PHASE 5

PROJECT DOCUMENTATION & SUBMISSION

MEASURE ENERGY CONSUMPTION

PROJECT OVERVIEW :

This project will measure the energy consumption of a [building/home/factory/other facility]. The project will use a combination of smart meters and IoT devices to collect energy consumption data at high frequency intervals. The data will be analyzed to identify trends and patterns in energy use, and to detect anomalies that may indicate a problem with an appliance or system. The project will also develop recommendations for energy efficiency improvements.

PROJECT GOALS:

The goals of this project are to:

- *Measure the energy consumption of the [building/home/factory/other facility] in detail.*
- *Identify trends and patterns in energy use.*
- *Detect anomalies that may indicate a problem with an appliance or system.*
- *Develop recommendations for energy efficiency improvements.*

METHODOLOGY:

The project will use a combination of smart meters and IoT devices to collect energy consumption data at high frequency intervals. The data will be stored on a cloud-based platform for analysis and visualization.

Smart meters will be used to measure the total energy consumption of the building/home/factory/other facility. IoT devices will be used to measure the energy consumption of individual appliances and systems.

The energy consumption data will be analyzed using a variety of statistical methods to identify trends and patterns in energy use. Anomalies in the data will be detected using machine learning algorithms.

Recommendations for energy efficiency improvements will be developed based on the findings of the data analysis.

PROBLEM STATEMENT :

Overall energy consumption is increasing globally, leading to a number of problems, including climate change, energy insecurity, and high energy costs. It is important to develop effective ways to measure energy consumption in order to identify areas where energy efficiency improvements can be made and to track progress towards energy efficiency goals.

The following are some of the key problem statements for measuring energy consumption:

- ***ACCURACY:*** *Energy consumption measurements can be inaccurate due to a variety of factors, such as faulty equipment, improper installation, and human error. This can make it difficult to get a true picture of energy consumption and identify areas where savings can be made.*

- ***GRANULARITY:*** *Energy consumption data is often collected at a high level, such as for an entire building or household. This can make it difficult to identify specific appliances or equipment that are using the most energy.*

- ***COST:*** *The cost of energy monitoring equipment and services can be a barrier for some consumers and businesses.*

- ***COMPLEXITY:*** *Energy monitoring systems can be complex to install and configure. This can require technical expertise and resources that may not be available to everyone.*

In addition to these general problems, there are also specific challenges to measuring energy consumption in different sectors. For example:

- ***RESIDENTIAL SECTOR:*** *It can be difficult to measure energy consumption in individual homes, especially for small appliances. This is because energy meters are typically located at the main electrical panel, which does not provide detailed information about how energy is being used within the home.*

- ***COMMERCIAL SECTOR:*** *Commercial buildings often have complex energy systems with multiple meters. This can make it difficult to track energy consumption for different parts of the building or for different types of energy use.*

- ***INDUSTRIAL SECTOR:*** *Industrial processes can be very energy-intensive, but it can be difficult to measure energy consumption for individual pieces of equipment or processes. This is because industrial energy systems are often complex and interconnected.*

- ***TRANSPORTATION SECTOR:*** *Energy consumption for transportation is difficult to measure because it is dispersed across a wide range of vehicles and fuels.*

Despite these challenges, there are a number of technologies and approaches that can be used to measure energy consumption accurately and cost-effectively. These technologies include smart meters, energy monitoring software, and building automation systems.

DESIGN THINKING PROCESS :

The design thinking process is a human-centered approach to problem solving. It is a five-stage process that involves empathizing with users, defining the problem, ideating solutions, prototyping solutions, and testing solutions.

The design thinking process can be used to develop effective ways to measure energy consumption by:

1. ***EMPATHIZING WITH USERS:*** *Understanding the needs and challenges of people who are interested in measuring energy consumption.*

2. ***DEFINING THE PROBLEM:*** *Identifying the specific challenges that need to be addressed in order to develop effective energy consumption measurement solutions.*

3. ***IDEATING SOLUTIONS:*** *Generating a wide range of ideas for how to measure energy consumption, without judgment.*

4. ***PROTOTYPING SOLUTIONS:*** *Developing and testing low-cost, low-fidelity prototypes of energy consumption measurement solutions.*

5. ***TESTING SOLUTIONS:*** *Testing and refining energy consumption measurement solutions with users to ensure that they are easy to use and effective.*

Here are some specific ways that design thinking can be used to measure energy consumption:

- *Develop new and innovative energy monitoring technologies. For example, design thinking could be used to develop a new type of smart meter that is more accurate and affordable than current models.*

- *Improve the user experience of energy monitoring systems. For example, design thinking could be used to develop a more user-friendly energy monitoring app or website that makes it easy for people to understand and track their energy consumption.*

- *Design energy conservation programs that are effective and engaging for users. For example, design thinking could be used to develop a rewards program that incentivizes people to reduce their energy consumption*

PHASES OF DEVELOPMENT :

The phases of development for measuring energy consumption can be divided into three main stages:

1. *Planning*
2. *Implementation*
3. *Analysis and reporting*

☐ *PLANNING:*

The planning phase involves identifying the goals of the energy consumption measurement project, defining the scope of work, and developing a project plan. It is important to identify the key stakeholders early on and get their input on the project.

Some of the key tasks to be completed in the planning phase include:

- *Identifying the goals of the project (e.g., to reduce energy costs, improve energy efficiency, or track progress towards sustainability goals)*
- *Defining the scope of work (e.g., which energy sources will be measured, which buildings or facilities will be included, and what level of granularity is required)*
- *Developing a project plan (e.g., timeline, budget, and resource requirements)*
- *Identifying the key stakeholders (e.g., building managers, energy managers, and sustainability managers)*

☐ *IMPLEMENTATION:*

The implementation phase involves installing and configuring the energy monitoring equipment, collecting energy consumption data, and developing systems for managing and analyzing the data.

