Power Consumption Analysis For House Holds

USING U.S.FEDERAL MACHINE LEARNING

1.Introduction

U. S. federal appliance energy efficiency standards are established using a set of criteria pertaining to their effects on industry, consumers, environmental quality, and other factors. These notes are part of a joint effort by the Office of Management and Budget (OMB) and the Department of Energy (DOE) to examine the issue of consumer welfare impacts of efficiency standards, and to extend and enhance the methodology by which these impacts are defined and estimated in the regulatory process. DOE's economic analysis of efficiency standards generally takes a life-cycle cost investment perspective focused on the trade-off between initial and operating costs for efficient equipment. In this perspective, the time value-of-money is represented by the cost of capital. In a more general framework, additional trade-offs may exist between investment and consumption, and consumer choice over the planning horizon can reflect preferences for future consumption. In this framework, these preferences combine with the cost-of-capital as drivers of consumer choice. This document presents a first version of a mathematical framework for analysing the similarities and differences between these two choice modelling approaches, and thus starts to address several theoretical economic issues raised by OMB. These notes have been prepared to facilitate discussion and investigation of analytical metrics for assessing welfare effects, initially from a theoretical perspective. Terminology and basic concepts in engineering and economic approaches to modelling household or consumer energy demand are reviewed, and a simple theoretical economic model of consumer energy efficiency and fuel choice is introduced and discussed. Going forward, this theoretical material may be useful in supporting empirical analysis to define and implement quantitative welfare estimates that relate life-cycle cost and other aspects of consumer appliance choices. This document reflects the philosophy that a clearlyarticulated theoretical framework can be useful in dealing with the potential challenges and complexities of identifying and obtaining data for such estimates and integrating it into practical quantitative tools. There is a long history of debate regarding consumer welfare effects of appliance standards, but the literature on this debate, as such, is not reviewed here. Indeed, this first version does not explicitly discuss standards per se. Instead, its aim is to facilitate discussion of the issues, provide a modelling starting point that can be discussed, debated, extended and improved, and to inform subsequent quantitative analysis. The departure point is the specific topic of metrics for assessing these consumer welfare effects.

1.1 Overview

In this project, we analyse the average usage and priority of home appliances based on the characteristics of power data in household. In the case of electric power used in household, the control ability of individual appliance is determined according to the characteristics, and the analysis. Depending on the result of this kind of analysis, it is possible to suggest more efficient energy operation from the viewpoint of the energy consumer. Therefore, by analysing the characteristics of each power source based on the time horizon, we set the priority of individual power resources according to the user preference. Through the application of this method, it is proposed to minimize the inconvenience of users' power operation and power operation fee. As a result, peak power was reduced by 15%, and the total power operation fee was reduced by 4%.

The consumption of goods and services is a primary component of economic well- being and, as such, a primary indicator of living standards.[1] Wealth and income are available to support consumption, today and in the future (through the saving that income generates). Income, consumption and wealth are three dimensions of the broader concept of economic well-being, and it is important to understand the relationships between them.

Everything else being equal, a person with a higher level of consumption is regarded as having a higher level of economic well-being than someone with a lower level of consumption. Consumption needs can be met through the spending of income, through the running down of wealth, and through borrowing.

1.2 Purpose

Data on expenditures at the micro level (households, families) have been collected since the late 19th and early 20th centuries, and have been used to bring light to various aspects of the economic situation of populations in countries around the world. This section describes some of the most common uses of micro data on household expenditures.

To compare income or consumption expenditure over time, it is necessary to be able to account for relative changes in the prices of the goods and services that households purchase to meet their needs. The consumer price index (CPI) is a measure of inflation: it measures changes in the price of a basket of goods and services, selected as representative of consumer spending, purchased by households. The CPI has been used for adjusting wages, pensions and social benefits and, in many countries, it plays an important role in the implementation of monetary policy and in the setting of interest rates by central banks. In some countries, the CPI is assumed to approximate the cost of living. Expenditure statistics are used for creating, implementing, monitoring and analyzing the effects of economic and social policy, including, for example:

- The planning of fiscal changes.
- The analysis of the results of government activities in the support of certain groups.
- The evaluation of programs to reduce disparities between regions and groups.

