IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 11, May 2026
Impact Factor: 8.2

Optimized Electricity Bill Prediction System

Rushikesh Manoj Sapkal, Yugandhar Dilip Patil, Prasad Bhagawan Todkar
Sahil Rajaram Patil, Shriram Chandrakant Kamble, Prof. A. A. Mahaldar
Department of Computer Science and Engineering
Ashokrao Mane Group of Institutions, Vathar

Abstract: *The Electricity Bill Prediction System is an online tool that helps people figure out how much their electricity bills will be. It uses computer programs to look at how much electricity people used in the past and then makes a good guess about how much they will use in the future. This project uses two ways to make predictions: one is called Linear Regression and the other is called Random Forest Regressor. The Electricity Bill Prediction System gives people an idea of what their bill will be right now and it also shows them how much electricity they are using and some graphs to help them understand. The system is easy to use. It really helps people use energy wisely and make smart plans for the future. The Electricity Bill Prediction System is about managing energy consumption efficiently and supporting smart energy planning, with the Electricity Bill Prediction System.*

Keywords: Electricity Bill prediction, ML, Linear Regression, Random Forest Regression, Predictive Analytics

I. INTRODUCTION

Electricity use is going up fast because of smart devices, industries and cities growing. This makes managing energy a big challenge for homes, offices and factories. Now electricity monitoring systems only show how much electricity you used each month on your bill. They do not give you real-time updates. Predict how much you might use in the future. The Optimized Electricity Bill Prediction System helps by using technology to track and predict how much electricity you will use. It uses Artificial Intelligence and the Internet of Things to make this happen. The system gets real-time data from sensors and looks at how you used electricity in the past with Machine Learning.

This project brings together React.js, Node.js, MongoDB, Python and IoT communication protocols. It creates a platform for managing smart energy. The system predicts your electricity bills finds unusual usage patterns and suggests ways to save energy. The goal of this system is to help reduce energy improve how we manage electricity and make smart homes and buildings run more smoothly with intelligent automation. It focuses on electricity consumption. Helps users understand and control their electricity use better. The system provides insights into electricity consumption. Offers practical advice, for optimizing energy use.

II. LITERATURE SURVEY

* Zhao and his team in 2022 came up with an energy monitoring system based on IoT. They used Machine Learning techniques to optimize energy use. Their work showed that intelligent analytics can help reduce electricity consumption. Smart energy monitoring systems are really helpful. Artificial Intelligence and IoT technologies make them work well.

* Chen and his team in 2021 developed a system that predicts electricity consumption in time. They used AI algorithms to analyze past energy usage data. This helped improve prediction accuracy. Electricity prediction systems are very important. They help us know how energy we will use.

* Ahmed and his team in 2020 implemented a home energy management system based on IoT. They used ESP32 and cloud technologies. Their work showed that real-time monitoring is crucial for homes. Home energy management systems are really useful. They help us manage our energy use at home.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 11, May 2026 Impact Factor: 8.2

* Kumar and his team in 2022 developed a web-based electricity monitoring platform. They used MQTT communication protocol and Node.js backend technologies. Their research emphasized the importance of communication protocols, for IoT environments. Lightweight communication protocols are really important. They help IoT environments work smoothly.

III. PROPOSED SYSTEM

3.1 System description:

The system we are proposing is built using a design. This design brings together IoT devices, Artificial Intelligence models, backend services, databases and web technologies. The system starts working when IoT sensors collect voltage data from electrical appliances in real-time. The ESP32 microcontroller then processes this data. It sends the data to the backend server using the MQTT protocol.

The backend server, built with Node.js gets the data. It checks if the data is valid then stores it in MongoDB. The server also sends usage data to the Python Machine Learning module. This module analyzes the data. It uses trained Machine Learning models to predict electricity bills. The React.js dashboard shows users live energy data predicted bills and suggestions, on how to optimize usage. The interface is interactive. The system also sends notifications through Firebase Cloud Messaging and Telegram Bot. It alerts users when it detects power usage.

This modular design makes the system scalable. It is flexible. Can process real-time data efficiently. The system is designed to handle devices, Artificial Intelligence models and web technologies. The system uses IoT devices to collect data. The Artificial Intelligence models are used for predictions. The system handles data with the help of backend services. The data is stored in databases. The system uses web technologies to display data.

3.2 Functional Modules:

3.2.1) User Authentication Module

The authentication module provides secure user access to the application.

Features include:

- User Registration
- User Login
- Password Protection
- Session Management

This module ensures secure handling of user information and prevents unauthorized access.

