

Real-Time Pricing Impacts: Multi-Step ORDCs with Extended Requirements

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- Analyze the pricing impacts in the Real-Time Market (RTM) for the following:
 - Unnested Synchronized Reserve (SR) from 30-min Reserve with the 30-min Reserve having a nested 30-min Online product.
 - The proposed reserve products are represented using Operating Reserve Demand Curves (ORDCs) with multi-step segments updated every 15 minutes.
- Simulations are performed for 7 days in 2025 including high-load summer and winter days with a few low-risk shoulder season days.
- PROBE Perfect-Dispatch (PD) was used to run the simulations for the RTM. Only combustion turbines (CTs) and diesel units were allowed to be committed and decommitted by PROBE PD. The unit commitment for steam units was held fixed to actual real-time operations, but were allowed to be redispatched by PROBE PD.
- The MAD reserve sub-zone was not enforced in any of the simulations.

PROBE PD does not have a 30-min Online product. Instead, we ran several sensitivities by increasing the SR requirements.

Four scenarios are simulated:

- Base Case:** Base Case with no changes
- 1/3rd Case:** Updated ORDCs for all products with PR not optimized, 30-min Reserve is unnested from SR with 1/3rd 30-min Online added to SR
- 2/3rd Case:** Updated ORDCs for all products with PR not optimized, 30-min Reserve is unnested from SR with 2/3rd 30-min Online added to SR
- Full Case:** Updated ORDCs for all products with PR not optimized, 30-min Reserve is unnested from SR with full 30-min Online added to SR

- The following days were selected for the simulations.

| Day | Season | Assessed Risk | Reason |
|-----------|--------|---------------|---|
| 1/22/2025 | Winter | High | High-risk winter day with high winter loads |
| 2/16/2025 | Winter | Medium | Medium-risk winter day |
| 4/1/2025 | Spring | Low | Shoulder season day |
| 6/23/2025 | Summer | Low | High-load summer day |
| 7/29/2025 | Summer | Low | High-load summer day |
| 9/17/2025 | Fall | Low | Shoulder season day |
| 10/1/2025 | Fall | Low | Shoulder season day |

*6/24/2025 had previously been simulated for the Day-Ahead Market results. Due to convergence issues with PROBE PD, this day is excluded from the real-time simulation results.

- The following table shows the daily average generation-weighted LMPs in the RTM.

| Day | Base Case (\$/MWh) | Multi-step ORDC 1/3rd case (\$/MWh) | Multi-step ORDC 2/3rd case (\$/MWh) | Multi-step ORDC Full case (\$/MWh) |
|------------|--------------------|-------------------------------------|-------------------------------------|------------------------------------|
| 01/22/2025 | 137.09 | 133.68 | 135.66 | 139.94 |
| 02/16/2025 | 32.2 | 32.20 | 32.22 | 32.29 |
| 04/01/2025 | 39.57 | 35.77 | 38.67 | 43.32 |
| 06/23/2025 | 73.59 | 74.29 | 81.69 | 88.71 |
| 07/29/2025 | 81.14 | 76.97 | 84.8 | 95.59 |
| 09/17/2025 | 42.13 | 40.47 | 40.71 | 41.76 |
| 10/01/2025 | 37.43 | 39.10 | 39.55 | 41.02 |

* The results are rounded to two decimal places.



Real-Time Simulation Results – AS MCPs

- The following table shows the daily average MCPs for the 10-Min Online Reserve in the RTM.

| Day | Base Case (\$/MWh) | Multi-step ORDC 1/3rd case (\$/MWh) | Multi-step ORDC 2/3rd case (\$/MWh) | Multi-step ORDC Full case (\$/MWh) |
|------------|--------------------|-------------------------------------|-------------------------------------|------------------------------------|
| 01/22/2025 | 17.40 | 8.48 | 13.80 | 28.70 |
| 02/16/2025 | 0.00 | 0.00 | 0.07 | 0.35 |
| 04/01/2025 | 12.55 | 8.92 | 13.48 | 22.98 |
| 06/23/2025 | 17.69 | 17.11 | 26.80 | 38.60 |
| 07/29/2025 | 22.88 | 18.50 | 28.44 | 40.08 |
| 09/17/2025 | 7.55 | 3.04 | 4.67 | 7.23 |
| 10/01/2025 | 7.08 | 4.28 | 6.45 | 10.19 |



Real-Time Simulation Results – AS MCPs

- The following table shows the daily average MCPs for the Primary Reserve and total 30-min Reserve products in the RTM.

