# 2024 Biennial ERCOT Report on the Operating Reserve Demand Curve

**November 1, 2024**

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## Acronyms

| | |
|---|---|
| ASDC | Ancillary Service Demand Curve |
| DAM | Day-Ahead Market |
| DRRS | Dispatchable Reliability Reserve Service |
| ECRS | ERCOT Contingency Reserve Service |
| EEA | Energy Emergency Alert |
| EOC | Energy Offer Curve |
| ERCOT | Electric Reliability Council of Texas |
| ERS | Emergency Responsive Service |
| HCAP | High System-Wide Offer Cap |
| HSL | High Sustained Limit |
| LCAP | Low System-Wide Offer Cap |
| LOLP | Loss of Load Probability |
| MCL | Minimum Contingency Level |
| NFRC | Non-Frequency Responsive Capacity |
| Non-Spin | Non-Spinning Reserve |
| ORDC | Operating Reserve Demand Curve |
| PBMCL | Probability of Reserves Falling Below the Minimum Contingency Level |
| PNM | Peaker Net Margin |
| PRC | Physical Responsive Capability |
| PUCT | Public Utility Commission of Texas |
| QSE | Qualified Scheduling Entity |
| QSGR | Quick-Start Generation Resources |
| RTC+B | Real-Time Co-optimization Plus Batteries |
| RTM | Real-Time Market |
| RTOFFCAP | Real-Time Off-Line Capacity |
| RTOFFPA | Real-Time Off-Line Reserve Price Adder |
| RTOLCAP | Real-Time On-Line Capacity |
| RTORDPA | Real-Time On-Line Reliability Deployment Price Adder |
| RTORPA | Real-Time On-Line Reserve Price Adder |
| RUC | Reliability Unit Commitment |
| SWCAP | System-Wide Offer Cap |
| VOLL | Value of Lost Load |

# Executive Summary

ERCOT provides this biennial report on the Operating Reserve Demand Curve (ORDC) to the Public Utility Commission of Texas (PUCT) in accordance with 16 Texas Administrative Code (TAC) § 25.505(e), which requires:

> *"Operating Reserve Demand Curve (ORDC) report. ERCOT must publish, by November 1 of every even numbered year, a report analyzing the efficacy, utilization, related costs, and contribution of the ORDC to grid reliability in the ERCOT power region."*

This report analyzes data related to the ORDC beginning October 1, 2022, after the reporting period from the 2022 ORDC Report concluded, through September 30, 2024. This report highlights significant developments and observations with regards to the ERCOT market design, including the increase and change in the composition of Ancillary Service requirements beginning with the introduction of the ERCOT Contingency Reserve Service (ECRS) in June 2023 and an assessment of the introduction of ORDC price-adder floors for On-Line reserves in November 2023. The report also includes an explanation of how the current ORDC will be replaced by Ancillary Service Demand Curves (ASDCs) upon the implementation of Real-Time Co-optimization plus Batteries (RTC+B) expected in late 2025. To effectively assess ORDC impacts, this report focuses its analysis on three primary study subperiods chosen to align with changes to the ORDC and/or market design:

1. October 1, 2022 through June 9, 2023 to evaluate the period prior to the introduction of ECRS and the ORDC price-adder floors;
2. June 10, 2023 through October 31, 2023 to evaluate the period immediately following ECRS launch; and
3. November 1, 2023 through September 30, 2024 to evaluate the period when both ECRS and the ORDC price-adder floors were in place.

<u>Key study results</u>:

The key results summarized below describe this report's analysis of the ORDC's efficacy, utilization, related costs, and contribution to grid reliability during the reporting period.

The performance of the ORDC during the reporting period was in line with expectations based on its current design and, as addressed further below, ERCOT does not recommend any changes to the ORDC at this time. The parameters of the ORDC's design were relatively stable during the current reporting period compared to the more fundamental changes that occurred during the reporting period assessed in the 2022 ORDC Report,[1] with the only recent enhancements being the implementation of the multi-step price-adder floor. During the current reporting period, factors beyond the ORDC had a greater impact on the ERCOT market, including growing demand, tighter conditions, lower natural gas

[1] *CY 2022 Reports of the Electric Reliability Council of Texas,* Project No. 52933, ERCOT's 2022 Operating Reserve Demand Curve Report – Corrected (Oct. 31, 2022).

prices, new solar and Energy Storage Resource (ESR) capacity, and additional Ancillary Service requirements.

- Summer 2023 saw several record-breaking increases in demand driven by economic growth and sustained drier, hotter temperatures. Summer 2023 had 49 days with a peak demand greater than 80 gigawatts (GW).
- Higher observed Hub average prices and lower natural gas prices led to more self-commitment based on expected prices and significantly reduced the need for Reliability Unit Commitment (RUC) compared to previous years. The table below illustrates the decrease in RUC since 2022.

| Year | Effective RUC Hours[2] | Total MWh Committed by RUC |
|---|---|---|
| **2022** | **7,922** | **2,329,709** |
| **2023** | **2,500** | **523,247** |
| **2024 (Jan-Sep)** | **1,213** | **367,373** |

- The ERCOT Contingency Reserve Service (ECRS) was introduced on June 10, 2023. ECRS is a service which is predominantly provided by On-Line Resources.[3] Having an ECRS Supply Responsibility provides a strong incentive to a Qualified Scheduling Entity (QSE) to have Resources On-Line. This incentive further contributed to increased levels of self-commitment based on expected future prices and the risk of not running on peak summer days. This behavior impacted the composition of On-Line and Off-Line reserves with an increase in the quantity of On-Line reserves.[4]
- In terms of the ORDC's **utilization**, higher overall reserve levels and the transition from some Off-Line reserves to On-Line reserves contributed to a reduction in the frequency and magnitude of ORDC price adders, which are tied to scarcity. Real-Time On-Line Reserve Price Adders were observed at higher levels of Physical Responsive Capability (PRC) stemming from the change in the composition of reserves. The ORDC price adders were a smaller component of system-wide prices overall in 2023 and 2024 compared to the previous study period assessed in the 2022 ORDC Report.

[2] The calculation of MWh of Resource capacity committed through the RUC process used the High Sustained Limits (HSLs) of the committed Resources and the amount of time over which the Resource was committed.

[3] In addition to online resources, Quick-Start Generation Resources, which can come online within 10 minutes in response to a Security-Constrained Economic Dispatch (SCED) dispatch instruction, are also eligible to provide ECRS.

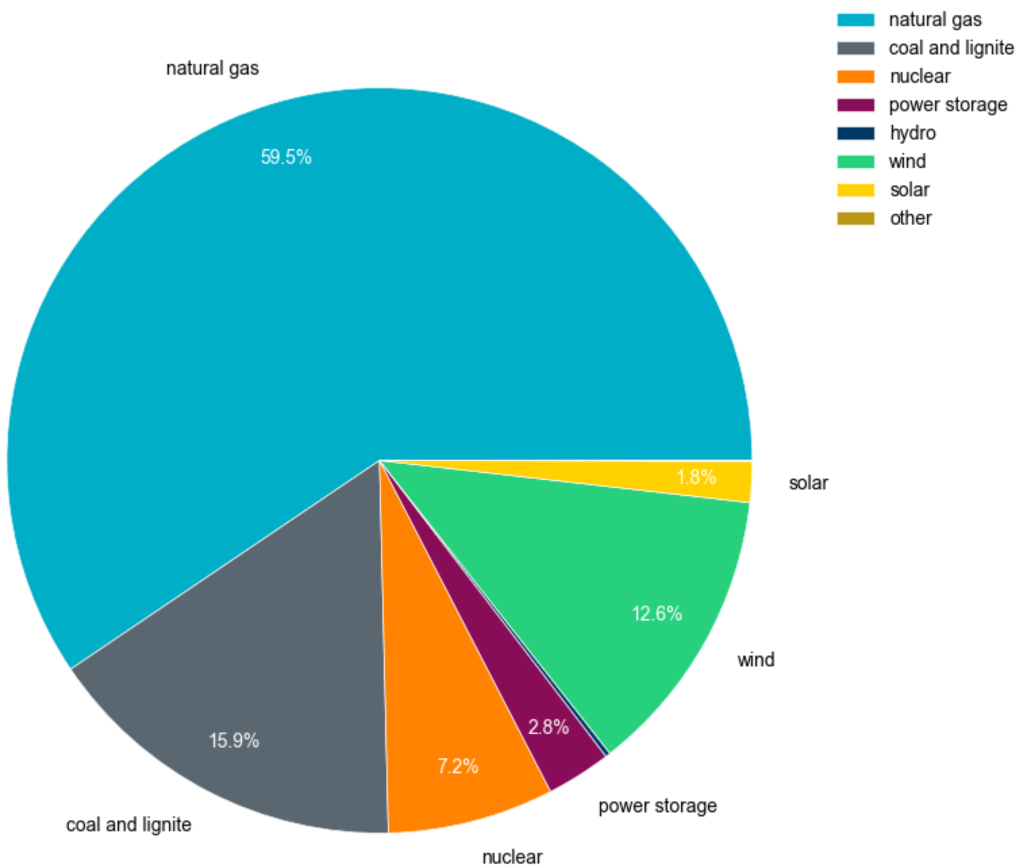
[4] Additional solar Generation Resource and ESR capacity also contributed to the On-Line reserve pool.

On November 1, 2023, ERCOT introduced ORDC Real-Time On-Line Reserve Price Adder (RTORPA) floors as an interim pricing support mechanism approved by the PUC.[5] The multi-step price-adder floor is meant to incent existing dispatchable generation to remain in the market and to reduce reliance on RUC. The price-adder floors, along with the increase of the Minimum Contingency Level (MCL) from 2,000 MW to 3,000 MW implemented on January 1, 2022, was intended to provide an additional price signal to incent self-commitment and is aligned with the desired reserve levels associated with ERCOT's operations posture post Winter Storm Uri.

- Price-adder floors are used in the calculation of ORDC price adders when the Real-Time On-Line Capacity (RTOLCAP) falls below certain On-Line reserve thresholds. Specifically:
    - A price floor of $20/MWh will be applied to the RTORPA when the calculated RTOLCAP is at or less than 6,500 MW.
    - A price floor of $10/MWh will be applied to the calculation of the RTORPA when the calculated RTOLCAP is at or less than 7,000 MW but greater than 6,500 MW.

- To date, the incidence of price-adder floors impacting prices has been limited due, in part, to the higher levels of On-Line Reserves than was the case during the 2022 ORDC Report study period. However, during the intervals in which the price-adder floors were in effect, approximately 85% of generation output was from dispatchable Resources, as shown in the graphic below. This indicates that the floors are directionally helping to support existing dispatchable generation in the market. With the price-adder floors providing incremental value toward their intended objectives, and with the replacement of the ORDC with ASDCs planned for December 2025, ERCOT is not recommending any changes to, or the elimination of, the floors at this time.

[5] *See Wholesale Electric Market Design Implementation*, Project No. 53298, Commission Staff Memorandum (Aug. 3, 2023) (Commission Staff's Memo memorialized the Commission's price floor discussion and decision at the August 3, 2023 Open Meeting).




