PJM's ORDC and Scarcity Pricing Proposal

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Market Design

Reserve Certainty Senior Task Force

March 17, 2026

New and Existing Reserve Products Cleared in the Real-Time Market

30-Min Reserves – Updated

Addresses net-load ramping, net-load forecast uncertainty and the need for replacement reserves for system recovery.

30-Min Ramp/Uncertainty Reserves (Online)

Addresses net-load ramping and net-load forecast uncertainty

10-Min Ramp/Uncertainty Reserves – Up and Down Reserves

Addresses net-load ramping and net-load forecast uncertainty

Synchronized Reserves (SR) (10-minute reserves) – 100% MSSC*

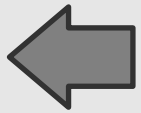
Contingency reserves and ACE recovery

New and Existing Reserve Products Cleared in the Day-Ahead Market

Energy Gap (Online) 60-Min reserves
Addresses the expected gap between the load forecast and cleared physical supply. Procured on elevated risk winter days.

Day-Ahead Scheduling Reserves (60-Min reserves)
Addresses net-load forecast uncertainty and generator performance risk in DA. Reserve quantities depend on risk assessment and are extended to include the Energy Gap on medium- and high-risk winter days.

30-Min Reserves and 10-Min RUR Up can meet the DASR and Energy Gap Requirements through product nesting.



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Synchronized Reserves (SR) (10-minute reserves) – 100% MSSC*
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ORDC Design Shapes

- For some of the ORDCs discussed and presented here, there is a downward sloping portion of the curve
- For uncertainty reserves that are intended to manage net-load forecast uncertainty, that analysis is based on historical deviations in the net-load forecast

ORDC Design Hierarchy

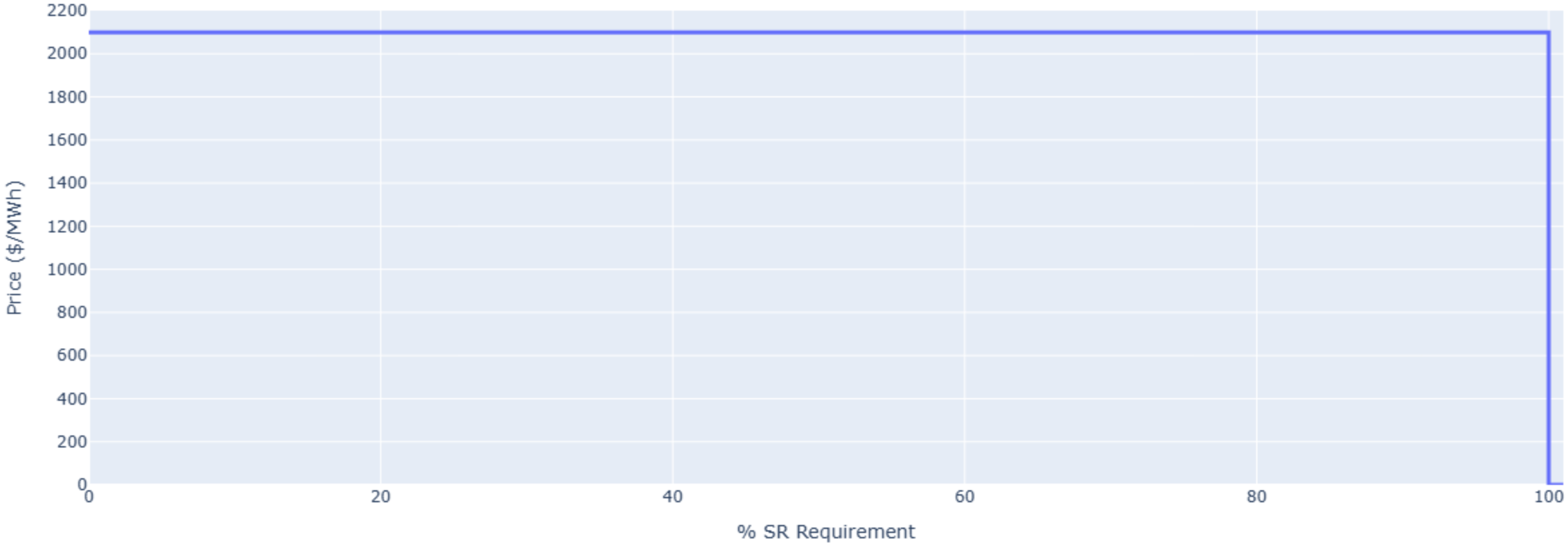
- The ORDCs have been designed to establish a reserve procurement hierarchy:
  - Synchronized Reserves are at the top of this hierarchy, and the ORDCs are designed such that the tops of all the other Demand Curves are lower than the SRDC
- Other Demand Curves are allowed to cross, but the “expected ramp” point on both the 10-Min RUR and 30-Min RUR are valued at the same penalty factor, which is twice the top of the Energy Gap Demand Curve

Design Principles for the Synchronized Reserve Demand Curve

- **PJM is proposing that the Synchronized Reserve Demand Curve be a single step at $2,100/MWh.**
- This sets the SR penalty price above the $2,000/MWh energy hard offer cap, which allows the willingness to pay for Synchronized Reserves to be high enough to allow economic redispatch up to that level to avoid SR shortage.
- This also ensures that the Synchronized Reserve Penalty Factor is higher than that of any of the other reserve products, creating the appropriate hierarchy in reserve value.
- PJM does not believe that a flat step at $2,100/MWh fully values scarcity as Synchronized Reserve levels are depleted. However, given the comprehensive conversations about investment signals across PJM's markets slated for later this year, PJM sees value in deferring the discussions around scarcity pricing until that broader review is conducted.

Synchronized Reserve Demand Curve

A single step at $2,100/MWh.

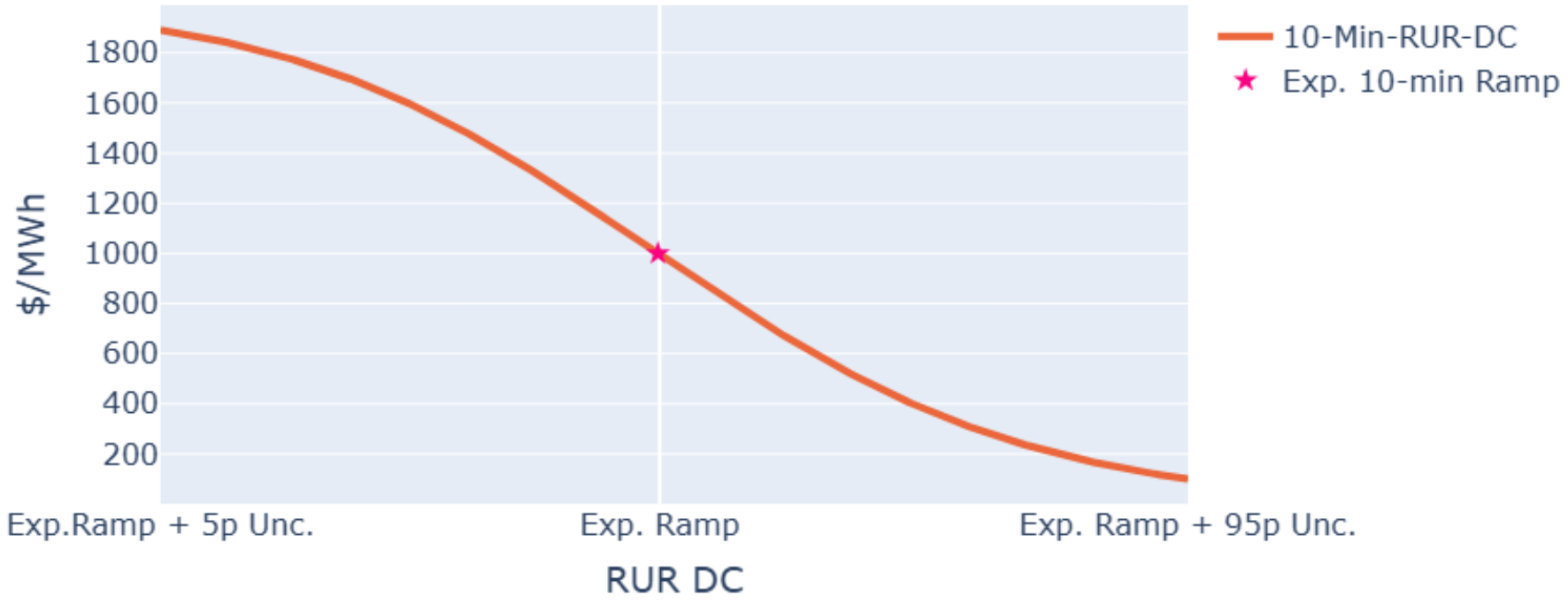


Design Principles for the 10-Min RUR Up Demand Curve

- The price for the expected net-load ramp is anchored at $1,000/MWh, the soft energy offer cap.
- The curve is then symmetric around this expected net-load ramp point, reflecting the increasing willingness to pay as the probability reaches near certainty that the net-load ramp will materialize in the next 10 minutes and the decreasing willingness to pay for reserves as the probability decreases that each incremental MW of reserves will address net-load ramping needs in the next 10-minutes.
- The tail on the righthand side of the 10-Min RUR Up curve is terminated at the 95th percentile uncertainty, above which the market would not pay for additional reserves.
- The left side of the reserve curve terminates below $2,000/MWh, maintaining the reserve hierarchy and ensuring that Synchronized Reserves are the highest value reserves.

