Market Design Concepts to Prepare for Significant Renewable Generation

Flexible Ramping Product: Market Design Concept Proposal

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NYS CLEAN ENERGY STANDARD GOALS

	Carbon Pricing in the Wholesale Markets	Market Design Concepts to Prepare for Significant Renewable Generation
Forum	Integrating Public Policy Task Force (IPPTF)	Market Issues Working Group (MIWG)
Led by	NYISO + NY DPS + NYSERDA	NYISO
Objective	To further explore options to incorporate the cost of carbon dioxide into wholesale energy markets with the goal of contributing to achieving New York State's public policies, while providing the greatest benefits at the least cost to consumers and appropriate price signals to incentivize investment and maintain grid reliability.	To propose, analyze and develop new energy and capacity market products and/or rule changes that would incent the participation of resources that can enhance the availability, flexibility, predictability, and dispatchability of the NY Power System.
2018 Deliverables	Draft proposal and supporting rationale for how carbon could be priced in NY's wholesale electricity markets.	1. Market Design Concept Proposals for viable near-term products and rule enhancements. 2. 3-5 year vision for market design.

MASTER PLAN - Q2 2018

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Agenda

- Background
- NYISO Flexible Ramping Product: MDCP
- Future Work & Stakeholder Feedback
- Flexible Ramping Product – Industry Experience
- NYISO Recommendation
- Next Steps
- Timeline
- Appendix I: NYISO Look-Ahead
- Appendix II: CAISO and MISO Ramp Product Implementations
- Appendix III: Previous Presentations

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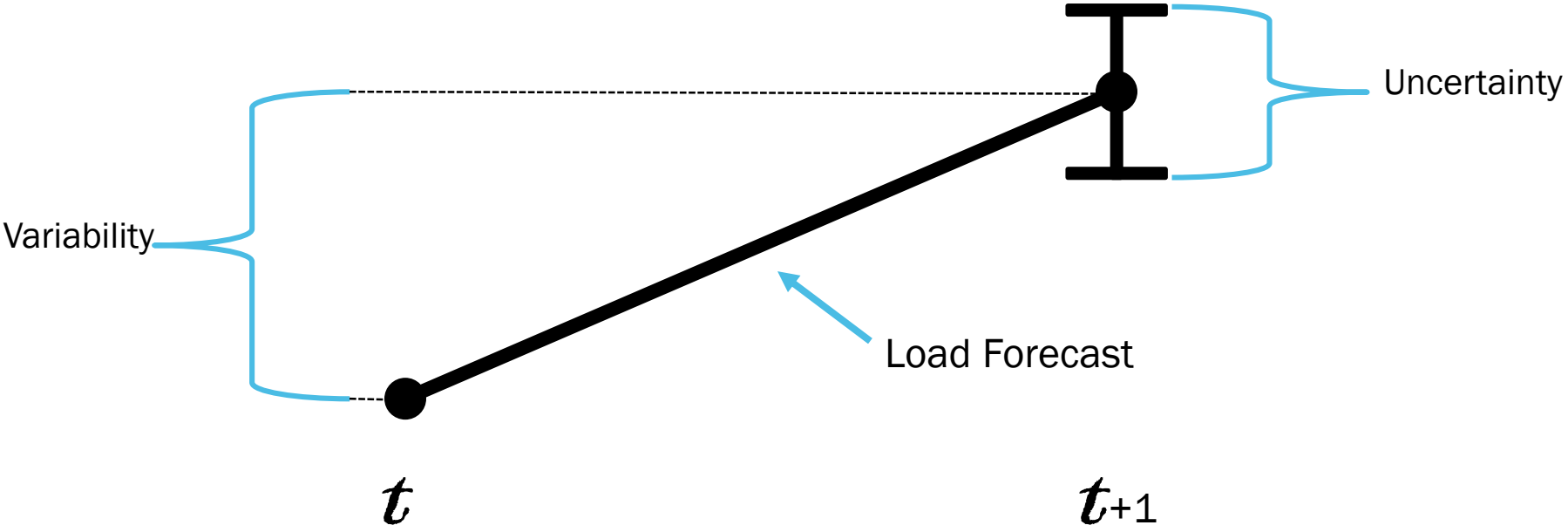
Background