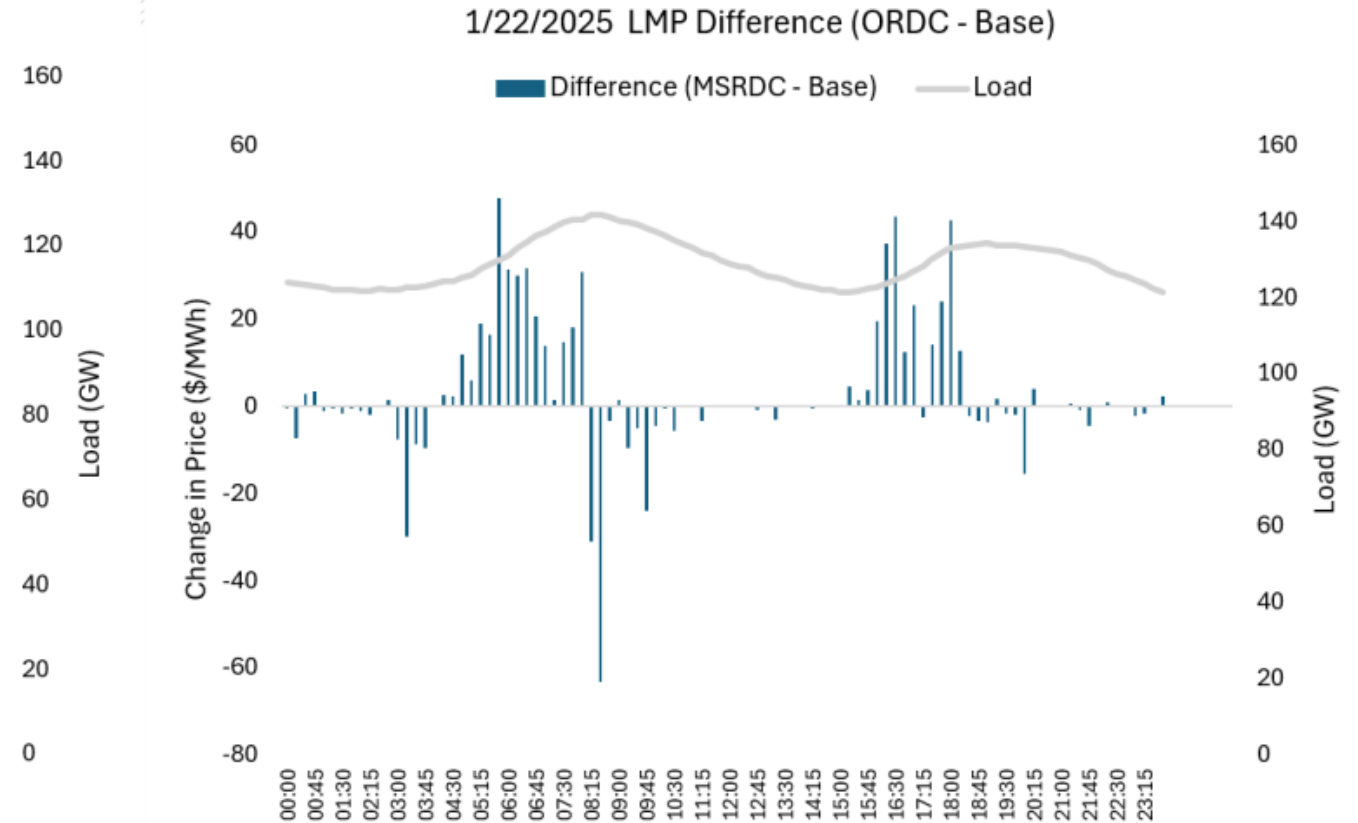
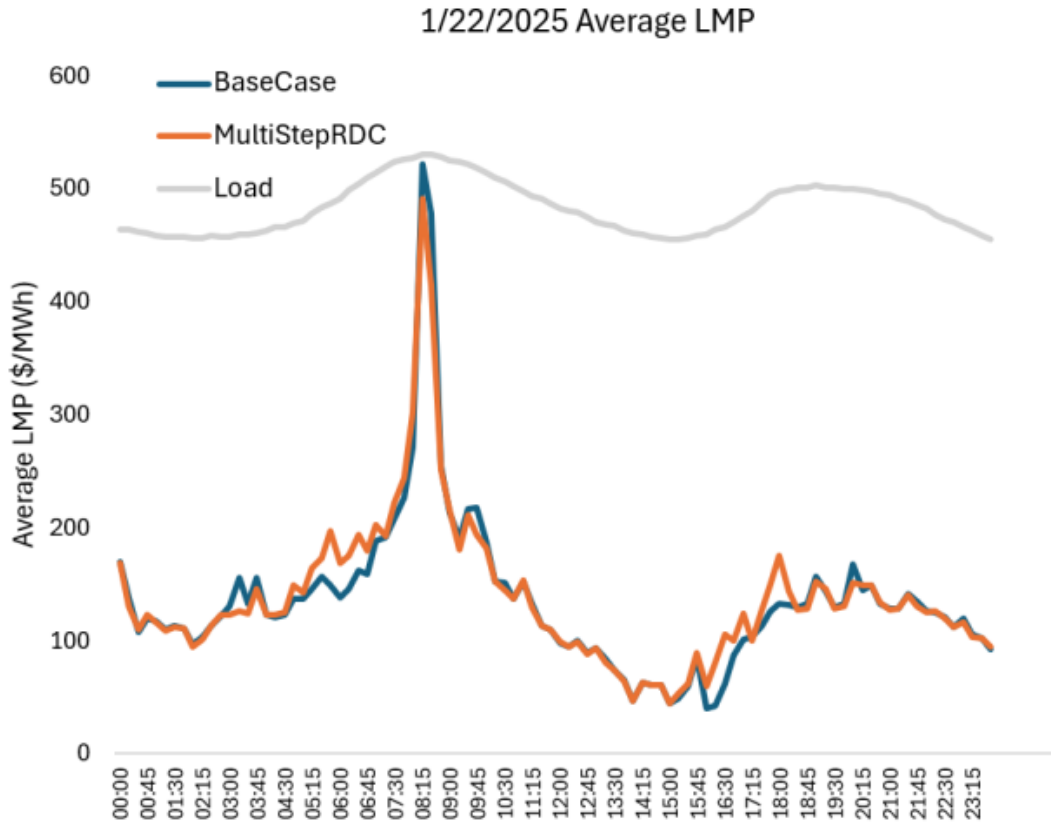
Primary Reserve

| Day | Base Case (\$/MWh) | Multi-step ORDC (\$/MWh) |
|------------|--------------------|--------------------------|
| 01/22/2025 | 17.40 | - |
| 02/16/2025 | 0.00 | - |
| 04/01/2025 | 12.54 | - |
| 06/23/2025 | 17.69 | - |
| 07/29/2025 | 22.88 | - |
| 09/17/2025 | 7.55 | - |
| 10/01/2025 | 7.08 | - |

