Operating Reserve Demand Curves (ORDC) for Reserve Price Formation Project

Delivery Year 2021/2022

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Market Implementation Committee

June 9, 2021

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Posted ORDCs

- PJM has developed and posted the set of ORDCs to be used for the 2021/2022 Delivery Year (June 1, 2021 through May 31, 2022).
  - Posted ORDCs will be effective on May 1, 2022 through May 31, 2022 (first month the reserve price formation project go-live).
- ORDCs developed for Synchronized Reserve (SR), Primary Reserve (PR) and 30-Minute Reserves.
- ORDCs developed using calendar years 2018, 2019 and 2020 data.
- ORDCs developed for the PJM RTO and Mid-Atlantic and Dominion (MAD) sub-zone.
  - No new reserve sub-zones created.

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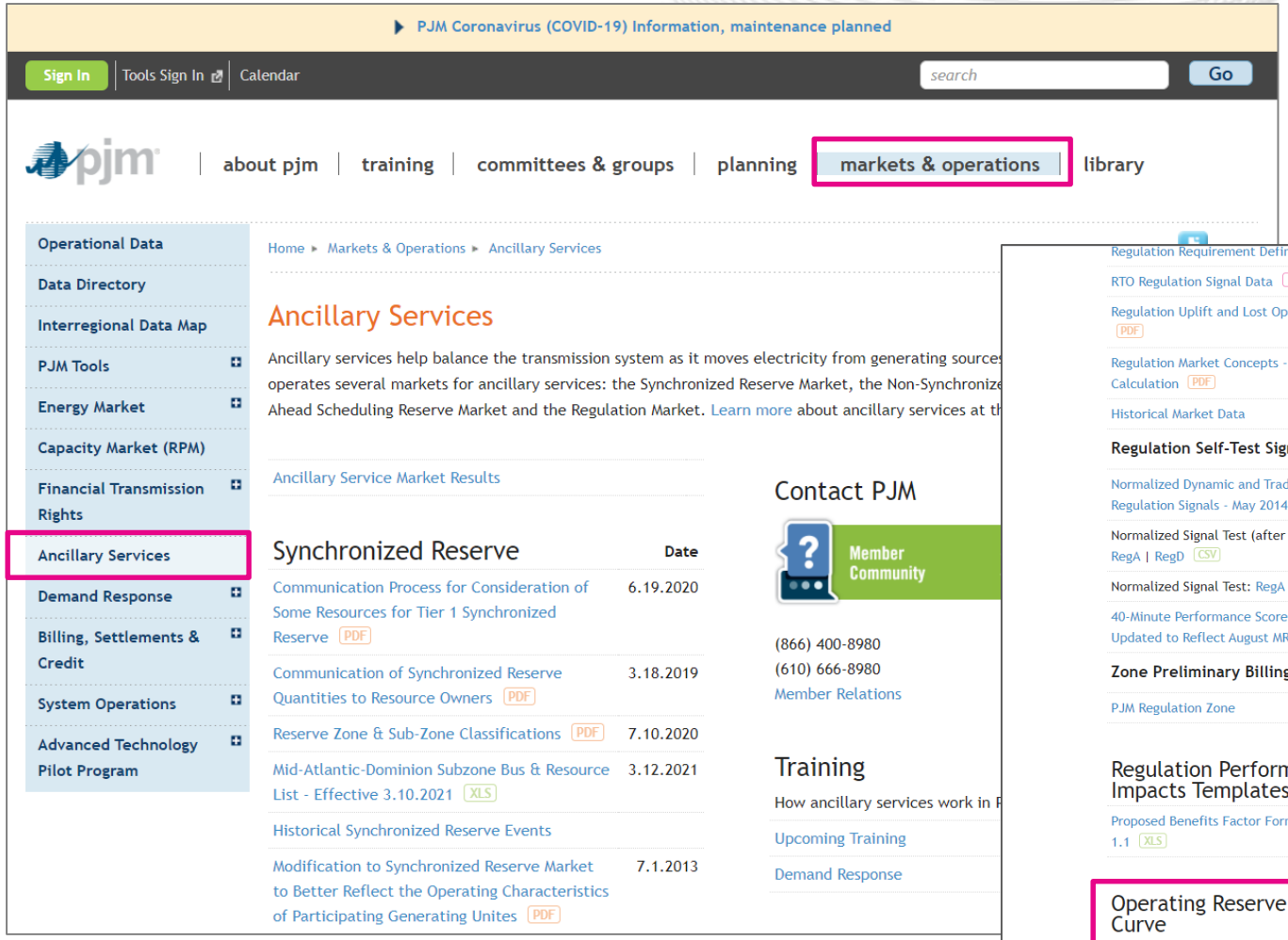
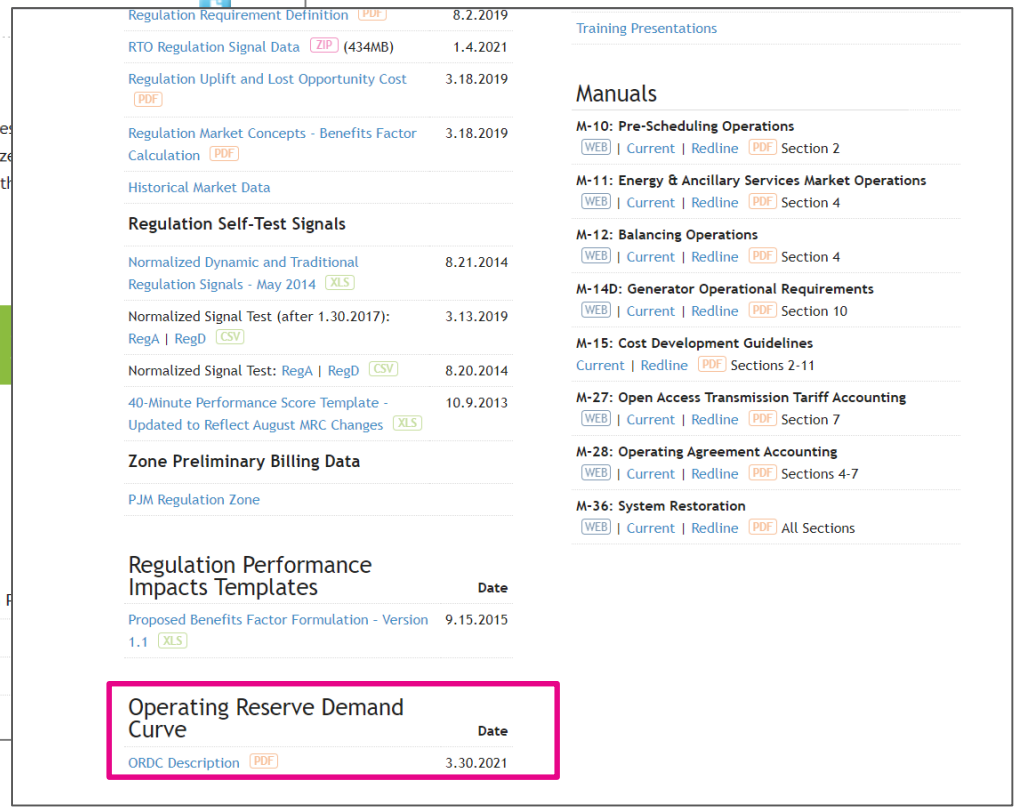
ORDC Posting Location