Flexible Ramping Product to Address Forecast Uncertainty

- The NYISO identified a potential need to procure additional ramping capability in the 2017 Market Assessment with 50% Renewables.*
- Volatility in load ramp net of renewable generation was observed in the Real-Time Market Study portion of the 2017 Market Assessment.
  - As output from intermittent generators changed, the power system had to respond quickly to swings in RT net load ramp that was not forecast in the DAM.
- A ramping product would enable the NYISO to procure additional ramp-up and ramp-down capability by holding a portion of wholesale generating capability to a high or low level of output.
  - Could be procured similar to how the NYISO currently procures 10- and 30-minute Reserves.
  - Could be split into two distinct products: ramp-up and ramp-down.
- A ramp-down product could provide flexibility not incented by the procurement of operating reserves or regulation today.

*Links to the 2017 Market Assessment:
Presentation: http://www.nyiso.com/public/webdocs/markets_operations/committees/bic_miwg/meeting_materials/2017-12-20/2017%20Market%20Assessment%20with%2050%20percent%20Renewables,%20Study%20Results%20and%20Market%20Design%20Concepts%20FINAL.pdf
Report: http://www.nyiso.com/public/webdocs/markets_operations/committees/bic_miwg/meeting_materials/2017-12-20/2017%20Market%20Assessment%20with%2050%20percent%20Renewables,%20Report.pdf

Flexible Ramping Product to Address Forecast Uncertainty – Description of Terms



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NYISO Flexible Ramping Product: Market Design Concept Proposal

NYISO Flexible Ramping Product

- **A new ramping product would be procured in both the DA and RT markets.**
  - NYISO would procure ramp on behalf of Load in the DA and RT markets to prepare for RT uncertainty.
  - Would allow generation to reduce risk by selling at the DA price.
- **A ramp product would be co-optimized with energy and other applicable ancillary services products.**
  - Would allow more efficient procurement of the ramp product.

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NYISO Flexible Ramping Product

- **A ramp product MW requirement would be set at a time interval sufficient to provide the desired flexibility (for example, each hour).**
- **The system ramping requirement would be procured as an energy rate over time (MW/min rate over the ramping interval).**
  - This would be fulfilled by resources capable of ramping by a specific amount over the ramping interval.
  - For example, a system requirement of 300 MW of down-ramp over 60 minutes could be met by one resource with a ramp rate of -5 MW/min sustained for 60 minutes, or two resources with ramp rates of -2.5 MW/min sustained for 60 minutes.
- **Online units bidding self-committed flex and ISO-committed flex would be eligible to provide the ramp product.**
- **The ramp product would be technology neutral.**
  - Resources meeting applicable qualifications would be able to provide the product.

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NYISO Flexible Ramping Product

- Resources providing the ramp product would be compensated with a clearing price that would include lost opportunity cost.
- Consistent with the treatment of reserves today, units would be allowed to bid a non-zero dollar value to provide the ramping product in DA if applicable.
  - Only bids of $0 would be accepted in RT.
  - The NYISO does not believe that resources face a cost of providing ramp in RT aside from lost opportunity cost.
- The shortage pricing methodology applied to operating reserves and regulation service today would apply to a ramp product.

Future Work & Stakeholder Feedback

Future Work covered in the Next Phase

As part of the market design complete phase of this project, the NYISO will collaborate with stakeholders to determine whether a ramp product would provide value in meeting reliability through the NYISO Energy markets:

- If a ramp product would provide value, then the NYISO should further determine:
  - Whether it is necessary to procure ramp-up, ramp-down, or both ramp-up and ramp-down.
  - Which location(s) would benefit (e.g. zonal, regional, NYCA-wide).
  - The MW necessary to procure.
  - The necessary time requirement for the ramp (*e.g.,* 60 minute, 30 minute, etc.).
  - The time interval necessary for the ramp requirement (*e.g.,* hourly).
  - Appropriate shortage pricing levels for the product.
  - Whether offline units should be eligible to provide the product.

