AI_PHASE 3

MEASURE ENERGY CONSUMPTION

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TEAM ID	**PROJ_212174_TEAM_4**
PROJECT NAME	**MEASURE ENERGY CONSUMPTION**
MAXIMUM MARKS	

Data Vistualization:

Data Visualization is a technique of presenting data graphically or in a pictorial format which helps to understand large quantities of data very easily. This allows decision-makers to make better decisions and also allows identifying new trends, patterns in a more efficient way.

Matplotlib and Seaborn:

Matplotlib and Seaborn are python libraries that are used for data visualization. They have inbuilt modules for plotting different graphs.
While Matplotlib is used to embed graphs into applications, Seaborn is primarily used for statistical graphs.

But when should we use either of the two? Let's understand this with the help of a comparative analysis. The table below provides comparison between Python's two well-known visualization packages Matplotlib and Seaborn.

Python provides various libraries that come with different features for visualizing data. All these libraries come with different features and can support various types of graphs. In this tutorial, we will be discussing four such libraries.

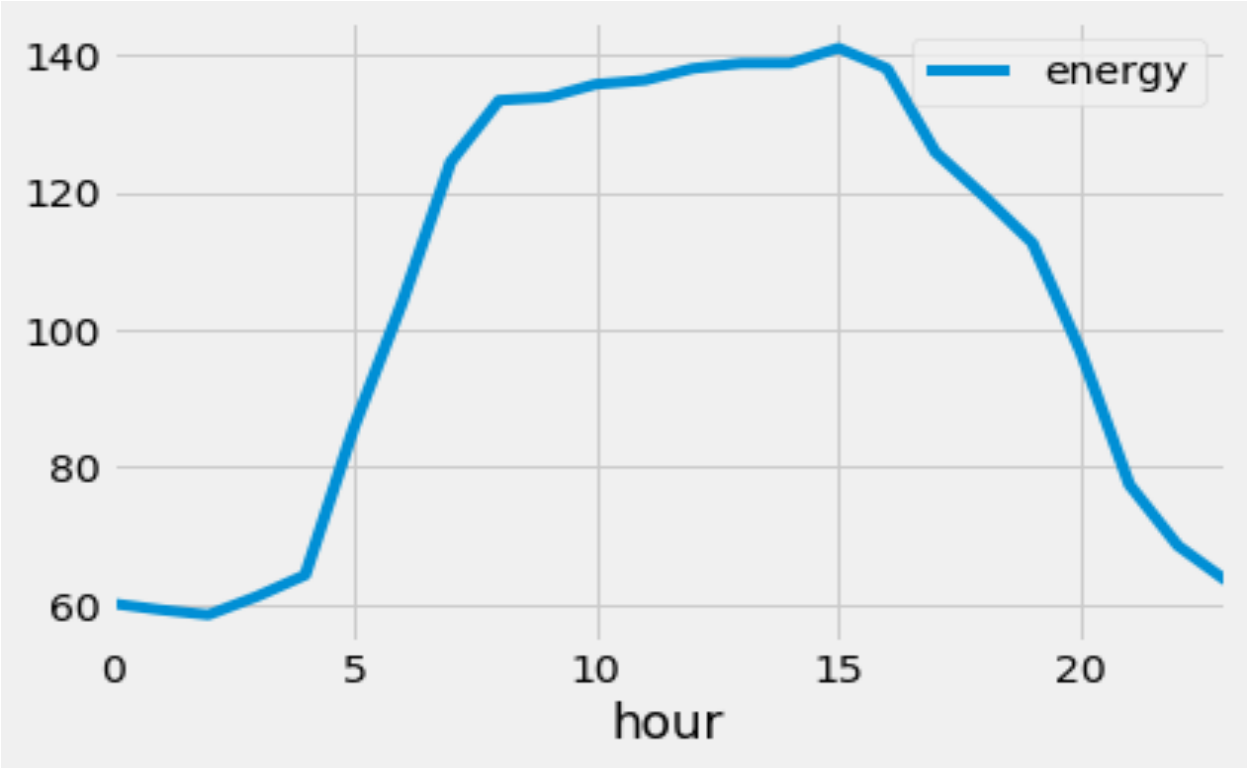
- Matplotlib
- Seaborn
- Bokeh
- Plotly

We will discuss these libraries one by one and will plot some most commonly used graphs.

