We are
⬡ Grid Guard Masters
AI load predictor and decision maker
It's like we're watching you!

Team members
Mahmoud Khaled   Mohamed Yasser
Mahmoud Hossam   Mohamed Yasser
Mahmoud Ibrahim   Mahmoud Ahmed
Marwan Mostafa   Abdelrahman Sam
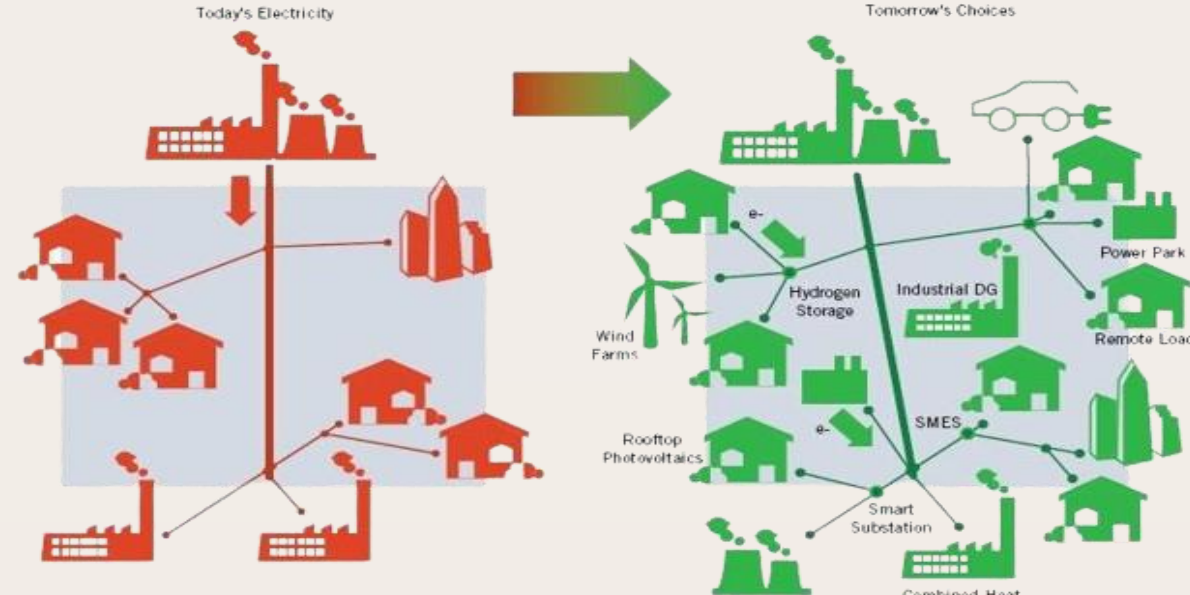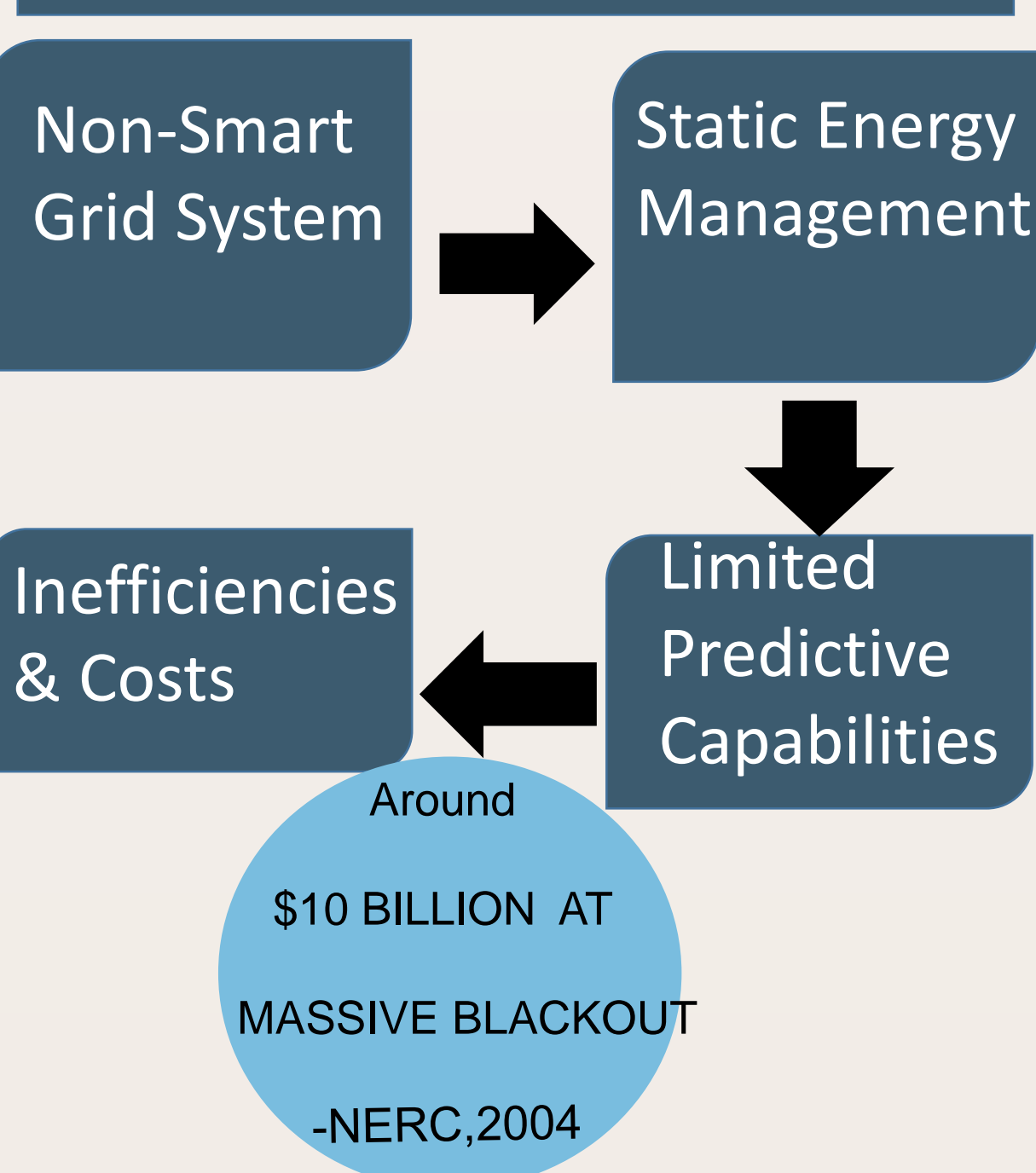Abdelrahman Ahmed