Expenditure statistics also provide a rich source of data for analyses of the consumption of and demand for different categories of products and services and for different social groups.

2.Literarure Survey

2.1 Existing problem

1.Given the rise of smart electricity meters and the wide adoption of electricity generation technology like solar panels, there is a wealth of electricity usage data available.

2.This data represents a multivariate time series of power-related variables, that in turn could be used to model and even forecast future electricity consumption.

3.In this, you will discover a household power consumption dataset for multi-step time series forecasting and how to better understand the raw data using exploratory analysis.

2.2 Proposed solution

- How to use the new understanding of the problem to consider different framings of the prediction problem, ways the data may be prepared, and modelling methods that may be used.
- How to explore and understand the dataset using a suite of line plots for the series data and histogram for the data distributions.
- The household power consumption dataset that describes electricity usage for a single house over four years.

3.Theoritical Analysis

Introducing Energy Consumption Theory and Its Positive Impact on the Economy

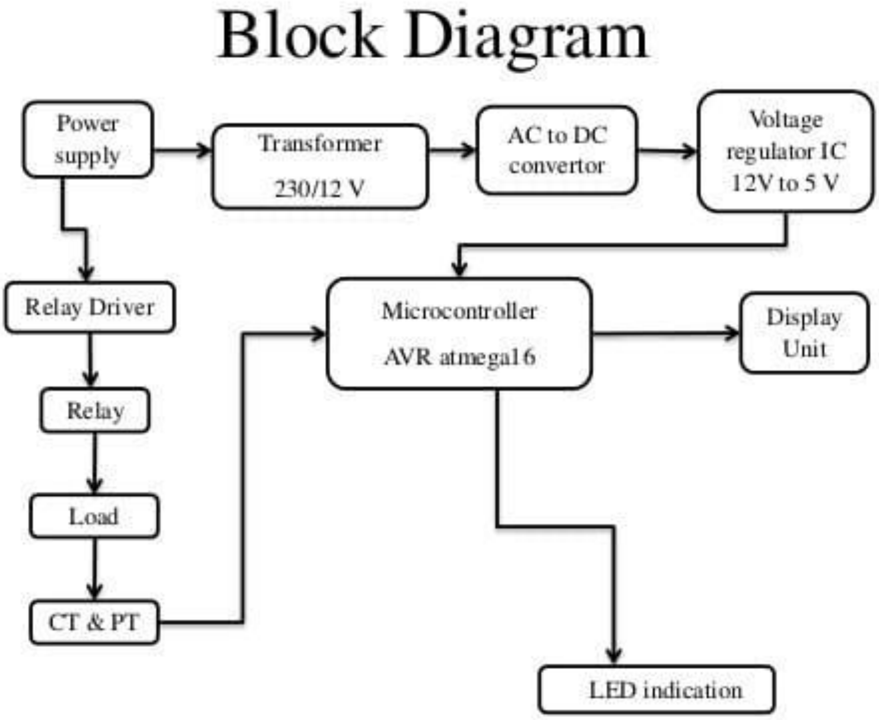
Energy Consumption Theory the Energy Consumption Theory (sometimes referred to as Energy Cost Theory) states that the cost of using energy resources in production and service business operation can be compensated by the overall positive economical impact of these operations. In our description, the energy resources include the material purchases and procurement that are related to the consumption of energy resources. The positive economical impact is due to the fact that the residual and incremental innovations in the aforementioned businesses lead to overall improvement in economy due to the random induced demand multiplier effect on monetary transactions. Moreover, the mentioned induced demand improvement in monetary transactions not only boosts the economy and improves the living standard of people, but it could dynamically trigger a set of innovative events on the part of the businesses and relevant stakeholders that may lead to a lower incremental cost of energy production, i.e., even though the business clients or customers are able to pay for the cost of the energy consumption due to their improved financial condition, it is possible for them to actually pay less for the energy consumption. The initial decision of increasing energy consumption is part of business initial innovations, whereas the dynamic effects that could lower the cost of energy consumption in the aforementioned businesses are part of business consequential innovations. This theory is an extension of the existing grand theories that support the economical impact of improved energy efficiency (see for example [5]). The environmental regulations on GHG and hazardous emissions are the same in this theory except that the energy efficiency factors that are not related to environment are slightly relaxed in the initial stage of energy consumption in order to allow production and service businesses to proceed with their operations. However, at later stages, the businesses should optimize their non-environmental energy efficiency factors. As stated before, this theory does not allow any relaxation on environmental regulations.