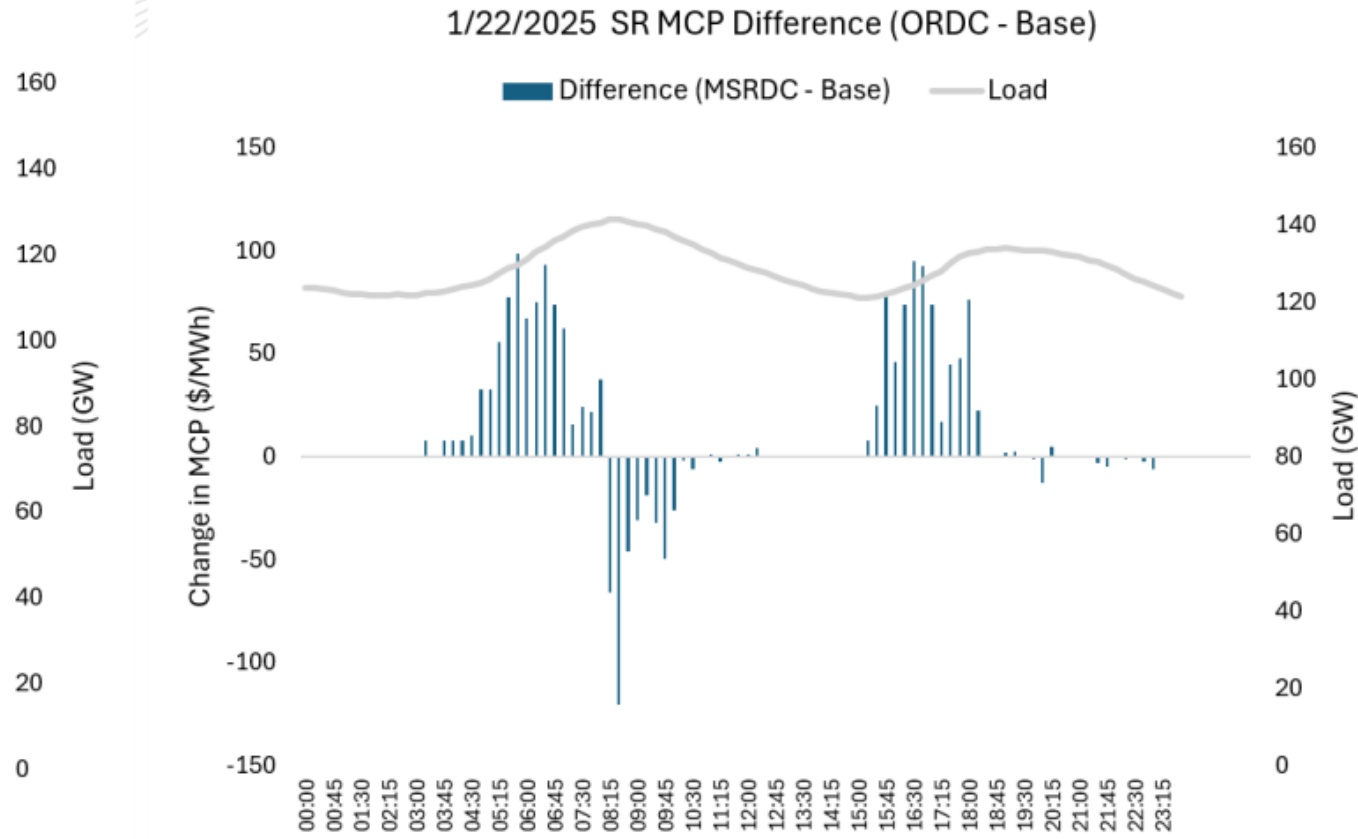
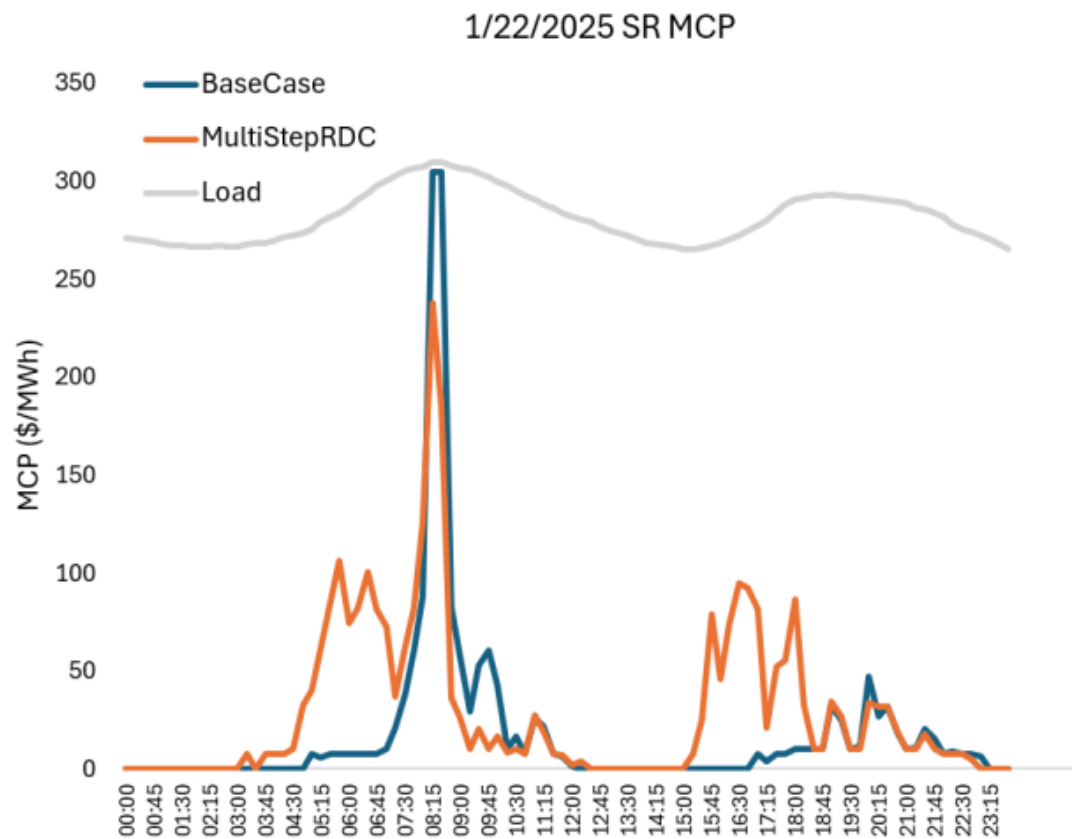
30-min Reserve

