

THE GB ELECTRICITY MARKET

HOSTEL ID : 84

Background and Problem Statement

- The GB electricity market, known for its liberalized and competitive environment, enables trading of electricity between generators, suppliers, and other market participants. Our focus is the intraday spot market, where electricity prices can fluctuate significantly within the day. By analyzing these fluctuations from October 1, 2024, to December 31, 2024, our goal is to devise a trading strategy that leverages observed price volatility patterns.
- The intraday spot market in the GB electricity market operates within a framework that allows for the buying and selling of electricity on a short-term basis, typically on the same day or the next day. Prices in this market are particularly volatile due to several factors including demand and supply dynamics, availability of renewable energy sources like wind and solar, and unforeseen outages or fluctuations in generation.

PROPOSED SOLUTION

Our proposed solution comprises three key components:

REGIME IDENTIFICATION

TREND IDENTIFICATION

TRADING STRATEGY FORMULATION

These methodologies integrate quantitative analysis with market intuition to effectively capitalize on intraday price movements within the GB electricity market.

REGIME IDENTIFICATION

We have employed three distinct techniques to classify market regimes. Initially, we utilized the Average True Range (ATR) approach to classify market volatility. Subsequently, we implemented the Cumulative Sum (Cusum) method to identify regime shifts. Finally, we adopted a time-based approach, specifically an hour-based classification, to account for the unique characteristics of the GB electricity market.

ATR Based Volatility Analysis

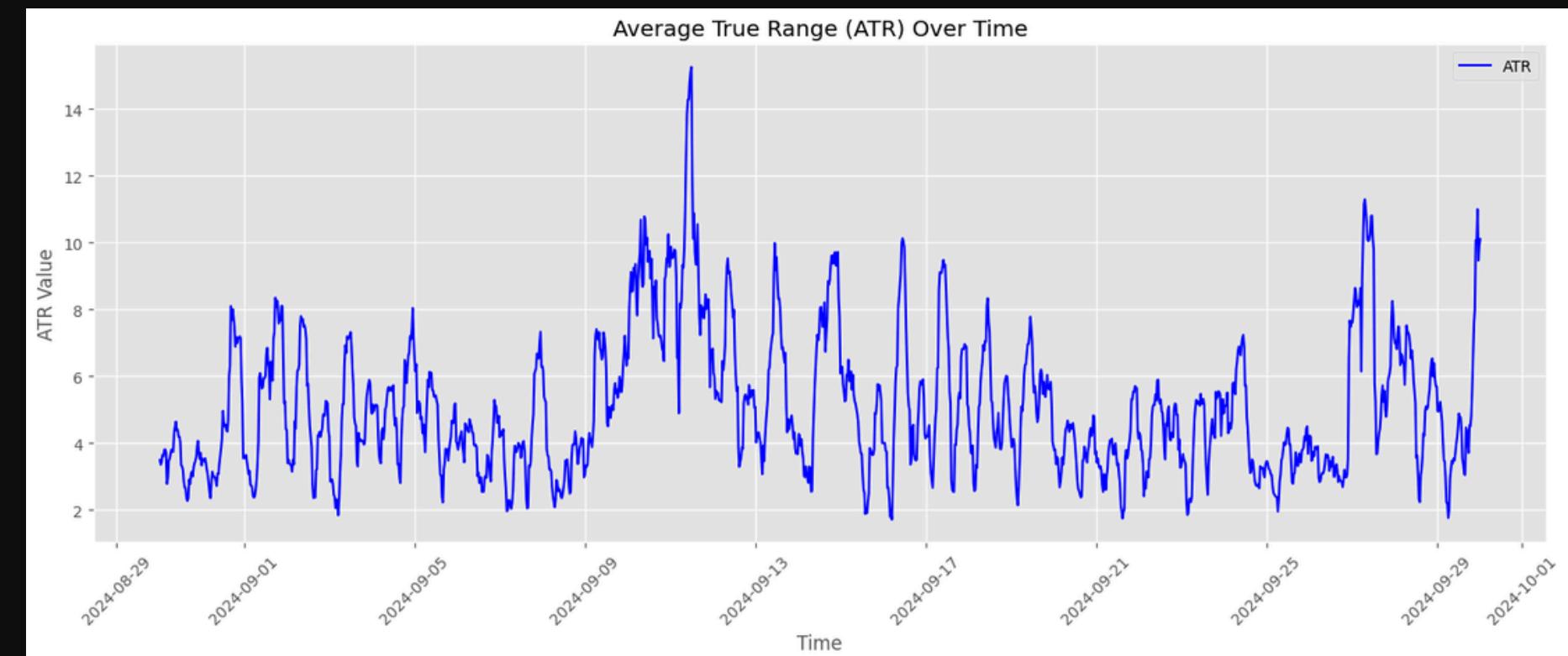
Why ATR ?

The Average True Range (ATR) was selected as a key metric to assess market volatility due to its statistical simplicity and effectiveness. ATR provides a clear measure of market fluctuation by calculating the average of true ranges over a specified period. This methodology is particularly efficient in capturing the extent of price movements, thereby enhancing the reliability of our capital allocation strategies per trade.

True Range : The True Range is determined by the greatest of the following:

- The difference between the current high and the current low.
- The absolute difference between the current high and the previous close.
- The absolute difference between the current low and the previous close.

This ensures that the ATR reflects the true magnitude of price movements, crucial for managing market risks and optimizing trade sizes.



