ANALYTATHON 3

Energia Trading Strategy Optimization

Part 1 ((April 1st – Sept 30th, 2019)

Queen's University Belfast
MSc Data Analytics
School of Mathematics and Physics

Author:

BHAGYAPRASAD VASTRAD

STD ID : 40468326

Abstract

This section delves into utilizing forecast data, including wind and demand predictions, for a comprehensive analysis of market behaviour. The insights aim to optimize energy procurement strategies by identifying pricing trends and deriving actionable insights to enhance cost efficiency in energy trading.

Introduction

The energy market operates on intricate dynamics influenced by demand, generation, and external factors such as weather conditions. Accurate forecasting plays a crucial role in predicting demand and generation trends, enabling better decision-making in energy procurement. This part focuses on analysing market behaviours using forecast data to derive strategies that minimize costs and risks for energy trading firms.

Objectives

- To analyse forecast-based data and identify meaningful patterns.
- To study market characteristics like price volatility and demand fluctuations.
- To establish baseline metrics such as Net Demand and Forecast Error for market analysis.

Dataset Description

Input Data

- **Forecasts**: Predictions of wind generation and energy demand.
- **Actuals**: Real-time data on generation and consumption.
- **Market Prices**: Data for Day-Ahead Market (DAM) and Balancing Market (BM).

Derived Features

- **Net Demand Calculation**: The difference between predicted demand and forecasted generation.
- **Forecast Error Metrics**: Quantification of errors in wind and demand forecasts

Methodology

Data Cleaning and Pre-processing

- Handled missing values by forward-filling
- Standardized data for consistent analysis

Exploratory Data Analysis

- **Visualizations**: Created time-series plots using Power BI to detect trends in DAM pricing.

Feature Engineering

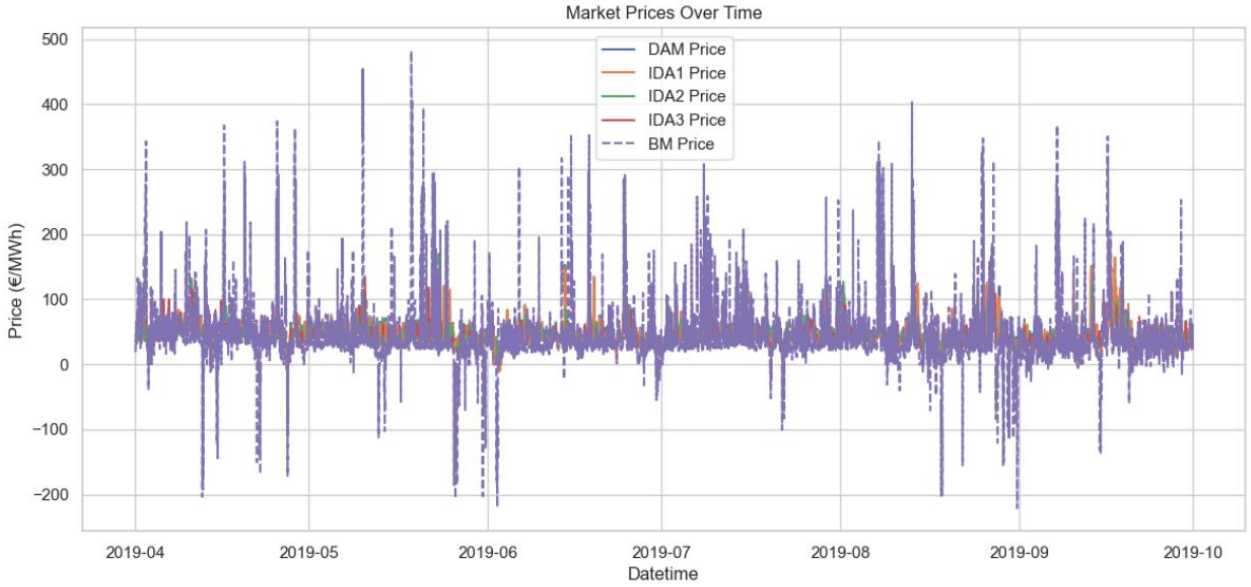
- Developed custom metrics for evaluating forecast reliability:

Tools Used

- **Python**: For data pre-processing, analysis, and feature generation.
- **Power BI**: For interactive visualizations and deeper market trend insights.

