



# PJM Proposal Summary

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Market Design

Reserve Certainty Senior Task Force

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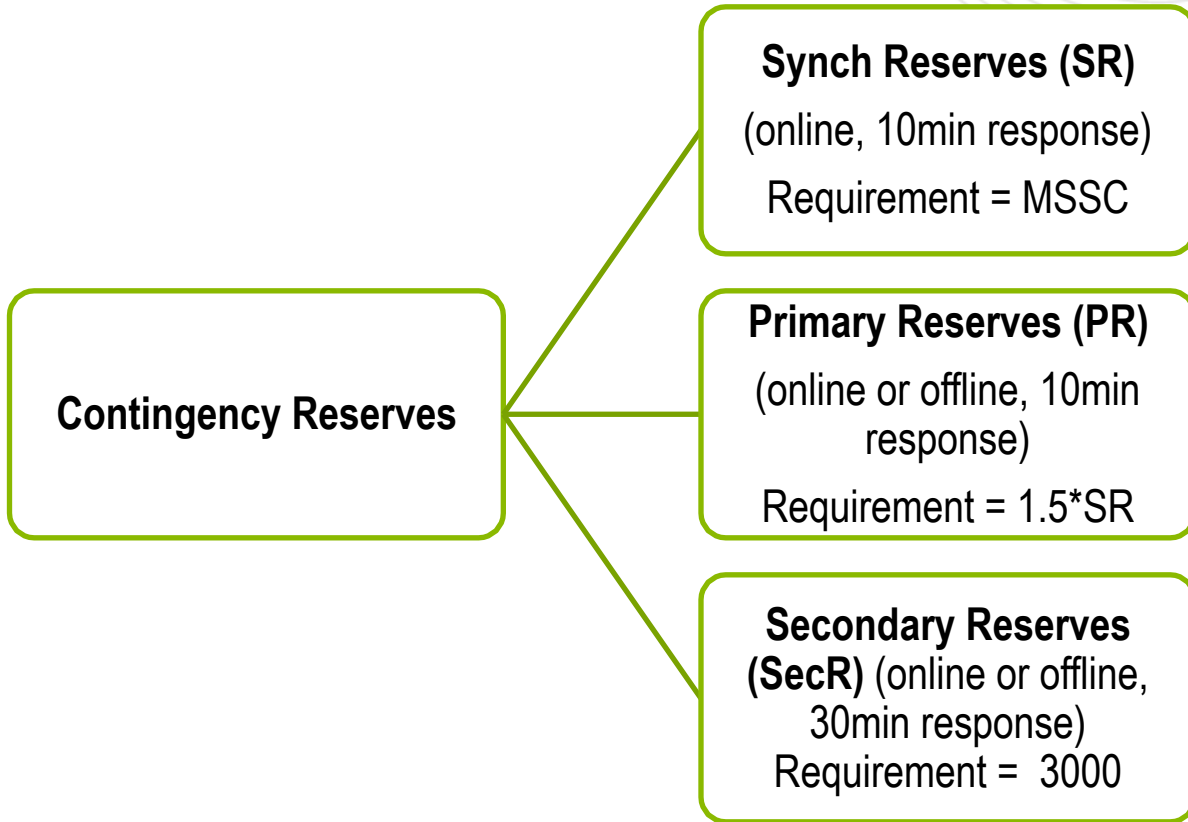
- 1) Reserve Requirements to align with operational needs
  - a) Align operational scheduling needs with the Day-Ahead Market
  - b) Address growing ramping and uncertainty system needs
- 2) Market Design Reserve Structure Changes
  - a) Define Eligibility and Incentive Performance of resources
  - b) Recognize the cost to provide reserves through offers
  - c) Value the flexibility to address the system reserve needs



