Synchronized Reserve Performance

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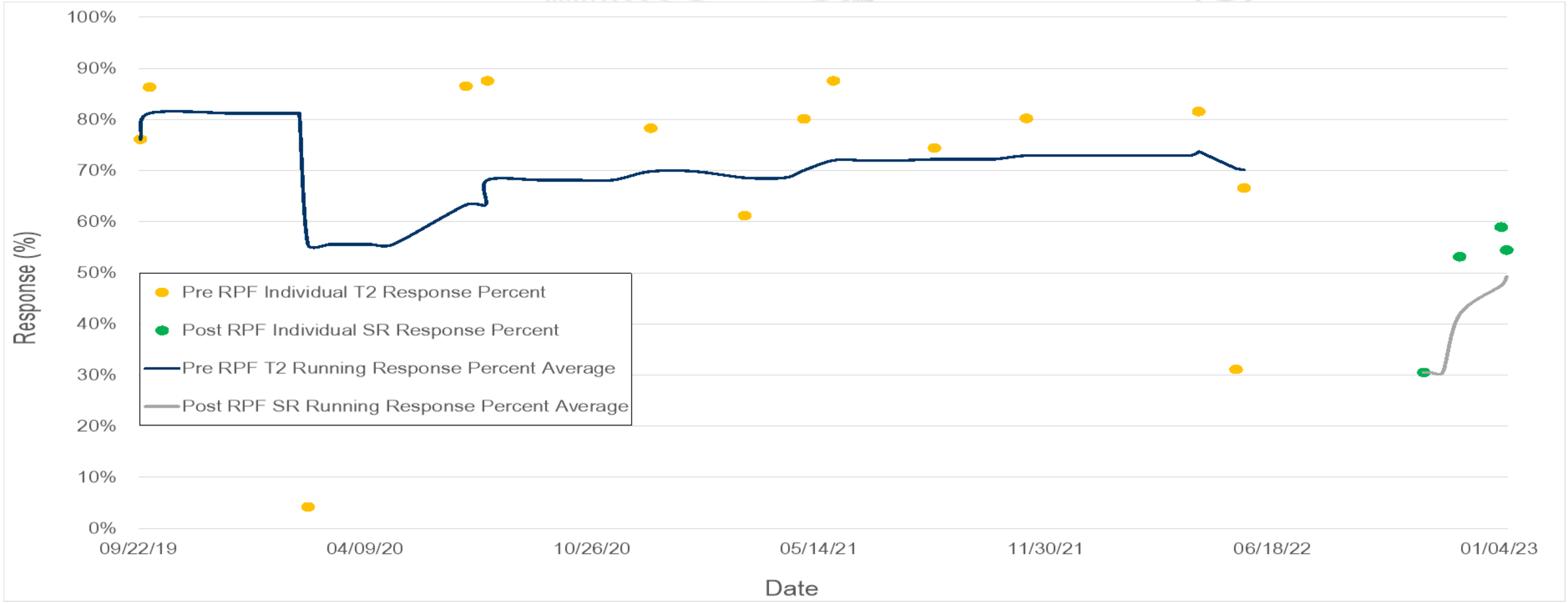
What are Reserves?

- Reserves are additional generation capacity above the expected load.
- Protects the power system against the uncertain occurrence of future operating events.
- Announced through the ALL CALL system