Instructor
Prof/ Maha Amin

Scan for seeing our reference
Scan me!

1-Abstract

Traditional grids often face inefficiencies due to limited predictive capabilities and static energy management strategies. Our proposed AI-driven framework revolutionizes traditional grid operations by integrating advanced machine learning algorithms for load prediction and dynamic decision-making so lets see what they have !
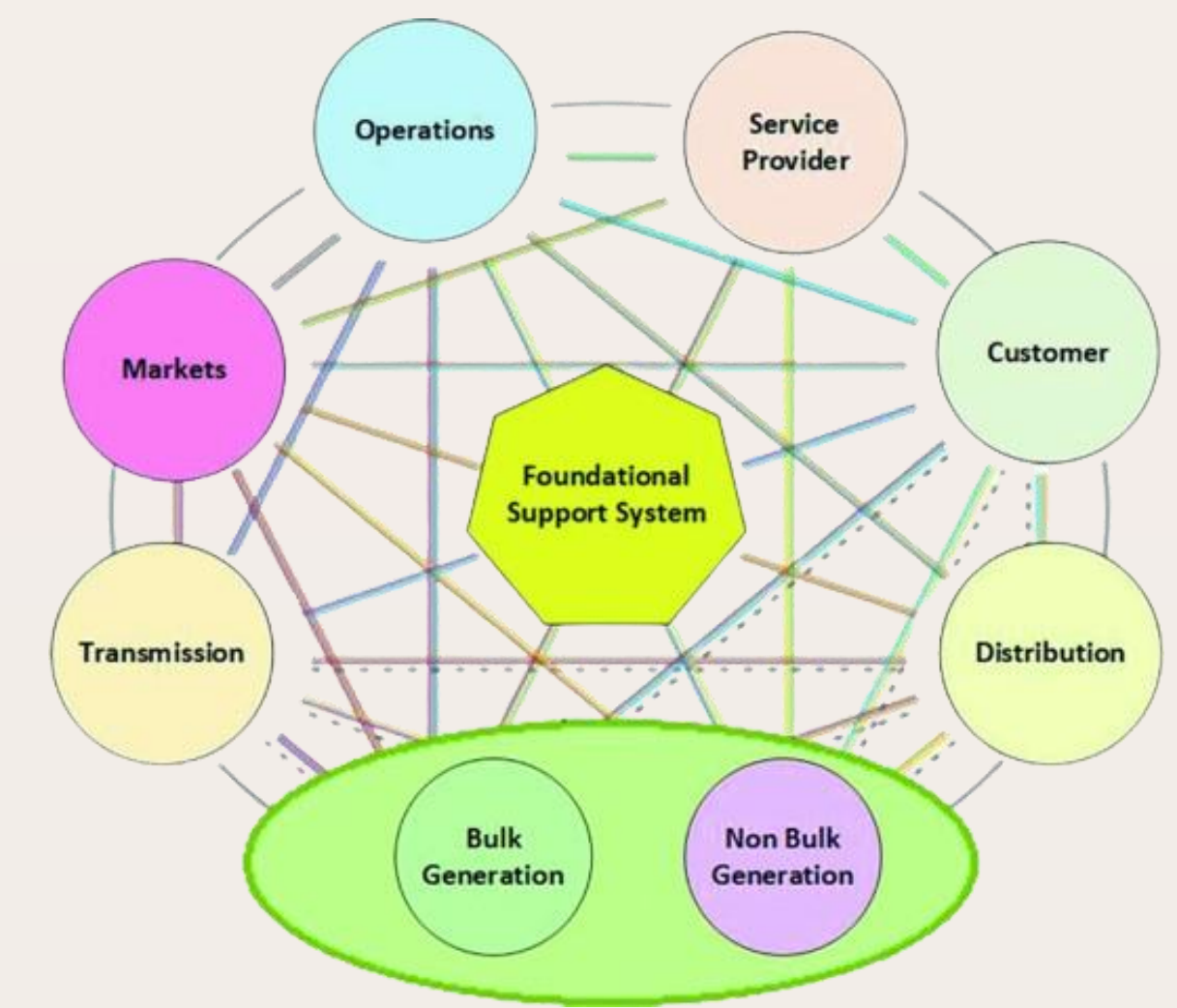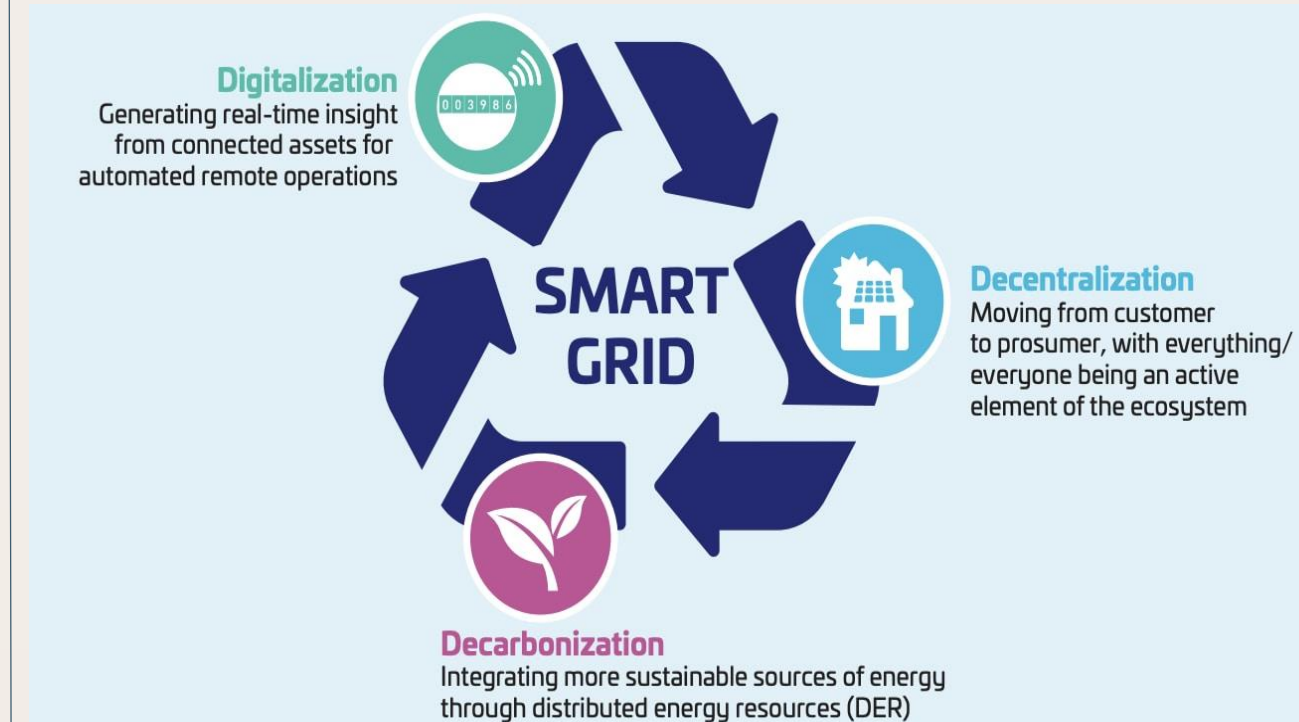
2-Problem definition

Non-Smart Grid System → Static Energy Management

Inefficiencies & Costs ← Limited Predictive Capabilities

Around $10 BILLION AT MASSIVE BLACKOUT -NERC,2004

3-Literature review

Nowadays, Ai is a trendy technology Which enable you to manage the whole thing with zero effort so **How it will work with our electrical grid?**

