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ABSTRACT

This project aims to optimize the profit earned from the power market for EnerjiSA Üretim, a leading power producer in Turkey. The data consist of 7 years' hourly Market Exchange Price (MEP), System Marginal Price (SMP), Net and Target Generation, Imbalance Cost due to errors in Target Generation forecast for a particular wind power plant (Çanakkale) of the company. Improvements are conducted by implementing arbitrage algorithm which works based on the methodology; store when the price is lower & sell when it is higher in the power market. Power will be stored in large-scale Li-ion batteries which is considered to be the best in the field of this project. The battery capacity is taken as 30 MW. The algorithm decides whether to charge or discharge in the current hour according to prices of the power market to optimize arbitrage opportunities. The other objective of the project is to minimize the penalties. For every hour EnerjiSA Üretim makes predictions for the next day's energy generation to the market. The company needs to pay penalty for the errors in their generation prediction. With the help of the battery, the company's penalties can be minimized. The methodology behind this minimization is simple; charge while company overproduces & discharge when company underproduces. With this methodology, the algorithm decreases the penalty both when charging and discharging.

OBJECTIVES

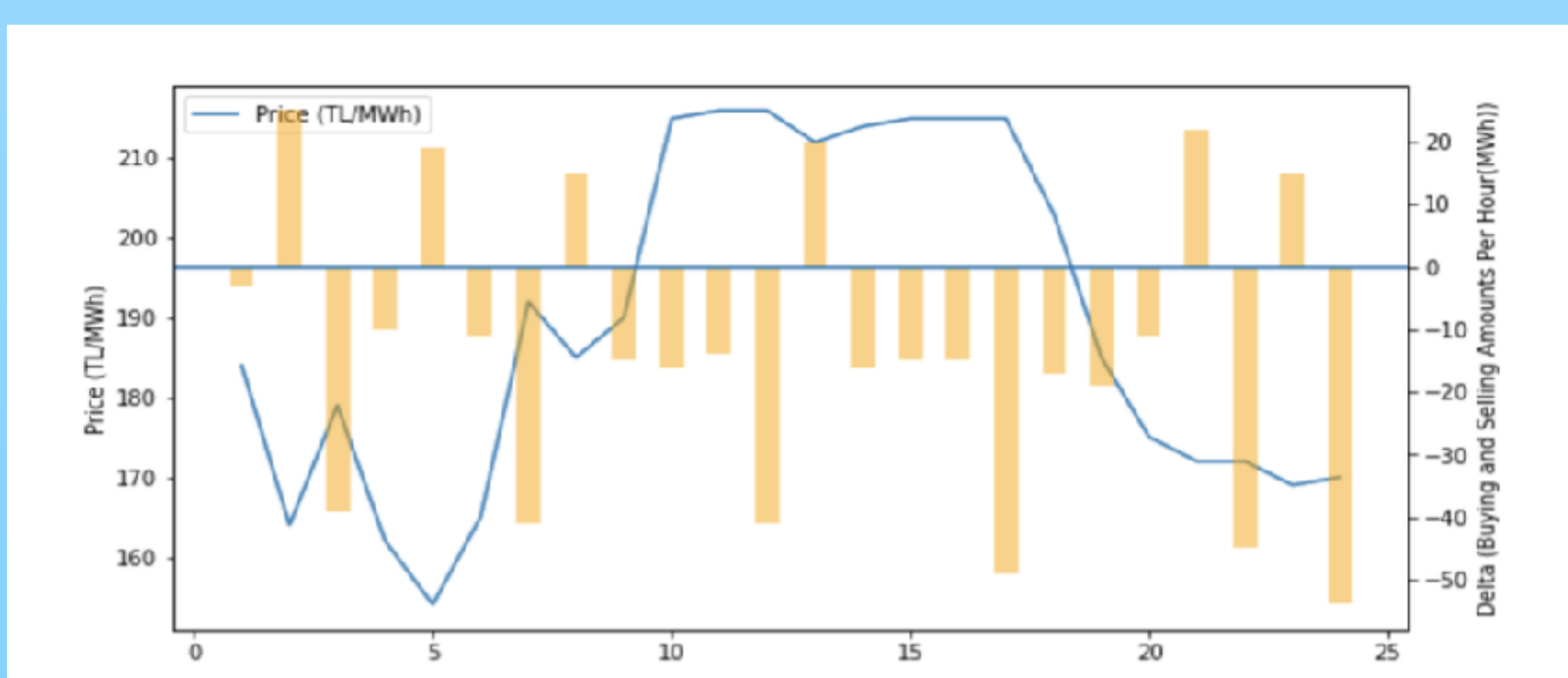
- ✓ Maximize the profit by benefiting from arbitrage opportunities in the market
- ✓ Minimize penalty costs due to errors in hourly generation forecasts

PROJECT DETAILS

The arbitrage algorithm is based on the following principles

- Grouping the prices with given priority to increase
- The battery is fully charged in the first hour of the group with increasing prices. The energy produced in the plant is sold until the last hour. By the last hour, the battery is completely discharged.
- The times when the prices are the same in a row are evaluated according to the algorithm of the group to which the hour belongs
- Only the amount of energy coming from Çanakkale is sold during the hours when prices are falling.