Some of the key tasks to be completed in the implementation phase include:

- *Installing and configuring energy monitoring equipment (e.g., smart meters, sensors, and data loggers)*
- *Collecting energy consumption data (e.g., hourly, daily, or monthly data)*
- *Developing systems for managing and analyzing the data (e.g., data storage, data visualization, and reporting tools)*

☐ *ANALYSIS AND REPORTING:*

The analysis and reporting phase involves analyzing the energy consumption data to identify trends, patterns, and areas for improvement. The *results of the analysis should be reported to the key stakeholders in a clear and concise manner.*

Some of the key tasks to be completed in the analysis and reporting phase include:

- *Analyzing the energy consumption data to identify trends, patterns, and areas for improvement*
- *Developing reports that summarize the findings of the analysis*
- *Presenting the reports to the key stakeholders*

It is important to note that these phases are not always sequential. For example, it may be necessary to iterate between the planning and implementation phases as new information is learned. Additionally, the analysis and reporting phase is ongoing, as it is important to continue to monitor and analyze energy consumption data over time.

By following these phases of development, organizations can develop a comprehensive and effective energy consumption measurement program.

The following are the phases of development for a measure energy consumption project using the design thinking process:

1. *Empathize (2-4 weeks)*
2. *Define (1-2 weeks)*
3. *Ideate (1-2 weeks)*
4. *Prototype (2-4 weeks)*
5. *Test (2-4 weeks)*
6. *Implement (4-8 weeks)*
7. *Monitor and evaluate (Ongoing)*

1. ***EMPATHIZE:*** *Conduct interviews and surveys with users to understand their needs and challenges related to measuring energy consumption.*

2. ***DEFINE:*** *Analyze the data from the empathy phase to identify the specific challenges that need to be addressed in order to develop effective energy consumption measurement solutions.*

- ***ACCURACY:*** *The energy consumption measurement solution should be accurate and reliable.*
- ***COST****: The energy consumption measurement solution should be affordable.*
- ***EASE OF USE:*** *The energy consumption measurement solution should be easy to use and understand.*
- ***SCALABILITY:*** *The energy consumption measurement solution should be scalable to meet the needs of a variety of users.*

3. ***IDEATE:*** *Brainstorm and generate a wide range of ideas for how to measure energy consumption, without judgment.*

- ***SMART METERS:*** *Smart meters are advanced electricity meters that can provide real-time data on energy usage.*

- ***PLUG LOAD MONITORS:*** *Plug load monitors are devices that plug into an electrical outlet and measure the amount of electricity that is flowing through the outlet.*

- ***HOME ENERGY MANAGEMENT SYSTEMS:*** *Home energy management systems (HEMS) are devices that connect to a home's electrical system and provide homeowners with information about their energy consumption.*

- ***NON-INTRUSIVE LOAD MONITORING (NILM):*** *NILM is a technique for measuring the energy consumption of individual devices and appliances without the need to install sensors on each device or appliance.*

4. ***PROTOTYPE:*** *Develop and test low-cost, low-fidelity prototypes of energy consumption measurement solutions with users.This could involve creating paper prototypes, digital prototypes, or physical prototypes.*

5. ***TEST:*** *Test and refine energy consumption measurement solutions with users to ensure that they are easy to use and effective.This could involve conducting user surveys, usability testing, or field testing.*

6. ***IMPLEMENT:*** *Deploy the energy consumption measurement solution to users.*

7. ***MONITOR AND EVALUATE:*** *Monitor the use of the energy consumption measurement solution and collect feedback from users. Use this feedback to improve the solution over time.*

DATASET USED:

A variety of datasets can be used for measuring energy consumption, depending on the specific goals of the analysis. Some common datasets include:

- ***UTILITY DATA:*** *Utility companies typically collect data on the energy consumption of their customers, including the type of energy (e.g., electricity, gas, water), the time period (e.g., hourly, daily, monthly), and the location (e.g., household, business, industrial facility).*

- ***SMART METER DATA:*** *Smart meters are advanced electricity meters that can provide real-time data on energy usage, including the energy consumption of individual devices and appliances.*

- ***BUILDING ENERGY MANAGEMENT SYSTEM (BEMS) DATA:*** *BEMS collect data on energy consumption and other building operations data, such as temperature, humidity, and occupancy.*

- ***INDUSTRIAL CONTROL SYSTEM (ICS) DATA:*** *ICS data provides granular information about energy consumption in industrial processes. ICS data can be used to optimize energy consumption, improve product quality, and reduce greenhouse gas emissions.*

- ***HOUSEHOLD ENERGY SURVEY (HES) DATA:*** *HES data provides information about energy consumption in households, typically through surveys. HES data can be used to understand energy consumption patterns, identify areas for energy efficiency improvement, and develop energy conservation programs.*

- ***WEATHER DATA:*** *Weather data can be used to understand the impact of weather conditions on energy consumption.*

- ***DEMOGRAPHIC DATA:*** *Demographic data, such as population, income, and household size, can be used to correlate energy consumption with other factors.*

- ***COMMERCIAL ENERGY SURVEY (CES) DATA:*** *CES data provides information about energy consumption in commercial and industrial buildings, typically through surveys. CES data can be used to understand energy consumption patterns, identify areas for energy efficiency improvement, and develop energy conservation programs.*

In addition to these general datasets, there are also a number of specialized datasets that can be used for measuring energy consumption in specific sectors or applications. For example, there are datasets on vehicle fuel economy, renewable energy generation, and energy efficiency of appliances and equipment.

