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Electricity Consumption Prediction Using Machine Learning Algorithms

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ABSTRACT: Electricity is important to the economy and an important part of modern life. Electricity is used by a lot of different people and businesses, as well as for daily needs. There are a lot of unknowns about how much electricity customers will use, and an accurate forecasting model is an important part of making the power system run and plan better. By making predictions about how much electricity will be used more accurate and reliable, power planning can be improved and the cost of daily maintenance can be cut. The main goal of this project is to help plan for future power consumption and load so that there is a balance between how much power is used and how much power is made. This will help reduce operating costs and waste of resources. The goal of this project is to create a machine learning platform model that can predict how much energy will be used. The two proposed algorithms for the predictive model are Linear Regression and k-Nearest Neighbor. Before the data is used to train and test models, it will be analysed and pre-processed.

KEYWORDS: Electricity, Power Consumption, Linear Regression and k- Nearest Neighbor.

I. INTRODUCTION

Electricity is one of the most amazing and important things people have ever made. Even though it is a source of energy used all over the world, people lived for hundreds of years without it. You can imagine that, at night, the world was pretty dark, with only a few candles to light the way. Still, even though people have lived without it, it is very unlikely that the human race would thrive without it. This is because the production of electricity made growth and development possible. Everything changed when the idea that electricity could be made and brought life to the world was brought to the world's attention.

Not only does it turn on the lights in our homes and make it easy for us to cook, clean, and go about our day or work as we normally do, but it also helps a lot of different industries, with technology being one of the biggest.

Electricity And Its Importance

Electricity is much cheaper than other forms of energy and is easy to change into other forms. It can be sent to many places quickly and easily. This kind of energy is easy to control and keep track of. And because of this, it is the most popular form of energy. We use electricity for lighting, heating, cooling, and refrigeration, as well as for medical purposes, running appliances, electronics, computers, public transportation systems, and a lot more. Today, it's hard to imagine living without electricity.

Using less energy or making less of it is what is meant by "energy conservation." This could be done by using less energy or by using things that use less energy. Saving energy is a big part of being sustainable and developing in a way that is sustainable. Saving energy is very important for a number of reasons. Along with making us less dependent on non-renewable energy sources like fossil fuels, it helps you save money on energy costs like utility bills and other energy bills. Using less energy also slows down the spread of development in areas where natural resources are being taken out, like oil or lithium. When we save energy and use it more efficiently, the amount of greenhouse gases that get into the Earth's atmosphere goes down.

Energy conservation is important to consumers because it helps them save money and protects the environment. When you save energy, you save money, which means that your living costs will go down. It helps people keep more money in their pockets and protects the environment from too much use of resources and too much carbon dioxide.

Electricity Consumption

Energy use is one of the most important parts of energy systems. After the energy crisis of the 1970s, people started to think about how much energy they used. Also, it is clear that the amount of energy used around the world is going up quickly. So, each country tries to use as little energy as possible in different areas, such as buildings, farms, factories, and vehicles. As energy comes from three different sources, such as fossil fuels, renewable resources, and nuclear energy, it takes a lot of work to keep track of how each type of energy is used in different places. But by doing so, we can estimate how much energy is used in different places and try to make plans that are tailored to a certain use.

India still uses about 0.6 toe (Ton of Oil Equivalent) of energy per person in 2020, which is about half of what the rest of Asia does. In 2020, each person used 940 kWh of electricity, which was about a third of the average for Asia. Due to the Covid-19 crisis, the total amount of energy used dropped by 5.6% in 2020, to 885 Mtoe, after rising quickly from 2010 to 2019 (4% per year).

In 2020, 44% of the country's energy comes from coal. This is followed by 24% from oil and 6% from biomass (22 percent). Natural gas makes up 6 percent, and hydroelectric, nuclear, solar, and wind power make up the other 4 percent.