| Day | Base Case (\$/MWh) | Multi-step ORDC (\$/MWh) |
|------------|--------------------|--------------------------|
| 01/22/2025 | 0.00 | 0.00 |
| 02/16/2025 | 0.00 | 0.00 |
| 04/01/2025 | 0.00 | 0.00 |
| 06/23/2025 | 0.00 | 0.00 |
| 07/29/2025 | 0.00 | 0.00 |
| 09/17/2025 | 0.00 | 0.00 |
| 10/01/2025 | 0.00 | 0.00 |

- High-Risk Winter day 1/22/2025, Full Case



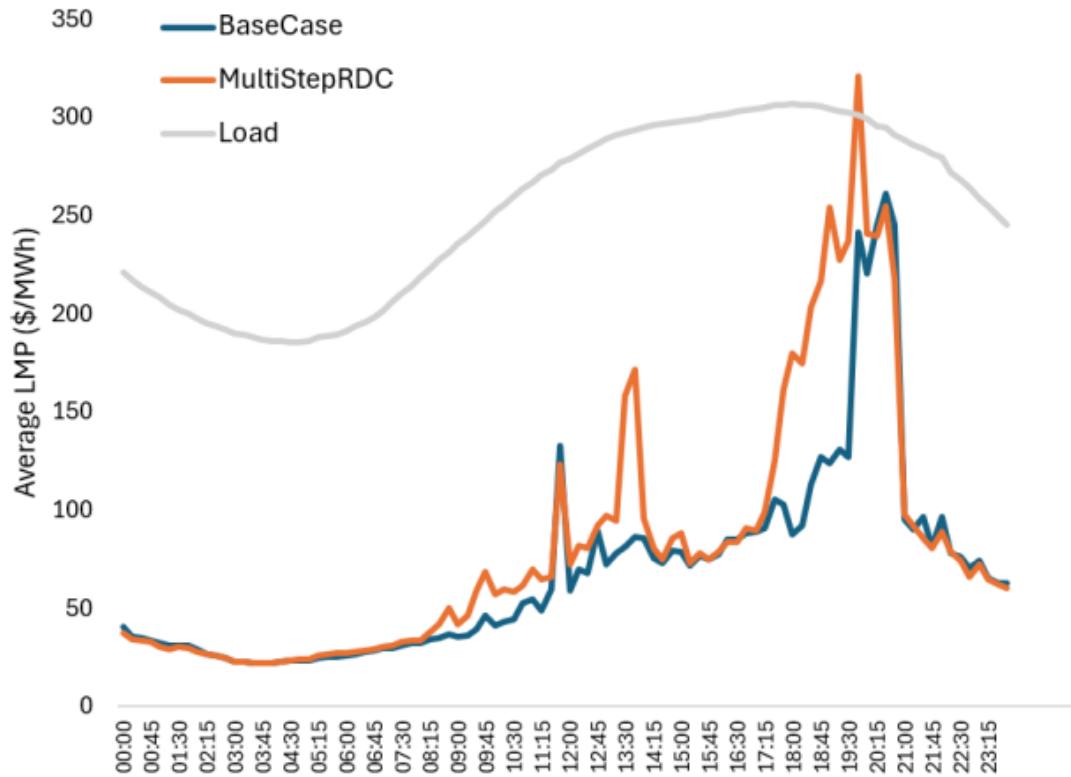
- High-Risk Winter day 1/22/2025, Full Case