Stakeholder Feedback

- **Whether the NYISO should continue to work on the design of a flexible ramping product will be determined as part of the 2019 stakeholder project prioritization process.**
- **Stakeholder feedback received at the April 3, 2018 MIWG should also be addressed as part of the Market Design Complete phase of this project:**
  - Appropriate pricing rules for a ramp product.
  - Whether forecasting improvements could be implemented instead of a ramp product.
  - Whether external transactions would be able to provide ramp (subject to more flexible scheduling at some interfaces).

Flexible Ramping Product – Industry Experience

Flexible Ramping Product – Industry Experience

- **Under CAISO's current flexible ramping product implementation, the ramp-up and ramp-down requirement for the CAISO Control Area can be met by other balancing authority areas importing and exporting to and from CAISO.**
  - When scheduling the flexible ramping product, constraints are not accounted for on imports from external balancing authority areas that must wheel energy through another balancing authority to reach CAISO.
  - The flexible ramping product has often been scheduled in balancing areas where congestion between the CAISO and the other balancing authority area prevents the delivery of the ramp product energy.*

*See CAISO presentation at the following link:
http://www.caiso.com/Documents/Discussion_FlexibleRampingProduct.pdf

Flexible Ramping Product – Industry Experience

- CAISO notes that it is "…currently in the process of identifying and evaluating modifications to the calculation of the flex ramp requirement." *
  - LMP price spikes have been observed when flexible ramp product requirements were zero.

*See CAISO presentation, page 15, at the following link: http://www.caiso.com/Documents/Presentation-FlexibleRampingProductPerformanceDiscussionFeb22018.pdf

NYISO Recommendation

NYISO Recommendation

The NYISO recommends that stakeholders prioritize the Flexible Ramping Product project after 2019. The following factors support the recommendation to consider this project again in the future:

- Delaying market design for this concept would permit further market outcomes from the CAISO implementation to develop and demonstrate evidence of value.
- There does not appear to be an immediate near-term need to develop this product:
  - The NYISO's look-ahead software currently considers net load variability when dispatching resources, and this has not yet been significantly impacted by intermittent renewables.
  - Wind generation has the ability to dispatch down for economic and reliability reasons.
  - 10 minute locational spinning reserves are currently providing the NYISO with adequate ramp-up capability.

NYISO Recommendation

- **Other projects offer more promise in the near term.**
  - For example, Reserve Procurement for Resilience is more directly related to a number of important emerging industry issues.
- **Resolving outstanding questions for the Market Design Complete phase of the Flexible Ramping Product project should be considered as intermittent renewable resource penetration increases.**

Next Steps

Next Steps

- **The NYISO will continue to discuss other projects for prioritization with stakeholders that will prepare the NYISO markets for large increases in intermittent renewable resources:**
  - Reserve Procurement for Resilience
  - Ancillary Services Shortage Pricing
  - Review Performance Incentives for Negative LBMPs
  - More Frequent Transaction Scheduling
- **The NYISO will review the results of the 2019 project prioritization to assess stakeholder interest in continuing the design for a flexible ramping product.**
  - The NYISO also encourages direct stakeholder feedback on this topic.

Timeline

Timeline

- **May 3, 2018**
  - Deadline for stakeholder feedback on Master Plan outline.
- **May 10, 2018**
  - Draft Master Plan posted with 5/15 MIWG materials.
- **May 15, 2018**
  - Discuss draft Master Plan.
- **May 25, 2018**
  - Deadline for stakeholder feedback on Master Plan draft.
- **June 12, 2018**
  - Present Final Master Plan at MC.
- **June 13, 2018**
  - Present Final Master Plan at MIWG.