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Future ORDC Work

ORDCs for the 2022/2023 Delivery Year (June 1, 2022 through May 31, 2023) will be developed and posted by April 1, 2022.

The 2022/2023 Delivery Year ORDCs will be developed using data from calendar years 2019, 2020 and 2021.

Will include ORDCs for the RTO, MAD and any new reserve sub-zone(s) identified by PJM.

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The ORDC:

Sets the reserve requirement for market clearing purposes

Puts a **defined limit on the cost** to be incurred when procuring reserves

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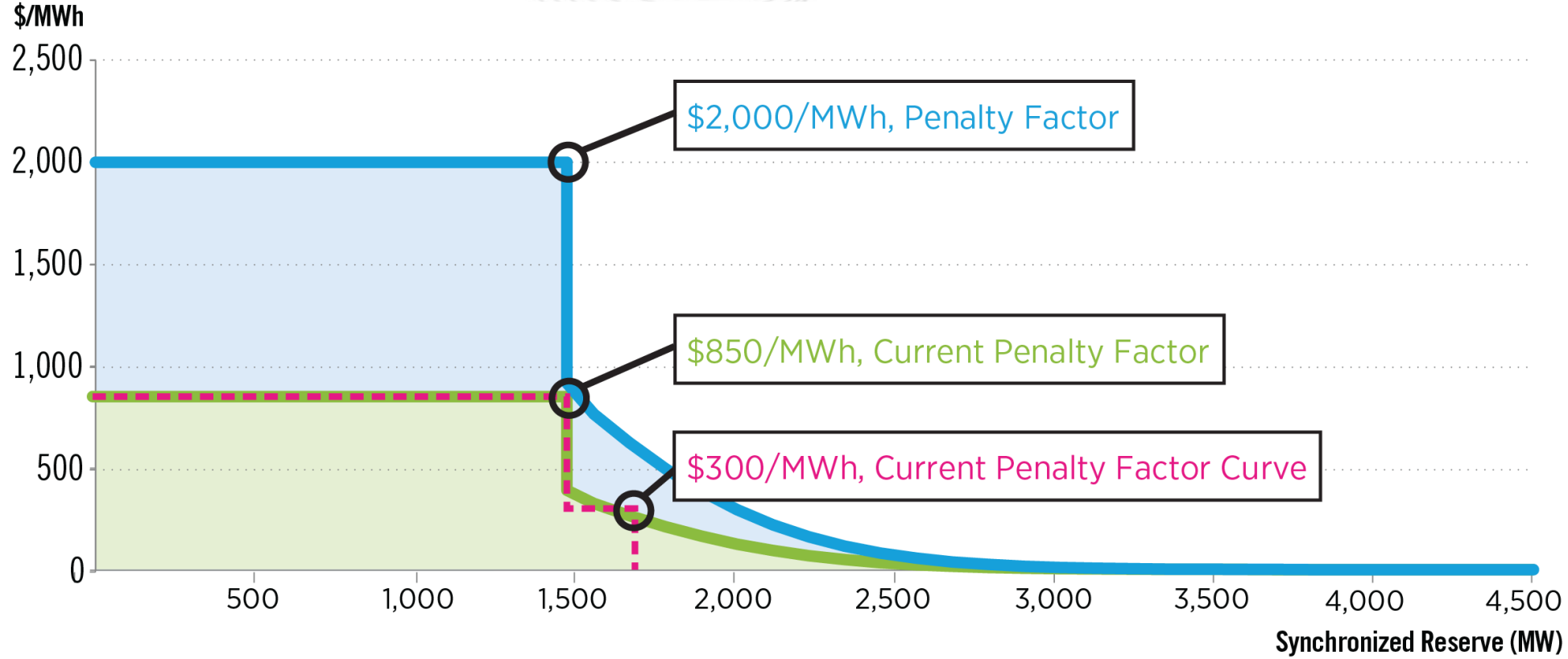
Synch Reserve ORDC Penalty Factor Comparison



For illustrative purposes only.

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Elements for ORDC Construction

	10-Min (SR)	10-Min (PR)	30-Min
MRR	DA – Eco Max of the largest unit* RT – Max (Output of largest online unit or Eco Max of largest online unit)*	DA and RT - 150% of the SR requirement	DA and RT - Max of 3,000 MW or largest active gas contingency (approximately 200% of largest unit)**
Uncertainties	Load, Wind, Solar, Thermal Forced Outages	Load, Wind, Solar, Thermal Forced Outages	Load, Wind, Solar, Thermal Forced Outages, Net Interchange
Adjusted by Regulation?	Yes	Yes	Yes
Look-Ahead Uncertainty Interval	30 minutes	30 minutes	60 minutes
Penalty Factor	$2,000/MWh	$2,000/MWh	$2,000/MWh

* Under normal operating conditions. May be increased due to additional spin needed due to transmission outage condition (M11 section 4.2.2) or operator actions.