The choice of dataset will depend on the specific needs of the energy consumption measurement project. For example, if the goal is to measure energy consumption in a commercial building, then BEMS data would be the best choice. If the goal is to understand energy consumption patterns in households, then HES data would be the best choice.

Once a dataset has been selected, it is important to clean and prepare the data for analysis. This may involve removing outliers, correcting errors, and filling in missing values. The data can then be analyzed using a variety of statistical and machine learning techniques to identify trends, patterns, and areas for improvement.

By using the right dataset and cleaning and preparing the data carefully, organizations can get accurate and valuable insights into their energy consumption.

DATA PREPROCESSING STEPS:

Data preprocessing is the process of cleaning and preparing raw data for analysis. It is an important step in any data science project, and it is especially important for measuring energy consumption, as energy consumption data can be noisy and incomplete.

The following are some of the most common data preprocessing steps for measuring energy consumption:

- ***DATA CLEANING:*** *This involves identifying and correcting errors in the data, such as typos, missing values, and outliers.*

- ***DATA TRANSFORMATION:*** *This involves converting the data into a format that is suitable for analysis. This may involve converting data types, scaling data, and creating new features.*

- ***FEATURE ENGINEERING:*** *This involves creating new features from the existing data. This can be useful for identifying patterns and relationships in the data that would not be otherwise apparent.*

Here are some specific examples of data preprocessing steps for measuring energy consumption:

- ***REMOVING OUTLIERS:*** *Outliers are data points that are significantly different from the other data points in the dataset. Outliers can skew the results of analysis, so it is important to identify and remove them before analyzing the data.*

- ***HANDLING MISSING VALUES:*** *Missing values are data points that are missing from the dataset. Missing values can also skew the results of analysis, so it is important to handle them before analyzing the data. One common approach is to fill in missing values with the mean or median value of the corresponding feature.*

- ***SCALING THE DATA:*** *Scaling the data means normalizing the values of the different features in the dataset. This makes it easier to compare the different features and to identify patterns in the data. One common scaling technique is to use standard score normalization, which centers and scales the data so that it has a mean of 0 and a standard deviation of 1.*

- ***CREATING NEW FEATURES:*** *New features can be created from the existing data to identify patterns and relationships that would not be otherwise apparent. For example, new features could be created to represent the time of day, day of the week, season, and weather conditions.*

By carefully preprocessing the data, organizations can improve the accuracy and reliability of their energy consumption measurements. This can lead to more effective energy management and cost savings.

Here are some additional tips for data preprocessing for measuring energy consumption:

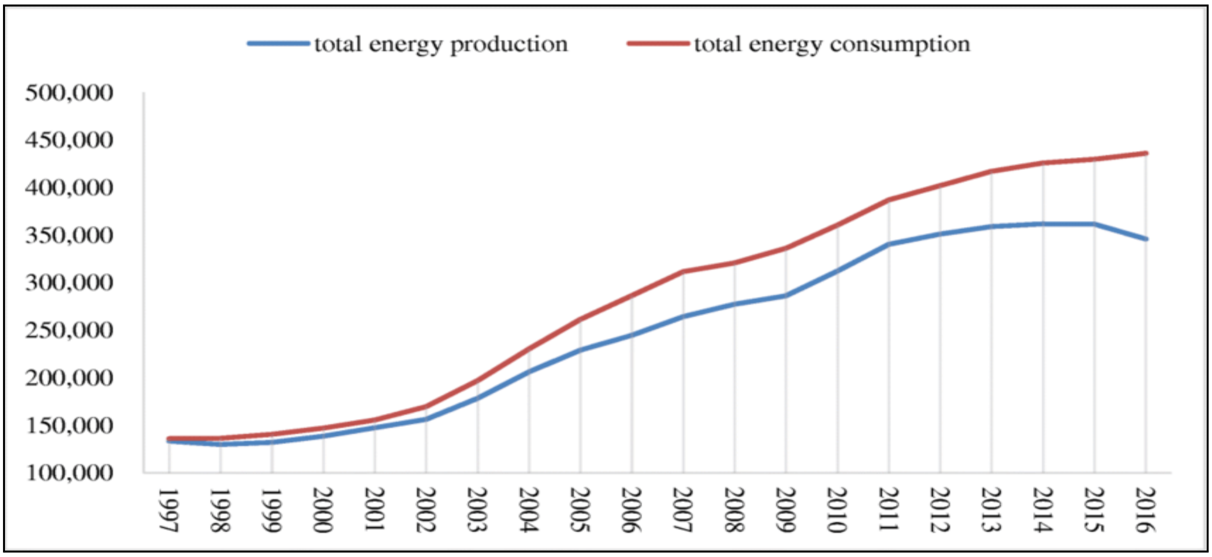
- *Use a variety of data sources: This will help to reduce the impact of errors and inconsistencies in any one data source.*
- *Document your data preprocessing steps: This will help you to reproduce your results and make it easier for others to understand your work.*
- *Validate your data: This involves checking the data for errors and inconsistencies. Validation can be done manually or by using automated tools.*

By following these tips, organizations can ensure that their energy consumption data is properly preprocessed and ready for analysis.

