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Item 15: Recommendation regarding 2026 ERCOT Methodologies for Determining Minimum Ancillary Service Requirement

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Board of Directors Meeting

September 22, 2025

- **Purpose**
  - Summarize proposed changes to ERCOT's Methodologies for Determining Minimum Ancillary Services Requirements for 2026 (2026 AS Methodology).
  - Section 3.16 of the Protocols requires the Board to review and recommend approval. Any such recommendations require approval by the Public Utility Commission of Texas before implementation.

- **Voting Item**
  - ERCOT requests the Board's endorsement of the 2026 Ancillary Services Methodology

Key Takeaways

- In accordance with the findings of the PUCT's 2024 Ancillary Services Study, ERCOT is proposing to use a probabilistic methodology for calculating hourly ERCOT Contingency Reserve Service (ECRS) and Non-Spinning Reserve Service (Non-Spin) quantities for 2026.
- The probabilistic model aligns ECRS and Non-Spin requirements with the risk profile, i.e. higher risk = higher requirement and lower risk = lower requirement.
- ERCOT is proposing minor changes to Regulation Service and Responsive Reserve Service (RRS).

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Background

- Ancillary Services are needed to maintain reliability when the system experiences forecast errors and/or the loss of generation.
- Drivers that influence the quantity calculations include:
    - MWs of intermittent resources serving load,
    - Load, wind, and solar forecast accuracy,
    - Probability of the loss of supply,
    - System inertia, and
    - MW size of the largest resource
- In general, as the percentage of load that is served by intermittent resources increases, more Ancillary Services are needed to protect reliability in real-time.
- ERCOT is continuing to improve its tools for managing variability and uncertainty closer to Real Time. These improvements help in aligning AS requirements with net risk profile.
- Further, in 2026, ERCOT is revising the ECRS and Non-Spin requirement determination methodology to a use probabilistic model to precisely model forced outage and net load forecast errors and the operational needs that these services are used to cover.
- Overall AS quantities in 2026 are increasing. This is because while the probabilistic approach improves modeling of risks, (1) forced outages and forecast errors still occur (2) as ERCOT continues to add variable renewable resources, the risk of weather forecast errors impacting assumed resource capacity and energy is expected to continue increasing.

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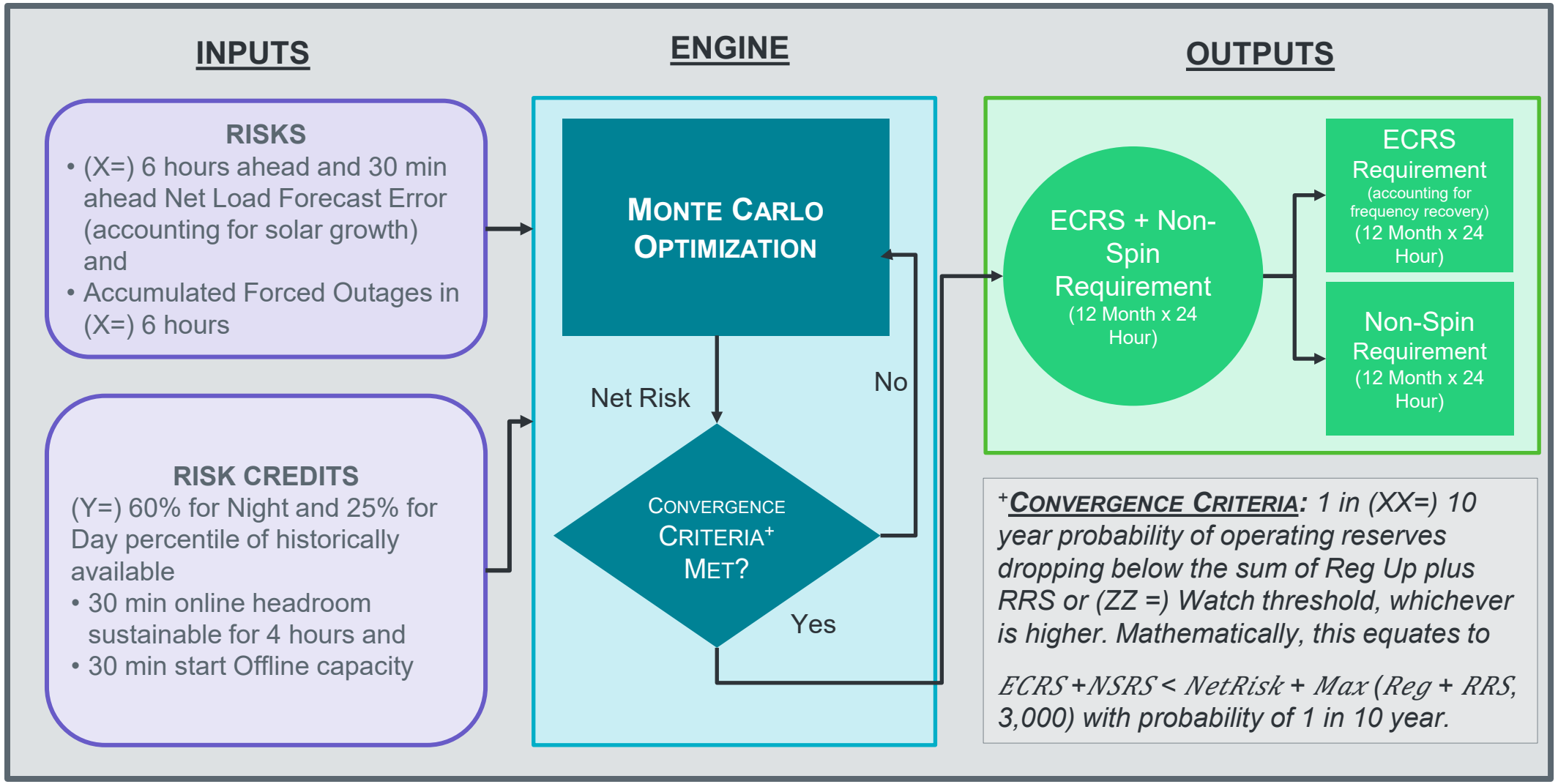
Probabilistic Methodology for ECRS and Non-Spin



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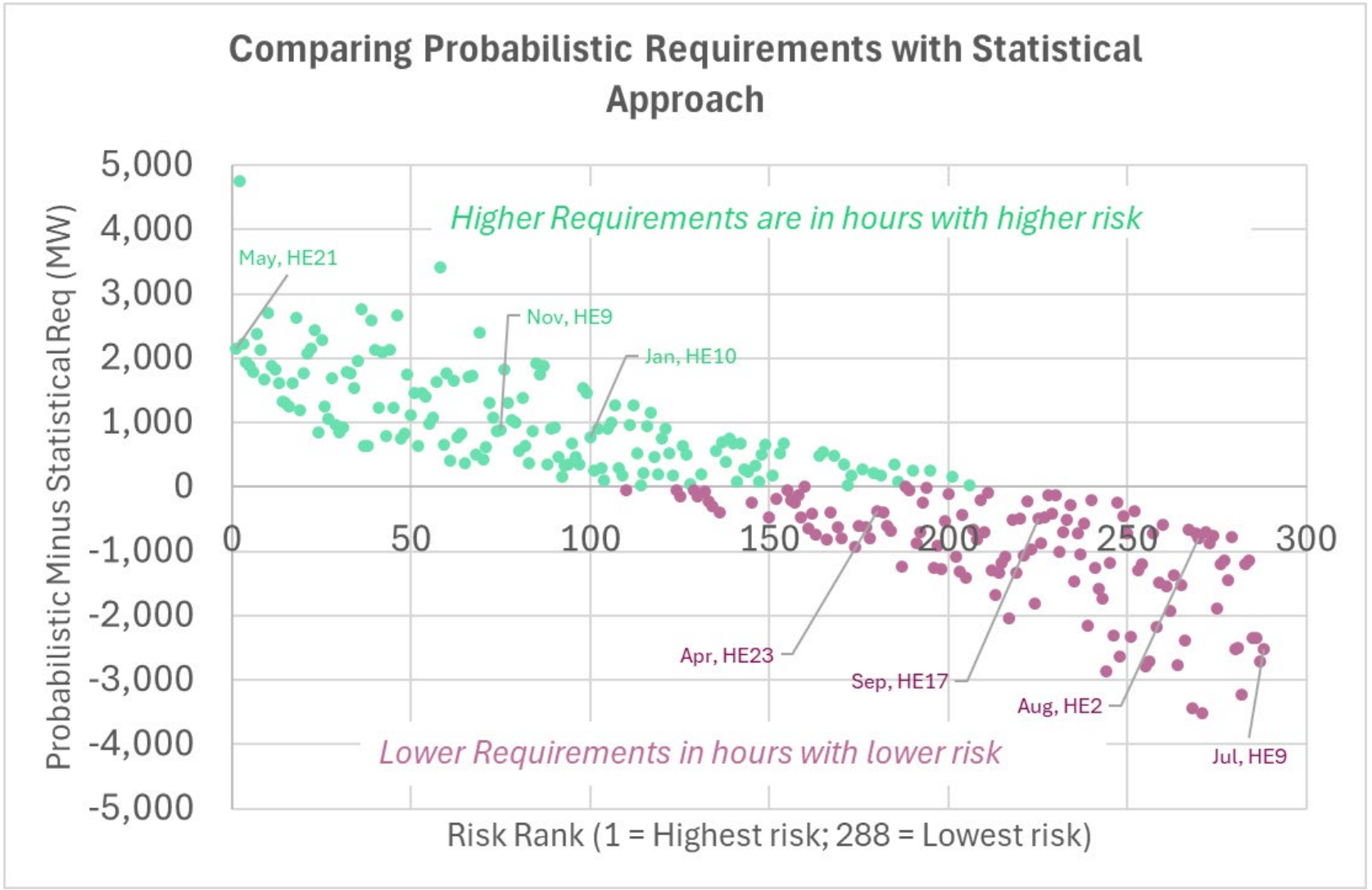
Benefit of Probabilistic Approach compared to Statistical



Key Takeaway: Probabilistic methodology generally increases required MW in higher risk hours, decreases required MW in lower risk hours, as compared to statistical approach.

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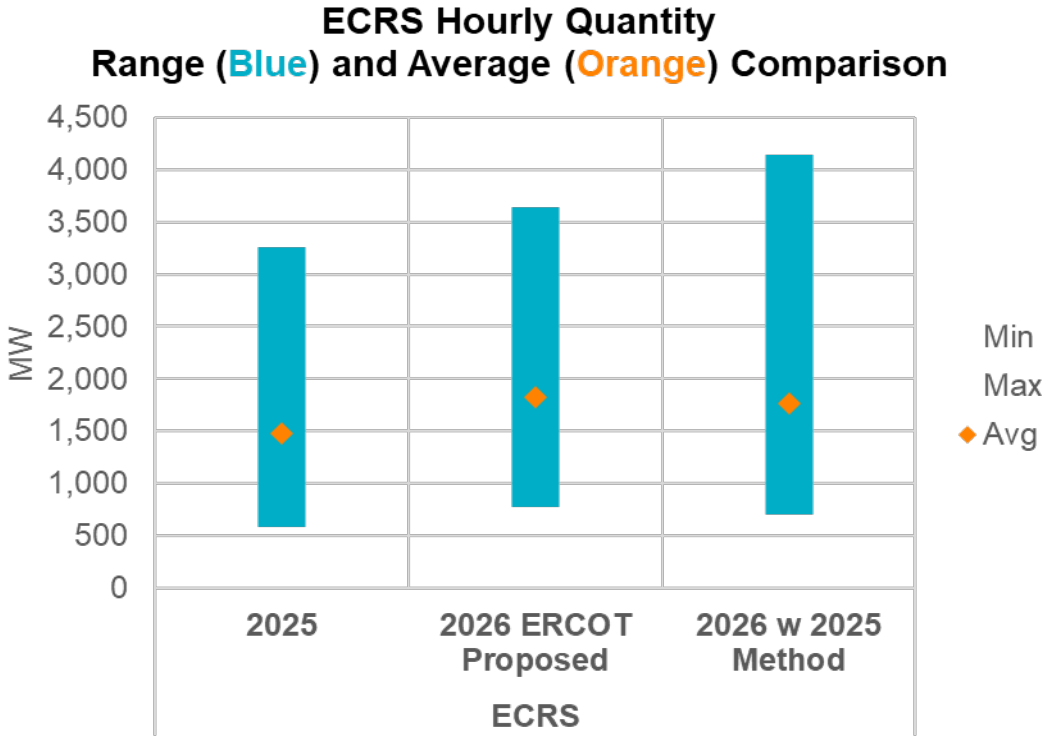
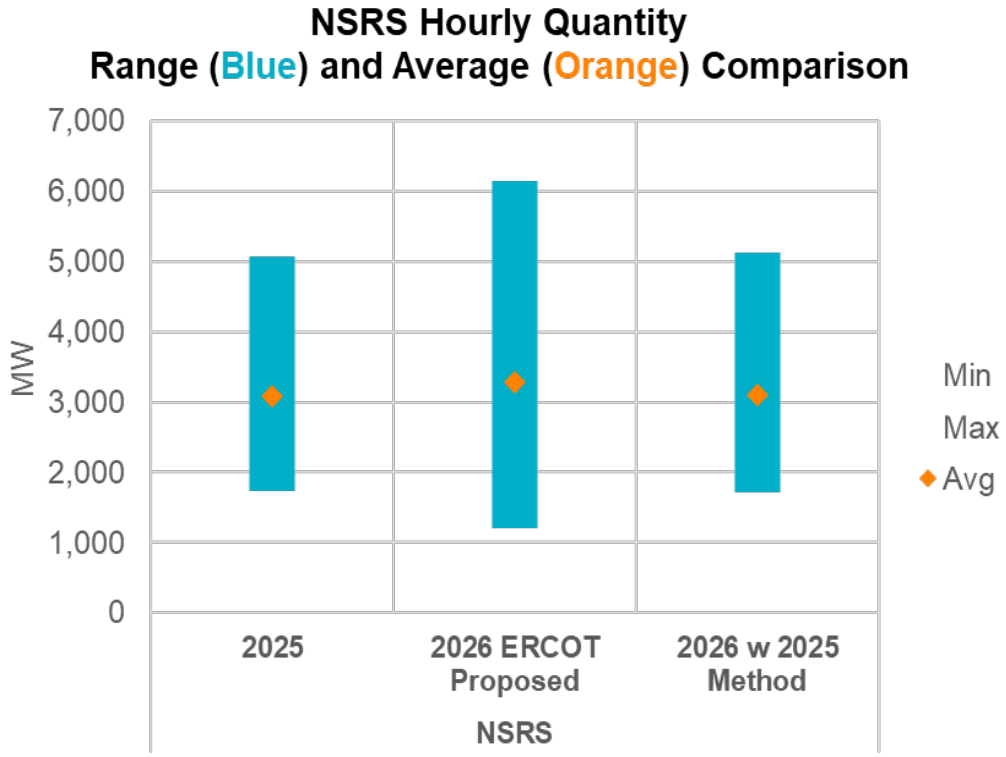
Impacts on Quantities for to ECRS and NSRS

ERCOT Contingency Reserve Service = Reserved capacity from Resources that respond within 10 minutes to (1) restore the frequency following the trip of a large generator and/or (2) provide supply during intra-hour net load forecast errors.