Examples

If hydrocarbon and sustainable energy resources (such as solar power) along with nanogenerators are used by production facilities in dry and hot locations to pump salty water from the sea or ocean and desalinate the extracted water supply, the sweet water can be used to irrigate and develop urban and rural infrastructure for these regions [6, Appendix I]. This will ultimately lead to more demand for energy to meet the population and business needs. Furthermore, tourism will flourish in these regions, and ultimately more energy will be needed to meet the air and ground transport requirements. CO2 Converting Units or other means to lower emissions can be employed in HC consuming facilities. It is interesting to note that in some CO2 conversion schemes, CO (syngas) is produced which can be reacted with water (water-gas shift reaction) to produce energy-rich Hydrogen gas that is needed to drive Fuel Cell technology [9]. Note that the initial business innovations in producing sweet water by the consumption of energy could lead to the dramatic improvement of multi-national economies. The mentioned businesses could use the generated income to perform Research and Development and invest in mixed energy-resource technologies in order to lower the environmental hazardous emissions (if applicable) and to lower the cost of energy production. In some cases, multi-national governments could provide subsidies to these businesses after receiving sufficient revenues from improved local and international economies.

3.1 Block diagram

As stated in the Introduction, these notes have been prepared as part of a joint OMB-DOE discussion on consumer welfare effects of appliance efficiency standards, and are aimed at facilitating discussion of issues and contributing to further work on technical methodology. Such work can proceed in several (complementary) directions. Specifically with regard to theoretical extensions of the model and results described above, next steps could include the following. First, in addition to the rate-of-time-preference, the so-called "intertemporal elasticity of substitution" is a critical behavioral parameter in dynamic choice models, and its effects on optimal choice in the model should be analyzed. Second, to investigate how energy service choice is combined with, and affected by, the consumer's preferences for other goods and services, a non-energy composite good can be introduced. Third, extensions to longer time horizons are important – in particular, the lifetime of energy technology as represented in the life-cycle cost model. Fourth, even before considering empirical applications, it will be important to introduce specific functional forms for utility in order to gain understanding of how these may affect the results. Fifth, more complex representations of energy service "production technologies" – e.g., incorporating possible nonlinearities – should be explored. As these examples indicate, there are multiple possibilities for further development.



3.1 Hardware/Software designing

Software designing:

- Let us build app.py flask file which is a web framework written in python for server-side scripting. Let's see step by step procedure for building the backend application Import required libraries.
- HTML pages "pca.html" for our home page and "result1.html" which comes to use when we print out the final predictions made, both of these are stored in the templates folder
- The finalized model is now to be saved. We will be saving the model as a pickle or pkl file.
- Matplotlib and Seaborn : Used for visualization with python.
- Numpy and Pandas: Open source data analysis and manipulation tool, built on top of the Python programming language.
- Configure app.py to fetch the user inputs from the UI, process the values, and return the prediction.

4.Experimental Investigation

The household power consumption dataset is a multivariate time series dataset that describes the electricity consumption for a single household over four years.

The data was collected between December 2006 and November 2010 and observations of power consumption within the household were collected every minute.