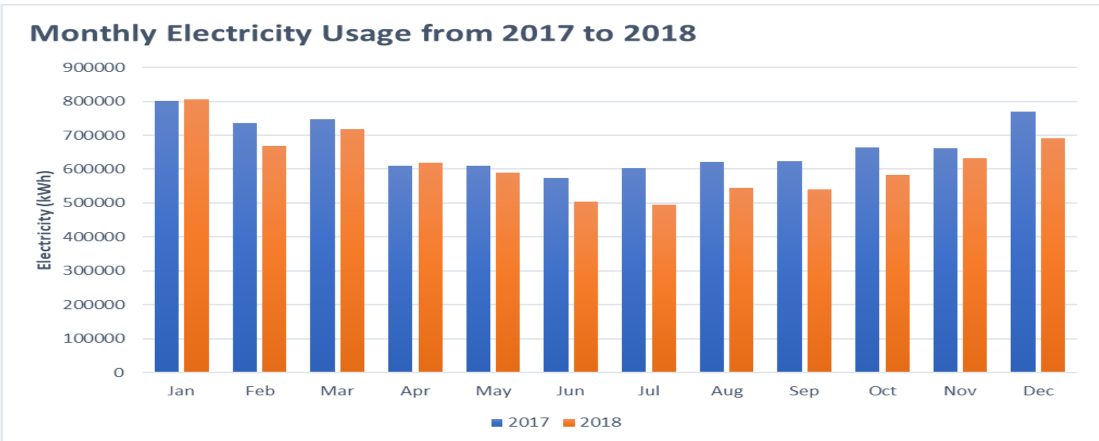
VISUALIZATION TECHNIQUES:

Data visualization is the process of using visual representations to communicate data. There are a variety of data visualization techniques that can be used for measuring energy consumption. Some common techniques include:

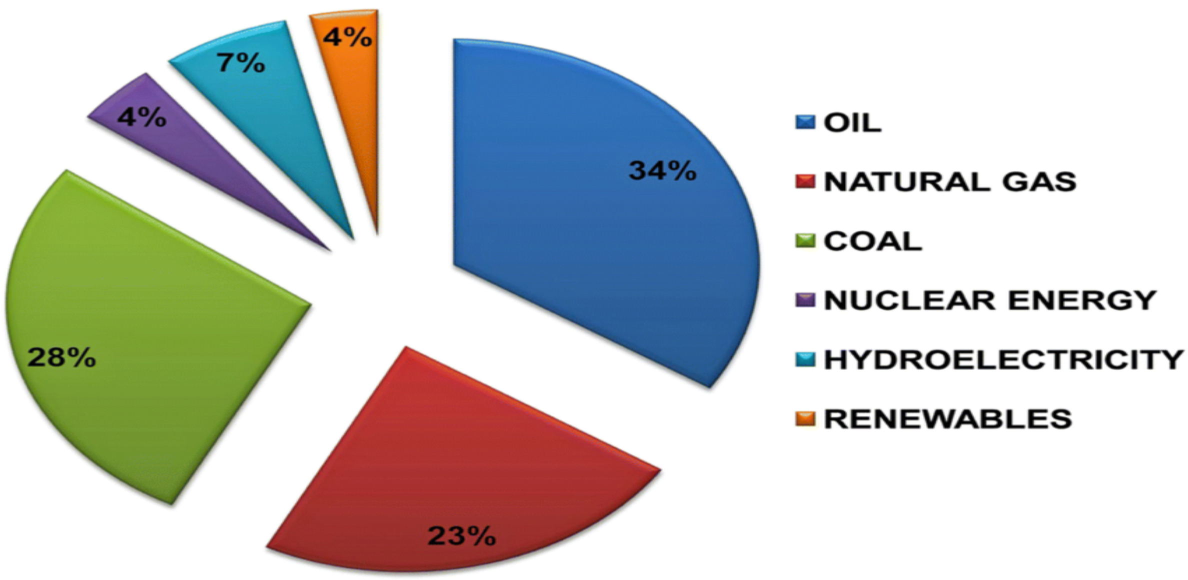
- ***LINE CHARTS:*** *Line charts can be used to track energy consumption over time. For example, a line chart could be used to track the monthly electricity consumption of a household over the past year.*



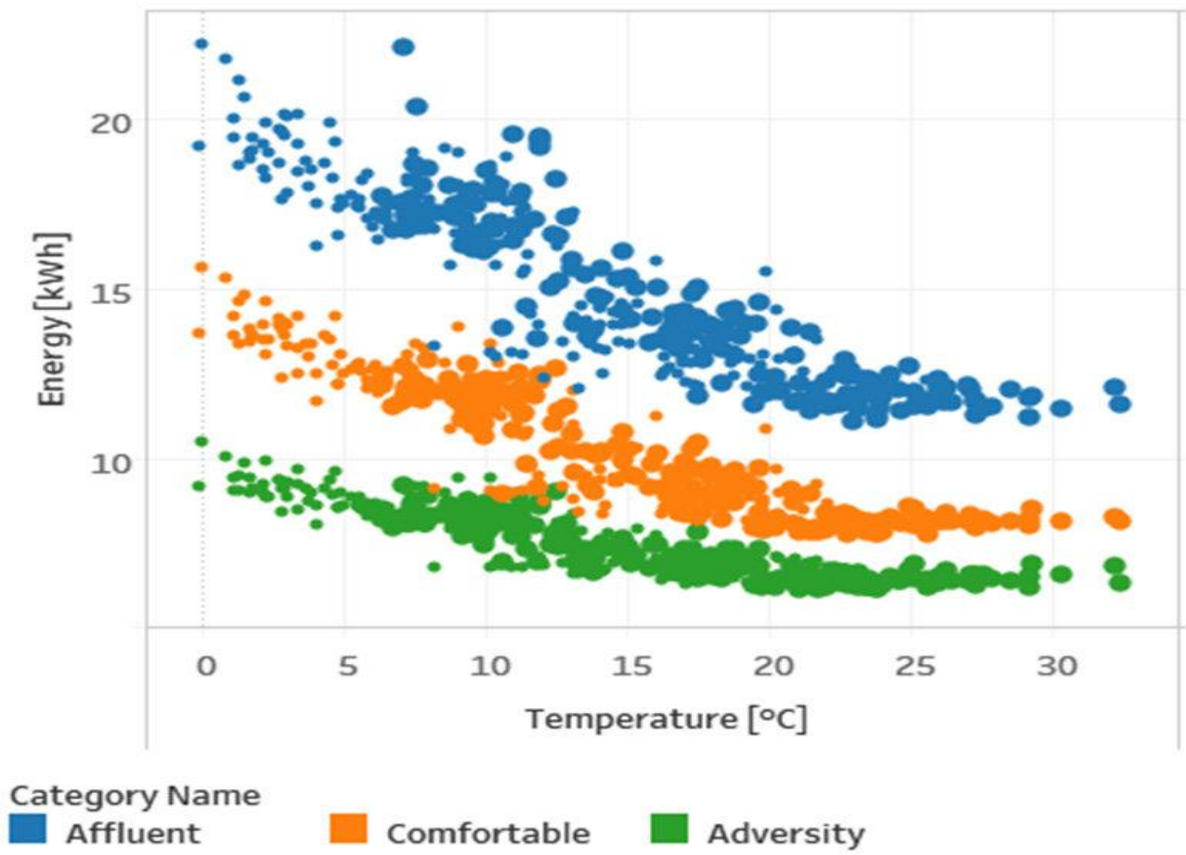
- ***BAR CHARTS:*** *Bar charts can be used to compare the energy consumption of different categories. For example, a bar chart could be used to compare the average monthly electricity consumption of different types of households, such as single-family homes and multi-family homes.*



