Price Formation Enhancements
Scarcity Pricing: Anchoring Penalty Prices to the Value of Lost Load

Policy Development Working Group

Afternoon Session 2

January 22, 2025

Workshop Goal

- Review and discuss updates to the value with which to anchor and scale pricing run penalty prices to ensure alignment with current Western Interconnection market conditions and proper scarcity value of reserves.

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Workshop Agenda

Topic	Presenter	Time
Welcome and Introductions	Brenda Marquez	10 minutes
Exploring Potential Enhancements	James Friedrich	80 minutes
Stakeholder Presentation: Price Formation Enhancements in Competitive Electric Markets	Seth Cochrane (Vitol)	30 minutes
Open Discussion and Q&A	All	30 minutes

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Scarcity Pricing

EXPLORING POTENTIAL ENHANCEMENTS

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The Role of Pricing Run Penalty Prices

- If the market cannot find a feasible solution with the submitted bids, it relaxes constraints at a **penalty price.**

- In the scheduling run, penalty prices help to prioritize different types of constraints and schedules.

- The **pricing run** replaces the scheduling run's penalty prices with prices anchored to and scaled by the relevant market bid cap to determine final market-clearing prices.

- The pricing run is what determines the final, binding **schedules** and **prices** in the CAISO market

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The Role of Pricing Run Penalty Prices

- The power balance penalty price in the pricing run is a key reference point for scaling other market constraint penalty prices.
  - It is set at $1,000/MWh under routine conditions, but increases to $2,000/MWh under certain conditions.
  - When the power balance penalty price is set to $2,000/MWh, all other market constraint penalty prices are scaled relative to this higher value.

- The market generally applies penalty prices uniformly across the regional footprint.
  - The market calculates unique FRU/FRD demand curves for each WEIM BAA based on its specific requirements but the "avoidance cost" is the same for all BAAs

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Revisiting the Problem Statement

- Anchoring penalty prices to the bid cap creates a somewhat arbitrary relationship. While the bid cap represents the maximum price a resource can offer, it doesn't necessarily reflect the economic harm caused by a supply shortfall or a reliability event. This can lead to:
  - **Understating the Value of Reliability**: If penalty prices are too low, they may not adequately incentivize market participants to take actions that prevent shortages or maintain grid reliability, especially if higher prices can be achieved outside CAISO administered markets.
  - **Increased Risk of Reliability Events**: If the cost of a shortage (as reflected in penalty prices) is lower than the true economic cost of lost load, the market may be less effective at preventing such events.

Introducing VOLL-Based Penalty Prices

- This is where the concept of **Value of Lost Load (VOLL)** comes in.

- VOLL represents an estimation of the economic cost to consumers for an involuntary interruption of electricity supply. It essentially quantifies the value that consumers place on reliable electricity service.

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How VOLL would be used

- Instead of tying penalty prices to the bid cap, they could be anchored to and scaled based on VOLL estimates. This would mean:
  - Conducting studies to estimate the economic cost of outages for different customer types and potentially different regions within the market footprint.
  - Setting administrative penalty prices for various constraint violations in the pricing run at levels derived from the VOLL estimates. For example, the penalty price for violating the power balance constraint (which could lead to load shedding) could be set at or near the estimated VOLL.
  - Scaling penalty prices under a VOLL-based construct similar to current practices. For example, penalty prices for less severe constraint violations could be scaled down proportionally from the VOLL-anchored maximum. The scaling will still consider the need to prioritize the relaxation of constraints based on their relative severity in the scheduling run.

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How VOLL would be used

- The general principle in many markets is to design the Operating Reserve Demand Curve (ORDC) so that it reflects the Expected Value of Lost Load (EVLL).
  - EVLL represents the risk-weighted cost of load shedding. It's the product of the consequence of load shedding (VOLL) and the probability of load shedding occurring (LOLP, or loss of load probability). EVLL = VOLL * LOLP
  - In other words, as the LOLP increases (meaning reserves are becoming more scarce and the risk of load shedding is rising), the price of reserves should increase proportionally, approaching the VOLL as the probability of an outage approaches 100%.