CODE AND OUTPUT: [DATA VISUALIZATION]

```
%matplotlib inline

#we are going to import our data analysis library, pandas. Since we are going to write pandas all the time, we shorten it to pd for brevity:

import pandas as pd


#We also import the pyplot library, which will be very useful to visualise our data with charts and plots.

import matplotlib.pyplot as plt


#In the next snippet we define a function, timeparser, which will convert our columns "date" and "time" into a Python datetime object. It basically tells Python in which format our "date" and "time" columns are.

plt.style.use('fivethirtyeight')

timeparser = lambda x: pd.datetime.strptime(x, '%Y-%m-%d %H:%M')


#We are ready to read the data. We will merge the columns "date" and "time" into a single column "datetime", using the parser function timeparser that we defined above.

df = pd.read_csv('energy-consumption.csv', parse_dates = {'datetime': ['date', 'time']}, date_parser = timeparser)

#here first thing we might want to know is how does the total energy profile looks like in an average day. This means that we want to consider both residential and commercial buildings of all types, and we do not discrimnate between weekdays and weekends. This graph is simple to produce, but perhaps not so informative: in reality there is no such thing as an *average* building or an *average* day.

Since we would like to have a plot with the **hour of the day** on the x-axis and the **energy consumption** on the y-axis, we first add a column to our dataset, which extracts the hour of the day from the "datetime" columns:


df['hour'] = df['datetime'].apply(lambda x: x.hour)

df.groupby('hour').mean().plot()
```

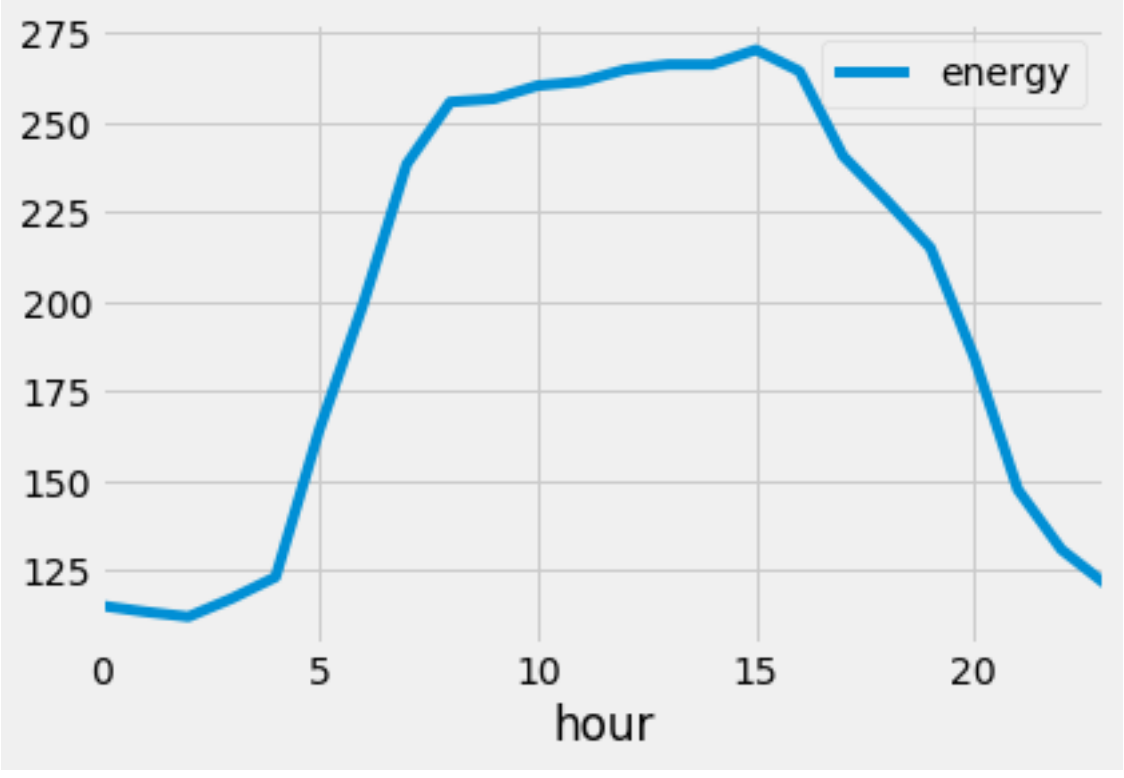
OUTPUT:



df[df.category == 'commercial'].groupby('hour').mean().plot()

OUTPUT:

