**Business Story**

**Enhancing Microgrid Efficiency through Advanced Data Analytics and Machine Learning**

**Background:** Microgrids represent a revolutionary approach to energy management, offering a localized power system that can operate independently or in conjunction with the main grid. Introduced by Bob Lasseter in 2001, microgrids integrate various components such as Distributed Energy Resources (DERs), energy storage, and intelligent control systems to optimize energy production and consumption. In this project, we focus on the University of La Reunion's Terre Sainte campus, a grid-connected microgrid, that leverages solar photovoltaic (PV) systems to enhance energy sustainability and efficiency.

**Objective:** The primary goal is to evaluate the potential of machine learning (ML) tools in predicting and optimizing the energy production and consumption within the Terre Sainte microgrid. This involves analyzing historical PV production data and weather data to develop predictive models that can forecast energy production and consumption patterns. The study aims to identify the key factors influencing PV production, optimize energy usage, and ensure the stability and efficiency of the microgrid.

. with weather and without weather data

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**Project Scope:**

1. **Data Collection and Management:**
   * Gather historical data on PV production from buildings equipped with PV systems (ESIROI, ENERPOS, and Dpt 1\_2).
   * Collect comprehensive weather data from the campus's weather station, including metrics such as Global Horizontal Irradiance (GHI), Beam Normal Irradiance (BNI), temperature, humidity, wind speed, and atmospheric pressure.
2. **Data Engineering and Cleaning:**
   * Consolidate and preprocess the collected data to ensure accuracy and completeness.
   * Handle missing values, outliers, and discrepancies in the data through appropriate data-cleaning techniques.
3. **Data Analysis and Modeling:**
   * Use ML models to forecast PV production and energy demand based on historical data.
   * Perform comparative analysis using models that incorporate weather data versus those that do not, to determine the impact of weather on PV production.
4. **Optimization and Insights:**
   * Identify periods of high and low PV production and analyze the corresponding weather conditions.
   * Develop strategies to balance energy production and consumption, and minimize the gap between energy supply and demand.

**Impact:** Implementing advanced data analytics and ML techniques will provide valuable insights into the operation of the Terre Sainte microgrid. The outcomes will help in optimizing energy production, reducing operational costs, and enhancing the reliability and sustainability of the microgrid. This project will serve as a model for other microgrids aiming to integrate renewable energy sources effectively.

**Data Files Overview**

1. **Dpt\_1\_2\_PV.txt**: Contains PV production data for the Department 1 and 2 buildings.
   * **Data Columns**: Timestamp, PV production in kW.
   * **Use**: Analyze PV production patterns for these buildings.
2. **ENERPOS\_PV.txt**: Contains PV production data for the Enerpos building.
   * **Data Columns**: Timestamp, PV production in kW.
   * **Use**: Analyze PV production patterns for the Enerpos building.
3. **ESIROI\_PV.txt**: Contains PV production data for the ESIROI building.
   * **Data Columns**: Timestamp, PV production in kW.
   * **Use**: Analyze PV production patterns for the ESIROI building.
4. **Meteo\_Terre\_Sainte.txt**: Contains weather data from the Terre Sainte campus.
   * **Data Columns**: Timestamp, GHI, BNI, DHI, Dry Bulb Temperature, Relative Humidity, Wind Speed, Wind Direction, Atmospheric Pressure, Rainfall.
   * **Use**: Correlate weather conditions with PV production to understand the impact of weather on energy production.
5. **Readme\_PV\_production\_files.txt**: Metadata for PV production files.
   * **Content**: Details about PV systems, data sources, and processing notes.
   * **Use**: Provides context and specifics about the PV production data, necessary for accurate interpretation.
6. **Readme\_Meteo\_files.txt**: Metadata for weather data files.
   * **Content**: Details about the weather station, data columns, and processing notes.
   * **Use**: Provides context and specifics about the weather data, necessary for accurate interpretation.

**Data Integration and Missing Data**

**Data Available:**

* PV production data for three buildings (Dpt 1\_2, Enerpos, ESIROI).
* Weather data from the Terre Sainte campus.

**Missing Data:**

* Load (energy consumption) data for buildings with PV installations (ESIROI, Enerpos, Dpt 1\_2).

**Recommendations for Merging:** To perform comprehensive analyses, you can merge the PV production data with the weather data. Specifically:

1. **Dpt\_1\_2\_PV.txt** + **Meteo\_Terre\_Sainte.txt**
2. **ENERPOS\_PV.txt** + **Meteo\_Terre\_Sainte.txt**
3. **ESIROI\_PV.txt** + **Meteo\_Terre\_Sainte.txt**