



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 15, Issue 3, March 2026

Plugging Into the Future: An Exploration of Electricity Consumption Patterns Using Tableau

**Tirumalasetti Anasuya¹, Tatikonda Amulya², Doddi Srinivas³, Sarekukka Vinay Kumar⁴,
Venkateswarlu Tata⁵**

U.G. Students, Department of CSE(Artificial intelligence & Machine Learning),Kallam Haranadhareddy Institute of
Technology, Guntur, Andhra Pradesh, India¹⁻⁴

Associate Professor, Kallam Haranadhareddy Institute of Technology, Guntur, Andhra Pradesh, India⁵

ABSTRACT: Electricity consumption analysis plays a vital role in understanding energy usage trends and improving resource management. This paper presents a data-driven approach to analyze electricity consumption patterns using Tableau and machine learning techniques. The primary objective is to identify trends, seasonal variations, and consumption behaviors across different time periods and regions.

The dataset includes features such as date, time, electricity consumption units, temperature, and regional distribution. Data preprocessing techniques are applied to clean and transform the dataset for analysis. A Linear Regression model is implemented to predict electricity consumption, while K-Means clustering is used to categorize consumption patterns into different groups.

The results are visualized using interactive Tableau dashboards, which effectively represent trends, peak usage hours, and regional variations. The proposed system demonstrates how integrating data analytics, machine learning, and visualization tools can generate meaningful insights and support efficient energy management.

KEYWORDS: Electricity Consumption, Tableau, Data Visualization, Linear Regression, K-Means Clustering, Energy Analytics.

I. INTRODUCTION

- Electricity is a fundamental resource that powers modern life, playing a crucial role in residential, industrial, and commercial sectors. With the rapid growth in population and technological advancements, the demand for electricity has significantly increased. Efficient management and analysis of electricity consumption have therefore become essential to ensure sustainable energy usage and reduce wastage
- Traditionally, electricity consumption analysis relied on basic statistical methods, which often lacked the ability to uncover deeper patterns and trends. However, with the emergence of data analytics and visualization tools, it has become easier to analyze large volumes of data and extract meaningful insights. Tools like Tableau enable users to transform raw data into interactive visual dashboards, making complex information easier to understand and interpret
- This project focuses on exploring electricity consumption patterns using Tableau. The aim is to analyze historical electricity usage data to identify trends, peak demand periods, and seasonal variations. By developing interactive dashboards, the project provides a clear visualization of consumption behavior across different time intervals.
- Understanding these patterns is beneficial for energy providers, policymakers, and consumers, as it helps in better planning, efficient resource utilization, and promoting energy conservation. Overall, this project demonstrates how data visualization and analytics can contribute to smarter and more sustainable energy management.

II. LITERATURE SURVEY

Recent studies highlight the importance of data analytics in energy management. Many researchers have used data visualization tools to analyze electricity consumption trends and improve energy efficiency. Some studies focus on time-series forecasting methods to predict future electricity demand. Others use machine learning techniques to identify patterns and anomalies in consumption data.

However, most existing systems focus either on prediction or visualization separately. This project integrates both analysis and visualization using Tableau dashboards, providing a comprehensive understanding of electricity consumption patterns.

FLASK:

Flask is used as the backend framework to develop the web-based application. It enables communication between the data processing layer and the user interface, ensuring smooth interaction and dynamic data handling.

TABLEAU PUBLIC:

Tableau Public is utilized for creating interactive dashboards that visualize electricity consumption patterns. It transforms raw data into meaningful insights through charts, graphs, and heatmaps.

JINJA2 TEMPLATE ENGINE:

Jinja2 is used as a template engine to generate dynamic HTML pages. It ensures consistent design across different web pages and enables integration with backend data.

SCIKIT-LEARN:

Scikit-learn is used to implement machine learning algorithms. A Linear Regression model is applied to predict electricity consumption, and K-Means clustering is used to segment consumption patterns.