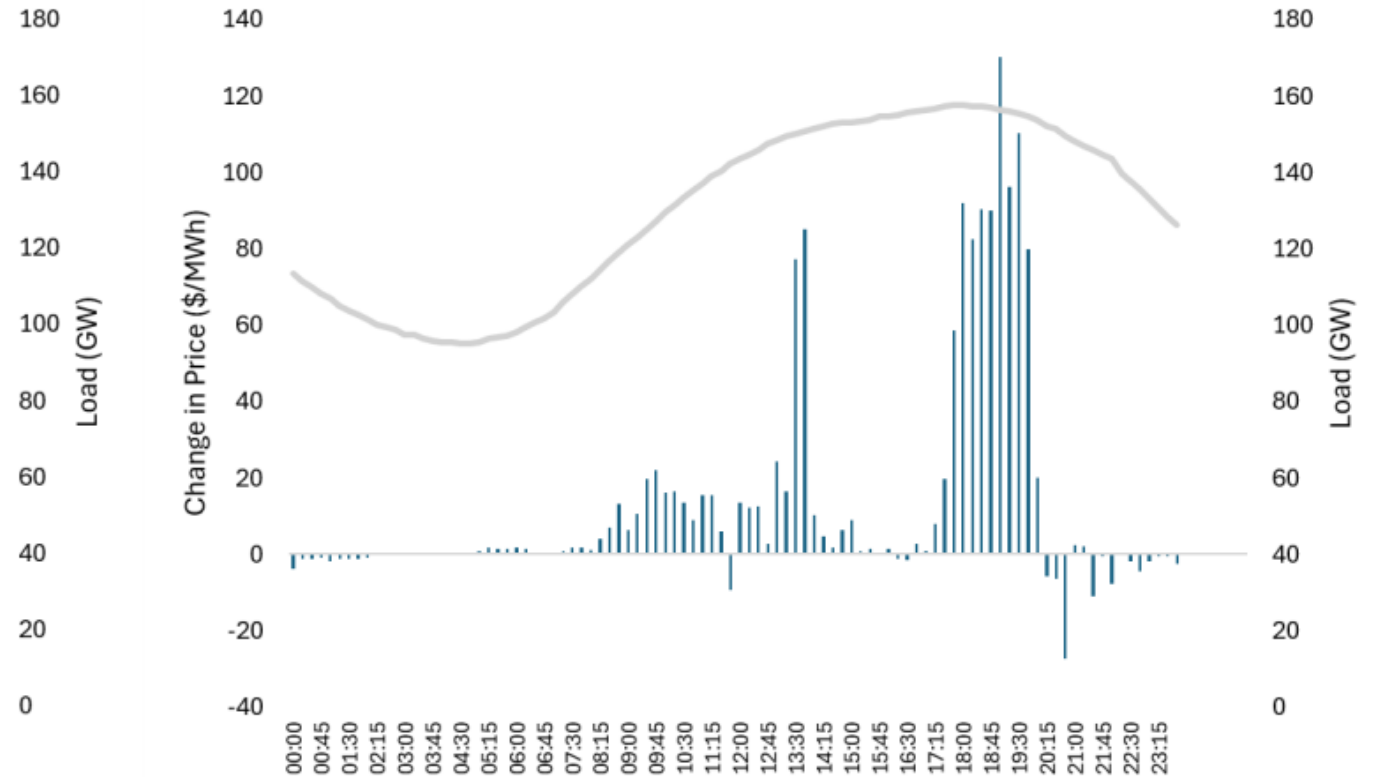
*All 30-Min reserve products had 0 \$/MWh MCP