Reserve Price Formation (RPF) and Synchronized Reserves Overview

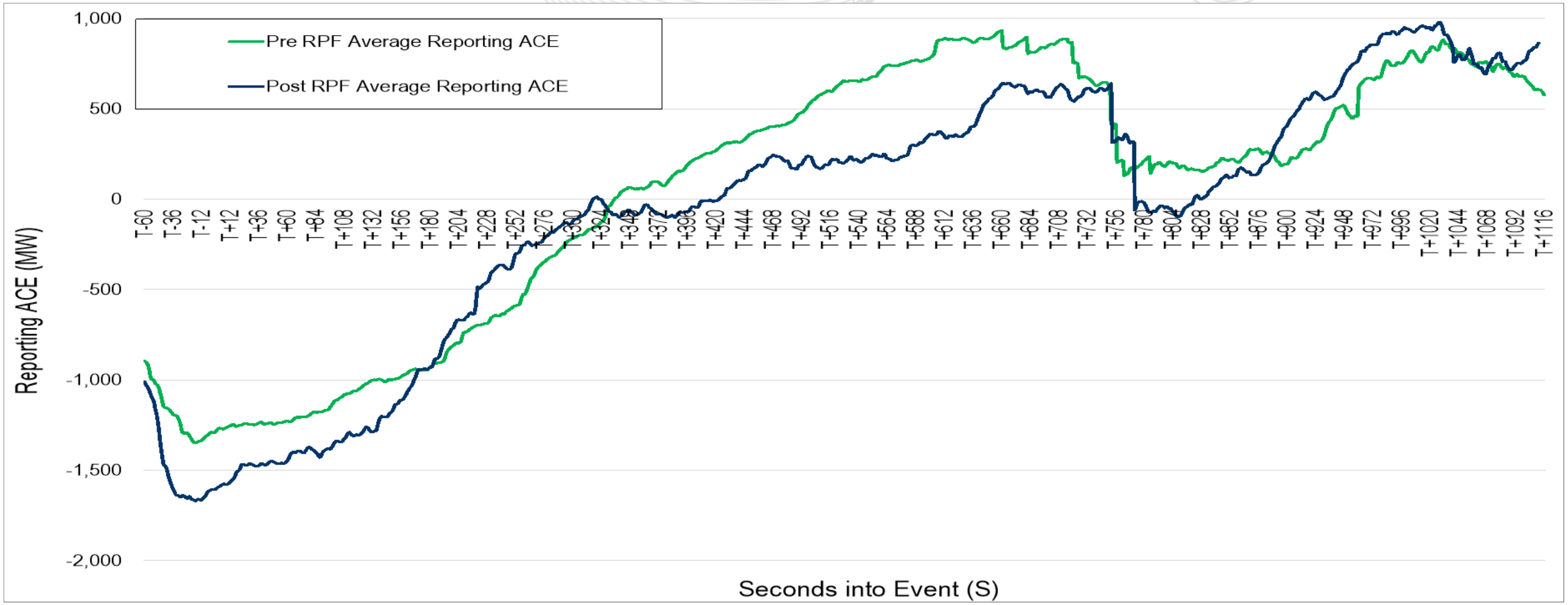
- Effective October 1, 2022 several aspects of the PJM Reserve markets changed as a result of RPF
  - Consolidation of Tier 1 (T1) and Tier 2 (Tier 2) Synchronized Reserve products
- Prior to RPF, the Synchronized Reserve Requirement was met by T1 and T2. However, T2 reserves were only assigned if the Synchronized Reserve Requirement could not be met by T1 alone.
  - Post RPF, the Synchronized Reserve Requirement is now being met exclusively by assigned reserves, similar to the pre RPF T2 product.
- Resources with a Synchronizes Reserve assignment are expected to respond to Synchronized Reserve events.
  - Penalties for non-response