Appendix I: NYISO Look-Ahead

NYISO Look-Ahead

- **Multi-interval optimization resolves forecast variability by prepositioning resources to meet ramp-up and ramp-down needs between intervals**
  - However, the success of this technique depends on a resource mix with adequate ramping capability

Example – Resource Assumptions

- The following simplified example shows the benefits of a multi-interval optimization, like that employed by the NYISO
  - The following assumptions will be used:*

Resource	UOL [MW]	Incremental Cost [$/MWh]	Ramp Rate [MW/Min]
Generator 1	200	$50	10
Generator 2	200	$10	20
Shortage Price	9999	$775	9999

*See *Tariff Amendment to Implement Flexible Ramping Product, California Independent System Operator Corporation,* ER16-2023, June 24, 2016, retrieved from the following link: http://www.caiso.com/Documents/Jun242016_TariffAmendment-FlexibleRampingProduct_ER16-2023.pdf

Example – Single Interval Optimization

Resource	UOL [MW]	Incremental Cost [$/MWh]	Ramp Rate [MW/Min]
Generator 1	200	$50	10
Generator 2	200	$10	20
Shortage Price	9999	$775	9999

Interval	t	t+1
Load [MW]	150	275
Load Ramp [MW]	125	0
Generator 1 Energy Schedule [MW]	0	50
Generator 2 Energy Schedule [MW]	150	200
Energy Price [$/MWh]	$10	$775
Generation/Load Balance [MW]	0	-25

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Example – Multi-Interval Optimization

Resource	UOL [MW]	Incremental Cost [$/MWh]	Ramp Rate [MW/Min]
Generator 1	200	$50	10
Generator 2	200	$10	20
Shortage Price	9999	$775	9999

Interval	t	t+1
Load [MW]	150	275
Load Ramp [MW]	125	0
Generator 1 Energy Schedule MW [MW]	25	75
Generator 2 Energy Schedule MW [MW]	125	200
Generator 1 Ramp Schedule [MW]	50	-
Generator 2 Ramp Schedule [MW]	75	-
Energy Price [$/MWh]	$10	$90
Generation/Load Balance [MW]	0	0

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Flexible Ramping Product

Resource	UOL [MW]	Incremental Cost [$/MWh]	Ramp Rate [MW/Min]
Generator 1	200	$50	10
Generator 2	200	$10	20
Shortage Price	9999	$775	9999

- A flexible ramping product to address forecast uncertainty would procure additional ramp-up and/or ramp-down capability beyond that needed to meet the forecasted load.
  - This would provide flexibility in anticipation of an increase in renewable generation

Interval	t	t+1
Load [MW]	150	275
Load Ramp [MW]	125	0
Generator 1 Energy Schedule [MW]	25	75
Generator 2 Energy Schedule [MW]	125	200
Generator 1 Ramp Schedule [MW]	50	-
Generator 2 Ramp Schedule [MW]	75	-
Energy Price [$/MWh]	$10	$90
Generation/Load Balance [MW]	0	0

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Appendix II: CAISO and MISO Ramp Product Implementations

MISO – Ramp Capability Product

MISO Ramp Capability Product – Reasons for Implementation

- **The RT optimization used by MISO for commitment and dispatch considers one 5-minute interval at a time.**
  - The ramp capability product helps the system position to meet ramping needs by setting aside ramp.
    - Avoids unnecessary shortage pricing events.

MISO Ramp Capability Product – Features

- **Ramp Capability Product features:**
  - Procured in DA and RT
  - The MW range output a resource can attain within 10 minutes beyond the next 10 minute target setpoint counts toward the ramp-up or ramp-down requirements
  - Cooptimized with energy and ancillary services
  - Requirement applies to the entire region (*i.e.*, not zonal)
  - Resources can provide only ramp-up, only ramp-down, or both
  - All online dispatchable resources are able to provide the product
    - Resources may opt out of providing the product, but most participate

MISO Ramp Capability Product - Requirements

- Ramp requirements determined by forecasted change in load for the region, wind generation, and interchange (*i.e.*, change in 'Net Demand'), plus
  - An additional amount of ramp up and ramp down are added to the requirement (*i.e.*, "Uncertainty," currently set to +/- 575 MW)
- DA hourly requirements are scaled to mimic the RT 10 minute Ramp up and Down Requirements
- Ramp Capability Up Requirement = max([Net Demand in future interval – Net Demand in current interval]+Uncertainty,0)
- Ramp Capability Down Requirement = max([Net Demand in current interval - Net Demand in future interval]+Uncertainty,0)