** May be increased due to operator actions.

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Modeling ORDC

Twenty-four different ORDCs will be modeled per reserve zone, one for each season and time-of-day blocks.

Using historical uncertainty data from most recent three full calendar years

Season	Time-of-Day Block (in Hour Beginning)
Summer (June – August)	1 (2300 – 0200)
Fall (September – November)	2 (0300 – 0600)
Winter (December – February)	3 (0700 – 1000)
Spring (March – May)	4 (1100 – 1400)
	5 (1500 – 1800)
	6 (1900 – 2200)

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Zonal Version of ORDCs

- The zonal ORDCs for each of the three products will be developed in a similar manner to the RTO ORDCs.
- The data used to calculate the zonal ORDC will be zonal data.
- The penalty factors will be identical to the RTO penalty factors.

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ORDC Calculation

- To derive the ORDCs, the Net Load Error probabilistic distribution is required.
  - This Net Load Error distribution is used to calculate the Probability of falling below the Minimum Reserve Requirement (PBMRR)
  - The PBMRR is multiplied by the Penalty Factor to determine each price point in the ORDCs
- The Net Load Error probabilistic distribution is a collection of Net Load Error values for each timestamp in the period 2018-2020
  - For instance, for the Summer TBlock 5 SR ORDC, the Net Load Error probabilistic distribution should have:

$$12 \times 4 \times 92 \times 3 = 13{,}248 \text{ values}$$

12: there are 12 5-min intervals in an hour, 4: there are 4 hours in each TBlock, 92: there are 92 days in the summer, 3: there are 3 summers in the period 2018-2020

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ORDC Calculation

- To derive the Net Load Error value for each timestamp T in 2018-2020, the forecast error data and the Regulation requirement data are combined according to the following formula:

Net Load Error at T = (Actual Load at T – Actual Wind Output at T – Actual Solar Output at T – Actual Net Interchange Schedule at T) – (Forecasted Load for T at T-X – Forecasted Wind Output for T at T-X – Forecasted Solar Output for T at T-X – Forecasted Net Interchange Schedule for T at T-X) + Forced Outages Thermal/Hydro Units between T-X and T – Regulation Requirement at T

where X is 30 minutes or 60 minutes depending on the ORDC being calculated

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ORDC Calculation

- The PBMRR value associated with Y MW in excess of the MRR is equivalent to determining how many points in the Net Load Error probabilistic distribution are greater than Y divided by the number of points in the Net Load Error probabilistic distribution
  - For instance, if Y is 400 MW then we will count how many of the 13,248 values are greater than 400 MW. This quantity is then divided by 13,248 to get the PBMRR associated with 400 MW in excess of the MRR.

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Comparison with EPFSTF ORDCs – Summer TBlock 5

Summer TBlock 5 - SR

Excess Above MRR	PBMRR April 2021	PBMRR EPFSTF	Price April 2021	Price EPFSTF
200	0.148	0.173	295	346.9
400	0.086	0.101	171.6	203
600	0.048	0.057	96	114.3
800	0.027	0.033	54.2	66.6
1000	0.012	0.018	24.8	35.3
1200	0.007	0.008	13.6	16.3
1400	0.004	0.004	7.7	8.5

Summer TBlock 5 – 30minR

Excess Above MRR	PBMRR April 2021	PBMRR EPFSTF	Price April 2021	Price EPFSTF
200	0.338	0.372	675.2	743.7
400	0.264	0.291	527.8	582.8
600	0.2	0.227	399.2	454.1
800	0.142	0.169	284.3	338.5
1000	0.099	0.124	197.8	248.4
1200	0.066	0.084	131.8	167.2
1400	0.042	0.055	83.8	109.2

PBMRR values are lower in the April 2021 ORDCs than in the last version of the ORDCs presented at the EPFSTF. Therefore, the prices are also lower.

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Comparison with EPFSTF ORDCs – Winter TBlock 3

Winter TBlock 3 - SR

Excess Above MRR	PBMRR April 2021	PBMRR EPFSTF	Price April 2021	Price EPFSTF
200	0.133	0.192	265.9	383.2
400	0.079	0.119	158.9	237.7
600	0.048	0.07	96.2	140.3
800	0.029	0.041	58.5	81
1000	0.017	0.023	34.8	46.5
1200	0.011	0.013	21.5	25.9
1400	0.007	0.007	13.3	14.5

Winter TBlock 3 – 30minR

Excess Above MRR	PBMRR April 2021	PBMRR EPFSTF	Price April 2021	Price EPFSTF
200	0.327	0.449	653.7	897.7
400	0.253	0.371	506.6	741.2
600	0.195	0.306	390.2	611.1
800	0.145	0.247	289	494.4
1000	0.107	0.195	213.9	390.7
1200	0.076	0.152	152.6	303.7
1400	0.055	0.122	110.9	244

PBMRR values are lower in the April 2021 ORDCs than in the last version of the ORDCs presented at the EPFSTF. Therefore, the prices are also lower.