It is a multivariate series comprised of seven variables (besides the date and time); they are:

- **global_active_power**: The total active power consumed by the household (kilowatts).
- **global_reactive_power**: The total reactive power consumed by the household (kilowatts).
- **voltage**: Average voltage (volts).
- **global_intensity**: Average current intensity (amps).
- **sub_metering_1**: Active energy for kitchen (watt-hours of active energy).
- **sub_metering_2**: Active energy for laundry (watt-hours of active energy).
- **sub_metering_3**: Active energy for climate control systems (watt-hours of active energy).

Active and reactive energy refer to the technical details of alternative current. In general terms, the active energy is the real power consumed by the household, whereas the reactive energy is the unused power in the lines.

We can see that the dataset provides the active power as well as some division of the active power by main circuit in the house, specifically the kitchen, laundry, and climate control. These are not all the circuits in the household.

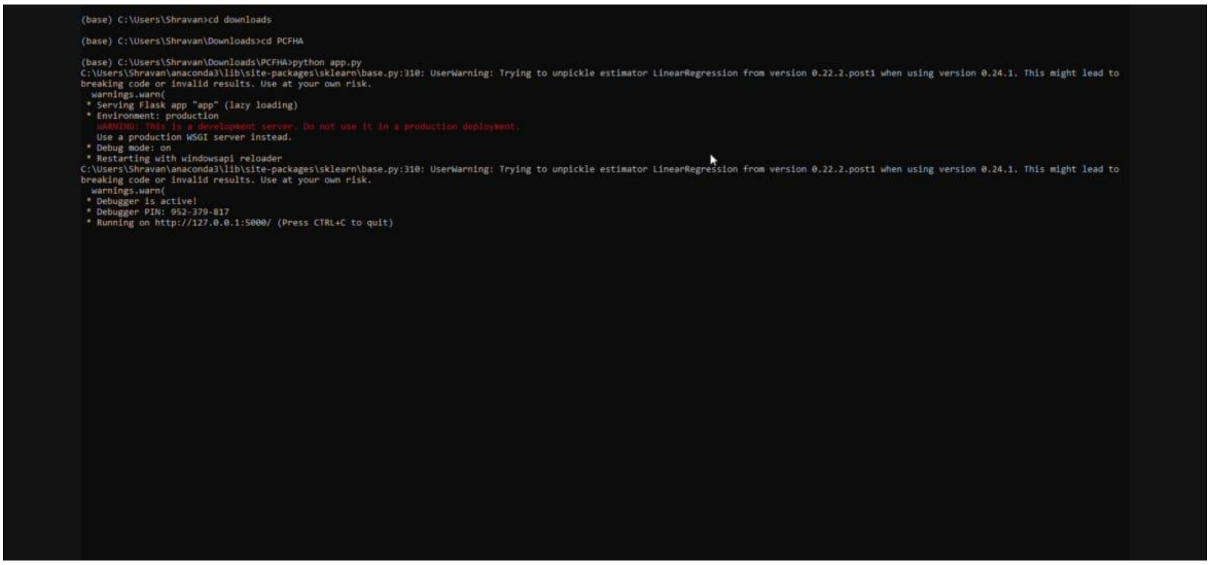
The remaining watt-hours can be calculated from the active energy by first converting the active energy to watt-hours then subtracting the other sub-metered active energy in watt-hours.