CUSUM - Cumulative Sum

The Cumulative Sum (Cusum) method is a sequential analysis technique used to detect changes in the mean level of a measured quantity, particularly useful in identifying shifts in process behavior. This method accumulates positive and negative deviations from a predetermined target mean, effectively highlighting even subtle shifts.

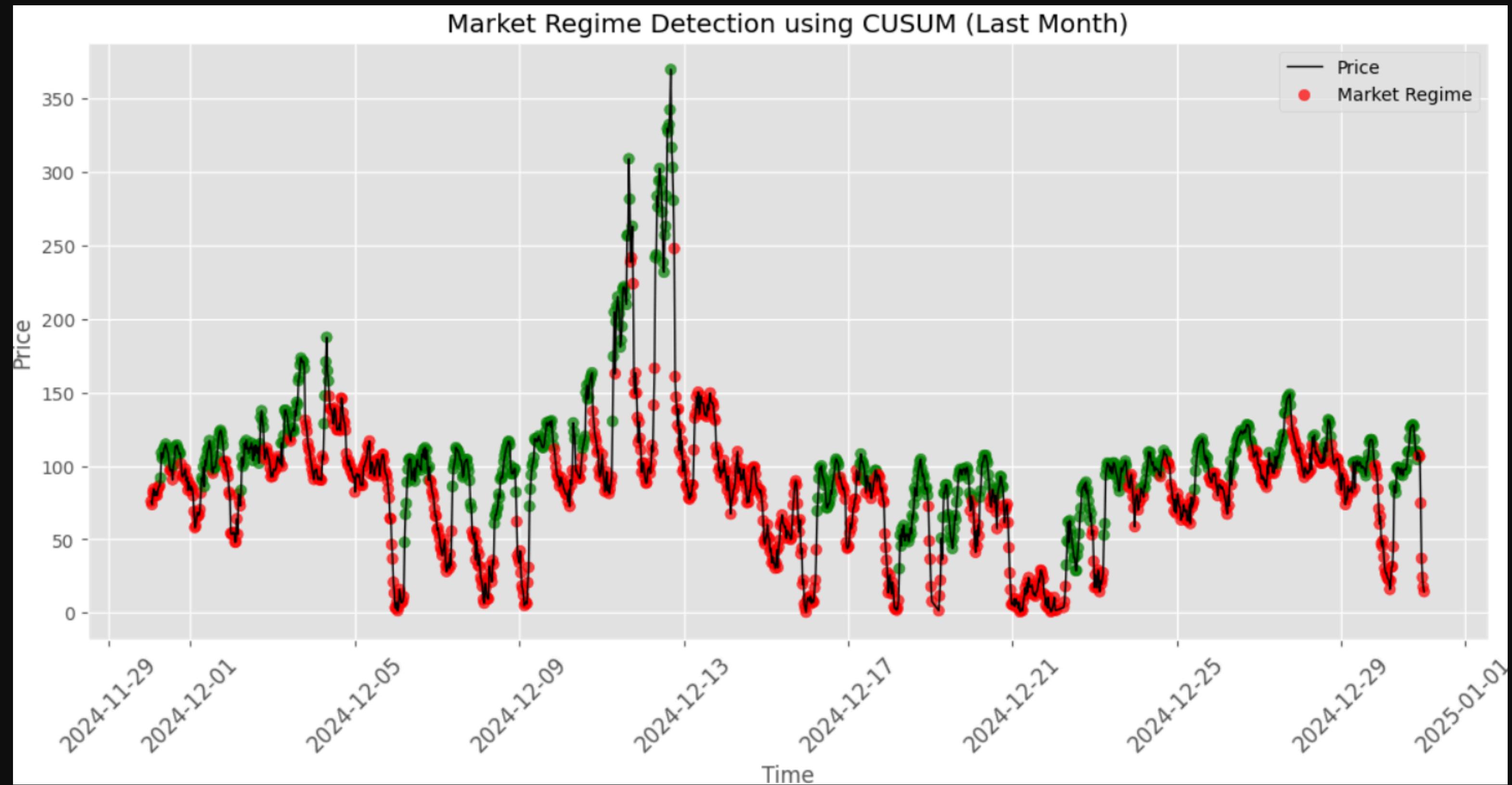
Key Calculations

Deviation: The difference between the observed value x_i (e.g., price) and the reference value:

$$d_i = x_i - \mu_0$$

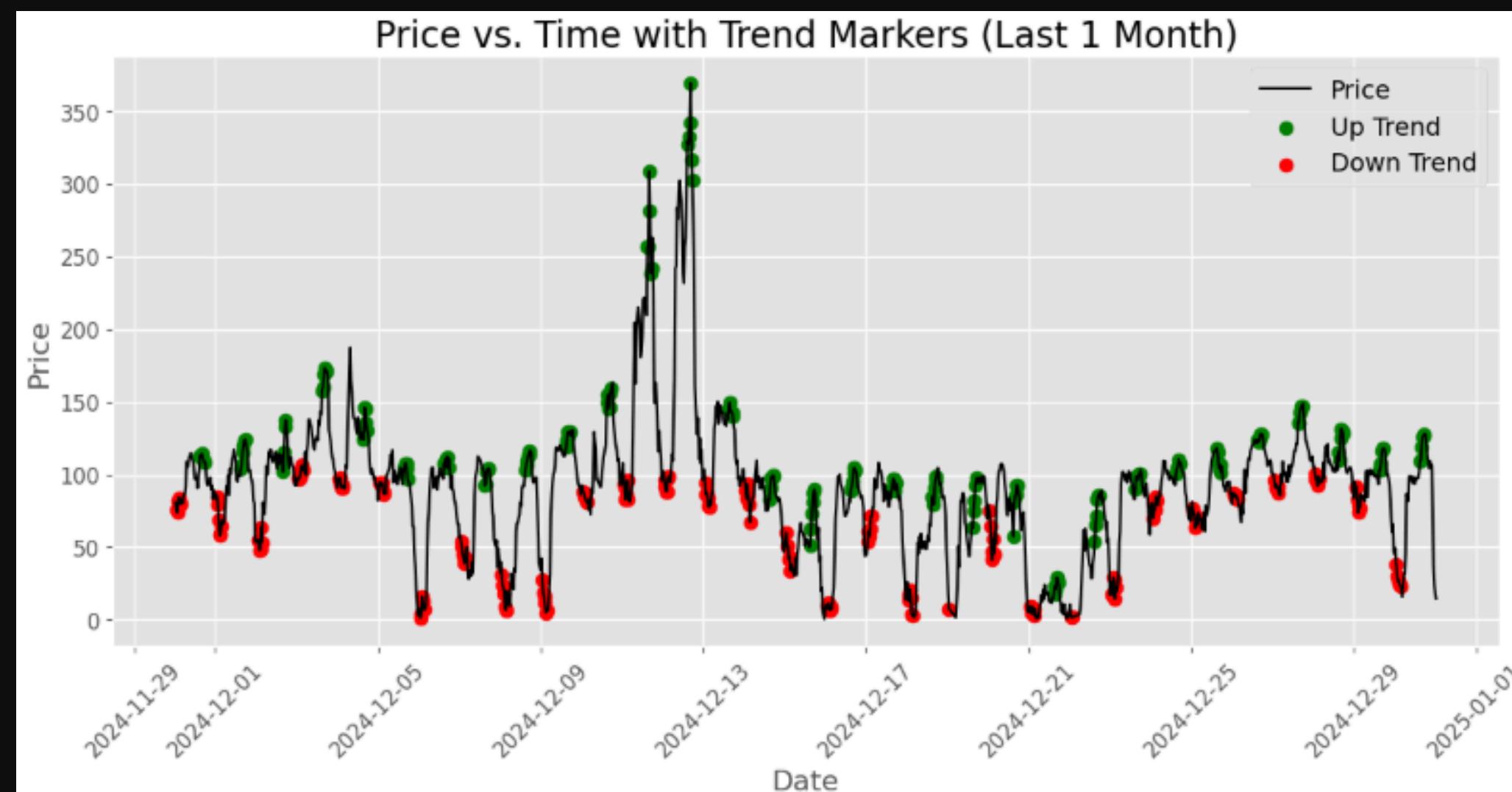
Cumulative Sum: Tracks the cumulative deviations over time:

$$S_m = \sum_{i=1}^m (x_i - \mu_0)$$



Time Specific Demand

With the help of research paper and news we recognize the influence of time-specific demand variations that influence the market. Typically, residential consumption increases significantly during the evening hours (i.e., from 3pm to 6pm), leading to higher electricity demand and early morning hours (i.e., from 1 am to 4 am) experience notably lower demand. Based on such observations, we classify times of day as likely to experience either bullish or bearish runs.



Trend Identification

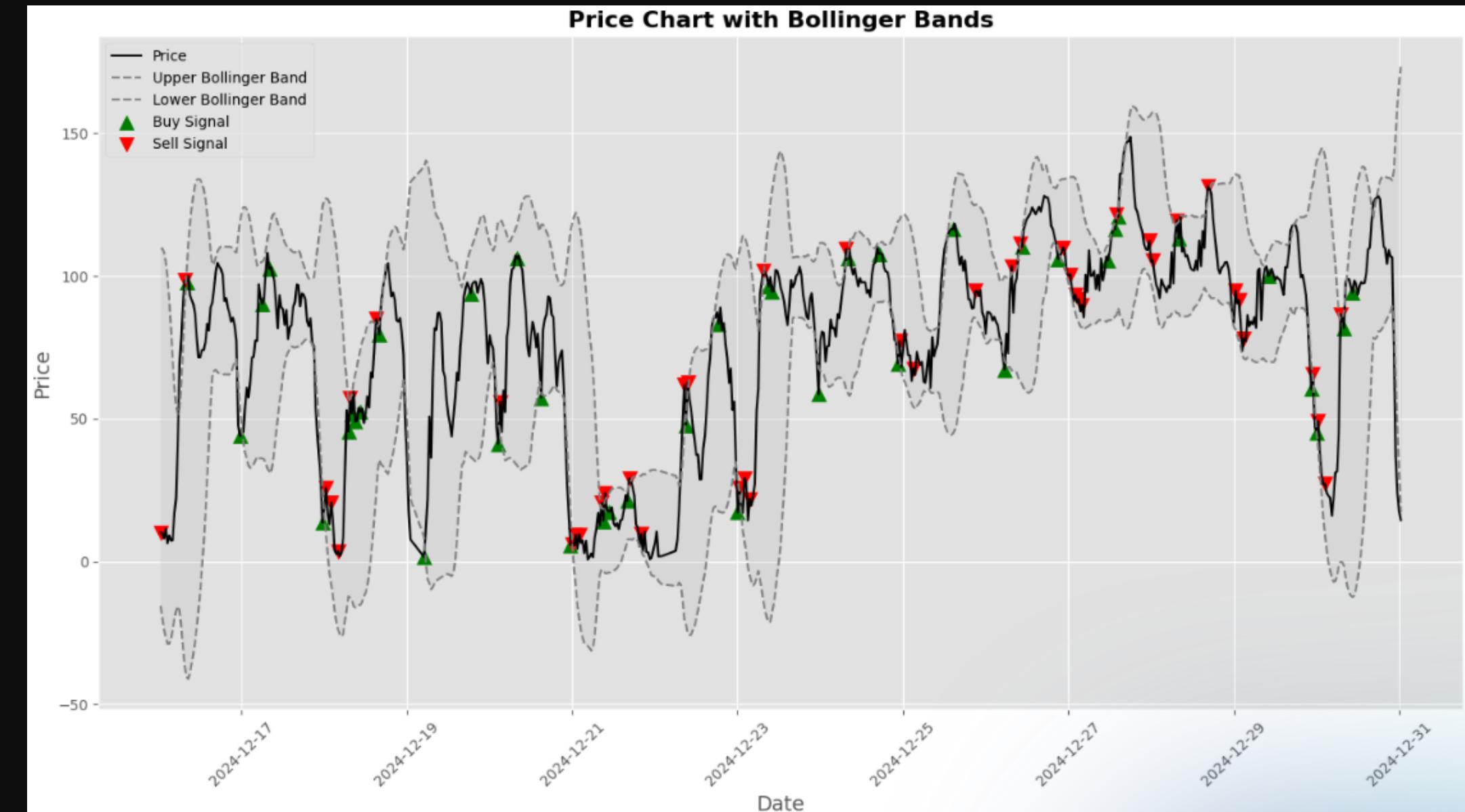
To effectively capture market trends and significant price movements, we employ two primary technical analysis tools: Bollinger Bands and the Zig-Zag indicator.

