CS301-Software Engineering – Class Practice Sessions – 2&3

Time: **Weekend** **Date: 1st April to 8th April, 2023**

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Theme: Evolution of digitalisation in the energy sector:

The energy sector is now in a profound transition towards a very important energy transformation, and digitalisation is one of the key facilitators to ensure that it is fulfilled. In the recent past, companies started by switching the use of analogue meters to digital meters, smart meters etc., in order to improve energy efficiency.
Digitalisation acts as a lever in the sector to combat climate change and optimise power generation processes to reduce emissions and meet the objective of decarbonisation of the energy model.

Main problems of the renewable energy sector:
Impediments faced by companies in the sector are:
• Geographically dispersed energy data,
• Lack of integrated platform,
• Inability to track assets,
• Lack of clear and traceable objectives

Benefits of digital transformation in the renewable energy sector:
Digitalisation, if carried out guided by an integrated operations platform, facilitates the integration of renewable energies, energy policies and transparency in the management of these. In addition, it allows to have the user much more connected, offering the following benefits:
• Digitalisation tools and platforms help build renewable energy plants with automated processes, for informed decision making. In addition, the interconnections they propose are the basis for a more decentralised generation, thus avoiding isolated 'energy islands'.
• These platforms reduce downtime by offering alerts based on predictive maintenance, anticipating asset maintenance. The modernisation of production plants is necessary to make them more competitive and efficient.
• They allow a more accurate forecast of the weather and market conditions, which helps to maximise renewable production, by offering a deep analysis of all information received in real time, to be able to make decisions and offer stability in demand.
• The use of artificial intelligence and machine learning to optimise the engineering and construction of new renewable sources and plants reduces time to market, anticipating the benefits of free C02 generation and increasing production.

Aim:
To develop Digital-based future energies:
New power plants are born digital by their design, guaranteeing the efficiency and high availability of their services. In addition, they are backed by digital twins that help with modelling, forecasting, and testing for optimal performance, from power generation to its link with the customers.

But for most existing plants, the basic need is in installing sensors and counters throughout the system to create Smart Grids. All these new systems must be connected to existing ones in order to achieve digitalisation in the sector.
Digitalisation:
To achieve this, energy companies must rely on management software capable of interconnecting all assets and centralising their management in order to transition to renewable energy generation and reduce the carbon footprint in their operations.

Target audiences:

- Private and public organisations, homes, etc.

Assignment scope:

1. List various requirements(scope) for the above program initiative that can be used for developing a suitable technology oriented digital solution.
2. Identify various technologies, tools, and systems available in the market to support these needs.
3. Generate one API and suitable data analysis Code base to access the energy related data set and perform data analysis.

Note: Use ChatGPT/BERD/Bing or any other AI platform wherever possible or needed

Deliverables:

1. List of requirements

➔ a) Integration of all energy assets onto an integrated platform for centralised management.
b) Installation of sensors and counters throughout the system to create Smart Grids and enable real-time monitoring and control of energy generation and consumption.
c) Use of digital twins for modelling, forecasting, and testing of energy generation and consumption.
d) Use of AI and machine learning for optimising engineering and construction of new renewable sources and plants.
e) Interconnection of new digital systems with existing ones to achieve digitalisation of the energy sector.
f) Ability to accurately forecast weather and market conditions to maximise renewable energy production.
g) Creation of automated processes for informed decision making and decentralised generation.
h) Implementation of predictive maintenance to reduce downtime and improve efficiency.
i) Providing transparency in energy management to stakeholders and customers.
j) Adoption of cybersecurity measures to prevent cyber threats.
Real-time monitoring: The system should be able to monitor energy generation and consumption in real-time, with frequent updates to ensure accuracy and responsiveness.

Predictive maintenance: The system should be able to identify potential maintenance issues before they become critical, using sensors and data analysis to predict when maintenance will be needed and scheduling it accordingly.

Energy forecasting: The system should be able to forecast energy demand and supply, using historical data and machine learning algorithms to make accurate predictions.

Integration with existing systems: The system should be able to integrate with existing energy management systems, such as SCADA and building automation systems, to ensure seamless data exchange and interoperability.

Energy efficiency analysis: The system should be able to analyze energy consumption patterns and identify areas where energy efficiency can be improved, such as optimizing building heating and cooling systems or identifying and reducing energy waste.

Demand response management: The system should be able to manage demand response programs, which encourage customers to reduce energy consumption during peak periods in exchange for incentives.

2. List of tools, technologies and systems to support such needs.

➔ a) Smart meters, IoT devices and sensors for real-time monitoring and control of energy generation and consumption.
b) Cloud platforms like Microsoft Azure, AWS, and Google Cloud for hosting digital platforms and performing data analytics.
c) Digital twin technology for modelling, forecasting and testing energy generation and consumption.
d) AI and machine learning tools for optimising engineering and construction of new renewable sources and plants.
e) Big data platforms like Hadoop, Spark, and Cassandra for storing and processing large volumes of energy-related data.
f) Blockchain technology for secure and transparent energy transactions.
g) Cybersecurity solutions like firewalls, encryption and intrusion detection systems for preventing cyber threats.

IoT sensors: These sensors can be used to monitor energy consumption and production in real-time, providing data for analysis and predictive maintenance.

Energy management software: These systems can be used to monitor and manage energy usage across a variety of systems and devices, providing insights and recommendations for improvement.

SCADA systems: These systems are commonly used in the energy industry to monitor and control energy generation and distribution systems.

Machine learning algorithms: These algorithms can be used to analyse large amounts of data and make accurate predictions about energy consumption and production.