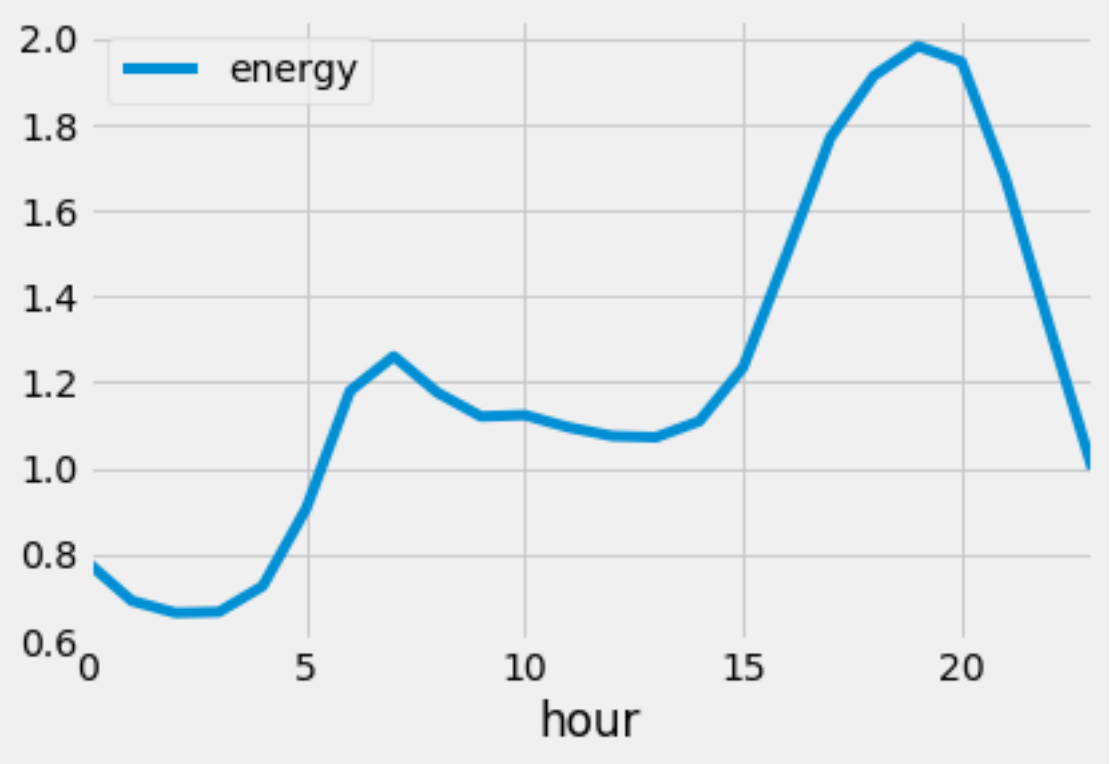
<matplotlib.axes._subplots.AxesSubplot at 0x7f15b4e8e978>



df[df.category == 'residential'].groupby('hour').mean().plot()

OUTPUT:

<matplotlib.axes._subplots.AxesSubplot at 0x7f15b2ca9240>



The situation is already more interesting here. The first thing we can notice is that commercial buildings consume much more energy than residential ones. At the lowest, they consume around 110kW/h and have peaks of more than 270kW/h. Residential buildings, on the other hand, have a consumption in the range from 0.6 to 2.0kW/h.

This explains why the first "overall" graph and the second "commercial-only" have a similar shape (commercial consumption dominates), but different values on the y-axis (due to averaging with the very low residential values).

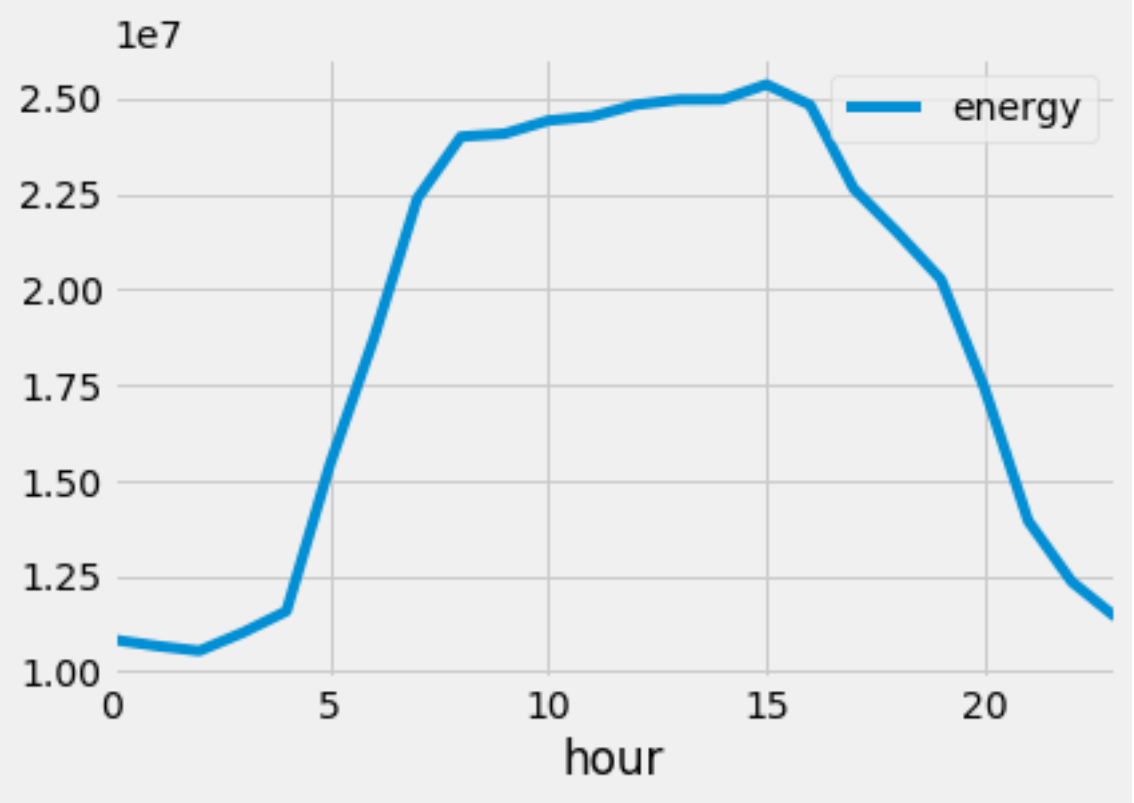
Also notice that the shape of the consumption curve is totally different for residential buildings: they have a first peak around 07:00, when people wake up, and then a larger