Non-Spinning Reserve Service = Reserved capacity from Resources that respond within 30 minutes to provide supply during longer-duration net load forecast errors and loss of generation capacity events until the event subsides, or other generation can provide energy.





Key Takeaway: ECRS and NSRS quantities are similar between 2026 vs 2025, but the optimization in the probabilistic model provides the ability to tailor quantities to higher risk times while achieving similar averages.

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Three Topics of Contention

ISSUE	FEEDBACK	ERCOT'S PERSPECTIVE
How far ahead to look at forecast error/forced outages?	6 Hours (ERCOT) OR 3 Hours (IMM and Consumers)	Lowering look-ahead period to 3 Hours would reduce overall amount of NSRS but would likely increase number of RUCs needed.
What is the level of risk ERCOT should try to avoid by procuring AS to cover forecast error?	Watch (ERCOT) OR Load Shed (IMM)	Changing from Watch to Load Shed only reduces quantities in about 1% of hours, since in the remaining hours quantities are already being set by need to restore Reg Up plus RRS. *ERCOT opposes eliminating ability to restore Reg Up and RRS from the convergence criteria as this is essential in meeting ERCOT's obligations under NERC's BAL001 and BAL003 standards.*
How much should we discount the AS quantities for a particular time period based on the "extra" headroom from resources that were historically committed by market in that time period?	60% in Night and 25% in Day (ERCOT) OR 50% (Consumers) OR 100% (IMM*)	RTC+B is likely to improve the efficiency of unit commitment, so counting on 100% of the historically available headroom would not be prudent. ERCOT proposed taking a moderate credit based on historically available headroom, and taking more of a credit at night, as this aligns with approach the past AS Methodologies have taken.

Key Takeaway: Buying more NSRS rather than RUCs was based on previous policy guidance, as was basing reserve quantities on avoiding a Watch rather than just avoiding Load Shed. Further, IMM's 1-hour risk analysis, does not recognize operating conditions with longer commitment lead times and ignores the need to prepare for additional unit trips.

*The IMM also recommends using a 1-hour duration for ESR headroom as opposed to 4-hour approved under NPRR1282.

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Proposed Changes to Regulation Up and Down

Regulation Up and Down = Services where Resources respond every 4 seconds to balance load and generation between 5-minute SCED runs.

WHAT IS CHANGING?

- Remove feedback from Fast Responding Regulation Service (FRRS).

WHY?

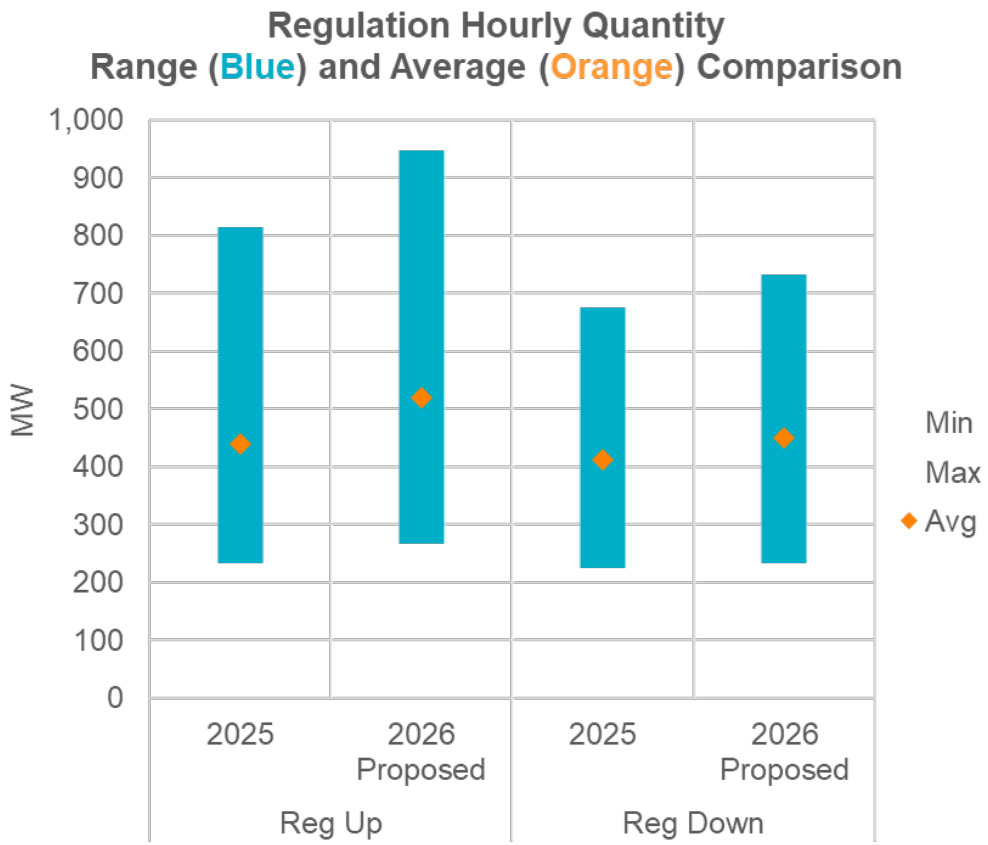
- The service will be retired with the implementation of Real Time Co-optimization plus Batteries (RTC+B) project.

OTHER FACTORS

- None

RESULT (BASED ON JANUARY-JULY 2025 DATA)

- Regulation Up average hourly quantities are **increasing 81 MW** (18.3%)
- Regulation Down average hourly quantities are **increasing 39 MW** (9.5%)



Key Takeaway: Regulation Service quantities are increasing in 2026 vs. 2025 due to increasing intra-hour net load forecast errors.

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Proposed Changes to Responsive Reserve Service (RRS)

Responsive Reserve Service = Reserved capacity from Resources that respond quickly to arrest the frequency decline following the trip of a large generator.

WHAT IS CHANGING?

- Change the minimum Responsive Reserve Service Primary Frequency Response (RRS-PFR) limit from 1,365 MW to 1,377 MW based on the historic performance of the ERCOT generation fleet

WHY?

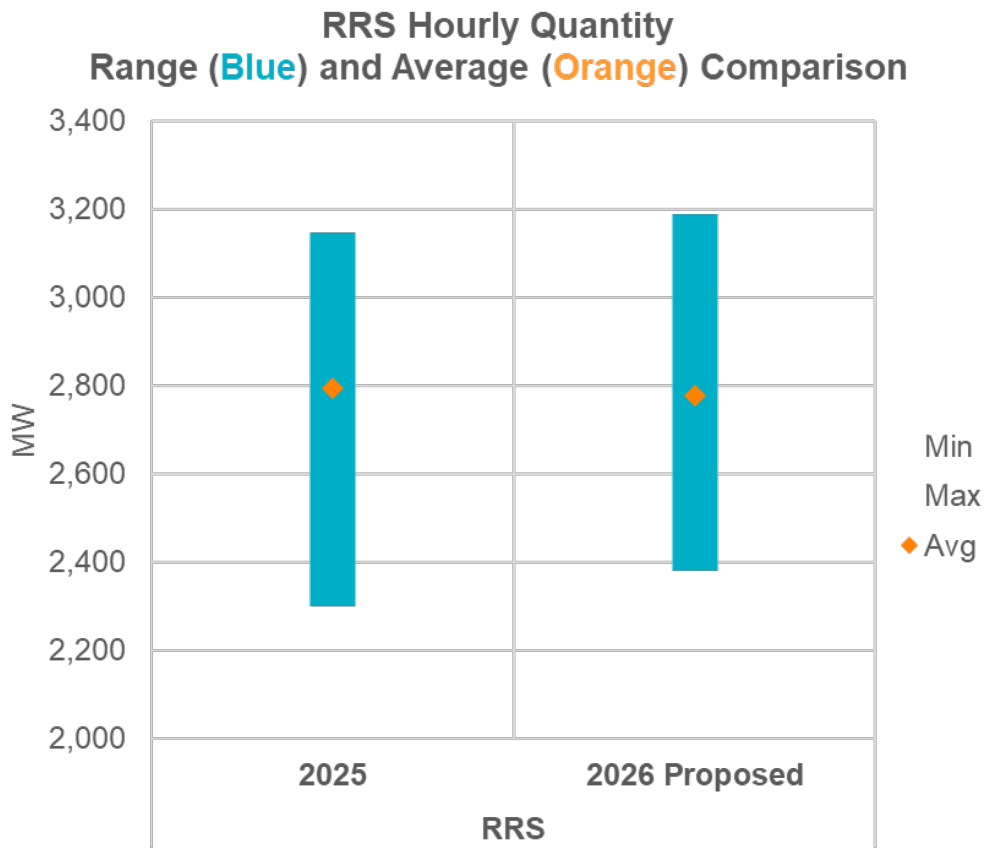
- This is a routine update based on NERC Reliability Standard BAL-003

OTHER FACTORS

- None

RESULT (BASED ON JANUARY-JULY 2025 DATA)

- RRS average hourly quantities are **reducing by 15 MW** (-0.5%)



Key Takeaway: The RRS methodology changes in 2026 are limited to routine changes that are made to align with NERC obligations. RRS quantities in 2026 are similar to 2025.

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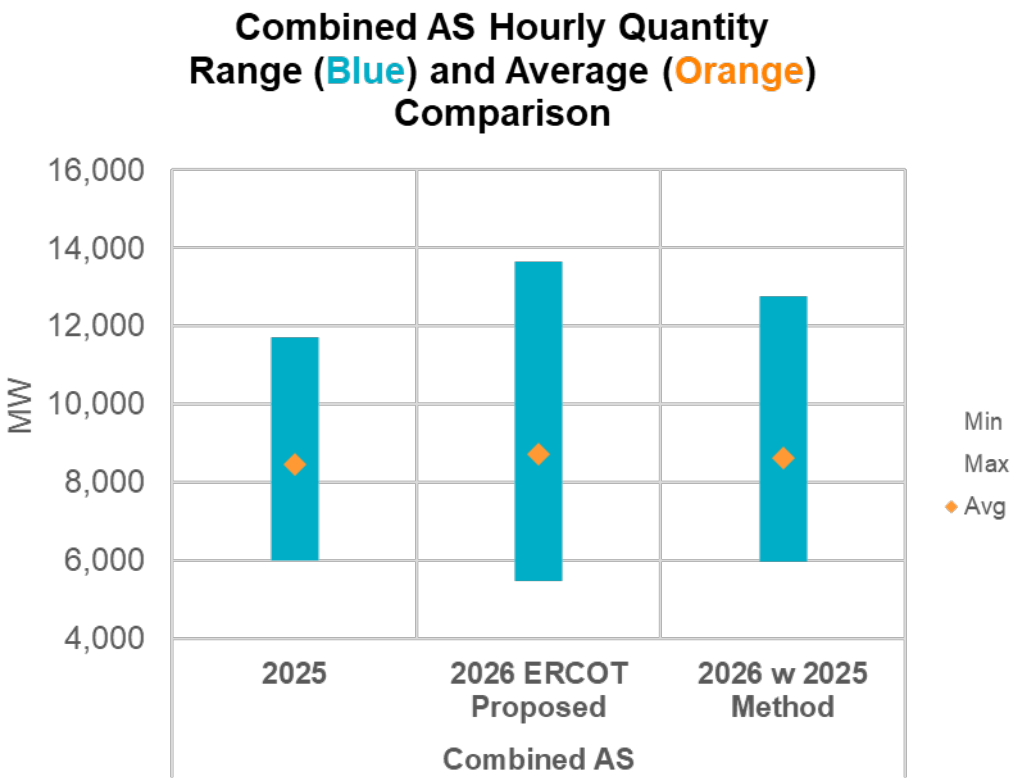
2026 Ancillary Services Methodology Summary

- To fulfill requirements in ERCOT Protocols Section 3.16, the Ancillary Services Methodology is reviewed annually. The ERCOT Protocols now require PUC approval of any changes to the methodology.
- ERCOT has reviewed the Ancillary Services Methodology and is proposing several changes for 2026, based on findings from PUC's AS Study, forecasted resource mix changes, and better accounting of risks. The changes do not decrease system reliability.
- ERCOT requests the Board endorse the 2026 Ancillary Services Methodology as proposed by ERCOT staff. Following ERCOT Board endorsement, ERCOT will seek the PUC's approval.



Key Takeaway: ERCOT is seeking the Board's endorsement of the 2026 Ancillary Services Methodology. Following Board endorsement, ERCOT expects to seek PUC approval before the end of 2025 so that the new methodology can be effective on January 1, 2026.