10-Min RUR Up Demand Curve

The net-load uncertainty distribution is approximately symmetric. Consequently, the 5th percentile is approximately the negative of the 95th percentile uncertainty. So, the curve is ~$1,900/MWh at the top, at $1,000/MWh at the center, and ~$100/MWh near the terminal point

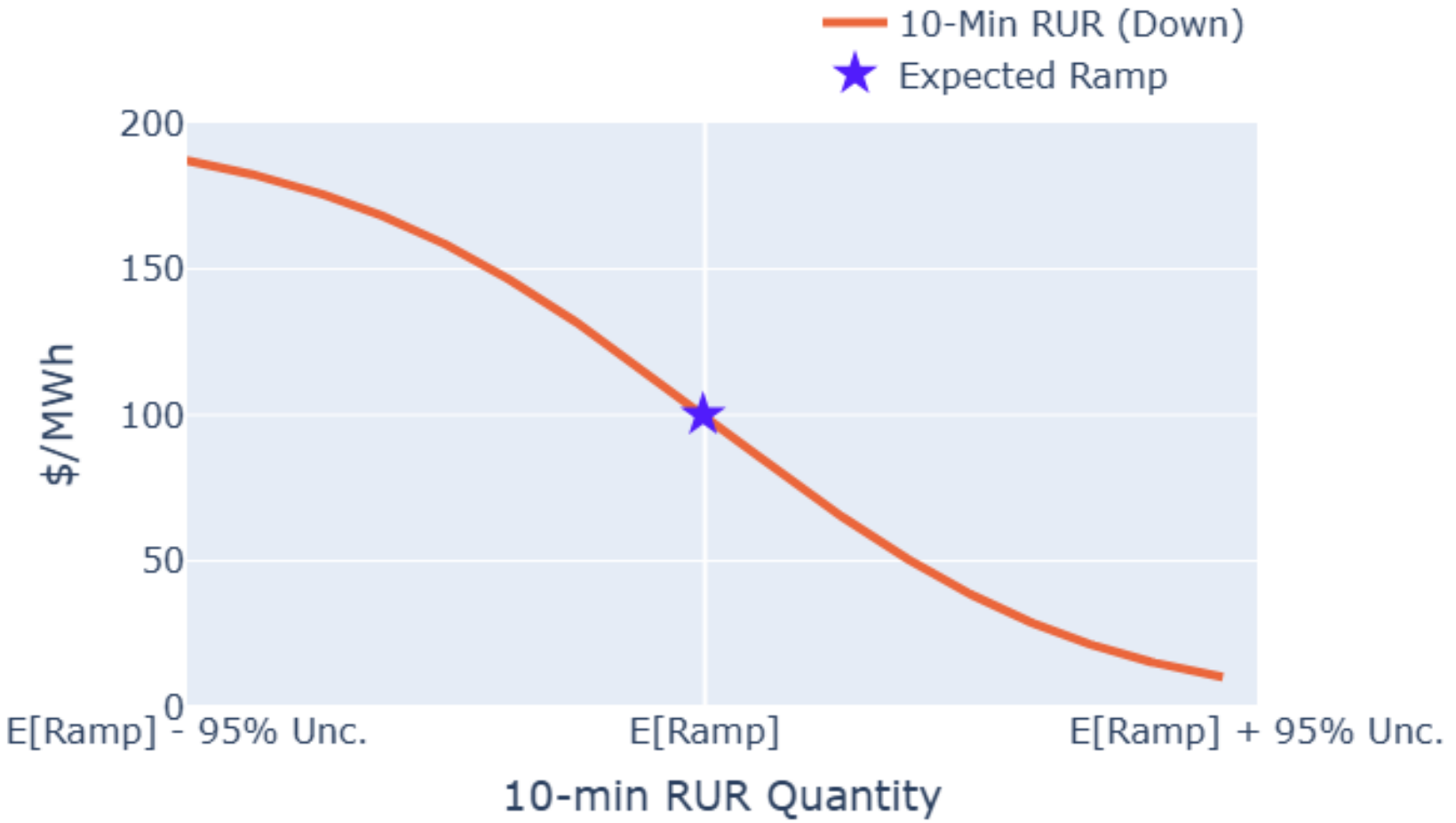


Design Principles for the 10-Min RUR Down Demand Curve

- The price for the expected net-load ramp down is anchored at $100/MWh, 10% of the expected net-load ramp up point on the 10-Min RUR Up curve.
- The shape of the 10-Min RUR Down Demand Curve is then based on the same probabilities that dictate the 10-Min RUR Up Demand Curve.
- The tail on the righthand side of the 10-Min RUR Down Demand Curve is terminated at the 95th percentile uncertainty, above which the market would not pay for additional reserves.
- Setting the 10-Min RUR Down curve as 10% of 10-Min RUR Up means that the median start up cost of a resource that can be committed in real-time lies between the 10-Min RUR Up and 10-Min RUR Down Demand Curves.

10-Min RUR Down Demand Curve

The net-load uncertainty distribution is approximately symmetric. Consequently, the 5th percentile is approximately the negative of the 95th percentile uncertainty. So, the curve is ~$190/MWh at the top, at $100/MWh at the center, and ~$10/MWh near the terminal point