The figure below according to a sample day of 2018 data demonstrates the battery's buying and selling amounts by MWh and related prices:



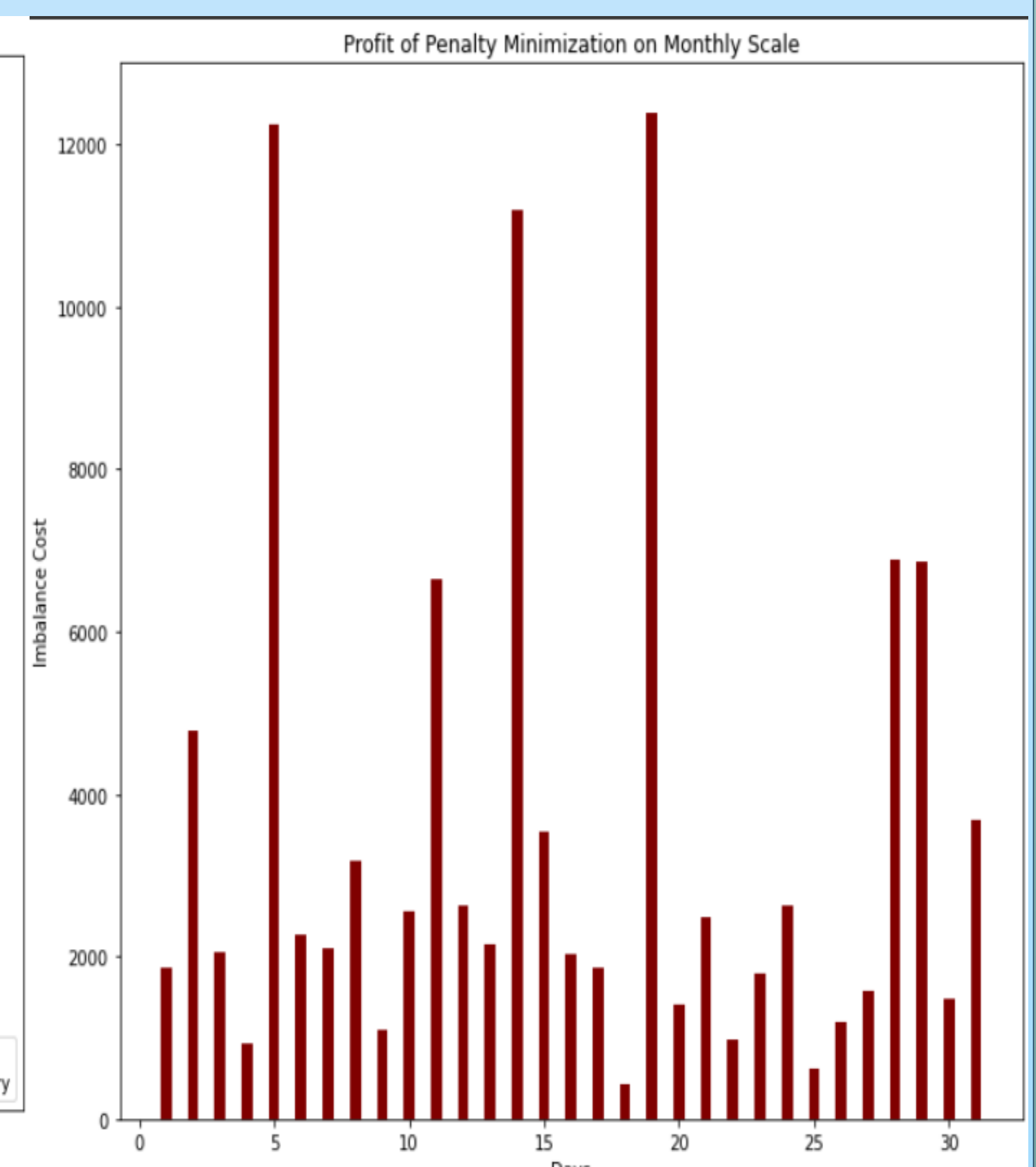
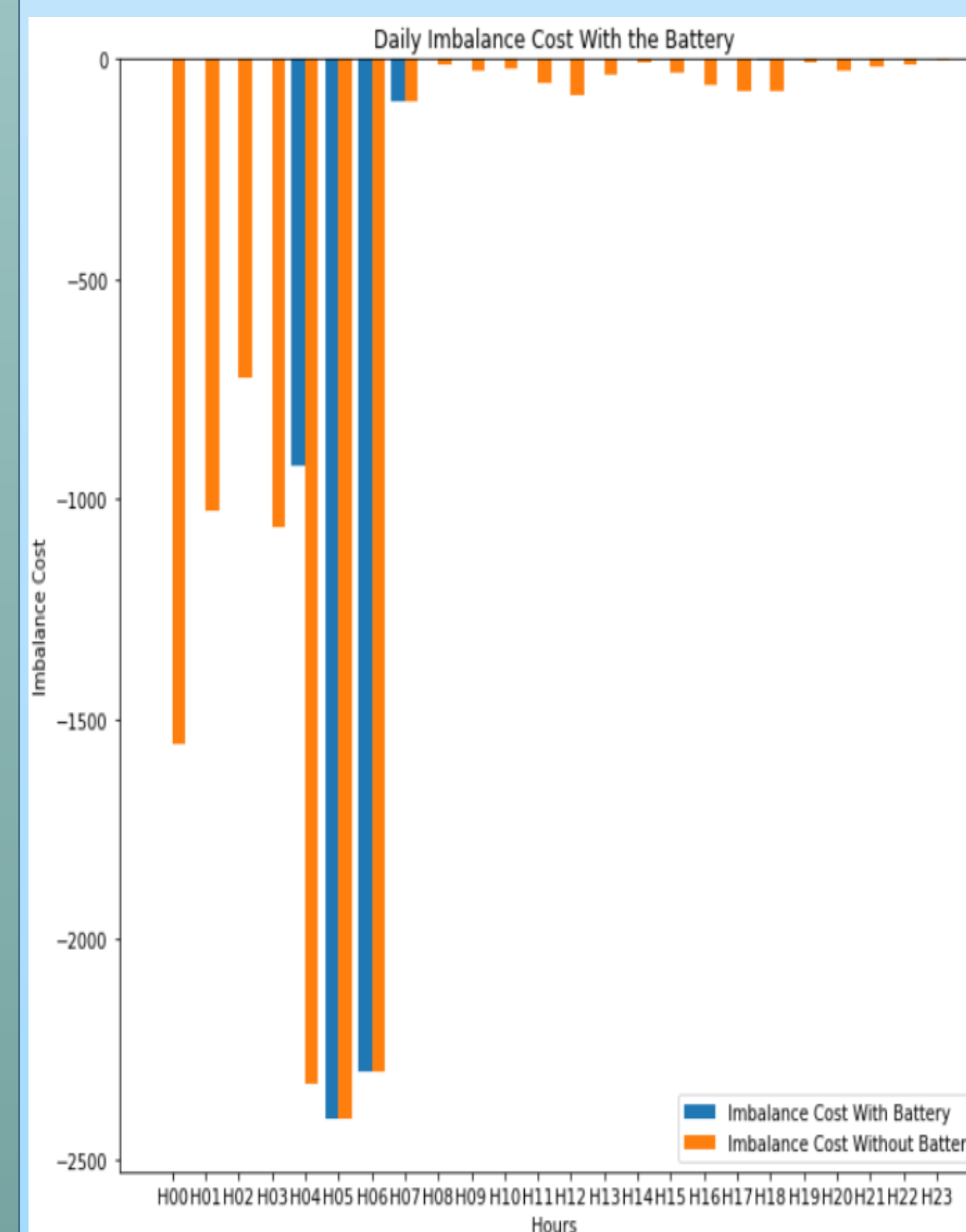
PROJECT DETAILS

The figure below shows the hourly profit of a sample day from 2018, when using the arbitrage algorithm:



Total Profit: 62.870 TL

The figures below are the result of the imbalance minimization algorithm. Applying the battery to minimize the penalty cost using the company's data we tested how profitable this algorithm will be. The chart on the right shows the results for a month past data. In the chart, profit of each day in the corresponding month with imbalance minimization algorithm is given. The chart on the left shows the hourly profits when the algorithm is applied to single day. The given day's penalty that the company received was 12.051 TL. The algorithm could reduce this amount to 5.732 TL. While this is the result of only one day of the year, we expect the profit to be high enough to catch the attention of the company.



CONCLUSIONS

We were able to implement battery use on arbitrage and minimization of imbalance cost. Results for both arbitrage and penalty cost algorithms are both encouraging. After combining and implementing these algorithms, we will analyze the results to characterize the corresponding statistical distributions. Using these, we will conduct a Monte Carlo simulation study to characterize the distribution of annual profit to be obtained from Li-Ion battery use.

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