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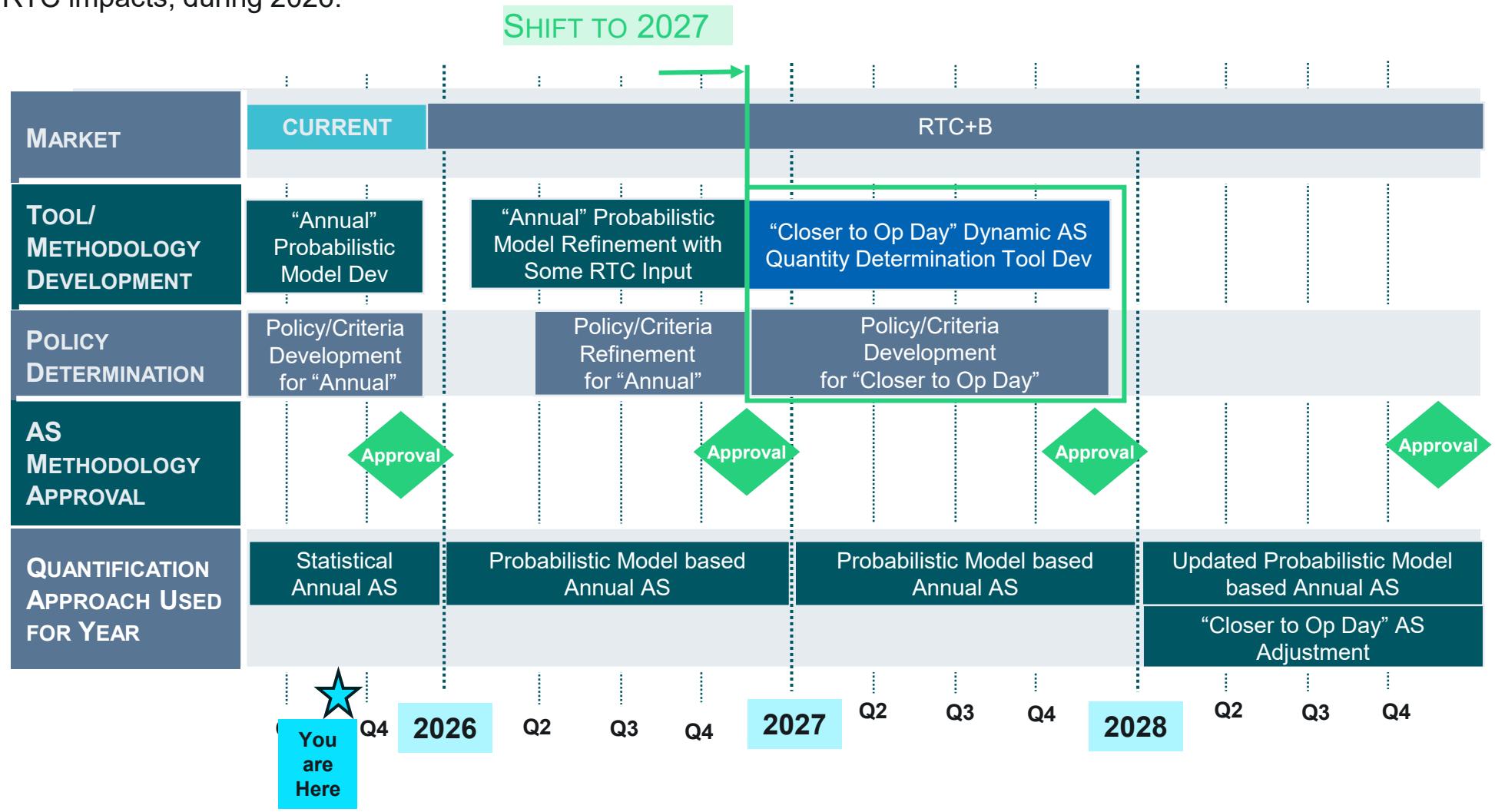
AS Methodology Evolution Road Map

Following approval of ERCOT's proposed probabilistic-based AS methodology for 2026, ERCOT proposes to move consideration of Dynamic AS Quantities to 2027, to allow additional refinement of the probabilistic model and risk criteria, as well as RTC impacts, during 2026.



2026 Ancillary Services Methodology—Consumer Comments for ERCOT Board Discussion, September 23, 2025

ERCOT Consumers' fundamental question is whether ERCOT's posture of "conservative operations" continues to best balance reliability and market efficiency. We all understood the need for conservative operations following Winter Storm Uri. But we are in a very dynamic industry that has undergone tremendous market and regulatory changes.

The first step in rightsizing operations is to revise a set of input parameters to the 2026 Ancillary Services Methodology. Our concern is in alignment with comments that the IMM shared with stakeholders. Consumers agree that over-procurement of Ancillary Services, despite best intentions to assure adequacy in shortage periods, starves the energy market of resources at just the moment that the market is poised to respond to scarcity conditions. Perceived under-response in the energy market then appears to justify reliance on non-market action—RUC and continued over-procurement of AS—in a never-ending spiral that inhibits the full capability of the energy market to respond to shortage and operate at peak efficiency. Market efficiency provides incentives for load response, supports self-commitment for generation, and ultimately promotes capital investment in new resources. Taken together, these results produce the best outcome for consumers – desired reliability at an efficient price.

While ERCOT Consumers accept that in PUC Project No. 55845 the Commission indicated its preference for a conservative approach to Ancillary Services by minimizing the chance of entering an Operational Watch, the Commission did not dictate the specific input parameters to be used in the probabilistic model. Those policy parameters should be subject to a full evaluation and debate among the stakeholders and the Board.

The draft AS methodology incorporates the most conservative assumptions/parameters for each of the key inputs to the probabilistic model. As the IMM has explained, those conservative policy choices are stacked one on another, resulting in excess AS quantities without achieving improved reliability. Please see Consumers' comments to the TAC for recommended modifications to input parameters.

It is a fundamental objective of the ERCOT market structure to reliably deliver power at lowest cost. Where competitive market solutions are possible, that objective will best be achieved. ERCOT Consumers support competitive solutions where possible, which will promote both reliability and economically efficient markets, to the benefit of all consumers. Over-procurement of Ancillary Services, no matter how well intentioned, restricts the energy market, preventing the most economically efficient outcome. ERCOT Consumers urge the Board to rebalance the scales between the AS and energy markets as recommended in Consumers' comments. For the 2026 Ancillary Services Methodology, the Board can do that by modifying some of the input parameters. For the long run, it's time to restructure our policy of conservative operations.

POTOMAC ECONOMICS

IMM Commentary on 2026 AS Methodology

Presented to:

ERCOT Board

Jeff McDonald
Potomac Economics

September 23, 2025

Summary of IMM Commentary

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- ERCOT's proposed AS Methodology employs several factors that inflate the target procurement levels beyond a sensible reliability level
  - Two gigawatts provide zero reliability improvement.
  - Key factors: "Watch" criteria, 6hr load forecast error, and 4hr ESR duration.
  - We propose a compromise that would procure 2,840 MW of ECRS and Non-Spin bringing total AS procurement to just over 6 GW.
- It is misaligned with reliability outcomes
  - ERCOT's operational objective is to avoid Watch conditions instead of reliability outcomes such as preventing firm load shed.
  - The input parameters for individual AS products are not based on the risks they are designed to manage.
- It will undermine performance in the energy-only market
  - Will procure excessive volumes of AS capacity.
  - Excess AS capacity will inefficiently reduce scarcity and prices in the market.
  - This undermines effective shortage pricing --> inhibit signals for new investment.

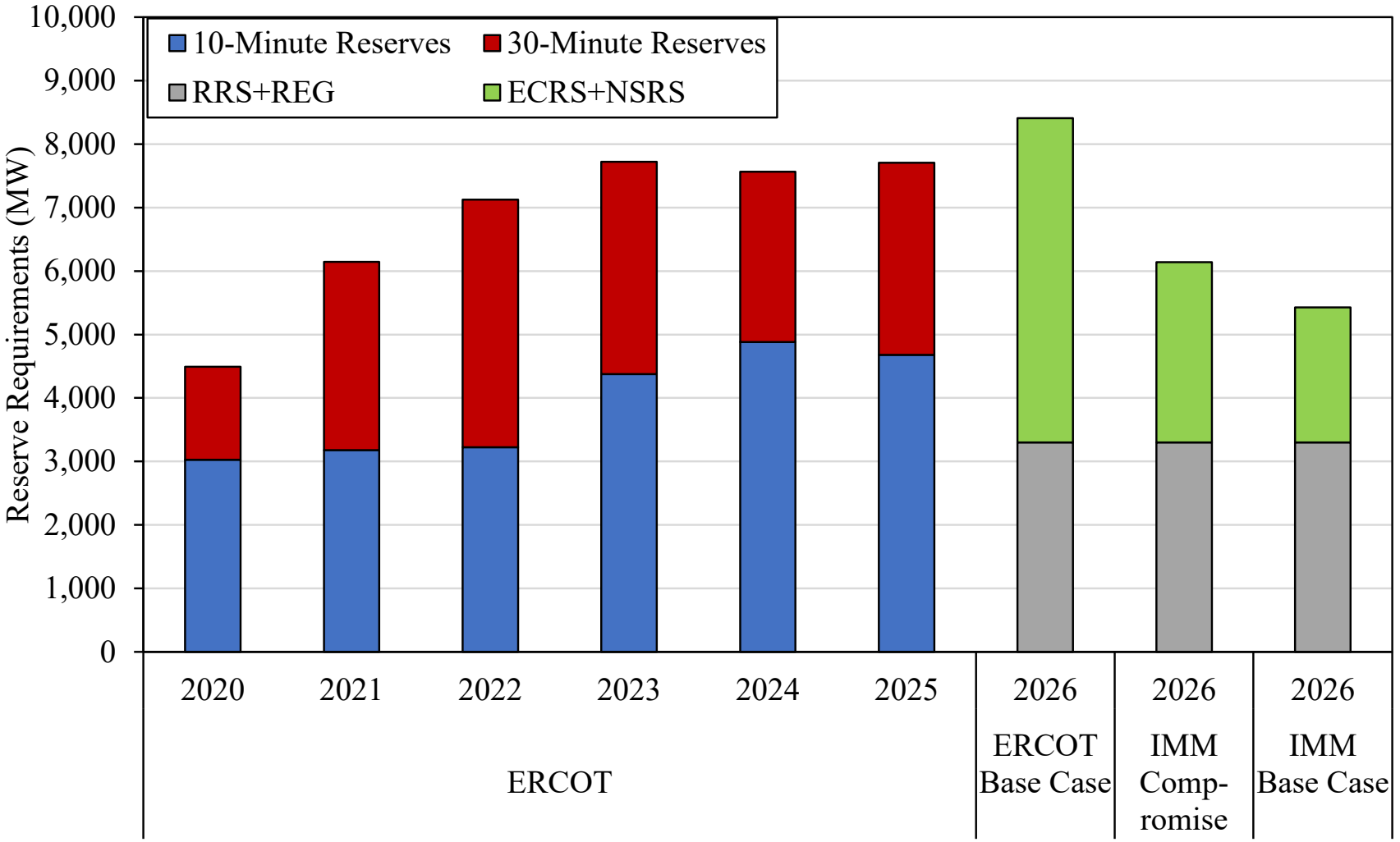
Summary of IMM Commentary (2)

POTOMAC ECONOMICS

- ERCOT has adopted a reasonable stochastic risk model, but the IMM disagrees with parameter assumptions included in ERCOT's proposal.
- In particular, the IMM has evaluated the impact of several key parameter settings:
  - Net Load Forecast Error Time Horizon (adds 1.2 GW)
  - Convergence Criteria (i.e., firm load shed vs. Watch) (adds 1.0 GW)
  - ESR Duration Requirement (adds 624 MW)
- IMM recommends
  - ERCOT provide analysis of (at least) the permutations noted by IMM including impact on procured capacity and reliability.
  - Adopt a compromise set of parameters with
    - Three hour load forecast error,
    - One hour ESR duration requirement,
    - Clear to 1-in-10 loss of load and not "Watch"
  - Reconsider conservative operations in light of (a) resilience improvements that have been made to date and (b) reliability based on load loss.