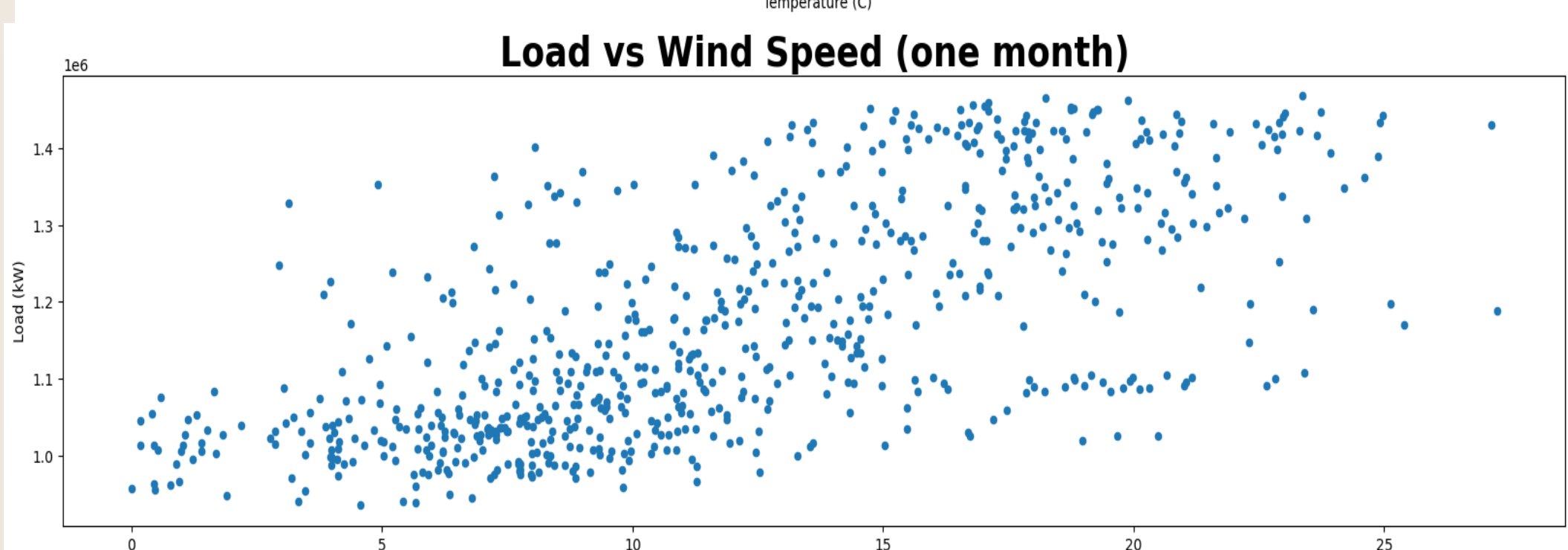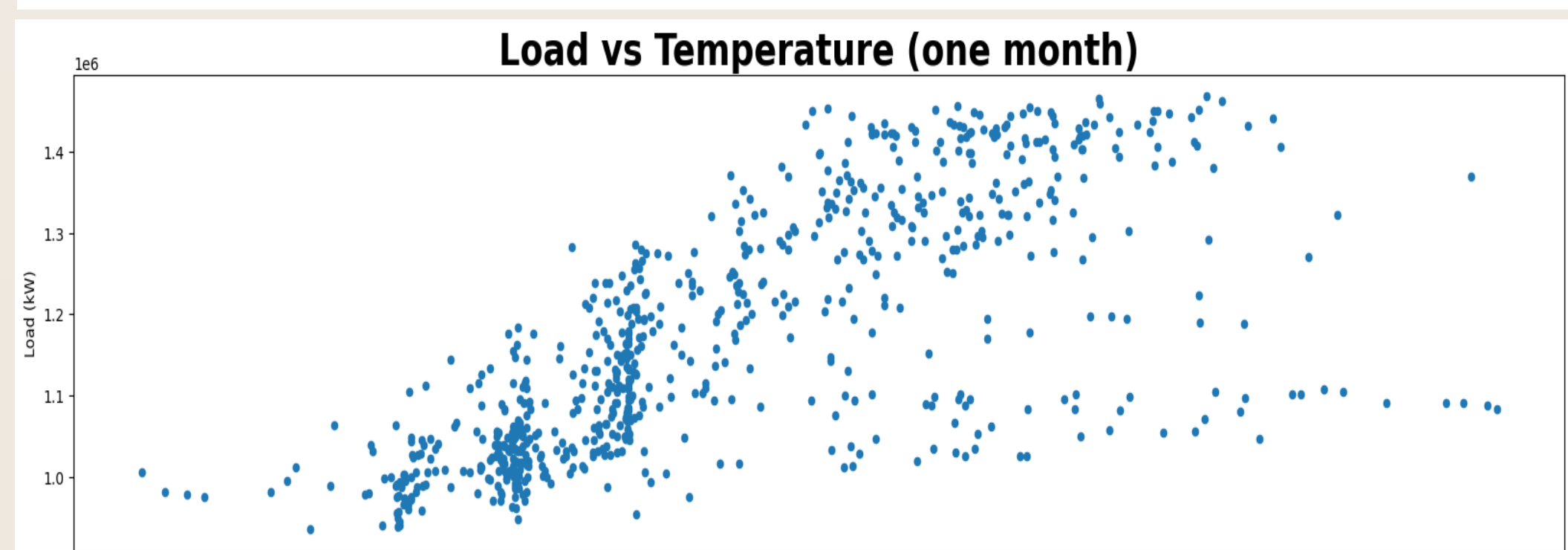