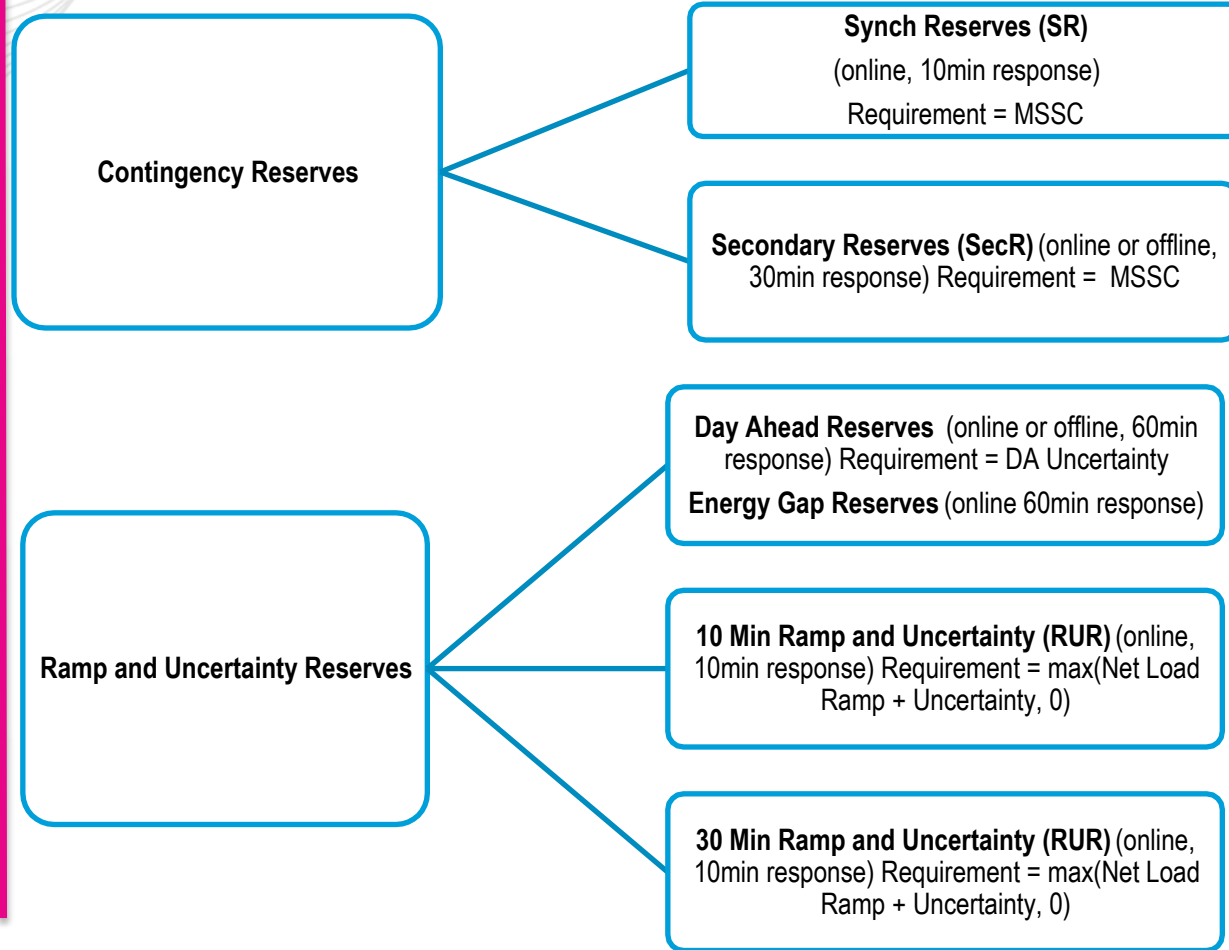
# Reserve Services included in PJM's Proposal

	Purpose	RTM / DAM	Response Time	Online Only	Locational
Synchronized Reserve	Contingency recovery	Both	10 minutes	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
10-Min Ramp/Uncertainty Reserve	Real-time net-load ramp and uncertainty	Both	10 minutes	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
30-Min Ramp/Uncertainty Reserve	Real-time net-load ramp and uncertainty	Both	30 minutes	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
30-Min Reserves	Replacement for contingency reserves	Both	30 minutes	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Day-Ahead Scheduling Reserves	Day-ahead uncertainty	DAM-only	60 minutes	<input type="checkbox"/>	<input type="checkbox"/>
Energy Gap Reserves	Scheduling physical supply to meet the PJM load forecast	DAM-only	60 minutes	<input checked="" type="checkbox"/>	<input type="checkbox"/>