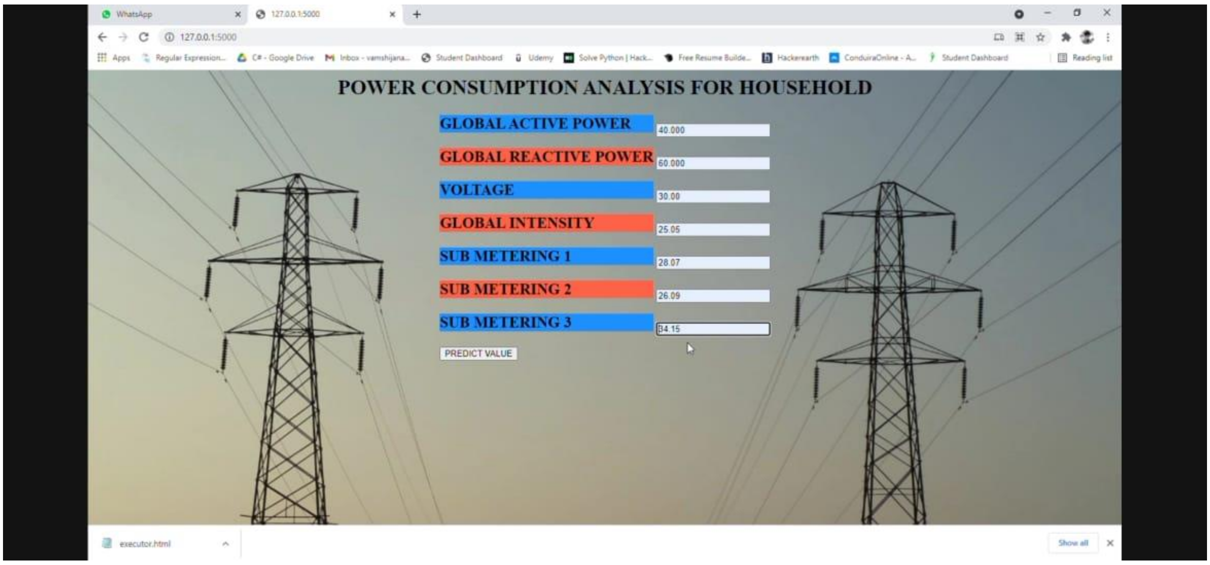
Source Code

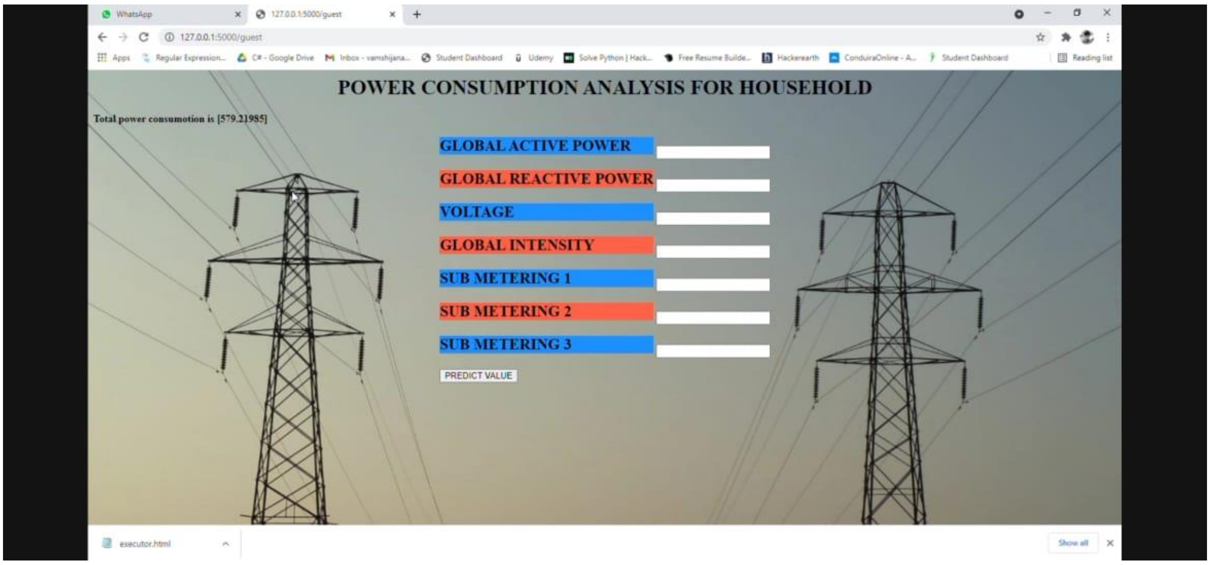
```
from flask import Flask, render_template,request

app = Flask(__name__)

import pickle

import numpy  as np
```

```
model = pickle.load(open("pcfha.pkl","rb"))
@app.route('/')
def hello_world():
   return render_template("executor.html")
@app.route('/guest' , methods = ["POST"])
def Guest():
   gap = request.form["gap"]
   grp = request.form["grp"]
   v = request.form["v"]
   gi = request.form["gi"]
   s1 = request.form["s1"]
   s2 = request.form["s2"]
   s3 = request.form["s3"]

   arr= np.array([gap,grp,v,gi,s1,s2,s3])
   user_input_prediction = arr.astype('float32')
   prediction = model.predict([user_input_prediction])

   return render_template("executor.html", y="Total power consumotion is  " +str(prediction))
if __name__ == '__main__':
    app.run(debug = True)
```