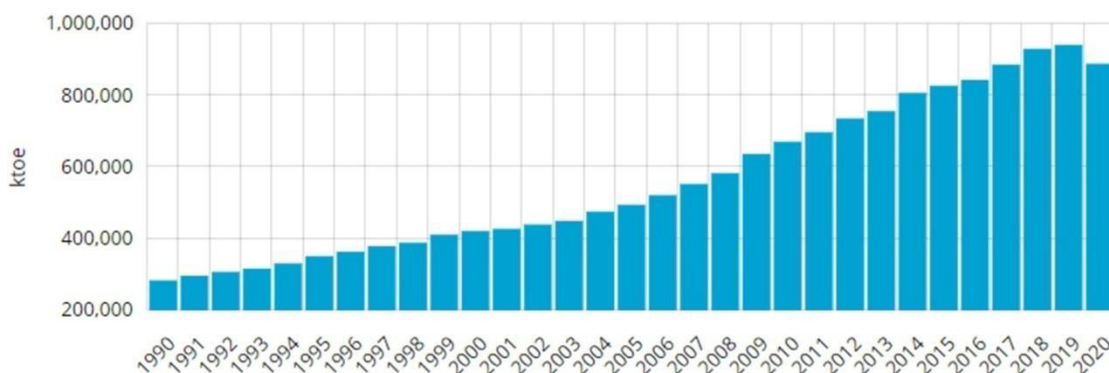


Figure1.2.1: Total Consumption of Electricity in India over last 20 years

The figure 1.2.1 describes the consumption of Electricity in India over last 20 years



The data used in this project is collected from KPTCL Hadadi Road, Davanagere spanning over the years 2017 to 2022.

II. LITERATURE REVIEW

"Data and Statistics" by the International Energy Agency (2021). The amount of electricity used around the world has continued to rise faster than the amount of energy used. From 1980 to 2013, the amount of electricity the world used each year went from 7300 TWh to 22,100 TWh. Since the turn of the 21st century, the world's electricity use has grown even faster, with an average annual growth rate of 3.4%, which is 1.2% higher than the average annual growth rate of energy use. [1]

"World Electricity Production by Source," by the International Energy Agency, 2019. In developing regions, the amount of electricity used is growing faster than in developed regions. Asia used 9,820 TWh, Central and South America used 1,050 TWh, and Africa used 710 TWh of electricity in 2013. This was an increase of 5.8, 2.4, and 2.3 times from 1980. During the same time period, electricity use went up by 87 and 148 percent in North America and Europe, respectively, which is much less than the growth in emerging and developing economies. [2]

Potential opportunities for energy conservation in existing buildings on university campuses: A field survey in Korea, by Min Hee Chunga and Eon Ku Rhee, Energy and Buildings, 2006. The Survey on Household Electricity Consumption in 2006 broke down how much electricity people used in their homes into very specific types of appliances. Based on the results of a cross-sectional study, the predictions for the years to come are not easy. In the first phase, most of the predictions were based on trends. This is because the new raw data are still being collected, and it is easier to build prediction models when there are more than one review point. There has only been a change in how the TV stock is put together. Since 2006, when flat-screen TVs became more popular, the number of cathode ray tube TVs has gone down while the number of flat-screen TVs has gone up. In and of itself, the number of TVs is in line with the trend. [3]

Institute for Energy Research, "Generation of Electricity" (2014) Electricity development in a country can be measured in part by how much electricity each person uses each year. In general, electricity use goes up faster when the process of industrialization moves quickly and goes down quickly when industrialization is done or almost done. The same is true for how much electricity each person uses in a year. Between the 1950s and the early 1970s, when the U.S. economy grew at its fastest rate ever, the amount of electricity each person used each year rose threefold, from 1990 kWh in 1950 to 7870 kWh in 1973. [4]

Energy and Buildings, Min Hee Chunga and Eon Ku Rhee, "Potential opportunities for energy conservation in existing buildings on university campuses: A field survey in Korea," Min Hee Chunga and Eon Ku Rhee, Eon Ku Rhee, "Po The industrial sector has used the most electricity, with its share going from about 72% in 1951-1952 to 64% in 1978-1979, a small drop. More than half of the industrial demand comes from aluminium, iron and steel, textiles, fertiliser, chemicals, cement, paper, and engineering. In the last 15 years, industrial demand has grown about 7% a year, but demand in the aluminium, chemicals, fertiliser, and engineering industries has grown between 9 and 15% a year.