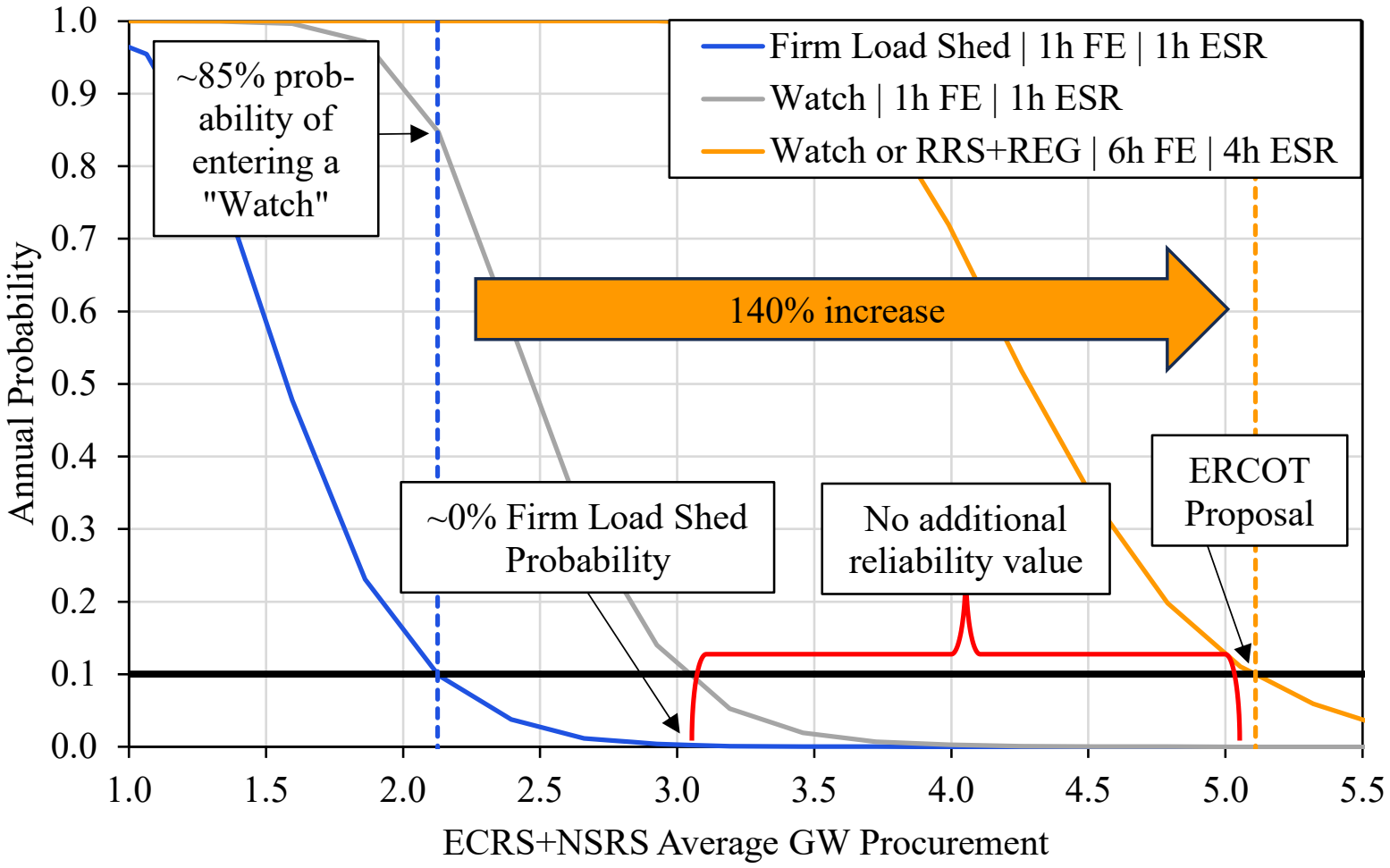
ERCOT Historical Reserve Procurement

IMM Base Case seeks to reduce excessive ECRS+NSRS capacity



Overall Impact of ERCOT Proposal

ERCOT proposal excessively procures AS for no additional reliability value



Summary of IMM Recommendations Regarding ERCOT's 2026 AS Methodology

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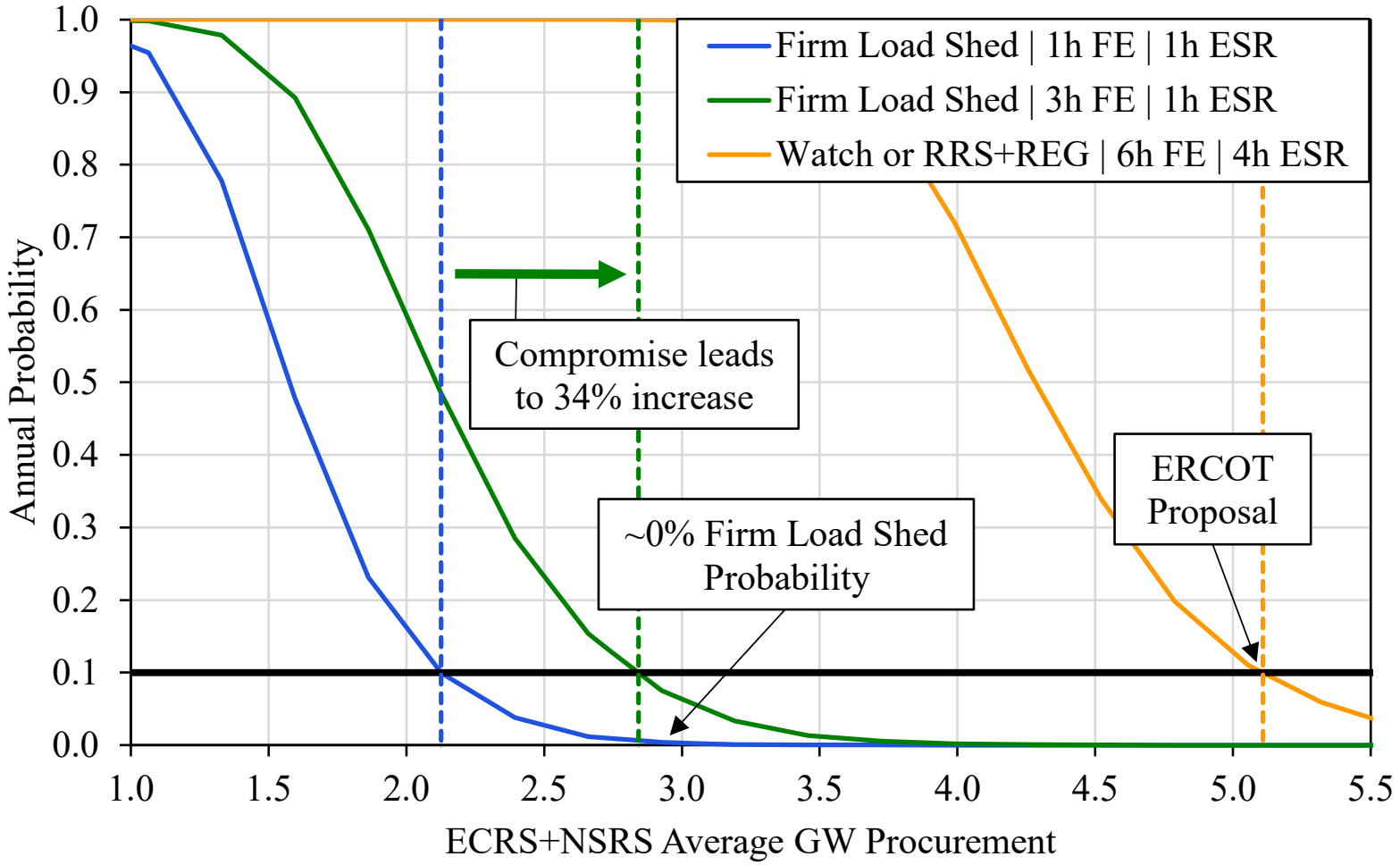
- ERCOT should provide additional modeled AS procurement scenarios using alternative parameter settings for ECRS and NSRS to provide a richer palette of information and alternatives, with reliability impacts, for approval purposes.
  - Differences in methodology between ERCOT and IMM models result in discrepancies between outputs, even when the same parameter settings are used
  - To be confident of the impact relevant parameter settings have, ERCOT should produce additional outputs based on different parameter setting scenarios. The additional scenarios should include those reported on by IMM.
  - The additional scenarios would be relevant to
    - Board decision regarding the most prudent AS Methodology
    - ERCOT meeting PUC guidance to assess the correlation between preventing loss of load and avoiding a "Watch"
- Adopt IMM compromise proposal
  - *Three hour load forecast error*, one hour ESR duration, and LOLP not "Watch".
- Reconsider "Conservative Operations" more broadly

Recommended Compromise Proposal

3-hour time horizon eliminates excess capacity while maintaining reliability



POTOMAC ECONOMICS

Memorandum

TO: TAC

FROM: Jeff McDonald, Andrew Reimers

DATE: August 22, 2025

RE: IMM Comments on 2026 AS Methodology

A. Executive Summary

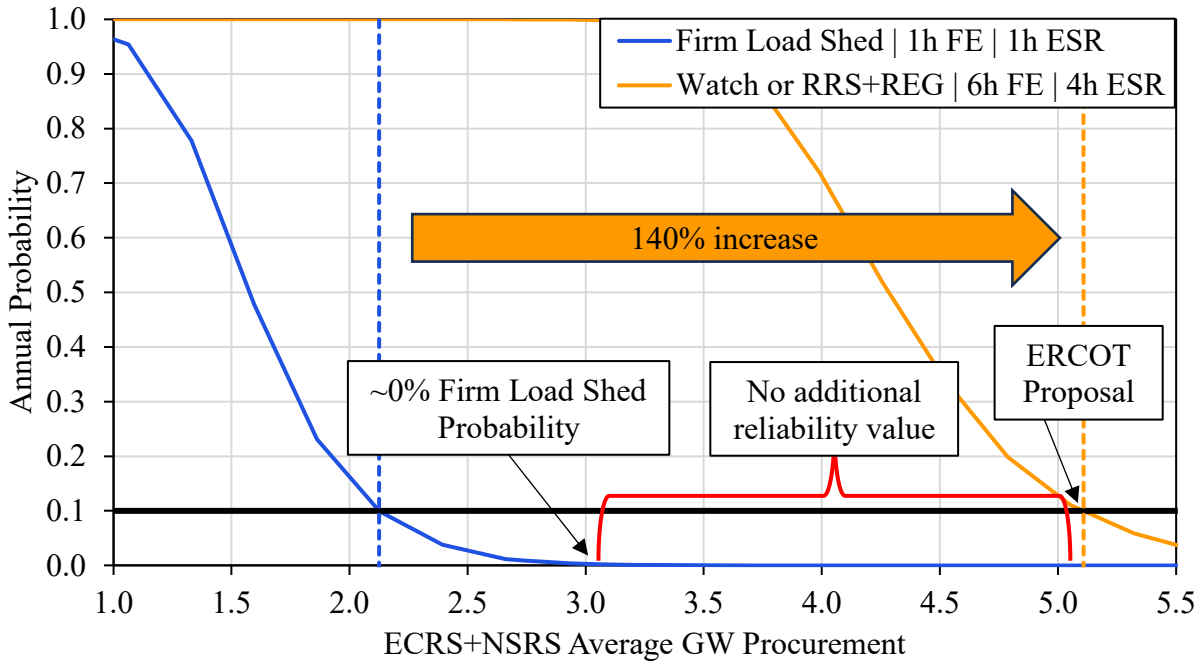
As the Independent Market Monitor for the ERCOT wholesale market, we appreciate the opportunity to present our concerns with ERCOT's proposed AS Methodology for 2026. Our concerns focus on two key issues: (1) the proposed methodology is not aligned with reliability outcomes, resulting in excessive AS procurements, and (2) it will undermine the performance of ERCOT's energy-only market. We begin by outlining our comments and conclusions surrounding these key issues. Next, we recommend changes that would achieve comparable reliability outcomes as the proposed methodology at a lower cost. Finally, we provide a more detailed discussion of each model input's contribution to the excessive procurement volumes, as well as a chronology of how ERCOT arrived at this conservative operational paradigm.

1. The AS Methodology is Misaligned with Reliability Outcomes

- ERCOT's operational objective is to avoid Watch conditions instead of reliability outcomes such as preventing load shedding.
- The input parameters for individual AS products are not based on the risks they are designed to manage. For NSRS, the forecast error time horizon is set at 6 hours, and the duration requirement for ESRs is set at 4 hours, even though NSRS should only needed for no more than one hour before elevated prices incentivize additional commitments from thermal resources.
- The ERCOT model does not apply headroom as a stochastic component and requires use of averages and adjustment factors instead. This reduces the value of using a stochastic model.

Together, these inputs result in the proposed AS Methodology that procures 140% more than what is required to satisfy the 1-in-10 reliability standard for load shed, *the last 2 GW of which provide no additional reliability*. This is illustrated in the following figure. The blue curve represents the probability of firm load shed at different procurement levels of ECRS and NSRS. This curve reflects the IMM base case and uses a one hour load forecast error and a one hour duration requirement for energy storage resources. The orange curve reflects the probability of

entering a Watch condition at different procurement levels of ECRS and NSRS and uses the ERCOT base case of a six hour load forecast error and a four hour duration requirement for energy storage resources. The procurement level required to achieve a one-in-ten (or 10%) probability of each outcome is identified by the intersection of horizontal black line with these two curves.



This figure shows that the level of total ECRS and NSRS needed to meet the one-in-ten (0.1 probability) reliability standard would average roughly 2.1 GW. In contrast, ERCOT's proposal would procure 5.1 GW of reserves, approximately 2 GW of which would have no reliability value.

2. The AS Methodology will Undermine the Performance of the Energy-Only Market

ERCOT's energy-only market design must allow for scarcity pricing to send market signals to incent investment in new generation. Procuring excessive volumes of ancillary services will inefficiently inject additional non-price-setting energy into the real time market and reduce prices. Ultimately, it can undermine the ability of shortage pricing to provide the efficient long-term signals for new investment.

The implementation of RTC could mitigate the impact of excessive operating reserve procurements if the ORDC and associated ASDCs scaled up with the AS procurement targets. However, the fact that the ASDCs will drop to the price floor at quantities well below the procurement targets, and that ERCOT will use out-of-market RUC commitments to meet the targets, will undermine the formulation of efficient scarcity pricing. In other words, the actions taken to procure and maintain the excessive levels of operating reserves will inefficiently prevent

the supply margin falling into ranges where the market will provide substantial and efficient scarcity pricing.

B. Recommended Compromise Proposal

We understand that the heightened reliability concerns following Winter Storm Uri together with the looming threat of rampant load growth is motivating a conservative AS methodology. However, the ERCOT proposal goes too far and will result in significant excess cost with no added reliability benefit. We identify a number of issues with the methodology proposed by ERCOT but have limited our recommendations to three key areas. As a compromise, we recommend:

- A 3-hour forecast horizon for determining the target volumes for NSRS.
- Using a 1-in-10 criteria based on the LOLP curve in place of the Watch criteria.
- Using a 1-hour discharge horizon for ESRs rather than 4 hours.

Regarding the three-hour forecast horizon, ERCOT already has a track record of using such an input in their AS Methodology from 2016 to 2022 without any adverse reliability consequences caused by inadequate NSRS capacity. This compromise, detailed in Scenario 2.2 in Table 1.1:

- Represents a 34% increase in AS procurement relative to the IMM baseline scenario;
- Achieves a near-0% probability of load shed, and
- Avoids setting reserve targets beyond this point that do not add any reliability value.

Table 1.1: IMM Compromise - Near-0% Load Shed Probability

#	Scenario name	Convergence Criteria (MW)	Forecast Error Time Horizon (Hours)	ESR Duration	Annual Probability	ECRS + NSRS Plan (MW)	Absolute Increase from IMM Base Case (MW)	Relative Increase from IMM Base Case (%)
0	IMM Base Case	1,500	1	1	1/10	2,126		
2.2	3-HA Forecast Error	1,500	3	1	1/10	2,842	716	33.7%
4	ERCOT Base Case	3,000	6	4	1/10	5,108	2,983	140.3%

C. Comprehensive Analysis on AS Methodology

1. Introduction

We applaud ERCOT's efforts to incorporate a stochastic risk methodology into their formulation of the AS Plan. We have not yet developed a position on the statistical or probabilistic techniques used in their proposed methodology. However, we remain concerned about many of the inputs to this methodology that are upstream of the new and improved modeling techniques. We have raised these concerns consistently for several years.

Much of our critique relates to "Conservative Operations," the operational paradigm ERCOT adopted in the aftermath of Winter Storm Uri. Conservative Operations refers to the set of policies and practices oriented around maintaining a larger operating reserve margin than what was standard practice in ERCOT before Winter Storm Uri to avoid going into a Watch and exceeding the required reserve levels of all other ISO in the US, as shown in Figure 1 in the Figures and Tables section at the end of these comments. It is implausible that this operating posture would have prevented the issues experienced during Winter Storm Uri. Further, several resilience mechanisms have been implemented since Winter Storm Uri, outside of the wholesale market, that will significantly reduce the impact of similar future winter storms. We classify the following input parameters to the proposed AS Methodology as part of the Conservative Operations paradigm:

- Setting operating reserve targets to achieve a one-in-ten standard for the probability of entering a "Watch," nominally defined as dropping below 3,000 MW, rather than the probability of firm load shed, which is defined as reserves dropping below 1,500 MW. This parameter increases the target level of the AS Plan by approximately 43%.
- Assessing the operational risk that NSRS is meant to manage based on the six hour-ahead forecast error for demand and generation from intermittent renewables. This parameter increases the target level of the AS Plan by approximately 57% compared to our recommendation of using a one hour-ahead forecast error.
- Accrediting the available headroom of ESRs according to the power output they can sustain for four hours, rather than our recommendation of one hour. This parameter increases the target level of the AS Plan by approximately 29%.
- Severely discounting the capacity of headroom in the system capable of providing operating reserves in the event of a contingency or forecast error that results in a reduction of reserves. *We are still estimating the relative impact of ERCOT's "risk credit" methodology in formulating the AS Plan.*

Together, this AS Plan is 140% larger than the IMM base case which achieves a 1-in-10 yearly probability of load shed. The last 2 GW of this plan provide no additional reliability value on average, as illustrated in Figure 2 (the same figure presented in the executive summary). We recommend that ERCOT revise their AS Methodology and consider operating reserve targets that reflect the reliability value they provide in mitigating real-time operational risks. The remainder of these comments detail our concerns with each of these parameters. A summary of

the independent impact of each of these parameters on the size of the AS Plan is included in Table 1 at the end of these comments, and we include portions of Table 1 throughout.

2. Convergence Criteria

Prior to Winter Storm Uri, ERCOT had a policy of issuing a voluntary conservation notice referred to as a Watch whenever operating reserves dropped below 3,000 MW. Such events were relatively commonplace, with an average of 82 hours per year with PRC below 3,000 MW for 2016-2020, as shown in Figure 3. The aftermath of Winter Storm Uri shone a spotlight on the reliability of the ERCOT grid and, given the recent legislative session and a gubernatorial election around the corner, it was decided that avoiding Watch conditions was of paramount importance. Thus, Conservative Operations was born, the primary feature of which was to run the system with a high level of operating reserves, whether procured through RUC or through the AS Methodology, as discussed in more detail in the following section.