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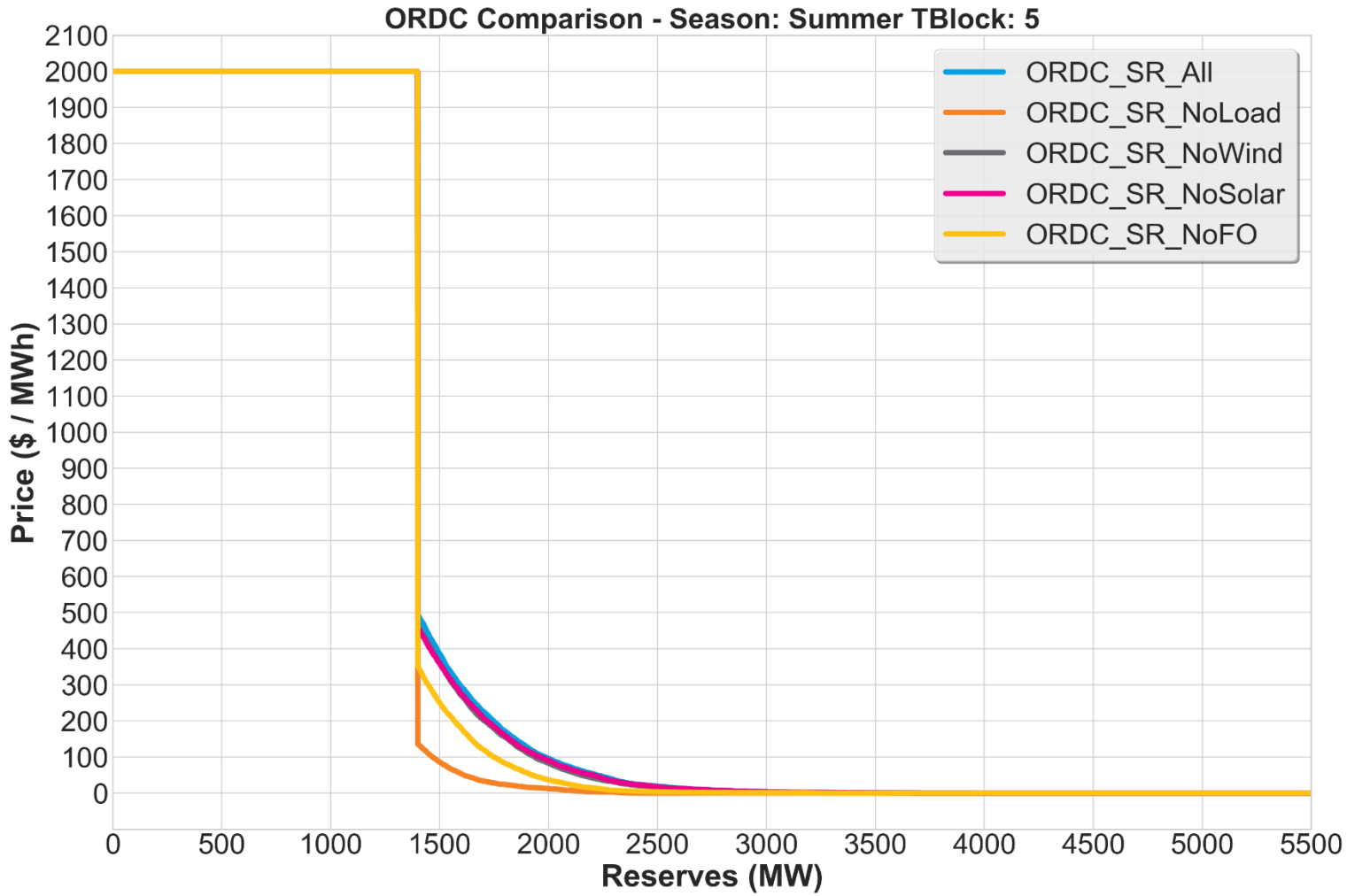
Contribution of each forecast error to ORDC – RTO SR Summer TBlock 5



RTO – SR – Summer TBlock 5

Major contributors are:

Load Forecast Error (NoLoad)
Forced Outages (NOFO)

Because the ORDC's height Decreases significantly when those forecast errors are removed from the ORDC calculation

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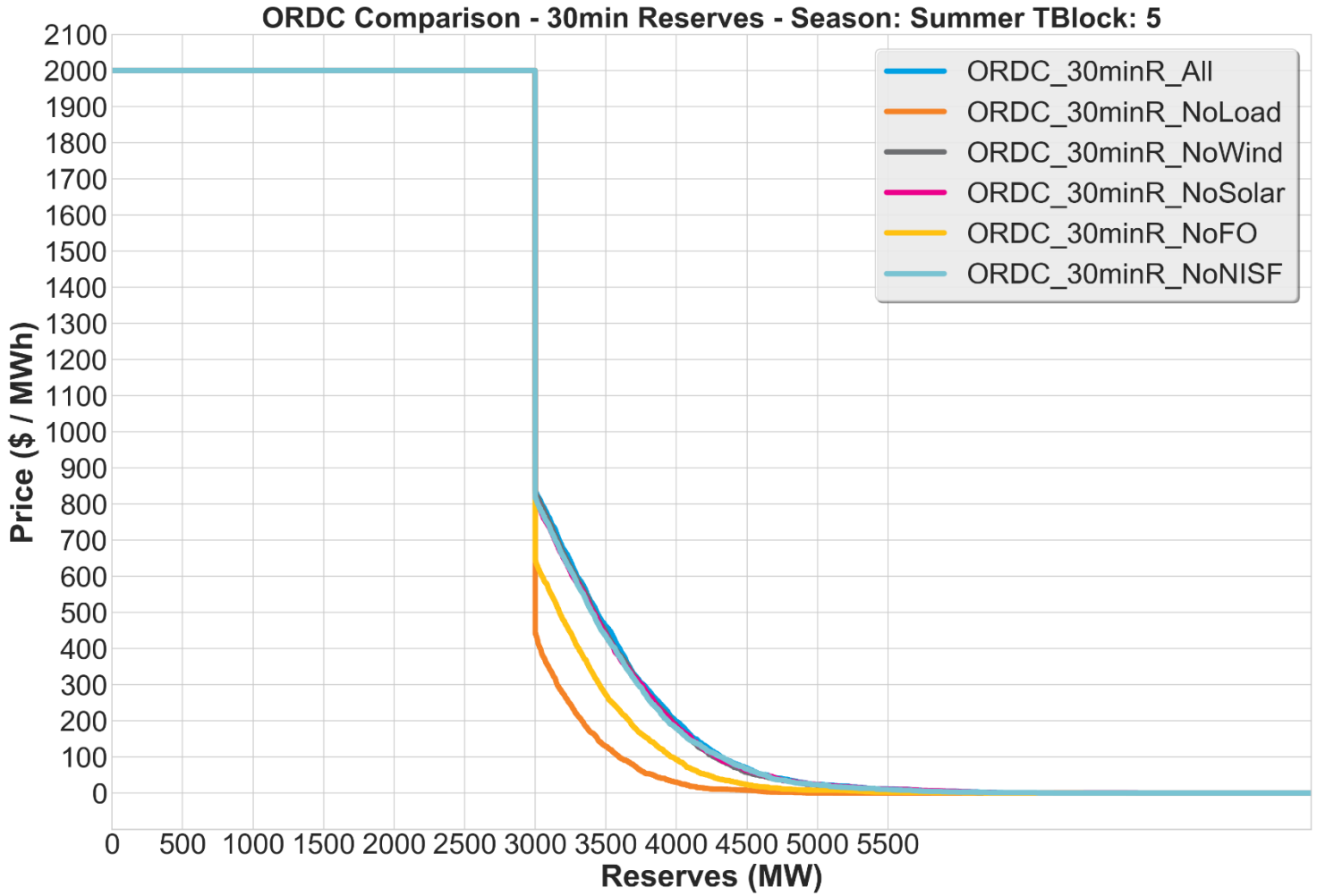
Contribution of each forecast error to ORDC – RTO 30minR Summer TBlock 5