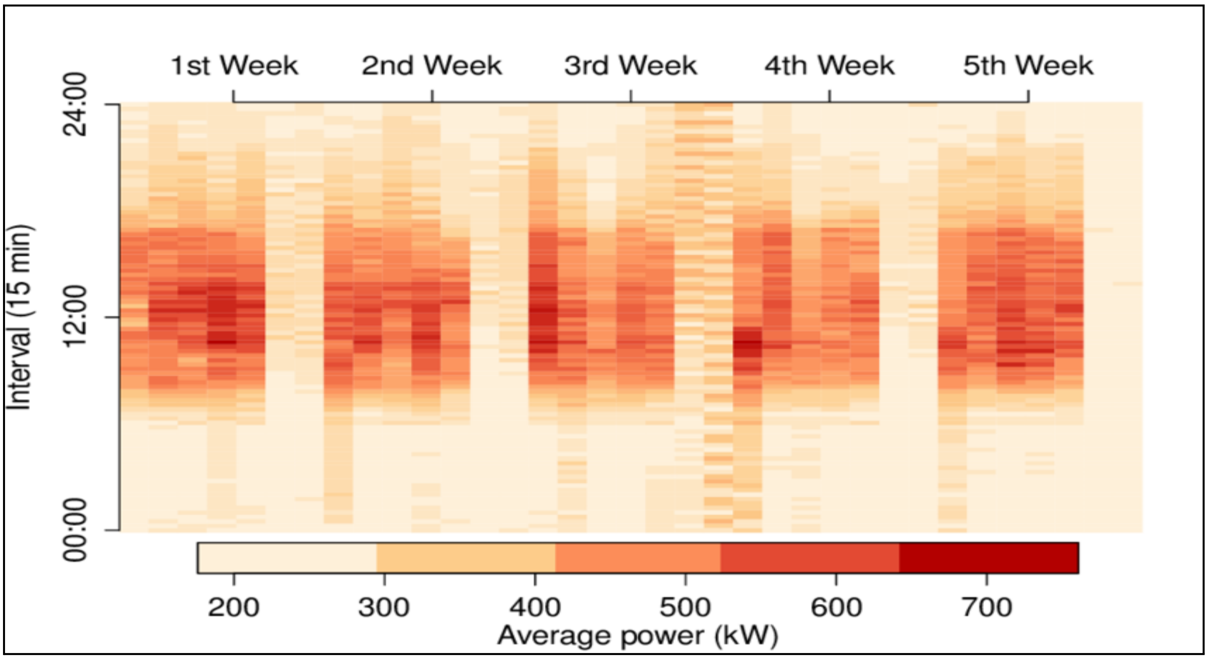
- ***PIE CHARTS:*** *Pie charts can be used to show the distribution of energy consumption. For example, a pie chart could be used to show the percentage of total energy consumption that is used for different purposes, such as heating, cooling, and lighting.*



- ***SCATTER PLOTS:*** *Scatter plots can be used to identify correlations between different variables, such as energy consumption and weather conditions. For example, a scatter plot could be used to identify the relationship between monthly electricity consumption and average monthly temperature.*



- ***HEATMAPS:*** *Heatmaps can be used to identify areas where energy consumption is high or low. For example, a heatmap could be used to identify the rooms in a building that are using the most energy.*



By using data preprocessing and visualization techniques, organizations can gain insights into their energy consumption data and identify opportunities to reduce energy consumption and costs.

