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Research Objective: To analyse intraday electricity price data in the Great Britain (GB) electricity market over a recent week (01/09/2024 - 08/09/2024). The goal is to identify patterns of volatility and propose a simple trading strategy to capitalise on these patterns.

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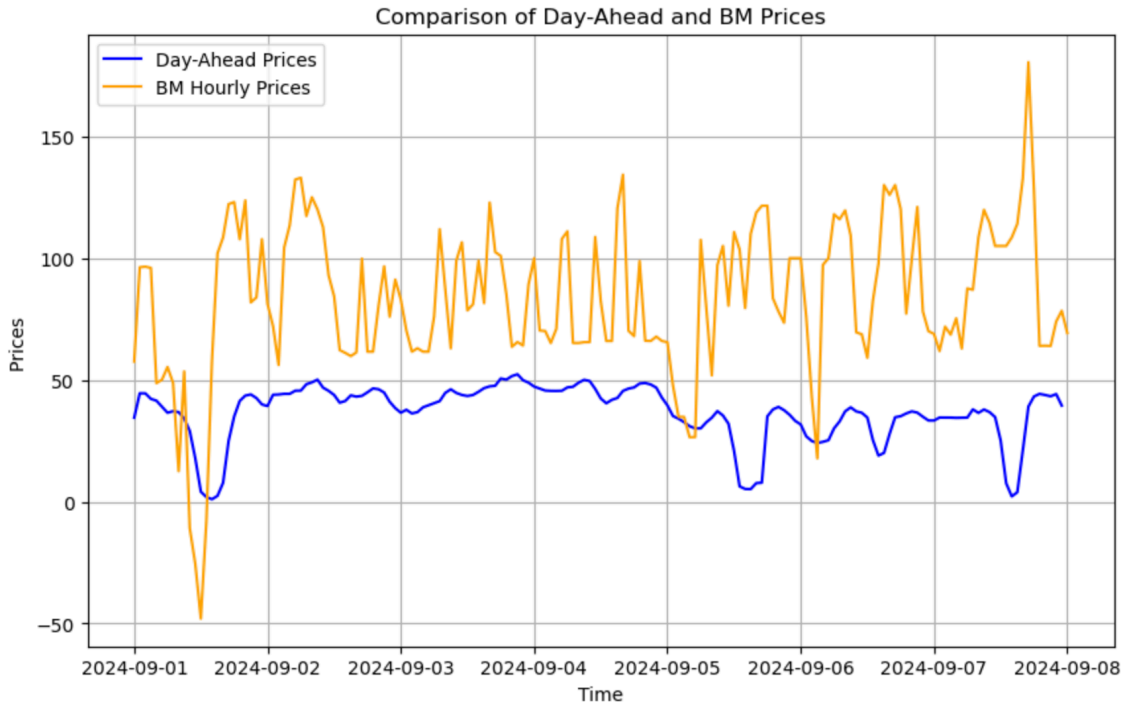
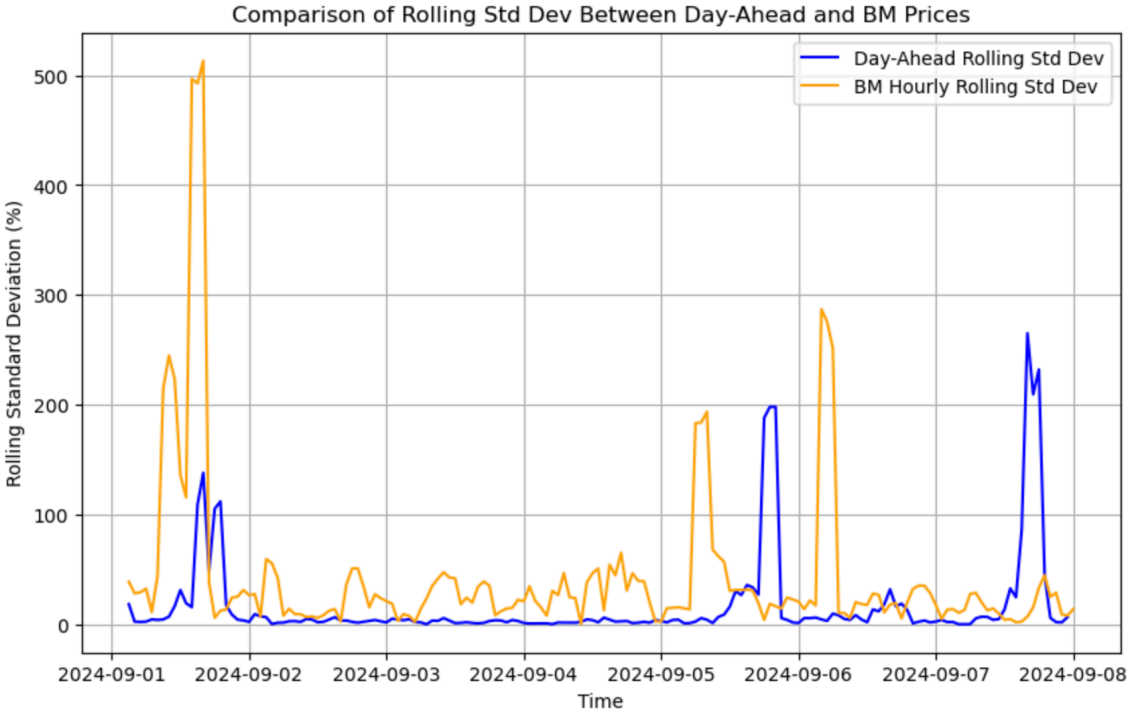
1. Data Collection