Contribution of energy output by fuel type when ORDC price floor was in effect

In terms of the ORDC's **efficacy**, the operation of the ORDC in this reporting period was consistent with current design expectations. As noted, ORDC design was relatively stable during this period and other non-ORDC factors and dynamics were the primary drivers of price impacts and market participant behavior. The ORDC continues to be an important **contributor to grid reliability** by incentivizing additional reserves when they are most needed, but it is not the only tool to support these goals. In consultation with the PUCT, ERCOT is working with stakeholders on the identification and development of additional mechanisms to help address future reliability needs, including the Dispatchable Reliability Reserve Service (DRRS) and an evaluation of the Performance Credit Mechanism (PCM). These mechanisms can play a complementary role with the ORDC, or with the ASDCs after RTC+B is implemented, to help support reliable grid operations, efficient market outcomes, and resource adequacy.

Other observations:

- Compared to the 2022 ORDC Report, prices were higher at levels of higher Physical Responsive Capability (PRC) due to the factors noted above. The proportion of intervals with low PRC (i.e., less than 5,500 MW) was lower compared to the 2022 ORDC Report.
- The time-weighted average RTORPA decreased in this reporting period. The following table illustrates the time-weighted RTORPA as well as a percentage of the all-in price.

| Year | Time-Weighted RTORPA | % of All-in Price |
|---|---|---|
| 2022 | $5.18/MWh | 7.97% |
| 2023 | $0.92/MWh | 1.81% |
| 2024 (Jan- Sep) | $0.23/MWh | 1.81% |

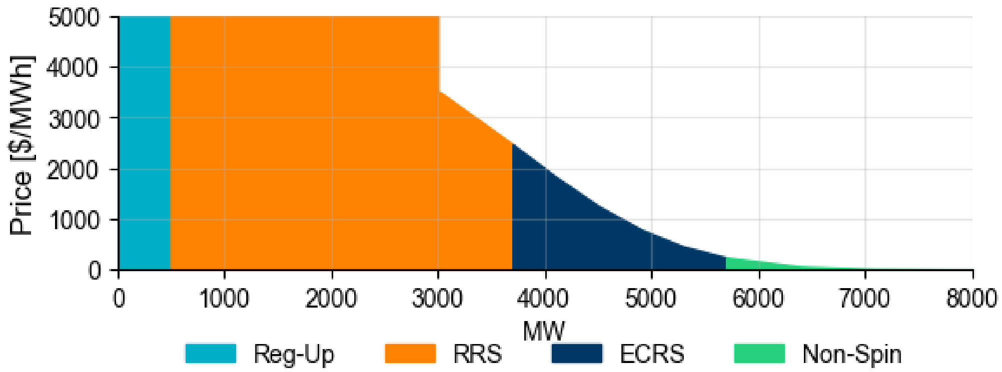
- In terms of **ORDC-related costs**, the RTORPA contributions to Peaker Net Margin (PNM) accumulations in 2023 and 2024, through September 2024, were lower compared to 2022. The table below compares RTPORA contributions to PNM since 2022. In general, the RTORPA played a more modest role in contributing to system-wide prices compared to the other factors noted previously.

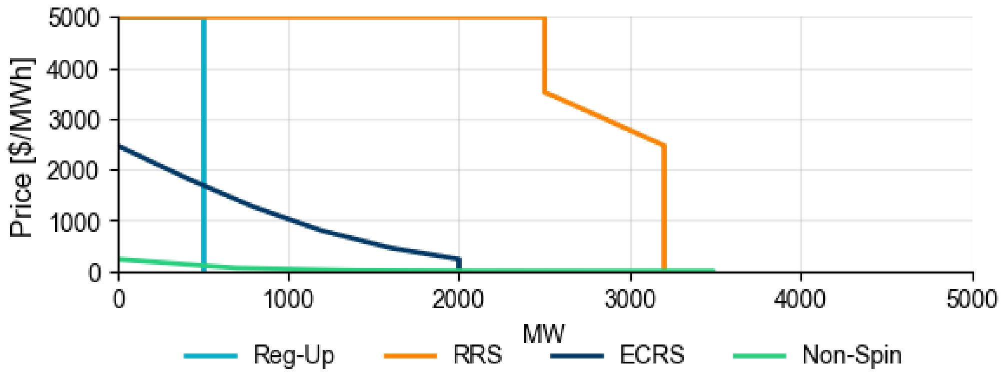
| Year | RTORPA Contributions to Peaker Net Margin |
|---|---|
| 2022 | 27.24% |
| 2023 | 3.02% |
| 2024 (Jan- Sep) | 1.99% |

Implementation of RTC+B Program:

- With the implementation of the RTC+B Program expected in December 2025, the value of reserves will be determined by a set of ASDCs whose shape and magnitude will be designed to replicate, as closely as possible, historical pricing outcomes of the ORDC, particularly during times of reserve scarcity or near-scarcity.[6]
- In consultation with the Real-Time Co-optimization Task Force (RTCTF), ASDCs were defined as slices of reserves under the ORDC curve, with the highest-valued Ancillary Services being Regulation-Up Service (Reg-Up), followed by Responsive Reserve Service (RRS), followed by ERCOT Contingency Reserve Service (ECRS), and lastly Non-Spinning Reserve Service (Non-Spin).
- The graphic below illustrates the hierarchy of the individual ASDCs. The graphic also illustrates how scarcity pricing, and the value of reserves are set by individual ASDCs as the quantity of reserves diminishes.

[6] Further detailed information and the methodology to determine ASDCs is included in the presentation to the RTC+B Task Force on February 21, 2024, available on ERCOT's website at: https://www.ercot.com/files/docs/2024/02/13/ASDC%20Overview%20-%20RTCBTF%20-%2002212024.pptx.


Price [$/MWh]
5000
4000
3000
2000
1000
0
0
1000
2000
3000
4000
5000
6000
7000
8000
MW
Reg-Up
RRS
ECRS
Non-Spin


Price [$/MWh]
5000
4000
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RRS
ECRS
Non-Spin

# 1. Background and Key Events

## 1.1. Operating Reserve Demand Curve (ORDC) Theory

The ORDC is a market-based construct for valuing operating reserves according to their scarcity. As initially described by Dr. William Hogan in Public Utility Commission of Texas (PUCT) Project No. 40000, the ORDC is based on the following principles:

> "The key connection [for the ORDC] is with the value of lost load (VOLL) and the probability that the load will be curtailed. Whenever there is involuntary load curtailment and the system has just the minimum of contingency operating reserves, then prices should rise to the VOLL. At any other level of operating reserves, set to protect the system for possible events in the immediate future, the value of an increment of operating reserves should reflect the probability of loss of load."[7]

Due to net load forecast error and other factors, there is uncertainty in the level of operating reserves that will be available in the near-term operational timeframe of the next 30 minutes to one hour. Therefore, there is a probability, referred to as the Loss of Load Probability (LOLP), that operating reserves will fall to the level that would require involuntary load curtailment within that timeframe. Thus, when there is involuntary load curtailment, the ORDC should theoretically rise to VOLL. At operating reserve levels not requiring firm load shed, the ORDC should theoretically reflect the LOLP multiplied by VOLL such that as operating reserves increase, the LOLP decreases and the ORDC eventually declines to zero.

## 1.2. Initial ERCOT Implementation

The ERCOT ORDC is fully defined in the Other Binding Document (OBD) titled "Methodology for Implementing ORDC to Calculate Real-Time Reserve Price Adder."[8] This section provides a brief summary of the complete description found in that OBD.

ERCOT's initial ORDC implementation introduced separate price adders for On-Line and Off-Line reserve categories to the five-minute Real-Time Market (RTM) in summer 2014. The Real-Time On-Line Reserve Price Adder (RTORPA) is associated with Real-Time On-Line Capacity (RTOLCAP), which encompasses all reserves that can be made available to the system within 30 minutes. The Real-Time Off-Line Reserve Price Adder (RTOFFPA) is associated with Real-Time Off-Line Capacity (RTOFFCAP), which refers to reserves that require between 30 minutes and one hour to be made available. Both adders are calculated in terms of VOLL and the probability of reserves falling below the minimum contingency level (PBMCL), where VOLL is equal to the System-Wide Offer Cap (SWCAP), and PBMCL is derived from LOLP and the Minimum Contingency Level (MCL).

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[7] *Commission Proceeding to Ensure Resource Adequacy in Texas,* Project No. 40000, Second Supplemental Comments of GDF Suez Energy Resources NA, Inc. at bates 6 (Jan. 22, 2013) (see attachment *Improved Electricity Scarcity Pricing and Operating Reserves*, William W. Hogan, Ph.D.).

[8] Available on ERCOT's website at: https://www.ercot.com/mktrules/obd/obdlist.

PBMCL is a shifted version of ERCOT's empirically-determined LOLP normal distribution. LOLP, which represents the probability of a Real-Time reserve shortfall, is determined by comparing the Hour-Ahead forecasted level of reserves to the level of reserves realized in Real-Time. The gap between these values, termed the reserve error, is assumed to follow a normal distribution characterized by a mean (Mu or μ) and a standard deviation (Sigma or σ). Once per season, ERCOT determines the LOLP distribution by compiling empirical reserve error data going back to the start of the Nodal Market[9] and fitting this data to a normal distribution. The LOLP curve is then shifted by the MCL to obtain PBMCL. Note that while the MCL described above in Section 1.1 matches the reserve level at which ERCOT will begin instructing firm load shed, ERCOT's MCL was initially set to 2,000 MW to address concerns related to long-term resource adequacy and to ensure that prices were sufficiently strong when the ERCOT system went into declared emergency conditions but not yet requesting firm load shed. As discussed in the 2022 ORDC Report, this value was increased to 3,000 MW.[10] See Figure below for an illustration of RTORPA in terms of LOLP, MCL, PBMCL, and VOLL.

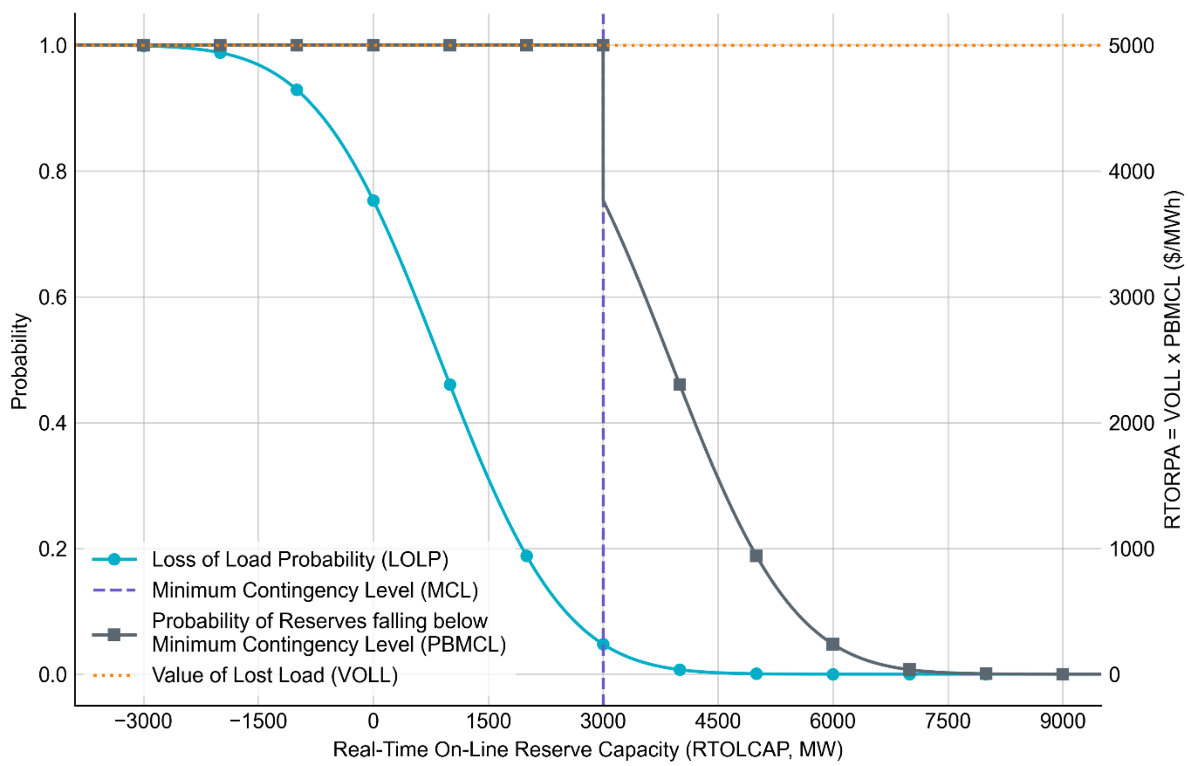


*Figure 1: RTORPA, LOLP, and PBMCL. Reserve error distribution Mu and Sigma are set to their most recent values, and RTOFFCAP is assumed to be 0 MW for illustration purposes. Note that multiplying the PBMCL curve by VOLL (currently equal to SWCAP at $5,000/MWh) yields the ORDC. RTORPA values may therefore be read from the right axis, assuming that System Lambda is zero.*

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[9] The Nodal Market began on December 1, 2010.