3.2.2) Electricity Consumption Input Module

This module allows users to enter electricity usage details such as:

- Units consumed
- Number of appliances
- Appliance usage duration
- Seasonal usage information
- Household electricity patterns

The collected data is used for Machine Learning prediction and optimization analysis.

3.2.3) Data Preprocessing Module

Data preprocessing improves the quality and consistency of electricity consumption data before prediction.

Preprocessing operations include:

- Data cleaning
- Missing value handling
- Feature normalization

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 11, May 2026
Impact Factor: 8.2

• Data transformation
• Dataset preparation
These preprocessing techniques improve prediction accuracy and model performance.

3.2.4) Electricity Bill Prediction Module

The prediction module is the core component of the system.
The project uses Machine Learning algorithms developed using Python and Scikit-learn frameworks. The trained model analyzes electricity consumption

IV. SYSTEM ARCHITECTURE

The Optimized Electricity Bill Prediction System has an organized structure. This makes it easy to add features and handle more data. The system is built like a series of services.

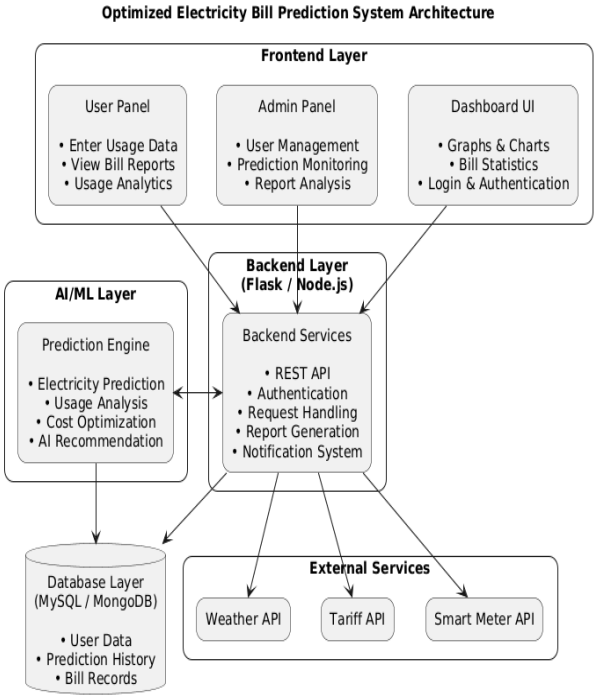

Fig 4.1 System Architecture

4.1 Front End:

The frontend has these parts:
• User Interface – this is where users can put in details about the electricity they use how they use appliances and what their old electricity bills were.
• Admin Interface – this is for people who manage the system they can see what users are doing look at predictions analyze how much electricity people are using and make sure the system is working properly.

4.2 Back End:

The backend layer is built using Python and the Flask framework. The backend is like the brain of the system
The backend does things, such as:

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 11, May 2026 Impact Factor: 8.2

- Handling REST API and checking who is making the request
- Processing and directing user request
- Preparing electricity data for use
- Managing requests, for predictions
- Talking to Machine Learning models
- Generating results and managing reports
- Connecting to the database and storing data

4.3 AI/ML Levels

The Machine Learning part of the system helps us predict things and understand data in a way using Machine Learning algorithms.

The main things this part of the system can do include:

- Predicting electricity bills
- Analyzing how electricity we use
- Looking at how we used electricity in the past
- Getting the right information from the data
- Giving us tips on how to use energy
- Figuring out how our electricity use will change over time

4.4 Integrated External Services

The system works with other services and programs to make it better and help us understand things more clearly.

Examples include:

- Smart meter integration programs
- Electricity tariff programs
- Notification services
- Data visualization services
- Cloud deployment platforms

4.5 Database Layer

The database layer is implemented using MySQL and stores all important application data.

The database maintains the following information:

- User records
- Login credentials
- Electricity consumption history
- Electricity bill prediction records
- Optimization reports
- System activity logs

V. METHODOLOGY

The Optimized Electricity Bill Prediction System uses machine learning to guess electricity bills based on how much electricity's used. This system helps users know how much they will pay for electricity in the future.

The system works with a client-server setup. Users put in their electricity usage details on a website. The system then sends this data to a server to process. Make a prediction.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 11, May 2026
Impact Factor: 8.2

A. Collecting Data

The data includes:
Electricity consumption
Appliance usage
Previous bill records
usage patterns

B. Preparing Data

To make the data better we:
Fix missing information
Clean the data
Make data consistent
Scale features

C. Algorithms Used

1. Linear Regression

Linear Regression helps predict electricity bills by finding a connection between electricity used and the bill amount. It quickly and efficiently predicts for datasets.