- High-Load Summer day 6/23/2025, Full Case

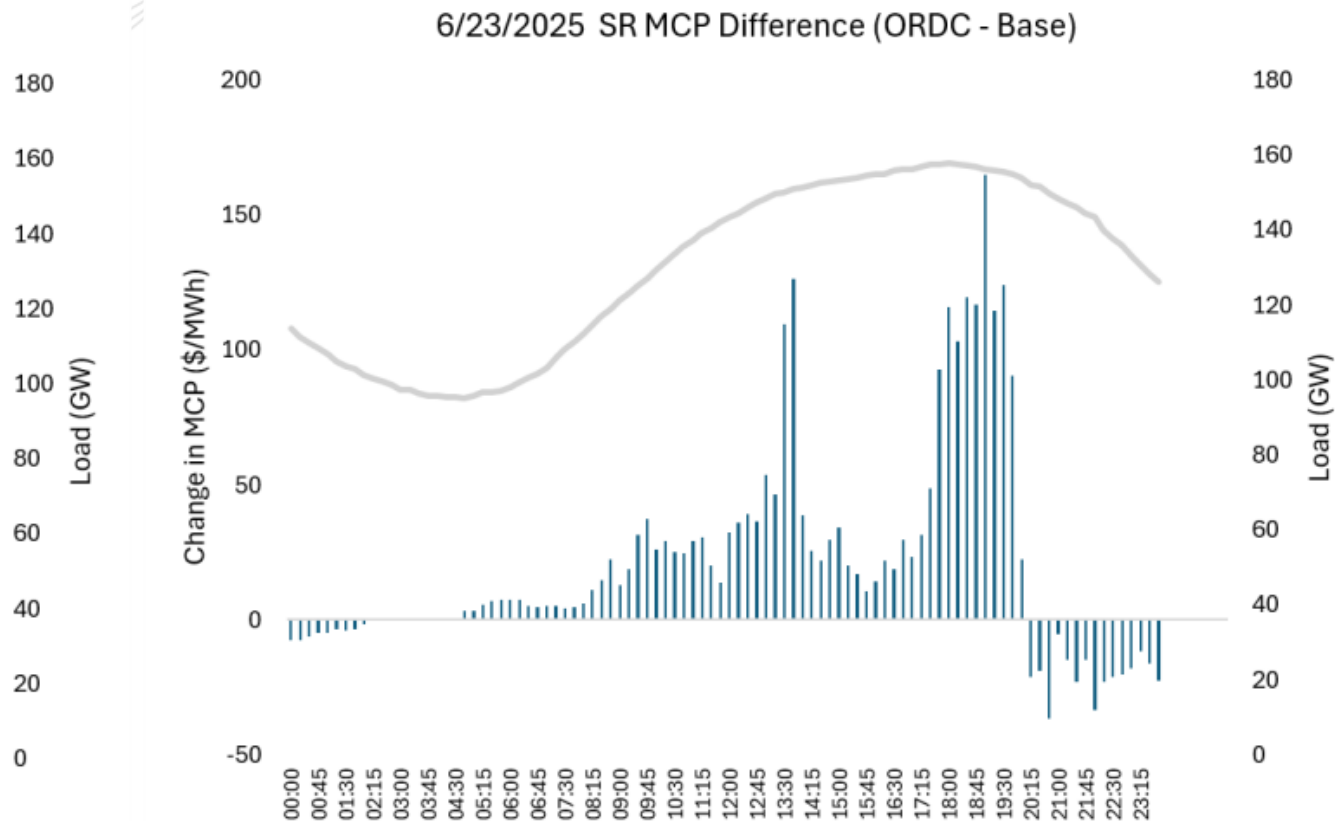
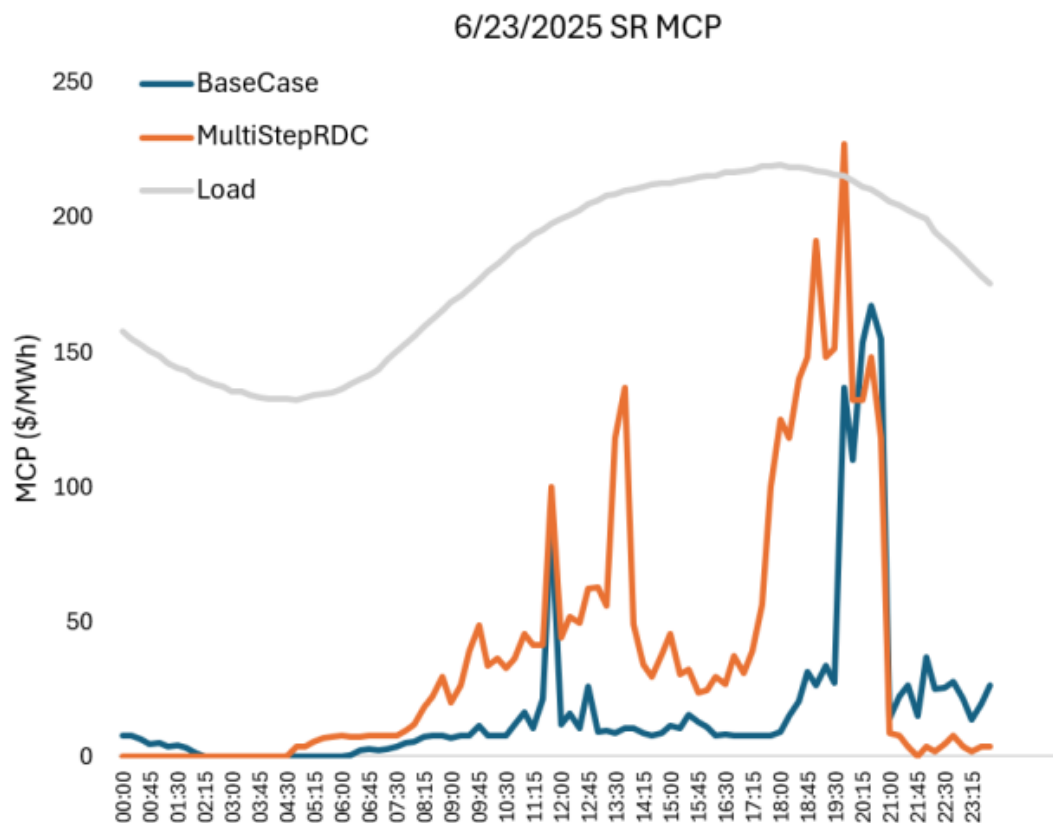
6/23/2025 Average LMP



6/23/2025 LMP Difference (ORDC - Base)