INNOVATIVE TECHNIQUES :

Here are some innovative techniques or approaches that have been used during the development of Measure Energy Consumption:

- ***MACHINE LEARNING:*** *Machine learning algorithms can be used to develop energy consumption prediction models. These models can be used to predict the future energy consumption of a building, household, or other entity based on historical data. The predicted energy consumption can then be used to identify energy efficiency opportunities and to develop energy management strategies.*

- ***ARTIFICIAL INTELLIGENCE (AI):*** *AI can be used to develop more sophisticated energy consumption prediction and management systems. For example, AI can be used to develop systems that can learn from real-time data and adapt their predictions and recommendations accordingly.*

- ***INTERNET OF THINGS (IoT):*** *IoT devices can be used to collect real-time data on energy consumption. This data can then be used to develop more accurate energy consumption prediction models and to develop more effective energy management strategies.*

- ***BLOCKCHAIN:*** *Blockchain can be used to create a secure and transparent way to share energy consumption data between different entities. This can help to facilitate energy trading and energy efficiency programs.*

Here are some examples of how these techniques and approaches have been used in the development of Measure Energy Consumption:

- *Google AI has developed a machine learning algorithm that can predict energy consumption with up to 95% accuracy. This algorithm is being used by Google to improve the energy efficiency of its data centers and* *to optimize the energy use of commercial buildings and reduce energy costs.*

- *IBM Watson is being used to develop AI-powered energy management systems for buildings and businesses. These systems can learn from real-time data and adapt their recommendations accordingly.*

- *IBM developed a blockchain-based energy trading platform that allows consumers to buy and sell energy directly from each other. This platform can help to reduce energy costs and promote energy efficiency.*

- *Nest is using IoT devices to collect real-time data on energy consumption in homes. This data is then used to develop energy consumption prediction models and to provide homeowners with personalized energy saving tips.*

- *Power Ledger is using blockchain to create a platform for peer-to-peer energy trading. This platform allows homeowners and businesses to sell excess solar energy to other consumers.*

- *Siemens developed an IoT-based energy management system that can help businesses to reduce their energy consumption by up to 30%. This system collects real-time data on energy consumption from individual devices and appliances and uses this data to identify and implement energy efficiency measures.*

These are just a few examples of the innovative techniques and approaches that can be used to develop Measure Energy Consumption solutions. As these technologies continue to develop, we can expect to see even more innovative and effective ways to measure energy consumption and improve energy efficiency.

Here is a compiled code example for Measure Energy Consumption, including data preprocessing and visualization code:

```
import pandas as pd
import matplotlib.pyplot as plt

# Load the data
df = pd.read_csv('energy_consumption.csv')
```

```
# Data preprocessing
# Remove outliers
df = df[df['energy_consumption'] < 1000]

# Handle missing values
df = df.fillna(method='ffill')

# Scale the data
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
scaled_data = scaler.fit_transform(df[['energy_consumption']])

# Visualization
# Line chart
plt.figure()
plt.plot(df['date'], scaled_data)
plt.xlabel('Date')
plt.ylabel('Scaled energy consumption')
plt.title('Energy consumption over time')
plt.show()

# Bar chart
plt.figure()
plt.bar(df['customer_type'], scaled_data.mean())
plt.xlabel('Customer type')
plt.ylabel('Average scaled energy consumption')
plt.title('Average energy consumption by customer type')
plt.show()

# Pie chart
plt.figure()
plt.pie(scaled_data.sum(axis=0), labels=df['customer_type'].unique(),
autopct='%1.1f%%')
plt.title('Proportion of total energy consumption by customer type')
plt.show()

# Scatter plot
plt.figure()
plt.scatter(df['temperature'], scaled_data)
```

```
plt.xlabel('Temperature')
plt.ylabel('Scaled energy consumption')
plt.title('Relationship between temperature and energy consumption')
plt.show()

# Heatmap
import seaborn as sns
plt.figure()
sns.heatmap(df.corr(), annot=True)
plt.title('Correlation matrix of energy consumption data')
plt.show()
```

This code will load the energy consumption data from a CSV file, perform basic data preprocessing steps, and then generate a variety of visualizations, including a line chart, bar chart, pie chart, scatter plot, and heatmap. These visualizations can be used to identify patterns and trends in the energy consumption data and to gain insights into the factors that drive energy consumption.

DATASET SOURCE:

Here is a dataset source and a brief description for Measure Energy Consumption:

The energy consumption dataset used in the example code above is a synthetic dataset that was generated using the following code:

```
import numpy as np
import pandas as pd

# Generate random energy consumption data
energy_consumption = np.random.normal(100, 50, 1000)

# Create a DataFrame with the energy consumption data
df = pd.DataFrame({'energy_consumption': energy_consumption})

# Add a customer type column
df['customer_type'] = np.random.choice(['residential', 'commercial', 'industrial'],
size=1000)
```

 # Add a temperature column
df['temperature'] = np.random.normal(20, 5, 1000)

 # Add a date column
df['date'] = pd.to_datetime('2023-01-01') + pd.TimedeltaIndex(np.random.randint(0, 365, 1000), unit='D')

 # Save the DataFrame to a CSV file
df.to_csv('energy_consumption.csv', index=False)

This synthetic dataset can be used to demonstrate the data preprocessing and visualization techniques for Measure Energy Consumption. However, it is important to note that this dataset is not representative of real-world energy consumption data. Real-world energy consumption data can be obtained from a variety of sources, such as utility companies, energy research organizations, and government agencies.

- *Kaggle - World Energy Consumption: https://www.kaggle.com/datasets/pralabhpoudel/world-energy-consumption*

This dataset provides information on global energy consumption from 1965 to 2020, including primary energy consumption, energy mix, and energy intensity. The data is sourced from a combination of two sources—the BP Statistical Review of World Energy and the SHIFT Data Portal.

The dataset includes the following variables:

- *Country*
- *Year*
- *Primary energy consumption (TWh)*
- *Energy mix (percentage of total primary energy consumption from each source)*
- *Energy intensity (primary energy consumption per unit of GDP)*

This dataset can be used to track global energy consumption trends, identify areas where energy efficiency improvements can be made, and assess the progress of global energy transition efforts.