Pre RPF Tier 2 Versus Post RPF Synchronized Reserve (SR) Performance*



*Events during Winter Storm Elliott excluded

Pre RPF Reporting ACE Versus Post RPF Reporting ACE*



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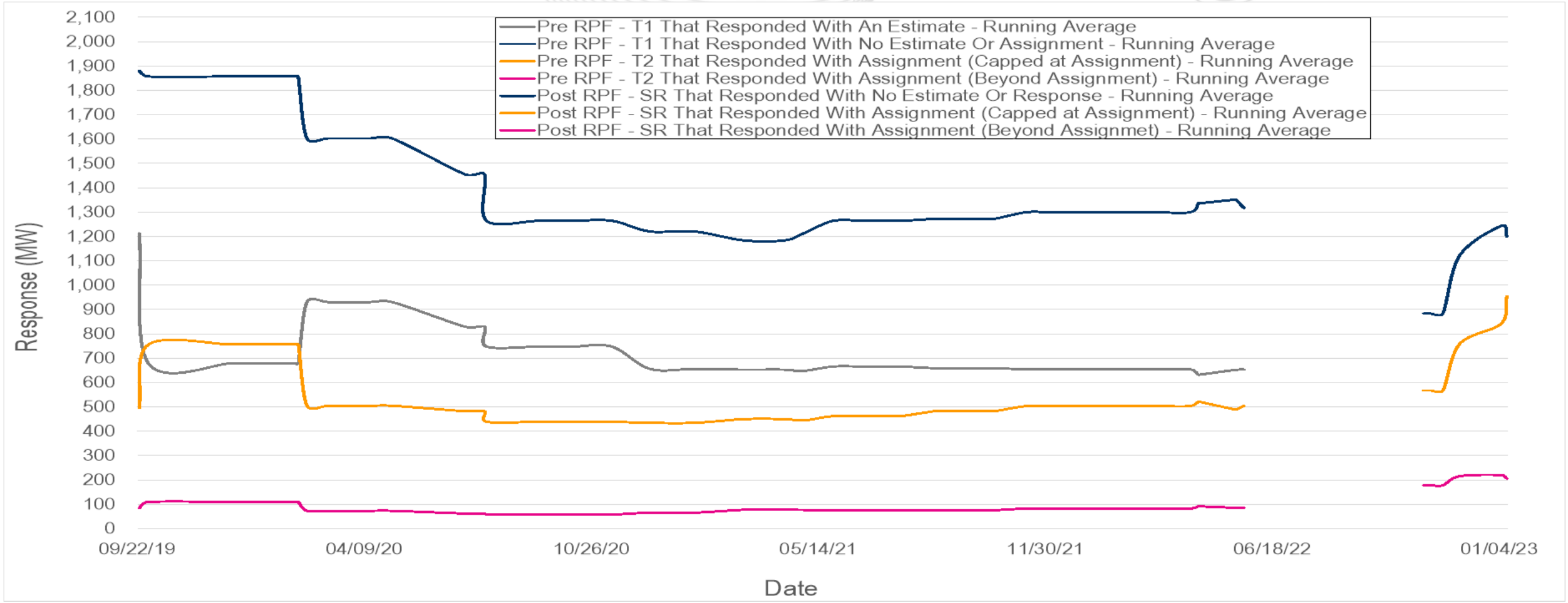
Pre RPF Response Versus Post RPF Response in MW*



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Summary

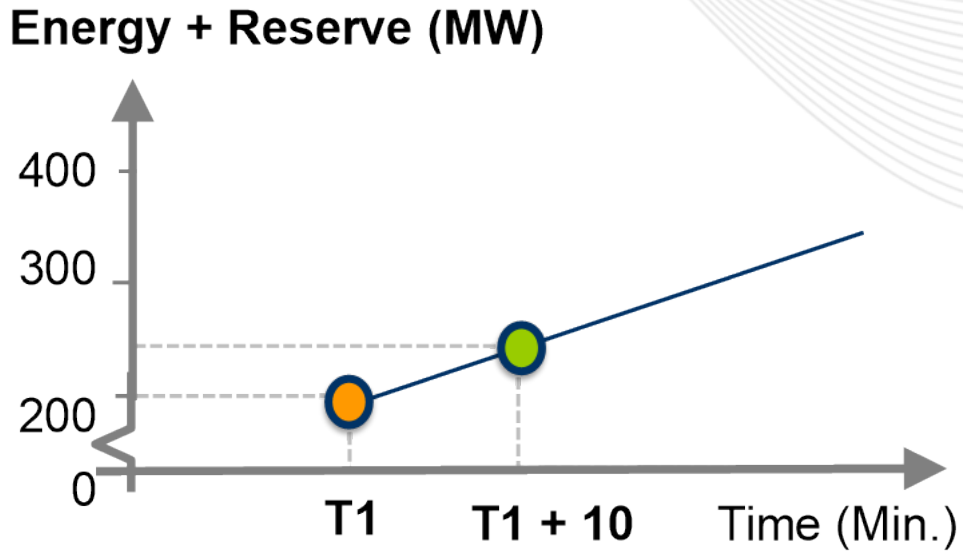
- Concerns about significant decrease in assigned reserves post RPF
  - Down by an average of 20.4%*
- Resources assigned to provide Synchronized Reserves have an obligation to respond or have penalties applied
- Small sample size of events
- PJM will continue to monitor
  - Look for trends in data
    - Positive or negative
    - Specific resources, resource types, resource owners
- PJM will begin outreach