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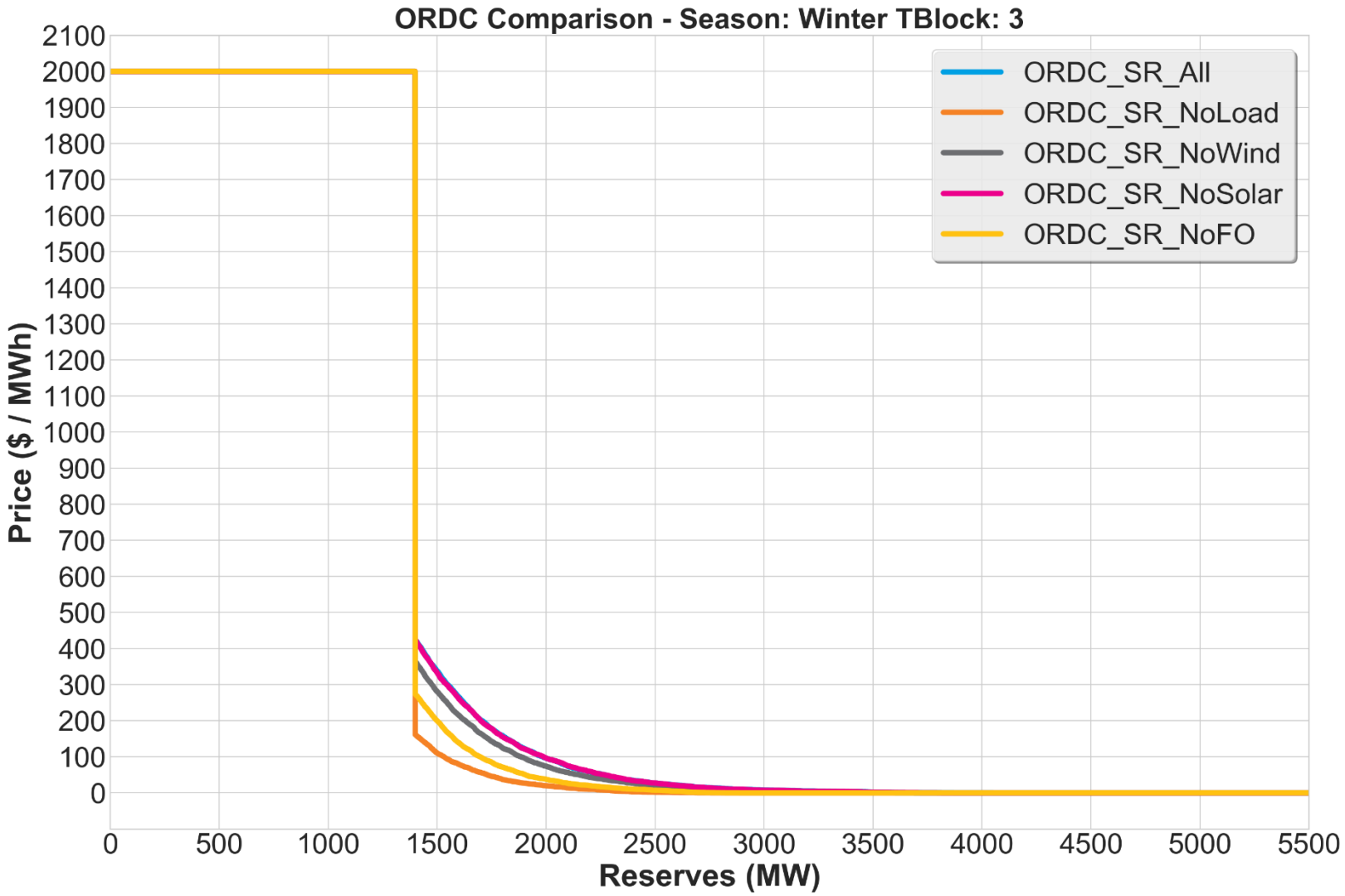