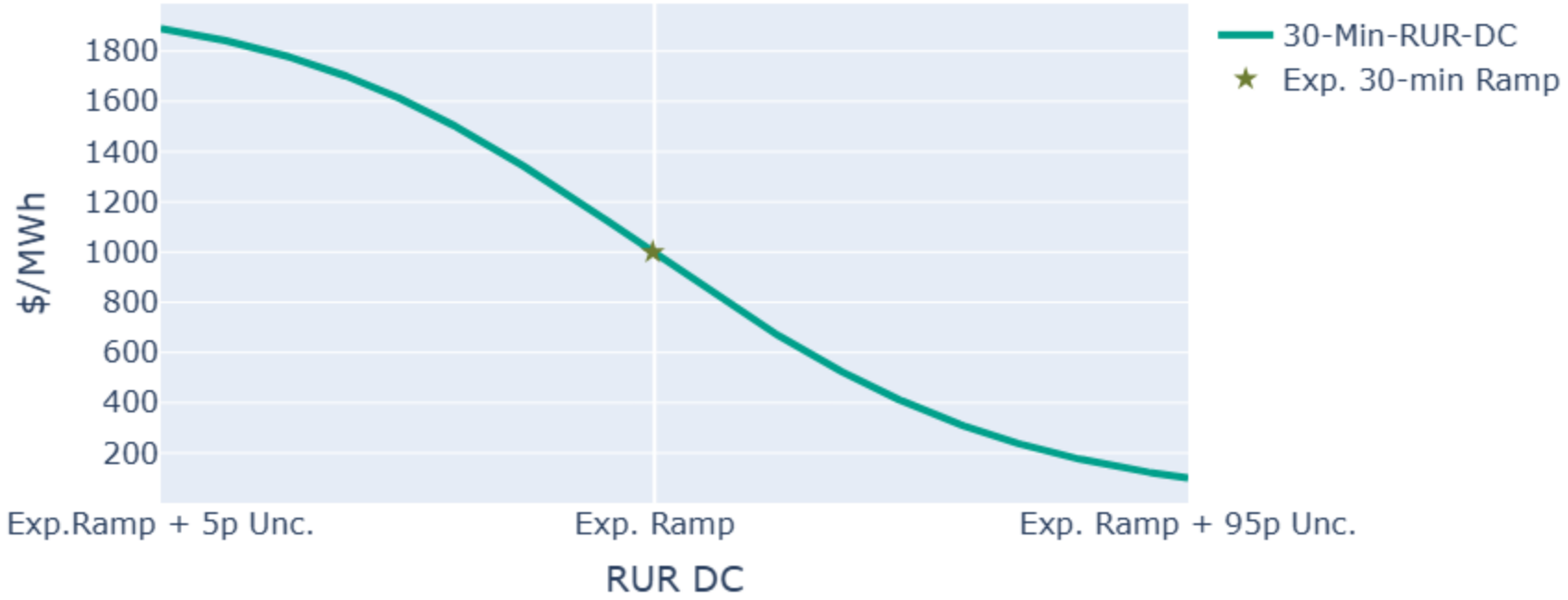


Design Principles for the 30-Min RUR Demand Curve

- The design principles for the 30-Min RUR product are the same as for the 10-Min RUR product, and the price for the expected net-load ramp is anchored at $1,000/MWh, the soft energy offer cap.
- The price rises to the left of this expected net-load ramp point and slopes down to the right, as a function of the probability of the net-load ramp materializing in the 20 minutes following the period addressed by the 10-Min RUR Up product.
- The tail on the righthand side of the 30-Min RUR curve is terminated at the 95th percentile uncertainty, above which the market would not pay for additional reserves.
- The left side of the reserve curve terminates below $2,000/MWh, maintaining the reserve hierarchy and ensuring that Synchronized Reserves are the highest value reserves.

30-Min RUR Demand Curve

The net-load uncertainty distribution is approximately symmetric. Consequently, the 5th percentile is approximately the negative of the 95th percentile uncertainty. So, the curve is ~$1,900/MWh at the top, at $1,000/MWh at the center, and ~$100/MWh near the terminal point

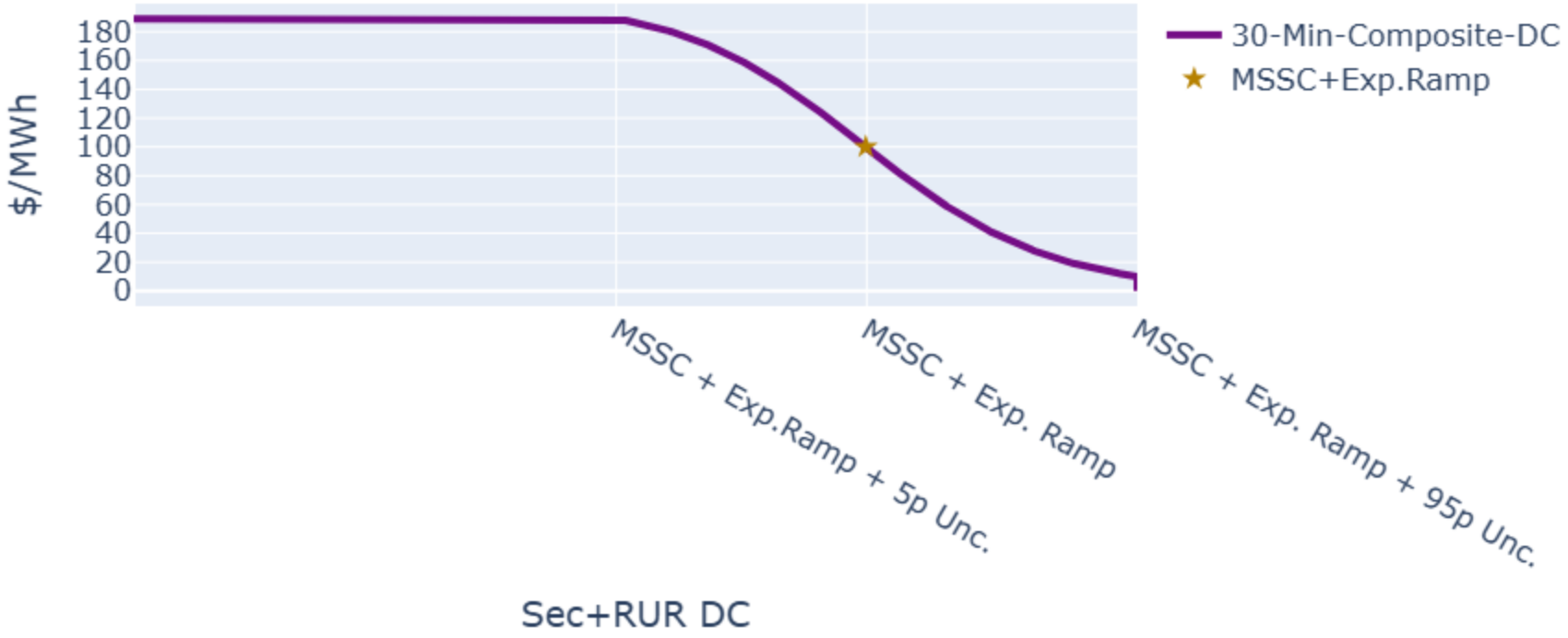


Design Principles for the 30-Min Reserve Demand Curve

- The 30-Min Reserve service is nested with the 30-Min RUR service, meaning that if the reserves are clearing on the demand curves, the penalty factors will be additive.
- The 30-Min Reserve Demand Curve is a flat step up to the quantity of MW that serve the Secondary Reserve need (i.e., the need to carry 30-Minute Reserves to backfill 10-minute contingency reserves).
- The tail on the righthand side of the 30-Min Reserve Curve reflects the 30-Min net-load ramping and uncertainty need, and the decreasing willingness to pay as the probability of the uncertainty materializing decreases.
- The maximum willingness to pay for 30-Minute Reserves has been set to $190/MWh, which is 10% of the maximum willingness to pay for 30-Min RUR. This ensures that even if both 30-Min RUR and 30-Min Reserves are clearing at 0 MW, the added price of both curves will not exceed the willingness to pay for Synchronized Reserves.

30-Min Reserve Demand Curve

The curve is priced at ~$190/MWh till MSSC + Expected Ramp + 5th percentile net-load uncertainty. It starts sloping downwards from this point to reach $100/MWh at MSSC + Expected Ramp. The value at the rightmost terminal point of the curve is $10/MWh

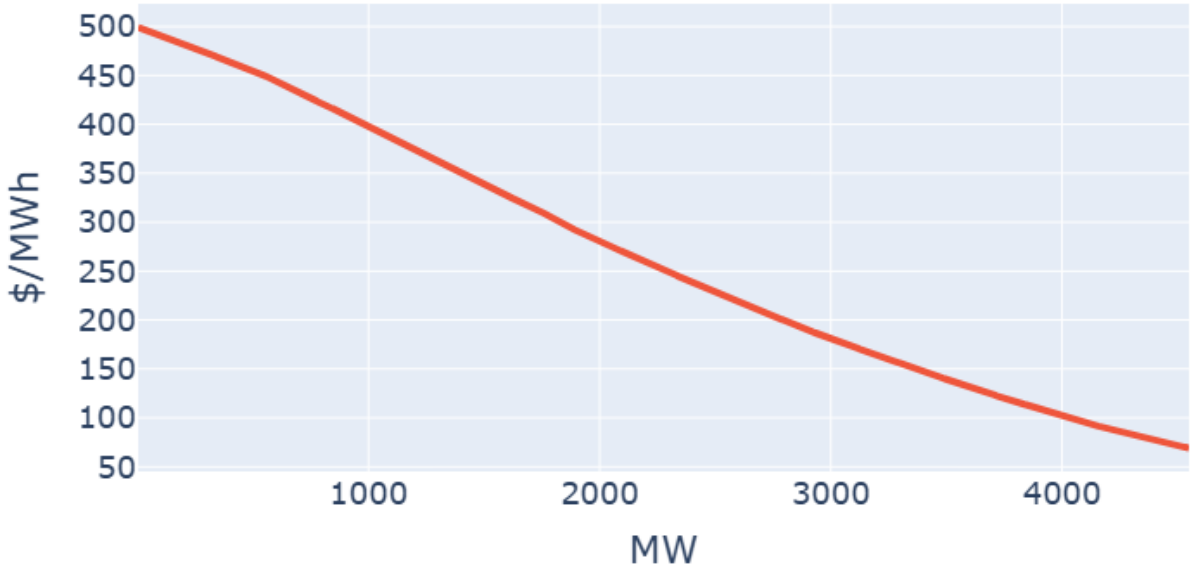


Notes on the Energy Gap Demand Curve

- Energy Gap Reserve service is nested with the 10-Min RUR Up and 30-Min RUR services
- These reserves would only be cleared on medium- and high-risk winter days.
- The Demand Curve would be fixed based on a historical analysis of instances where the Day-Ahead Market cleared insufficient physical supply to meet PJM's load forecast.