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Potential Benefits of VOLL-Based Penalty Prices

- **More accurate price signals** by reflecting the true economic cost of load shedding.

- **Improved system reliability** by aligning penalty prices more closely with the actual cost of lost load.

- **Enhanced market efficiency** by improving market dispatch and commitment decisions and maximizing market participation across the footprint.

MISO ER25-579-000 (Filed November 2024)

- MISO argues its current VOLL of $3,500/MWh is outdated (established in 2009) and understates the true value of lost load.
  - For reference all CAISO pricing run penalty prices are anchored to $1,000 or $2,000/MWh

- MISO proposes to establish a new "Pricing VOLL" of $10,000/MWh. This would serve as:
  - A price cap in both the day-ahead and real-time markets.
  - An administrative price during an EEA-3 that results in MISO-directed load shedding.

- MISO also proposes a new "System VOLL" of $35,000/MWh. This would be used to scale MISO's ORDC.

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MISO VOLL Analysis

- MISO updated its VOLL calculations in late 2023 using the methodology from this LBNL study (https://www.osti.gov/servlets/purl/1172643).
  - The LBNL study is a meta-analysis that compiles and analyzes data from numerous stated preference studies and provides outage cost functions that estimate VOLL based on factors like customer class, outage duration, time of day, and season. MISO did not conduct its own survey to estimate VOLL, which would be very expensive and time-consuming.

- This updated analysis produced a range of VOLL values significantly higher than the current $3,500/MWh. For example, a MISO-wide, load-weighted average across all customer classes resulted in a VOLL of $36,889/MWh for a 1-hour outage.

- Even when focusing primarily on residential customers (as the original VOLL did), the updated analysis suggests a VOLL in the range of $13,640/MWh.
  - MISO chose the $10000/MWh value primarily based on the lowest willingness to pay among different customer classes, focusing on the residential sector because its load-shedding procedures prioritize shedding residential load first.

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MISO filing includes a "circuit breaker" proposal

- MISO proposes adding market price "circuit breakers" to its Tariff.
  - These circuit breakers will reduce the VOLL under certain conditions during a MISO-declared EEA-3.
  - E.g., after four cumulative hours of EEA-3, the VOLL will be reduced from $10,000/MWh to $5,000/MWh.

- The purpose is to mitigate the financial impacts of long-duration shortage conditions on market participants

- The reduction in VOLL is tied to the length of the shortage based on data showing that the cost of outages decreases as the duration of the outage increases.

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Other studies

- Gorman and Callaway (2024) found an average VOLL estimate of $10-14/kWh ($10,000-14,000/MWh) for California residential customers.

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Market Surveillance Committee comments on VOLL

- [Market Surveillance Committee Scarcity Pricing Background Discussion (2020)](#) discusses two main views on defining penalty prices for reserve demand curves.
- One view is that the value of reserves should be estimated by the value of lost load and the probability of controlled load shedding being required within that balancing area at some point over the next hour with that level of reserves. The second is to estimate the value of reserves by examining the cost of the actions operators would take to maintain that level of reserves.
- The presentation states that both views have limitations:
  - The first view assumes that the only cost of low reserves is the potential for controlled load shedding, when an important cost of inadequate reserves is the increased potential for uncontrolled load shedding.
  - The second view assumes that costs of operator actions can always be measured.

Challenges and Considerations

- Depending on the methodology, estimating VOLL can be complex and resource-intensive.

- VOLL studies often rely on stated preference methods. These methods have limitations. What people say they are willing to pay in a hypothetical scenario may differ from their actual behavior during an outage.

- CAISO would need to collect and harmonize data on load profiles, outage patterns, and customer valuations of reliability from across EDAM/WEIM BAAs.

- In the EDAM/WEIM, the concept of a system-wide VOLL is less straightforward since each BAA is responsible for its own resource adequacy. Each BAA may have different reliability standards, planning reserve margins, and outage cost tolerances.

- It is unclear whether sufficient data exists to perform accurate LOLP calculations in WEIM BAAs since not all resources are participating in the market and there is no WEIM-wide market for operating reserves.