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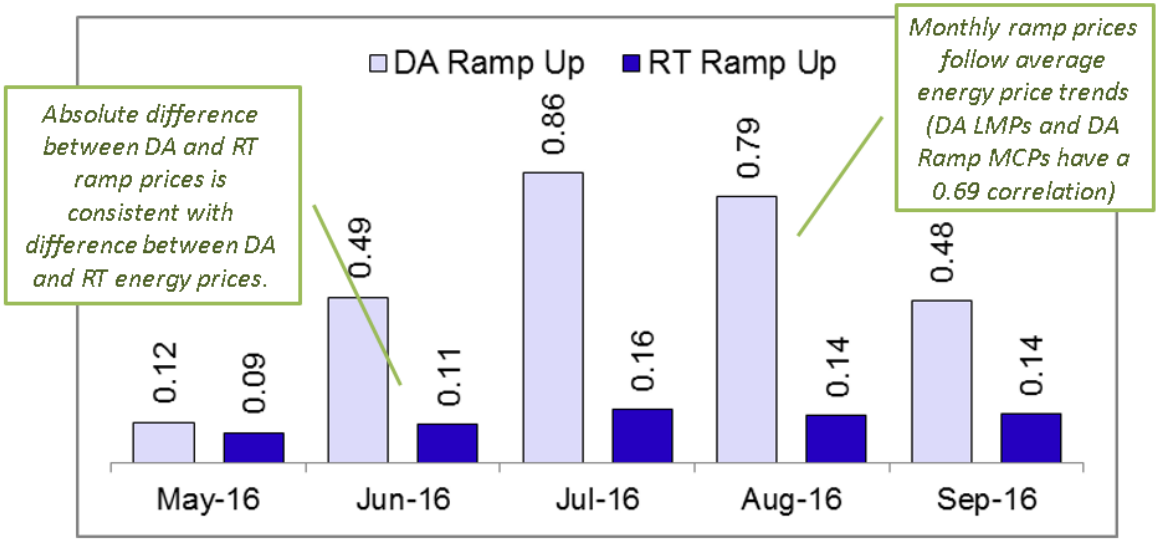
MISO Ramp Capability Product - Bidding

- **Units do not provide bids for this product**
  - The ramp capability clearing price is based on unit lost opportunity cost given the clearing price of other products
    - *E.g.*, if a unit bidding $30/MWh for energy is dispatched down from producing energy priced at $40/MWh by 1 MW in order to provide ramp up, then the clearing price of ramp will be $10/MWh, all else equal

MISO Ramp Capability Product – Demand Curve

- **Demand curve price currently set to $5/MWh for ramp up and ramp down**
  - Demand curve prices were determined by simulating with different demand curve price levels
    - Appropriate trade-offs with other products were considered
    - Cost of procuring the ramp requirement was considered

Monthly Average RCP Up Marginal Clearing Prices (MCPs)



Average DA MCP = $.55/MWh, RT MCP = $.13/MWh

Source: "Ramp Capability Product Performance Update" MISO Market Subcommittee, November 29, 2016:
https://cdn.misoenergy.org/20161129%20MSC%20Item%2005f%20Ramp%20Capability%20Post%20Implementation%20Analysis74816.pdf

Date range: 5/1/16 – 9/30/16

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CAISO – Flexible Ramping Product

CAISO Flexible Ramping Product – Reason for Implementation

- **CAISO advisory intervals were solving perfectly to the forecasted load that was input into the market software**
  - Relatively small forecast errors would result in high prices
    - Power balance violations occurred more often in the model and the energy price cap would set the price.
      - CAISO does not go short of reserve requirements in the 5-minute dispatch
    - This issue was expected to become more prevalent with increased intermittent renewables