Energy Gap Reserve Demand Curve

- An Energy Gap Demand Curve shape for winter is illustrated in the plot in the lower right.
- This curve is based on historical observations from November – March from December 1, 2022, through December 1, 2025.
- The price at an Energy Gap Reserve level of 0 MW is $500/MWh, half of the price of the RUR services at the expected net-load ramp.
- The terminal point of the demand curve is at roughly 4,500 MW (90-th percentile of the historical observed Energy Gap in winter).
- The price at 4,500 MW is approximately $70/MWh



DASR Demand Curve

- DASR resources have the least stringent eligibility criteria, and they are procured to address DA uncertainty in net-load and generator performance. They also do not have a two-market settlement: no obligation to buy back uncleared reserves in real-time market.
- The DASR requirement is also met by the other ramping and uncertainty reserve products (including the Energy Gap) in the Day-Ahead Market, meaning that if the reserve services clear on the demand curve, these prices would be additive.
- **PJM is proposing a single stepped DASR Demand Curve priced at $50/MWh (slightly above the average system marginal price of electricity).**

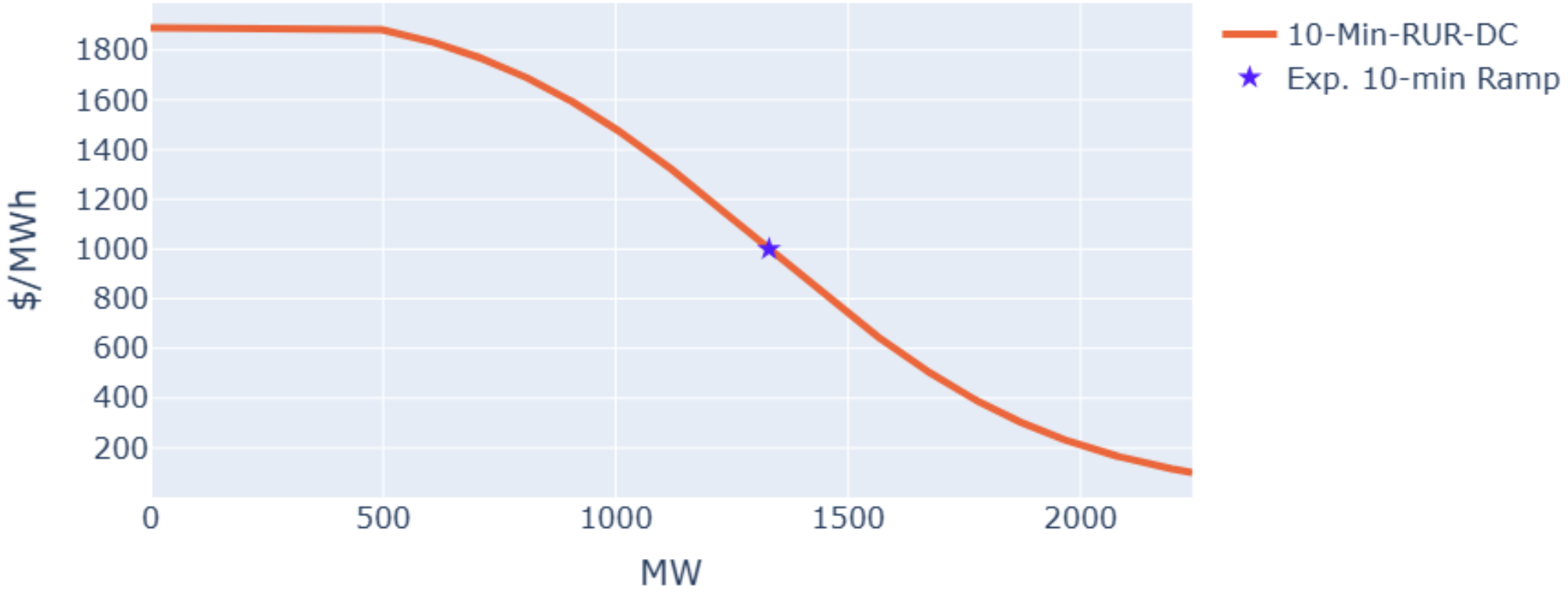
Administrative Pricing

- Today, PJM caps SR prices at $1,700/MWh and the system marginal energy price at $3,700/MWh, based on the maximum SR price of $1,700/MWh + the $2,000/MWh energy hard offer cap.
- During load shed events, PJM administratively sets the system marginal energy price to be equal to this $3,700/MWh cap.
- **Moving forward, PJM proposes to increase this price cap and administrative pricing point to $4,100/MWh to represent the increased maximum SR price of $2,100/MWh + the $2,000/MWh energy hard offer cap.**

Example ORDCs for June 24th (Day-Ahead)

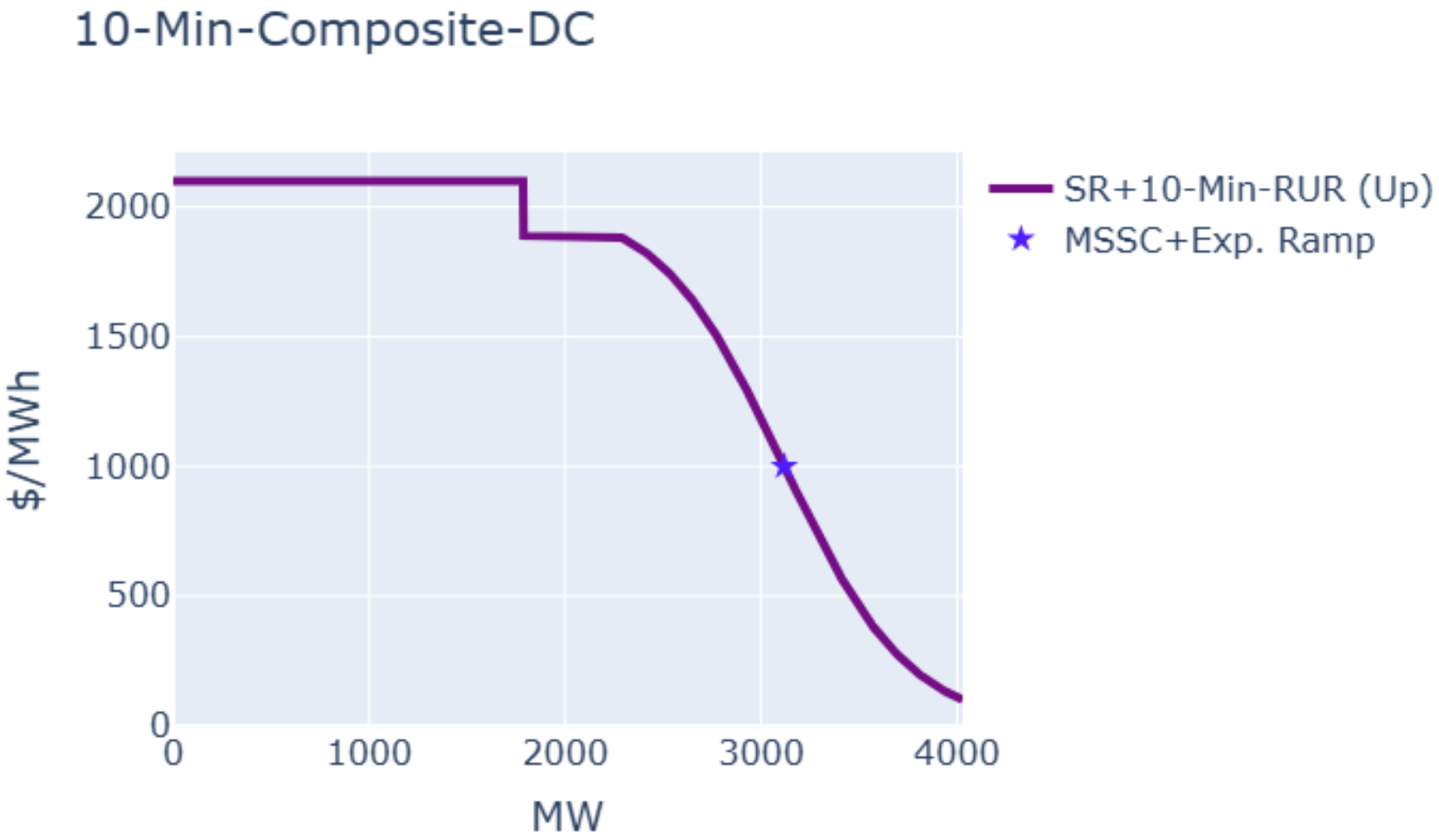
Ex. Hour 1: 11:00; 10-Min RUR Up curve; Positive Ramp

