Electricity Demand Analysis Report

1. Introduction

This report presents an exploratory data analysis (EDA) of the electricity demand dataset. The goal is to identify trends, correlations, anomalies, and key features that can enhance forecasting models.

2. Data Overview

The dataset includes the following key attributes:

- Electricity demand: Power consumption over time

- RRP (Regional Reference Price): Pricing structure based on demand

- Weather factors: Temperature, solar exposure, and rainfall

- Special events: Holidays and school days

Missing Data

- `solar_exposure`: 1 missing value

- `rainfall`: 3 missing values

These missing values may require imputation to improve forecasting models.

3. Demand & Pricing Analysis

- Demand exhibits periodic fluctuations, with peaks observed during certain hours, days, and months.

- High demand often correlates with higher RRP, indicating price surges during peak usage periods.

- Hourly demand trends show significant variation, requiring dynamic pricing strategies.

Business Impact & Recommendations

- Optimizing peak pricing strategies by adjusting electricity rates based on demand fluctuations.

- Enhancing energy distribution planning by identifying peak demand periods for better resource allocation.

- Incorporating weather-based forecasting since temperature significantly impacts electricity consumption.

4. Correlation Analysis

- Electricity demand is positively correlated with temperature, meaning that higher temperatures increase power consumption.

- Moderate correlation between RRP and demand suggests that price changes are influenced by usage patterns.

- Weather factors like solar exposure and rainfall may have indirect effects on demand trends.

5. Weather Impact on Demand

- Higher temperatures result in increased electricity usage, likely due to cooling requirements.

- Seasonal variations affect power consumption, requiring adjustments in forecasting models.

6. Special Events Impact

- Holidays generally show lower demand, while school days contribute to higher consumption.

- Event-based adjustments in forecasting models can enhance accuracy.

Business Impact & Recommendations

- Adjust energy distribution for special events by shifting energy resources to match demand fluctuations.

- Implement school-day-specific pricing adjustments to optimize revenue based on predictable demand changes.

7. Anomaly Detection

- Extreme demand spikes were detected using Z-score analysis.

- Possible causes: Unexpected weather conditions, operational issues, or major social events.

- Actionable recommendation: Incorporate anomaly detection mechanisms in forecasting models.

Business Impact & Recommendations

- Early identification of demand spikes can prevent grid failures and ensure supply stability.

- Develop anomaly-handling models to reduce the impact of unexpected demand fluctuations on pricing.

8. Feature Engineering for Forecasting

To improve forecasting accuracy, the following features were created:

- Hour-based demand variations to capture daily consumption patterns.

- Day of the week indicators to identify weekday versus weekend usage patterns.

- Monthly demand trends to track seasonal fluctuations.

- Yearly data segmentation to capture long-term trends.

- Lag features to analyze past demand patterns and improve predictive models.

9. Conclusion & Recommendations

- Impute missing values to ensure complete data for better forecasting.

- Leverage temperature and seasonal patterns to refine demand predictions.

- Adjust forecasts for special events to accommodate expected changes in consumption.

- Use anomaly detection techniques to handle outliers and ensure data accuracy.

- Develop machine learning models that incorporate engineered features for improved forecasting accuracy.

This analysis provides a foundation for optimizing electricity demand forecasting and pricing strategies. Further modeling can refine these insights for business impact.