The percentages of domestic (9%), commercial (6%), public lighting (1%), public water works (3%), and railways (3%) haven't changed much over the past 30 years. However, the percentage of the agricultural sector has grown from about 3% in 1951-1952 to more than 14% in 1978-1979, and it is expected to grow even more as rural electrification programmes, which are strongly supported by the central and state governments in India, continue to spread. Most of the demand for electricity in the agricultural sector comes from powered pump sets used for irrigation and other electric farm tools. [5]

He wrote "D manic power-aware shared path protection algorithms in WDM mesh networks" in 2013. The consumption part of the bill is based on how much electricity the building uses in kilowatt-hours in a month. The demand part is the highest amount of power used in kilowatts during the month. Monthly demand charges can be anywhere from a few dollars to almost \$20 per kilowatt and can be based on the highest peak in the last year. This charge can be a big part of your bill, so try to cut your peak demand as much as you can. [6]

Muhammad, "Eligibility Di orientation in Inefficient Optical Networks with Hardened Path Protection," 2013. During the heating time, a lot more electricity is used than during the cooling time. In the case of the university campus, it has been found that the area used for heating is bigger than the area used for cooling. Also, since the heating load is usually bigger than the cooling load, it has been found that the EHP system uses more electricity. In the case of the university campus, power use goes down during vacations and up during terms. The most electricity is used when a new school year starts in March and September.[7]

"Energy Saving in Access Networks: Gain or Loss from a Cost Point of View," by P. Wiatr. June 2013. Most computers now come with some kind of power management settings turned on, but users or IT staff can turn them off. Make sure they're turned on and set up to save the most energy. Some users may think that turning on power management settings will stop software updates from happening automatically, but that is not the case. When the computer wakes up from sleep mode, updates will be downloaded automatically. [8]

N.-H Bao "Power-aware provisioning strategy in optical WD networks with shared path protection" Technology with optical fibres Students have been the brains and hearts behind efforts to make campuses green for a long time. Their work with recycling programmes goes back to the 1970s, when many of the parents of today's students were in college. The National Wildlife Federation's (NWF) Campus Ecology Report is a collection of the conservation efforts that are being led by students today. Many schools have had competitions between dorms to see which one could save the most energy. [9]

Zahedi, Gholamreza; Azizi, Saeed; Bahadori, Alireza; Elkamel, Ali; R. Wan Alwi, Sharifah "Estimating electricity use with an adaptive neuro-fuzzy network: A case study from Ontario, Canada" (2013) As the oil crisis and the collapse of the economy took their toll, the United States went through a period of stagflation, during which the amount of electricity each person used each year grew more slowly. From the middle of the 1950s to the end of the 1960s, Japan's economy grew quickly, too. This led to a huge increase in the demand for electricity and a big rise in the amount of electricity each person used. But Japan's economy was badly hurt by two oil crises in the 1970s, which slowed both economic growth and electricity demand growth.[10]

Summary of Literature Survey

A survey of energy consumption data was used to look at how much energy the campus of the university uses now. Here's what happens next: On a college campus, the air conditioning is mostly run based on both the cooling and heating periods and the temperature of the air outside. From the middle of June to the middle of September, cooling is on, and the set temperature is 27°C. The heat is on from the middle of November to the middle of March, and the temperature is set to 18°C. The EHP (Electric Heat Pump) system is slowly replacing the old way of cooling and heating.

A negative opinion was given about the use of new and renewable energy because it was not profitable. Due to price changes for each energy source and the fact that electricity is the cheapest source of power for education, it takes up a lot of space in terms of specific gravity. The amount of electricity used has been going up for a long time. During the heating season, more electricity is used than during the cooling season. Also, when people go on vacation, they use less electricity, and when school starts in March and September, they use the most electricity.

A link between the number of members or the total gross floor area and the amount of electricity used was studied. Consequently, it drew to be the mutual linear proportional relation. The unit total area average electricity



consumption amount of the university campus is about 71.34kWh / m² yr.

Existing System

With the help of a remote monitoring system, they were able to get power and data. The data was looked at to see how well it could predict monthly electricity costs.