In the summer of 2024, the IMM and ERCOT collaborated on the AS Study mandated by PURA 35.004(g), wherein we proposed a stochastic risk methodology that would more effectively capture the risks that real-time operating reserves, particularly ECRS and NSRS, were meant to address. This stochastic risk methodology is a Monte Carlo simulation of historical system conditions that accounts for the probability of forced outages and forecast error. The distribution of outcomes produced by these simulations determines the underlying probability of adverse system conditions such as firm load shed. That determination depends on "convergence criteria," i.e., the level of reserves below which an iteration is flagged as an outage. For our analysis, we used a convergence criterion of 1,500 MW of operating reserves, the same criteria ERCOT uses to signal an EEA3 and the point at which ERCOT nominally begins firm load shed.

ERCOT has repeatedly argued that we should use the probability of going into a Watch so that the results would reflect the de facto operating policy. That is, the analysis should work backwards from the decision that Watch conditions were to be avoided and that an exceptionally high level of operating reserves was the way to achieve that goal. We have consistently maintained that formulating the AS Methodology according to the probability of going into a Watch is inappropriate because it is an arbitrary, ill-defined threshold that is only significant because it functions as the first official warning sign that conditions are becoming tight. Alternatively, we proposed that if more conservative reliability targets were desirable, they should be defined according to objective reliability criteria, e.g., a one-in-twenty probability of firm load shed rather than a more typical one-in-ten standard as shown in Table 1.2.

Table 1.2: Base Case Comparison with 1-in-20 Criteria and Watch Criteria

#	Scenario name	Convergence Criteria (MW)	Forecast Error Time Horizon (Hours)	ESR Duration	Annual Probability	ECRS + NSRS Plan (MW)	Absolute Increase from IMM Base Case (MW)	Relative Increase from IMM Base Case (%)
0	IMM Base Case	1,500	1	1	1/10	2,126		
0.1	1/20 Standard for Firm Load Shed	1,500	1	1	1/20	2,341	215	10.1%
1.1	"Watch" Criteria	3,000	1	1	1/10	3,047	922	43.4%

Table 1.2 shows that a one-in-twenty standard for firm load shed would increase the target level of operating reserves by a little more than 10% rather than the 43% increase implied by the one-in-ten standard for going into a Watch.

ERCOT continued to assert that it was appropriately cautious to formulate the AS Methodology based on the probability of going into a Watch. The PUC adopted ERCOT's position in the form of guidance to that effect.[1] Thus, ERCOT's current proposed AS Methodology is formulated to achieve a one-in-ten standard of entering a Watch, a significantly more expansive criteria than is used by any other ISO in the US.

ERCOT's convergence criteria includes another even stricter component that escalates the bias for excess reserves in their proposal. Their convergence criteria selects the maximum of either 3,000 MW (i.e., a Watch) or the sum of the target volumes for RegUp and RRS. The latter criterion is the stricter of the two in 67% of hours in our study period, with RegUp and RRS summing on average to 3,149 MW. In Table 1.3, scenarios 1.2 and 1.3 show that the distinction between 1,500 MW and 3,000 MW in the convergence criteria is overwhelmed by the sum of RegUp and RRS, both resulting in target volumes approximately 50% higher than the IMM base case. The rationale for including this stricter criterion in their formulation is not clear, as the thresholds for Watch conditions and firm load shed are both defined according to PRC, rather than shortages of RegUp and RRS.

[1] PUC guidance was to continue to operate to the Watch criteria until further data and assessment could be used to assess the appropriateness of operating to a Watch, Emergency Alert, or Load Shed event. The assessment is due to the PUC no later than the 2027 AS Methodology process.

Table 1.3: RegUP and RRS Sum Comparison with Watch Criteria

#	Scenario name	Convergence Criteria (MW)	Forecast Error Time Horizon (Hours)	ESR Duration	Annual Probability	ECRS + NSRS Plan (MW)	Absolute Increase from IMM Base Case (MW)	Relative Increase from IMM Base Case (%)
0	IMM Base Case	1,500	1	1	1/10	2,126		
1.2	Max of Firm Load Shed or Reg + RRS	MAX(1,500, RRS+REG)	1	1	1/10	3,180	1,054	49.6%
1.3	Max of "Watch" or Reg + RRS	MAX(3,000, RRS+REG)	1	1	1/10	3,189	1,063	50.0%

3. Time Horizon for Forecast Error

One of the main risks that ECRS and NSRS are intended to manage is the impact of forecast errors for demand and intermittent renewable generation. Under-forecasted demand and over-forecasted renewable generation have the effect of discouraging commitment from thermal resources, which can result in a supply shortfall in real-time. The AS Methodology should reasonably incorporate the probability of such shortfalls. A key parameter to that end is the time horizon over which these forecast errors are calculated.

All inputs to the risk assessment should be based on the operational risks that the product is meant to manage. NSRS, for example, is designed to mitigate the risks associated with forced outages or forecast errors over a time horizon of approximately one hour. In the event of such risks manifesting themselves, market pricing should be sufficient to incentivize commitment of offline resources to maintain the reliability of the system. Our analysis has consistently shown that ERCOT has significant capacity from offline reserves that can start in an hour or less under tight system conditions, as illustrated in Figure 4. These conditions produce higher prices which in turn elicit a market response of self-commitment from available off-line resources. Setting this parameter to six hours nearly doubles the perceived risk associated with forecast error, as shown in Figure 5. This parameter effectively assumes that none of the offline capacity will self-commit in response to evolving system conditions, which is contrary to historical experience.

ERCOT's operational history demonstrates that six hours is an unnecessarily long time-horizon to run the system reliably. From 2016 to 2022, the methodology for determining the target volumes for NSRS used a three hour ahead forecast error. Over that time, there was no firm load shed caused by a lack of sufficient NSRS.

Figure 6 shows the increase in the unit hours of resources committed through RUC and the increase in the average lead time between the commitment instruction and real-time. The

following year, to achieve its desired level of operating reserves through the market rather than through overreliance on RUC, ERCOT increased the time horizon used for calculating forecast error in the NSRS methodology to six hours. Thus, *the methodology followed from the operational paradigm,* which itself was not supported by sound reliability criteria.

In summary, the operational response to Winter Storm Uri was to run the system with a higher level of operating reserves with the goal of avoiding Watch conditions. The AS Methodology was adjusted to reflect these decisions and not based on objective reliability criteria.

4. Duration Accreditation for ESRs

We have consistently argued that the duration requirement for ESRs to carry ECRS or NSRS should both be set at one hour to reflect the time that may be needed to provide energy while thermal resources start-up in response to market conditions after a contingency. ERCOT has maintained the position that the duration requirement for ESRs to carry NSRS should be set at four hours. We covered our objection to this parameter in detail in our comments on NPRR 1282.[2] Incorporating this four-hour duration requirement into the AS Methodology discounts the reliability value provided by ESRs and increases the target volume for NSRS by more than 29%.

5. Risk Credit Accounting

ERCOT's risk credit parameters unreasonably discount the headroom in the system. Risk Credit Accounting refers to accounting of the amount of capacity that can respond within 30 minutes. During daytime hours, ERCOT accounts for only 25% of available headroom, excluding capacity already carrying ancillary services. This decision is inconsistent with their convergence criteria, which is based on the probability of a Watch. A Watch, like the probability of firm load shed, is a function of PRC, and ERCOT's risk credit methodology effectively discounts 75% of the available PRC in their estimation of the probability of a Watch. We have come to understand that ERCOT's proposal to discount headroom stems from their use of average values in their model, but we still view the approach as undermining the value of using a probabilistic model.

and the corresponding response to such conditions by the grid operators and the real-time market dispatch. In our portion of the AS Study, we account for all available capacity that can respond to a contingency such as a forced outage or under-commitment of thermal resources caused by forecast error. We accounted for capacity that is already carrying AS, unloaded headroom from generation and energy storage resources, and demand response from price-responsive loads. The rationale for this accounting is twofold. First, it reflects the likelihood that operators will take advantage of any capacity available in the system before initiating firm load shed. Second, it reflects the functioning of the real-time market with co-optimization of energy and operating reserves. Following a contingency, some volume of operating reserves must be converted to energy, after which operating reserves are then reallocated to the remaining unloaded headroom.

2 https://www.ercot.com/mktrules/issues/NPRR1282

We acknowledge that there are legitimate shortcomings to this type of accounting, particularly when based on historical system conditions. The level of available operating reserves depends on the composition of the resource mix, which is changing rapidly with the deployment of solar and energy storage resources and resulting commitment decisions of thermal resources, which are implicitly influenced by the target level of operating reserves procured in the market. That is, reducing the target level of operating reserves procured in the market would reduce the level of commitment, thus also reducing the level of free headroom available in the system. We would advise that forecasts of the changing generation mix and corresponding impacts on thermal commitments be incorporated into the AS Methodology. This is a more reasonable approach than discounting the capacity available in the system as ERCOT has proposed.

6. Operating Reserves and the Energy-Only Market

We have sought to comprehensively document the effect of these parameters on increasing the target operating reserve volumes set by the AS Methodology and to demonstrate that they were set based on upstream policy decisions not connected to objective reliability criteria. Zooming out from the specific impacts on the AS Methodology, policies associated with Conservative Operations have been implemented all along the interface of operations and market design, often with inconsistent and conflicting implications. Consider the decision to increase the target volumes set by the NSRS Methodology in 2022. The motivation for this decision was to achieve the desired level of operating reserves through the Day-Ahead Market without as much reliance on RUC. Empirical analysis demonstrating the need to maintain an increased level of operating reserves was not provided to support the increased procurement level. Increasing the NSRS volumes procured in the DAM was a plausible strategy for achieving this goal because in the current market design, DAM always procures the entirety of the AS Plan.

Once RTC is implemented, however, sloped ASDCs will be incorporated into the day-ahead and real-time markets. As currently formulated, these demand curves do not scale with the target volumes defined by the AS Plan. The ASDCs are fixed despite significant variation in the hourly volumes of target reserves, and the AORDC is only defined up to 10,000 MW. At the extremity of the AORDC, the shortage price for reserves is so low as to allow the market to go short on AS in periods of modest scarcity but low probability of reliability issues. This dynamic is, in fact, how RTC is meant to function, where shortages of operating reserves are a critical aspect of price formation. ERCOT operations, however, has signaled skepticism of this feature of RTC, indicating their intention to use RUC to increase operating reserves when the market does not procure the entirety of the AS Plan *that was inflated specifically to avoid overreliance on RUC*. The logic leading to this set of decisions is circular, but ERCOT continued to work in this construct by imposing a $15/MWh floor on any shortages of AS in the day-ahead and real-time markets.

The ultimate effect of this kind of excessive operating reserve policy will be to simultaneously increase costs for consumers while suppressing the price signals needed for maintaining resource adequacy. Consumers will be subject to increased costs due to uplift from RUC and from DAM make-whole payments and the $15/MWh floor on the AORDC. At the same time, the excess supply of reserves and reluctance to endure any shortage of reserves will suppress the price

signal that the ASDCs are meant to produce. Ultimately, this suppression of genuine shortage pricing will reduce the incentive for new entry, and the modest increase in revenues under minimal shortage conditions will serve only as a transfer payment to incumbent generators above the reliability value their resources provide.

Beyond our recommendations on the AS Methodology, we call for a more general reconsideration of Conservative Operations with the goal of cost-effectively achieving objective reliability targets. This reconsideration should be applied both to the AS Methodology and to the corresponding formulation for the ASDCs.[3] The ASDCs and the AS Methodology should be explicitly linked such that the shortage pricing represented by the ASDCs reflects with the marginal reliability value of the corresponding ancillary service. We elaborate on the proper formulation of the ASDCs and on the AS Methodology in our most recent edition of the State of the Market report in recommendation 2024-1.

[3] The PUC did provide guidance at the end of the AS Study requiring ERCOT to provide analysis for operating to a Watch, Emergency Alert, and Load Shed event no later than the 2027 AS Methodology process. We note that this guidance did not preclude ERCOT from providing that analysis for the 2026 AS Methodology process and given the excessive procurement of reserves under the current set of assumptions, we believe that such analysis should be performed for the 2026 AS Methodology.

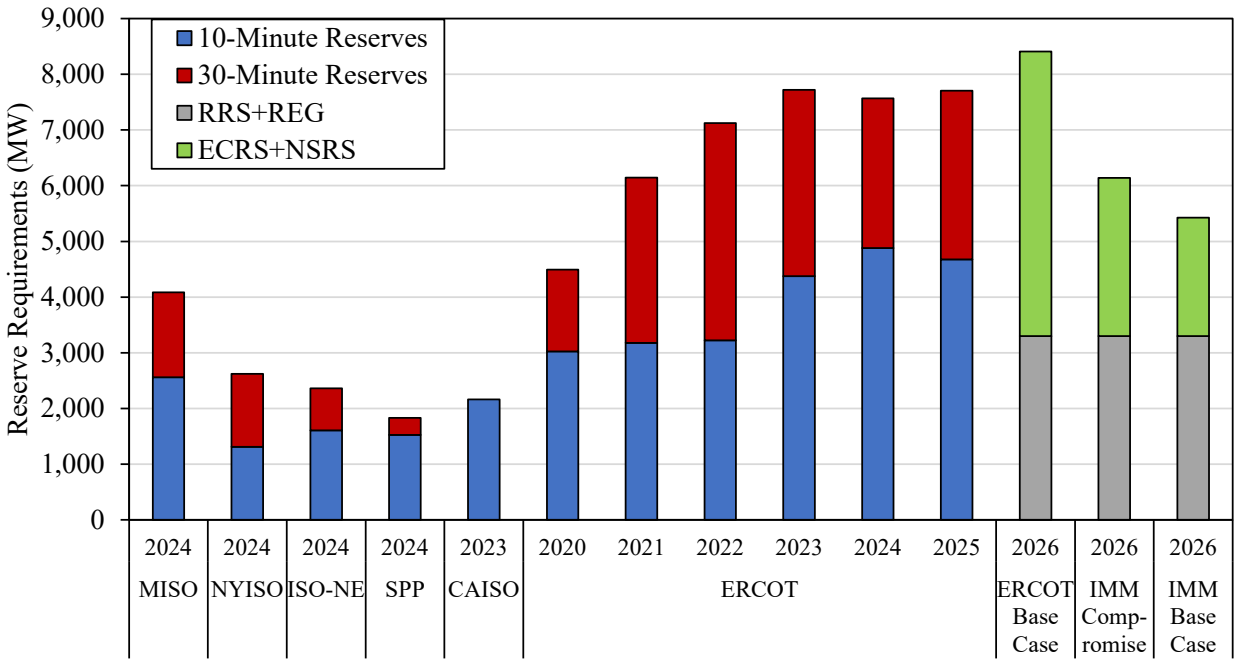
D. Figures and Tables

Table 1. Summary of Impacts of Input Parameters for ERCOT's 2026 AS Methodology[4]

#	Scenario name	Convergence Criteria (MW)	Forecast Error Time Horizon (Hours)	ESR Duration	Annual Probability	ECRS + NSRS Plan (MW)	Absolute Increase from IMM Base Case (MW)	Relative Increase from IMM Base Case (%)
0	IMM Base Case	1,500	1	1	1/10	2,126		
0.1	1/20 Standard for Firm Load Shed	1,500	1	1	1/20	2,341	215	10.1%
1.1	"Watch" Criteria	3,000	1	1	1/10	3,047	922	43.4%
1.2	Max of Firm Load Shed or Reg + RRS	MAX(1,500, RRS+REG)	1	1	1/10	3,180	1,054	49.6%
1.3	Max of "Watch" or Reg + RRS	MAX(3,000, RRS+REG)	1	1	1/10	3,189	1,063	50.0%
2.1	6 HA Forecast Error	1,500	6	1	1/10	3,338	1,212	57.0%
2.2	3 HA Forecast Error	1,500	3	1	1/10	2,842	716	33.7%
3	4 hr. ESR Duration	1,500	1	4	1/10	2,750	624	29.4%
4	ERCOT Base Case	3,000	6	4	1/10	5,108	2,983	140.3%

[4] Note this set of values differs from the previously submitted memo due to calibrating the IMM calculation of ERCOT base case to the preliminary quantities provided by ERCOT for that case.