In this section, I analysed electricity price data for the Great Britain market from September 1 to 8, 2024, using day-ahead (hourly) and Balancing Mechanism (BM)(half-hourly) prices. The market typically has three types of prices: day-ahead, intraday, and Balancing Mechanism. Since free intraday price data was unavailable, I used BM prices as a proxy. While BM prices are more volatile due to real-time grid adjustments, they serve as a reasonable approximation for intraday prices. Data sources and table overviews can be found in the references and Appendix (B,C,D).



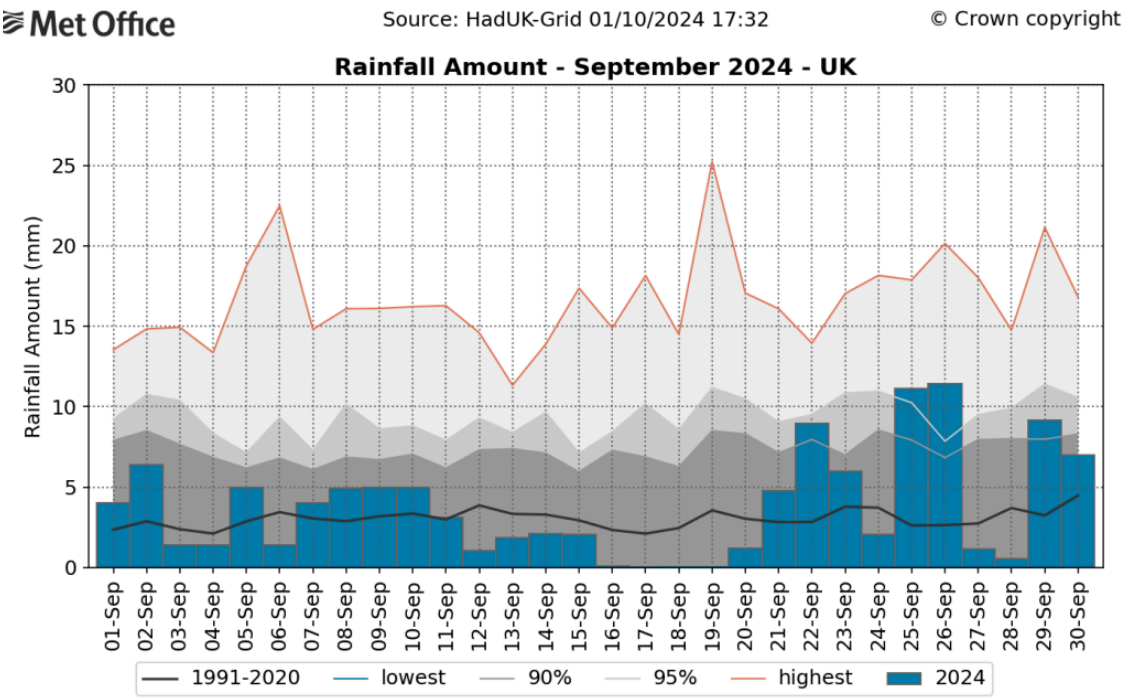
2.Data Analysis

In this section, both prices are analysed to look for high and low volatility periods using rolling standard deviation of both BM and Day-ahead price changes.