- 10-Min expected ramp requirement is 1,333 MW
- 10-Min 95th percentile uncertainty requirement is 907 MW



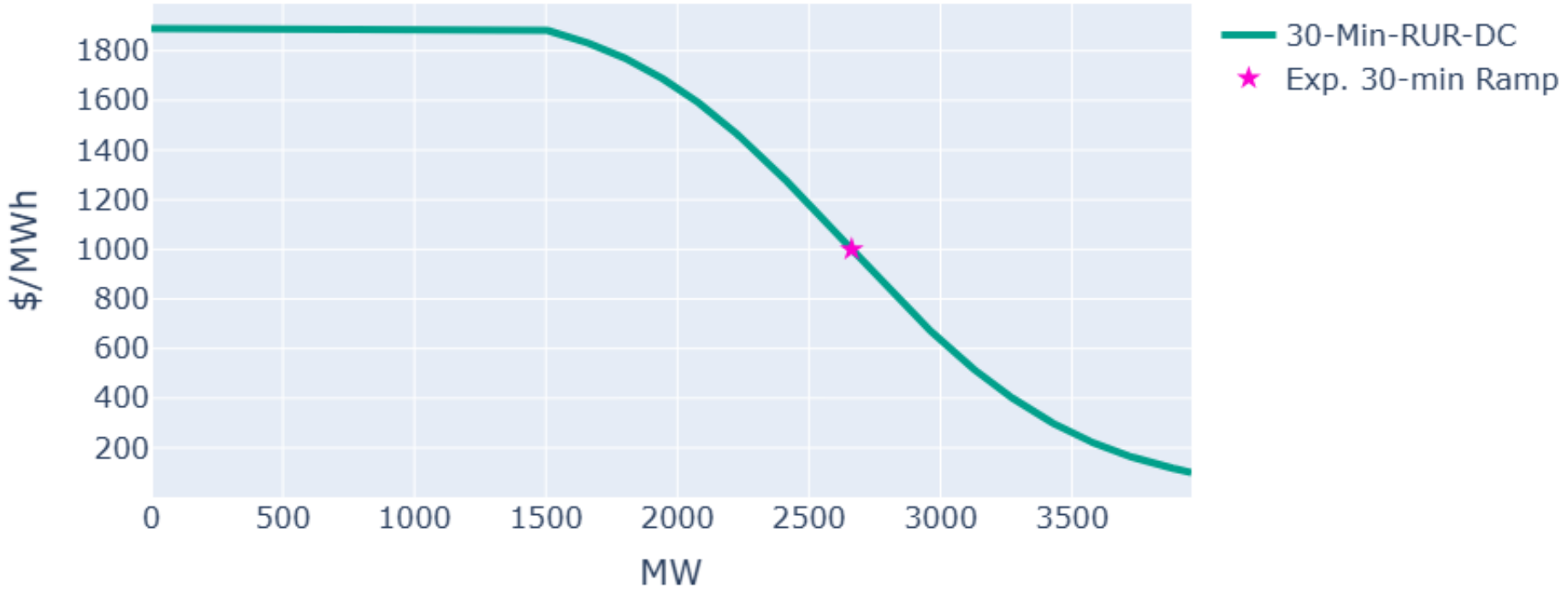
Example Hour 1: 11:00 — 10-Min Up Composite Curve

- The SR curve is a single step of $2,100/MWh till MSSC = 1,788 MW on June 24
- The effective demand curve for the online resources with 10-Min response time (up) is a composite of the SR demand curve and the 10-Min RUR Up curve



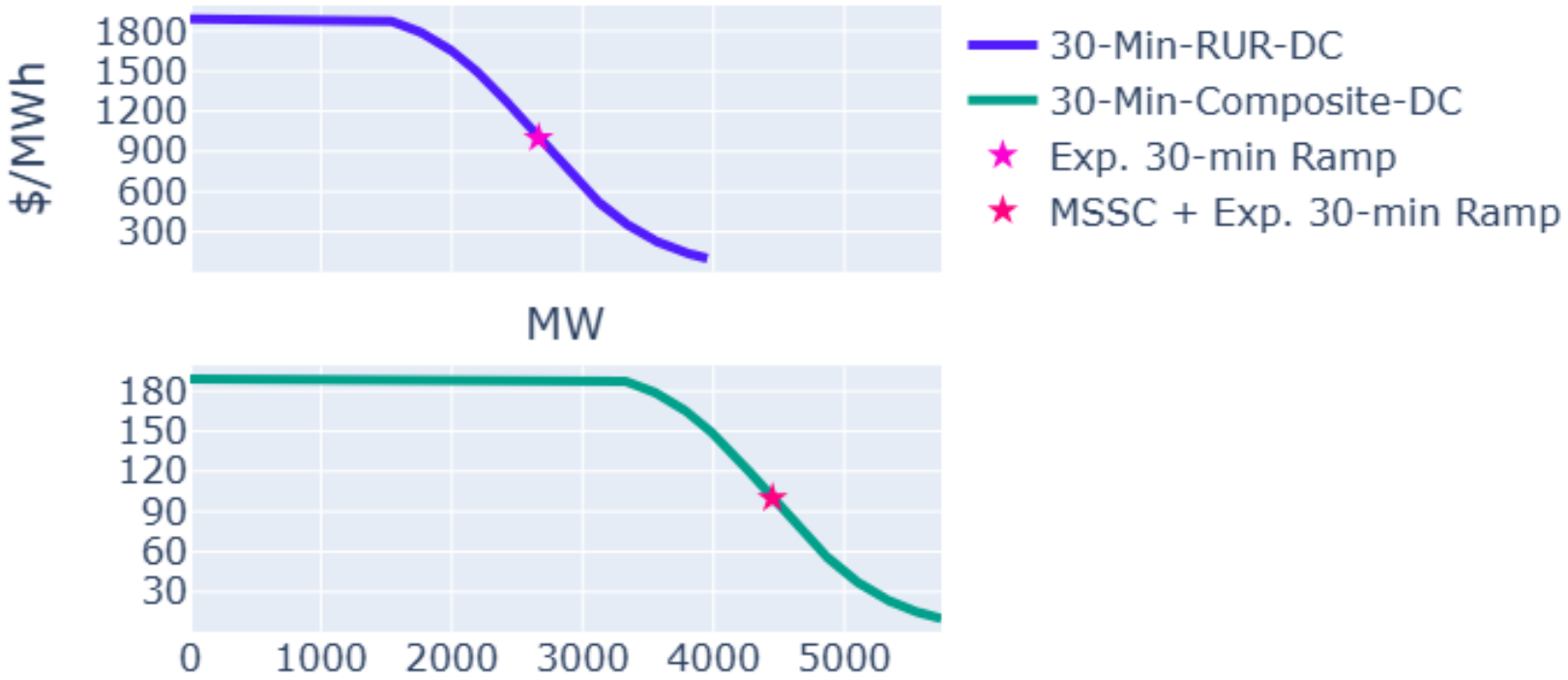
Ex. Hour 1: 11:00, 30-Min RUR curve; Positive 30-Min Ramp

- 30-Min expected ramp requirement is 2,667 MW
- 30-Min 95th percentile uncertainty requirement is 1,287 MW