Bollinger Bands: These bands measure market volatility and indicate overbought or oversold conditions. They consist of:

- Upper Band: $\text{SMA} + 2 \times \text{STD}$
- Lower Band: $\text{SMA} - 2 \times \text{STD}$
- Middle Band: SMA

The bands dynamically adjust to volatility, providing crucial trading signals. Prices moving outside the bands often suggest a mean reversion opportunity, as they typically revert back within the bands.

Zig-Zag Indicator: This indicator filters out minor price fluctuations to highlight significant trends, identifying major swing highs and lows. It helps clarify trend directions by removing market noise and confirming trend continuations or reversals.



Trading Strategy

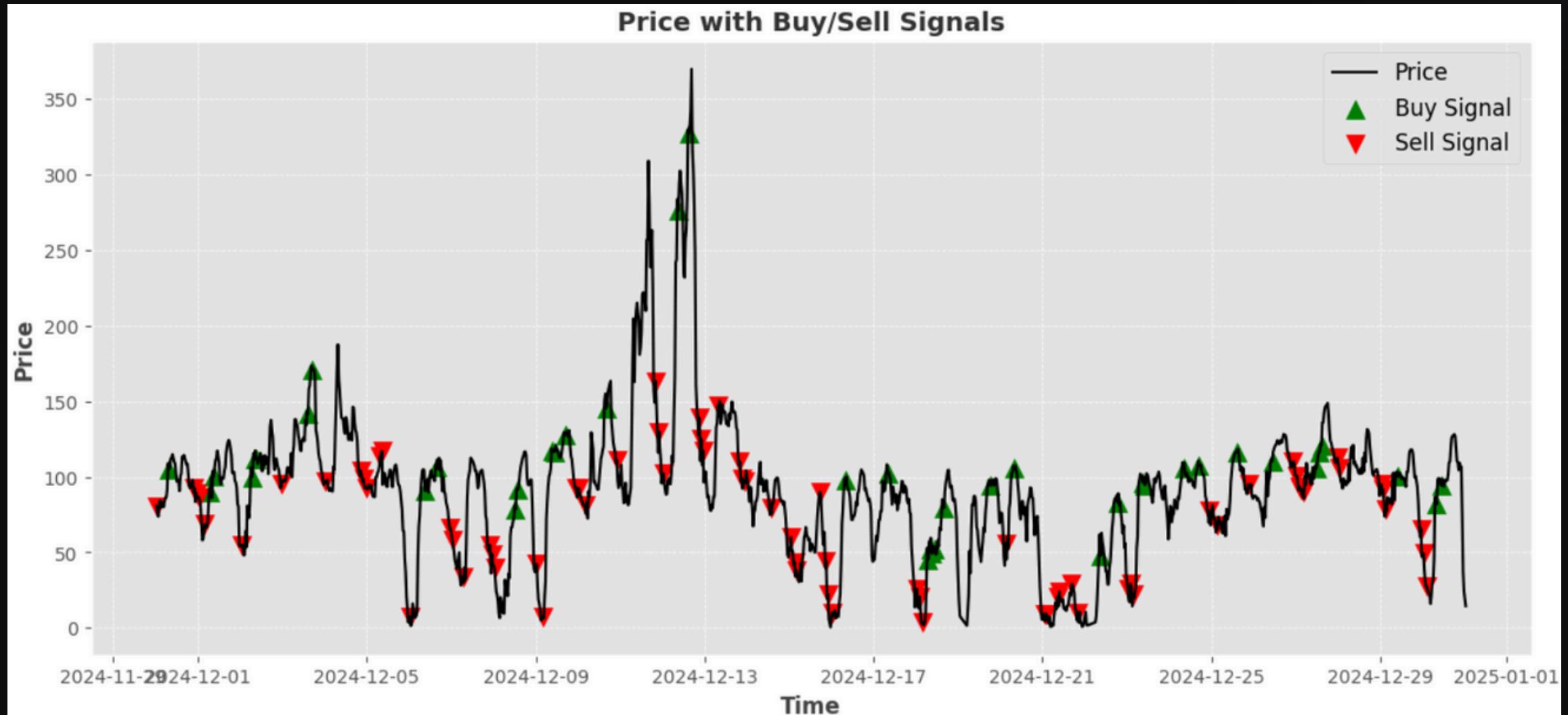
Our strategy integrates the CUSUM method and Trend Identification to optimize trade execution. This approach aligns our trading signals with market dynamics, enhancing the probability of successful outcomes by capitalizing on the confluence of real-time market insights.