Figure 1: Reserve Requirements Across Various US Electricity Markets



ERCOT procures significantly more 10 minute and 30 minute reserves than other ISOs.

Figure 2: Annual Probability of Firm Load Shed and entering Watch Conditions

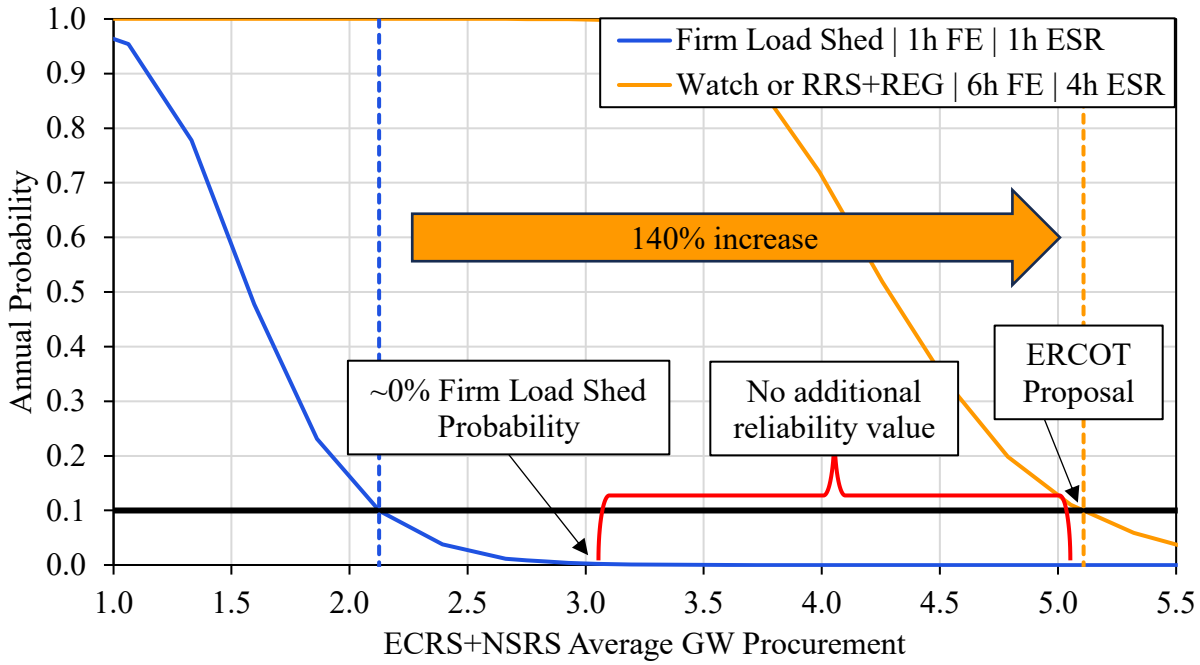
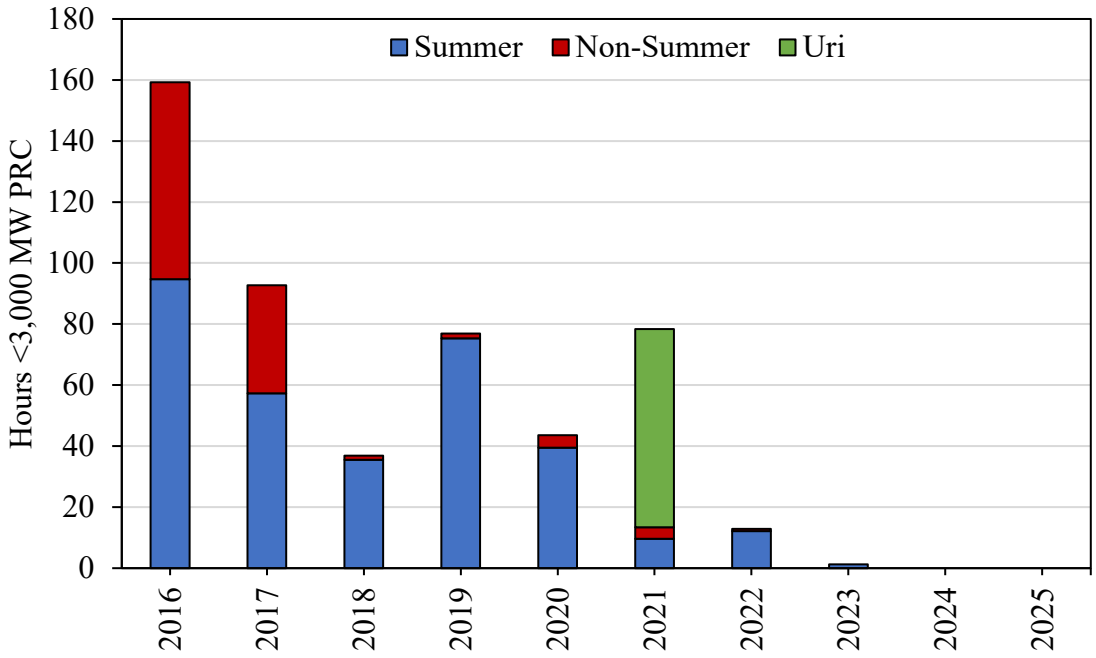


Figure 3: Annual duration of PRC less than 3,000 MW between 2016 and 2025

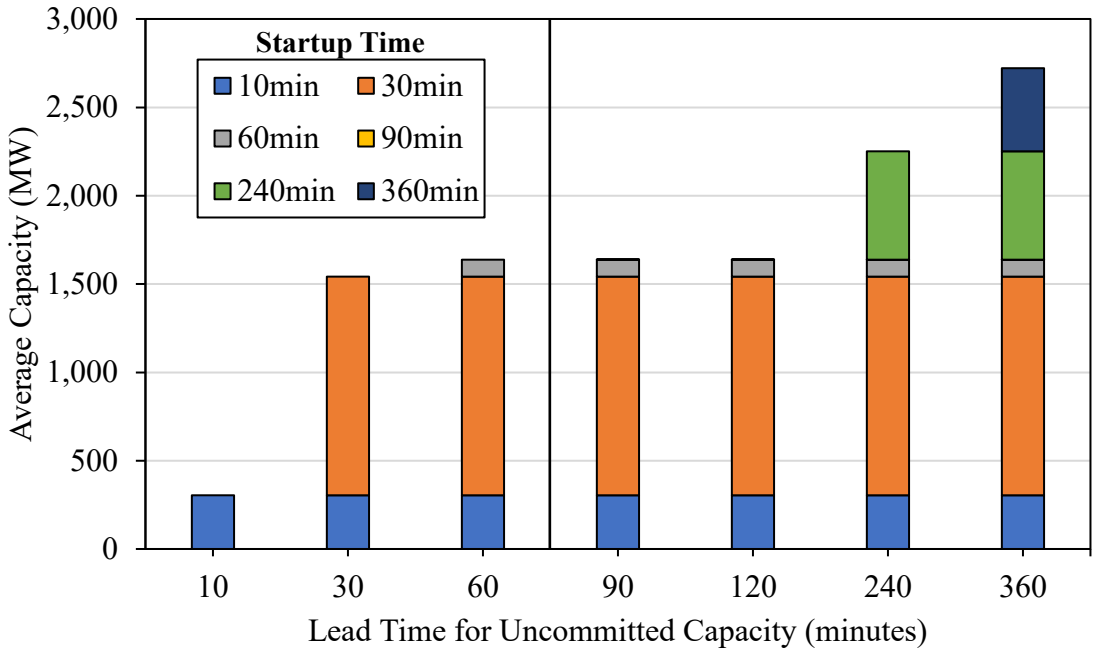


For the five years before Winter Storm Uri, PRC dropped below 3,000 MW for 82 hours on average every year.

Table 2: RegUp + RRS across June 2023 - December 2024

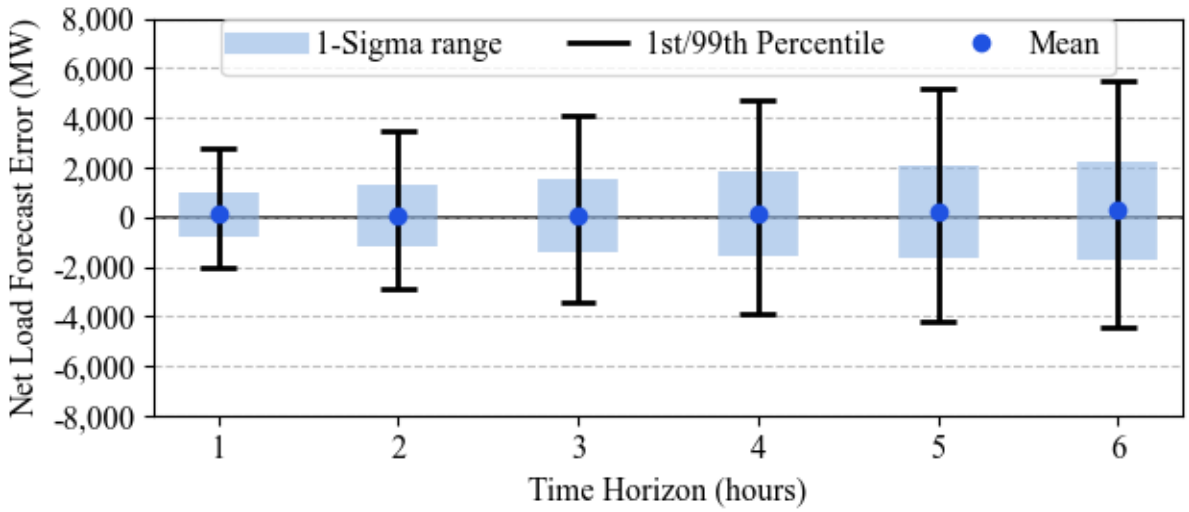
Parameter	Value
Min MW	2,403 MW
Max MW	3,889 MW
Average MW	3,149 MW
Hours >3,000 MW	67%

Figure 4: Resource Availability Across Response Time Intervals



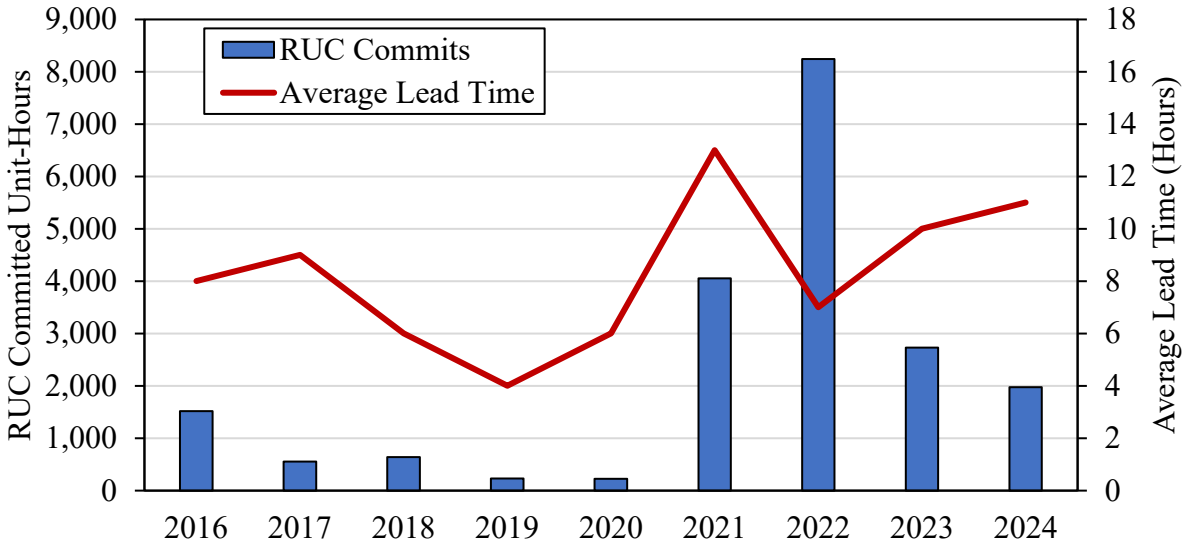
The cumulative capacity of reserves available to start under tight system conditions (PRC < 5,000 MW) includes more than 1,500 MW of capacity capable of starting in an hour or less.

Figure 5: Net Load Forecast Error Across Different Time Horizon Durations



Forecast error risk is nearly twice as high six hours ahead as one hour ahead, ignoring the likelihood of self-commitment from quick-start resources.

Figure 6: RUC Commitments Between 2016 and 2024



After Winter Storm Uri in 2021, the frequency of RUC commits increased substantially, and the average RUC instruction was given further in advance of real-time.

Date: September 15, 2025
To: Board of Directors
From: Nitika Mago, Director Balancing Operations Planning
Subject: 2026 ERCOT Methodologies for Determining Minimum Ancillary Service Requirements

Issue for the ERCOT Board of Directors

ERCOT Board of Directors Meeting Date: September 22-23, 2025

Item No.: 15

Issue:
Whether the Board of Directors (Board) of Electric Reliability Council of Texas, Inc. (ERCOT) should recommend approval of the proposed 2026 ERCOT Methodologies for Determining Minimum Ancillary Service Requirements (2026 AS Methodology) as presented herein, to be effective January 1, 2026.

Background/History:
Ancillary Services are necessary to maintain the reliability of the ERCOT System. The ERCOT Protocols define these Ancillary Services and charge ERCOT with determining a methodology for the minimum levels of Ancillary Services required. Paragraph (2) of Protocol Section 3.16 requires ERCOT to review the methodology at least annually, and paragraph (3) of Section 3.16 requires the Board to review and recommend approval of ERCOT's methodology.

ERCOT staff previously presented the 2025 ERCOT Methodologies for Determining Minimum Ancillary Service Requirements (2025 AS Methodology) to the Board on October 10, 2024, which the Board approved to be effective January 1, 2025 as requested.