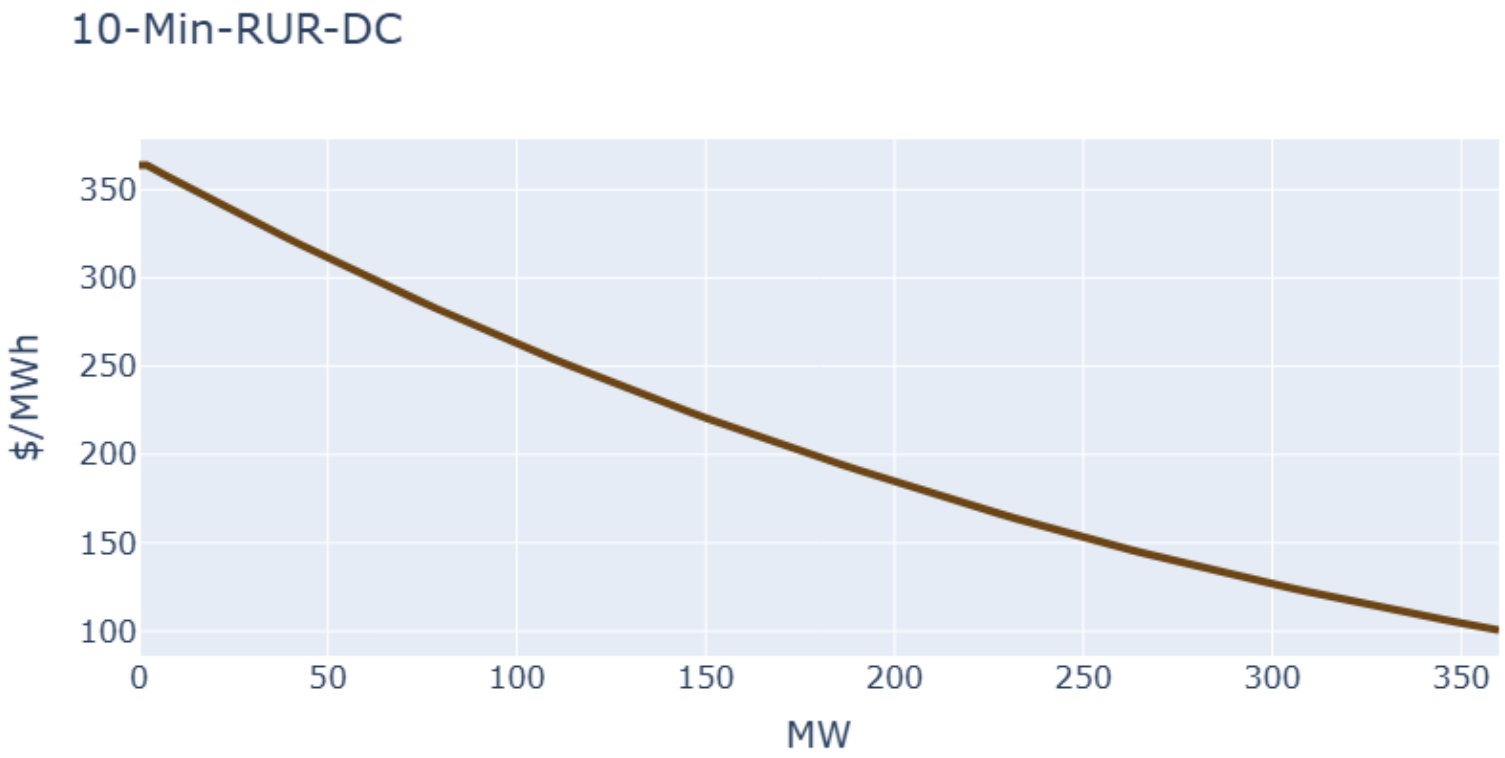
Ex. Hour 1: 11:00, 30-Min Reserve Curve

- 30-Min Reserve curve is a right shifted version (by MSSC) of the RUR demand curve, but centered at $100 instead of $1,000/MWh
- The plot shows both — RUR (top), 30-Min Reserves (bottom)



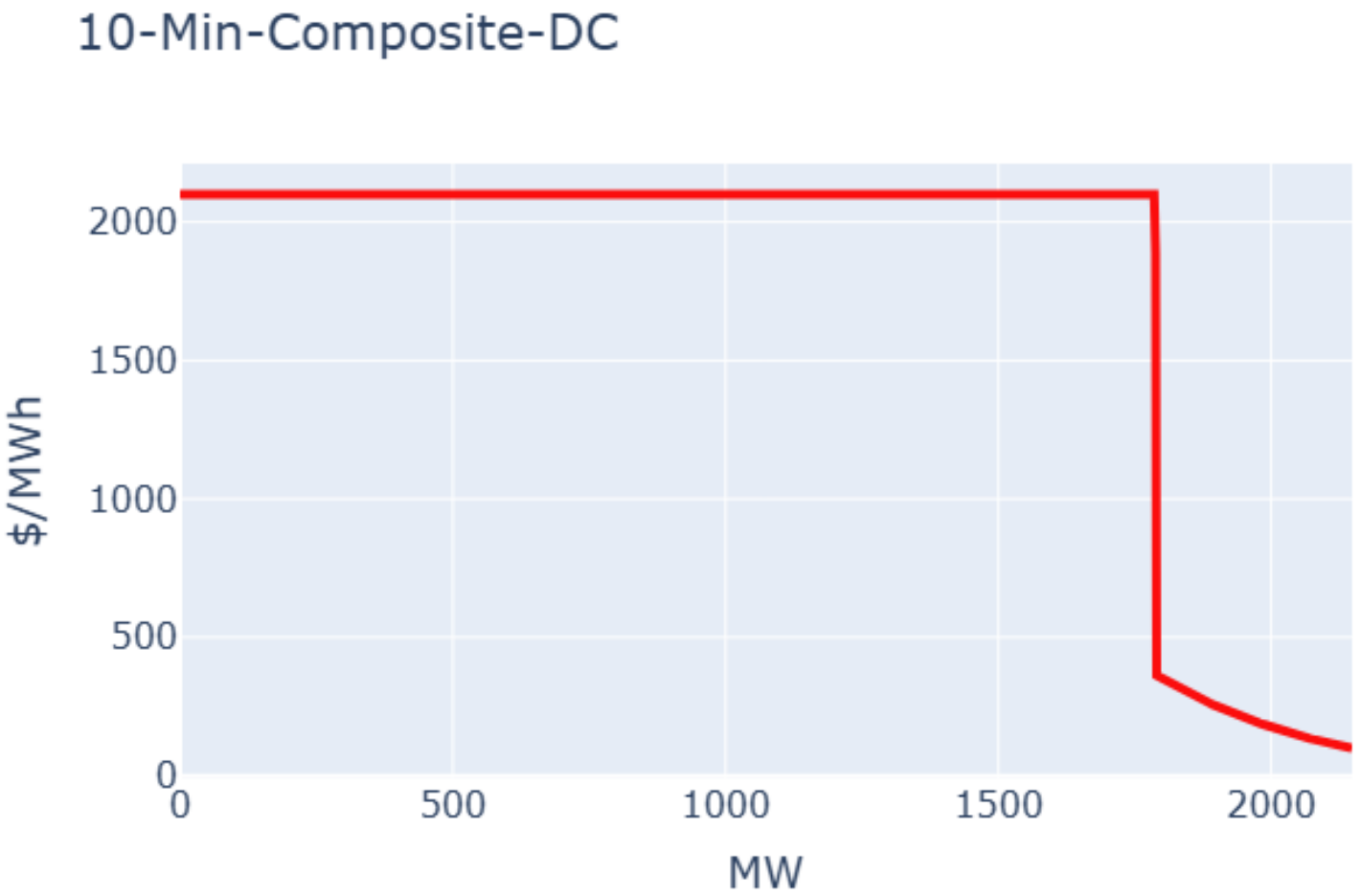
Ex. Hour 2: 20:00; 10-Min RUR Up curve; Negative Exp. Ramp with a Positive Uncertainty Tail

- 10-Min expected ramp requirement is -384 MW (i.e., ramp down)
- 10-Min 95th percentile uncertainty requirement is 744 MW