Signal Generation:

- We execute trades when the signals generated by our trend identification strategy align with the identified market regime using CUSUM method. This synchronization ensures we capitalize on opportunities that match our analytical insights, optimizing trade timing and effectiveness.

Capital Allocation Strategy

- When our generated signals align with our hourly regime analysis indicating bullish conditions, we assign 10% of our capital to the trade, reflecting our higher conviction. In all other scenarios, we allocate 5% of our capital, adopting a more conservative approach due to lower certainty.



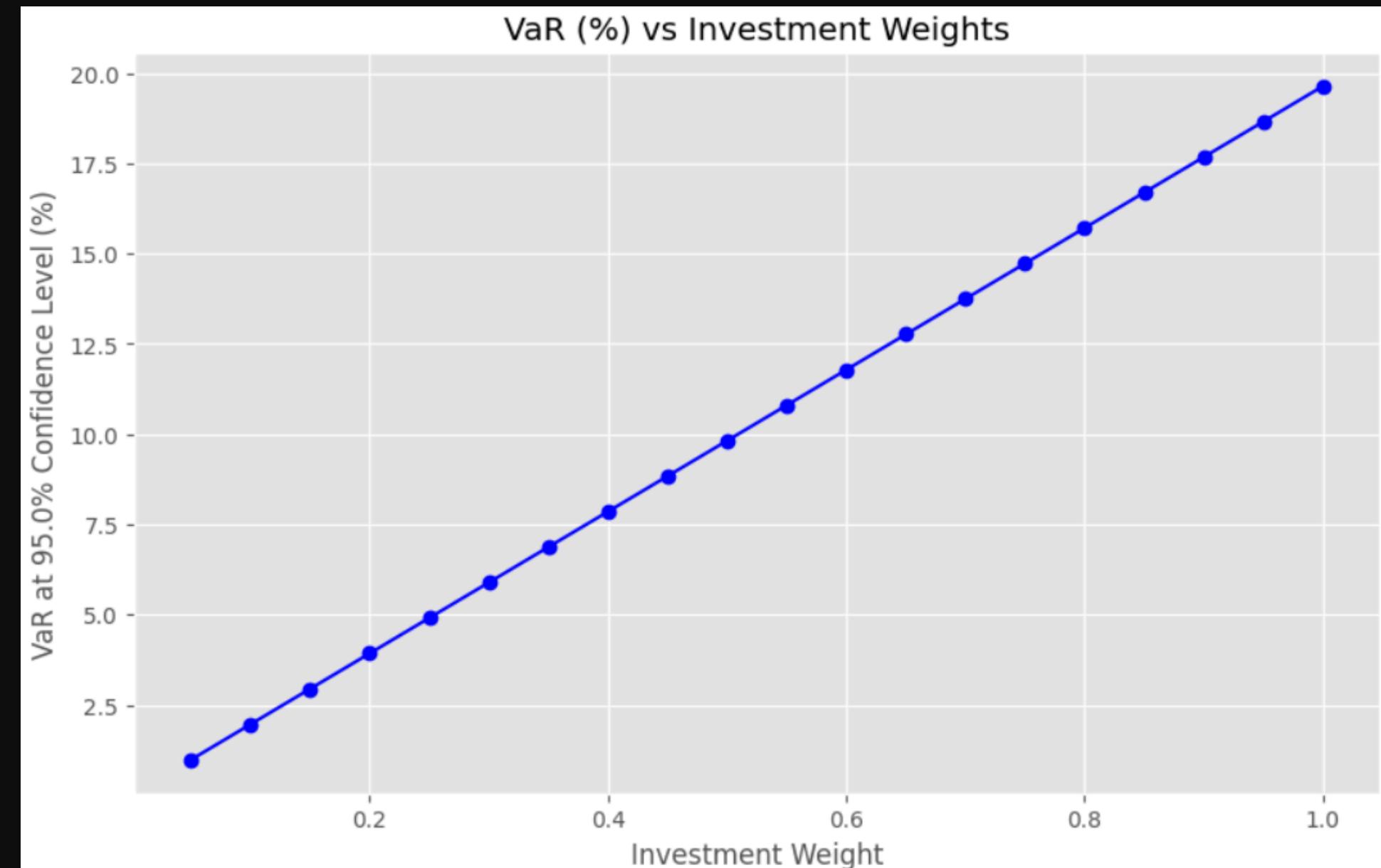
RISK MANAGEMENT

Considering the high volatility inherent in the GB electricity market, our strategy includes a rigorous risk management protocol using Value at Risk (VaR) calculations. VaR helps us determine the maximum potential loss in a set time frame, which guides our capital allocation decisions:

VaR Computations: We calculate the VaR at a 95% confidence level to understand potential losses and adjust our capital allocation accordingly. This computation takes into account historical volatility and price trends to set thresholds for loss tolerance.