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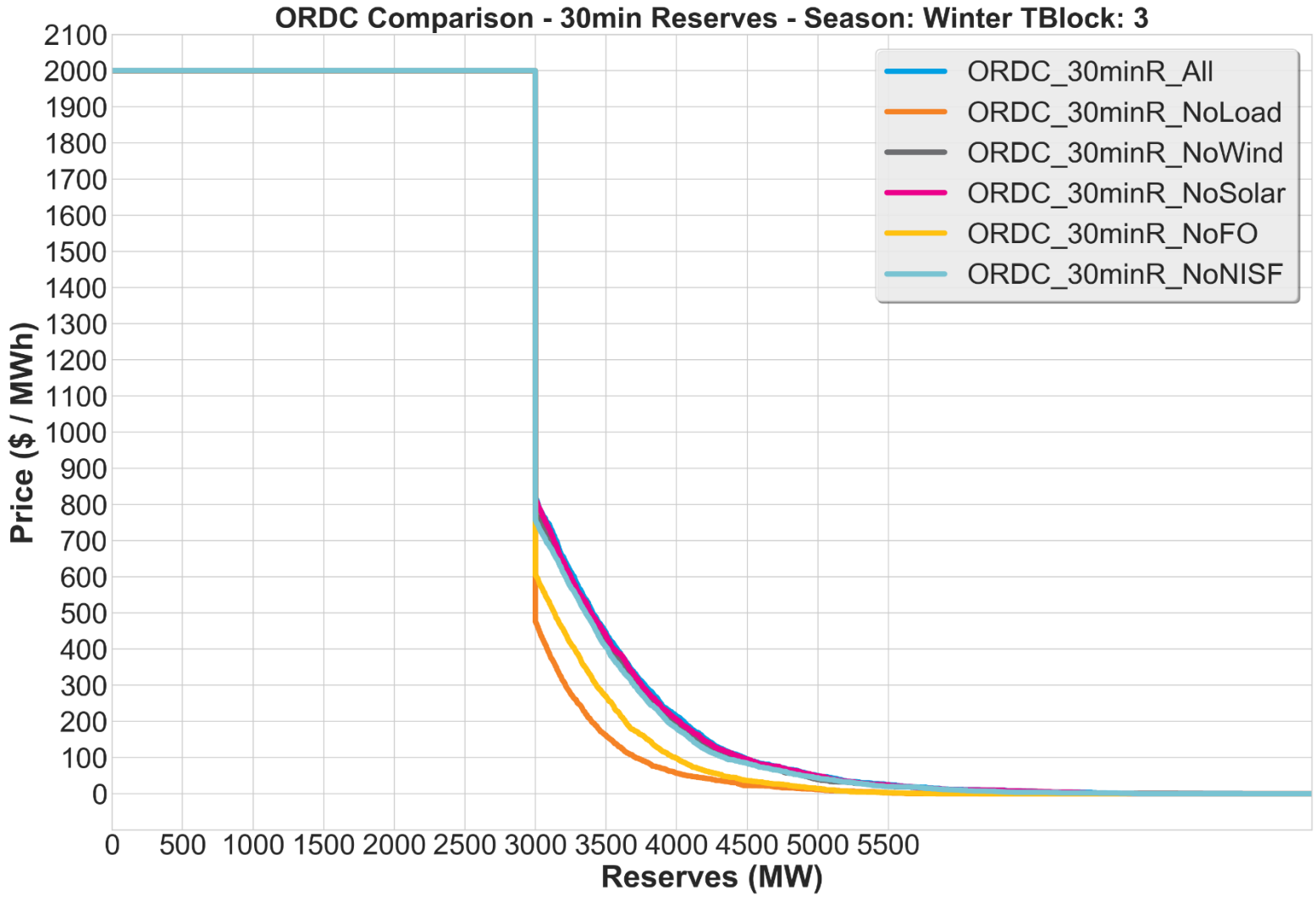
Contribution of each forecast error to ORDC – RTO 30minR Winter TBlock 3



RTO – 30minR –Winter TBlock 3

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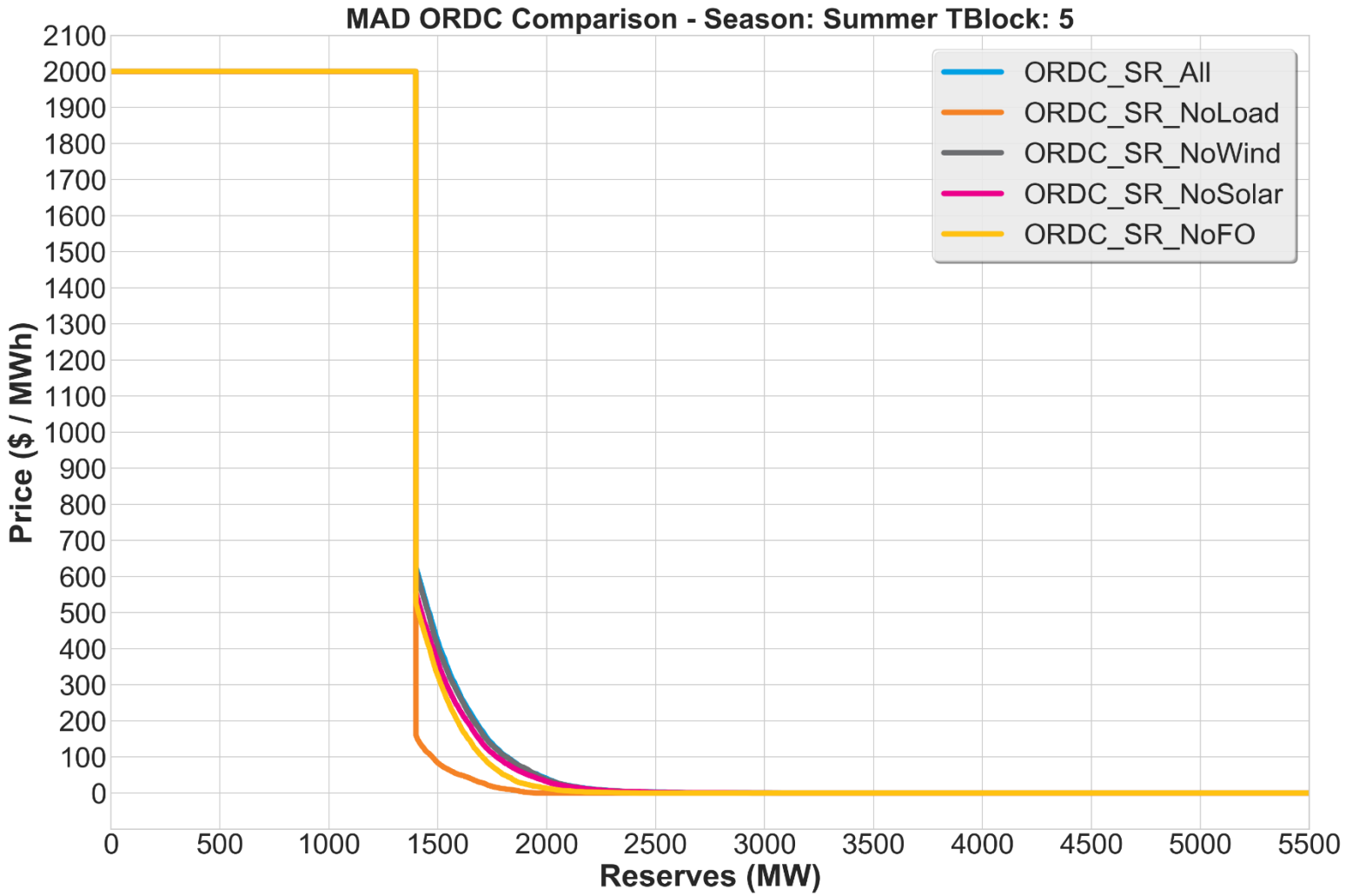
Contribution of each forecast error to ORDC – MAD SR Summer TBlock 5