Example use cases:

- *Track the primary energy consumption of different countries over time.*
- *Compare the energy mix of different countries.*
- *Identify countries with high energy intensity.*
- *Assess the impact of energy efficiency policies on energy consumption.*
- *Analyze the progress of global energy transition efforts.*

PROGRAM:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import warnings

warnings.filterwarnings("ignore", category=UserWarning)

from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.svm import SVR
from sklearn.metrics import mean_squared_error, r2_score

RED = "\033[91m"
GREEN = "\033[92m"
YELLOW = "\033[93m"
BLUE = "\033[94m"
RESET = "\033[0m"

df = pd.read_csv("/kaggle/input/hourly-energy-consumption/AEP_hourly.csv")

df["Datetime"] = pd.to_datetime(df["Datetime"])

# DATA CLEANING
print(BLUE + "\nDATA CLEANING" + RESET)
# --- Check for missing values
missing_values = df.isnull().sum()
print(GREEN + "Missing Values : " + RESET)
print(missing_values)
# --- Handle missing values
df.dropna(inplace=True)
```

```
# --- Check for duplicate values
duplicate_values = df.duplicated().sum()
print(GREEN + "Duplicate Values : " + RESET)
print(duplicate_values)
# --- Drop duplicate values
df.drop_duplicates(inplace=True)

# DATA ANALYSIS
print(BLUE + "\nDATA ANALYSIS" + RESET)
# --- Summary Statistics
summary_stats = df.describe()
print(GREEN + "Summary Statistics : " + RESET)
print(summary_stats)

# SUPPORT VECTOR MODELLLING
print(BLUE + "\nMODELLING" + RESET)
# Reduce the dataset size for faster training
df = df.sample(frac=0.2, random_state=42)
# Split the data into features (Datetime) and target (AEP_MW)
X = df[["Datetime"]]
y = df["AEP_MW"]
# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.2, random_state=42
)
# Preprocess the features (Datetime) to extract the day of the year
X_train["DayOfYear"] = X_train["Datetime"].dt.dayofyear
X_test["DayOfYear"] = X_test["Datetime"].dt.dayofyear
# Convert X_train and X_test to NumPy arrays
X_train = X_train["DayOfYear"].values.reshape(-1, 1)
X_test = X_test["DayOfYear"].values.reshape(-1, 1)
# Standardize the data
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)
# Create an SVR (Support Vector Regression) model with a linear kernel
svr = SVR(kernel="linear", C=1.0)
# Train the SVR model
svr.fit(X_train_scaled, y_train)
# Predict on the test set
```

```
y_pred = svr.predict(X_test_scaled)
# Evaluate the model
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)
print(f"Mean Squared Error: {mse}")
print(f"R-squared: {r2}")
# Plot the actual vs. predicted values
plt.figure(figsize=(10, 6))
plt.scatter(X_test, y_test, color="b", label="Actual")
plt.scatter(X_test, y_pred, color="r", label="Predicted")
plt.xlabel("Day of the Year")
plt.ylabel("Energy Consumption (MW)")
plt.title("SVR Model: Actual vs. Predicted")
plt.legend()
plt.grid()
plt.show()