## CURRENT



## FUTURE



**MSSC = Most Severe Single Contingency**

# Introduction of new reserve products for uncertainty and ramping



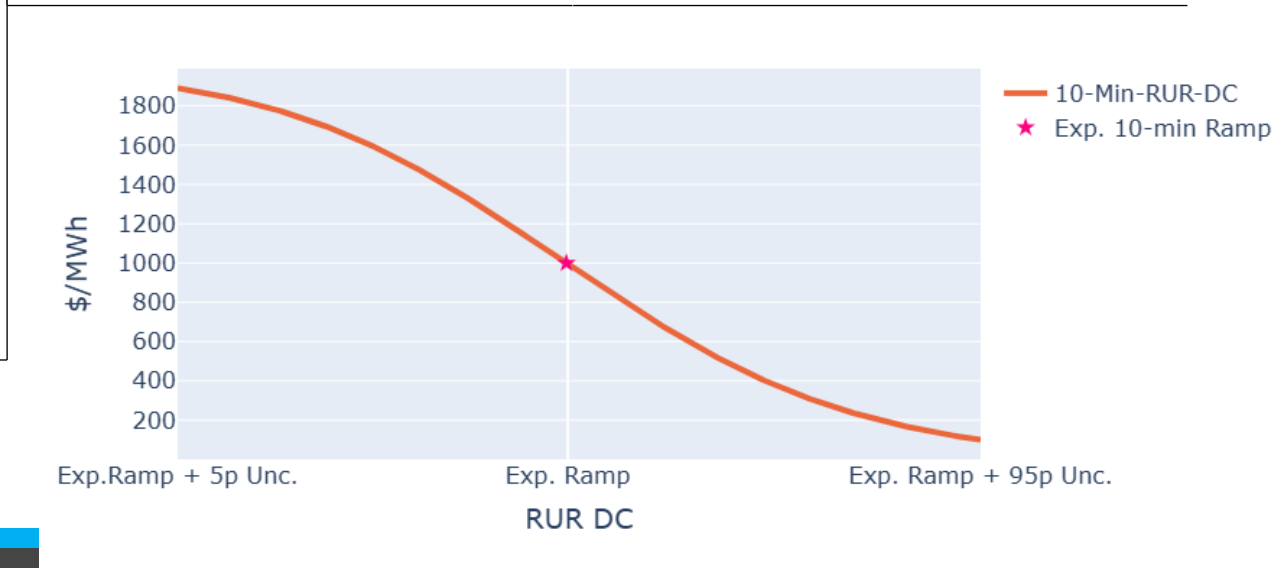
# 10 Minute Ramp and Uncertainty

<b>10-Min Ramp/ Uncertainty Reserve</b>	<b>Performance Expectations</b>	<b>Consequences for Non-Availability</b>	<b>Consequences for Non-Performance</b>
	Follow PJM's energy dispatch instructions	Pay for shortfall at 1.25 times the 10-Min RUR clearing price	Energy deviation penalties
	<b>Day-Ahead Soft Offer Cap</b>	<b>Real-Time Soft Offer Cap</b>	<b>Cost Allocation</b>
	\$10/MWh	Capped at \$0	Allocated to real-time load <b>and exports</b> based on load ratio share across the entire RTO

<b>Requirement</b>	<b>Settlement</b>	<b>Locational Procurement</b>
Expected Ramp = $\text{Net-Load Forecast}_{T+10} - \text{Net-Load Forecast}_T$	Balancing Settlement	Yes

Where, Net-Load Forecast = Load Forecast – Wind Forecast – Solar Forecast – **Expected Energy from Resources Starting-Up**

Uncertainty = % Load Forecast Uncertainty x Forecasted Load + % Wind Forecast Uncertainty x Forecasted Wind + % Solar Forecast Uncertainty x Forecasted Solar



	Uncertainty		
	Load*	Wind*	Solar*
<b>10 Minute</b>	<b>0.4%</b>	<b>1.9%</b>	<b>3.1%</b>

\* Illustrative Uncertainty % based on 24/25 Data



# 10 Minute Ramp and Uncertainty Down

<b>10-Min Ramp/ Uncertainty Reserve</b>	<b>Performance Expectations</b>	<b>Consequences for Non-Availability</b>	<b>Consequences for Non-Performance</b>
	Follow PJM's energy dispatch instructions	Pay for shortfall at 1.25 times the 10-Min RUR clearing price	Energy deviation penalties
	<b>Day-Ahead Soft Offer Cap</b>	<b>Real-Time Soft Offer Cap</b>	<b>Cost Allocation</b>
	\$10/MWh	Capped at \$0	Allocated to real-time load based <b>and exports</b> on load ratio share across the entire RTO

