Executive Summary

Electritect

Master in Big Data & Business Analytics

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Academic year: 2023-2024

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1. Introduction

This document is intended to give a summary of the work developed in the Capstone Project Report, being the the culmination to the Master's degree in Big Data & Business Analytics at IE School of Science and Technology. This work is also based on the project started at IE Venture Lab.

The project presented the optimization algorithm for energy usage of an industrial site, which resulted in a system achieving cost savings by 20.5% over one-month period.

2. Problem

Electricity is essential for a wide range of applications across residential, commercial, and industrial sectors, playing a pivotal role in improving quality of life. As global economies expand and technology progresses, the demand for electricity continues to rise, particularly among large corporations that are the backbone of industrial activities.

These organizations, characterized by their high energy demands, account for nearly 60% of total industrial energy usage. Energy costs can constitute up to 30% of total operational expenses in energy-intensive industries.

Industrial companies, in particular, grapple with inefficiencies and energy waste through outdated systems and processes. This scenario underscores the need for robust energy management strategies. Industry 4.0 offers a solution by leveraging innovative technologies like Big Data, Cloud Computing, and Smart Sensors to enhance productivity and optimize energy use. These advanced technologies enable industries to improve efficiency, reduce costs, and align with sustainability goals, addressing the urgent need for effective energy management in today's industrial sector.

3. Proposed Solution

In order to overcome the problems stated, our team came up with **Electritect**. Electritect aims to be an innovative Software as a Service (SaaS) designed to optimize energy consumption and enhance energy performance without affecting production levels or service quality.

To make this happen, implementation of hardware equipment (IoT) is necessary. Since global energy lectures would not make any significant advantage to the information that energy companies posses, it is necessary to go beyond and acquire more information regarding the infrastructure.

In order to prove for Electritect's business model, the team conducted a research study in order to find a online dataset that fulfilled a series or requirements that could serve to showcase the potential energy optimization.

After in-depth search, the Industrial Site Dataset was selected. This contains real-world data related to energy consumption from a 3-site industry from the European Union.

4. Results

After performing an exploratory data analysis (EDA), where we understood the inner relationships between variables and the need to choose and process one of these datasets, it came time to perform the optimization study. This process comprised several essential components, each playing a critical role in minimizing the energy cost of the industrial site. The key elements include the Objective Function, Constraints, Bounds, and Parameters.

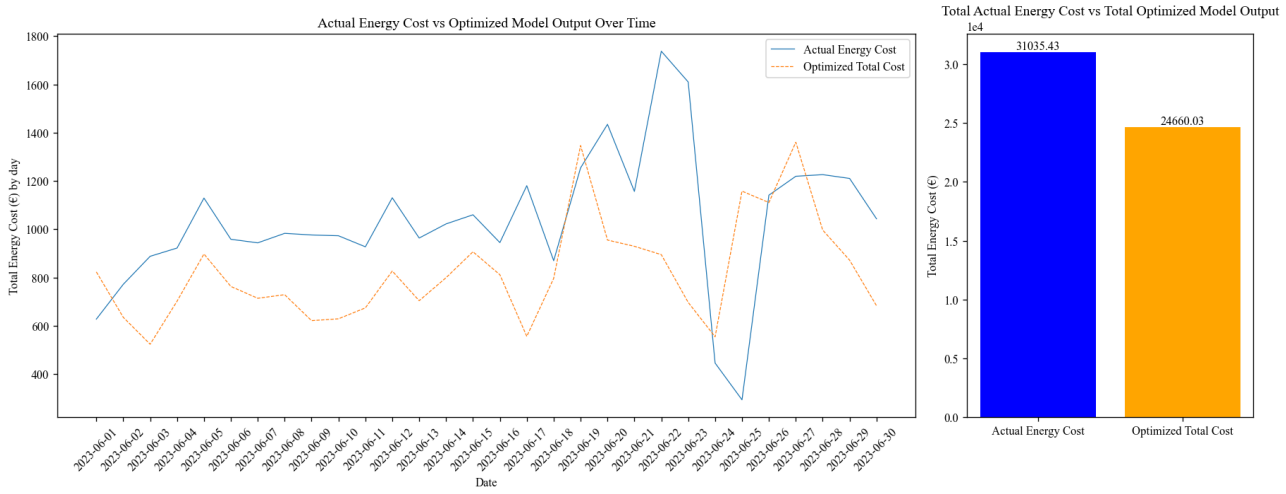

Figure 1: Line and Bar Graph Comparing Actual and Optimization Model Energy Costs over one-month period.

Due to the complexity involved, especially in large-scale industrial applications, standard Python libraries may not be sufficient for conducting advanced optimization. For this project, we have chosen to use **Pyomo**, a Python-based open-source optimization modeling language.

Parameters were introduced to the optimizer for each hour of the day and the optimizer solved to minimize the object function. Consequently, in the month of June 2023, the optimizer resulted in **savings for value of 6,375.40€**, equivalent to **20.5% cost improvement**. These results are represented in Figure 1.

5. Conclusions

This Capstone Project showcased the integration of skills gained throughout the Master's program and Venture Lab, demonstrating notable accomplishments and addressing significant challenges. Working with an online dataset posed limitations in fully understanding the industrial site's operations, potentially affecting the accuracy of assumptions and analysis. The dataset's incomplete representation of industry sectors and issues with sensor reliability contributed to discrepancies during the Exploratory Data Analysis (EDA).

Key achievements include the effective cleaning and processing of datasets, incorporating external factors like energy prices and weather conditions, and introducing synthesized data. The optimization results were particularly impressive, with Electritect achieving savings approximately double the typical 10±5% improvement seen in similar cases.

5.1. Future Lines of Work

Moving forward, Electritect aims to explore advanced optimization software and techniques, including more sophisticated forecasting equations and reinforcement learning algorithms like `Q-Learning`. Standardizing the implementation process with could services for example, will reduce setup time and enhance value delivery for clients. A comprehensive orientation period is essential to ensure all energy consumption sources are included in the optimization model, supported by real-world data to replace synthesized data.

Electritect also plans to expand its scope to optimize other energy sources, such as natural gas and water systems. While a prototype IoT hardware and software solution was developed, the team recognizes the benefits of partnering with established IoT suppliers for scalable solutions.

Building on the project's achievements, the team anticipates further increasing cost savings by an additional 10% with these future developments.

6. GitHub Repo

Click on this GitHub hyperlink to access the repository.