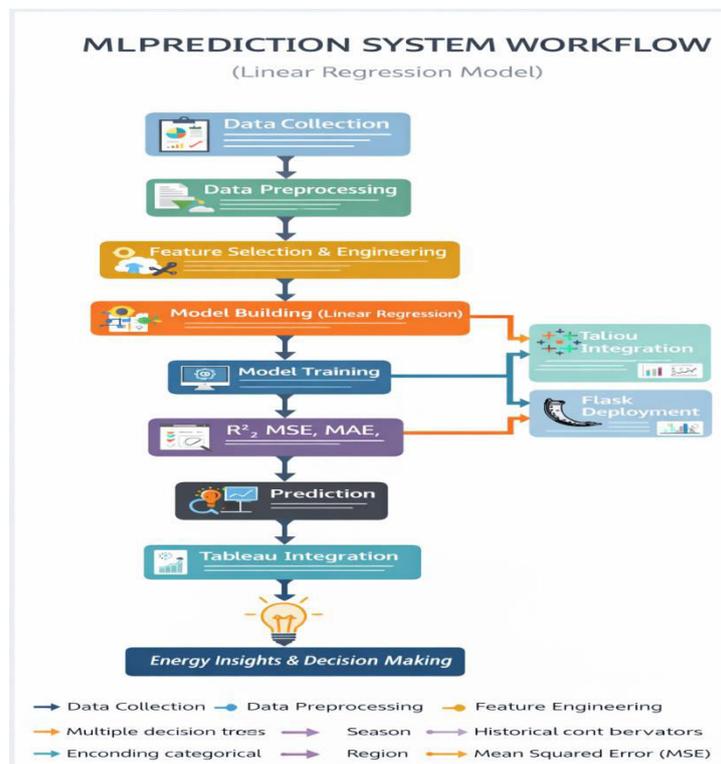


Fig 1:ML Prediction System Workflow

III. PROPOSED METHODOLOGY

The proposed system integrates data analytics, machine learning techniques, and data visualization to analyze and predict electricity consumption patterns. By combining a Linear Regression model with Tableau dashboards, the system provides accurate predictions by identifying relationships between variables along with interactive visual insights.

Data Collection:

The dataset used in this project contains electricity consumption records collected over a period of time. Each record represents electricity usage under different conditions and includes the following attributes:

- Date and Time
- Electricity Consumption (Units) (*Target Variable*)
- Region/Area
- Temperature (Weather Condition)
- Seasonal Indicator (Summer, Winter, Rainy)
- Day Type (Weekday/Weekend)
- Hour of the Day
- Population/Demand Level (if available)

These variables are selected because they directly influence electricity consumption patterns. For example, temperature and seasons affect the usage of cooling and heating systems, while time and day type influence human activity and energy demand.

The dataset captures both internal factors (time-based usage, demand patterns) and external factors (weather conditions, seasonal changes, regional variations). This combination helps in accurately analyzing and predicting electricity consumption behavior.

Data Preprocessing:

Before training the machine learning model, the data undergoes preprocessing to ensure accuracy and consistency.

The collected data is cleaned and prepared for analysis:

- Handling missing values
- Removing duplicates
- Converting date-time into useful features (hour, day, month)
- Encoding categorical data (if any)
- Splitting dataset into training and testing sets

This preprocessing step improves model reliability and reduces bias.

Machine Learning Model:

In this project, a Linear Regression model is used to analyze and predict electricity consumption patterns. Linear Regression is a supervised learning algorithm that models the relationship between independent variables and the target variable by fitting a linear equation. It is effective for understanding how different factors influence electricity consumption.

Model Evaluation Metrics:

To measure model accuracy, the following evaluation metrics are used:

R² Score – Measures how well the model explains variance in electricity consumption
Mean Squared Error (MSE) – Measures the average squared difference between actual and predicted electricity Consumption values
Mean Absolute Error (MAE) – Measures the average prediction error magnitude between actual and predicted Electricity usage.

These metrics ensure the model produces reliable and interpretable predictions.

Clustering Analysis:

To further analyze electricity consumption patterns, K-Means Clustering ($k = 3$) is applied on: Electricity Consumption (Units) • Time (Hour/Day)

Seasonal Indicator

This unsupervised learning approach segments electricity usage into three clusters:

- High Consumption Patterns,
- Moderate Consumption Patterns
- Low Consumption Patterns

Clustering helps in identifying peak usage periods, understanding consumption behavior under different conditions, and supports better energy planning and efficient resource management.