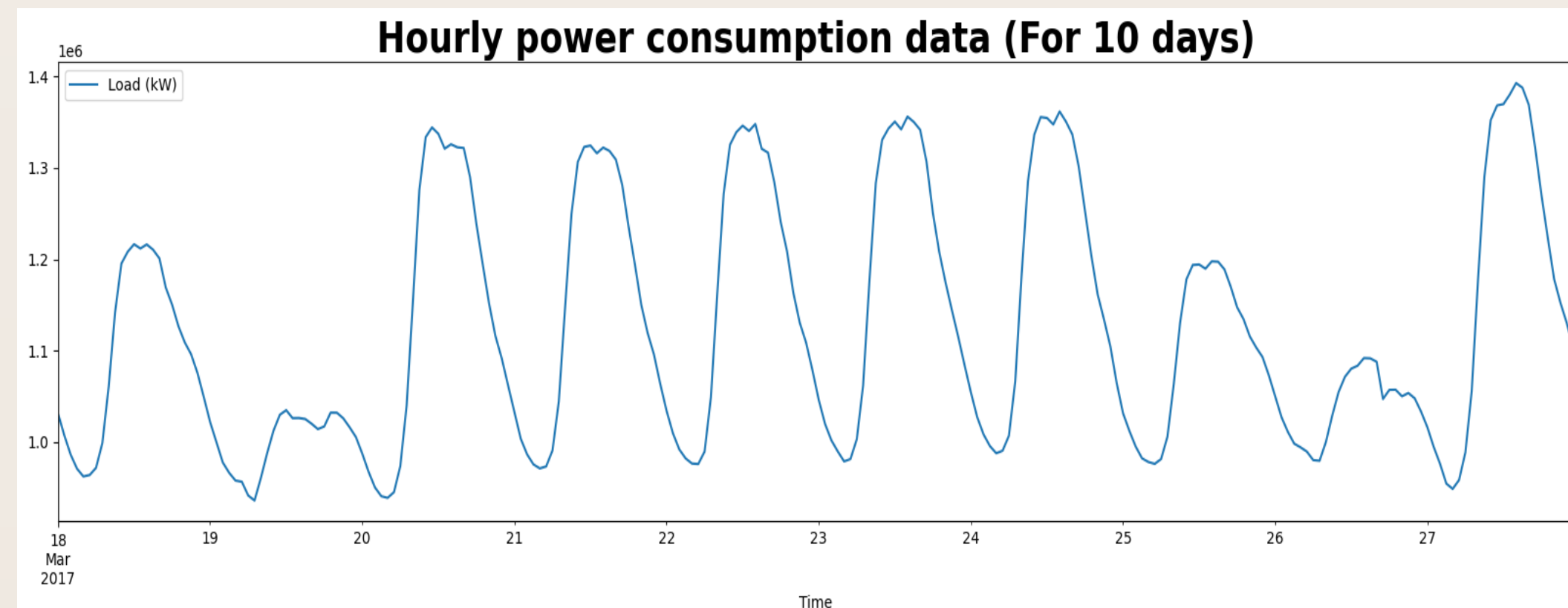Typical purposes of SG(Smart Grid)