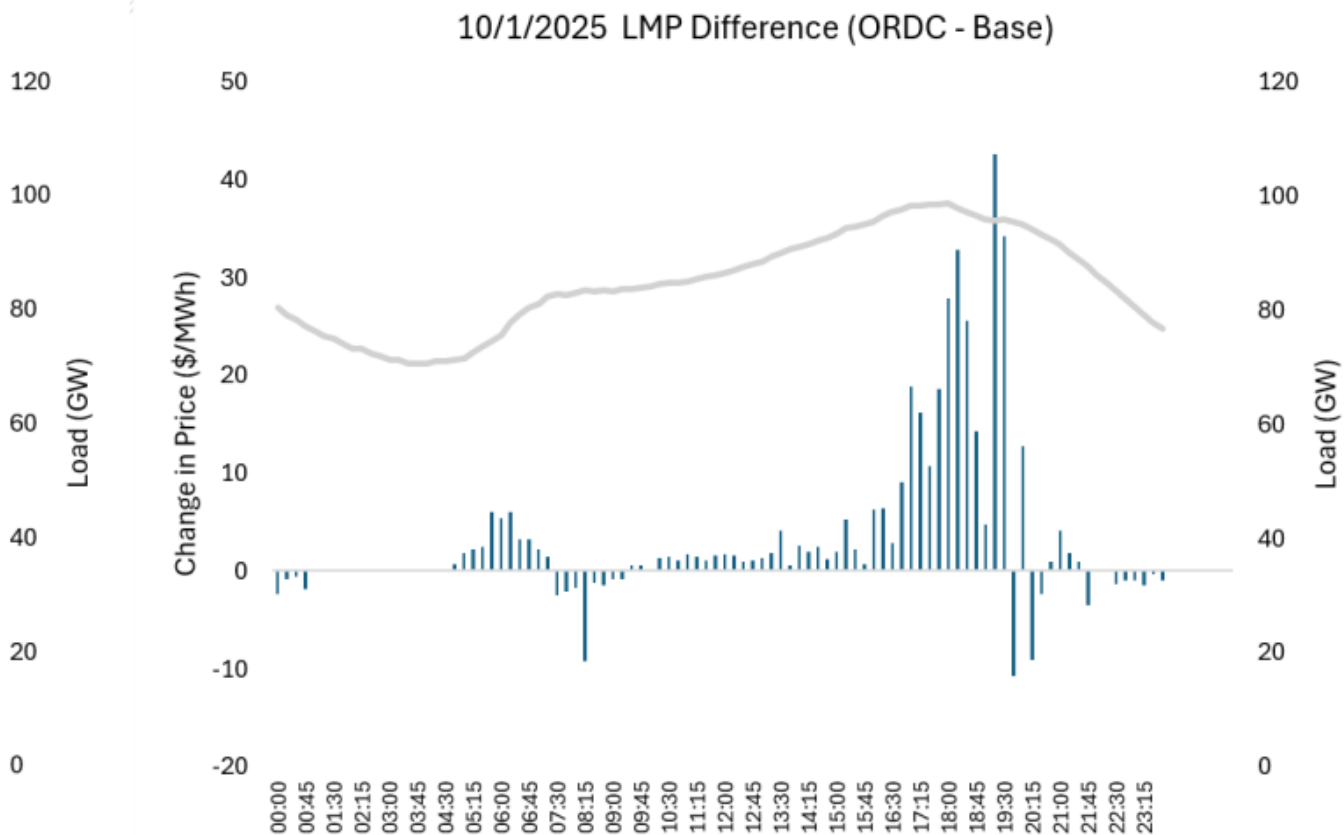
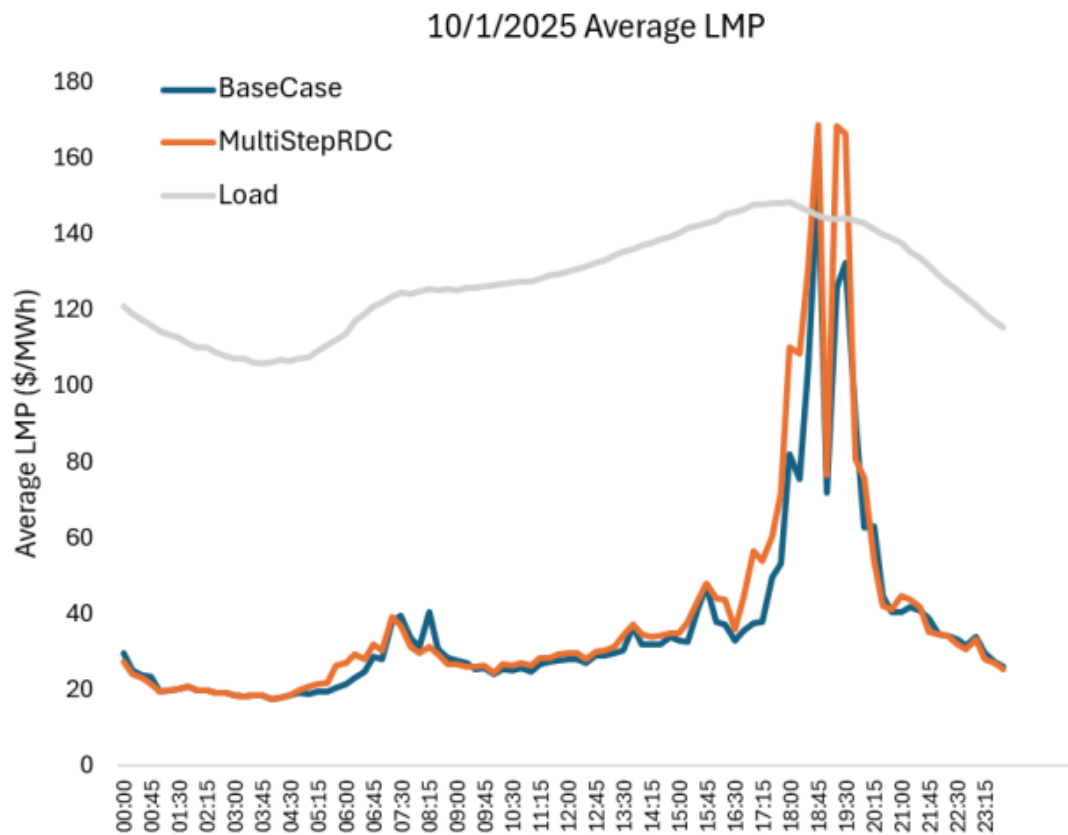


