cost Value ($/MWh)	5 (100% of CRM Value in MW)	5 Cost Value ($/MWH)	6 (>100% of CRM Value in MW)	6 Cost Value ($/MWH)
10 MW CRM	2	$200	4	$300	6	$600	8	$1,500	10	$2,500	>10	$4,000
20 MW CRM	4	$200	8	$300	12	$600	16	$1,500	20	$2,500	>20	$4,000
30 MW CRM	6	$200	12	$300	18	$600	24	$1,500	30	$2,500	>30	$4,000
50 MW CRM	10	$200	20	$300	30	$600	40	$1,500	50	$2,500	>50	$4,000
100 MW CRM	20	$200	40	$300	60	$600	80	$1,500	100	$2,500	>100	$4,000

Rationale for the First Three Steps

- **The following methodology was used to support the derivation of the proposed values for the first three steps of the revised transmission demand curve:**
  - Data presented on the following slide was derived from all RTD binding transmission constraints from July 2017 through February 2018 (i.e., the data period from the 2018 study)
  - The following data filters were applied:
    - This data includes constraints resolved with shortage MW, excluding any Shadow Price that was set by the current graduated Transmission Shortage Cost mechanism (i.e., Shadow Prices equal to $350, $1,175 and $4,000 per MWh were removed from the dataset)
      - "shortage MW" means the sum of any demand curve MW provided through the graduated Transmission Shortage Cost mechanism and any relaxation MW (i.e., constraint relaxation) that were relied upon to relieve a transmission constraint
    - Constraints with Shadow Price of less than $1.00 per MWh were also removed from the dataset

Rationale for the First Three Steps

Maximum Shadow Price at:	Number of Constraints in Grouping	95%	97%	99%	Standard Deviation	Median Shadow Price
All Constraints	84,260	$ 198.15	$ 267.97	$ 588.42	143	$ 20.39
Voltage Level						
Interfaces	10,462	$ 226.33	$ 261.77	$ 380.57	99	$ 49.73
345 kV	20,688	$ 114.03	$ 158.57	$ 304.84	166	$ 16.72
230 kV	1,322	$ 713.98	$ 985.90	$ 2,340.09	418	$ 114.54
138 kV	51,255	$ 197.15	$ 285.08	$ 588.44	121	$ 17.77
115 kV	533	$ 285.18	$ 423.42	$ 506.04	114	$ 91.54
CRM Value						
100	10,462	$ 226.33	$ 261.77	$ 380.57	99	$ 49.73
50	11,263	$ 161.65	$ 243.39	$ 713.98	228	$ 12.92
30	15,281	$ 185.69	$ 244.47	$ 331.04	81	$ 22.21
20	41,869	$ 206.51	$ 323.19	$ 600.14	139	$ 17.76
0	5,385	$ 63.23	$ 72.91	$ 101.16	143	$ 1.05
Location						
West	530	$ 1,159.88	$ 2,211.78	$ 3,583.55	612	$ 157.82
Central	5,132	$ 62.53	$ 69.29	$ 96.19	137	$ 23.65
North	1,730	$ 242.79	$ 278.67	$ 432.27	176	$ 55.12
Mohawk	216	$ 3,133.38	$ 3,267.71	$ 3,651.33	1009	$ 81.25
Capital	10,404	$ 234.30	$ 277.58	$ 451.17	105	$ 50.85
Hudson Valley	998	$ 219.13	$ 423.64	$ 1,541.35	255	$ 36.87
Dunwoodie	429	$ 204.82	$ 215.14	$ 239.62	68	$ 49.76
NYC	40,358	$ 175.33	$ 262.20	$ 588.65	127	$ 14.93
LI	24,463	$ 201.04	$ 255.20	$ 382.77	90	$ 21.25

- **Data in the chart represents constraints resolved through the re-dispatch of physical resources.**
  - Constraints with Shadow Prices equal to the pricing values of the "steps" of the current graduated Transmission Shortage Cost mechanism were excluded.
- **The table shows that 99% of the binding RTD constraints resolved through the re-dispatch of physical resources for the study period were resolved at a Shadow Price of $588.42 or less.**

Rationale for the Fourth and Fifth Steps

- In the security constrained economic unit commitment and dispatch algorithms, the objective is to minimize overall production cost while satisfying all applicable constraints.
- The software is required to coordinate and co-optimize Energy and reserve products.
- The NYISO reviewed certain potential trade-offs between Energy and reserve products to provide insight.
- For example, the following slide provides information related to an assessment of reserve and Energy (transmission) trade-offs for the Leeds-Pleasant Valley constraint.

Rationale for the Fourth and Fifth Steps

- An RTD interval was evaluated involving the Leeds-PV line for the loss of Athens-PV line constraint, during a period with little surplus of SENY 30-Minute Reserves
- A simulation was used to determine the price level at which the economic dispatch would begin going short of SENY 30-minute reserves and converting that reserve to energy to solve the transmission overload.
  - The assessment incrementally increased the current $1,175 per MW price point of the graduated Transmission Shortage Cost mechanism.
    - The case was rerun until the economic dispatch started converting the SENY 30-minute reserve to energy
    - This occurred at a value of approximately $1,500 per MW considering an average shift factor of approximately 33% for SENY units on the Leeds-PV constraint.
- After determining an appropriate value for the fourth step, a value for the fifth step was derived to help provide for a graduated price increase between the fourth and final (sixth) step

