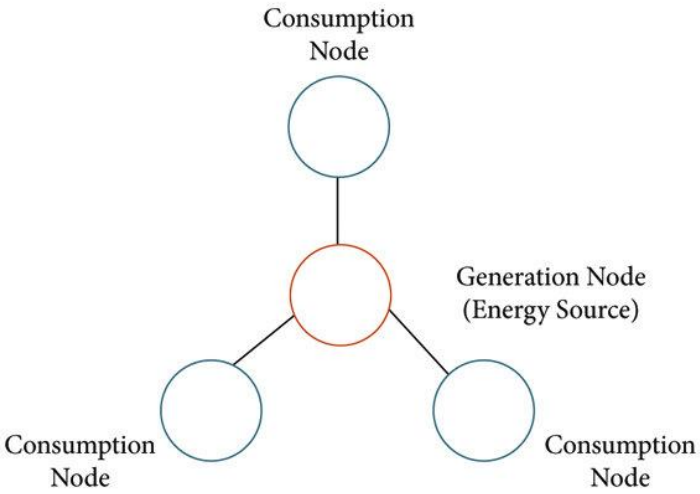
Title:

"Smart Grid Optimization: Integrating Renewable Energy for Sustainable Power Systems"

Introduction:

In this hackathon, participants will tackle the pressing challenge of integrating renewable energy source of wind energy into smart grids to create sustainable power system functionalities. The smart grid power generation follows the **4-Node Star Architecture.**



Synopsis:

The hackathon will offer participants access to an extensive dataset at hourly level of granularity comprising of:

1. Renewable wind energy generation data.
2. Smart grid data indicating stability status.

Their challenge will be:

1. To build predictive models capable of accurately forecasting power generation. (we are providing the forecasted value of independent variables).
2. Additionally, they'll assess grid stability. (Please note: As shown in above figure. One Generation node has three Consumption node. Thus, participants has to divide the Power generated in Generation node in the ratio mentioned below between the three nodes.)

This will empower operators to make real-time, data-driven decisions. Participants will delve into hands-on data analysis, feature engineering, and model development to unravel the

complex interplay between smart grid dynamics, renewable energy generation, and overall grid performance.

Problem Statement:

1) Considering the past 5 years of data provided, predict total power generated (p) for the first 3 months of 2024 at an hourly granularity. (Independent variables for first 3 months of 2024 for consideration is shared in a separate file.)
2) For above problem you need to merge all 20 files data as an final input file. Which will be consisting of Date time, Air, Pressure, wind speed and Power generated variables.
3) Considering this total power generated (p), prepare a database such that the generated power is distributed to 3 different consumption nodes (refer the 4-Node Star Architecture) with Node 1 will be taking 20% of total power, Node 2 will be taking 45% of total power and Node 3 will be taking 35% of total power generated respectively.
4) Use this existing and the newly prepared dataset to determine the Stability ("stability", **Dependent Variable**) of the power Grid.
5) For above problem you need to consider Grid folder data consisting of price per unit, unit consumption, and grid stability report on hourly basis. Also, you need to add Power generated and stored at each Node(predicted during 3rd step)
6) Final report can be presented different ways.
    a. For instance, participants could analyze the output to determine the percentage of 'Stable' and 'Unstable' grid conditions over the span of three months. This analysis would provide valuable insights into the overall stability trends of the grid during the specified time period. Additionally, they could delve deeper to identify patterns in the hours when the grid is most prone to instability. By examining the frequency and duration of 'Unstable' conditions throughout the day, participants can uncover the specific time ranges when grid instability is most prevalent. Such insights can inform grid operators about potential vulnerabilities and enable them to implement proactive measures to mitigate instability risks during these critical hours.

    P.S.: Your insights may need not be restricted to these examples. You are welcome to explore and present your own views.

Data Description:

The dataset includes 5 years of data on three parameters to be used to determine power generated by wind energy. The dataset is divided on the basis of year and each parameters are in separate files. The parameters are:

- Air Temperature (°C)

- Pressure (atm)
- Wind Speed (m/s)
- Power generated (MW) **[Target Variable]**

Additionally, the smart grid dataset encompasses various parameters mentioned below:

- Power Generated (MW): power_gen_1, power_gen_2, power_gen_3 (the total power generated is distributed into each node as 20%, 45% & 35% respectively)
- Price per unit: p1, p2, p3
- Power Consumption: C1, C2, C3 (It is arithmetically negative as it is being consumed)
- 'stability': a categorical (binary) label ('stable' or 'unstable') **[Target Variable]**

NOTE:

- All the independent variables forecasted values for Jan, Feb, March months of year 2024 has been kept in a file. Also, we have kept the target variables using which you can validate your models for 3months time.
- All datasets are timestamped at an hourly granularity, providing insights into the temporal dynamics of energy generation and consumption within the smart grid environment.

Dataset source:

https://drive.google.com/file/d/1QwGpTEJE8PQJXMR_-4O76c5p7hpI3Fmy/view?usp=sharing

Impact:

The hackathon aims to foster innovation in the field of sustainable energy systems by empowering participants to develop cutting-edge machine learning solutions for smart grid optimization. By harnessing the power of data-driven decision-making, participants will contribute to the advancement of grid reliability, resilience, and efficiency. Moreover, the insights gained from the hackathon will inform policy-makers, industry stakeholders, and research communities about the opportunities and challenges associated with renewable energy integration, ultimately accelerating the transition towards a low-carbon energy landscape.