Exploratory Data Analysis:

Market Prices Over Time



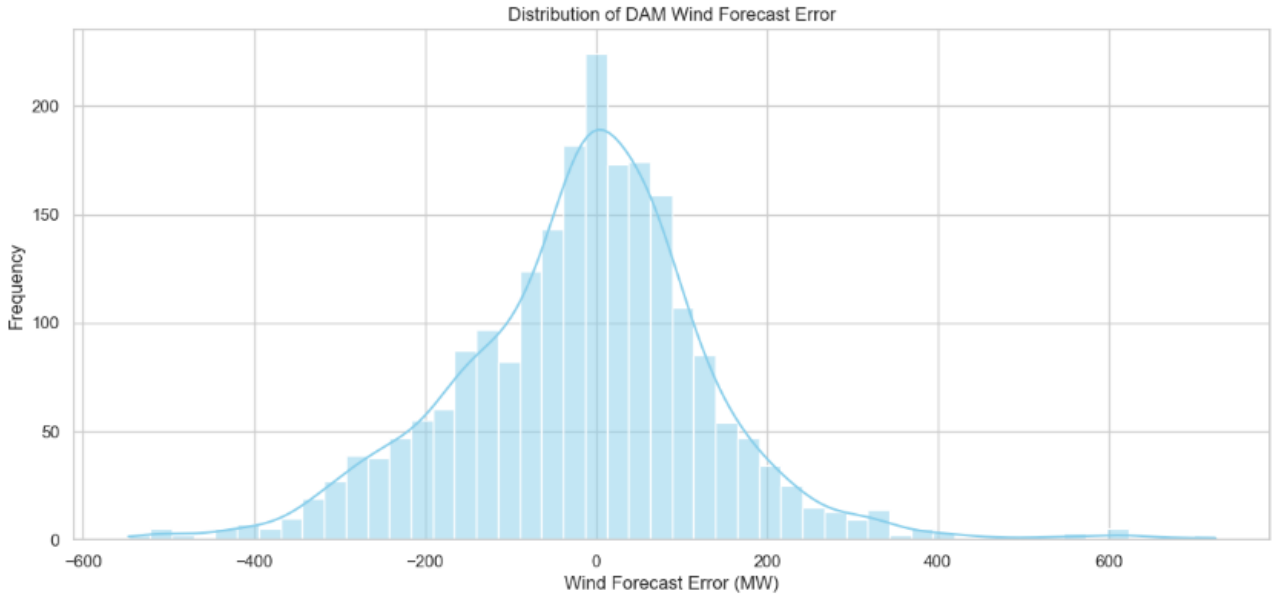
What it shows:

BM Prices (dashed line) are very volatile, with both very high and very low spikes.
DAM, IDA1, IDA2, IDA3 Prices are relatively smoother.
Huge price spikes occur randomly across months.
In general, forward markets (DAM/IDAs) are more predictable, while Balancing Market (BM) is risky.

Meaning for Strategy:

Buying all power from BM is very risky.
Buying from DAM or IDAs may offer safer, more stable prices.

DAM Price vs DAM Net Demand



Histogram: Distribution of DAM Wind Forecast Error

What it shows:

- The forecast error distribution is roughly centered around 0, which is good forecasts are
- unbiased on average.
- Most errors are between -200 MW and +200 MW.
- However, sometimes the wind is over-predicted or under-predicted by 400–600
- MW, causing market shocks.

Meaning for Strategy:

* Forecast errors are common and can impact prices heavily if large.
* On days with very large forecast errors, real prices can be much worse than expected — BM price
spikes may happen if wind is lower than forecasted.

Basic Strategy Simulation:

Strategy	Meaning
Buy All in DAM	Safe, predictable, but sometimes not the absolute cheapest.
Buy All in BM	Very risky could be cheaper or much more expensive.
50/50 Split	Balances risk and stability.

Results Summary

Strategy	Total Cost (€)	Insights
Buy All in DAM	€41,210,532	Stable but more expensive
Buy All in BM	€37,953,163	Cheaper overall, but risky
Buy 50% DAM + 50% BM	€39,581,848	Middle ground — better than DAM-only,safer than full BM

Key Observations

1) Buying only in BM was cheapest historically during April–September 2019.
- → BM prices were lower on average despite the spikes.