SG Challenges

4-Data description

Data source
Scan me!

Initially, we scoured databases on platforms like Kaggle and similar sites. However, many were either encrypted or had derived parameters, Ultimately, we found a suitable database within the IEEE databases that met all our criteria. Real time,weather conditions,etc..

Hourly power consumption data (For 10 days)

Load vs Temperature (one month)

Load vs Wind Speed (one month)

`true_DS.corr()`

	Load (kW)	Pressure_kpa	Cloud Cover (%)	Humidity (%)	Temperature (C)	Wind Direction (deg)	Wind Speed (kmh)
Load (kW)	1.000000	-0.050032	0.016469	-0.168171	0.557408	0.328756	0.457311
Pressure_kpa	-0.050032	1.000000	-0.654851	-0.627756	-0.153052	-0.211696	-0.381218
Cloud Cover (%)	0.016469	-0.654851	1.000000	0.667652	-0.059279	0.030966	0.240750
Humidity (%)	-0.168171	-0.627756	0.667652	1.000000	-0.250388	0.017097	0.029974
Temperature (C)	0.557408	-0.153052	-0.059279	-0.250388	1.000000	0.373802	0.411038
Wind Direction (deg)	0.328756	-0.211696	0.030966	0.017097	0.373802	1.000000	0.450958
Wind Speed (kmh)	0.457311	-0.381218	0.240750	0.029974	0.411038	0.450958	1.000000

Correlation Table

5-AI Model

See our Kaggle
Scan me!

MinMaxScaler method:

MinMaxScaler is a data normalization technique commonly used in machine learning to scale features to a specified range, typically between 0 and 1. This scaling method rescales each feature individually by subtracting the minimum value of the feature and then dividing by the difference between the maximum and minimum values. The formula for Min-Max scaling is:

$$X_{scaled} = \frac{X - X_{min}}{X_{max} - X_{min}}$$

Hourly power consumption data - BEFORE NORMALIZATION

Hourly power consumption data - AFTER NORMALIZATION

before and after normalization (notice the range of the load)

LSTM (Type of RNN models):

An LSTM (Long Short-Term Memory) model is a type of recurrent neural network (RNN) architecture It's designed particularly and effectively for tasks involving time series data,natural language processing (NLP),and sequential pattern recognition.

Input Layer | LSTM Layer-1 | LSTM Layer-2 | LSTM Layer-3 | Output Layer

Metrological Data with previous PN Data

6-Grid operations

The Known Grid comprises three primary components: generation, transmission, and distribution. Each component involves numerous considerations and operations. To streamline the process, we select key operations and considerations from these three processes for study and automation within the system. And here the Main operations we consider about