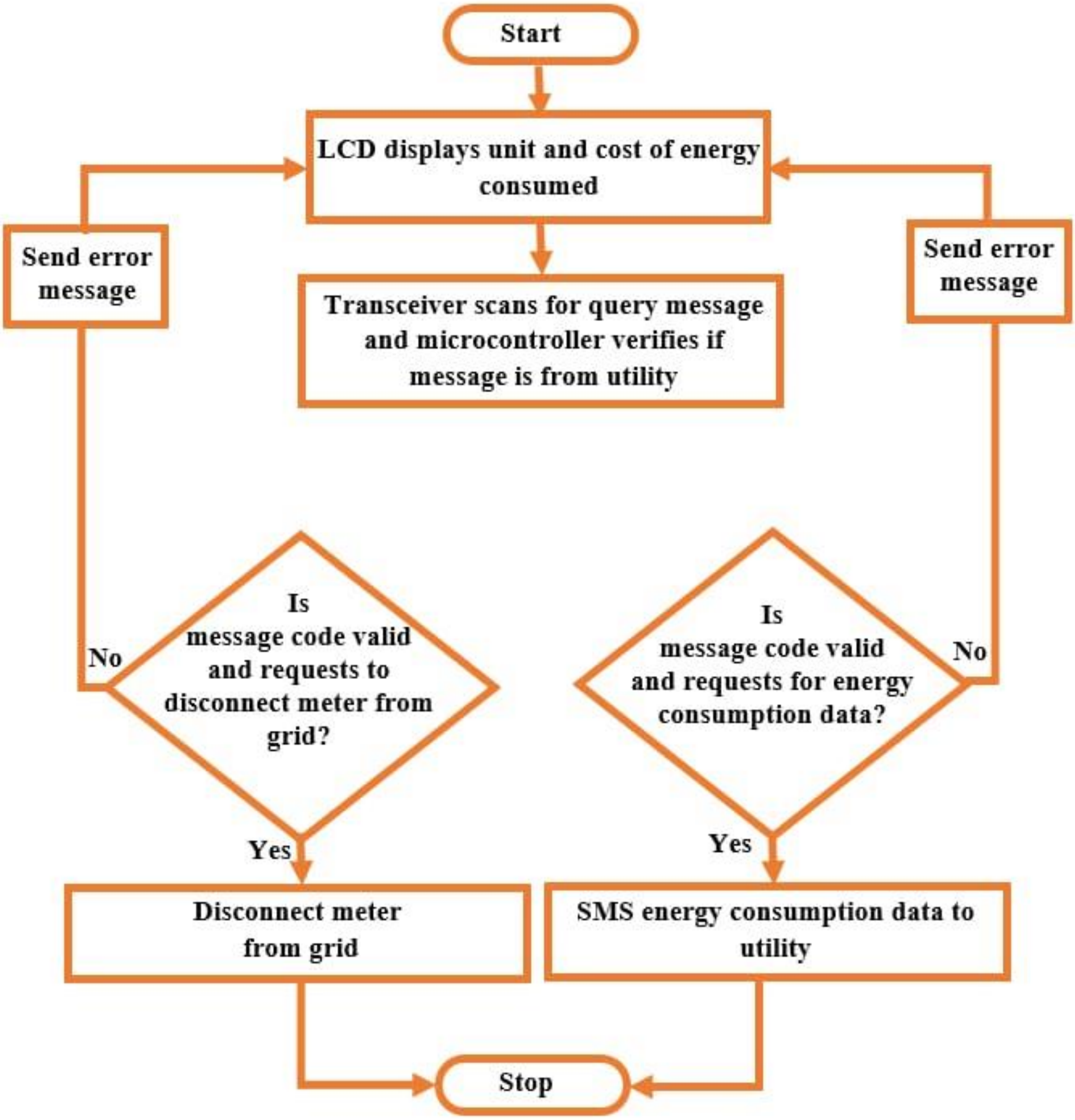
Output


(base) C:\Users\Shravan>cd downloads
(base) C:\Users\Shravan\Downloads>cd PCFHA
(base) C:\Users\Shravan\Downloads\PCFHA>python app.py
C:\Users\Shravan\anaconda3\lib\site-packages\sklearn\base.py:310: UserWarning: Trying to unpickle estimator LinearRegression from version 0.22.2.post1 when using version 0.24.1. This might lead to breaking code or invalid results. Use at your own risk.
warnings.warn(
* Serving Flask app "app" (lazy loading)
* Environment: production
WARNING: This is a development server. Do not use it in a production deployment.
Use a production WSGI server instead.
* Debug mode: on
* Restarting with windowsapi reloader
C:\Users\Shravan\anaconda3\lib\site-packages\sklearn\base.py:310: UserWarning: Trying to unpickle estimator LinearRegression from version 0.22.2.post1 when using version 0.24.1. This might lead to breaking code or invalid results. Use at your own risk.
warnings.warn(
* Debugger is active!
* Debugger PIN: 952-379-817
* Running on http://127.0.0.1:5000/ (Press CTRL+C to quit)


POWER CONSUMPTION ANALYSIS FOR HOUSEHOLD
GLOBAL ACTIVE POWER
40.000
GLOBAL REACTIVE POWER
60.000
VOLTAGE
30.00
GLOBAL INTENSITY
25.05
SUB METERING 1
28.07
SUB METERING 2
26.09
SUB METERING 3
34.15
PREDICT VALUE


POWER CONSUMPTION ANALYSIS FOR HOUSEHOLD
Total power consumotion is [579.21985]
GLOBAL ACTIVE POWER
GLOBAL REACTIVE POWER
VOLTAGE
GLOBAL INTENSITY
SUB METERING 1
SUB METERING 2
SUB METERING 3
PREDICT VALUE

5.Flowchart



6.Result

- Open the anaconda prompt from the start menu.
- Navigate to the folder where your app.py resides.