*Events during Winter Storm Elliott excluded

Calculated Capability

Reserve Market	Resource Type				
	Condensers	Other Gen	Wind/Solar/ Nuclear	ESR/Hydro	Load Response
SR	Based on the following offer parameters submitted as part of the resource's energy offer: (A) ramp rate; (B) condense to generation time constraints; (C) Economic Minimum; and (D) the lesser of Economic Maximum and Synchronized Reserve Maximum	Based on the resource's initial energy output and the following offer parameters submitted as part of the resource's energy offer (A) ramp rate; (B) Economic Minimum; and (C) the lesser of Economic Maximum and Synchronized Reserve Maximum MW		Use SR Offer MW Constrained by Eco Limits	

SR MW Calculation Example from an Online Unit



Unit G

STATUS: **Online 200 MW**	ECOMIN: **100 MW**	ECOMAX: **600 MW**	SYNCHMAX: **500 MW**
RAMP RATE (RR): **5 MW/Min**			

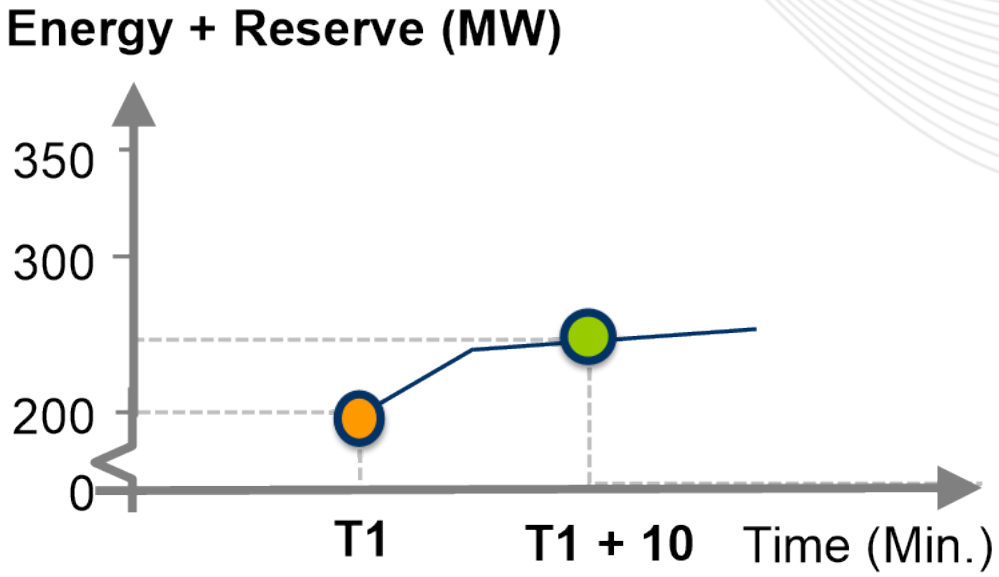
SR MW Capability = max{ 0, min[min(EcoMax, SynchMax) – Initial MW, RR*10] }

= max{0, min [min(600, 500) – 200, 5*10] }

= max{0, min [500 - 200, 50]

= **50 MW**

SR MW Calculation Example from an Online Unit with Segmented Ramp rate



Unit S

STATUS: **Online** **200 MW**	ECOMIN: **100 MW**	ECOMAX: **600 MW**	SYNCHMAX: **500 MW**

MW	Ramp Rate (RR) MW/Min
200	1
230	5
500	0.5

SR MW Capability = max{ 0, min[min(EcoMax, SynchMax) – Initial MW, RR*10] }

= max{0, min [min(600, 500) – 200, 5 x 6 + 0.5 x 4] }

= max{0, min [500 - 200, 32]