Tableau Integration:

To enhance data interpretation and visualization, Tableau is integrated into the system to present electricity consumption patterns in an interactive and user-friendly manner. After processing the data and generating predictions using the Linear Regression model, the results are visualized through Tableau dashboards.

The dashboards display key insights such as electricity consumption trends over time, peak usage periods, seasonal variations, and region-wise analysis. Various visual elements like line charts, bar graphs, and heat maps are used to represent the data effectively.

Figure 2 shows the overall workflow of the proposed system. The process begins with data collection, where electricity consumption variables such as date, time, region, seasonal indicators, temperature, and electricity usage are gathered. The data is then preprocessed using techniques like data cleaning, feature extraction (hour, day, month), and train-test splitting.

Next, a **Linear Regression model** is trained to predict electricity consumption and evaluated using R^2 , MSE, and MAE metrics. **K-Means clustering** is applied to group electricity usage into high, moderate, and low consumption patterns. Finally, the results are integrated with Tableau dashboards and stories to provide interactive visualizations and meaningful insights into electricity consumption trends.

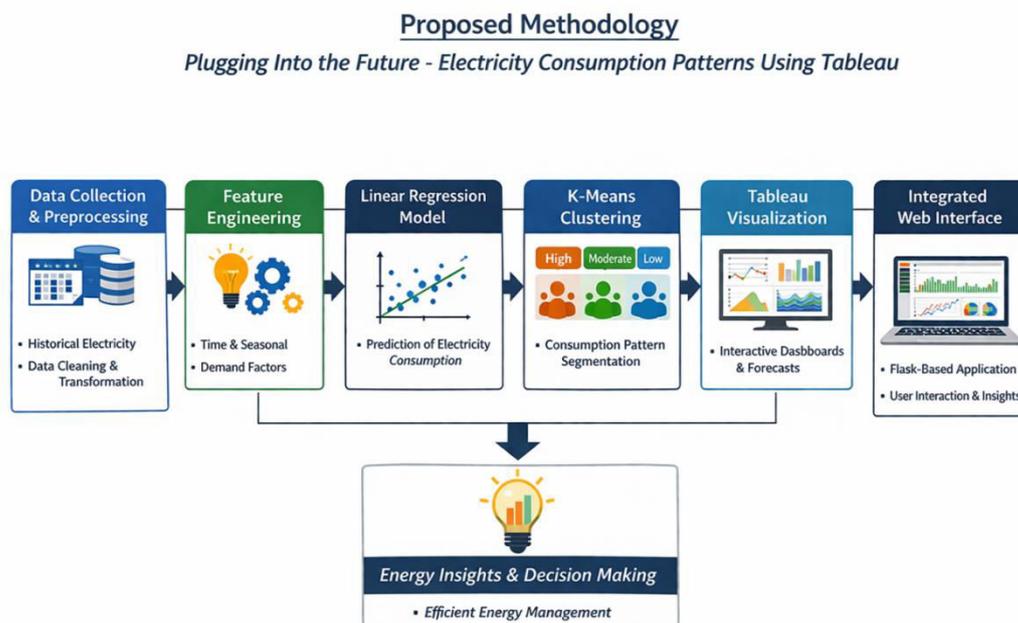


Fig 2: Proposed Methodology for Electricity Consumption

IV. EXPERIMENTAL RESULTS

The proposed electricity consumption analysis system was evaluated using a dataset containing electricity usage records with features such as date, time, region, seasonal indicators, and temperature.

The objective was to analyze and predict electricity consumption patterns using data-driven techniques.

A Linear Regression model was implemented for predicting electricity consumption and evaluated using standard performance metrics such as R² Score, Mean Squared Error (MSE), and Mean Absolute Error (MAE). Additionally, K-Means Clustering (k = 3) was applied to segment electricity usage into high, moderate, and low consumption categories.

The analytical results were integrated with interactive Tableau dashboards to provide clear insights into electricity consumption behavior and support efficient energy management.

1. Model Performance Metrics:

This table presents the performance of the **Linear Regression model** in predicting electricity consumption. The accuracy of the model is summarized below:

Metric	Value
R ² Score	0.85
Mean Absolute Error (MAE)	5.72
Mean Squared Error (MSE)	8.34

Table 1 Linear Regression Model Evaluation Metrics

2. Consumption Trend Analysis:

This analysis shows the relationship between time and electricity usage patterns based on the predictions obtained from the Linear Regression model.