[10] Changes to the HCAP and MCL were put into effect on January 1, 2022.

The value of a particular Resource's reserve contribution depends on how quickly it can be made available to the system. The Mu and Sigma parameters of PBMCL are adjusted between RTORPA and RTOFFPA to reflect this. Figure illustrates the difference between the two adders as a function of reserve uncertainty over the next operating hour. Total reserve uncertainty is assumed to be split evenly between two 30-minute intervals. During the second interval, both reserve categories (RTOLCAP and RTOFFCAP) are available. RTOFFPA is therefore calculated using the full Mu and Sigma and is paid to reserves that fall into the RTOFFCAP category. During the first 30-minute interval of the next operating hour, however, only RTOLCAP is available. RTORPA therefore has an extra term, in addition to the RTOFFPA term, to compensate faster-acting reserves for their additional value. The extra term is calculated using a shortened PBMCL curve that captures reserve uncertainty over the first half of the upcoming operating hour, with Mu scaled by one-half and Sigma scaled by 0.707.

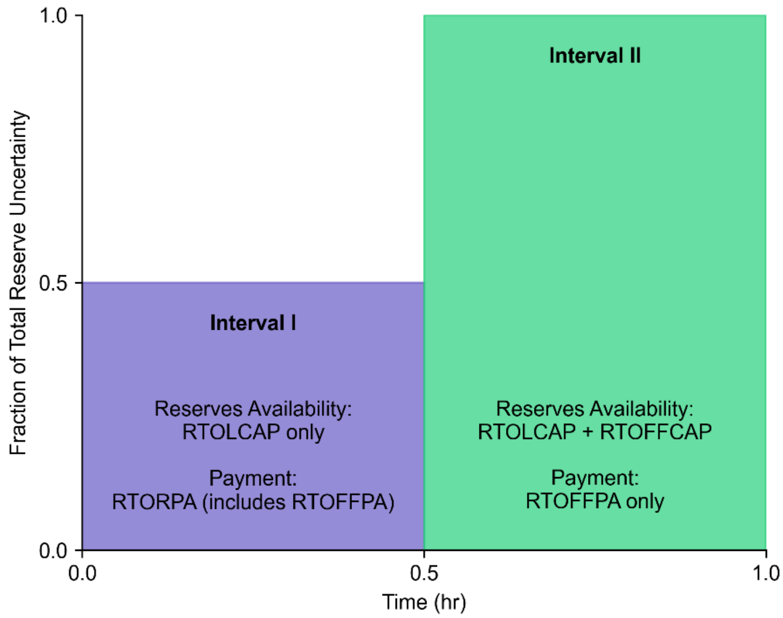


*Figure 2: ERCOT ORDC perspective on reserve uncertainty over the next operating hour. During Interval I (the first 30 minutes), only RTOLCAP is available, making it more valuable than RTOFFCAP.*

There are two additional relevant details. First, Protocols limit the sum of System Lambda and all price adders to SWCAP. Thus, RTORPA can only reach SWCAP if System Lambda is zero. Second, there is one additional price adder called the Real-Time On-Line Reliability Deployment Price Adder (RTORDPA). This adder, which is unrelated to the ORDC and calculated after System Lambda and RTORPA are determined, accounts for the price impacts of Protocol-defined out-of-market actions, such as Reliability Unit Commitment (RUC) and Emergency Response Service (ERS) deployments.

### 1.3. Subsequent ERCOT ORDC Adjustments

There have been significant administrative changes to ERCOT ORDC parameters since the initial implementation of ORDC in June 2014, as illustrated below. In March 2019, the Mu, the mean value of the LOLP distribution, was administratively shifted upward by 0.25 times Sigma, then by an additional 0.25 times Sigma in March 2020. VOLL (which is set equal to SWCAP) changed twice, from the High System-Wide Offer Cap (HCAP) of $9,000/MWh down to the $2,000/MWh Low System-Wide

Offer Cap (LCAP) following Winter Storm Uri, then back up to the new HCAP of $5,000/MWh on January 1, 2022. Finally, the MCL was increased from 2,000 MW to 3,000 MW on January 1, 2022.

The current study period included one change to the ORDC with the introduction on November 1, 2023, of a multi-step price-adder floor to be used in the calculation of RTORPA when the RTOLCAP falls below certain On-Line reserve thresholds.

- A price floor of $20/MWh is now applied to the RTORPA when the calculated RTOLCAP is at or less than 6,500 MW.
- A price floor of $10/MWh is applied to the calculation of the RTORPA when the calculated RTOLCAP is at or less than 7,000 MW but greater than 6,500 MW.

Another notable change during the current study period was ERCOT's introduction of the ERCOT Contingency Reserve Service (ECRS) on June 10, 2023, as a new Ancillary Service to help restore and maintain the frequency of the ERCOT System and to help manage net-load ramping.

To help isolate the effects of these changes, the analysis presented in this report compares three subperiods (which are shaded in Figure ) selected to highlight three administratively distinct chapters of ORDC history, along with the previous study subperiods from the 2022 ORDC Report.

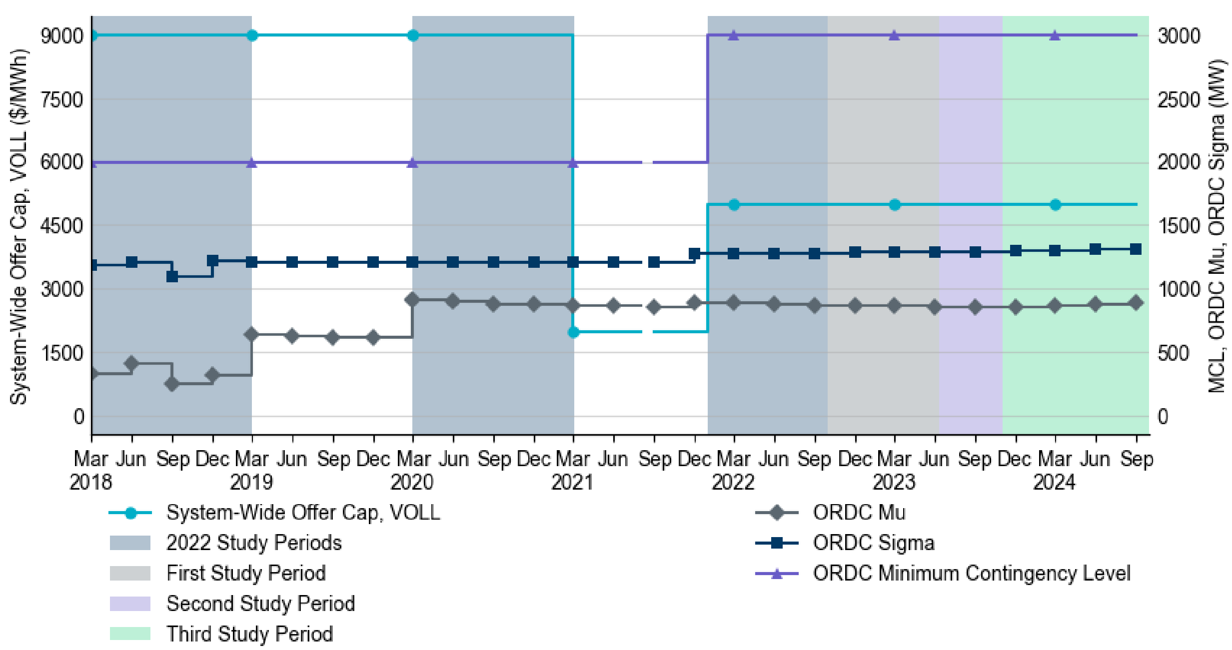


*Figure 3: Timeline of relevant ORDC parameters. The SWCAP price is plotted against the left vertical axis, while the MW values (minimum contingency level, ORDC Mu, and ORDC Sigma) are plotted against the right axis. The current three study subperiods considered in this report are shaded in different colors and the three study subperiods from the 2022 ORDC Report are all shaded in the same color. (Note that prior to 2019, ORDC Mu and Sigma were calculated by first partitioning reserve error data into six blocks according to time of day; there are therefore six Mu and Sigma values for each 2018 season. The 2018 Mu and Sigma values shown in this figure are averages taken across the six time-of-day values for each 2018 season.)*

The first study subperiod extends from the beginning of October 2022 through June 9, 2023. This period captures the ORDC prior to the introduction of ECRS and ORDC price-adder floors respectively.

The second study subperiod covers June 10, 2023, to the end of October 2023 and captures the period after the introduction of ECRS as well as the impact of higher demand and summer temperatures.

The third study subperiod covers the beginning of November 2023 to the end of September 2024, which is the period under which the ORDC price-adder floors have been in place.

To summarize: the three study subperiods described in this section and shown in Figure  were selected to facilitate comparison between three administratively distinct chapters in ORDC history as well as significant market design changes. Some of the results from the 2022 ORDC Report study period have been included as well to provide additional context to compare ORDC impacts in previous years.

# 2. ORDC Impact on Reserves

## 2.1. RTORPA Impact on RTOLCAP

To assess ORDC impacts on Real-Time system-wide prices and reserves, we can subtract the RTORDPA from the widely used system-wide price signal "System Lambda plus Price Adders" to obtain "System Lambda plus RTORPA." Figure  illustrates the relationship between this ORDC-influenced system-wide price and RTOLCAP, with one subplot per study subperiod. In each subplot, System Lambda plus RTORPA is plotted against RTOLCAP. The shaded area represents all possible values RTORPA could assume independently: the upper bound represents the case where RTOFFCAP is zero (and the RTOFFPA component of RTORPA is therefore at its maximum value), while the lower curve is created by setting RTOFFCAP arbitrarily large resulting in an RTOFFPA component of $0/MWh. Note that RTORPA prevents the sum of System Lambda and RTORPA from falling below the lower bound of each shaded region. Moving from left to right, the graphs show that this lower bound has increased in the second and third study subperiods. Beginning in the second study subperiod, System Lambda plus RTORPA was higher at higher reserve levels.  This can be attributed both to an increase in Ancillary Service requirements and, particularly in 2023, the frequency of higher demand from extreme heat days during this period leading to tighter conditions and the dispatch of higher-cost Resources. The charts illustrate a continued relationship between the price signal and the level of On-Line Reserves.