Rationale for the Last Step

- **The current $4,000 per MW maximum Shadow Cost value remains appropriate and should be retained**
  - This value remains sufficient to facilitate efficient re-dispatch of higher cost physical resources
    - For example, this pricing value would be sufficient to facilitate redispatch of a GT with at 25% shift factor and a cost of $1,000 per MWh
  - To eliminate reliance on constraint relaxation for facilities assigned a non-zero CRM value, this final step is extended to provide pricing for transmission shortages beyond 100% of the applicable CRM value

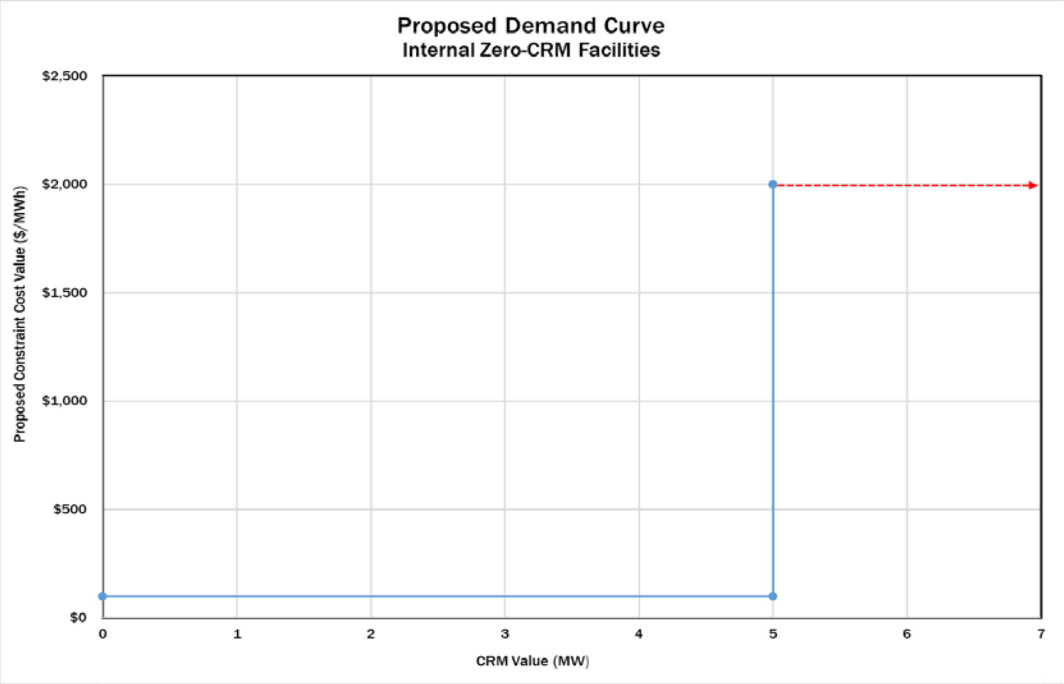
Appendix III: Market Design Concept Proposal for Current Internal Zero CRM Facilities

Market Design Concept Proposal

- **Current Internal Zero Value CRM Facilities: The NYISO proposes to apply a non-zero CRM value to internal facilities currently assigned a zero value CRM and utilize a separate demand curve mechanism for such facilities.**
  - These facilities would not utilize the six-step demand curve mechanism proposed for all other facilities assigned a non-zero CRM value.
  - The NYISO proposes to apply a two-step transmission demand curve to these facilities.
  - Since many of these facilities are located out of generation complexes a small non-zero CRM value is being proposed to avoid unnecessarily reserving the available capability of these facilities.

Market Design Concept Proposal : Current Internal Zero value CRM Facilities

- Proposed transmission demand curve for internal facilities currently assigned a zero value CRM:



- Apply a small non-zero CRM value of 5MW to all internal facilities currently assigned a zero CRM value.
- Up to 5 MW is priced at $100 per MWh.
- >5 MW is priced at $2,000 per MWh.

Rationale for First Step

Maximum Shadow Price at:	Number of Constraints in Grouping	95%	97%	99%	Standard Deviation	Median Shadow Price
All Constraints	84,260	$ 198.15	$ 267.97	$ 588.42	143	$ 20.39
Voltage Level						
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- The table shows that 99% of the binding RTD constraints related to zero value CRM facilities that were resolved through the re-dispatch of physical resources for the study period (July 2017-February 2018) were resolved at a Shadow Price of $101.16 or less.

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Rationale for Second Step

- **The NYISO proposes to implement a $2,000 per MW maximum Shadow Cost value for internal facilities currently assigned a zero value CRM.**
  - This value is sufficient to facilitate efficient re-dispatch of higher cost physical resources
    - For example, this pricing value would be sufficient to facilitate the redispatch of generators that have greater than 50% shift factors and a cost of $1,000 per MWh
    - Higher shift factors are typical for resources that are able to relieve a constraint located in export constrained areas

Appendix IV: Market Design Concept Proposal for External Interfaces

Market Design Concept Proposal : External Interfaces

- **External Interfaces: The NYISO proposes continued use of the current single value $4,000 per MW shadow price capping mechanism for external interfaces (i.e., the current pricing logic for facilities assigned a zero value CRM).**
- **Rationale:**
  - NERC rules require external interfaces to be scheduled to the same limit as the neighboring control areas.
  - Applying a demand curve mechanism for external interfaces is not appropriate as the only resources available for commitment are transactions and the Real-Time Dispatch converts transactions to fixed interchange in which there are no resources available.
  - Due to the need to schedule to the same limit with external interfaces a CRM is not applied.

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