To figure out how much electricity will be used, a convolutional neural network and a support vector machine algorithm were used. A support vector machine was used to predict the amount of electricity used to within 12 percent (this is called the relative prediction error, or RPE). Overall, the machine-learning models that were made made the RPE of electricity 54% better than what was done before with a multiple linear regression method.

After more research, it was found that the support vector machine overestimated electricity use by 4% from January to December (mean percentage error, or MPE). During the period from March to October, however, the amount of electricity that was used more than was predicted was cut down to 1%.

Problem Statement

Increases in power demand and loads, especially non-linear loads, have caused the power system to work harder than it was designed to, making it harder to run the network of the power system. This makes the system less safe because there isn't enough control over the large power flows. This could cause us to lose a lot of equipment and cost us a lot of money. The goal of this project is to create a new way to analyse and predict how much electricity will be used in a certain area for a certain amount of time based on data from the past.

Proposed Objectives

This analysis is organized as follows:

- Get a public dataset of how much electricity is used in the area and clean it up by dealing with missing values and outliers.
- To see and understand how people use electricity over time.
- To create a training and testing model using Machine Learning Algorithms, Linear Regression, and k-Nearest Neighbor.
- To figure out what can be learned from how well the algorithms work.

Gaps Identified

- Using combinations of occupant characteristics instead of each one alone gives new information about how the occupant affects energy demand. Studying occupant traits instead of actual behaviour data lets you work with bigger data sets.
- Using a big set of data, the average real and theoretical energy use of different building types and features for each energy label was compared.

III. METHODOLOGY PRESENTED

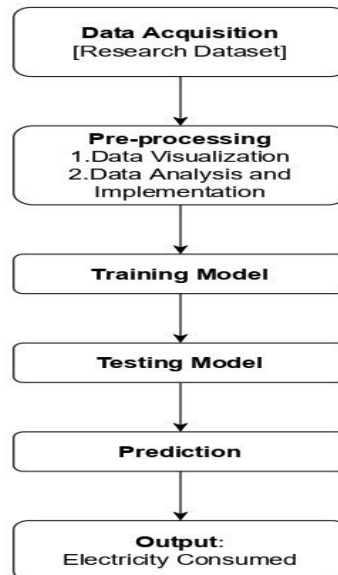


Figure: Methodology

The Figure describes the Methodology

Detailed Description of The Methodology

1. Dataset Acquisition:

Acquisition of datasets is the process of getting the datasets needed for the proposed project. Here, we are collecting data from the public that predicts how much electricity a certain area or building will use.

2. Pre-Processing:

During pre-processing, the data is displayed so that patterns, bad data, and outliers can be found and used to learn more about the dataset. Data pre-processing is needed to clean the data and make it fit for a machine learning model. It also makes a machine learning model more accurate and efficient.

- Dealing with null and missing values: We'll figure out the average of a column or row that's missing a value and put that number in its place. This strategy works well for features that have numbers, like age. Here, we'll use the Scikit-learn library, which has many libraries for building machine learning models.
- You can also deal with missing values by getting rid of the rows or columns that have null values. If more than half of the rows in a column are empty, the whole column can be dropped.
- Getting rid of "outliers," which are samples that are very different from the rest of the data. Putting the features or data points on a graph is the easiest way to find an outlier. One of the best and easiest ways to figure out what the overall data means and what the outliers are is to look at the data visually. Most of the time, scatter plots and box plots are the best ways to find outliers.

- Feature selection: The main goal of feature selection is to get rid of useless or duplicate data from the model.
- The entire dataset is divided into training data and testing data.

3. Training of the Model:

A training model is a set of data used to teach an ML algorithm how to do something. It is made up of a set of sample output data and the sets of input data that affect that output. The training model is used to run the input data through the algorithm to see if the output from the algorithm matches the output from the sample. The model is changed based on what this correlation tells us. Training a model is as easy as using labelled examples to find good values for all the weights and the bias. We will teach the model using data that has already been cleaned up.

IV. TESTING

In machine learning, model testing is the process of judging how well a model works on a testing set after it has been fully trained. The testing set, which is made up of a set of testing samples, should be kept separate from both the training and validation sets. However, it should follow the same probability distribution as the training set. We will test the model with test data that has already been cleaned up and evaluate the model.