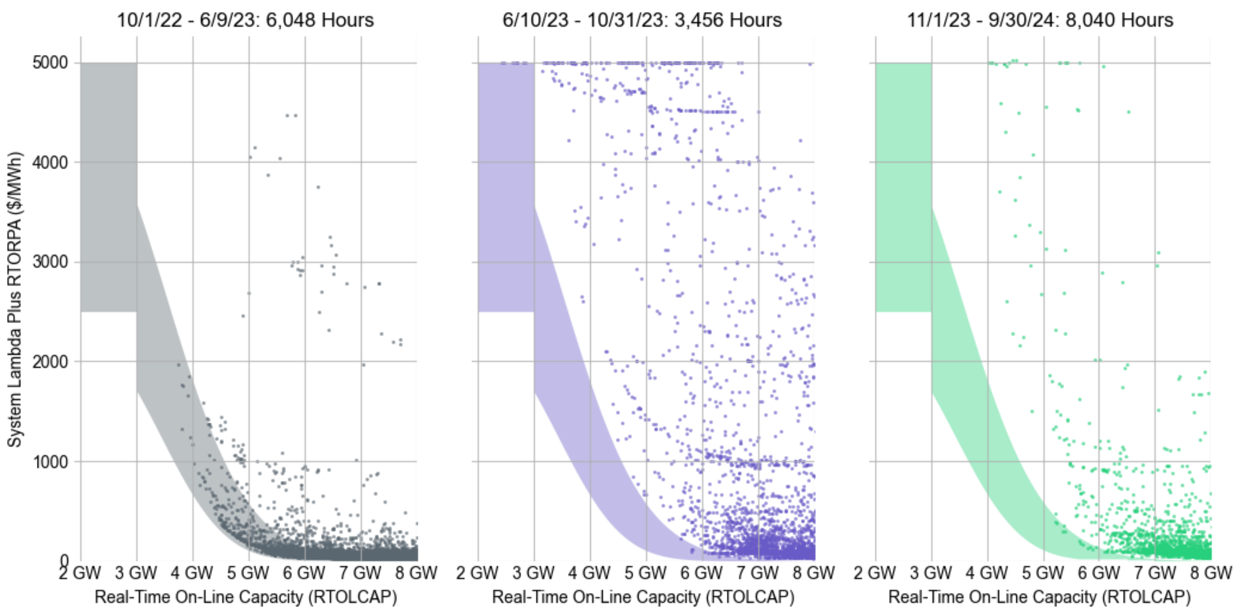


*Figure 4a: System Lambda plus Price Adders versus RTOLCAP during the **current** three study subperiods (from left to right). The shaded area represents all possible RTORPA values: its lower bound reflects the scenario where RTOFFCAP is arbitrarily large, while its upper bound represents RTOFFCAP = 0 MW.*

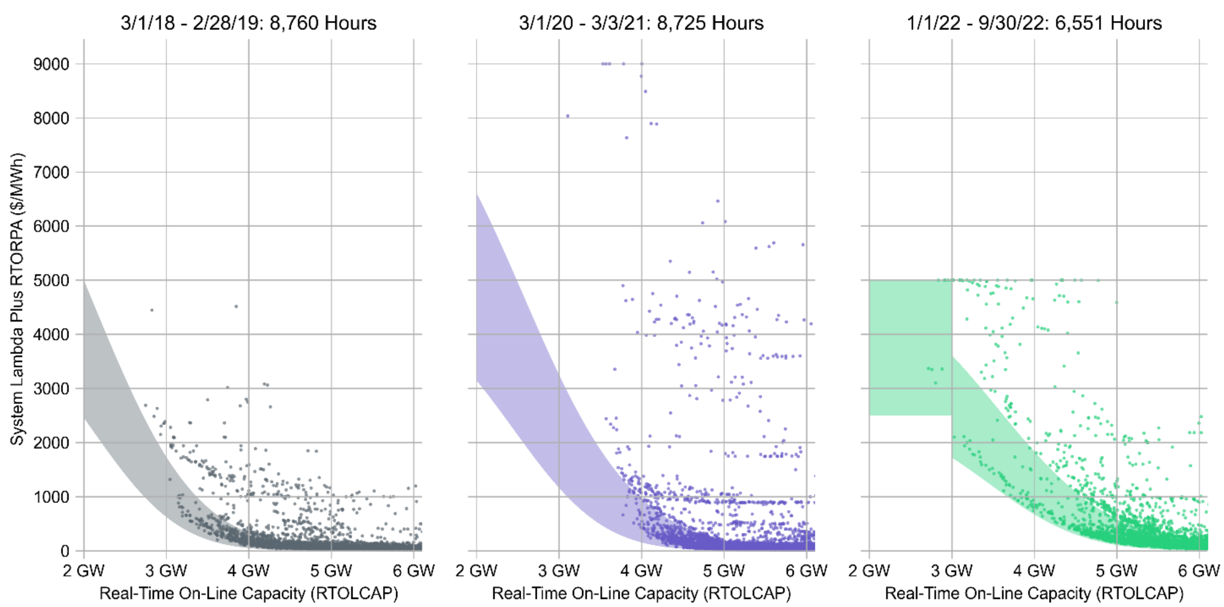


*Figure 4b: System Lambda plus Price Adders versus RTOLCAP during three study subperiods from the 2022 ORDC Report (from left to right). The shaded area represents all possible RTORPA values: its lower bound reflects the scenario where RTOFFCAP is arbitrarily large, while its upper bound represents RTOFFCAP = 0 MW.*

### 2.2. RTORPA Impact on Spinning and Non-Spinning Reserves

While RTORPA is only paid to On-Line reserves (i.e., the RTOLCAP category), it is useful to consider its impact on total On-Line and Off-Line reserves. Total reserves may be expressed as RTOLCAP plus RTOFFCAP; this sum is designated as $R_{SNS}$ within the ORDC methodology. Figure 5a and Figure 5b illustrate the sensitivity of both On-Line ($R_S$) and Off-Line reserves ($R_{SNS}$ - $R_S$) to RTORPA in the $0.01/MWh to $31.50/MWh range for each of the three study subperiods. For each study subperiod, SCED intervals were divided into RTORPA bins $2/MWh in width, and the respective average values were calculated for each bin. The introduction of ECRS led to an increase in On-Line reserve requirements. Figures 5a and 5b help illustrate the impact that this change had on RTORPA prices observed at levels of On-Line and Off-Line reserves. Figure a illustrates the rightward shift or increase in On-Line reserve levels at the same RTORPA prices. Figure b illustrates a leftward shift or decrease in the quantity of Off-Line reserve levels at the same RTORPA prices. To understand this phenomenon, it is important to remember that the quantity of Off-Line Reserves is a component of the calculation of RTORPA.[11] In other words, the increase in On-Line Reserves along with the decrease in Off-Line Reserves helps to explain the RTORPA being observed at higher reserve levels. The impact of the ORDC price-adder floors in the third study subperiod is illustrated by noticeable variances at the floor values of $10 and $20, respectively.

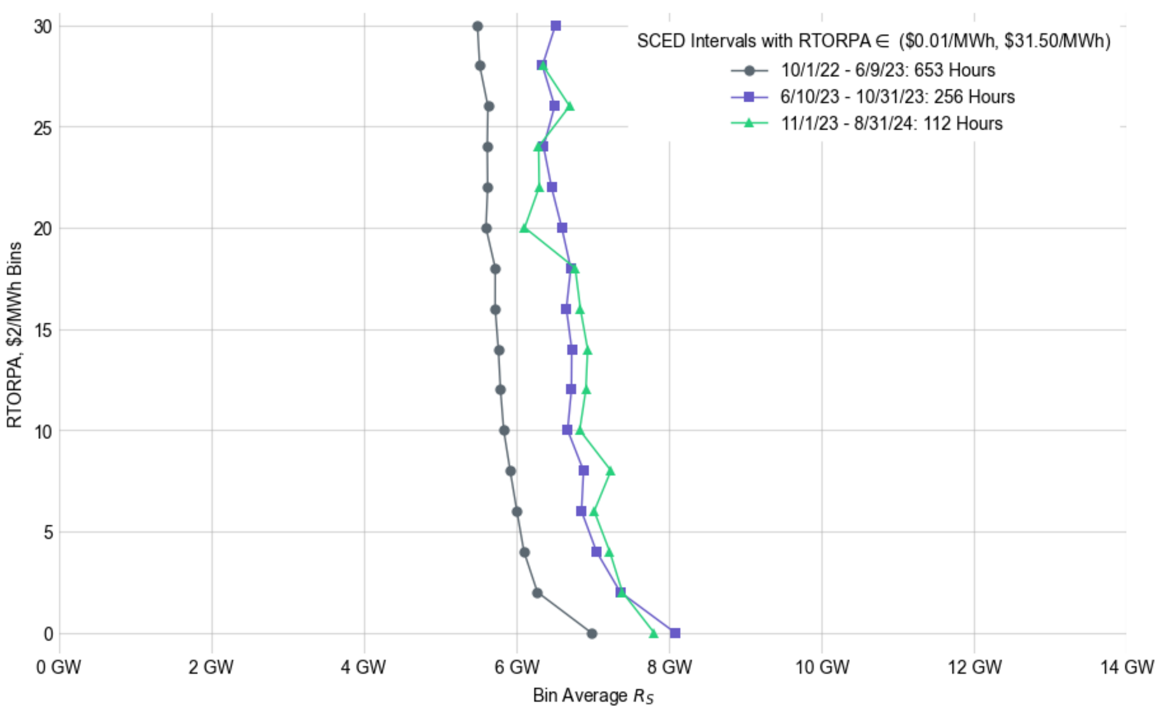


*Figure 5a: RTORPA in $2/MWh bins versus bin average Spinning ($R_S$) during the **current** three study subperiods*

[11] Note that the Real-Time Off-Line Reserve Price Adder (RTOFFPA) is a component in the final determination of the RTORPA as the Real-Time On-Line Reserve Capacity (RTOLCAP) contributes to preventing load shedding in both halves of the hour.