CAISO Flexible Ramping Product - Features

- **Flexible Ramp Product features:**
  - Only in Real-Time Unit Commitment (RTUC), RTD
    - Market software includes a look-ahead capability
  - RTUC energy schedules binding at the Fifteen Minute Market (FMM) price from RTUC, re-optimized and settled in RTD
  - The MW output a resource can attain within 5 minutes counts toward the flexible ramping product requirement
  - Cooptimized with energy and ancillary services
  - Requirement applies to the entire region (*i.e.*, not zonal)
  - Resources can provide only ramp up, only ramp down, or both

CAISO Flexible Ramping Product - Requirements

- **Hourly requirements calculated every day and posted the day prior**
- **RTD Net Load Forecast Error is the difference between the binding interval and the prior advisory for the same interval**
  - 30-day histogram tracks the net forecast error for each hour of the day
  - Flex up uncertainty requirement is the 97.5 percentile
  - Flex down uncertainty requirement is the 2.5 percentile

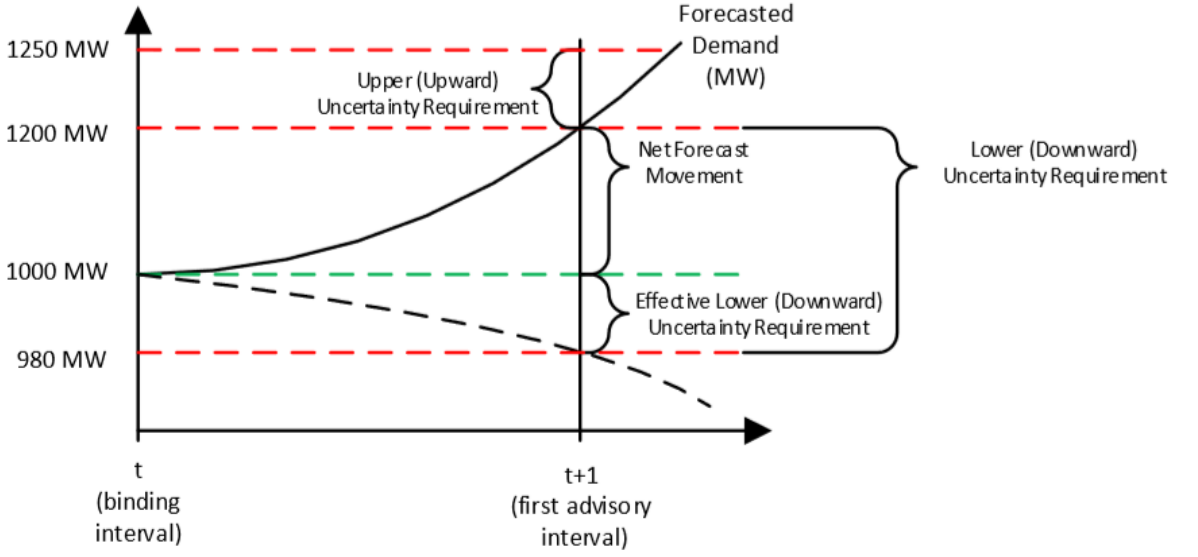

Figure 1 Flexible Ramping Product Uncertainty Requirements

Source: CAISO Business Practice Manual for Market Operations: https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Market%20Operations