V. CALCULATION AND PREDICTION

The electricity use for each mode (Active, Sleep, and Off) is calculated separately, and then all three are added together with the power mode to get the total electricity use by mode. The UEC, or unit electricity consumption, is used to figure out how much electricity a device uses each year. The average consumption is then found, and the electrical load is used to predict consumption over a period of time.

VI. EXPERIMENTAL RESULT AND DISCUSSION

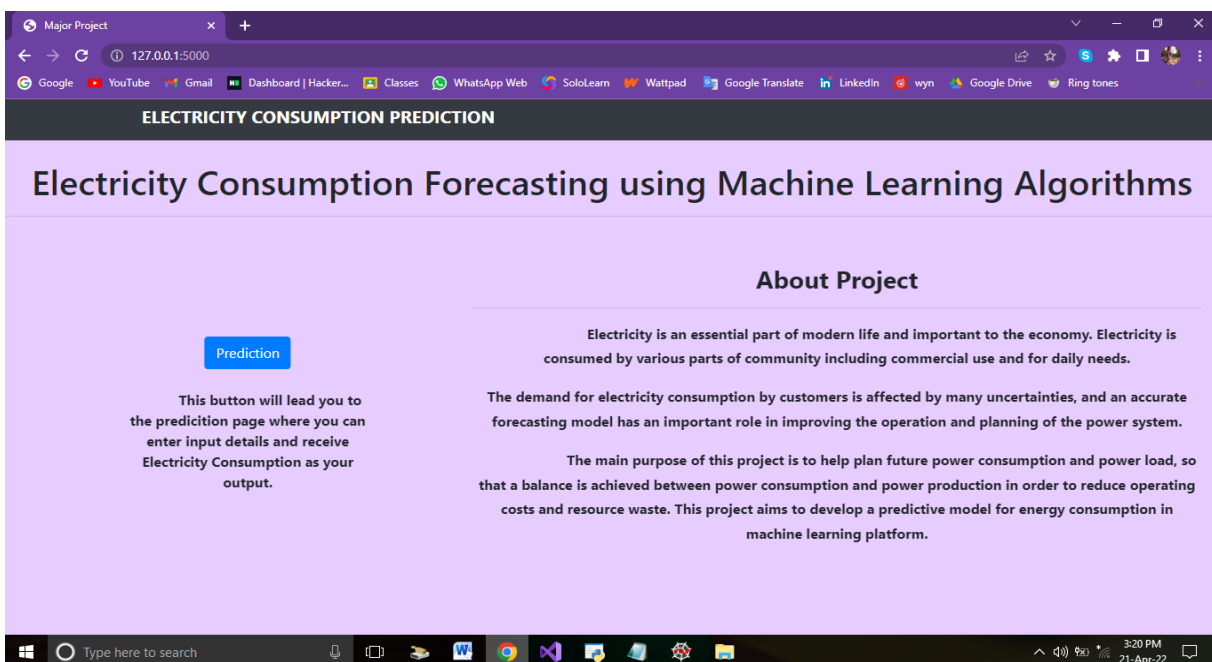


Figure: Home Page of UI



The figure shows home page of prediction of Electricity Consumption.

A screenshot of a web browser displaying the 'ELECTRICITY CONSUMPTION PREDICTION' application. The page has a light purple background. At the top, there's a title 'Prediction of Electricity Consumption'. Below it, there are input fields for 'Month' (set to 8), 'Year' (set to 2023), and 'Area' (set to Shamnur). A blue 'Submit' button is below the 'Area' field. To the right, a list titled 'The areas accounted in this project are as follows:' includes: Hadadi, Tolahunase, Kukkavada, Yallamma, Belavanur, Naganur, Jarikatte, Turchagatta, Shamnur, Saraswathi, Attigere, Industrial, Vidyanagara, Ranganatha, JH patel 1, JH patel 2, NJ Taralabalu, S S Hi-Tech, and Vivekananda. At the bottom left, there are two small circular icons with text: 'Please enter numeric alternatives of month.' and 'Please enter the year in yyyy format.' The browser's address bar shows '127.0.0.1:5000/Prediction?'. The Windows taskbar is visible at the bottom.