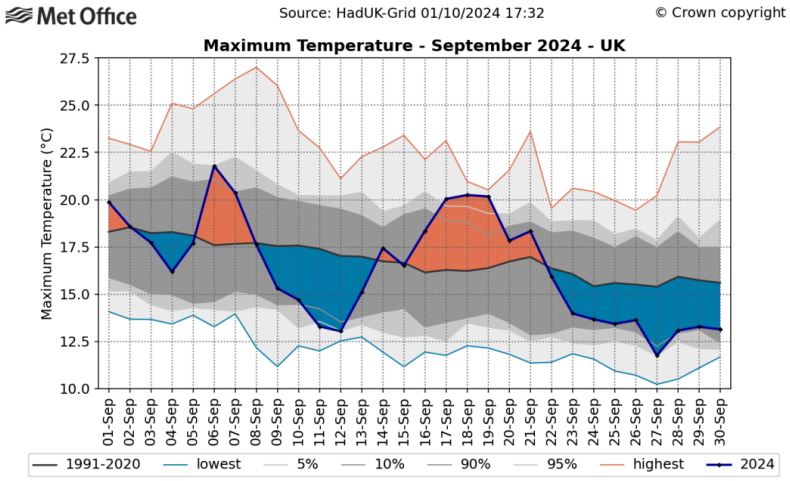


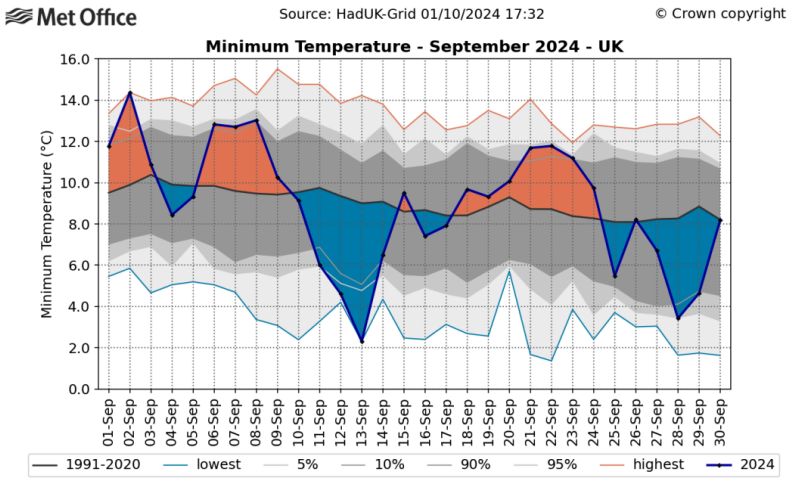
The graphs clearly shows three major spikes in volatility on 1st, 5th and 6th September according to the BM data.This can be due to high demand fluctuations due to weather patterns changes like rainfall or temperatures.The September statistics of UK's rainfall amounts shows the sudden increase in rainfall on 5th September which matches with the high volatility period.Even the maximum temperature data shows a sudden increase on 5th September which can add to the volatility increase and the price increase in the markets.These reasons can contribute towards the volatility increase on 5th and 6th September.

An interesting aspect here is that the BM prices reduce sharply even till negative.Negative prices may seem odd but it is actually due to the National Grid paying the Suppliers to reduce generation due to sudden decrease in demand.Suddenly reducing demand has costs for the suppliers which is why they might need monetary incentives.This electricity demand reduction can be due lower maximum temperatures and rainfall increase between 1st and 2nd September shown in UK weather data.