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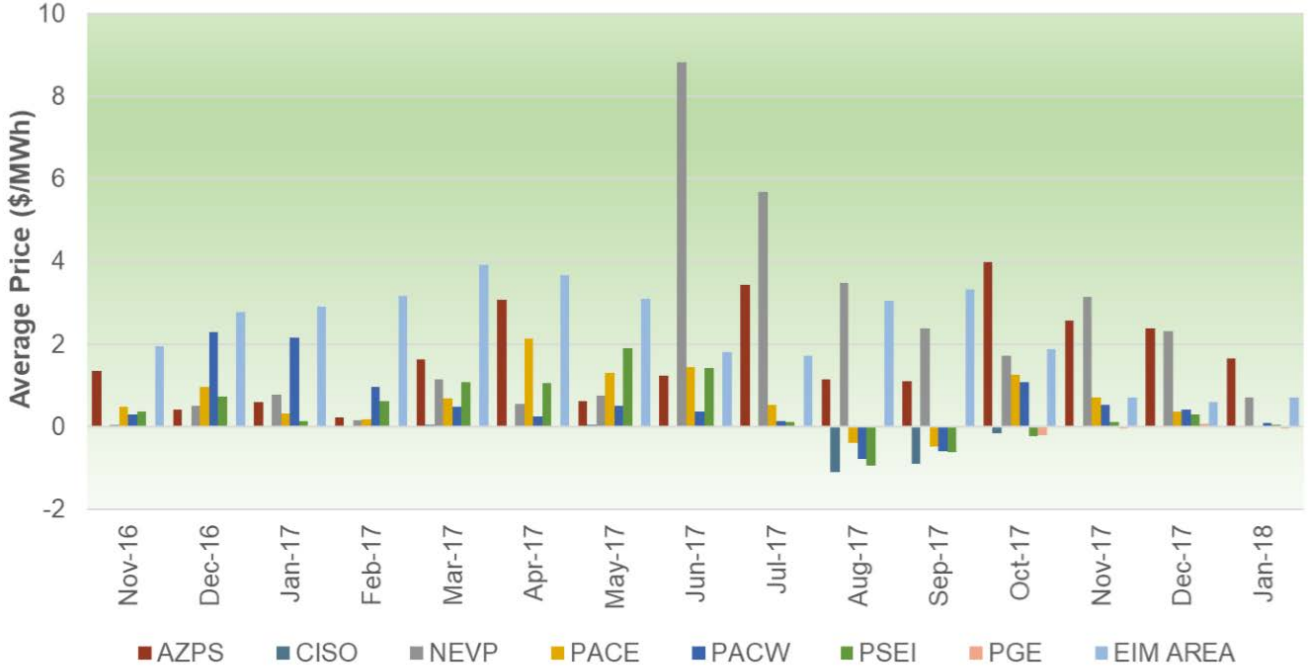
CAISO Flexible Ramping Product – Demand Curve

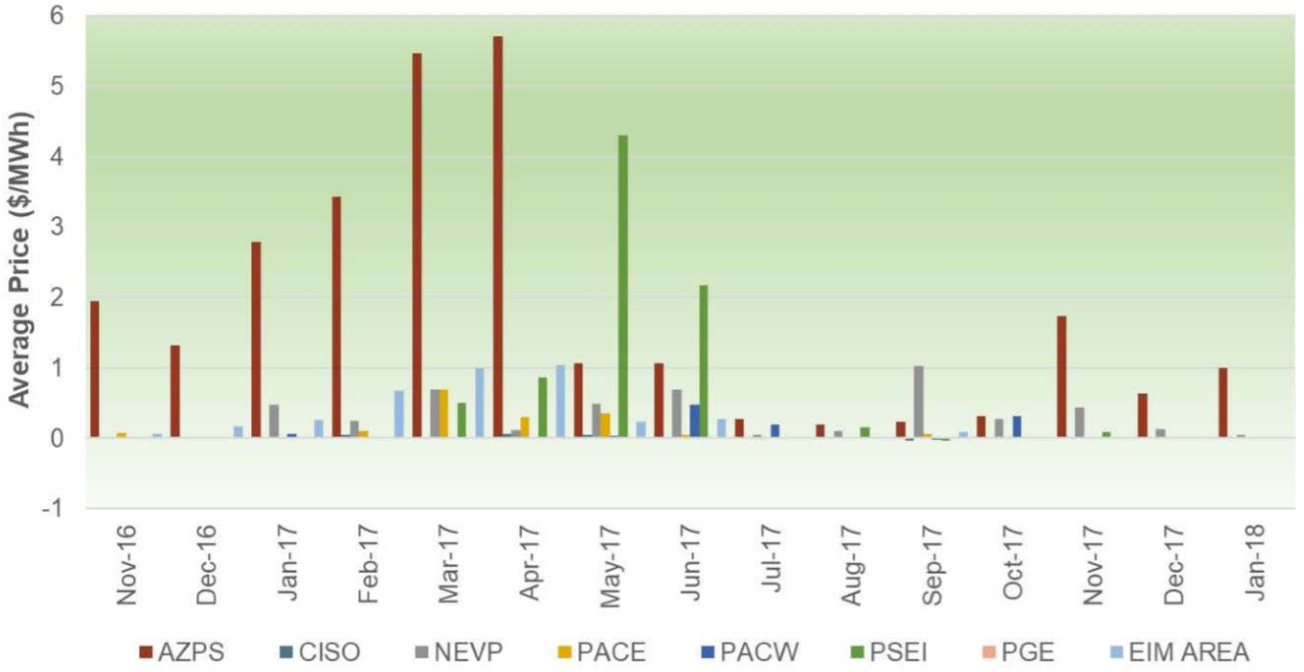
- **Units do not provide bids for this product**
  - Clearing price is based on lost opportunity cost
- **Ramp up demand curve price capped at $247/MWh**
  - This is a value slightly less than the contingency reserve relaxation parameter
    - Allows for appropriate trade-offs
  - The probability of a load balance constraint binding a certain level of procured flexible ramp is multiplied by $247/MWh
    - Multiple levels of procured ramp are used in this calculation to form the ramp up demand curve
- **Ramp down demand curve price is capped at $152/MWh**
  - This value is slightly more than the regulation down relaxation parameter
    - Allows for appropriate trade-offs
  - Ramp-down demand curve calculated using the same methodology as that used for the ramp up demand curve, but at a price of $152/MWh