Figure: Input Page of UI

The Figure shows Input Page of prediction of Electricity Consumption

A screenshot of the same web application showing the result. The page displays 'CONSUMPTION IN UNITS:' followed by the value '474099.9999999999'. The browser's address bar now shows '127.0.0.1:5000/predict'. The Windows taskbar is visible at the bottom.

Figure: Result Page of UI

The figure shows Result page of prediction of Electricity Consumption.

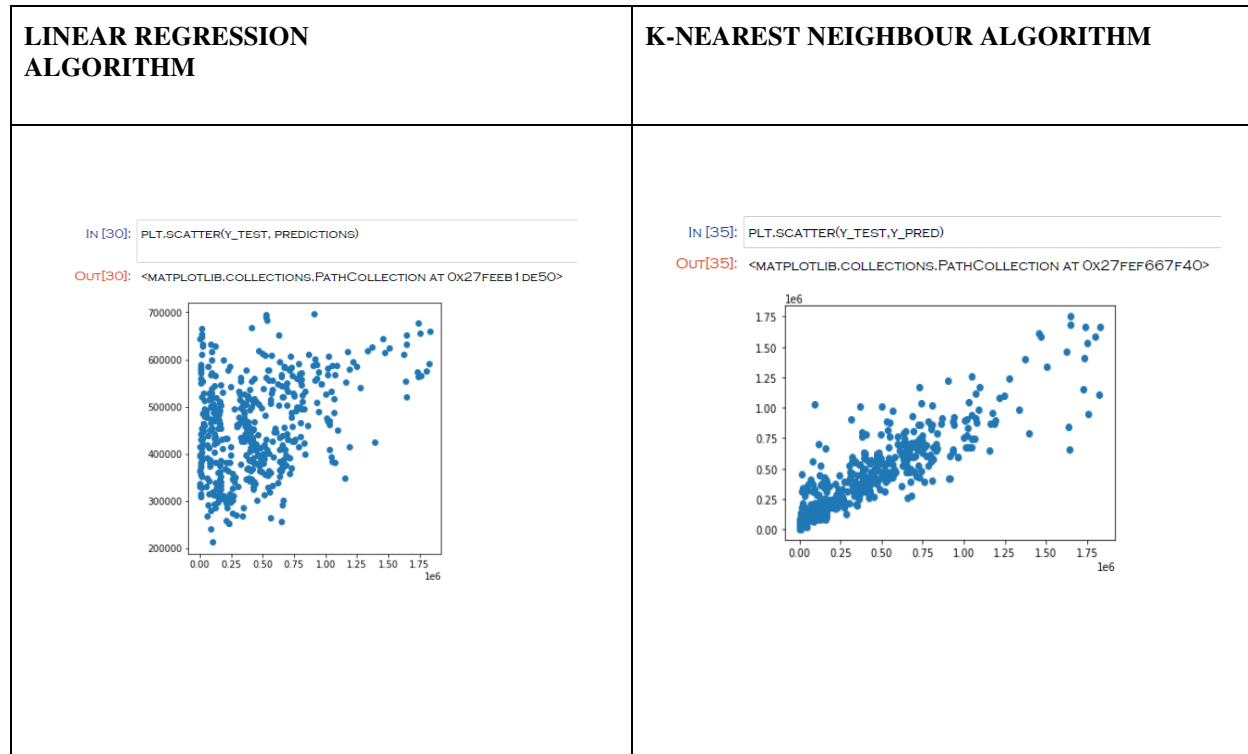


Figure: Comparison of Accuracy
The figure shows Comparison of Accuracy.

Based on how well each model did in different tests, the K-Nearest Neighbor Algorithm did the best and is good for predicting how much electricity will be used.

VII. CONCLUSION

Summer and winter are the times when people use the most electricity. As far as can be seen, Belavanur, Shamnur, and Saraswathi use the most electricity, while Tolahunse uses the least. The prediction model is more accurate with the help of the K-Nearest Neighbor algorithm. Taking into account the number of installations in an area as well as bank losses could make the model even more accurate and reliable. Also, this could be made better by getting more reliable and up-to-date data to make the model more accurate.

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