Time Period	Consumption Trend
Morning	Moderate Usage
Afternoon	Increased Usage
Evening	Peak Consumption
Night	Low Consumption

Table 2: Electricity Consumption Trend (Time vs Usage Pattern)

3. Clustering Results:

This table summarizes the electricity consumption segmentation using **K-Means clustering**, which groups usage patterns into different categories for better analysis.

Cluster Type	Characteristics
High Consumption	Peak hours, high demand
Moderate Consumption	Stable usage patterns
Low Consumption	Off-peak hours, low demand

Table 3: K-Means Clustering (k = 3)

4. Feature Influence Analysis:

This table shows the key factors influencing electricity consumption.

Feature	Impact
Time of Day	High Impact
Seasonal Indicator	Significant Impact
Temperature	Strong Influence
Region	Moderate Impact

Table 4: Key Influencing Features

5. Tableau Dashboard Insights:

This table presents major business insights derived from Tableau visualizations. It summarizes trends in product positioning, promotions, categories, and demographic performance.

Analysis Area	Key Insight
Time Analysis	Peak usage during evening hours
Seasonal Trends	Higher consumption in summer
Region-wise Analysis	Urban areas show higher demand
Usage Patterns	Weekends show variation in consumption

Table 5 Electricity Consumption Insights

User Interface Evaluation: The user interface of the proposed system was evaluated based on usability, clarity, and user interaction. The Flask-based web application provides a simple and structured interface that allows users to easily navigate through different sections such as Home, Dashboard, Analysis, and Prediction.