MAD – SR – Summer TBlock 5

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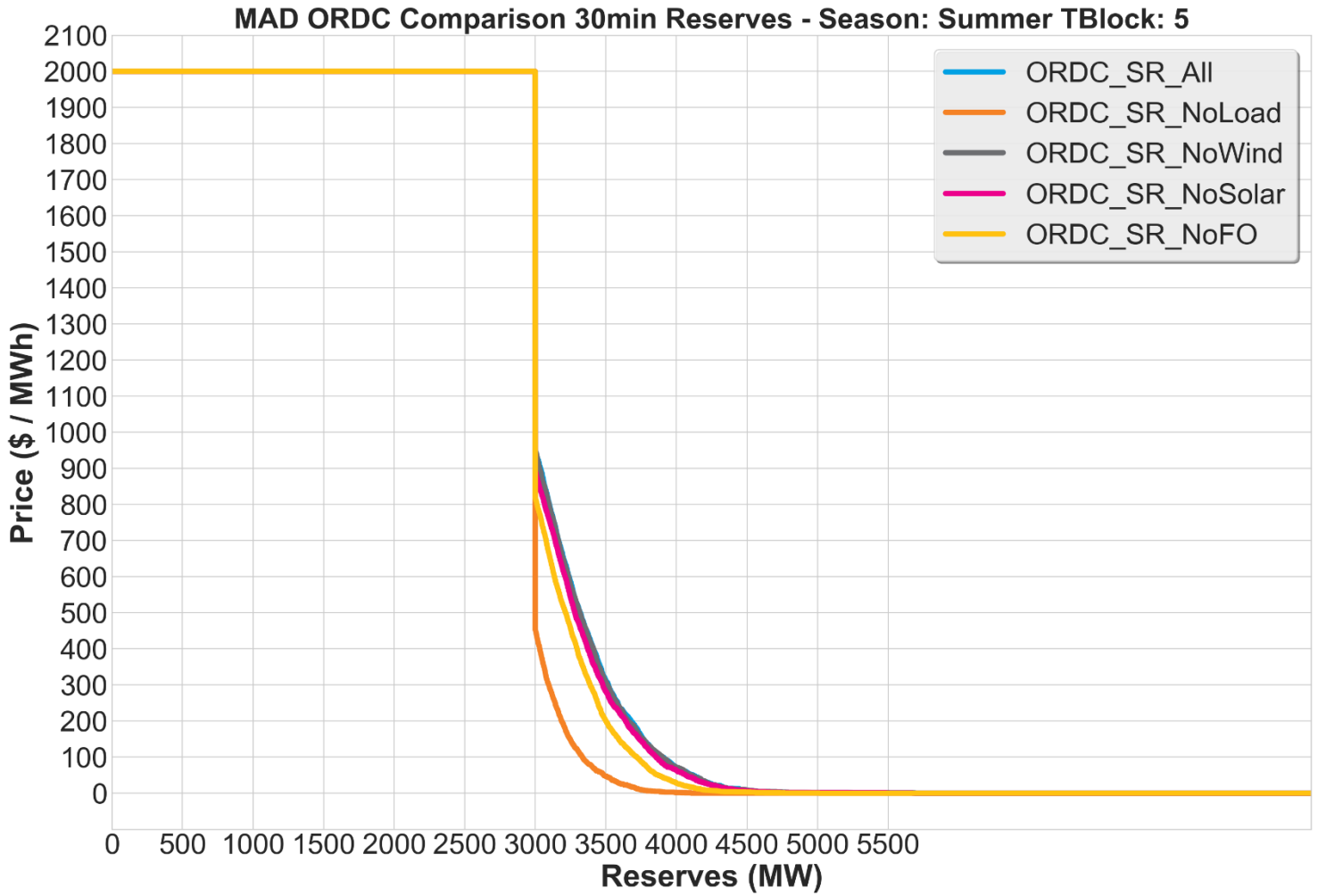
Contribution of each forecast error to ORDC – MAD 30minR Summer TBlock 5