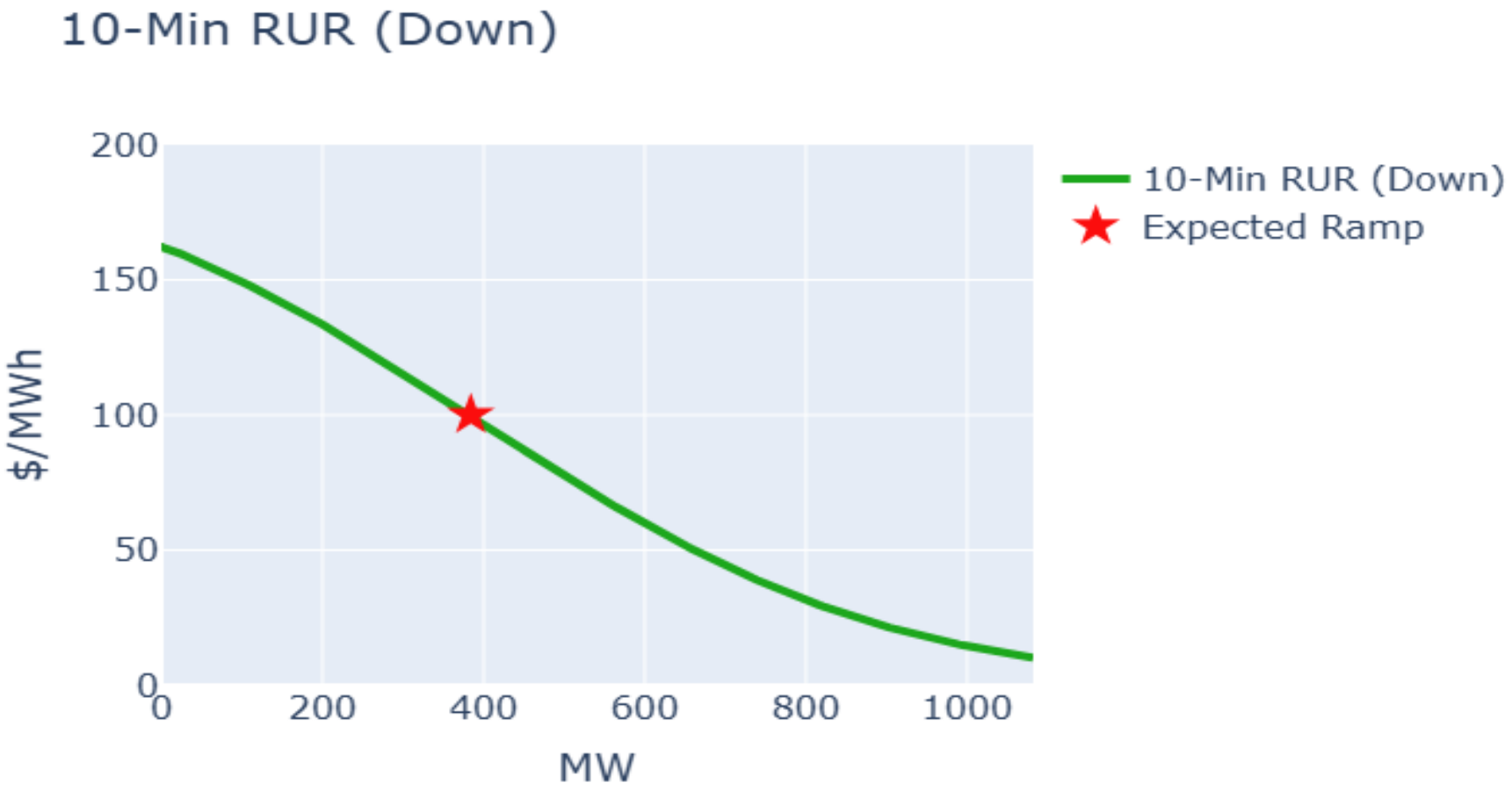
Ex. Hour 2: 20:00 — 10-Min Up Composite Curve

The effective demand curve for the online resources with 10-Min response time (up) is a composite of the SR demand curve and the 10-Min RUR Up curve



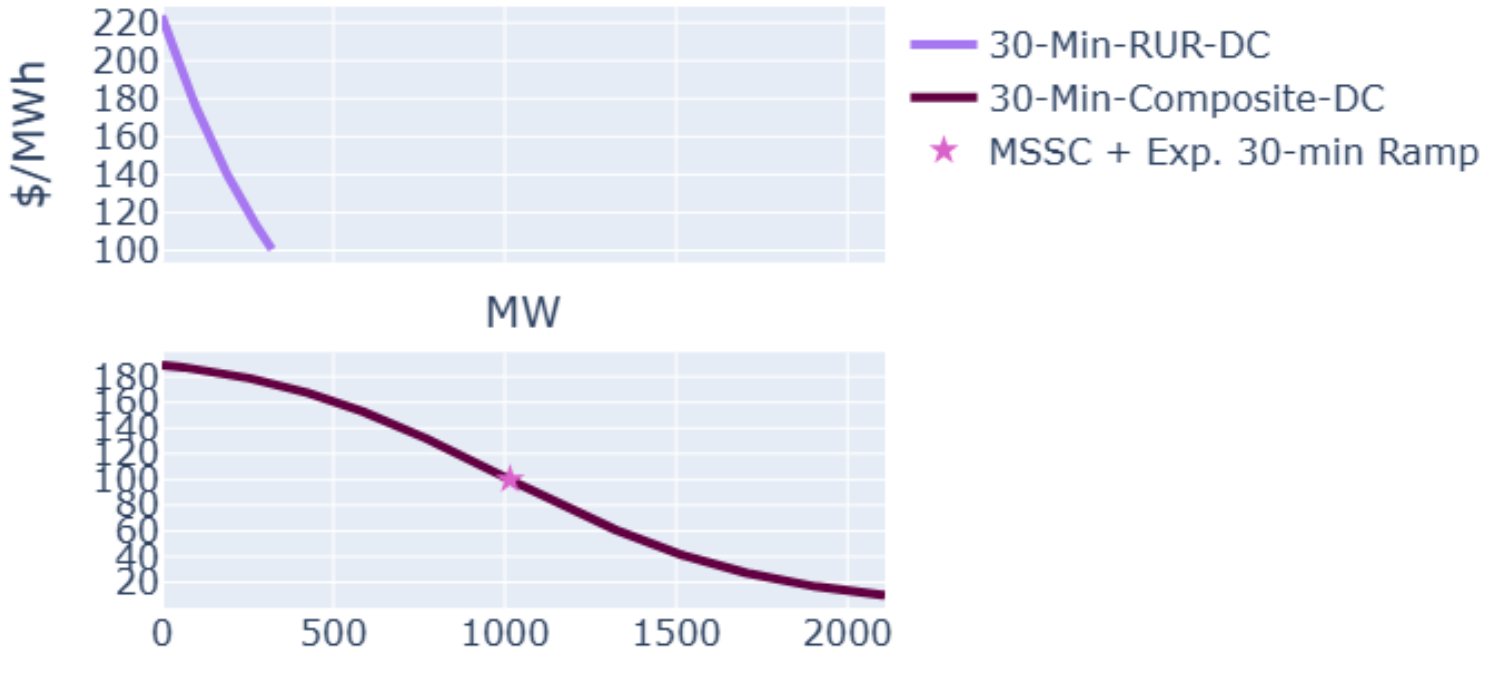
Ex. Hour 2: 20:00; 10-Min RUR Down curve

- 10-Min expected down ramp requirement is 384 MW
- 10-Min 95th percentile uncertainty requirement is 744 MW



Ex. Hour 2: 20:00, 30-Min RUR & 30-Min Reserve curve; Negative Exp. Ramp & Positive Uncertainty Tail

- 30-Min expected ramp requirement is -769 MW
- 30-Min 95th percentile uncertainty requirement is 1090 MW
- Only the tails of the 30-Min RUR curve and the 30-Min Reserve curve have positive MW segments
- The 30-Min Reserve curve has more segments due to the right shift by 1,788 MW (MSSC)
- The plot shows both curves — 30-Min RUR (top), 30-Min Reserves (bottom)



Example Hour 3: 23:00, Negative Net-Load Ramp with No Positive Uncertainty Tail

- The expected 10-min ramp and 30-min ramp requirements are -1,532 MW and -3064 MW, respectively
- The 95th percentile uncertainty requirements for 10-min and 30-min are 549 MW and 822 MW, respectively
- Consequently, there is no 10-Min RUR Up and 30-Min RUR requirement, and therefore, no demand curves for these products
- Further, the rightmost point of the 30-Min Reserve demand curve is