<b>Requirement</b>	<b>Settlement</b>	<b>Locational Procurement</b>
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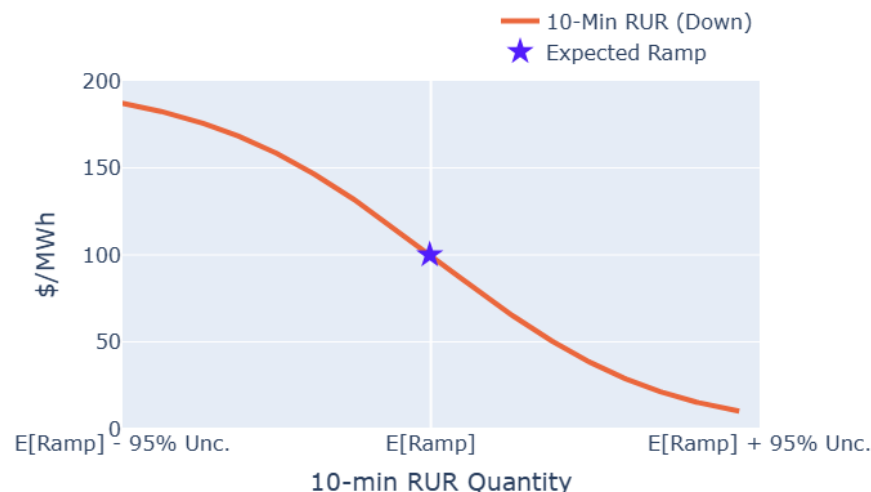
$$\text{Expected Ramp} = \text{Net-Load Forecast}_T - \text{Net-Load Forecast}_{T+10}$$

Where, Net-Load Forecast = Load Forecast – Wind Forecast – Solar Forecast – **Expected Energy from Resources Starting-Up**

Uncertainty = % Load Forecast Uncertainty x Forecasted Load + % Wind Forecast Uncertainty x Forecasted Wind + % Solar Forecast Uncertainty x Forecasted Solar

Balancing Settlement

Yes



## Uncertainty

	<b>Load*</b>	<b>Wind*</b>	<b>Solar*</b>
<b>10 Minute</b>	<b>0.4%</b>	<b>1.9%</b>	<b>3.1%</b>