= **32 MW**

SR MW Calculation Example for Synchronous Condenser

Unit C

STATUS: **Online Condensing** **-0.2 MW**	ECOMIN: **25 MW**	ECOMAX: **60 MW**	SYNCHMAX: **60 MW**
RAMP RATE (RR): **10 MW/Min**	CONDENSE TO GEN TIME: 3 **Min**		

SR MW Capability = max{0,min [min(EcoMax, SynchMax), EcoMin + RR x (10 min – Condense to Gen Time)] }

= max{0, min [min(60, 60), 25 + 10 x (10 – 3)] }

= max{0, min [60, 25 + (10 x 7)] }

= max{0, min [60, 95] }

= **60 MW**

SR MW Assignment Example for Resources that Must Submits SR Offer MW

Resource Type Hydro

EcoMin	EcoMax	SR Offer
10 MW	30 MW	30 MW

SR MW Capability	= max [0, min (EcoMax – EcoMin, SR Offer MW)] = max [0, min (30 – 10, 30)] = 20 MW

Resource Type Economic Load Response

EcoMin	EcoMax	SR Offer
2 MW	5 MW	3 MW

SR MW Capability	= max [0, min (EcoMax – EcoMin, SR Offer MW)] = max [0, min (5 – 2, 3)] = 3 MW

Non-Performance

- Resources are credited every 5-minute for reserve capability reservation and are expected to be ready to respond to Synchronized Reserve Event.
- Failure to provide directed response results in obligation to repay
  - Resource credited Synchronized Reserve capacity in amount that actually responded for all 5-minute intervals resource was assigned or self-scheduled Synchronized Reserve on day event occurred
  - Retroactive obligation to refund at SRMCP the amount of shortfall for all Real-time settlement intervals resource was assigned or self-scheduled over immediate past interval
    - Duration is equal to lesser of:

      average number of days between events (21-days for 2023, 22-days for 2022) OR

      number of days since resource's last non-performance
- Event duration less than 10-minutes, resources credited amount of assigned Synchronized Reserve. No retroactive obligation to refund shortfall
- See section 6.3.3 of M28: https://www.pjm.com/-/media/documents/manuals/m28.ashx

Example of a Non-Performance Refund Calculation

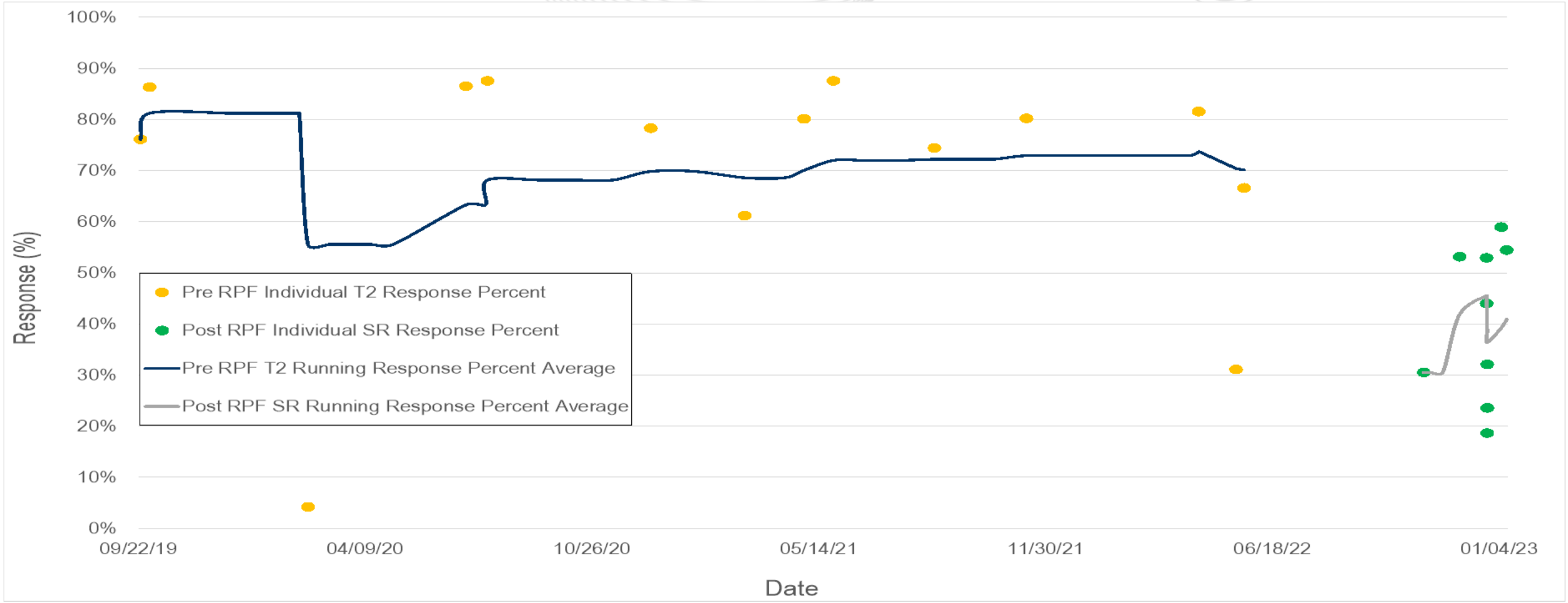
January 10th – Event Results				
Resource	SR Assigned	Response	Under Response	Over Response
A	50 MW	50 MW	0	0
B	25 MW	25 MW	0	0
C	30 MW	0	30	0