- Synchronization for parallel operating generators
- Power Factor autocorrection
- Classifing Loads according to their Priorities
- Turning ON/OFF generators according to their capacity, power needed and optimize the selection process from cost view
- Determine an acceptable point of operating to according to active Vs reactive power of synchronous generators
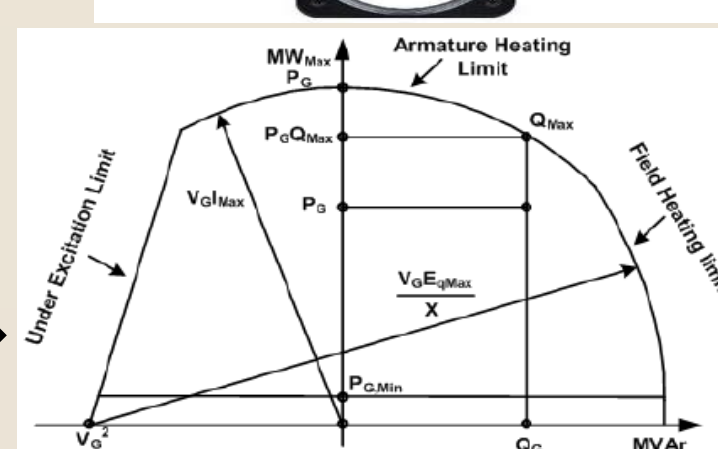
Graph showing synchronizing process
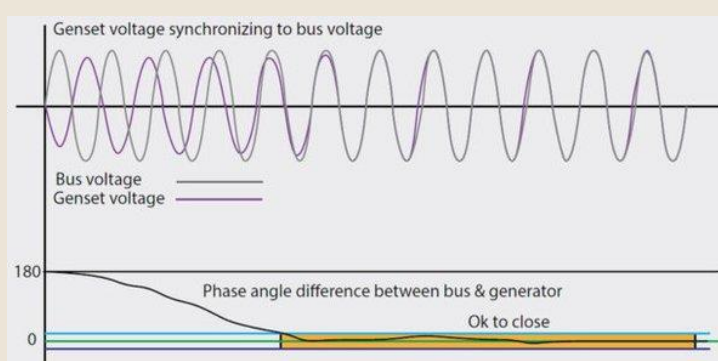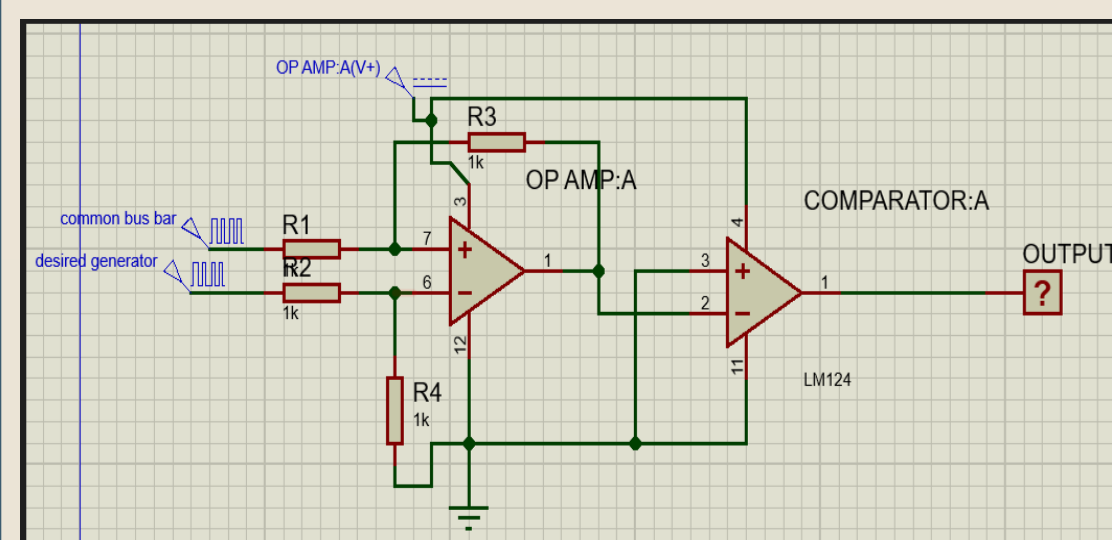
"Illustrative figure for real circuit"
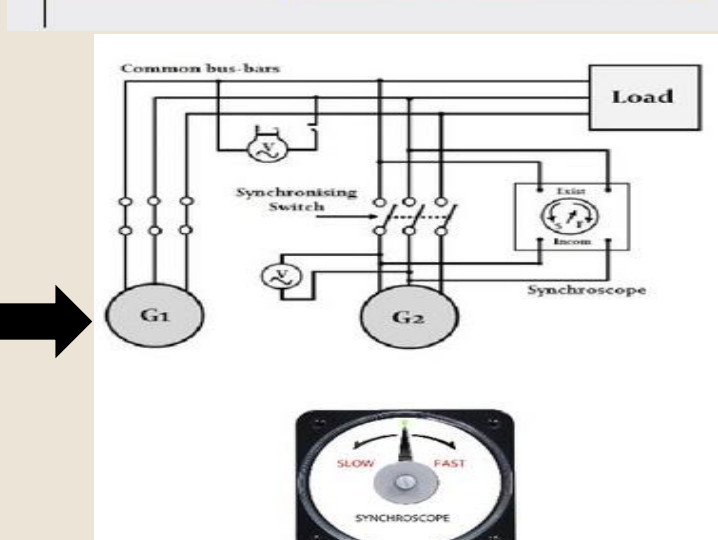
Active VS Reactive power for sync generators

7-implementation

Hardware:-