MAD – 30minR – Summer TBlock 5

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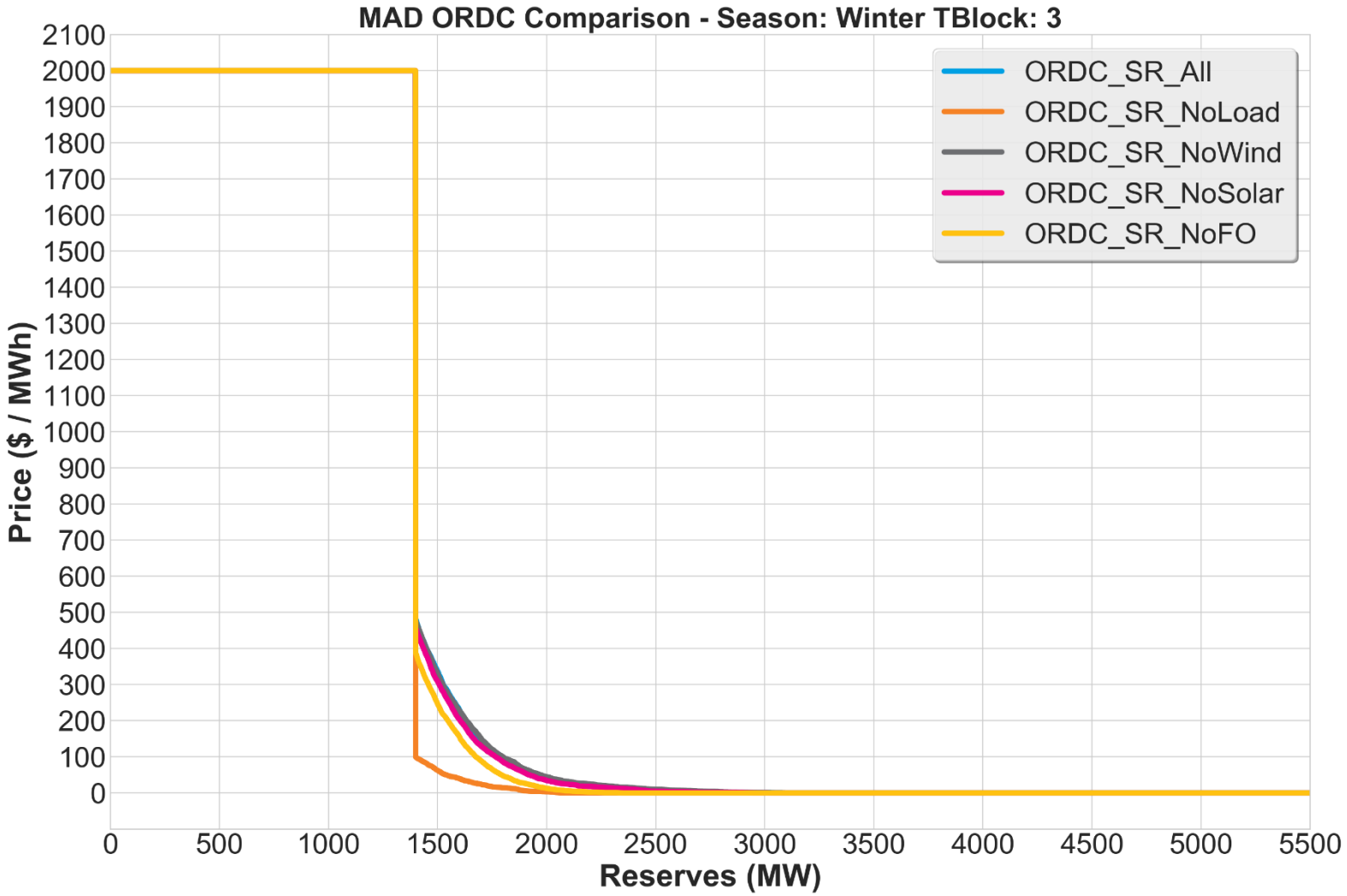

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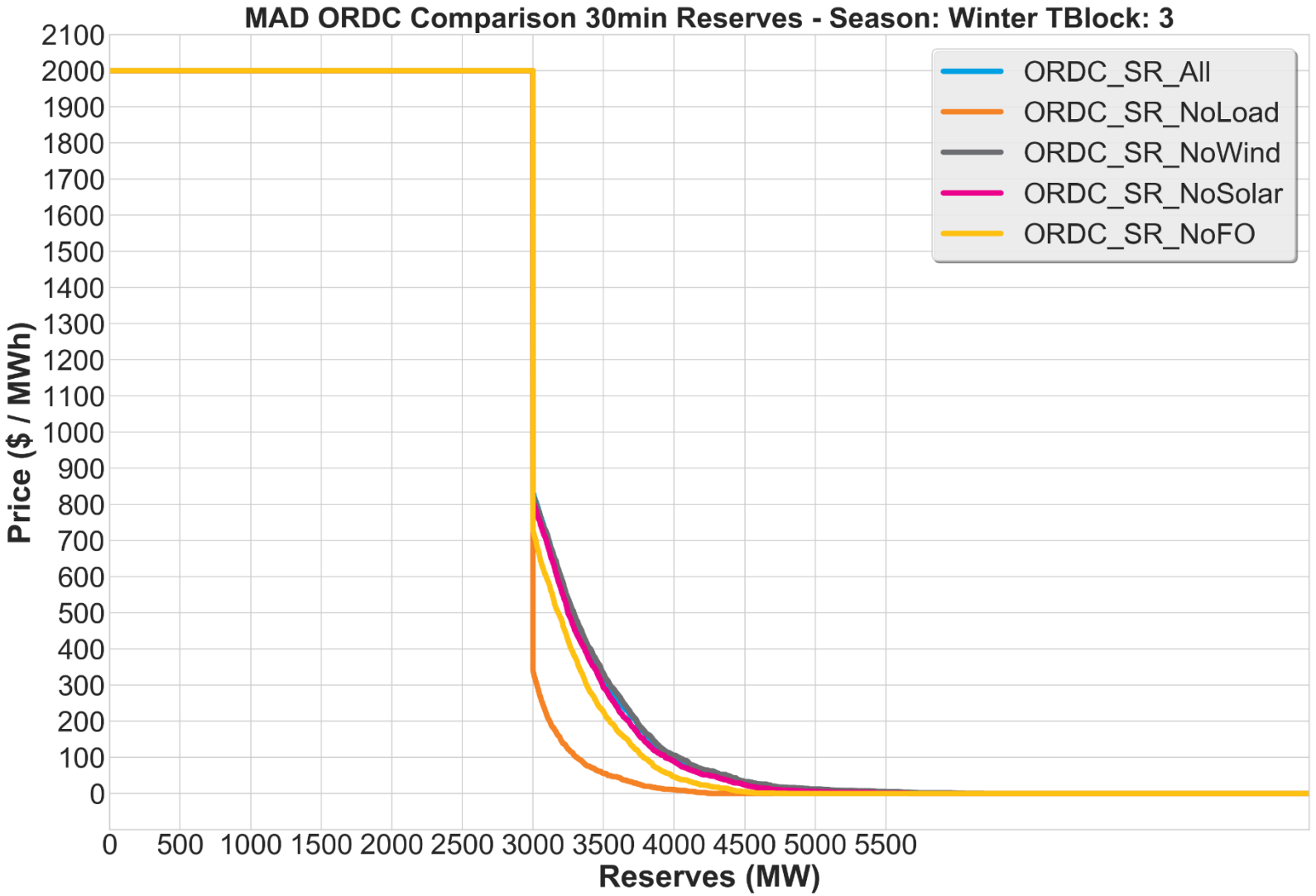

MAD – 30minR –Winter TBlock 3

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