peak at 18:00-21:00, when most people come back home from work.
Another thing we can do is to plot, instead of the *average* energy consumption, the *total* one, i.e. the sum of all consumptions. Since there is a big difference in magnitude between the consumptions of commercial and residential buildings, we expect this plot to ave a shape similar to the residential one and - in fact - this is the case:

df.groupby('hour').sum().plot()

OUTPUT:

<matplotlib.axes._subplots.AxesSubplot at 0x7f15b2c32a20>



FIXING THE DATA:

#Fixing the data is going to be easy. With a couple of lines of code we can account for the DST shift. We will add a column adj_energy which will give the adjusted energy consumption, taking into account the time shift.

df['shift_energy'] = df['energy'].shift(1)

df['adj_energy'] = df.apply(lambda row: row['shift_energy'] if row['dst'] else row['energy'], axis = 1)

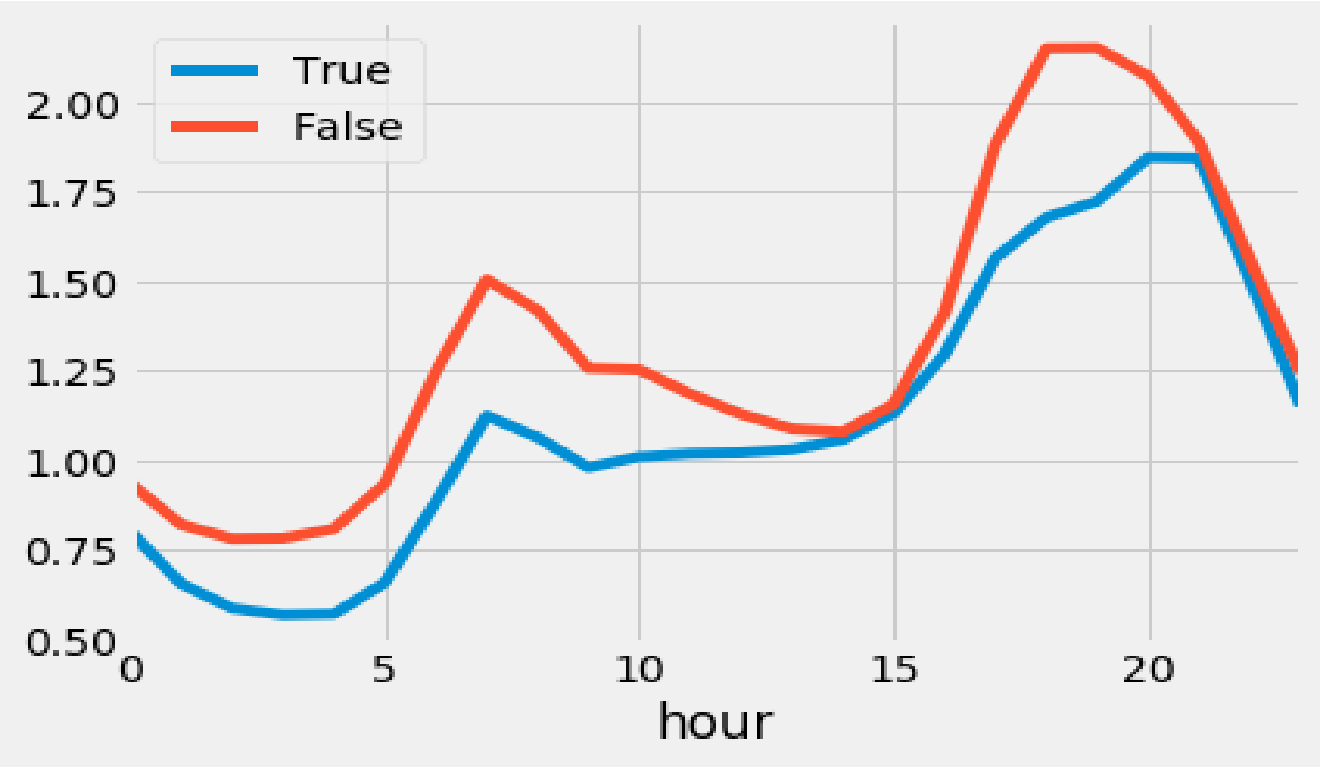
#Let's now print the last two plots again, to verify that this time there is no shift:

fig, ax = plt.subplots()

for dst in [True, False]:

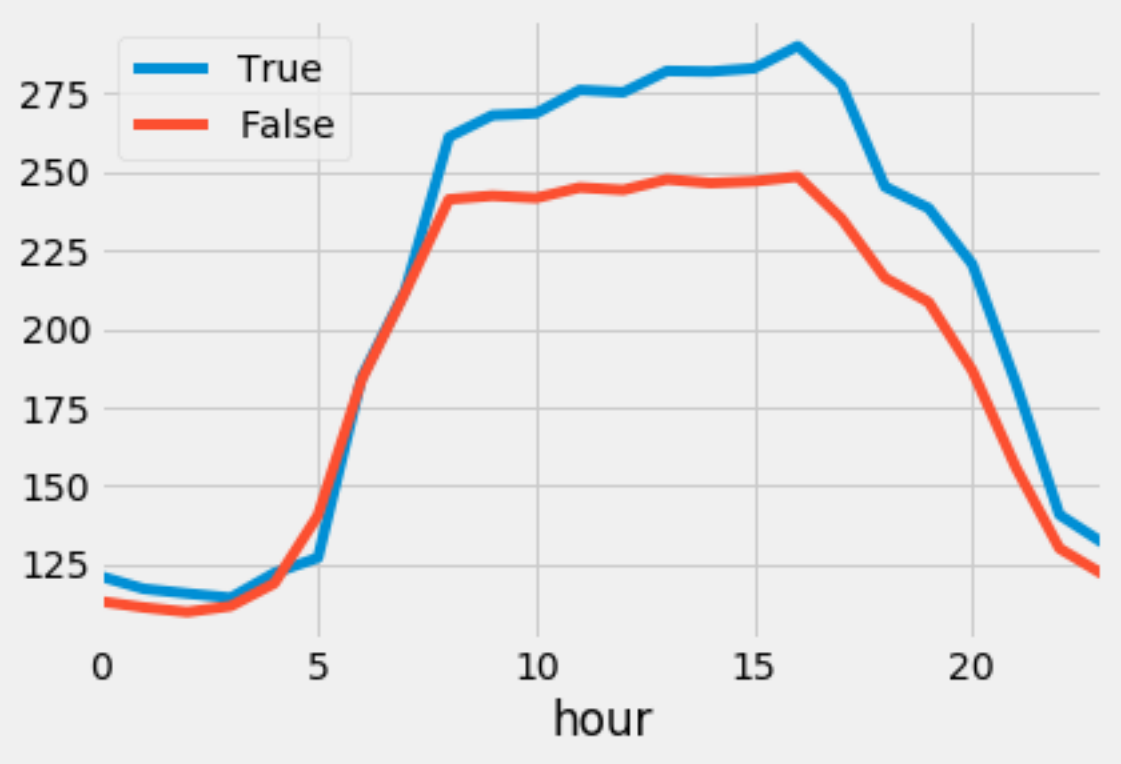
    ax = df[(df.category == 'residential') & (df.dst == dst)].groupby('hour').mean().plot(ax = ax, y = 'adj_energy', label = str(dst))

OUTPUT:




```
fig, ax = plt.subplots()
for dst in [True, False]:
    ax = df[(df.category == 'commercial') & (df.dst == dst)].groupby('hour').mean().plot(ax = ax, y = 'adj_energy', label = str(dst))
plt.show()
```

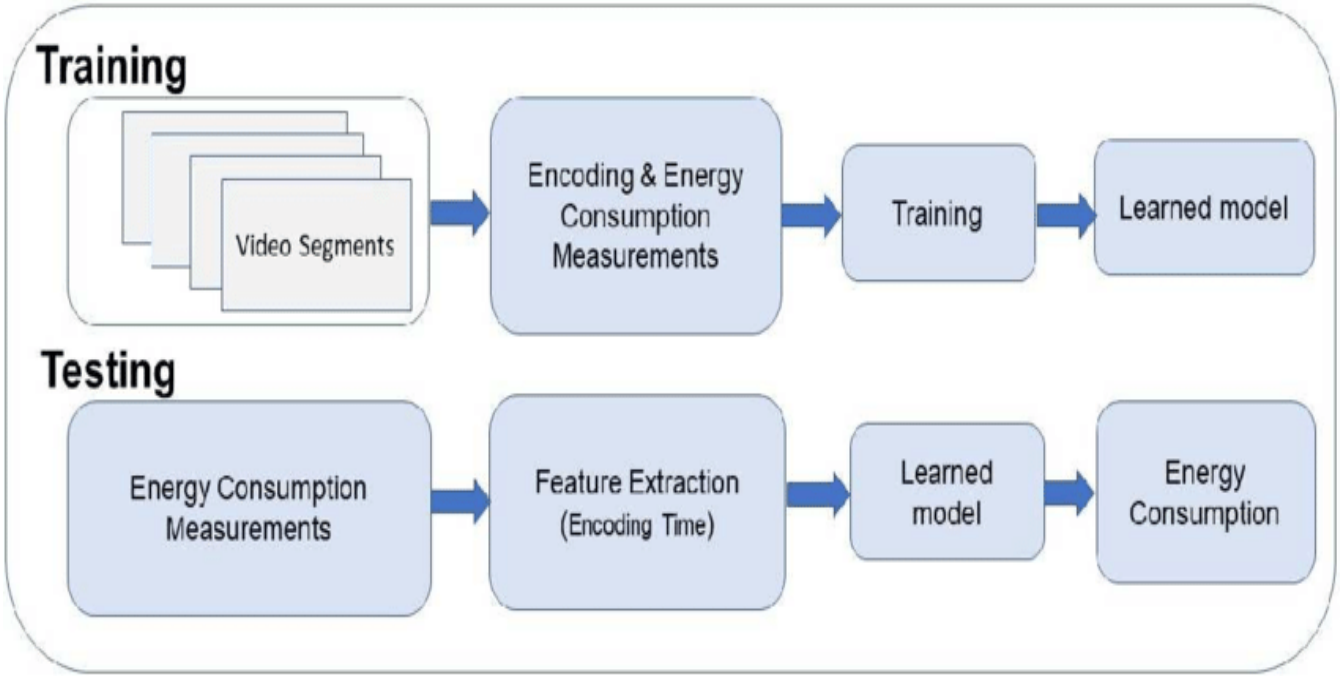
OUTPUT:



HOW CAN PYTHON BE USED FOR DATA VISUALIZATION?

The process of finding trends and correlations in our data by representing it pictorially is called Data Visualization. To perform data visualization in python, we can use various python data visualization modules such as Matplotlib, Seaborn, Plotly, etc

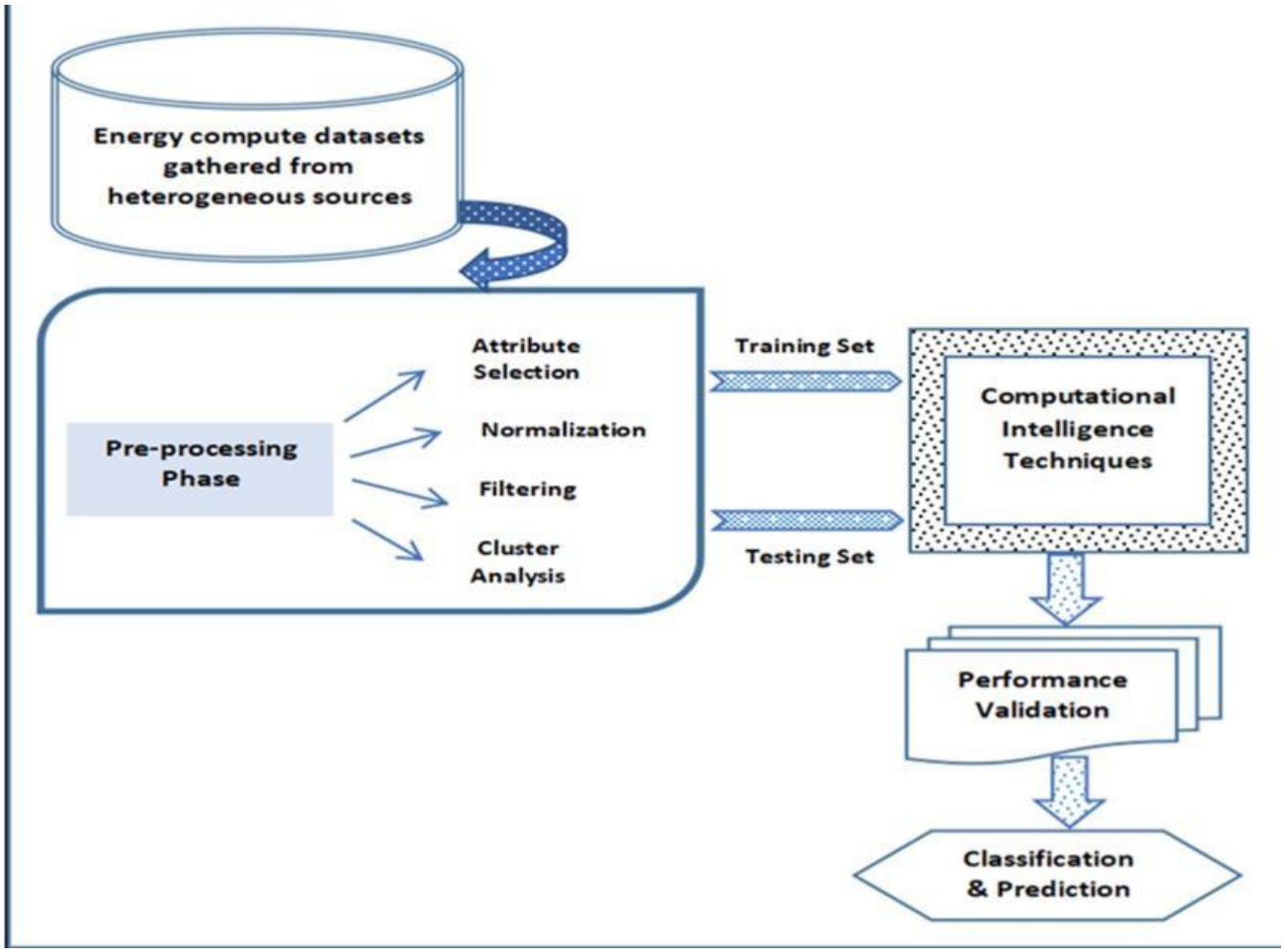
ENERGY CONSUMPTION ARCHITECTURE DIAGRAM:



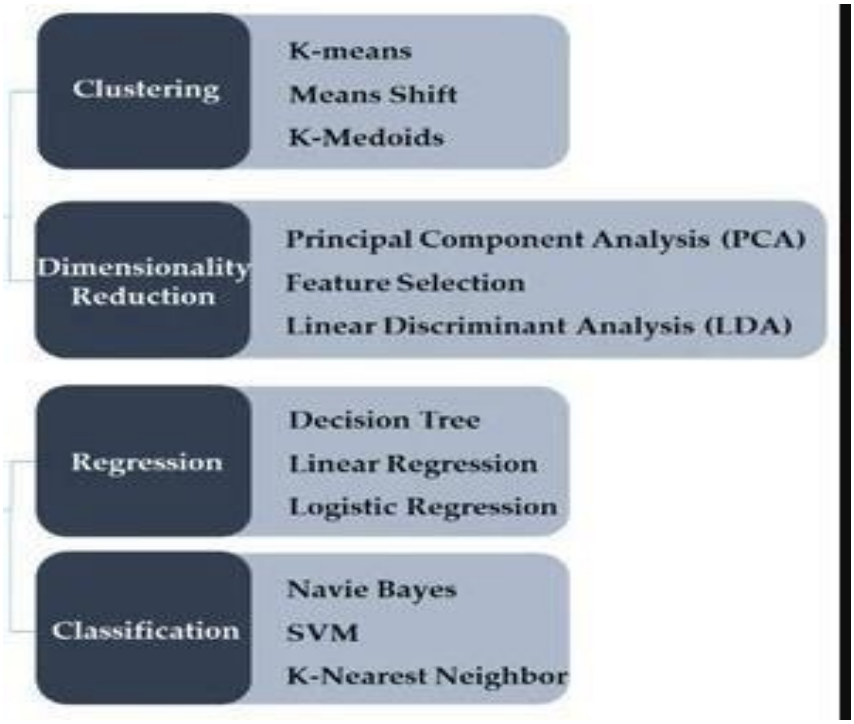
There are 3 modules,

1) **DATA PREPROCESSING:**

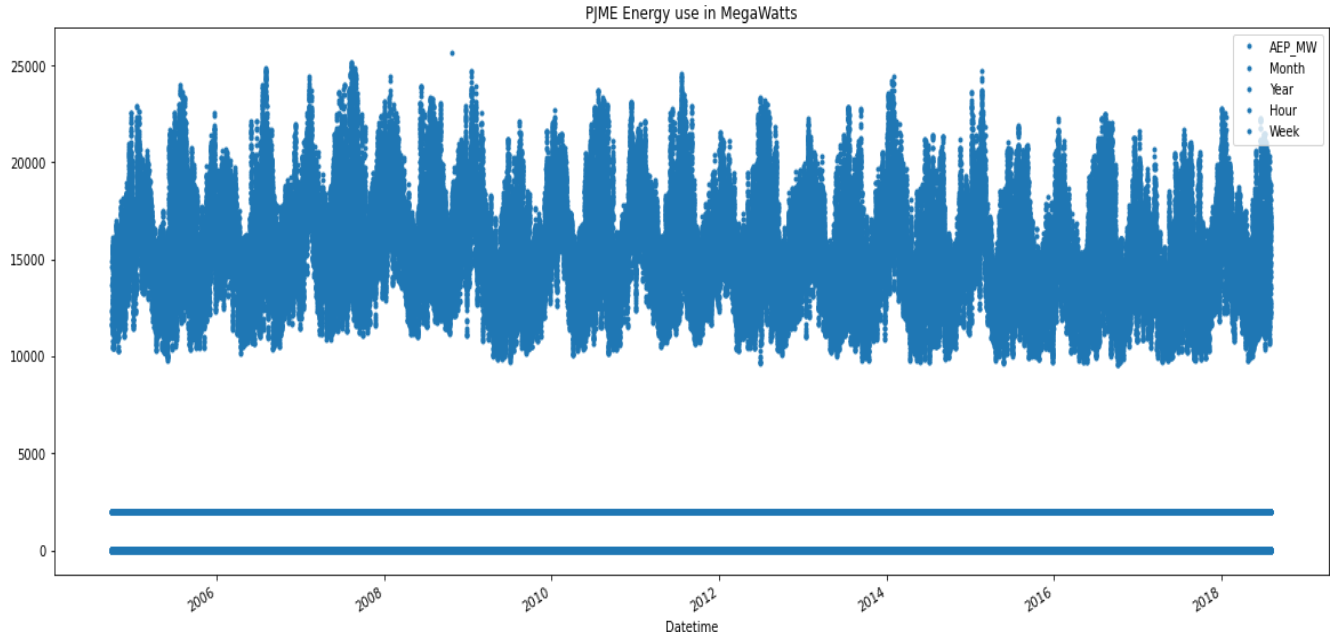
Data preprocessing in Python refers to the process of cleaning, transforming, and organizing raw data into a format suitable for analysis or machine learning. Python provides various libraries and tools to perform data preprocessing tasks efficiently.