1. Resource A: No refund
2. Resource B: No refund
3. Resource C: Refund for the shortfall
    a. Day of Event refund of 30 MW (prorated) applied to all hours the resource was assigned on January 10th.
    b. Retroactive charge: Pays 30 MW * applicable RT_SRMCP/12 in the assigned intervals for lesser of 22 day or last non-performance.

See the link for additional examples: https://www.pjm.com/-/media/training/core-curriculum/ol-reserve-market/06-performance-measurement-and-compensation.ashx

Appendix

Pre RPF Tier 2 Versus Post RPF Synchronized Reserve (SR) Performance*



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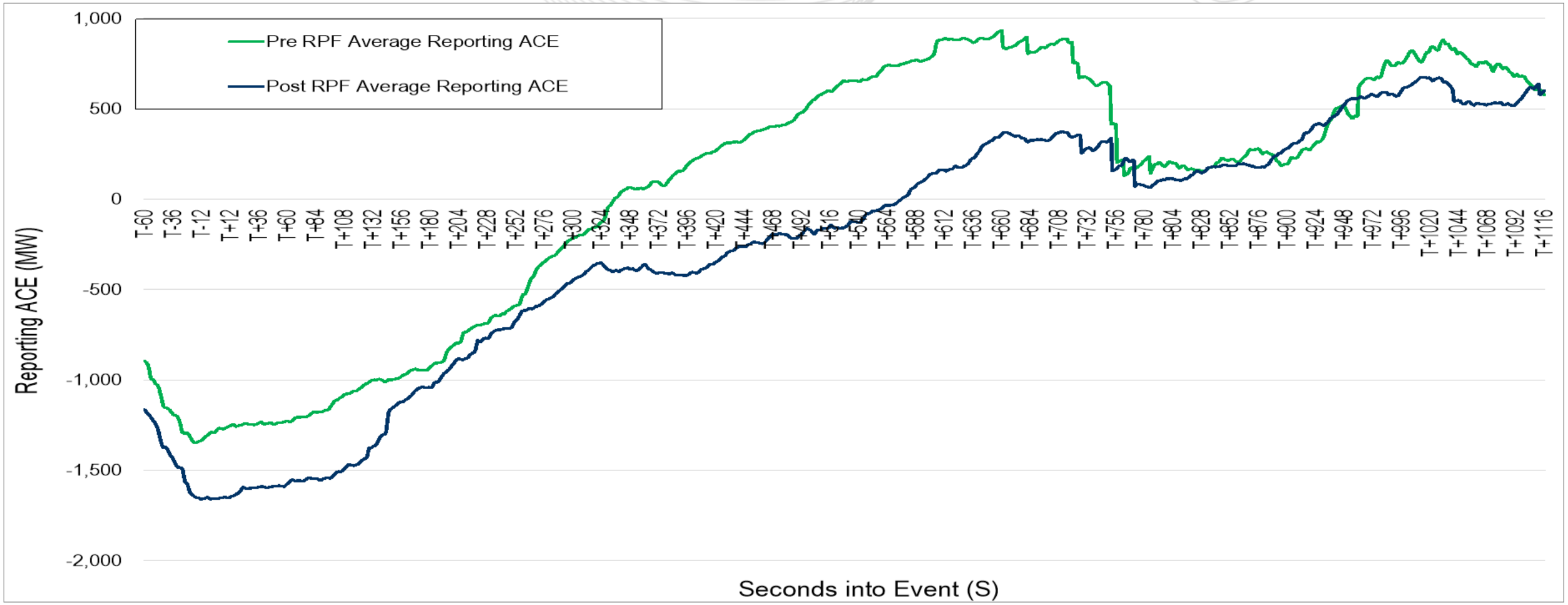