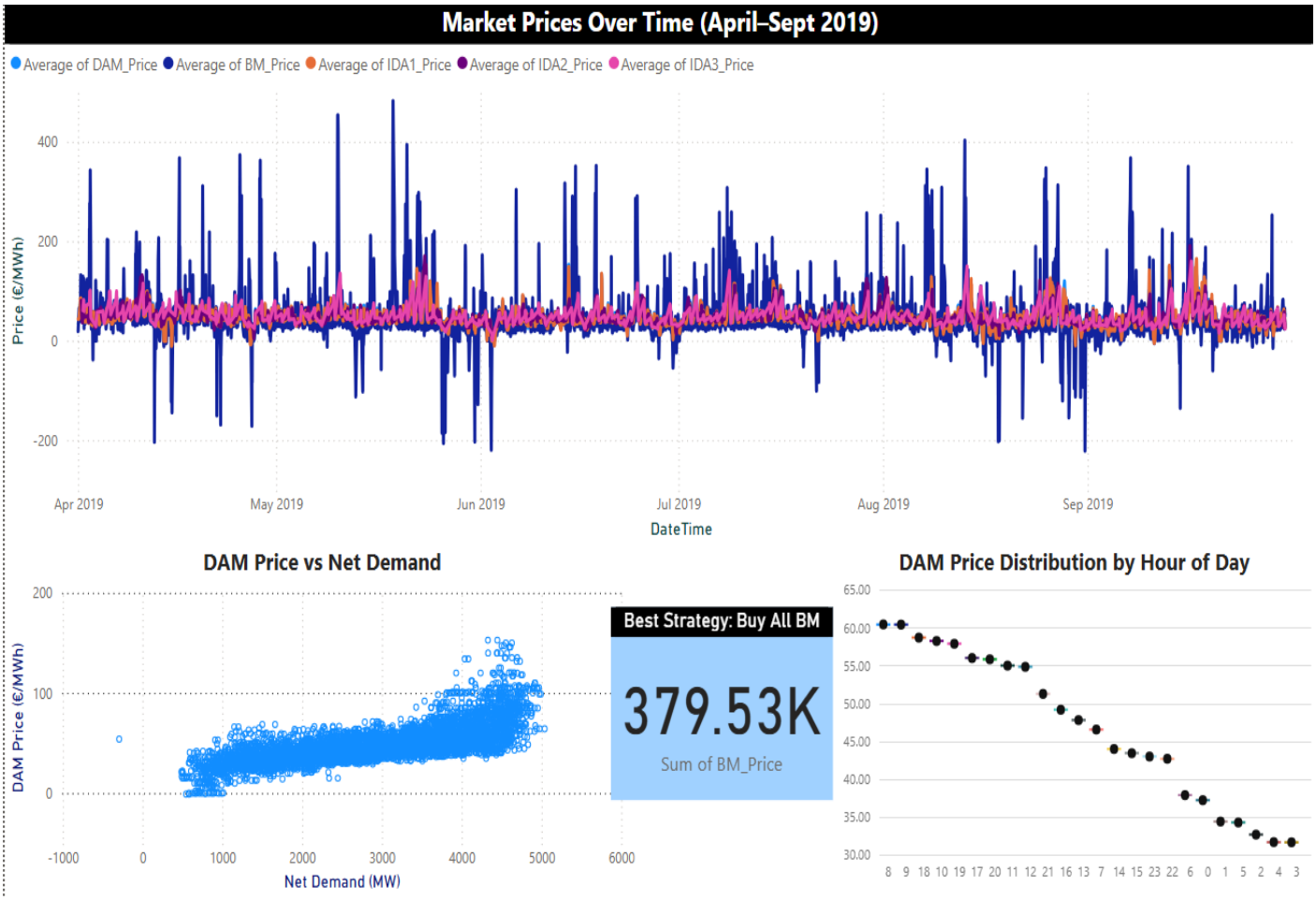
2) But remember: BM is risky — lots of price volatility (as we saw earlier).
- You could get huge spikes (>€400) randomly.
- BM prices are also very unpredictable day-to-day.

3) Split 50/50 strategy also performs better than all-in DAM.
- It captures some low BM prices while reducing risk.

Meaning for Energia's Strategy

- Blindly buying 100% DAM is not optimal.
- Some flexibility (e.g., buying partly in DAM, partly later) can save millions.
- BM market opportunities can be exploited carefully, but must be managed for risk.

Power Bi Dashboard:



Conclusion: Historical Strategy Optimization (April–Sept 2019)

- Based on the analysis of historical data between April 1st and September 30th, 2019:
- The cheapest overall strategy would have been to buy all electricity in the Balancing Market (BM).
- Buying 100 MW consistently in the BM would have cost approximately €37.95 million, which is lower compared to €41.21 million if buying fully in the Day-Ahead Market (DAM).
- Splitting purchases (50% DAM, 50% BM) would have resulted in a total cost of €39.58 million, still better than only DAM but more expensive than full BM.
- A basic smart strategy based only on Net Demand thresholds did not outperform the simple BM buying.
- However, it is important to note that BM prices are highly volatile, and although they were cheaper overall in this period, they can sometimes spike dramatically, introducing significant financial risk.
- DAM prices, while slightly more expensive, offered much more price stability, reducing risk exposure.
- Thus, buying in the BM would have been optimal based on cost alone, but a risk-averse supplier might prefer splitting between DAM and BM for more predictable outcomes.