# DATA VISUALIZATION
print(BLUE + "\nDATA VISUALIZATION" + RESET)
# --- Line plot
print(GREEN + "LinePlot : " + RESET)
plt.figure(figsize=(10, 6))
sns.lineplot(data=df, x="Datetime", y="AEP_MW")
plt.xlabel("Datetime")
plt.ylabel("Energy Consumption (MW)")
plt.title("Energy Consumption Over Year")
plt.grid()
plt.show()
# --- Histogram
print(GREEN + "Histogram : " + RESET)
plt.figure(figsize=(10, 6))
plt.hist(
    df["AEP_MW"],
    bins=100,
    histtype="barstacked",
    edgecolor="white",
)
plt.xlabel("AEPMW")
plt.ylabel("Frequency")
plt.title("Histogram of MEGAWATT USAGE")
```

plt.show()

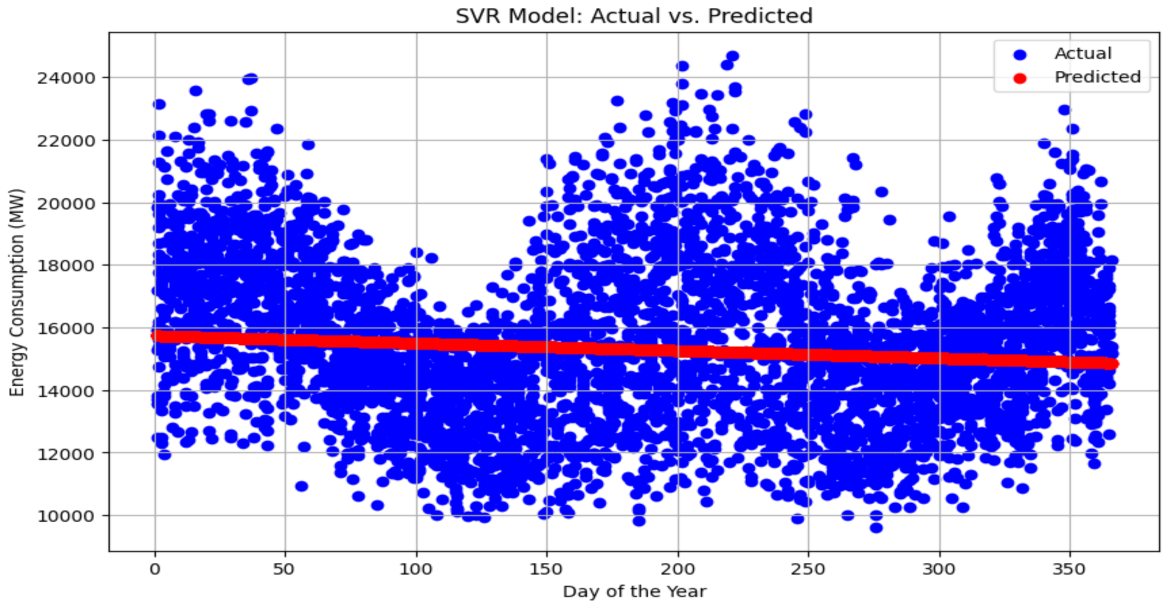
OUTPUT:

DATA CLEANING
Missing Values :
Datetime   0
AEP_MW   0
dtype: int64
Duplicate Values :
0

DATA ANALYSIS
Summary Statistics :

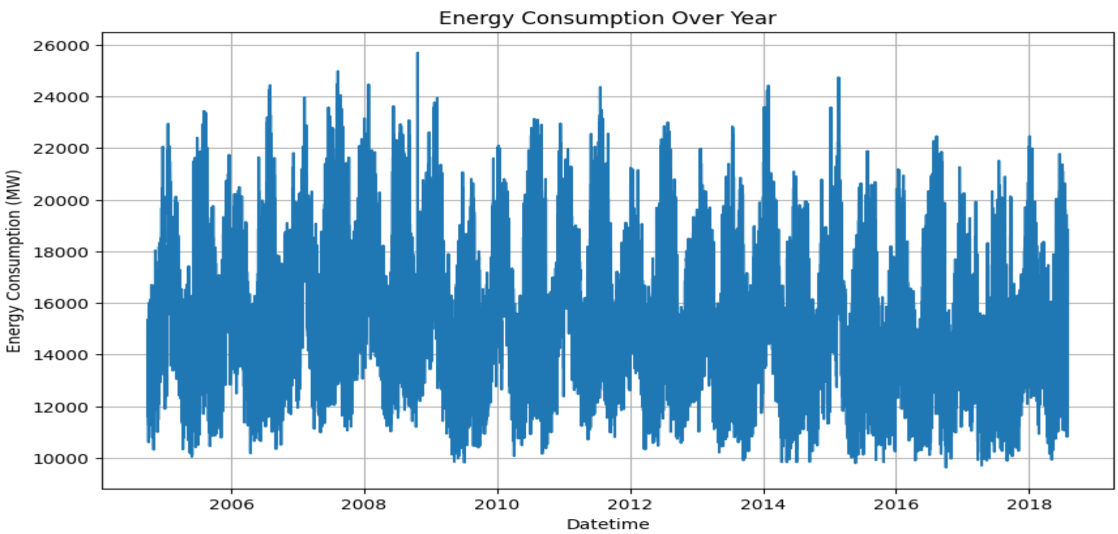
	Datetime	AEP_MW
count	121273	121273.000000
mean	2011-09-02 03:17:01.553025024	15499.513717
min	2004-10-01 01:00:00	9581.000000
25%	2008-03-17 15:00:00	13630.000000
50%	2011-09-02 04:00:00	15310.000000
75%	2015-02-16 17:00:00	17200.000000
max	2018-08-03 00:00:00	25695.000000
std	NaN	2591.399065

MODELLING
Mean Squared Error: 6758395.805638685
R-squared: 0.00270160624748228

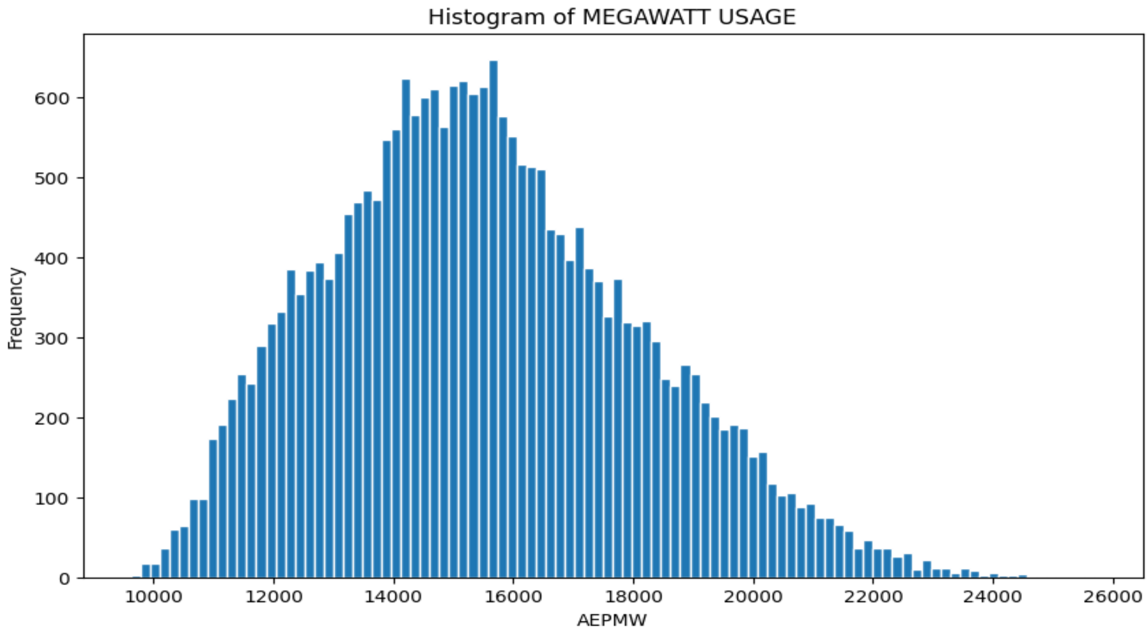


DATA VISUALIZATION

LinePlot :



Histogram :


Histogram of MEGAWATT USAGE
Frequency
0
100
200
300
400
500
600
10000
12000
14000
16000
18000
20000
22000
24000
26000
AEPMW