2. Random Forest Regressor

Random Forest Regressor is a method that uses decision trees to make a better prediction and avoid errors.

D. Training the Model

The data is split into two parts: for training and, for testing. The machine learning models learn from electricity use records. This helps them understand usage patterns and make guesses.

VI. RESULTS AND DISCUSSION

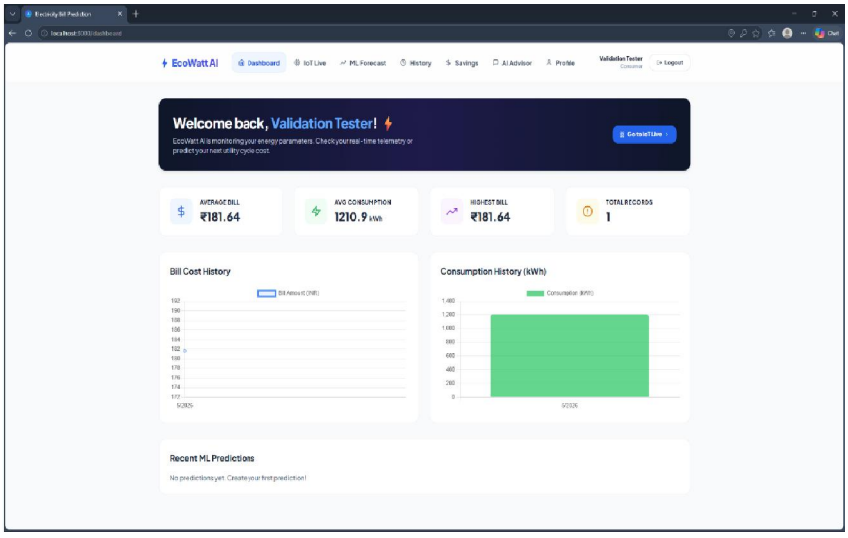

Fig 6.1.Dashboard

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 11, May 2026
Impact Factor: 8.2

The picture shows what the EcoWatt AI – Optimized Electricity Bill Prediction System looks like. This system has a dashboard that shows how electricity you are using right now. It also shows what your electricity bill might be for the month and some other information about how energy you use. You can see things like how much your average bill's how much energy you use in kWh, what your bill might be, for the month and how many records there are.

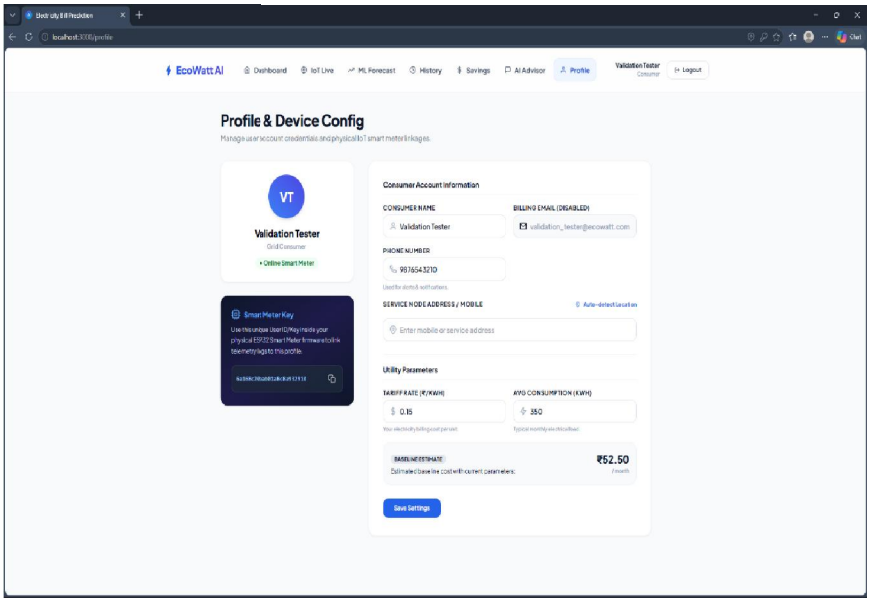

Fig 6.2. Profile

The figure shows the Profile & Device Configuration page of the EcoWatt AI – Optimized Electricity Bill Prediction System. This page helps users manage their account details. It also helps with meter connectivity and electricity usage settings. The dashboard has consumer information, like name, phone number and billing email. It also shows tariff rate and average electricity consumption. A smart meter key is provided for device connection. The estimated monthly electricity cost is also shown.

