Peak Energy Demand Prediction Models

New River Light & Power

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Company Background

For over a century, Appalachian State University's New River Light and Power (NRLP), a nonprofit electric utility operated by the Division of Finance and Operations, has reliably supplied power to the residents of Western North Carolina. Currently serving nearly 9,000 residents and commercial customers in and around Boone, NRLP began purchasing electricity from Carolina Power Partners in January 2022, enhancing its capacity for increased renewable energy opportunities. In collaboration with App State's Office of Sustainability, Facilities Operations, and the Renewable Energy Initiative, NRLP has supported various energy efficiency projects on campus, including installing solar panels and funding for the Broyhill Wind Turbine. NRLP holds the American Public Association's Reliable Public Power Provider (RP3) designation for providing reliable and safe electric service and annually allocates approximately $650,000 of its budget to App State general scholarship fund. The mission of NRLP is to provide electrical service efficiently and reliably to Appalachian State University, the town of Boone, and the surrounding community, while also supporting the university's financial needs. In fulfilling its mission, NRLP serves as a positive link between Appalachian State University, the town of Boone, and the surrounding community, contributing to economic development and public relations.

Scope of Project

The project's primary purpose is to develop a predictive model that accurately forecasts peak energy demand for Appalachian State University's New River Light and Power (NRLP), aiding in identifying periods of maximum power consumption and enabling consumers to optimize their energy usage and save on costs. This model will also support NRLP in enhancing operational efficiency and sustainability. Energy consumption patterns significantly impact operational costs and sustainability efforts for both residential and commercial consumers. High peak demand periods can lead to increased costs, strain on the power grid, and potential service disruptions. The goal is to predict these peak demand times, allowing NRLP to proactively manage energy distribution and provide consumers with actionable insights to reduce their consumption during critical periods. The challenge lies in accurately forecasting peak energy demand based on factors such as historical energy usage, weather patterns, local events, and economic activity. Addressing this problem involves creating a model that can predict when these peaks will occur, thus enabling NRLP and its customers to take preemptive measures to mitigate the impact of high energy consumption periods.

The core objective is to develop a robust predictive model that leverages historical energy consumption data, weather conditions, and other relevant variables to forecast peak energy demand with high accuracy, serving as the foundation for NRLP's efforts to manage energy distribution more effectively. By providing consumers with timely information about expected peak demand periods, the project aims to enable them to adjust their usage patterns accordingly, promoting better energy efficiency. This, in turn, can help consumers save money on their energy bills by avoiding peak-hour usage, which is often billed at higher rates. Additionally, by lowering peak demand, NRLP can reduce its operational costs associated with energy procurement and distribution.

Furthermore, this project aligns with NRLP's commitment to sustainability by promoting more efficient energy use, reducing the overall carbon footprint, and supporting the integration of renewable energy sources. The development of this predictive model will enable NRLP to make informed decisions about energy distribution, improve customer satisfaction by providing them with tools to manage their energy consumption effectively and contribute to the overall sustainability goals of the university and the community.

Project Significance

The project's significance lies in its potential to revolutionize how NRLP manages its energy distribution and how consumers interact with their energy usage. By accurately predicting peak energy demand, NRLP can optimize its operations, reduce costs, and enhance its sustainability efforts. Consumers, on the other hand, will benefit from the ability to adjust their energy usage patterns to save money and contribute to a more sustainable future. The anticipated outcome of this project includes the development of a robust predictive model that accurately forecasts peak energy demand, as well as the implementation of strategies to communicate efficiency. NRLP can expect to see improvements in operational efficiency, cost savings, and customer satisfaction. Consumers, on the other hand, will have access to valuable information that can help them make informed decisions about their energy usage. However, there are limitations to consider. The accuracy of the predictive model depends on the quality of the data used for training and validation. Factors such as unexpected weather patterns, changes in consumer behavior, or unforeseen events can also impact the model's accuracy. Additionally, the effectiveness of the project relies on consumers' willingness to adjust their energy usage based on the forecasts provided.

Alignment with Program of Study

The project of predicting peak energy demand aligns closely with the curriculum and objectives of the Applied Data Analytics program. Throughout my studies, I have taken courses that provide the foundational knowledge and technical skills necessary for this project. One such course was Programming for Business Analytics, where I learned to program using Python, a versatile and powerful language widely used in data science and analytics. In this course, I became more proficient in performing preliminary data analysis using essential Python libraries such as Pandas for data manipulation, Seaborn and Matplotlib for data visualization, and Jupyter Notebooks for interactive computing. These skills are directly applicable to this project, as I plan to utilize Python for data preprocessing, analysis, and model building.

Furthermore, the course on Forecasting and Time Series Models has equipped me with advanced techniques for analyzing temporal data. In this course, I enhanced my skills in R programming, which is particularly strong in statistical analysis and visualization. I learned to create time series models using techniques such as ARIMA (AutoRegressive Integrated Moving Average), exponential smoothing, and regression analysis. These models are critical for accurately predicting future energy demand based on historical patterns.

Additionally, this course provided a deep dive into understanding the intricacies of time series data, including trend, seasonality, and noise, which are essential considerations when forecasting energy demand. The theoretical knowledge and practical experience gained from these courses will enable me to develop robust predictive models that can identify peak demand periods with high accuracy.

Project Plan

The project will have weekly check-ins that are due by 5 pm on Fridays starting June 7th.

Initial Project Schedule

Weeks 1-3 (5/28/24-6/14/24): Meet with Dr. Hassler (project sponsor) to get the data and figure out what exactly is trying to be done, create project proposal, preliminary data analysis, and research machine learning models to try.

Weeks 4-6 (6/17/24-7/5/24): Collect additional data if needed (probably will need to get weather data) and explore various machine learning techniques for forecasting peak energy demands before the mid-term presentation.

Weeks 7-10 (7/8/24-8/4/24): Continue exploring machine learning models to forecast the demand and complete the final presentation.