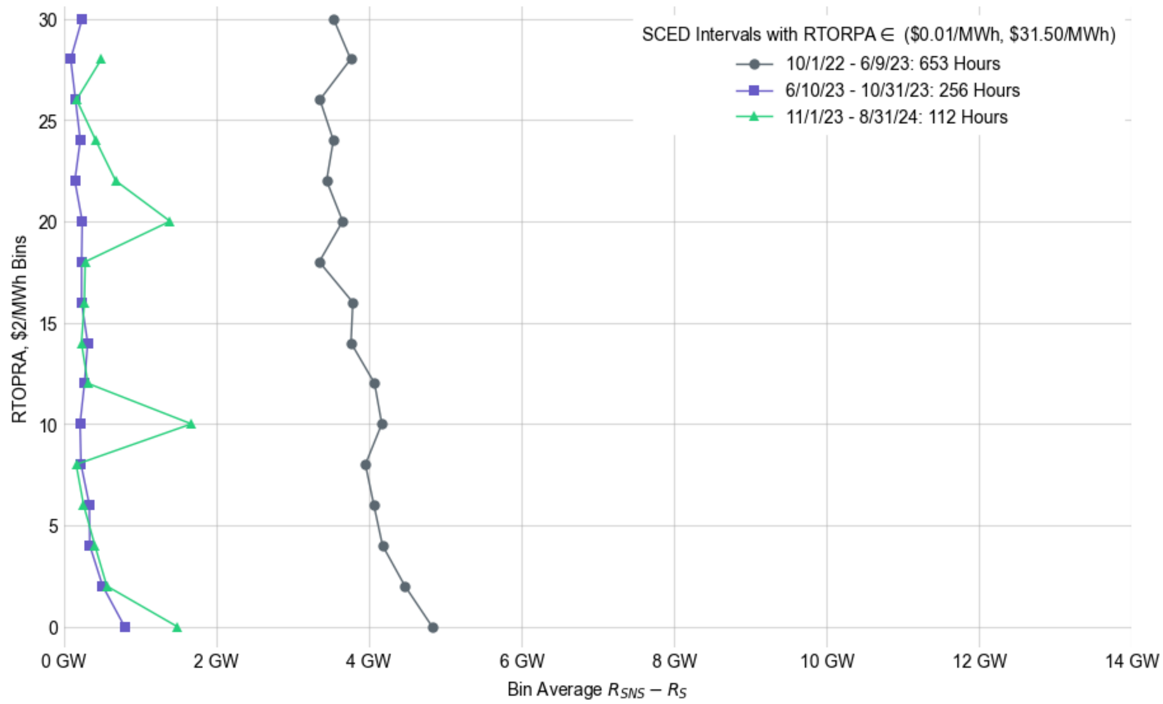


*Figure 5b: RTORPA in $2/MWh bins versus bin average Non-Spinning Reserves ($R_{SNS}$ -$R_S$) during the* ***current*** *three study subperiods*

## 2.3. RTORPA Impact on Self-Commitment Incentives

The ORDC and future price expectations for the Operating Day play an important role in spurring the self-commitment of marginal Resources, incentivizing them to enter the reserve pool and contribute to On-Line Reserves. Ideally, this can help avoid out-of-market actions such as RUCs. To determine whether it is economic to commit a particular Resource on a given day, a Qualified Scheduling Entity (QSE) must compare the Resource's start-up costs to its expected revenue over the course of its minimum run time. ERCOT has estimated that a $10/MWh RTORPA value is sufficient to cover the start-up costs of a marginal combustion turbine with a four-hour minimum run time. Figure 6 illustrates the fraction of days during each study subperiod where the four-hour rolling time-weighted average RTORPA exceeded $10/MWh. These are days where a Resource with a four-hour minimum run time could have received at least $10/MWh on average from RTORPA payments alone by self-committing at an appropriate time.[12] This year the fraction of days meeting the $10/MWh over 4-hour price-duration criterion is under 2%, less than the previous two study subperiods as illustrated in Figure . This is also illustrative of the impact to the RTORPA with the increase in On-Line Reserves, additional capacity

[12] It is worth noting that a QSE cannot know what RTORPA prices will materialize over the next four hours in advance; in other words, only with perfect knowledge of the future could a QSE self-commit a Resource on every day for which it is economical to do so. Also, even if RTORPA payments are expected to cover a Resource's start-up costs, a QSE would only commit that Resource if anticipated LMPs are sufficiently high compared to its Energy Offer Curve (EOC).

from solar Resources and Energy Storage Resources (ESRs) and milder conditions compared with 2023.[13]

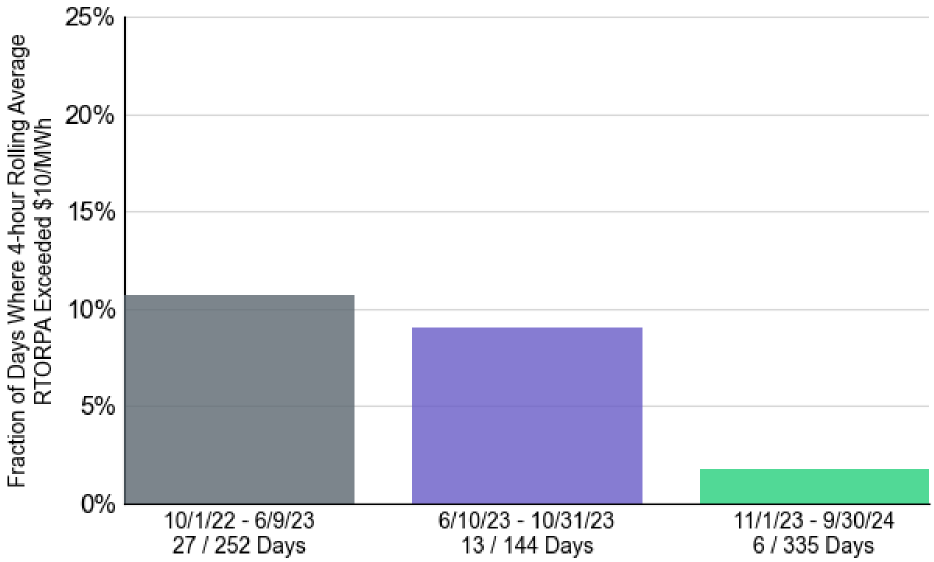


*Figure 6: Fraction of days where 4-hour rolling time-weighted average ORDC adder exceeded $10/MW during the **current** three study subperiods*

However, other market factors, particularly the increase in demand and tight conditions in summer 2023, led to higher hub average prices. This gave rise to higher price expectations which in turn provided many more opportunities for marginal combustion turbines to economically self-commit and enter the On-Line reserve pool. Figure  illustrates the downward trend in RUC during this study.

[13] From January, 2024 to September, 2024 total operational capacity increased by 4.5 GW and 3.9 GW for solar Generation Resources and ESRs respectively.

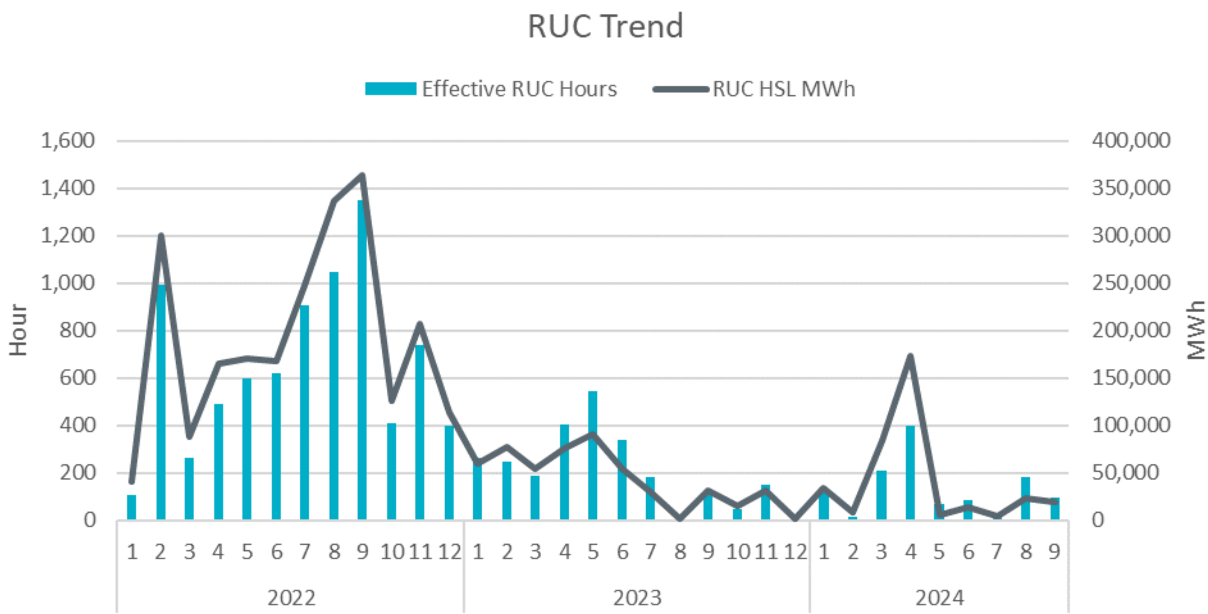


*Figure 7: Effective RUC Hours and RUC HSL MWh trend from 2022 to September 2024*

## 2.4. ORDC Impact on Physical Responsive Capability (PRC)

While ORDC price adders are paid to reserves according to the RTOLCAP and RTOFFCAP categories, Real-Time operations such as Ancillary Service deployments and Energy Emergency Alert (EEA) events are driven by a measure of operational reserves called Physical Responsive Capability (PRC). PRC is closely related to RTOLCAP, but the two reserve measures differ in a few ways. PRC excludes Non-Frequency Responsive Capacity (NFRC) as well as Off-Line Quick-Start Resources that may be able to respond quickly to grid conditions but are not synchronously connected. Generally, PRC also limits calculated reserve headroom to 20% of each Resource's High Sustained Limit (HSL). When system conditions tighten and reserves become scarcer, RTOLCAP and PRC tend to converge: NFRC decreases, On-Line Generation Resources are dispatched at levels closer to their HSLs, and Quick-Start Generation Resources (QSGRs) come On-Line. We therefore expect some sensitivity of PRC to RTORPA during low-PRC SCED intervals. Figure 8 plots uncapped RTORPA (calculated directly from the ORDC without applying SWCAP to System Lambda plus Price Adders) against PRC for SCED intervals where PRC was below 5,500 MW.[14] The fraction of SCED intervals with PRC below 5,500 MW varies significantly between the three subperiods: 29.8%, 5.18% and 1.22%, respectively. The average PRC across this PRC range is less varied: 4,901 MW during the first study subperiod and 5,098 MW and 5,251 MW from the second and third. The most significant difference between these three sets of SCED intervals is in average RTORPA: $4.76/MWh in the first study

[14] An increase in the PRC threshold to 5,500 MW was chosen to better illustrate conditions and increase the sample size during this study period versus the 2022 ORDC Report.

subperiod, $175.02/MWh in the second study subperiod, and $43.82/MWh this year.[15] These statistics are summarized in Table 1. Figure 8 illustrates the decrease in 2024 in average RTORPA, along with the significant decrease in instances of SCED intervals with PRC less than 5,500 MW, compared to the previous two subperiods. This is also illustrative of the trend of increasing amounts of On-Line reserves (and a reduction in Off-Line reserves) observed in this study.

[15] The quantity of Off-Line Reserves is also a component of the calculation of the On-Line Reserve Price Adder. Therefore, a reduction in the quantity of Off-Line Reserves helps to explain the phenomenon of observed RTRORPA prices at higher levels of PRC.