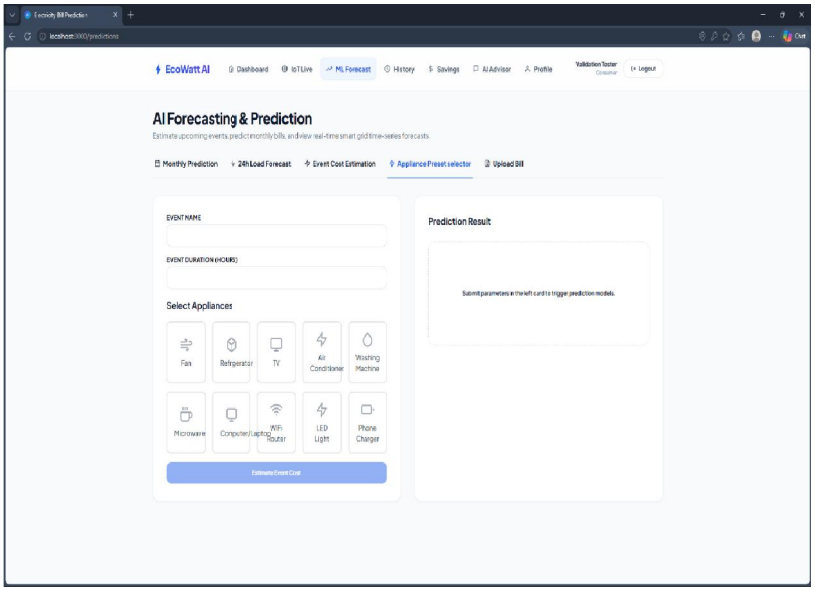

Fig 6.3.Prediction

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 11, May 2026
Impact Factor: 8.2

The picture shows the AI Forecasting and Prediction part of the EcoWatt AI system. This system helps users guess how electricity they will use and how much it will cost. Users can pick which household appliances they use and how long they use them for. The system then uses computer models to look at how people use these appliances and predicts how much electricity will be used and how much the bill will be. It can also do kinds of predictions like predicting usage for a whole month or just for a day and it can estimate how much events will cost. The design is easy to use and understand. It helps users make good choices to save energy and money.

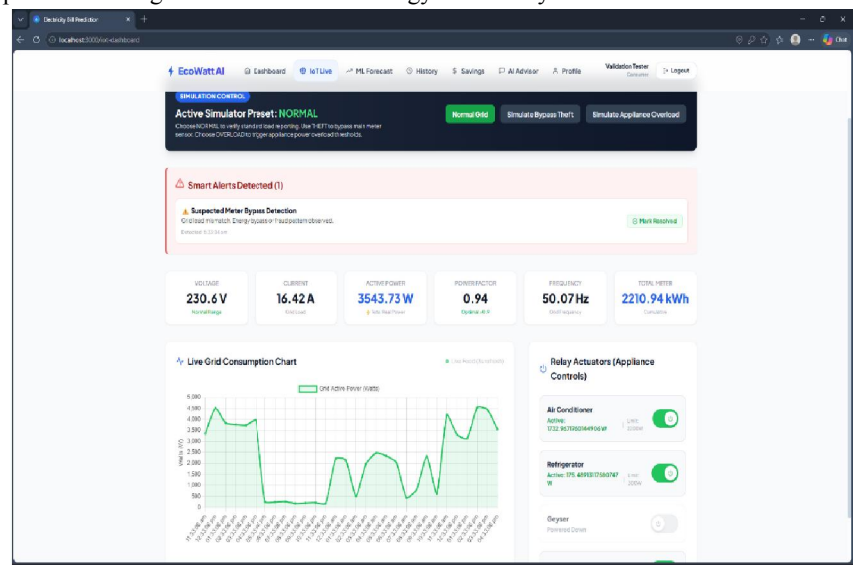

Fig 6.4.IOT

The picture shows the Live Monitoring Dashboard of the EcoWatt AI – Optimized Electricity Bill Prediction System. This part of the EcoWatt AI – Optimized Electricity Bill Prediction System lets you see what is happening with the electricity now. You can see things like how much voltage and current're being used and how much power is being used. The IoT Live Monitoring Dashboard also shows you the power factor, frequency and total energy consumption. This is all possible because of the meters that are connected to the internet.