Daily maximum and daily minimum temperature





3.Trading Strategy Proposal

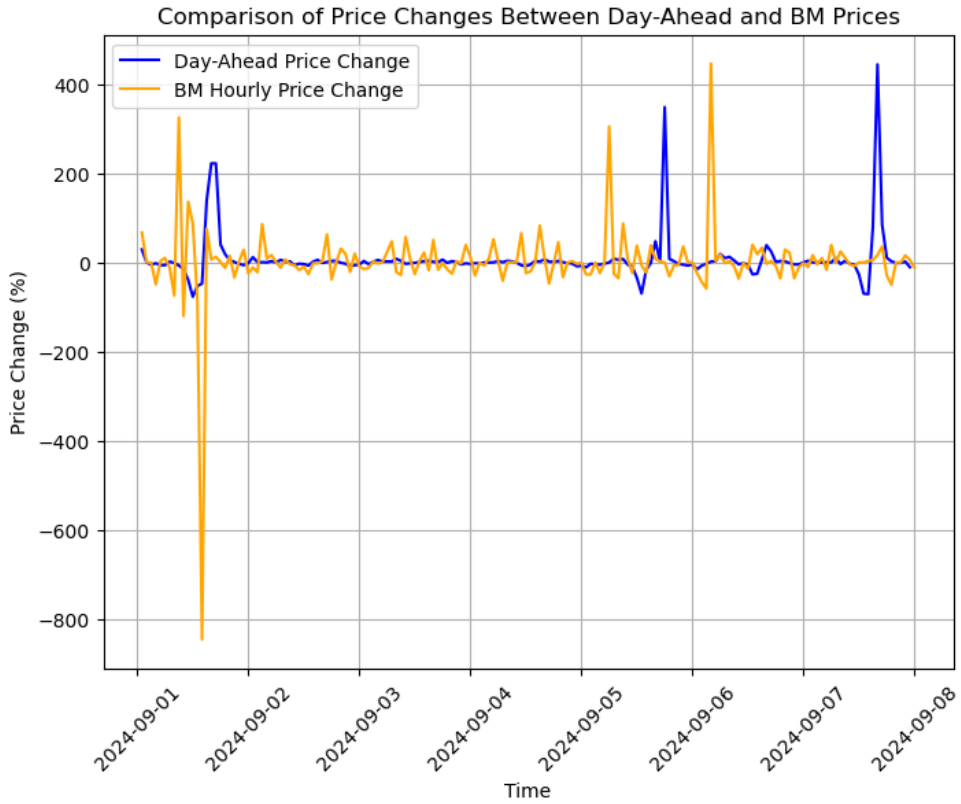
For the trading strategy, I had two datasets, day-ahead with hourly prices and BM with half hourly prices.I wanted to use both together to analyse the relationship between the two prices.For this I created a merged dataset by resample BM data into hourly prices so as to not discard the original datapoints and combine with day ahead data.This dataset is listed in the appendix(E).

The first idea of using volatilities for a trading strategy seemed not feasible due to very high volatility of BM prices but on observing price changes of BM and Day ahead data, it can be seen that the BM prices are somewhat reverting to the day-ahead price changes.

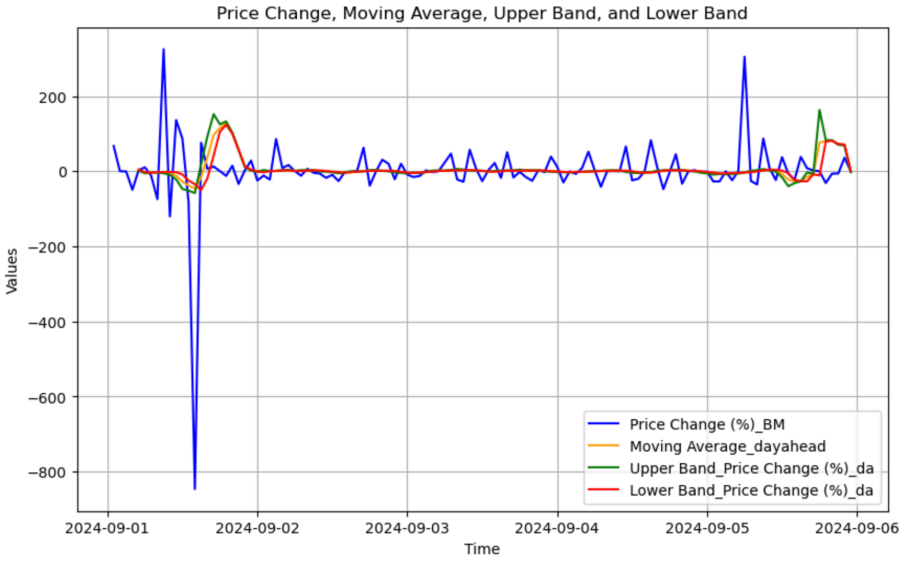
Hence I used a mean reversion strategy with moving average of day ahead price changes as the reverting line and two bands(upper and lower) as thresholds to buy and sell.