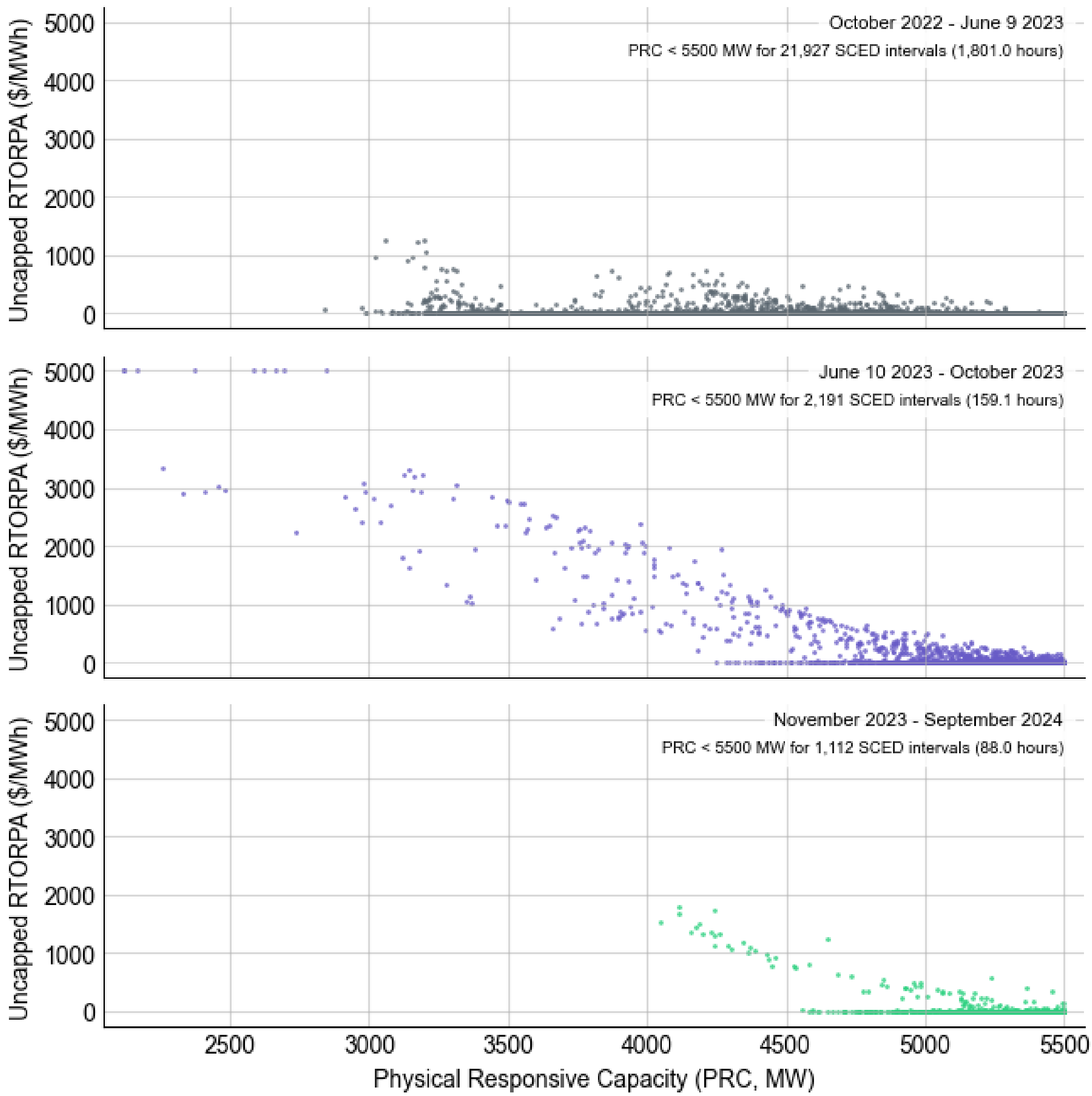


*Figure 8: Uncapped RTORPA (calculated without applying SWCAP to System Lambda plus Price Adders) vs PRC for the second and third study subperiods. Only SCED intervals with PRC below 5,500 MW are shown during the* ***current*** *three study subperiods*

| Study Subperiod | SCED Intervals with Low PRC (PRC < 5,500 MW) | Fraction of Total Intervals with Low PRC | Average PRC Across Low-PRC Intervals | Minimum PRC | Average RTORPA Across Low-PRC Intervals |
|---|---|---|---|---|---|
| **Oct 2022 – June 2023** | **21,927** | **29.89%** | **4,901 MW** | **2,840 MW** | **$4.76/MWh** |
| **June – Oct 2023** | **2,191** | **5.18%** | **5,098 MW** | **2,114 MW** | **$175.02/MWh** |
| **Nov 2023 - Sep 2024** | **1,112** | **1.14%** | **5,253 MW** | **4,049 MW** | **$42.94/MWh** |

*Table 1: Summary statistics for SCED intervals with PRC below 5,500 MW shown for the* ***current*** *three study subperiods*

## 3. ORDC Impact on Prices

Generators and loads in the ERCOT System are settled at Settlement Point Prices (SPPs) every 15 minutes. SPPs are a combination of Locational Marginal Prices (LMPs) for energy, the RTORPA, and the RTORDPA. Figure 9 illustrates the contributions of each of these price components by month going back to October 2022. Real-Time Hub Average prices have been lower in 2024 than in 2023: $27.37/MWh in 2024 compared to $52.48/MWh in 2023. This is due in part to the reduction in natural gas prices which are highly correlated with spot market prices.[16] The time-weighted average RTORPA is also lower in 2024: $0.30/MWh or 0.90% of the all-in price for 2024 through September compared to $1.15/MWh or 1.69% of the all-in price in 2023. Compared to the 2022 ORDC Report study period, higher Hub Average prices and lower natural gas prices provided a stronger incentive to Resource owners to self-commit based on anticipated future pricing outcomes.

[16] The average Fuel Index Price (FIP) was $5.58/MMBtu in 2022, $2.21/MMBtu in 2023, and $1.82/MMBtu in 2024 through September.

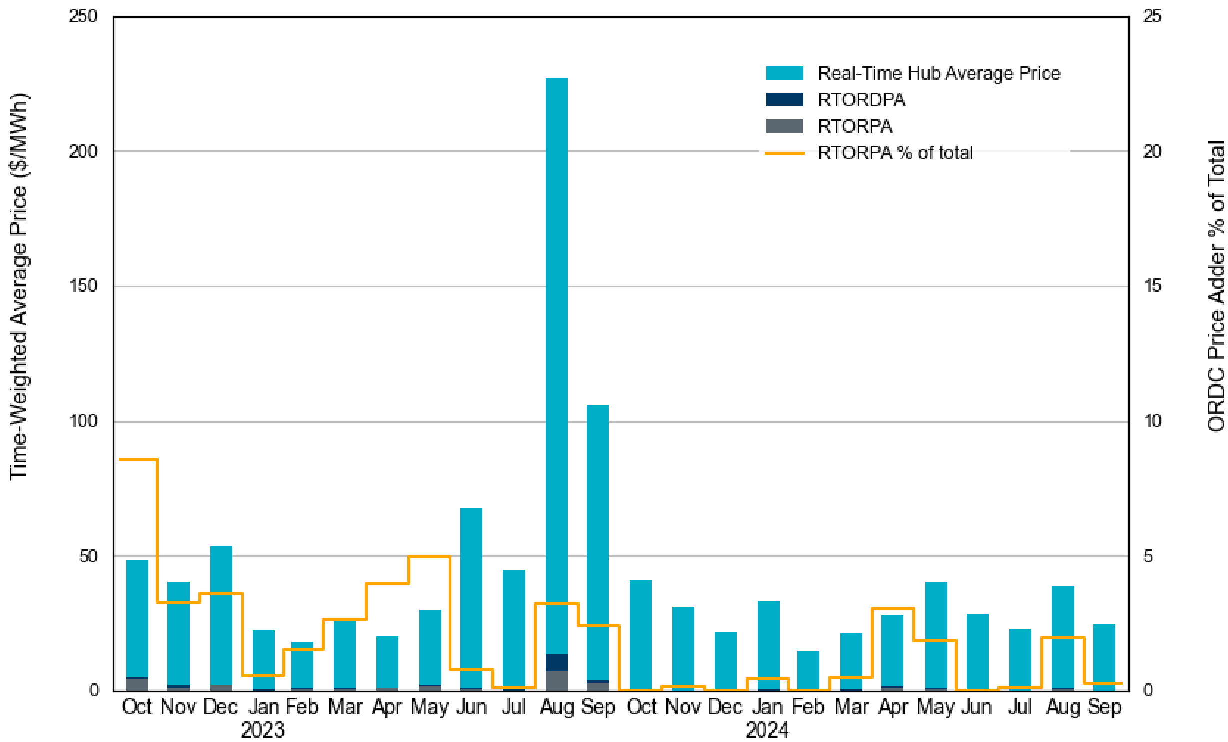


*Figure 9: Relative contributions of ORDC and RDPA to total Real-Time Energy Prices by month*

Figure 10 illustrates the price contributions of LMPs, RTORPA, and RTORDPA specifically during intervals when PRC was less than 5,500 MW. As can be seen in the figure, RTORPA's contribution to total prices was less pronounced overall when PRC was relatively low whereas Hub Average prices sent a much stronger self-commitment incentive during tight conditions. In 2024 through September, when PRC was below 5,500 MW, the time-weighted average RTORPA was $13.6/MWh, or 3.57% of the all-in price. In 2023, these values were $43.85/MWh and 3.84%, respectively.

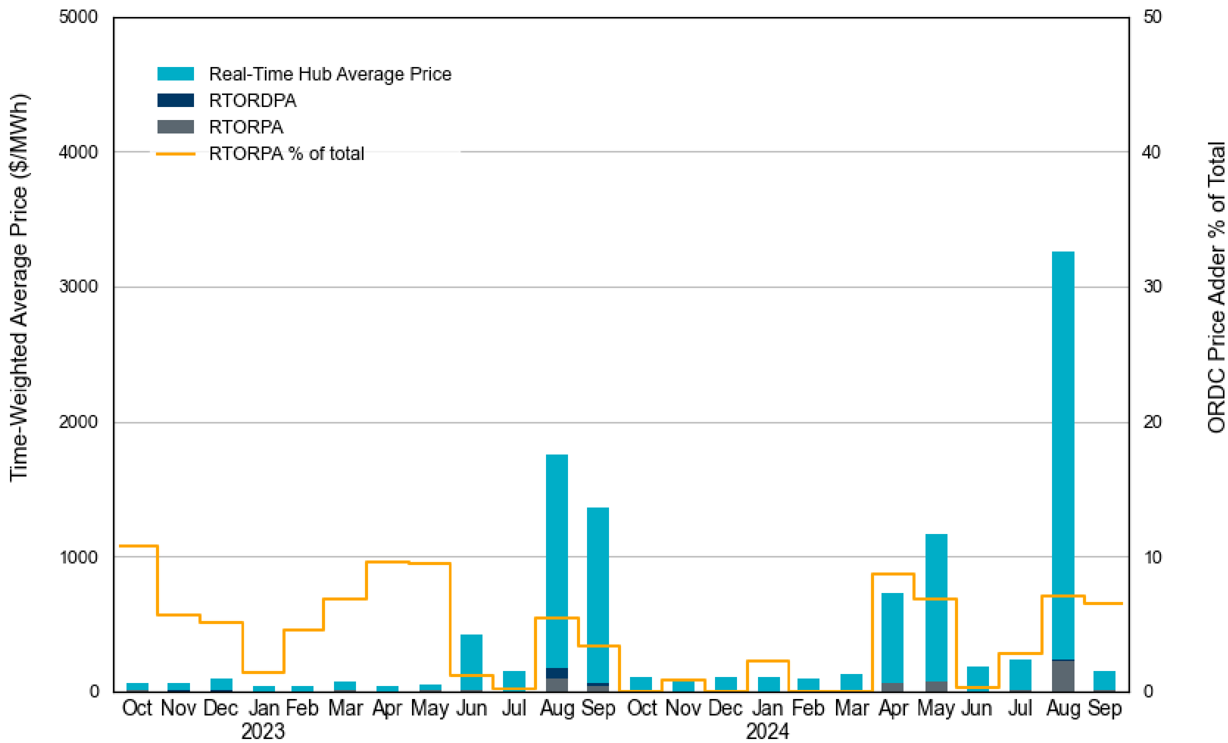


*Figure 10: Relative contributions of ORDC and RDPA to total Real-Time Energy Prices for SCED intervals below 5,500 MW PRC by month*

## 4. ORDC Impact on Peaker Net Margin (PNM)

Peaker Net Margin (PNM) represents the net revenue that a hypothetical peaker Generation Resource could have earned from the Real-Time Market. This value accumulates throughout the year and is reported on the ERCOT website daily. The PNM threshold is administratively established by 16 TAC § 25.509(b)(6)(C). Once the PNM threshold is met, ERCOT will transition the SWCAP from the HCAP to the LCAP for the remainder of the year. PNM is calculated using SPPs and is therefore sensitive to Real-Time LMPs, RTORPA, and RTORDPA. Figure 11 indicates that monthly PNM totals have been lower overall in 2024 than in 2023. The contribution from RTORPA is also lower overall in 2024 compared to contributions from higher Hub Average prices in 2023.