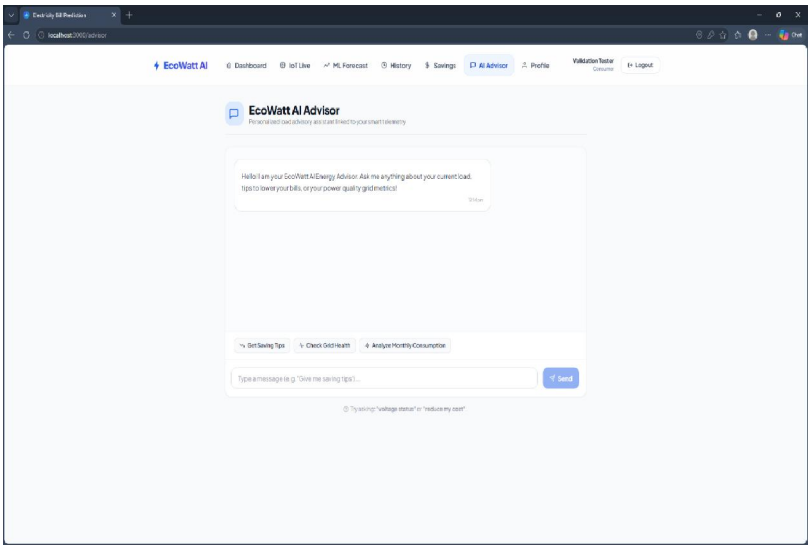

Fig 6.5.Ai System

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 11, May 2026 Impact Factor: 8.2

The EcoWatt AI – Optimized Electricity Bill Prediction System can also find problems, like when someone's trying to bypass the meter or when there is too much power being used. It can even find things happening with the power. When it finds these problems it sends out alerts to help keep everything safe and to help use energy wisely. The IoT Live Monitoring Dashboard also has graphs that show how energy the whole grid is using right now.. You can control the appliances that are connected to the system. This makes it easy for you to see what is using energy and to turn things off when you are not using them.

VII. CONCLUSION

In this project we made the Optimized Electricity Bill Prediction System. This is a website that looks at how people use electricity and tells them what their next electricity bill will be. It uses Artificial Intelligence and Machine Learning to do this.

The Optimized Electricity Bill Prediction System has some features.

- It can tell you what your next electricity bill will be.
- It looks at how energy you use.
- It gives you ideas on how to save energy.
- It shows your energy use in pictures.
- It keeps track of all the information, in a list.

The Optimized Electricity Bill Prediction System helps people understand how they use electricity. It also helps them manage their energy use.

The Machine Learning part of the system looks at how electricity you used before. Then it tells you what your next bill will be. The part that helps you save energy gives you tips. These tips help you use electricity. This makes your energy use better.

The Optimized Electricity Bill Prediction System is designed in a way. It has parts that work together. These parts help the website and the Artificial Intelligence and Machine Learning parts work smoothly. The website is easy to use. This makes it easy for people to use the Optimized Electricity Bill Prediction System.

REFERENCES

[1]. Hippert, H. S., Pedreira, C. E. And Souza R. C. Wrote a paper in 2001 about using networks for short term load forecasting. They. Evaluated the use of neural networks for this purpose. You can find this paper in the IEEE Transactions on Power Systems volume 16 issue 1 on pages 44 to 55. The paper is available online at https://ieeexplore.ieee.org/document/910178.

[2]. Zhang, G., Eddy Patuwo, B. And Hu M. Y. Published a paper in 1998 about forecasting with neural networks. They talked about the state of the art in this field. This paper was published in the International Journal of Forecasting volume 14 issue 1 on pages 35 to 62. You can read this paper online at https://www.sciencedirect.com/science/article/abs/pii/S0169207097000537.

[3]. Hong, T. And Fan S. Wrote a review in 2016 about probabilistic electric load forecasting. They covered a lot of topics in this area. This review was published in the International Journal of Forecasting volume 32 issue 3 on pages 914 to 938. The review is available online at https://www.sciencedirect.com/science/article/abs/pii/S0169207015001236.

[4]. Ahmad, T. And Chen H. Did a case study in 2020 about predicting electricity consumption using machine learning techniques. They used these techniques to make predictions. This study was published in the Journal of Cleaner Production volume 256. You can find it online at https://www.sciencedirect.com/science/article/abs/pii/S0959652620347454.

[5]. Wang, J. And others published a paper in 2021 about using deep learning models to forecast electricity consumption in smart homes. They talked about the models they used and the results they got. This paper was

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 11, May 2026
Impact Factor: 8.2

published in Energy Reports, volume 7 on pages 4514 to 4525. You can read it online at https://www.sciencedirect.com/science/article/pii/S2352484721007732.

[6]. Chollet F. Wrote a book in 2018 called Deep Learning with Python. This book is about learning and how to use it with Python. You can buy this book from Manning Publications at https://www.manning.com/books/deep-learning-with-python.

[7]. Géron, A. Wrote a book in 2019 called Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow. This book is a hands-on guide to machine learning. It covers many topics. You can find this book, on the Media website at https://www.oreilly.com/library/view/hands-on-machine-learning/9781492032632/.