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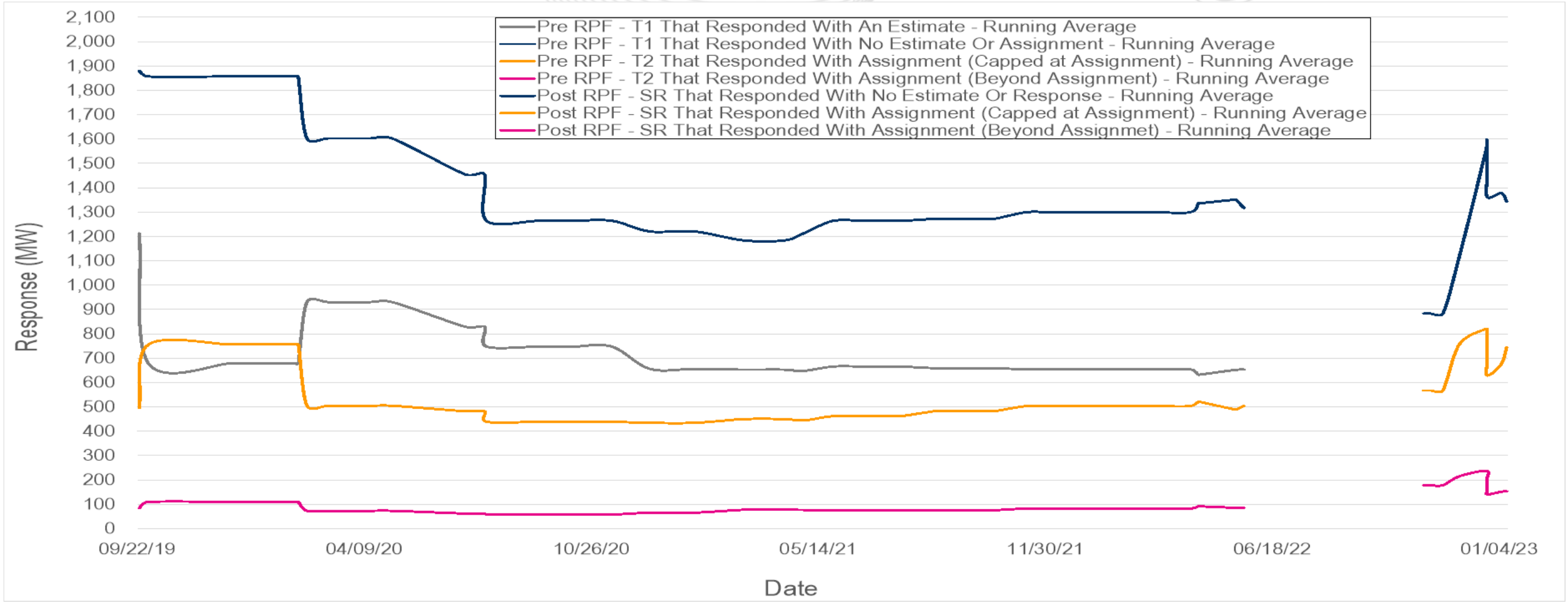
Pre RPF Response Versus Post RPF Response in MW*



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