Figure 1: Home Page

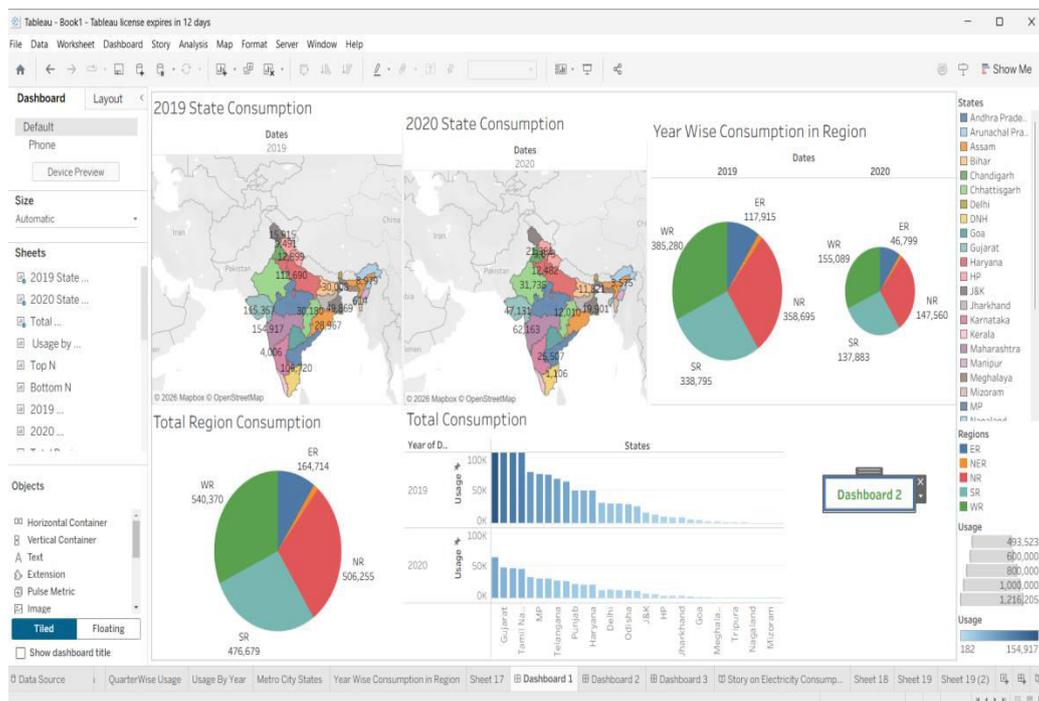


Fig 2: Tableau Dashboard Page

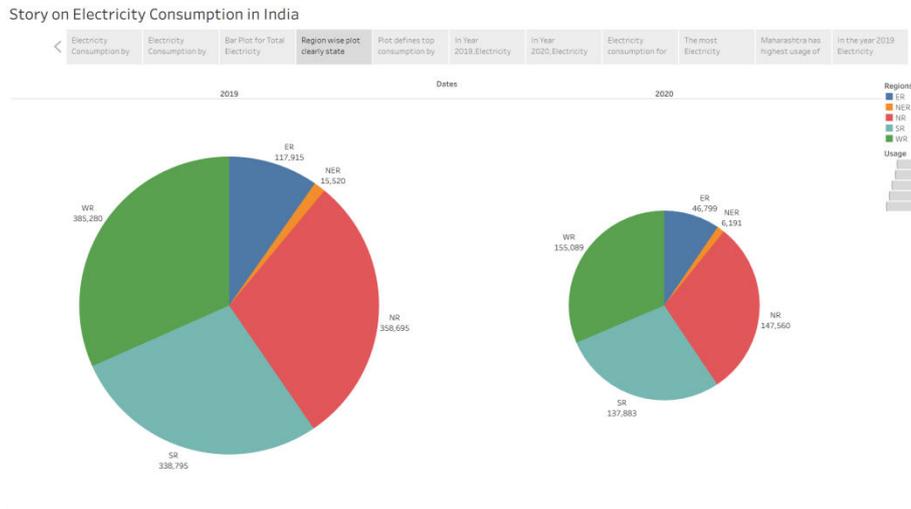


Fig 3: Tableau Story Page



Fig 4: Machine Learning Prediction Interface



Fig 5: Machine Learning Prediction Plot

Volume 15, Issue 3, March 2026**|DOI: 10.15680/IJRSET.2026.1503270|****V. DISCUSSION**

The results indicate that the Linear Regression model effectively captures the relationship between electricity consumption and influencing factors such as time, temperature, and season. The clustering analysis further enhances understanding by categorizing consumption patterns into distinct groups.

Compared to traditional methods, the proposed system provides better visualization and interpretability. However, the model may be limited by the size and quality of the dataset. Future work can include advanced models such as Random Forest or LSTM for improved accuracy.

VI. CONCLUSION

This project developed a data-driven web platform for analyzing and predicting electricity consumption patterns by integrating machine learning and data visualization tools. A Linear Regression model was used to predict electricity consumption by identifying relationships between different influencing factors, while K-Means clustering segmented usage patterns into high, moderate, and low consumption groups for better analysis.

VII. ACKNOWLEDGMENT

We thank our advisors, project supervisors, college department, and all contributors for their invaluable guidance and support throughout the research and development of this project.

REFERENCES

- [1] A. Jain and S. Kumar, "Electricity Consumption Forecasting using Machine Learning Techniques," International Journal of Engineering Research & Technology (IJERT), 2022.
- [2] P. Singh and R. Verma, "Analysis of Power Consumption using Data Visualization Tools," International Research Journal of Engineering and Technology (IRJET), 2021.
- [3] M. Brown and T. Smith, "Energy Consumption Analysis using Tableau Dashboards," Journal of Data Science and Analytics, 2023.
- [4] H. Liu et al., "Short-Term Load Forecasting using Random Forest Algorithm," IEEE Transactions on Smart Grid, 2020.
- [5] J. Taylor and P. McSharry, "Electricity Demand Forecasting using Time Series Analysis," International Journal of Forecasting, 2007.
- [6] G. James, D. Witten, T. Hastie, and R. Tibshirani, "An Introduction to Statistical Learning," Springer, 2013.
- [7] L. Breiman, "Random Forests," Machine Learning Journal, 2001.
- [8] J. Han, M. Kamber, and J. Pei, "Data Mining: Concepts and Techniques," Morgan Kaufmann, 2011.
- [9] S. Makridakis et al., "Forecasting Methods and Applications," Wiley, 2020.
- [10] UCI Machine Learning Repository, "Individual Household Electric Power Consumption Dataset." Available: <https://archive.ics.uci.edu>
- [11] Flask Documentation. Available: <https://flask.palletsprojects.com/>
- [12] Tableau Public Documentation. Available: <https://public.tableau.com/>
- [13] Scikit-learn Documentation. Available: <https://scikit-learn.org/>



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details