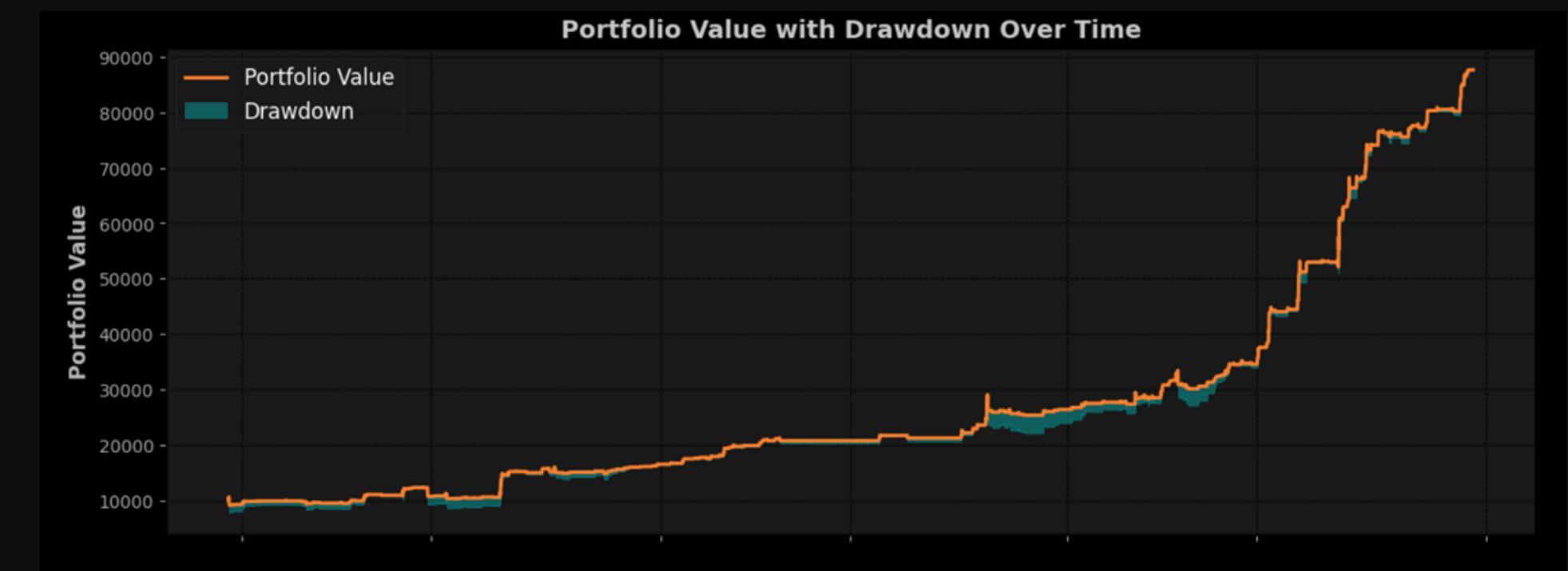
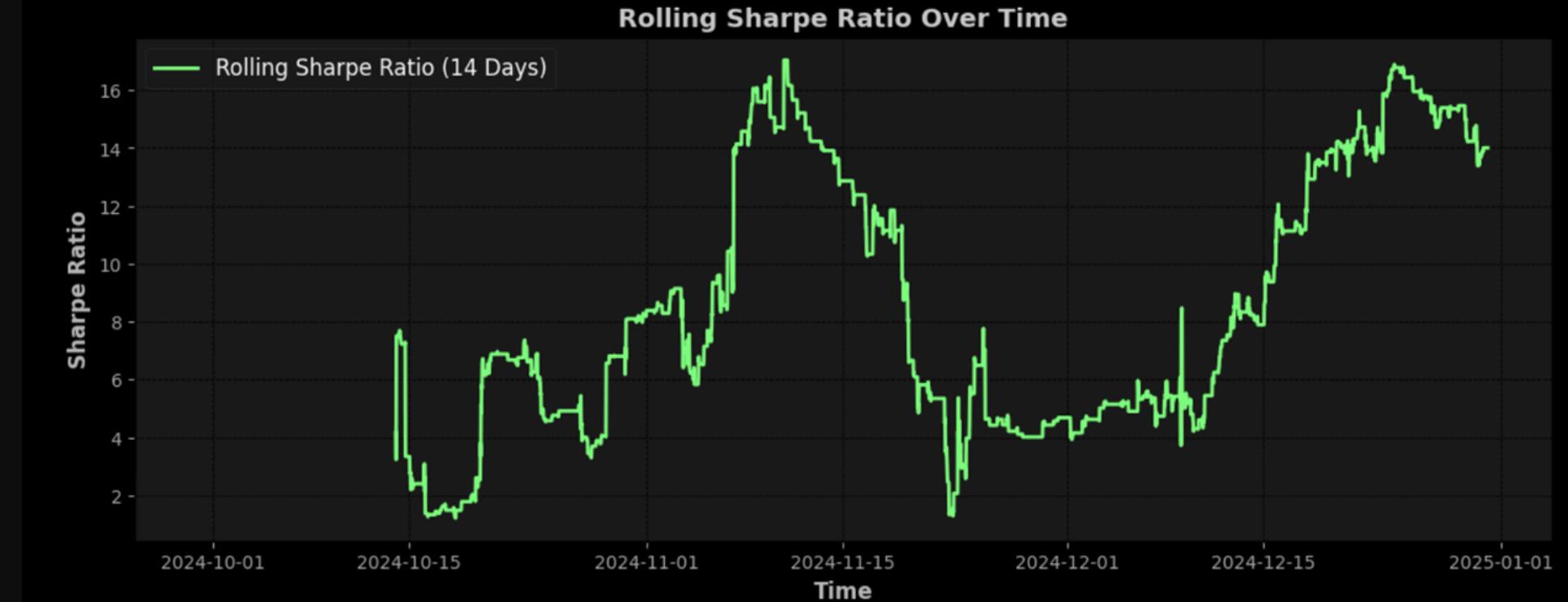
Profit Taking Strategy: When a position reaches a profit of 5% or more, we proactively take profits by squaring off 60% of the position. This strategy allows us to secure a substantial part of the gains while still leaving a portion of the position to benefit from any potential further upside. Also upon the leftover open position the stop loss is set from the new bar. Ensuring this open position remains profitable.

