

# Forecasting Electricity Demand and Peak Demand Projection

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## ABSTRACT

One of the most crucial elements of the modern power infrastructures effective operation is the ability to forecast electricity demand. Demand forecasting is complicated because electricity consumption varies greatly depending on a number of factors including environmental patterns time of day seasonal variations and consumer habits. This reports suggested project is the creation of an AI-based system that provides the peak load and electricity demand based on time-related meteorological and historical data. The proposed project seeks to improve the accuracy of electricity peak load forecasting. Machine learning and time-series models are used when electricity demand is at its highest. Customers are able to provide instant results of the forecasts of electricity utilization and necessary costs thanks to this suggested system.

## I. INTRODUCTION

The goal of the project Forecasting Electricity Demand and Peak Demand Projection is to create a dependable data-driven system that can precisely forecast future peak load demand and electricity consumption. Due to the increasing complexity of contemporary power grids brought on by urbanization population growth industrial development and the integration of renewable energy sources accurate demand forecasting has become crucial. Weather time of day seasonal variations holidays and consumer behavior are just a few of the variables that affect electricity demand. The suggested system uses both sophisticated machine learning techniques (Random Forest LSTM) and conventional statistical methods (ARIMA exponential smoothing) to analyze past electricity data in addition to external

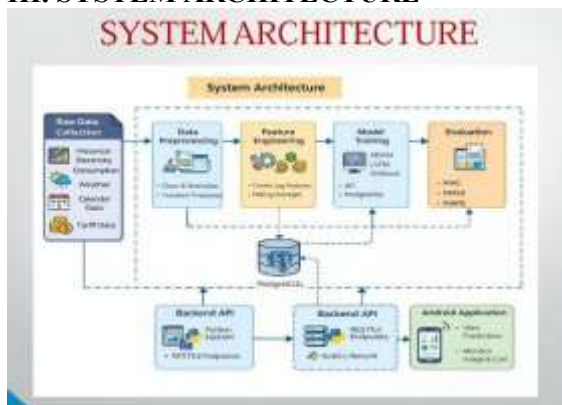
variables in order to produce precise short-term and long-term demand forecasts and peak load predictions. Because inaccurate estimation can result in grid overload voltage instability outages and infrastructure stress peak demand forecasting is an essential component. To guarantee accuracy and model selection the system analyzes data forecasts and displays findings through demand prediction reports and performance evaluation metrics like MAE RMSE and MAPE. In order to help utilities increase efficiency dependability and energy management key features include peak demand estimation to support reserve planning and prevent grid overload weather-integrated forecasting using environmental factors short-term and long-term prediction for operational and strategic planning and historical load analysis to identify usage patterns.

## II. RELATED WORK RELATED WORK

Due to its significance in guaranteeing dependable power supply and effective grid management electricity demand forecasting has been extensively researched. In order to examine past electricity consumption and spot seasonal trends early research mostly used statistical time-series models like ARIMA exponential smoothing and regression techniques. These models demonstrated limitations in capturing nonlinear relationships and dynamic demand variations influenced by weather consumer behavior and economic factors despite being successful for short-term forecasting under stable conditions. Machine learning methods like Artificial Neural Networks Random Forest and Support Vector

Machines have been extensively used to increase forecasting accuracy with the development of artificial intelligence. Large datasets and a variety of influencing factors such as temperature humidity calendar effects and socioeconomic indicators can be processed by these models. Forecasting reliability over both short-term and long-term prediction horizons has been further improved by hybrid approaches that combine statistical and machine learning models. Deep learning models like LSTM and RNN which successfully capture temporal dependencies in electricity consumption data and support peak demand prediction are the focus of recent research. Furthermore real-time data collection and scalable forecasting solutions are made possible by the integration of IoT devices cloud-based platforms and smart meters. The need for adaptable and affordable forecasting solutions like the suggested system is highlighted by the fact that despite these developments current systems frequently encounter difficulties like high implementation costs data dependency and limited customization.

### III. SYSTEM ARCHITECTURE



### IV. METHODOLOGY

Using cutting-edge AI techniques in machine and deep learning algorithms the suggested methodologies focus on creating an intelligent and data-driven system capable of forecasting future power demand and peak load. This method uses a strictly systematic and

procedural approach as described below to ensure quality forecasting processing functionality across the various seasons and loading behaviors. The process is data acquisition wherein historical electrical load data is collected using weather APIs and open sources. In order to enhance model training this data is preprocessed by handling missing data eliminating outliers normalizing numerical data and creating new variables using time and lag variables. Following this preprocessing he moves on to feature engineering and modeling which finds the key characteristics that influence consumption. These features are then fed into machine learning and deep learning models such as ARIMA Random Forest and LSTMs. In order to learn consumption trends and consumption during peaks the models are subsequently trained using historical data. Factors like MAE RMSE and APE are taken into consideration when choosing the best model that can be used for forecasting. The process then proceeds to the forecasting generation stage where the best models found are used to create both short-term and long-term electrical load forecasts. In order to obtain peak values future spiking demands are also assessed in an analysis. Customers are given data and graphs loading curves and charts are used to illustrate the information. Lastly the system that stores forecast findings can be used to evaluate and report accuracy. Reports can even be downloaded and this method provides a reliable and scalable way to perform forecasts in utility operations to improve grid reliability.

### V. RESULTS AND DISCUSSION

The systems developed electricity consumption cost calculation modules output and working interface. shows the input screen where the user enters the amount of electricity used each week and the cost per unit. The user enters these values and then selects Calculate. The estimated monthly electricity usage and associated cost are calculated by the system after processing the inputs. displays the output screen with the computed results. The system multiplies weekly usage by the number of

weeks in a month to automatically calculate the monthly units consumed based on the entered weekly units and price per unit. After that it multiplies monthly units by the unit price to determine the total monthly electricity cost. The instantaneous display of the results shows that the system can estimate costs accurately and effectively. Overall these screenshots verify that the implemented module offers an easy-to-use interface and generates accurate calculations for monthly cost forecasting and electricity consumption.

## VI. CONCLUSION AND FUTURE WORK

The suggested Electricity Demand and Peak Load Forecasting System effectively forecasts future periods of peak load and electricity demand by utilizing AI-based models historical data and meteorological variables. Utilities can enhance planning avoid overloads and preserve grid stability by using the processes of data preprocessing feature selection model training and evaluation to ensure accurate and dependable forecasting. While performance testing verifies the efficacy and efficiency of the system in smart energy management graphical user interfaces improve usability. In order to make the system more scalable flexible and appropriate for contemporary smart grid infrastructure future enhancements will incorporate real-time and renewable energy data add predictive cost and fault analysis enable multi-regional forecasting and implement cloud-based deployment with automated model retraining.

## VII. REFERENCES

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