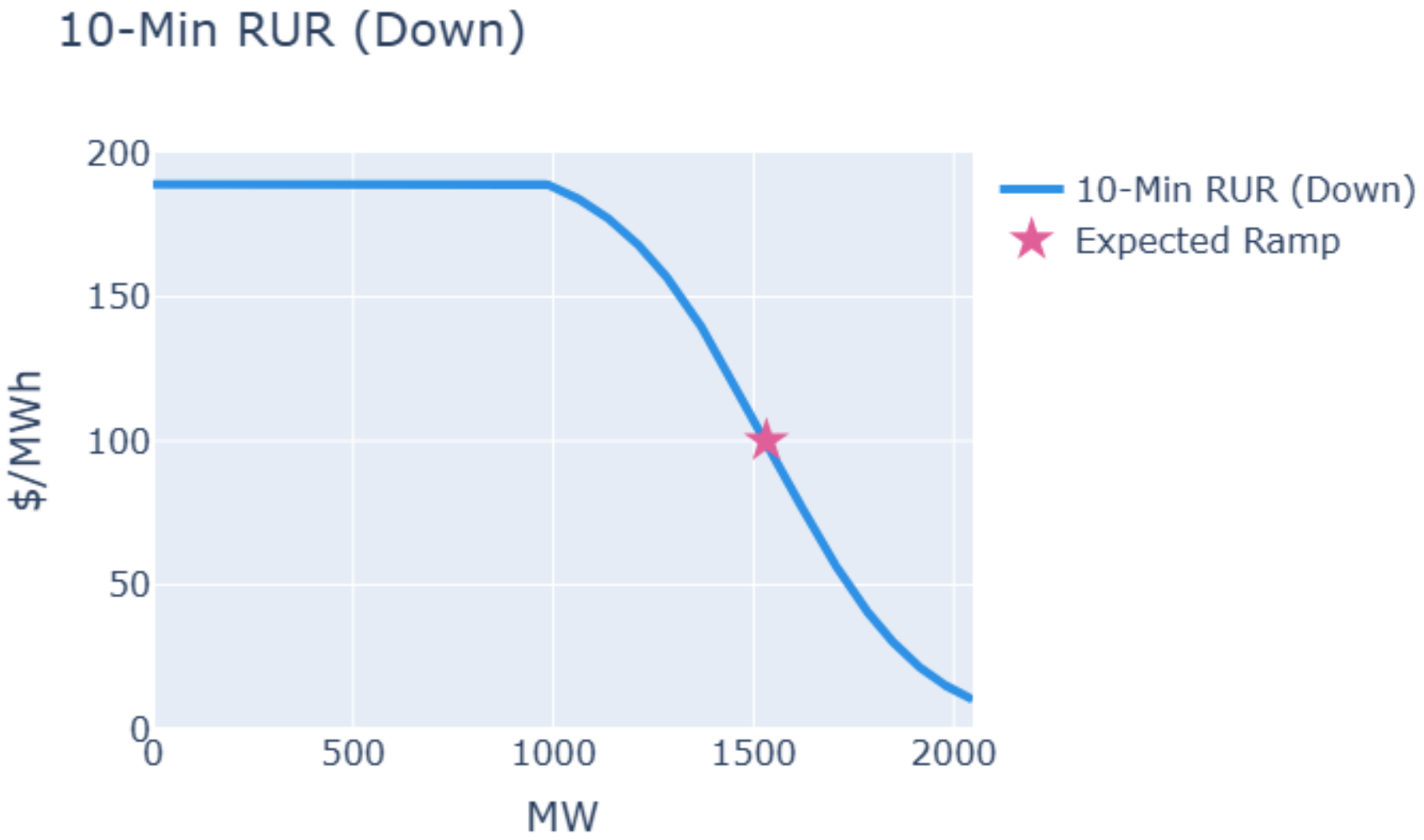
MSSC + Exp. Ramp + 95th percentile uncertainty = 1,788 – 3,064 + 822 = – 454 MW

Hence, there is no 30-Min Reserve requirement

- SR and 10-Min Down RUR are the only RT reserves that will be procured in this hour

Ex. Hour 3: 23:00; 10-Min RUR Down curve

- 10-Min expected down ramp requirement is 1532 MW
- 10-Min 95th percentile uncertainty requirement is 549 MW



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PJM's ORDC and Scarcity Pricing Proposal

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Acronyms

Acronym	Term & Definition
SR	**Synchronized Reserves** are reserves provided by resources that are synchronized to the grid and can respond within 10 minutes.
ORDC	An **Operating Reserve Demand Curve** is an administrative pricing curve that represents the markets willingness to pay for reserves at different reserve levels.
RUR	**Ramping/Uncertainty Reserves** are reserves that would be procured to manage forecasted ramp and uncertainty operational flexibility needs.
MW	A **Megawatt** is a unit of power equaling one million watts (1 MW = 1,000,000 watts) or one thousand kilowatts (1 MW = 1,000 KW).

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Appendix:
Technical Details of the Methodologies

10-Min RUR Up Demand Curve

- Uncertainty analysis based on bi-directional uncertainty around 10-min net-load ramp in historical data from Jan 2023 - Dec 2025
- For any historical time sample t, the uncertainty is defined as the difference between the 20-Min forward forecast and the 10-Min forward forecast (to emulate the forecasts from the RT-SCED perspective)
- Uncertainty distribution fit on this data (CDF denoted F). For an RUR level r, the function

$$P(r) = 1 - F(r)$$

represents the conditional probability of experiencing subsequent SR shortage given a 10-min up ramp limited system

- $P(r)$ is scaled to be at price $1,000/MWh (soft offer cap) at expected ramp point (overall curve is between $100–$1,900/MWh)
- Since RUR requirement is based on the 95th percentile uncertainty, the curve is restricted between 5th and 95th percentile uncertainties (to preserve symmetry)

10-Min RUR Down Demand Curve

- Uncertainty analysis based on bi-directional uncertainty around 10-min net-load ramp in historical data from Jan 2023 - Dec 2025
- For any historical time sample t, the uncertainty is defined as the difference between the 20-Min forward forecast and the 10-Min forward forecast (to emulate the forecasts from the RT-SCED perspective)
- Uncertainty distribution fit on this data (CDF denoted F). For an RUR level r, the function

$$P(r) = F(-r)$$

represents the conditional probability of having inadequate down-ramping operational flexibility

- $P(r)$ is scaled to be at price \$100/MWh (10% of the soft offer cap) at expected ramp point (overall curve is between \$10–\$190/MWh)
- Since RUR requirement is based on the 95th percentile uncertainty, the curve is restricted between 5th and 95th percentile uncertainties (to preserve symmetry)

30-Min RUR Demand Curve

- Uncertainty analysis based on bi-directional uncertainty around net-load ramp between 10-min through 30-min after SCED target in historical data from January 2023 - December 2025
- Uncertainty distribution fit on this data (CDF denoted F). For an RUR level r, the function

$$P(r) = 1 - F(r)$$

represents the conditional probability of going short SR given a 30-min up ramp limited system

- $P(r)$ is scaled to be at price $1,000/MWh (soft offer cap) at expected ramp point (overall curve is between $100–$1,900/MWh)
- Since RUR requirement is based on the 95th percentile uncertainty, the curve is restricted between 5th and 95th percentile uncertainties (to preserve symmetry)

Energy Gap Reserve Demand Curve (Winter Only)

- The downward sloping demand curve associates a marginal value ($/MWh) at a specific Energy Gap reserve level (in MW) as detailed below
- Uncertainty distribution fit to historical realizations of energy gap from Dec 2022 through Dec 2025 for the winter season (November through March). Cumulative Distribution Function denoted F
- For a given energy gap level $r \geq 0$, the following function represents probability of clearing less physical supply in the Day-Ahead Market as compared to the load forecast in the winter season

$$P(r) = 1 - F(r)$$

- $P(r)$ is scaled by $500 to obtain the inverse demand function
- We restrict $F(r)$ at the 90th percentile, so that the terminal point of the demand curve is the 90th percentile of the historical observations of the Energy Gap (in MW)