\* Uncertainty % based on 24/25 Data



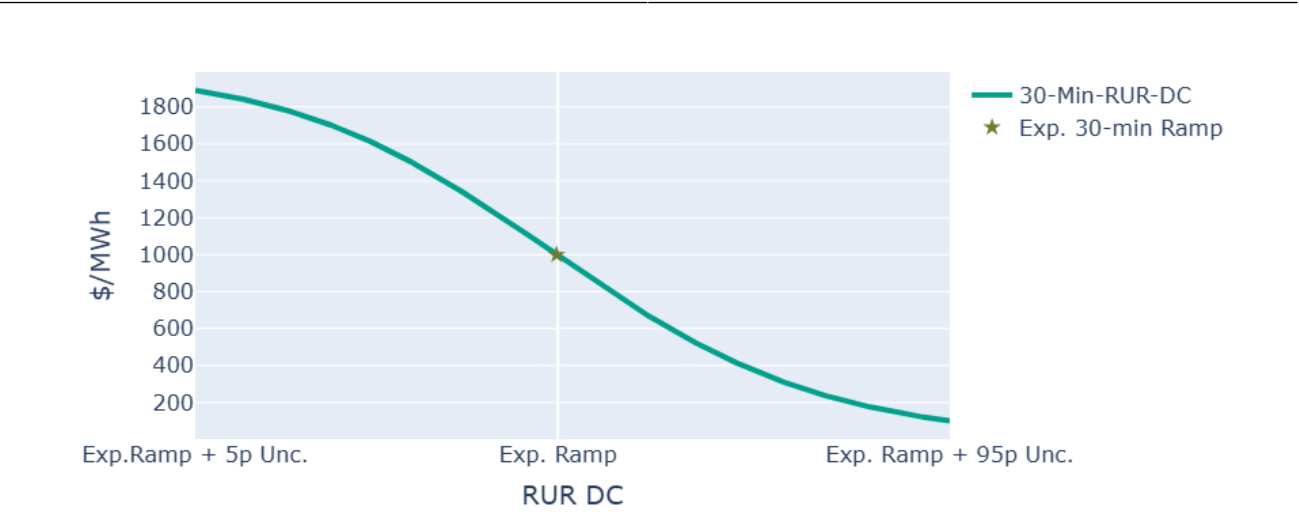
# 30 Minute Ramp and Uncertainty

<b>30-Min Ramp/ Uncertainty Reserve</b>	<b>Performance Expectations</b>	<b>Consequences for Non-Availability</b>	<b>Consequences for Non-Performance</b>
	Follow PJM's energy dispatch instructions	Pay for shortfall at 1.25 times the 30-Min RUR clearing price	Energy deviation penalties
	<b>Day-Ahead Soft Offer Cap</b>	<b>Real-Time Soft Offer Cap</b>	<b>Cost Allocation</b>
	\$10/MWh	Capped at \$0	Allocated to real-time load <b>and exports</b> based on load ratio share across the entire RTO

<b>Requirement</b>	<b>Settlement</b>	<b>Locational Procurement</b>
Expected Ramp = Net-Load Forecast <sub>T+30</sub> - Net-Load Forecast <sub>T+10</sub>	Balancing Settlement	Yes

Where, Net-Load Forecast = Load Forecast – Wind Forecast – Solar Forecast – **Expected Energy from Resources Starting-Up**

Uncertainty = % Load Forecast Uncertainty x Forecasted Load + % Wind Forecast Uncertainty x Forecasted Wind + % Solar Forecast Uncertainty x Forecasted Solar



	Uncertainty		
	Load*	Wind*	Solar*
<b>30 Minute</b>	<b>0.6%</b>	<b>2.7%</b>	<b>4.0%</b>

\* Uncertainty % based on 24/25 Data

## CURRENT

Day-Ahead Scheduling Reserve is calculated in RAC after the Day-Ahead market

Calculated As:

Load forecast at peak \* (Under-forecasted Load Forecast Error (LFE) + (FOR) Generator Forced Outage Rates)

DASR is currently = Load forecast at peak \*4.51%

## FUTURE

Reflect the Day-Ahead Scheduling Reserve needs in the Day-Ahead market

Move to an uncertainty and risk framework that dynamically sets the reserve needs based on the expected operating conditions and accounts for variable resource uncertainty

Operating Days will be classified as high, medium or low risk which will drive the DASR requirement

Proposed Risk Values	Percentile	Load	Generator Performance	Solar	Wind
Low	80 <sup>th</sup> Load / 50 <sup>th</sup> Others	2.19%	2.03%	11.28%	9.68%
	80 <sup>th</sup> All	2.19%	3.12%	19.71%	21.48%
Medium	85 <sup>th</sup> All	2.42%	3.49%	22.50%	24.19%
	90 <sup>th</sup> All	2.79%	3.88%	25.51%	26.54%
High	95 <sup>th</sup> All	3.55%	4.68%	31.33%	32.43%

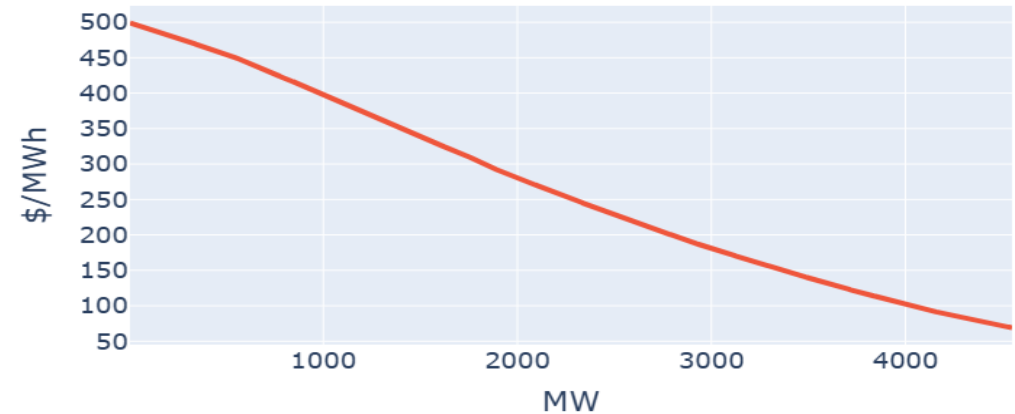
$$DASR_T = \text{load forecast}_T * \text{load error} + \text{load forecast}_T * \text{gen performance} + \text{solar forecast}_T * \text{solar error} + \text{wind forecast}_T * \text{wind error}$$