Stop-Loss Strategy: If a position incurs a loss exceeding 2%, we square off the entire position immediately. This strict stop-loss criterion helps us minimize losses and preserve capital.



PERFORMANCE METRICS AND RESULTS

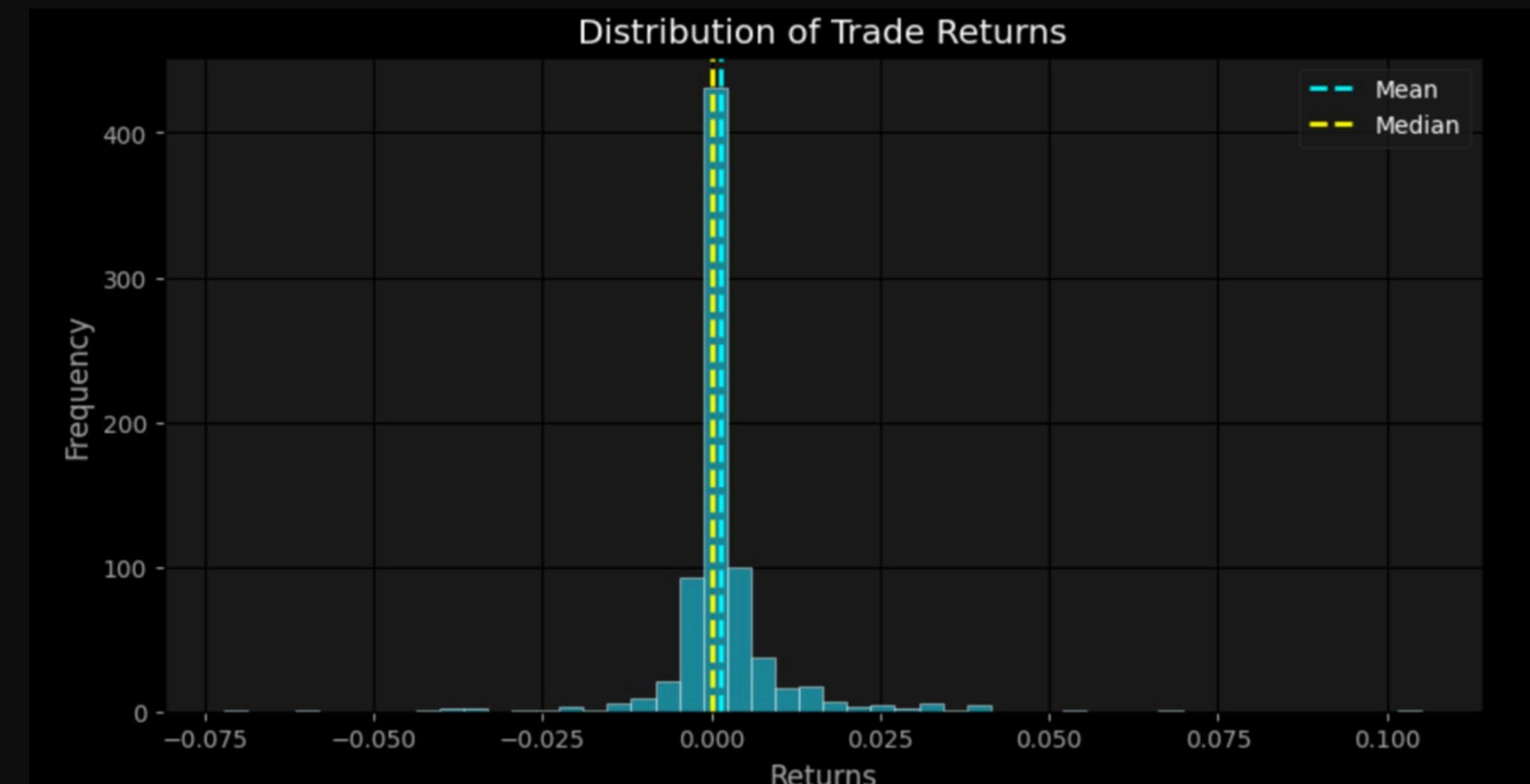
- **Sharpe Ratio (9.24):** This measures how much excess return we earn for each unit of risk. A high value indicates strong risk-adjusted performance.
- **Maximum Drawdown (-7.25%):** This represents the largest decline from a peak before recovering, showing the worst potential loss during the period.
- **Annualized Volatility (54.02%):** This measures how much returns fluctuate over time, with higher values indicating more variation.
- **Sortino Ratio (5.26):** Like the Sharpe Ratio but focused only on downside risk, it evaluates performance considering only negative returns.
- **Returns (327.42% in 3 months):** The total profit generated over the period, reflecting the overall success of the strategy.