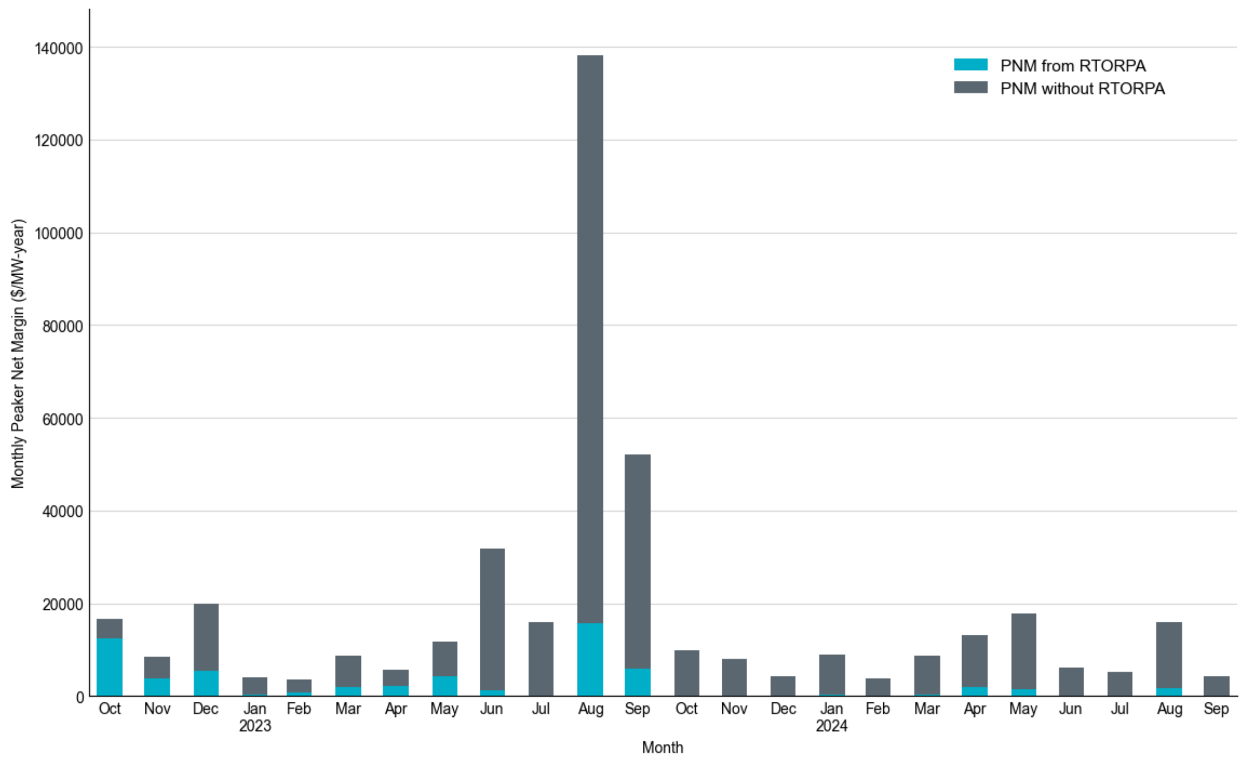


*Figure 11: Peaker Net Margin with and without the ORDC Price Adder by month*

Figure 12 illustrates the accumulation of PNM for 2023. The RTORPA made up 3.02% of the total PNM for 2023.

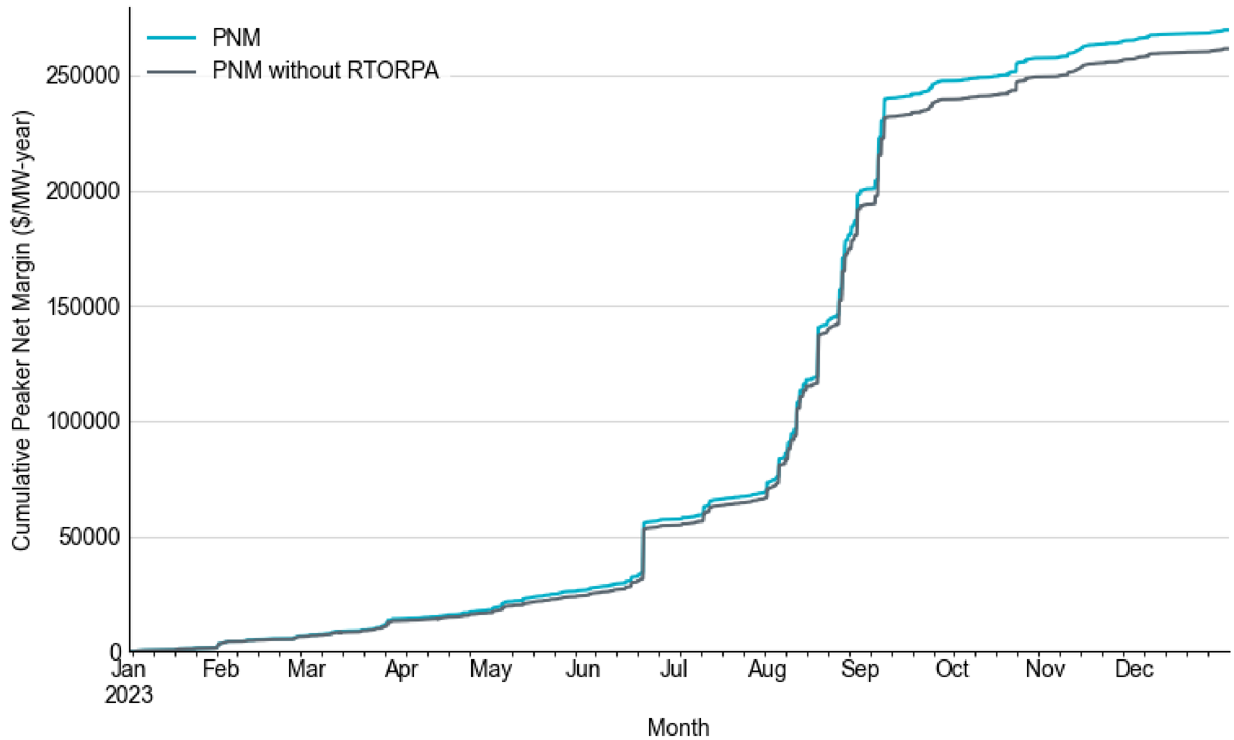


*Figure 12: Cumulative Peaker Net Margin with and without ORDC Price Adders for 2023*

PNM accumulation in 2024, illustrated in Figure 13, has been more modest due in part to more moderate weather and increased generation supply relative to 2023. RTORPA has made up 1.99% of the total PNM accumulated in 2024 through September.

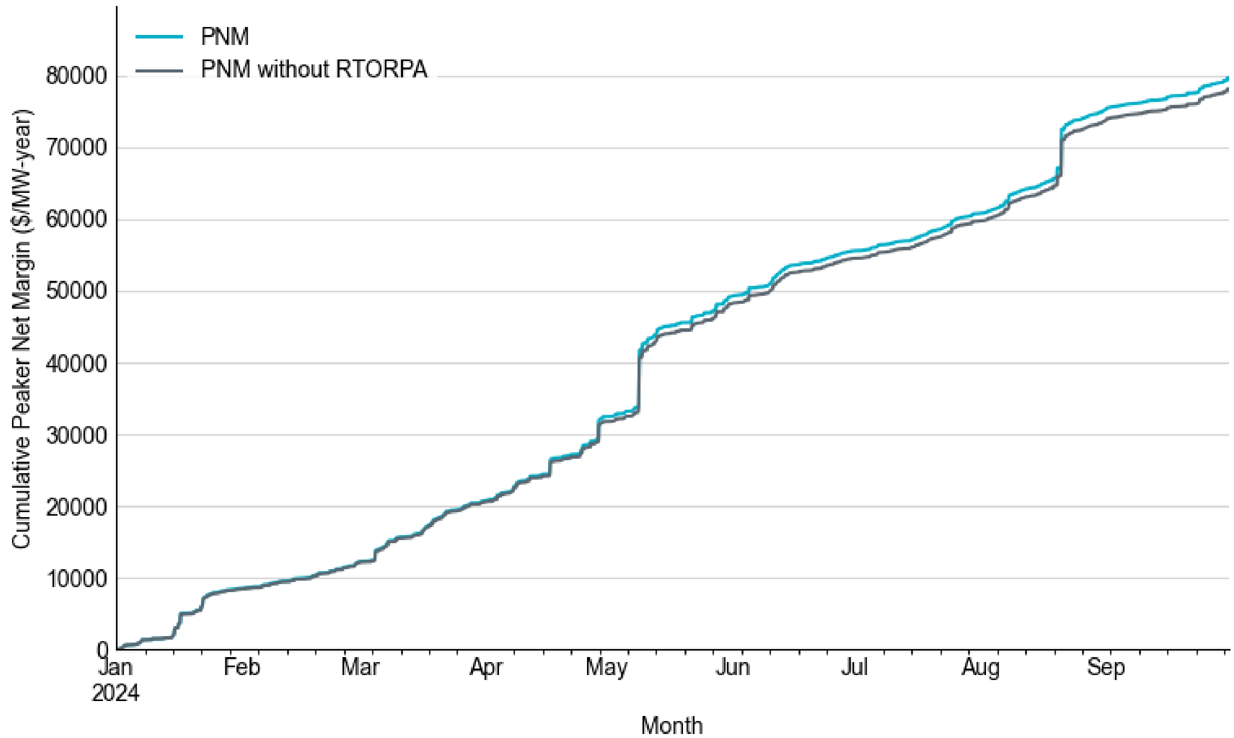


*Figure 13: Cumulative PNM with and without ORDC price adders for 2024*

## 5. Impact of ORDC Price Floor

As indicated previously, ERCOT introduced a multi-step RTORPA floor in November 2023. Figure 14 contains three graphs which illustrate the impact of the ORDC price floors since their implementation. The first two graphs show intervals in which the floors impacted RTORPA by highlighting 177 intervals due to the 7,000 MW floor (orange) and 81 intervals due to the 6,500 MW floor (purple). The third graph shows the ORDC floors' contribution to cumulative revenue. As of October 1, 2024, the ORDC floors have contributed an additional approximately $11.3M of revenue.