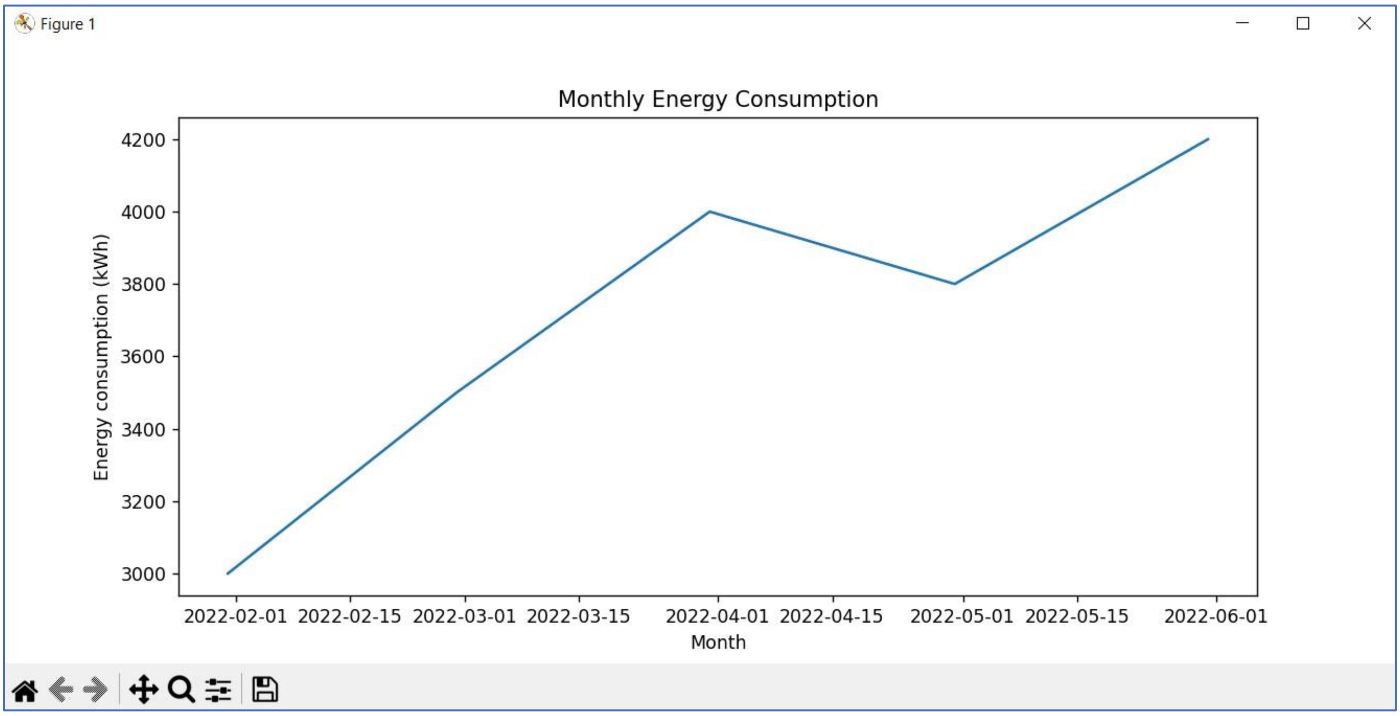
Demand response platforms: These platforms can be used to manage demand response programs, encouraging customers to reduce energy consumption during peak periods.

3. Working API code:

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

# Define API endpoint and parameters
# url = 'https://api.data.gov.in/resource/979de2b8-dba4-4c91-827f-d33824a5e824'
# params = {'api-key': '579b464db66ec23bdd0000017de3bb26b00b41cf61f619570e2f0b04',
'format': 'json', 'offset': 0,
#            'limit': 1000}

# Make API request and convert response to pandas dataframe
# response = requests.get(url, params=params)
# data = response.json()

# Assuming we receive input as given below from the above api...
data = {
  "success": True,
  "records": [
    {
      "month": "2022-01",
      "energy_consumed": "3000"
    },
```

```
    {
      "month": "2022-02",
      "energy_consumed": "3500"
    },
    {
      "month": "2022-03",
      "energy_consumed": "4000"
    },
    {
      "month": "2022-04",
      "energy_consumed": "3800"
    },
    {
      "month": "2022-05",
      "energy_consumed": "4200"
    }
  ]
}

if 'records' in data:
    df = pd.DataFrame(data['records'])
    df.rename(columns={'energy_consumed_actual': 'energy_consumed'}, inplace=True)
    df['energy_consumed'] = pd.to_numeric(df['energy_consumed'])

    # Convert date column to datetime format and set as index
    df['month'] = pd.to_datetime(df['month'], format='%Y-%m')
    df.set_index('month', inplace=True)

    # Calculate monthly energy consumption
    monthly_energy = df['energy_consumed'].resample('M').sum()

    # Calculate mean and median monthly energy consumption
    mean_monthly = monthly_energy.mean()
    median_monthly = monthly_energy.median()

    print(f"Mean monthly energy consumption: {mean_monthly} kWh")
    print(f"Median monthly energy consumption: {median_monthly} kWh")

    # Plot monthly energy consumption
    plt.plot(monthly_energy.index, monthly_energy)
    plt.xlabel('Month')
    plt.ylabel('Energy consumption (kWh)')
    plt.title('Monthly Energy Consumption')
    plt.show()

else:
    print('No records found in the response.')
```

OUTPUT:




```
C:\Users\LENOVO\projects\SE_RenewableEnergy\venv\Scripts\python.exe C:\Users\LENOVO\projects\SE_RenewableEnergy\demo3.py
Mean monthly energy consumption: 3700.0 kWh
Median monthly energy consumption: 3800.0 kWh
```