Due to our test of synchronization at low voltage we designed a circuit to condition an input signal to MCU to decide sync/not sync

Software:-

- Prediction Panel is a user-friendly software application designed to empower you with accurate load demand predictions and decision making , providing valuable insights for planning ahead using ML&algorithms

1 0 1 1 0 1 1 0
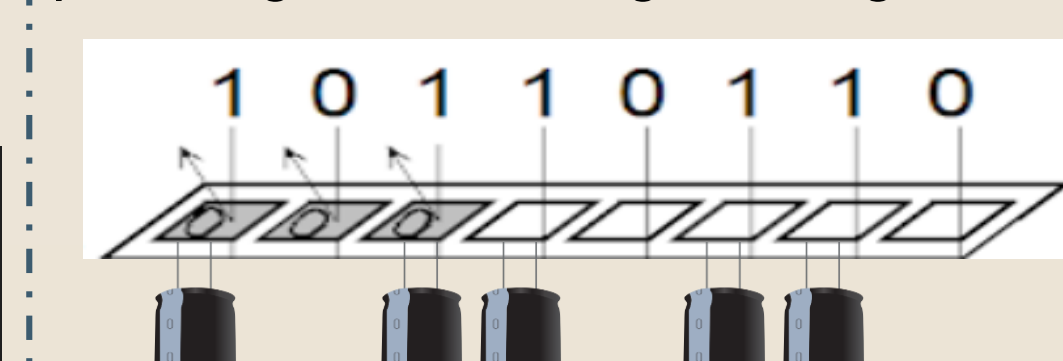
- The best Capacitor combination can be found by iterating over all bit masks , representing set bit '1' as a capacitor to use ,this isk nown as Bitmasks technique
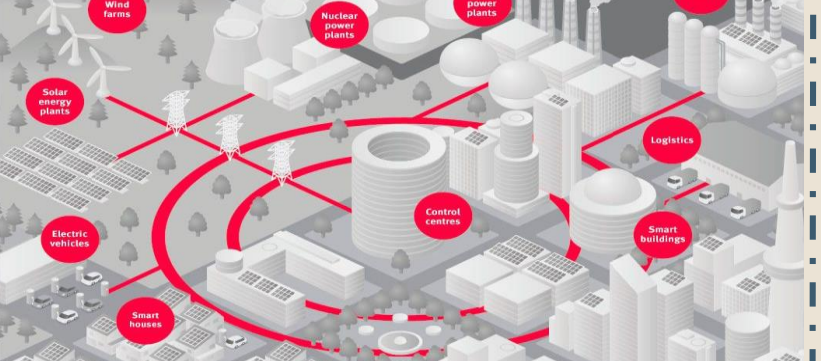
AI model + Python-based prediction Panel → Controller C++