- High-Load Summer day 6/23/2025, Full Case



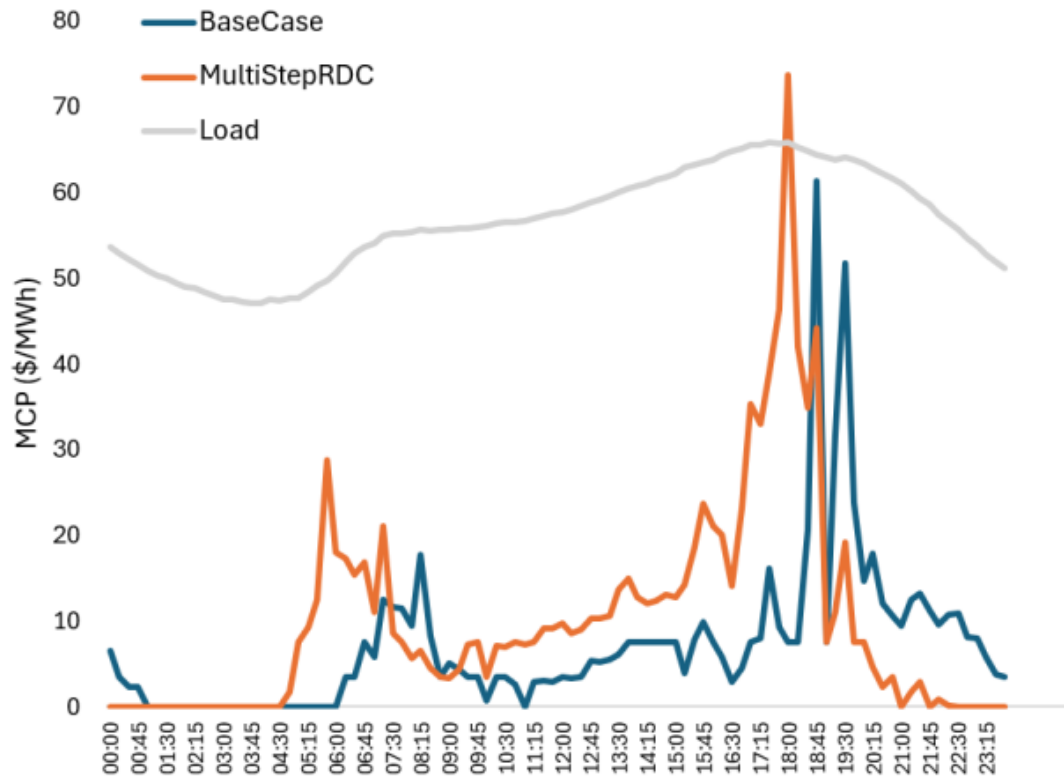
*All 30-Min reserve products had 0 \$/MWh MCP

- Representative Fall day 10/1/2025, Full Case

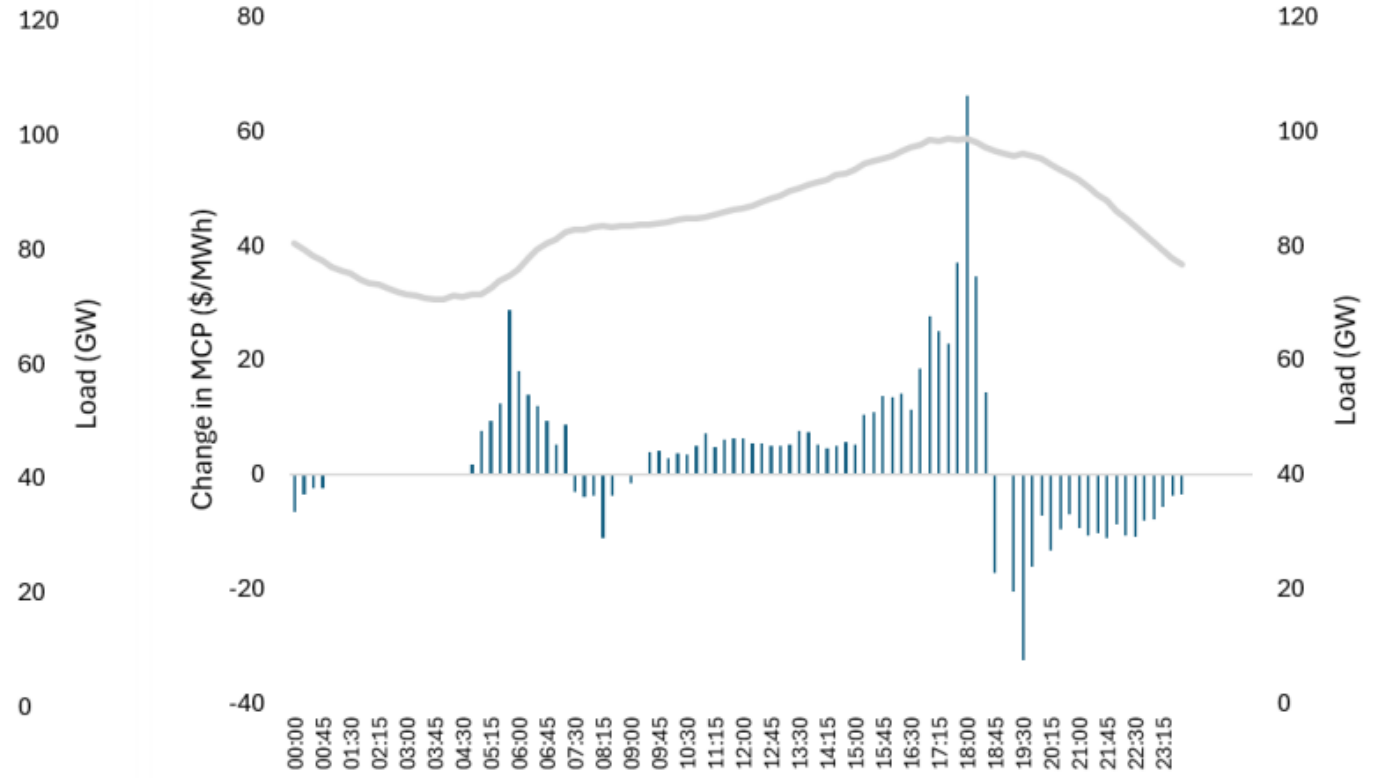


- Representative Fall day 10/1/2025, Full Case

10/1/2025 SR MCP



10/1/2025 SR MCP Difference (ORDC - Base)



*All 30-Min reserve products had 0 \$/MWh MCP

- Real-time energy LMPs see a slight increase in the Full Multi-step ORDC Case compared to the Base Case.
- Generally, higher LMPs are observed leading up to the daily peak load and lower LMPs coming off the daily peak load.
- The Full Multi-step ORDC Case results in higher average Online 10-Minute Reserve MCPs compared to the Base Case, especially during the peak hours. In the Base Case, the AS MCPs are mainly driven by Primary Reserve. In the Full Multi-step ORDC case, the AS MCPs are driven by the large Online 10-Minute Reserve requirement.