# Day Ahead Scheduling Reserves

	Performance Expectations	Consequences for Non-Availability	Consequences for Non-Performance
<b>Day-Ahead Scheduling Reserve</b>	Maintain availability to provide energy and reserves consistent with day-ahead assignments Come online when called by PJM in real-time	Pay for the unprovided reserves at the greater of 1.25 the DASR market clearing price or the RT 30-Min clearing price	Pay for the shortfall at the greater of 1.5 the DASR market clearing price or <del>1.25</del> <b>1.5</b> times the RT 30-Min res. price
	Day-Ahead Soft Offer Cap	Real-Time Soft Offer Cap	Cost Allocation
	\$10/MWh	N/A	allocated to real-time load <b>and exports</b> based on load ratio
	Requirement / ORDC	Settlement	Locational Procurement
	<p>Based on Risk Day, <math>DASR_T = \text{load forecast}_T * \text{load error} + \text{load forecast}_T * \text{gen performance} + \text{solar forecast}_T * \text{solar error} + \text{wind forecast}_T * \text{wind error}</math></p> <p>Hourly DASR values would be capped at the DASR values for the peak load hour.</p> <p>This MW value will be procured <i>net</i> of RUR and Energy gap products (nested market design)</p> <p>ORDC will be single step demand curve at \$50</p>	DA Only	No

Energy Gap	Performance Expectations	Consequences for Non-Availability	Consequences for Non-Performance
	Maintain availability to provide energy and reserves consistent with day-ahead assignments  Follow PJM's energy dispatch instructions	Pay for the unprovided reserves at the greater of 1.25 the EG market clearing price or the RT 30-Min RUR clearing price	Energy deviation penalties
	Day-Ahead Soft Offer Cap	Real-Time Soft Offer Cap	Cost Allocation
\$10/MWh	Capped at \$0	Allocated to real-time load <b>and exports</b> based on load ratio share across the entire RTO	

- Energy Gap Reserves are procured to mitigate the reliability risk of having insufficient physical supply cleared through the Day-Ahead Market to meet PJM's load forecast.
- Energy Gap is only procured on medium- and high-risk days that fall within the "winter" season (November – March).

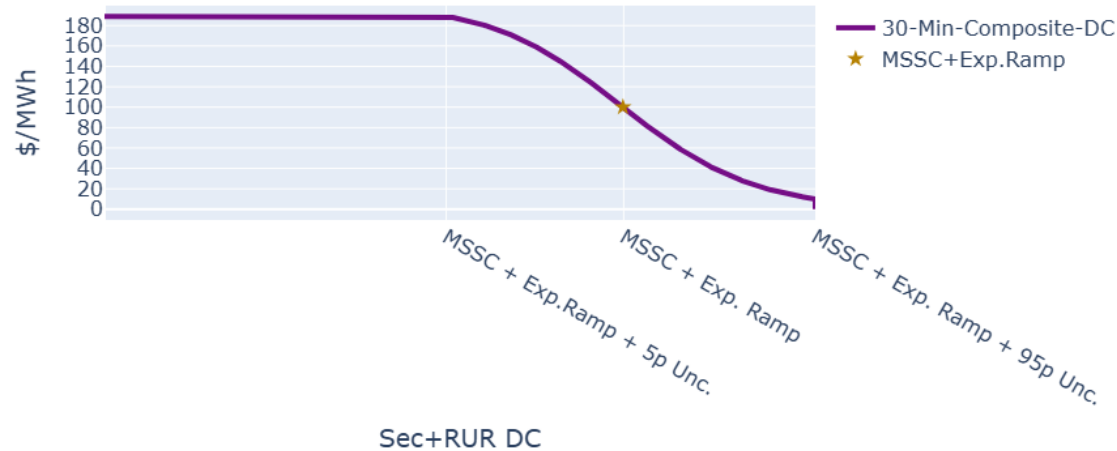


# Updates to Contingency Reserves

- Offer Structure Changes
  - Day-Ahead Soft Offer Cap: \$10/MWh + Expected Penalty Rate
  - Real-Time Soft Offer Cap: \$10/MWh + Expected Penalty Rate
- Penalty Structure Changes
  - Consequences for Non-Availability: Pay for shortfall at 1.25 times the SR clearing price
  - Consequences for Non-Performance: Pay for the **greater of a) the** shortfall at the average cost of Synchronized Reserves **or b) the highest system marginal energy price in the 6 intervals following the Synchronized Reserve Event**
- ORDC Update to a single step demand curve at \$2,100 at the reliability requirement (MSSC)
- Locational Procurement- same interface modeling with nodal pricing