Average Flexible Ramp Up Price ($/MWh)



Source: Market Performance and Planning Forum, February 20, 2018:
http://www.caiso.com/Documents/AgendaandPresentation-MarketPerfomanceandPlanningForum-Feb202018.pdf

Average Flexible Ramp Down Price ($/MWh)



Source: Market Performance and Planning Forum, February 20, 2018:
http://www.caiso.com/Documents/AgendaandPresentation-MarketPerfomanceandPlanningForum-Feb202018.pdf

Appendix III: Previous Presentations

Previous Presentations

Date	Working Group	Discussion points and links to materials
9-12-16	Budget & Priorities Working Group (BPWG)	Presentation of stakeholder feedback, proposed scope of the project
10-19-16	Market Issues Working Group (MIWG)	Presentation providing more detail on the scope and timeline of the project
11-22-16	Market Issues Working Group (MIWG)	Presentation updating project status
1-31-17	Market Issues Working Group (MIWG)	Integrating Public Policy Update (Phases 1 and 2)
2-16-17	Market Issues Working Group (MIWG)	Phase 2: Study Description and Assumptions Review
3-28-17	Market Issues Working Group (MIWG)	Phase 2: Study Description and Assumption Update
4-24-17	Market Issues Working Group (MIWG)	Phase 2: Preliminary DAM Results
6-21-17	Market Issues Working Group (MIWG)	Phase 2: Real-time Study Description and Assumptions
7-13-17	ICAP Working Group (ICAP WG)	The ICAP Market - Preliminary Findings (Phase 2)
8-22-17	ICAP Working Group (ICAP WG)	IPP Phase 2 Capacity Market Results and background information
8-25-17	Market Issues Working Group (MIWG)	IPP Phase 2: Simulation Progress
9-25-17	Market Issues Working Group (MIWG)	IPP Phase 2: RT Energy Market Simulation Results
10-3-17	Market Issues Working Group (MIWG)	Presentation discussing market assessment paper
10-16-17	Market Issues Working Group (MIWG)	IPP Phase 3: Initial Concepts under Consideration
11-02-17	Market Issues Working Group (MIWG)	IPP Phase 3: Stakeholder Feedback Posted
12-5-17	Market Issues Working Group (MIWG)	IPP Phase 3: Review of Potential Market Product and/or Structure Enhancements
12-20-17	Market Issues Working Group (MIWG)	Market Assessment for Accommodating Public Policy
1-10-18	Market Issues Working Group (MIWG)	Market Assessment for Accommodating Public Policy: Stakeholder Feedback
1-25-18	Market Issues Working Group (MIWG)	Accommodating Public Policy: Initial Prioritization

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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