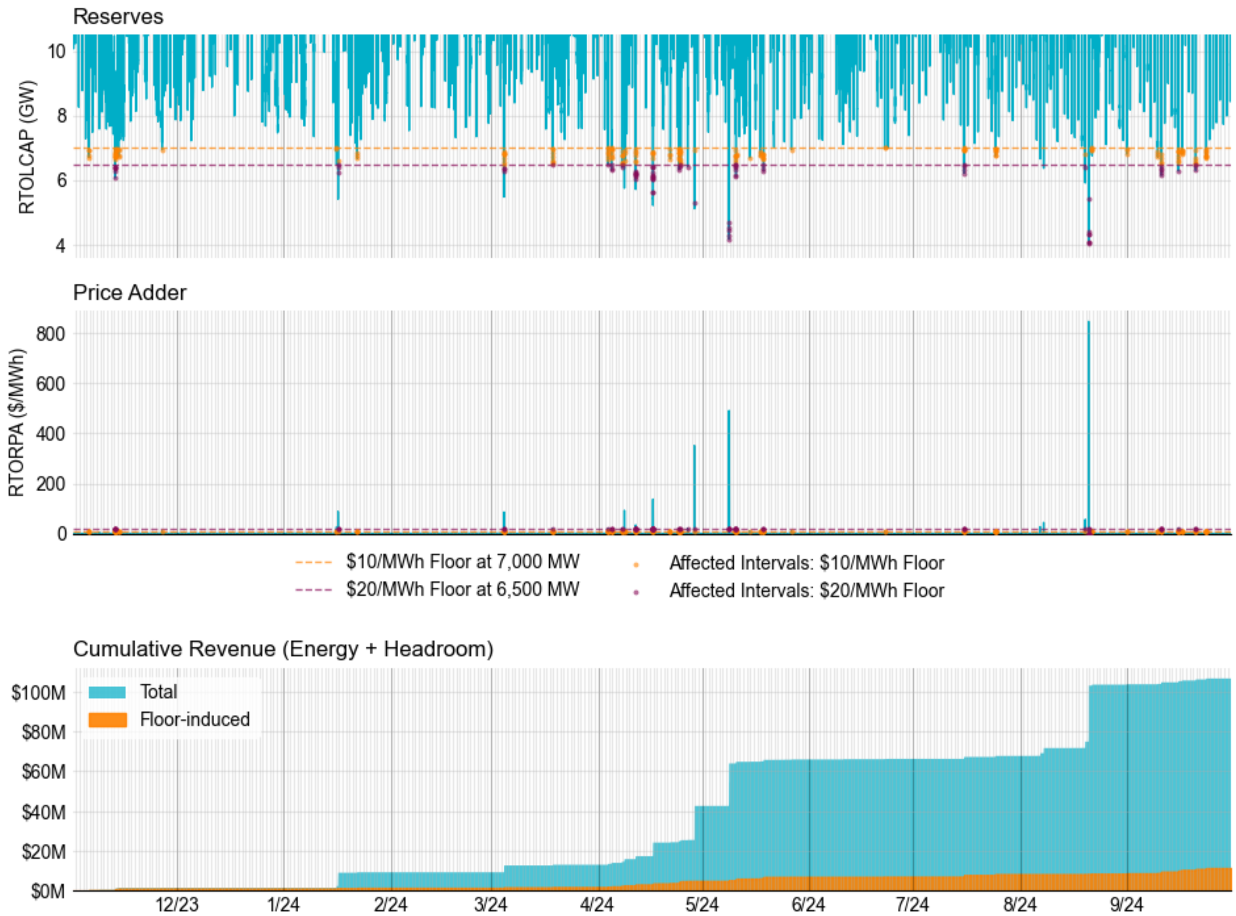


*Figure 14: Floor-affected intervals and floor-induced revenue since the introduction of ORDC price floors*

Figure 15 illustrates the impact of the ORDC price floors on the RTORPA each month. "RTORPA Difference" is the increase in RTORPA due to the ORDC floors.

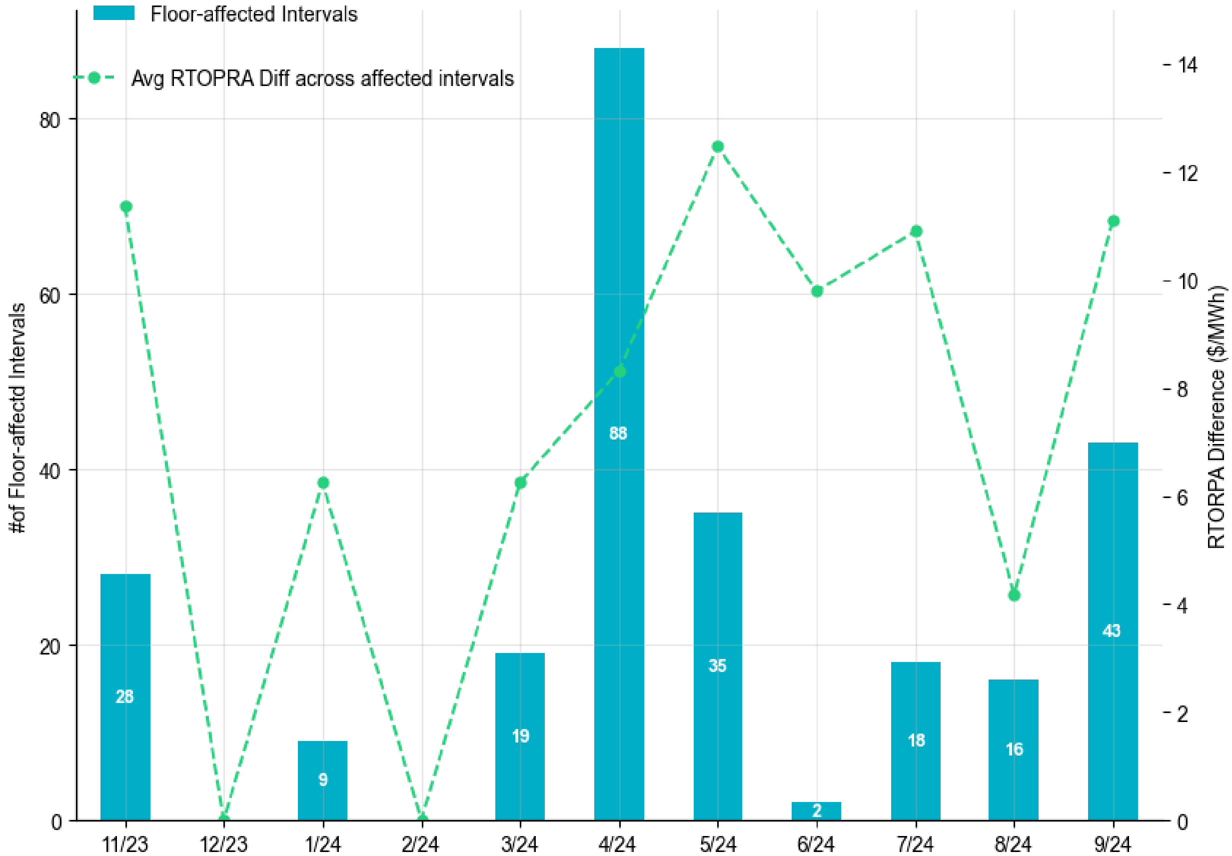


*Figure 15: Number of floor-affected intervals and average RTOPRA difference*

Figure 16 shows the contribution of energy output of generation by fuel type of the Resource when the ORDC price floor was in effect. Approximately 85% of the Resource mix came from dispatchable generation when the multi-step price floor was in effect.

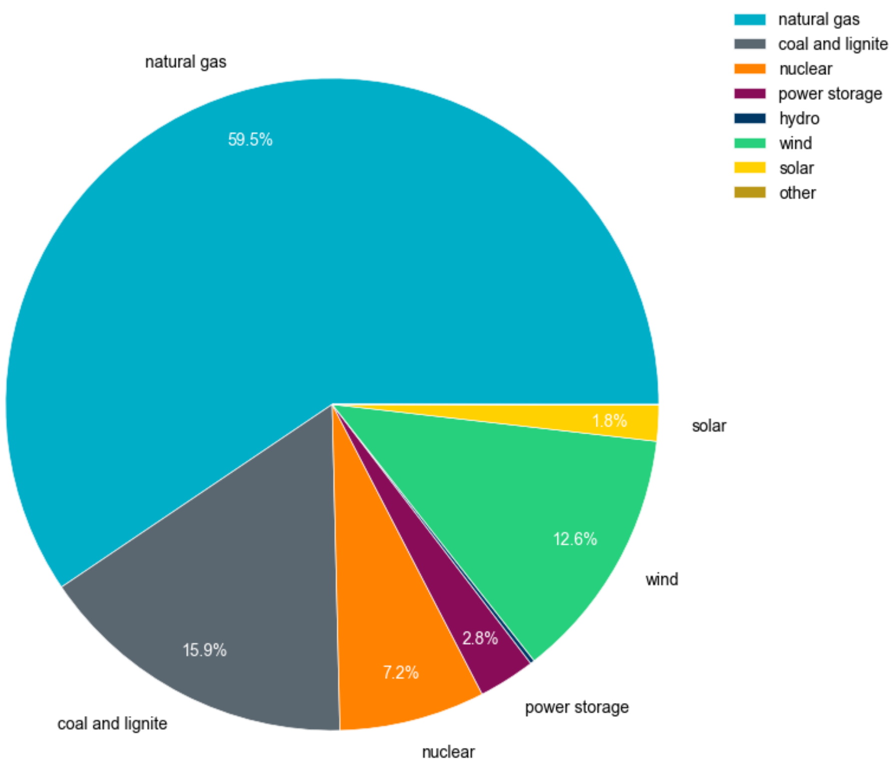


*Figure 16: Contribution of energy output by fuel type when ORDC price adder-floor was in effect*

The incidence and impact of the RTORPA floors have been less than the amounts that were produced in ERCOT's back-cast analysis of the price floors as a bridging solution.[17] The change in the composition of reserves led to On-Line Reserve Price Adders occurring at higher levels of reserve and consequently led to fewer instances where reserves were at or below the levels at which the floors would be applied. As explained above, other market factors had a larger impact on the amount of On-Line reserves and commitment decisions; this fact coupled with the limited incidence of utilization of the price-adder floors limits the ability to discern direct impacts from this design on the amount of RUC activity. As noted previously, RUC activity is much lower overall during the reporting period. The price-adder floors are still providing incremental value toward their intended objectives: during the intervals in which the price-adder floors were in effect, approximately 85% of generation output was from dispatchable Resources. With the planned implementation of RTC+B in December 2025, the ORDC (including the RTORPA floors) will be replaced by ASDCs. As such, ERCOT is not recommending any changes to, or the elimination of, the RTORPA floors at this time.

[17] The back-cast analysis is provided in ERCOT's presentation to the Special Technical Advisory Committee meeting held on March 31, 2023, available on ERCOT's website at: https://www.ercot.com/files/docs/2023/04/03/Proposed-Bridging-Option-Discussion---Special-TAC---033123.pptx.

## 6. Conclusion

This biennial ORDC report provided an analysis of data related to the ORDC and the ERCOT market overall beginning October 1, 2022, after the reporting period from the 2022 ORDC Report concluded, through September 30, 2024. The report noted some of the significant system and market developments and their impact relative to the ORDC and market outcomes generally. The report also provided an explanation of how the current ORDC paradigm will be replaced by ASDCs upon the implementation of the RTC+B Program expected in late 2025. In comparison to the 2022 ORDC Report, market outcomes in this study were influenced to a greater extent by other factors such as increasing demand, lower natural gas prices, capacity additions and Ancillary Service requirements.

In conclusion, based on the analysis and review underlying this report, the ORDC performed in a manner consistent with design expectations and ERCOT does not recommend any changes to the ORDC at this time. The ORDC is one tool among others to promote both reliable and economic outcomes. ERCOT is currently engaged in the discussions taking place both at the PUCT and in the ERCOT stakeholder process around future market design and will continue to work with stakeholders and the Commission to identify and evaluate market enhancements and mechanisms to support reliable grid operations, efficient market outcomes, and resource adequacy.