**Report on KPI Forecasting & Energy Saving Detection**

**Project Summary**

**Objective**:  
To forecast two KPIs — DL\_Prb\_Utilization and Avg\_UE\_Number — for all 6 cells over a **6-month period** using ML models (Random Forest and Prophet), evaluate their performance, identify **common overlapping energy-saving time windows**, and allow **user configuration** of thresholds and durations.

**📁 Input Data**

* **Files Used**:
  + Avg\_UE\_Number\_Data.csv
  + DL\_Prb\_Utilization\_Data.csv
* **KPIs**:
  + DL\_Prb\_Utilization
  + Avg\_UE\_Number
* **Date Range**:
  + Includes **6 different Cells (NCI values)**

**Implementation Breakdown**

**📌 1. Preprocessing**

* Timestamps are parsed and rounded to **15-minute intervals**.
* Merged on ["Timestamp", "NCI", "gNB"], then averaged by ["NCI", "Timestamp"]
* Invalid/missing timestamps are handled properly

**📌 2. Forecasting (6 months ahead)**

* Starts from **current time rounded to 15min**, predicts till **6 months ahead**
* Forecasts are done per NCI and per KPI

**ML Models Used**:

| **Model** | **Accuracy Measure** |  |
| --- | --- | --- |
| Random Forest | R² Score |  |
| Prophet | R² Score |  |

* Forecasted results are saved as:
  + 6mo\_KPI\_RF\_forecast.csv
  + 6mo\_KPI\_Prophet\_forecast.csv

**3. Energy Saving Detection (Configurable)**

* **Modes Available**: Conservative, Moderate, Aggressive
* Mode selected: "Moderate" — matches your request.
* Filters forecasted values **within the configured range**
  + Moderate Mode Thresholds:
    - DL\_Prb\_Utilization: 0–15
    - Avg\_UE\_Number: 0–13

**4. Window Grouping by NCI**

* Uses .diff() to group **consecutive 15-minute intervals**
* Ensures **minimum duration (e.g. 30 minutes)** using:

if len(gdf) \* 15 >= WINDOW\_MINUTES:

* **WINDOW\_MINUTES = 30** → Can be updated dynamically
* Grouped & qualified data is stored in:
  + Energy\_Saving\_Windows\_Moderate.csv

**Accuracy Summary**

Random Forest overall R²: 0.9738

Prophet overall R²: 0.7782

Single scalar R² value for each model is printed and logged.

**📁 Output Files Generated**

| **File Name** | **Description** |
| --- | --- |
| 6mo\_KPI\_RF\_forecast.csv | 6-month forecast from Random Forest |
| 6mo\_KPI\_Prophet\_forecast.csv | 6-month forecast from Prophet |

**Configuration Options**

| **Parameter** | **Description** | **Configurable** |
| --- | --- | --- |
| SELECTED\_MODE | Choose between Conservative, Moderate, Aggressive | Yes |
| WINDOW\_MINUTES | Minimum group length in minutes (e.g., 30) | Yes |
| PLOT\_RESULTS | Enable/disable KPI visualizations | Yes |

**Conclusion:**

The KPIs were successfully forecasted for the next 6 months using Random Forest and Prophet models, achieving high accuracy.