The primary changes for the 2026 AS Methodology in comparison to 2025 AS Methodology are related to Regulation Service, ERCOT Contingency Reserve Service (ECRS) and Non-Spinning Reserve (Non-Spin) Service. No change has been proposed to the methodology used to compute Responsive Reserve Service. The changes that are shown in red-line in ***Attachment A*** and can be summarized as follows:

- Responsive Reserve Service (RRS)
    - No Change – i.e., same methodology as approved on October 10, 2024.

- Regulation Service
  - Remove feedback from Fast Responding Regulation Service (FRRS)
- ERCOT Contingency Reserve Service (ECRS) and Non-Spinning Reserve Service (NSRS)
  - Move to a probabilistic model that uses prior four years of 6-hour-ahead-risk (net load (load minus wind minus solar) forecast error and cumulative forced outages of conventional resources), 30-minute-ahead net load forecast error, and moderate risk credit or discount based on historically available headroom to determine ECRS and NSRS quantities such that there is a 1-in-10-year probability of operational reserves dropping below the sum of procured Regulation Up + Responsive Reserve Service quantities or Watch threshold, whichever is higher due to uncertainty in net load forecast and conventional resource availability.

In addition to the changes proposed in the 2026 AS Methodology as outlined above, ***Attachment A*** updates the minimum level of RRS from Resources providing RRS using Primary Frequency Response to 1,377 MW.

On August 27, 2025, the Technical Advisory Committee (TAC) endorsed the proposed 2026 AS Methodology, with an effective date of January 1, 2026.

Key Factors Influencing Issue:

Regulation Service: The proposed methodology change accounts for the retirement of Fast Responding Regulation Service (FRRS) with the implementation of Real Time Co-Optimization plus Batteries (RTC+B) project (in December 2025).

ERCOT Contingency Reserve Service and Non-Spinning Reserve Service: The proposed change to move from a statistical analysis to a probabilistic model for determining ECRS and Non-Spin quantities is linked to two of the AS Methodology related recommendations in the Public Utility Commission's (PUC's) 2024 Ancillary Service Study. The proposed probabilistic model utilizes net risk data (net risk = risk – discount) as input in an optimization with convergence criteria to identify the necessary ECRS and NSRS quantities by month and hour. The following summarizes the key parameters in this probabilistic model and ERCOT's recommended values for the same:

- Historic load, wind and solar forecast error and cumulative thermal forced outage capacity data are used to determine risk inputs to the model. 6 hours lookahead window is recommended for this data. This recommendation is informed by policy guidance from Summer 2021 to operate to a higher reliability threshold (i.e. operate the system more conservatively with limited Reliability Unit Commitments

(RUC)) and is based on historic availability of offline resources during RUC timeframe.

- Historic four-hour sustainable (online and offline) headroom that is achievable within 30 minutes is used to determine a discount on the risks. A 60% discount during night hours and 25% discount during the day is recommended. This recommendation is informed by the recognition that with the implementation of RTC+B project it is likely that the efficiency of unit commitment will improve, thereby reducing the available headroom but the historic trend of having higher available headroom capacity during night hours will continue.
- A probability and capacity floor/threshold establish the convergence criteria for the optimization. A 1-in-10-year probability and greater of PRC level to declare a Watch (presently 3,000 MW) or sum of Reg Up plus RRS requirement are recommended. These recommendations are informed by policy guidance from PUC and policy makers and to meet all NERC requirements in the BAL standards around frequency control. It is worth recognizing that there is a minimal difference in outcomes between 3,000, 2,500 and 1,500 MW or 1-in-10, 1-in-5 or 1-in-1 since quantities for most hours are a function of the amount of Reg Up plus RRS that these reserves have to replace.

These changes were endorsed by the Reliability and Operations Subcommittee (ROS), Wholesale Markets Subcommittee (WMS), and TAC.

Conclusion/Recommendation:
ERCOT staff recommend that the Board recommend approval of the proposed 2026 ERCOT Methodologies for Determining Minimum Ancillary Service Requirements, attached as ***Attachment A***, as endorsed by TAC, to be effective January 1, 2026.

ELECTRIC RELIABILITY COUNCIL OF TEXAS, INC.

BOARD OF DIRECTORS RESOLUTION

WHEREAS, Protocol Section 3.16 requires that the Board of Directors (Board) of Electric Reliability Council of Texas, Inc. (ERCOT), review and recommend approval of the ERCOT methodology for determining the minimum Ancillary Service requirements;

WHEREAS, Protocol Section 3.16 requires, prior to implementation, approval by the Public Utility Commission of Texas (PUCT) of any Board recommendation for determining the minimum Ancillary Service requirements; and

WHEREAS, the 2026 ERCOT Methodologies for Determining Minimum Ancillary Service Requirements (2026 AS Methodology) recommended by ERCOT staff and as endorsed by the Technical Advisory Committee (TAC), as set forth in ***Attachment A***, to be effective on January 1, 2026, and has recommended that the Board approve the 2026 AS Methodology; and

WHEREAS, after due consideration of the alternatives, the Board of Directors (Board) of Electric Reliability Council of Texas, Inc. (ERCOT) deems it desirable and in the best interest of ERCOT to recommend approval of the 2026 AS Methodology;

THEREFORE, BE IT RESOLVED, that ERCOT recommends the PUCT authorize and approve ERCOT to implement the 2026 AS Methodology, as set forth in Attachment A, as endorsed by TAC, to be effective on January 1, 2026.

CORPORATE SECRETARY'S CERTIFICATE

I, Brandon Gleason, Assistant Corporate Secretary of ERCOT, do hereby certify that, at its _____ meeting, the Board passed a motion approving the above Resolution by _____.

IN WITNESS WHEREOF, I have hereunto set my hand this ___ day of _____, 2025.

_____

Brandon Gleason

Assistant Corporate Secretary

Attachment A

ERCOT Methodologies for Determining Minimum Ancillary Service Requirements

ERCOT Board Recommended approval on XX~~10~~/XX~~10~~/202X~~4~~

PUC Approved on XX~~11~~/XX~~21~~/202X~~4~~

Effective Date of 0~~5~~1/0~~5~~1/202~~6~~5

TABLE OF CONTENTS

Introduction

Paragraph (2) of Protocol Section 3.16, Standards for Determining Ancillary Service Quantities, requires that methodologies for determining the amounts of Ancillary Services to be required by ERCOT must be developed at least annually. Paragraph (3) of Protocol Section 3.16 requires review of this methodology by the ERCOT Board of Directors and approval by the Public Utility Commission of Texas (PUCT).

This document discusses the various Ancillary Services for which requirements are to be developed. Further, detailed methodologies for determining those requirements are included as part of this document.

Specifically, methodologies are required for the determination of the quantities of Regulation Service, ERCOT Contingency Reserve Service (ECRS), Non-Spinning Reserve (Non-Spin) and Responsive Reserve (RRS) that are required to maintain system reliability. Those procedures are discussed below.

These procedures are intended for determining each of the Ancillary Service requirements for all months of the upcoming year. This procedure will be performed annually. The Ancillary Service requirements are determined annually and will be posted to the Market Information System (MIS) by December 20th for the upcoming year. If necessary, any additional incremental adjustment to the posted Ancillary Service requirements for a particular month will be made using this procedure and will be posted to the MIS prior to the 20th of each month for the upcoming month. If the Ancillary Service requirements identified through this process for a particular operating day are found to be insufficient based on the expected operating conditions for that day, ERCOT may make an updated Ancillary Service requirements posting for that day if the need for incremental adjustments is identified ~~day-ahead and may use the Supplemental Ancillary Service Market (SASM) process for similar adjustments made~~ closer to Real-Time. For any additional months for which ERCOT is required to provide an Ancillary Service requirement forecast, the forecasted requirement will be set to the historical requirement for the same month of the previous year.

Commented [ERCOT1]: No SASM in RTC

Regulation Service Requirement Details

Introduction

Regulation Service consists of resources that can be deployed by ERCOT in response to changes in ERCOT System frequency to maintain the target ERCOT System frequency within predetermined limits according to the Operating Guides. ERCOT is required to evaluate normal requirements for Reg-Up Service and Reg-Down Service on an annual basis. It is ERCOT's practice to use historical rates of Regulation Service usage to perform evaluation and determine the required quantities for this service. Regulation Service is deployed in order to correct actual frequency to scheduled frequency and to ensure North American Electric Reliability Corporation (NERC) requirements are met.

Summary

The Regulation Service requirements are calculated with the expectation that sufficient Regulation Service will be available to cover the 95th percentile of deployed regulation or net load variability. An adjustment may also be made based on historic CPS1 performance.

Procedure

To evaluate Regulation Service requirements, ERCOT will collect historical Resource Registration information, CPS1 data, Regulation Service deployment data, and ERCOT system load data. For determining the base Reg-Up requirements for a particular hour, ERCOT will calculate the 95th percentile of the positive net load (load – wind – solar) forecast error for the same month of the previous two years. For determining the base Reg-Down requirements, ERCOT will calculate the 95th percentile of the negative net load (load – wind – solar) forecast error for the same month of the previous two years. To better reflect balancing needs within the hours, the net load variability may be updated to account for accumulated Area Control Error (ACE).

In order to consider the increased amount of wind and solar penetration, ERCOT will calculate the increase in installed wind and solar generation capacity, respectively. Then, depending on the month of the year and the hour of the day, ERCOT will add incremental MWs that are derived using the wind and solar forecast error adjustment tables and associated increase in wind and solar generation capacity, to the values determined above. The wind and solar forecast error adjustment tables for incremental MWs for Reg-Up and Reg-Down come from the study ERCOT performs annually, using similar techniques as the 2008 GE wind study, but using actual wind and solar data respectively. The increase in wind (or solar) generation capacity will be calculated by taking the total nameplate capacity of wind (or solar) resources in the ERCOT network model at the time of the procurement study and subtracting out the total nameplate capacity of wind (or solar) resources in the ERCOT model at the end of the month being studied from the previous year.

ERCOT will post these monthly amounts for Regulation Service requirements for the upcoming year on the MIS.

If any incremental changes to the annually posted amounts are needed then the revised amounts for the following month will be posted to the MIS prior to the 20th of the current month. ERCOT may include adjustments for hours in a month considering monthly average for CPS1 and 12-month rolling average CPS1 scores. If it is determined that during the course of the year that the ERCOT monthly average for CPS1 score was less than 140% for a specific month, ERCOT will

apply an extra 10% of both Reg-Up and Reg-Down for hours in which the CPS1 score was less than 140%. Additionally, if the ERCOT 12-month rolling average CPS1 score is less than 140%, for the next month ERCOT will procure an extra 10% of both Reg-Up and Reg-Down for hours in which the hourly CPS1 score was less than 140%. This value will increase to 20% if the CPS1 score falls below 100%.

~~*Non-Spinning Reserve (Non-Spin) Requirement Details*~~

Commented [ERCOT2]: Moving language relevant to 2026 methodology into the updated ECRS and Non-Spin section

~~Introduction~~

~~Non-Spinning Reserve (Non-Spin) consists of Generation Resources capable of being ramped to a specified output level within 30 minutes or Controllable Load Resources that are capable of being interrupted within 30 minutes and that are capable of running (or being interrupted) at a specified output level for at least four consecutive hours. Non-Spin may also be provided by Load Resources that are not Controllable Load Resources and are capable of reducing consumption based on an ERCOT Extensible Markup Language (XML) instruction within 30 minutes and maintaining that deployment until recalled. Non-Spin may be deployed to replace loss of generating capacity, to compensate for Load forecast and/or forecast uncertainty on days in which large amounts of reserve are not available online, to address the risk of net load ramp, or when there is a limited amount of capacity available for Security-Constrained Economic Dispatch (SCED).~~

~~The periods when load is increasing and wind and/or solar are decreasing requires other generation resources to increase output or come online quickly to compensate for the sudden net load increases. As a result, net load ramp risk should be accounted for in the determination of Non-Spin requirements. While net load forecast analysis may cover reserves required for forecast uncertainty, it may not necessarily cover exposure to the loss of generation and net load ramp risk. Due to this risk, it may be necessary for ERCOT to have additional reserves available to protect against forecast uncertainty and Forced Outages of thermal Resources within an Operating Day.~~

~~Summary~~

~~Analysis for Non-Spin requirements are conducted using data from the same month of previous three years. For the purpose of determining the amount of Non-Spin to purchase for each hour of the day, hours will be placed into 4-hour blocks. The net load uncertainty for the analyzed days for all hours which are considered to be part of a 4-hour block will be calculated and a percentile will be assigned to this block of hours based on the risk of net load ramp. The same calculation will be done separately for each block. The Non-Spin requirement for the month for each block is calculated using the assigned percentile (based on risk of net load ramp) for the block minus the average Reg-Up requirement during the same block of hours ("Non-Spin block"). The Non-Spin requirement for each hour in the month is calculated by adding an adjustment that accounts for intra-day Forced Outage of thermal Resources to the previously calculated "Non-Spin block" quantity that the hour falls in.~~

~~ERCOT will post the monthly amounts for Non-Spin requirements for the upcoming year on the MIS. Following this posting, ERCOT will monitor the weather and net load forecast (i.e. load, wind and solar forecasts) near Real-Time and may procure up to an additional 1,000 MW of Non-Spin for Operating Hours that are (a) identified as having an increased potential of high forecast~~

variability, (b) there is a risk that the actual net load during these Operating Hours could be higher than forecast (after making appropriate forecast model selection) and (c) the expected available capacity and expected reserves including the posted minimum Non-Spin requirements during these Operating Hours is not sufficient to cover the projected net load forecast uncertainty risk.

The minimum amount of Non-Spin procured from SCED dispatchable Resources in any hour shall not be less than ERCOT's Most Severe Single Contingency (MSSC) value.

Procedure

ERCOT will determine the Non-Spin requirement using the 75th to 95th percentile of hourly net load uncertainty from the same month of the previous three years. Net load is defined as the ERCOT load minus the estimated un-curtailed total output from Intermittent Renewable Resource (IRR), which includes both Wind-powered Generation Resources (WGRs) and Photo-Voltaic Generation Resources (PVGR) at a point in time. The forecast of net load is computed by subtracting the aggregate IRR High Sustained Limits (HSLs) in the Current Operating Plans (COPs) from the Mid-Term Load Forecast (MTLF). The COPs and MTLF used for HE23, HE24, HE01 and HE02 are the updated values as of four hours prior to each Operating Hour. For remaining hours, the COPs and MTLF used are the updated values as of six hours prior to each Operating Hour. The net load uncertainty is then defined as the difference between the average 5-minute net load within the hour and the forecasted net load.