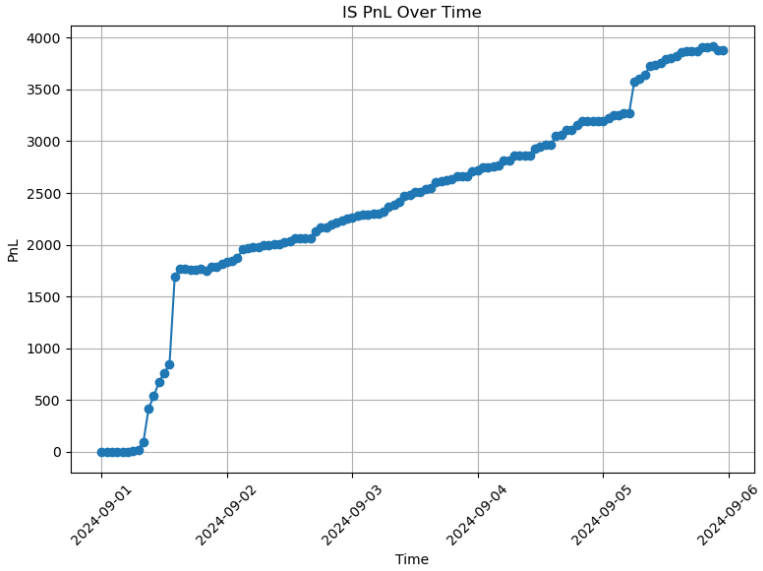
My rationale behind the strategy is that if the BM price is more than the upper band, it has high chances to revert below towards the day ahead average line.This is why a ‘sell’ signal is generated in this case. Similarly, a ‘buy’ signal is generated if BM price moves below the lower band and ‘hold’ signal is generated if price is between these bands.

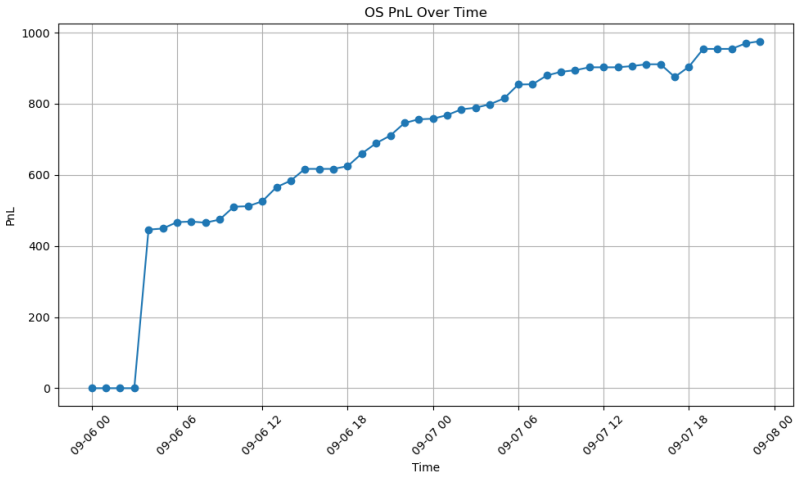
These bands are created by assuming a deviation of 0.25 of the moving average line which I used owing to high volatility of BM prices.



To test out the strategy and predicting it's profitability potential,I split the data into in sample(1/09/24 - 5/09/24) and out sample periods(6/09/24 - 8/09/24).The profit and loss(PnL) charts below depict that the strategy is profitable in both the testing periods.







4.Risk Assessment

The proposed mean reversion strategy shows profitability but faces key risks like:
High volatility of BM prices may cause large losses, but tighter stop-losses and volatility-adjusted bands can be used to mitigate this. Lag in resampling data can lead to poor timing, so multi-timeframe data can be used for better precision. If mean reversion fails, dynamic, exits and confirmation indicators can be used. To avoid overfitting, cross-validation and stress-testing on varied data can be used to ensure robustness in live markets.