UI of implemented SW
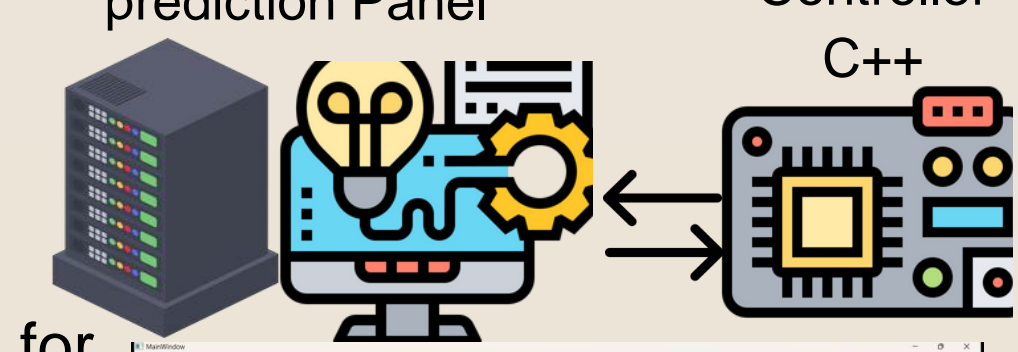
Scan to see our repo

8-Results

-This system can act remotely on network incidents, improving our supply and our relationship with the environment.

-Smart Grid technologies is expected to achieve a 12% reduction in electricity consumption and CO_2 emissions in 2030.
-The Smart Grid, combined with a portfolio of generation and end-use options, could reduce 2030 overall CO_2 emissions from the electric sector by 58% relative to 2005 emissions (EPRI 1020389).

-The response of model to new data is very accurate! Making the system more reliable, efficient and profitable

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MSE: 0.00016837847246634533
MAE: 0.010180646818587756
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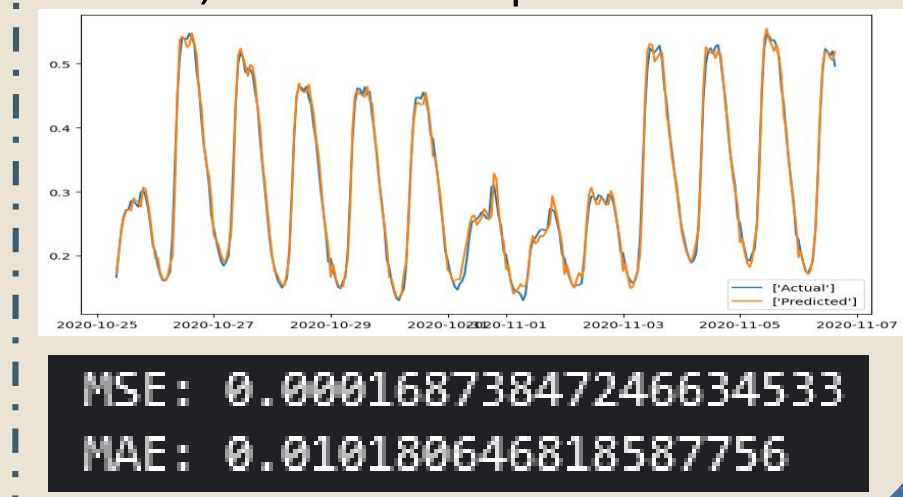
9-Future Work

- Enhance model functionality to support dynamic updates using live load data stream
- Detecting Malicious acts using AI ,defending against cyber attacks
- implement Power Flow calculation using graph representation ,Physics&Maths principals and matrix manipulation ,leading to more management and control features for the grid
- Implement Grid Coordinate operator > Grid connections fault detection at controller and electronics level