HYPOTHESIS TESTING RESULT

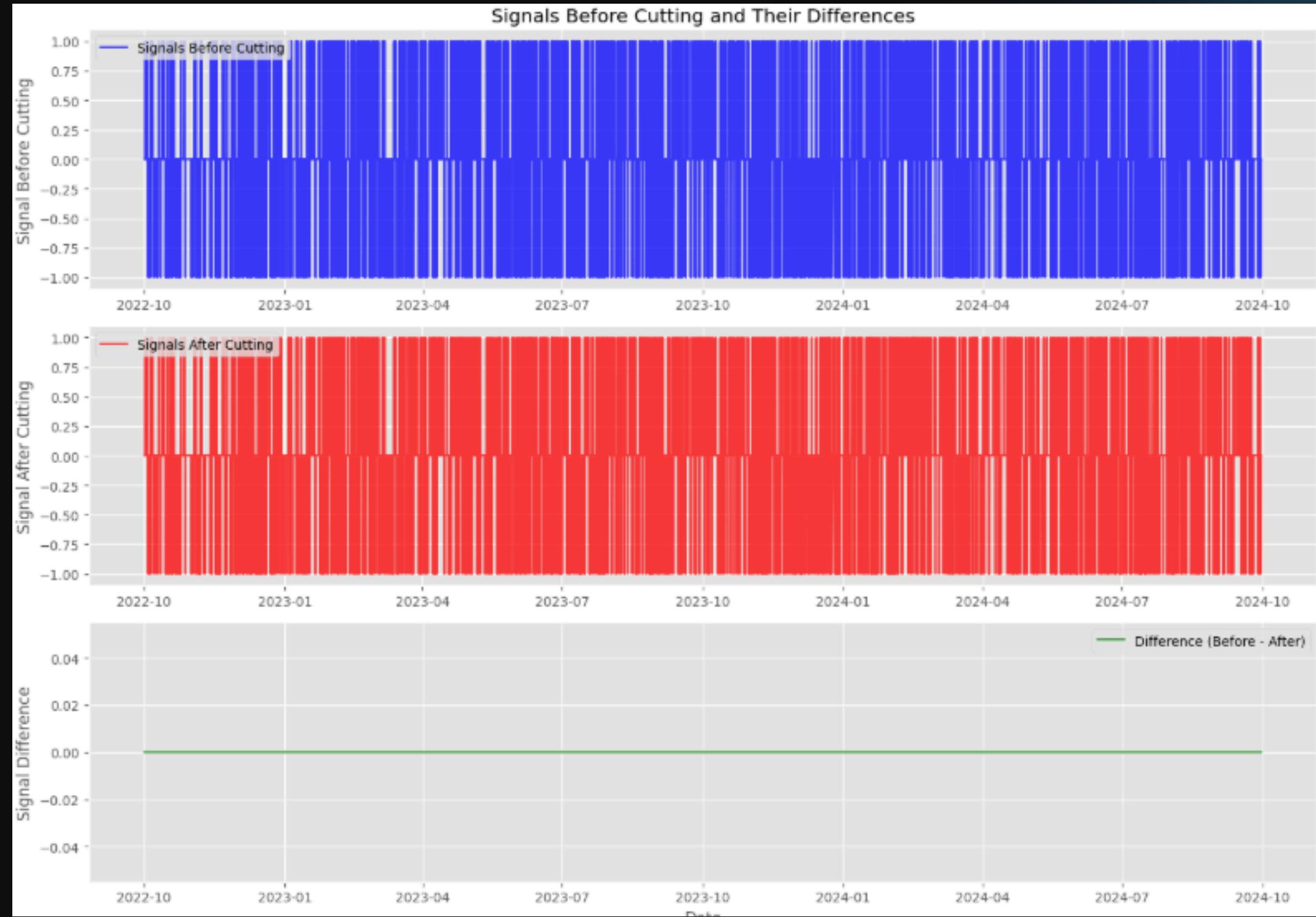
OUR TRADING STRATEGY HAS BEEN STATISTICALLY VALIDATED FOR EFFECTIVENESS AND PROFITABILITY, AS EVIDENCED BY OUR HYPOTHESIS TESTING:

- **T-test Statistic:** 3.86 with a P-value of 0.00012, confirming statistical significance at the 0.05 level.
- **Mean Return:** 0.00132 with a 95% Confidence Interval of [0.00063, 0.00197], indicating reliable positive returns.
- **Win Rate:** 40.90%, with a Profit Factor of 1.94, demonstrating profitability despite a win rate below 50%.
- **Profitability:** Total Profit of 2.10 exceeds Total Loss of 1.08, underscoring the strategy's overall profitability



Look-Ahead Analysis

To ensure the robustness of our trading strategy and to avoid lookahead bias, we employed the data cutting method for look-back analysis. This technique involves dividing the historical data into segments and analyzing each independently. By confirming that signals remain consistent across different segments, we validate the reliability and effectiveness of our strategy under varied historical conditions.



Plot of (Before Signal - After Signal)

Thank You.