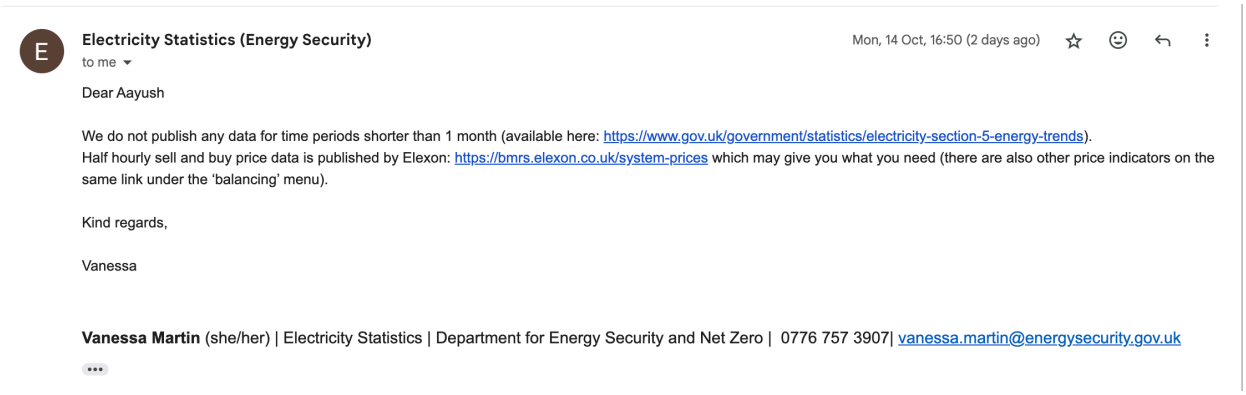
5.Reflection

There are a lot of limitations to this analysis given the unavailability of intraday prices and time constraints.Some of them include the proxy data used which is not the actual data.
The analysis is constrained by the resampling of BM data, which may overlook key intra-hour movements.Additionally, the strategy may be overfitted to the analysed time period, limiting its generalisability.

Improvements: With more time or resources, incorporating real-time BM data at finer intervals and using dynamic bands could enhance precision. Including external factors like weather data and conducting stress tests across varied market conditions would improve robustness and comprehensiveness.

Appendix

A:Email correspondence from the UK Govt Energy Department providing data links.



Electricity Statistics (Energy Security) Mon, 14 Oct, 16:50 (2 days ago)

to me

Dear Aayush

We do not publish any data for time periods shorter than 1 month (available here: https://www.gov.uk/government/statistics/electricity-section-5-energy-trends).
Half hourly sell and buy price data is published by Elexon: https://bmrs.elexon.co.uk/system-prices which may give you what you need (there are also other price indicators on the same link under the 'balancing' menu).

Kind regards,

Vanessa

Vanessa Martin (she/her) | Electricity Statistics | Department for Energy Security and Net Zero | 0776 757 3907| vanessa.martin@energysecurity.gov.uk

B : BM price data overview

	SettlementDate	StartTime	SettlementPeriod	Price(GBP/MWh)
0	2024-09-01	2024-09-01 00:00:00+00:00	3	57.12
1	2024-09-01	2024-09-01 00:30:00+00:00	4	58.04
2	2024-09-01	2024-09-01 01:00:00+00:00	5	96.50
3	2024-09-01	2024-09-01 01:30:00+00:00	6	96.00
4	2024-09-01	2024-09-01 02:00:00+00:00	7	96.50
...	...	...	...	...
332	2024-09-07	2024-09-07 22:00:00+00:00	47	64.29
333	2024-09-07	2024-09-07 22:30:00+00:00	48	83.69
334	2024-09-08	2024-09-07 23:00:00+00:00	1	87.51
335	2024-09-08	2024-09-07 23:30:00+00:00	2	69.27
336	2024-09-08	2024-09-08 00:00:00+00:00	3	69.27