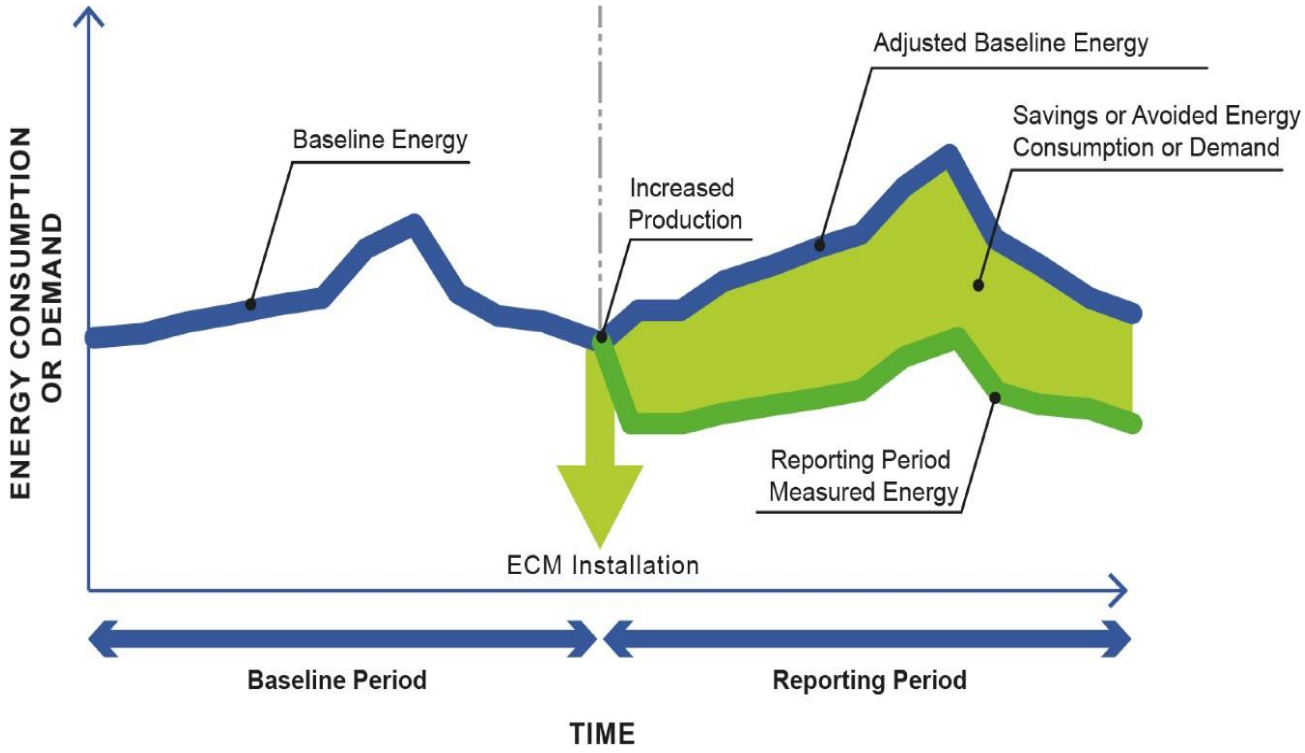


2) ALGORITHMS USED:



3) DATA VISUALIZATION OUTPUT:





CONCLUSION:

- Python provides a range of libraries and tools for data acquisition, processing, and visualization, making it a suitable language for energy monitoring applications.
- By integrating Python with appropriate hardware or APIs for energy data retrieval and employing data analysis libraries like Pandas and visualization tools like Matplotlib or Plotly, developers can create robust systems to monitor and analyze energy consumption patterns.
- Moreover, Python's extensive community support and a rich ecosystem of libraries contribute to the flexibility and scalability of energy monitoring solutions, making it a preferred language for implementing such systems.
- Overall, Python facilitates the development of efficient, customizable, and insightful solutions for tracking and managing energy consumption.