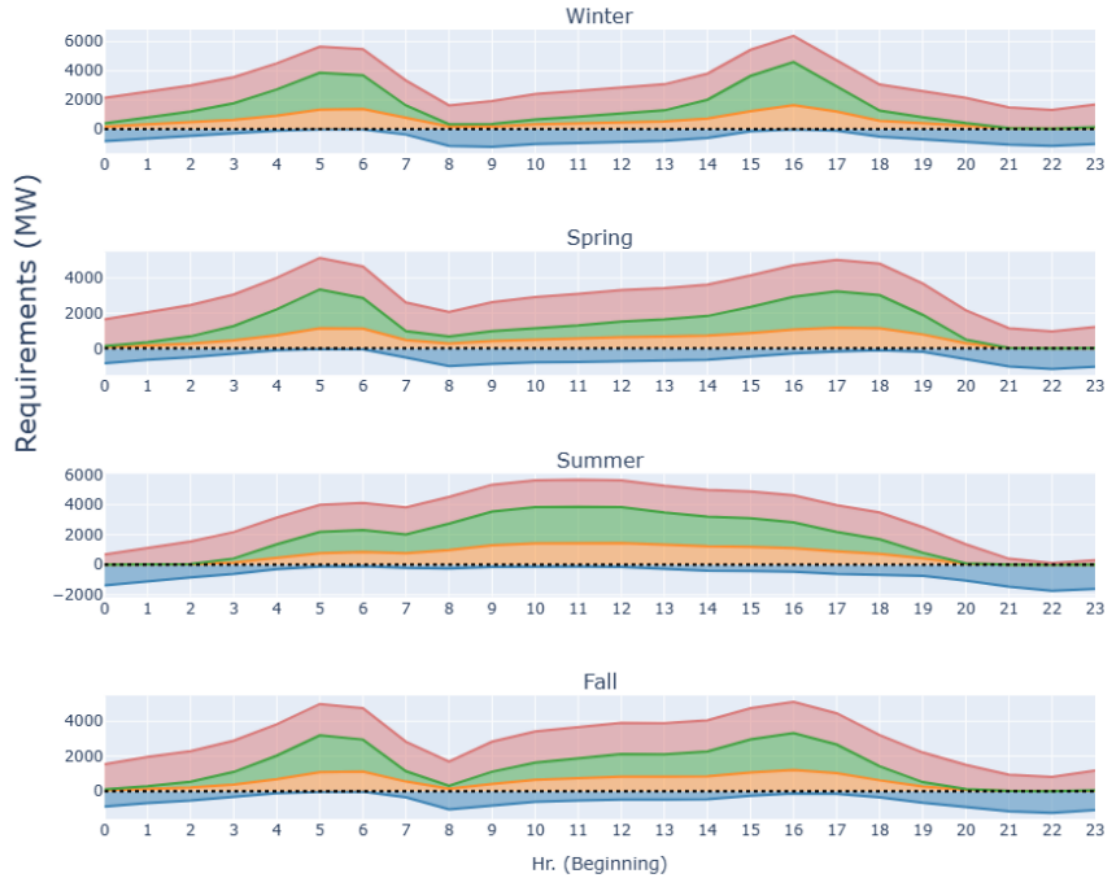
The PJM Proposal Removes Primary Reserves → PAI Triggers will be set on SR shortages

<b>30 Minute Reserves</b>	Performance Expectations	Consequences for Non-Availability	Consequences for Non-Performance
	Come online when called by PJM	N/A	Pay for the shortfall at a rate of 1.5 times the real-time reserve market clearing price
	Day-Ahead Soft Offer Cap	Real-Time Soft Offer Cap	Cost Allocation
	\$10/MWh	\$10/MWh	Allocated to real-time load <b>and exports</b> based on load ratio share across the entire RTO