C: Day Ahead price data overview

	datetime	Price(GBP/MWh)
0	2024-09-01 00:00:00	34.50
1	2024-09-01 01:00:00	44.52
2	2024-09-01 02:00:00	44.49
3	2024-09-01 03:00:00	42.23
4	2024-09-01 04:00:00	41.48
...	...	...
163	2024-09-07 19:00:00	44.27
164	2024-09-07 20:00:00	43.82
165	2024-09-07 21:00:00	43.30
166	2024-09-07 22:00:00	44.19
167	2024-09-07 23:00:00	39.47

D:Volatility highs and lows each day

BM volatility

	Date	max_rolling_std	max_std_timestamp	min_rolling_std	min_std_timestamp	avg_rolling_std
0	2024-09-01	513.340991	2024-09-01 16:00:00	5.975836	2024-09-01 18:00:00	132.055259
1	2024-09-02	59.463507	2024-09-02 03:00:00	2.599481	2024-09-02 16:00:00	23.182876
2	2024-09-03	47.465247	2024-09-03 10:00:00	2.247522	2024-09-03 05:00:00	23.025457
3	2024-09-04	65.246168	2024-09-04 17:00:00	0.278181	2024-09-04 10:00:00	31.037574
4	2024-09-05	193.622793	2024-09-05 08:00:00	2.716711	2024-09-05 00:00:00	45.851568
5	2024-09-06	287.133348	2024-09-06 04:00:00	5.404942	2024-09-06 18:00:00	51.309074
6	2024-09-07	44.752088	2024-09-07 19:00:00	1.924501	2024-09-07 14:00:00	15.520553
7	2024-09-08	13.844433	2024-09-08 00:00:00	13.844433	2024-09-08 00:00:00	13.844433

DayAhead Volatility

	date	max_rolling_std	max_std_timestamp	min_rolling_std	min_std_timestamp	avg_rolling_std
0	2024-09-01	138.090677	2024-09-01 16:00:00	2.241102	2024-09-01 05:00:00	32.181691
1	2024-09-02	9.335094	2024-09-02 01:00:00	0.308388	2024-09-02 04:00:00	3.536078
2	2024-09-03	5.715193	2024-09-03 10:00:00	0.048298	2024-09-03 07:00:00	2.808858
3	2024-09-04	6.138995	2024-09-04 14:00:00	0.219376	2024-09-04 05:00:00	2.232723
4	2024-09-05	198.165967	2024-09-05 19:00:00	1.021248	2024-09-05 04:00:00	33.786572
5	2024-09-06	31.954517	2024-09-06 16:00:00	0.935047	2024-09-06 20:00:00	8.397733
6	2024-09-07	265.139268	2024-09-07 16:00:00	0.126251	2024-09-07 04:00:00	40.224439

E:Merged_Df (x represents Day Ahead data and y represents BM data)

	StartTime	Price(GBP/MWh)_x	Price Change (%)_x	Rolling Std Dev_x	datetime	Price(GBP/MWh)_y	Price Change (%)_y	Rolling Std Dev_y	date
0	2024-09-01 00:00:00	57.58000	NaN	NaN	2024-09-01 00:00:00	34.50	NaN	NaN	2024-09-01
1	2024-09-01 01:00:00	96.25000	67.158736	NaN	2024-09-01 01:00:00	44.52	29.043478	NaN	2024-09-01
2	2024-09-01 02:00:00	96.50000	0.259740	NaN	2024-09-01 02:00:00	44.49	-0.067385	NaN	2024-09-01
3	2024-09-01 03:00:00	96.00000	-0.518135	38.850653	2024-09-01 03:00:00	42.23	-5.079793	18.425364	2024-09-01
4	2024-09-01 04:00:00	48.69008	-49.281167	28.380568	2024-09-01 04:00:00	41.48	-1.775989	2.548159	2024-09-01

References

Source Data:

Nord Pool. (2024). Day-ahead prices for Great Britain on September 1, 2024. https://data.nordpoolgroup.com/auction/n2ex/prices?deliveryDate=2024-09-01&currency=GBP&aggregation=PriceTrend&deliveryArea=NO2

Elexon. (2024). Balancing mechanism prices. https://bmrs.elexon.co.uk/system-prices

Met Office. (2024). *Monthly weather report for September 2024*. https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/summaries/mwr_2024_09_for_print_v1.pdf

Source Code :

https://github.com/Aayush-Mishra07/GB-Electricity/blob/main/Electricity%20(1)%20(1)%20(1).ipynb