- Now type “python app.py” command.
- It will show the local host where your app is running on http://127.0.0.1.5000/

- Copy that local host URL and open that URL in the browser. It does navigate me to where you can view your web page.
- Enter the values, click on the predict button and see the result/prediction on the web page.

7.Advantages and Disadvantages

Advantages:

- ➢ To give a convenient life, heat, power to our houses, cookers etc.
- ➢ Easier to product transmitted and distributed (than other form of energy)
- ➢ When it is consumed, it does not leave any residue behind it (clean energy)
- ➢ It can easily be converted into other forms of energy.
- ➢ Electricity can be used to start a person's heart (for medical)

Disadvantages:

- ➢ It causes electric fields and magnetic fields to form, which may cause health problems(radiation)
- ➢ Global Warming.
- ➢ Cause an electric shock (which reduce your physical energy and lasting mental damage)

8.Applications

1.The household power consumption dataset is a multivariate time series dataset that describes the electricity consumption for a single household over four years.

2.To use the new understanding of the problem to consider different framings of the prediction problem, ways the data may be prepared, and modelling methods that may be used.

3.To assess the energy efficiency and energy usage of their homes.

9.Conclusion

Finally, total power consumption by all the appliances is calculated and displayed.

10.Bibliography

https://github.com/smartinternz02/SI-GuidedProject-4242-1626241163