The risk of net load ramp is determined based on the change in net load over an hour divided by highest observed net load for the season. A fixed value of 68th percentile will be assigned to HE23, HE24, HE01 and HE02 to the net load forecast uncertainty calculated previously. Additionally, in all seasons excluding Winter, in hours HE03, HE04, HE05, HE06 a fixed value of 68th percentile will be assigned for the net load forecast uncertainty calculated previously. For the remaining hours, a fixed value of percentile ranging between 75th percentile and 95th percentile will be assigned to the net load forecast uncertainty calculated previously. Periods where the risk of net load ramp is highest will use 95th percentile and 75th percentile for periods with lowest risks.

ERCOT has seen significant growth in installed wind and solar capacity from one year to the next; an increase in wind and solar capacity also tends to increase the MW quantity of error in their respective forecasts. Hence, ERCOT's reliance on historical wind and solar forecast errors alone creates a possibility of under-estimation of the Non-Spin requirement.

To address this, ERCOT will include the impact of increase in over-forecast error from the expected growth in wind and solar generation installed capacity into the future Non-Spin requirement. The net wind impact is calculated by a multiplication of the projected wind capacity growth between the same month of current year and the next year, and incremental MW adjustment to Non-Spin value per 1000 MW of incremental wind generation capacity. The incremental MW wind adjustment to the Non-Spin value per 1000 MW increase in wind installed capacity is calculated as the change in 50th percentile of the historical wind over-forecast error for 4-hour blocks of each month in the past 5 years, which is then normalized to per 1000 MW of installed wind capacity. The net solar impact is calculated by a multiplication of the projected solar capacity growth between the same month of current year and the next year, and incremental MW adjustment to Non-Spin value per 1000 MW of incremental solar generation capacity. The incremental MW solar adjustment to the Non-Spin value per 1000 MW increase in solar installed capacity is

~~calculated as the change in 50th percentile of the historical solar over-forecast error for 4-hour blocks of each month in the past 3 years, which is then normalized to per 1000 MW of installed solar capacity.~~

~~To account for increased capacity needs due to unplanned generation Outages that occur during an Operating Day, ERCOT will include an incremental adjustment in the Non-Spin requirements that accounts for intra-day Forced Outages of thermal Resources. This Forced Outage adjustment is calculated as the 75th percentile of the historical intra-day Forced Outages (accumulated since midnight) for six-hour blocks of each month in the past three years. ERCOT will purchase Non-Spin such that the combination of Non-Spin and Reg-Up Services cover the uncertainties of net load forecast errors depending on the net load ramp risk and intra-day Forced Outages.~~

Responsive Reserve (RRS) Requirement Details

Nodal Operating Guide Section 2.3.1.1, Obligation, sets the minimum RRS requirement for all hours under normal conditions. ERCOT will procure amounts of RRS that vary by hour of the day and by month. These RRS amounts will be published by month in six separate blocks covering four-hour intervals. These amounts will be based on expected diurnal load, solar, and wind patterns for the month, will cover 70% of historic system inertia conditions for each block of hours for the month, and will use the equivalency ratio for RRS between Load Resources and Generation Resources to establish the conditions for each block of hours. The equivalency ratio will be used to establish the total reserves assuming the Day-Ahead Market (DAM) will use a one to one equivalency ratio. The minimum level of RRS procured from Resources providing RRS using Primary Frequency Response shall be determined for each month by ERCOT through the use of studies and shall not be less than ~~1,365~~ 1,377 MWs. The remaining capacity required for RRS will be procured from all Resources qualified to provide RRS including Load Resources. The maximum amount of RRS that can be provided by Resources providing Fast Frequency Response (FFR) is limited to 450 MW. DAM will limit the combined RRS procured from Load Resources controlled by high set under frequency relay and Resources providing FFR to 60% of the total RRS requirement. ERCOT may increase the minimum capacity required from Resources providing RRS using Primary Frequency Response if it believes that the current posted quantity will have a negative impact on reliability or if it would require additional Regulation Service to be deployed. ERCOT will procure additional 200 MW of RRS for each percent of Reserve Discount Factor (RDF) when ERCOT estimates RDF to be less than 1. This adjustment will only apply for those 4-hour blocks where the 85th percentile of weighted average temperate is greater than 95°F. RDFs are reviewed and adjusted based on the generators performance during an unannounced test. RRS amount will be published as a monthly requirement along with the equivalency ratio for each 4-hour block. Additionally, ERCOT will make incremental adjustments to account for Resources operating in synchronous condenser fast response mode providing RRS. This adjustment will only apply to those 4-hour blocks when system inertia is typically expected to be less than 250 GW*s. ERCOT will post these monthly amounts for the upcoming year on the MIS. These annually published amounts are the minimum quantity that will be procured in the DAM for each hour of the year.

Commented [ERCOT3]: Based on preliminary FRO from NERC

Self-arranged RRS used to fulfill a Qualified Scheduling Entity's (QSE's) RRS requirement will be limited to 60% from Resources providing FFR and Load Resources excluding Controllable Load Resources.

If the percentage level for Resources providing FFR and Load Resources, excluding Controllable Load Resources, specified in the Protocols is changed, that change will be reflected in these requirements.

ERCOT Contingency Reserve Service (ECRS) and Non-Spinning Reserve (Non-Spin) Requirement Details

Commented [ERCOT4]: Edited this to capture details related to probabilistic methodology

Introduction

ECRS is a service that is provided using capacity that is capable of being ramped to a specified output level within 10 minutes. ECRS may be provided by unloaded, On-Line Generation Resource capacity; Quick Start Generation Resources (QSGRs); Load Resources that may or may not be controlled by high-set, underfrequency relays; Controllable Load Resources; and Generation Resources operating in synchronous condenser fast-response mode as defined in the Operating Guides. ECRS may be deployed to restore frequency within 10 minutes of a significant frequency deviation to recover deployed Regulation Service, to compensate for intra-hour net load forecast uncertainty and variability on days in which large amounts of online thermal ramping capability is not available, or when there is a limited amount of capacity available for Security-Constrained Economic Dispatch (SCED).

Non-Spin consists of Generation Resources capable of being ramped to a specified output level within 30 minutes or Controllable Load Resources that are capable of being interrupted within 30 minutes and that are capable of running (or being interrupted) at a specified output level for at least four consecutive hours. Non-Spin may also be provided by Load Resources that are not Controllable Load Resources and are capable of reducing consumption based on an ERCOT Extensible Markup Language (XML) instruction within 30 minutes and maintaining that deployment until recalled. Non-Spin may be deployed to replace loss of generating capacity, to compensate for Load forecast and/or forecast uncertainty on days in which large amounts of reserve are not available online, to address the risk of net load ramp, or when there is a limited amount of capacity available for Security-Constrained Economic Dispatch (SCED).

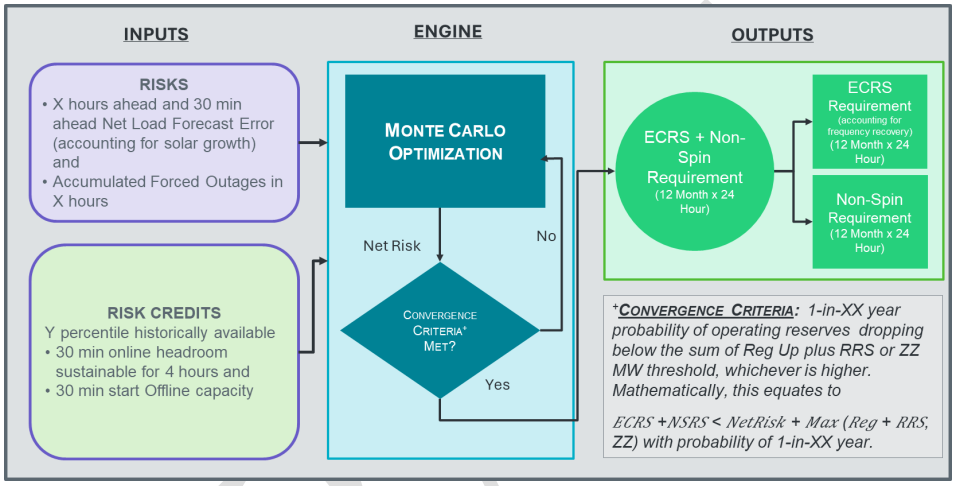
The periods when load is increasing and wind and/or solar are decreasing requires other generation resources to increase output or come online quickly to compensate for the sudden net load increases. As a result, net load ramp risk should be accounted for in the determination of Non-Spin requirements. While net load forecast analysis may cover reserves required for forecast uncertainty, it may not necessarily cover exposure to the loss of generation and net load ramp risk. Due to this risk, it may be necessary for ERCOT to have additional reserves available to protect against forecast uncertainty and Forced Outages of thermal Resources within an Operating Day.

Procedure~~Summary~~

A diagram of a probabilistic methodology used to calculate ECRS and NSRS requirements is shown below. The methodology utilizes an accounting of r~~R~~isk for which ECRS and NSRS are needed and accounting of historic excess capacity that may have available to respond to these risks.

Risks accounting ~~which~~ includes~~s~~ 30 minute ahead and 6 hour ahead historic net load forecast errors and historic rolling 6 hour ahead forced outages of conventional Resources from the previous four years~~ unitsRisk Credits which include 30 minute ramp able online headroom~~

~~capacity that is sustainable for 4 hours and excludes capacity/energy reserved for Ancillary Service obligation, and offline capacity which can be brought online within 30 minutes and does not have an Ancillary Service obligation~~. ERCOT continues to see significant growth in installed solar capacity from one year to the next; an increase in solar capacity also tends to increase the MW quantity of error in its forecast. Hence, ERCOT's reliance on historical solar forecast errors alone creates a possibility of under-estimation of the total requirement of ECRS and NSRS. To address this ERCOT will include and adjustment for expected increase in solar forecast error due to expected increase in installed capacity of solar Resources.



Risk credits include historic online capacity that can be ramped to in 30-minutes and sustained for 4 hours, and historic offline capacity that can be brought online in 30 minutes. The engine will consume the risk and 60% of the historically available capacity for night hours (HE23-HE5) and 25% of the historically available capacity in day hours (HE6-HE22) as inputs, run a monte carlo optimization to compute a combined ECRS and NSRS ~~which will increase and reduce month/hour~~ requirement for each month and hours ~~based on the~~a ~~designated~~ convergence criteria. The convergence criteria will ~~to~~ensure that the ~~total~~ ECRS and Non-Spin requirements computed (12 x 24 = 8760 values) ~~meet the net load~~are setup such that there is a 1 in 10-year probability of operational reserves dropping below the sum of procured Reg Up and RRS or ~~to risk to avoid an Emergency Condition~~Watch threshold (~~insufficiency of reserves with a threshold of Watch,~~Physical Responsive Capability (PRC) = 3,000 MW), whichever is higher, due to uncertainty in net load (load – wind - solar) forecast and conventional resource availability. ~~insufficient uncertainty reserves, with a 1 in 10 year probability and additionally restore procured Reg Up and RRS.~~ The ~~Once we have total risk requirement for~~ hourly requirement for ECRS and Non-Spin will be derived by using the 30 minute ahead and 6 hour ahead historic~~, we use a ratio-based analysis on~~ net load forecast error and ~~to allocate~~the combined ECRS and Non-Spin ~~specific~~ requirements from the optimization. ECRS requirement may be increased further to account for the capacity needed to recover frequency following a large unit trip~~-~~.

Commented [ERCOT5]: Updated based on Feedback from OPUC and the Consumer segment

~~**Procedure**~~

~~ERCOT will procure amounts of ECRS that vary by hour of the day and by month. ERCOT will determine the ECRS requirement as the maximum of capacity needed to recover frequency following a large unit trip and capacity needed to cover for intra-hour net load forecast errors.~~ The frequency recovery related capacity for ECRS is computed for each hour in every month as capacity needed following a supply-side trip to recover frequency; will be based on expected diurnal load, solar, and wind patterns; will cover 70% of historic system inertia conditions for each hour for the month and will include an adjustment to account for Regulation Up requirement in the hour.

~~Intra-hour net load forecast is utilized in establishing Base Points for SCED dispatchable Resources. ERCOT has observed larger intra-hour net load forecast errors during times when there are sudden net load ramps. Through including intra-hour net load forecast errors in calculating ECRS quantities, uncertainty in forecasting intra-hour net load (and hence intra-hour net load ramps) will be accounted for. Specifically, the intra-hour net load forecast error related capacity for ECRS is computed using the 85th to 95th percentile of intra-hour net load uncertainty from the same hour and same month in the previous two years. Net load is defined as the ERCOT load minus the estimated un-curtailed total output from Intermittent Renewable Resource (IRR), which includes both Wind-powered Generation Resources (WGRs) and Photo-Voltaic Generation Resources (PVGR). The forecast of net load is computed by subtracting the Intra-Hour Wind Power Forecast (IHWPF) and Intra-Hour Photo-Voltaic Power Forecast (IHPPF) from the Intra-Hour Load Forecast (IHLF). The IHWPF, IHPPF and IHLF used are the updated values as of thirty minutes prior to each Security Constrained Economic Dispatch (SCED) interval. The net load uncertainty is then defined as the difference between the average net load within the SCED interval and the forecasted net load.~~

~~The risk of net load ramp is determined based on the change in net load over an hour divided by highest observed net load for the season. The fixed value of percentile ranging between 85th percentile and 95th percentile will be assigned to the net load forecast uncertainty calculated previously. Periods where the risk of net load ramp is highest will use 95th percentile and 85th percentile for periods with lowest risks.~~

~~ERCOT has seen significant growth in installed solar capacity from one year to the next; an increase in solar capacity also tends to increase the MW quantity of error in their respective forecasts. Hence, ERCOT's reliance on historical solar forecast errors alone creates a possibility of under-estimation of the ECRS requirement. To address this, ERCOT will include the estimated impact of increase in over-forecast error from the expected growth in solar generation installed capacity into the future ECRS requirement. The net solar impact is calculated by a multiplication of the projected solar capacity growth between the same month of current year and the next year, and incremental MW adjustment to ECRS value per 1000 MW of incremental solar generation capacity. The incremental MW solar adjustment to the ECRS value per 1000 MW increase in solar installed capacity is calculated as the change in 50th percentile of the historical solar over-forecast error for 4-hour blocks of each month in the past 2 years, which is then normalized to per 1000 MW of installed solar capacity.~~

ERCOT will post the monthly amounts for ECRS and Non-Spin requirements for the upcoming year on the MIS. Following this posting, ERCOT will monitor the weather and net load forecast

(i.e. load, wind and solar forecasts) near Real-Time and may procure up to an additional 1,000 MW of Non-Spin for Operating Hours that are (a) identified as having an increased potential of high forecast variability, (b) there is a risk that the actual net load during these Operating Hours could be higher than forecast (after making appropriate forecast model selection) and (c) the expected available capacity and expected reserves including the posted minimum Non-Spin requirements during these Operating Hours is not sufficient to cover the projected net load forecast uncertainty risk.

The minimum amount of Non-Spin procured from SCED dispatchable Resources in any hour shall not be less than lower of ERCOT's Most Severe Single Contingency (MSSC) value and the Non-Spin requirement for that hour.