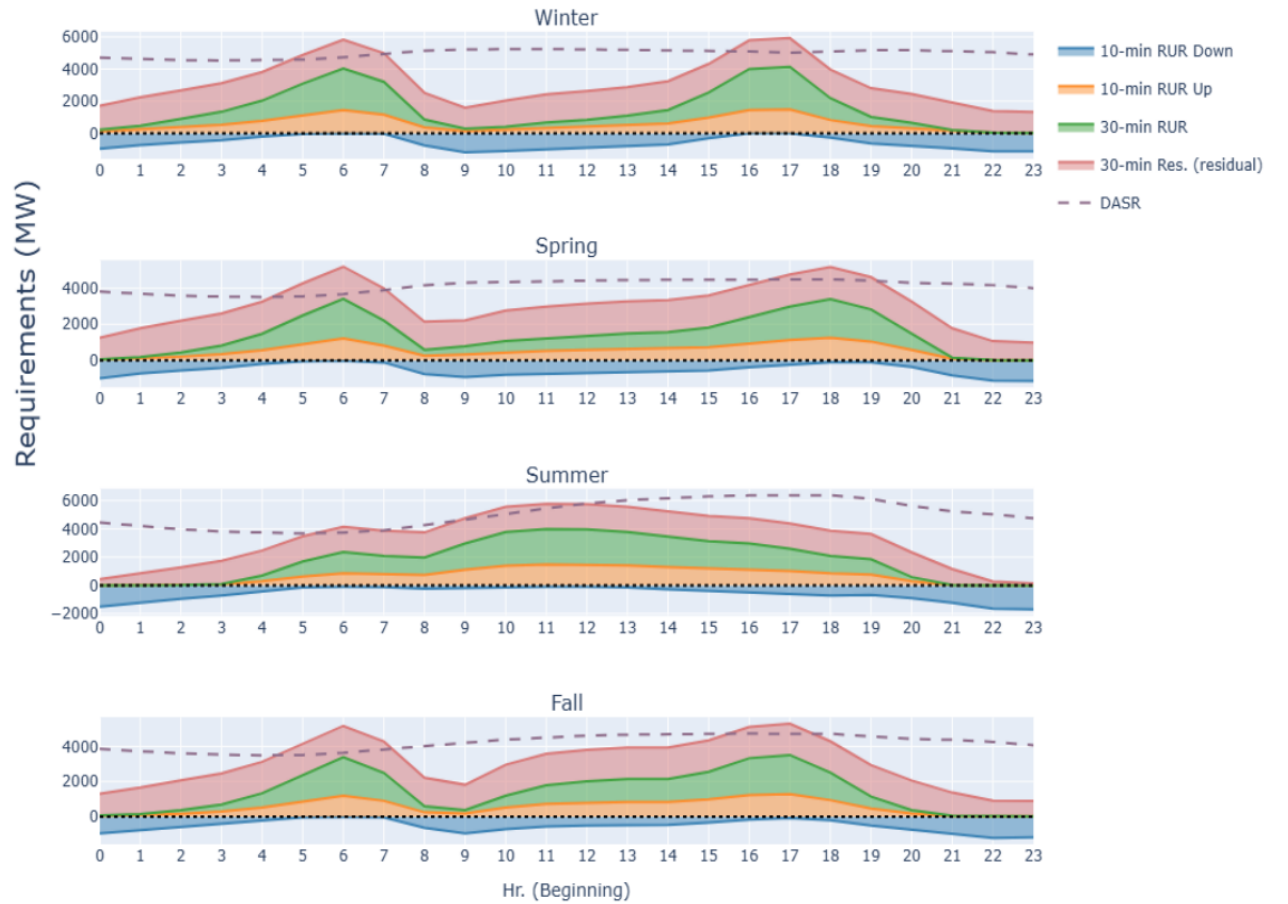


The 30-Min Reserve service is nested with the 30-Min RUR service

Seasonal Average 24-Hour Requirements (RT)



Seasonal Average 24-Hour Requirements (DA\_LowRisk)



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## **PJM Proposal Summary**



### Member Hotline

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

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THINK BEFORE  
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malicious  
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(610) 666-2244 / [it\\_ops\\_ctr\\_shift@pjm.com](mailto:it_ops_ctr_shift@pjm.com)

