EDP Challenge Documentation

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A. EDP: THE COMPANY

EDP is a global company and one of the largest players in the European energy sector, ranking as the 4th largest producer of wind energy. EDP takes pride in being a leading utility integrated into the Dow Jones Sustainability Indexes (World). Its mission is to build a new energy future by promoting renewable sources.

To achieve this, EDP has committed to:

- Being 100% green by 2030;
- Targeting 20 GW of renewable installed capacity by 2025;
- Innovating to shape the future of the energy sector;
- Empowering communities to live more sustainably.

EDP's energy strives to create a better future, fueled by people from 3 continents, 29 markets, and 44 different nationalities. EDP will harness the power of wind, sun, and water to lead the global energy transition. Together, EDP will become fully green, choosing the Earth as its guiding principle.

B. THE CHALLENGE:

1. Introduction

The **global shift to renewable energy** is essential for reducing carbon emissions and advancing ecological transitions. However, this shift brings challenges because renewable sources like wind and solar are intermittent (energy is only generated when the sun is shining or the wind is blowing). As a result, energy production from these sources doesn't always align with demand, leading to issues such as shortages, grid instability, price fluctuations, and even negative prices when there is excess supply. Ensuring energy security and maintaining grid stability are critical for a successful energy transition.

Battery Energy Storage Systems (BESS) offer a vital solution by storing excess renewable energy generated during periods of surplus (such as sunny or windy days) and releasing it when demand is higher, or when renewable generation is low. This capability allows BESS to shift energy availability over time, making renewable energy more reliable, preventing curtailment (the forced reduction of renewable output), and avoiding energy shortages. Moreover, BESS helps to reduce the need for backup power plants that rely on fossil fuels.
BESS plays a pivotal role in energy trading, where operators can purchase energy when prices are low and sell it when prices rise, efficiently allocating energy throughout the day. This

process of **energy arbitrage**, combined with services such as frequency regulation to maintain grid stability, creates multiple revenue streams (referred to as **revenue stacking**). Precise forecasting of electricity prices and market conditions is critical for maximizing these revenues. BESS must charge and discharge energy at optimal times, making accurate predictions of future conditions an essential part of this challenge.

The challenge we propose is to develop the most precise forecasts for the **Balancing Mechanism** in the UK. By doing so, our BESS will optimize its trading strategy, maximizing profitability while efficiently allocating renewable energy and supporting a smooth transition toward a cleaner, more sustainable energy system.

2. Balancing Mechanism

In Great Britain, the **Electricity System Operator (ESO)** ensures the balance between electricity supply and demand through the **Balancing Mechanism**. This process is crucial for maintaining the stability of the grid in real-time.
Two key metrics used in the Balancing Mechanism are the **Net Imbalance Volume (NIV)** and the **System Price**:

- The **NIV** represents the net volume of balancing actions taken by the ESO during each settlement period to align supply and demand. A **positive NIV** indicates that the system is long, meaning demand exceeds generation, while a **negative NIV** suggests that demand exceeds generation.
- The **System Price** reflects the marginal cost of these balancing actions and determines the price that "out of position" market participants either pay to, or receive from, Elexon, the administrator of the Balancing Mechanism.

Every settlement period, which occurs every half hour, has corresponding values for both the **NIV and the System Price, resulting in 48 sets of data per day.**

3. First Step: Simplified Example of BESS Trading (only Day Ahead)

The following graphs show how the BESS optimizes its operations in the **Day-Ahead market**:

- **Charging**: The battery charges when electricity prices are low, allowing it to store energy at a reduced cost. In this example, this occurs in the morning, around 9:00 a.m.
- **Discharging**: The battery discharges and sells energy back to the grid when prices are high. This process happens later in the day, around 6:00 p.m., when electricity prices are significantly higher.

This process of **energy arbitrage** allows the BESS to generate revenue by taking advantage of the daily fluctuations in electricity prices.

After this initial step in the **Day-Ahead market**, the system can then look for further arbitrage opportunities in the **Balancing Mechanism**, where it can adjust its positions to capture additional revenue when supply and demand imbalances occur.

Detailed explanation of the three graphs (Figure 1):

The following graphs illustrates how a **Battery Energy Storage System (BESS) operates** in the **Day-Ahead market**, optimizing its energy management to maximize revenue through price arbitrage.

1. **Top graph (Day-Ahead (DA) Price):** The purple line represents the fluctuation of electricity prices throughout the day. We can see that prices hit their lowest point around 9:00 a.m. and peak around 6:00 p.m.
2. **Middle graph (Battery Actions):** This graph shows the battery's actions in response to the changing electricity prices.
   - **Light blue (Grid to Battery Charge):** This indicates when the battery is charging, which happens when electricity prices are low (around 9:00 a.m.). This allows the battery to store energy at a reduced cost.
   - **Dark blue (Battery to Grid Discharge):** This indicates when the battery is discharging and selling energy back to the grid. This happens when electricity prices are high (around 6:00 p.m.), maximizing revenue by selling energy when market prices are at their peak.
3. **Bottom graph (State of Charge):** This graph shows the battery's charge level throughout the day. It begins charging in the morning when prices are low (around 9:00 a.m.), reaches full charge during the day, and then starts discharging when prices rise, around 6:00 p.m.

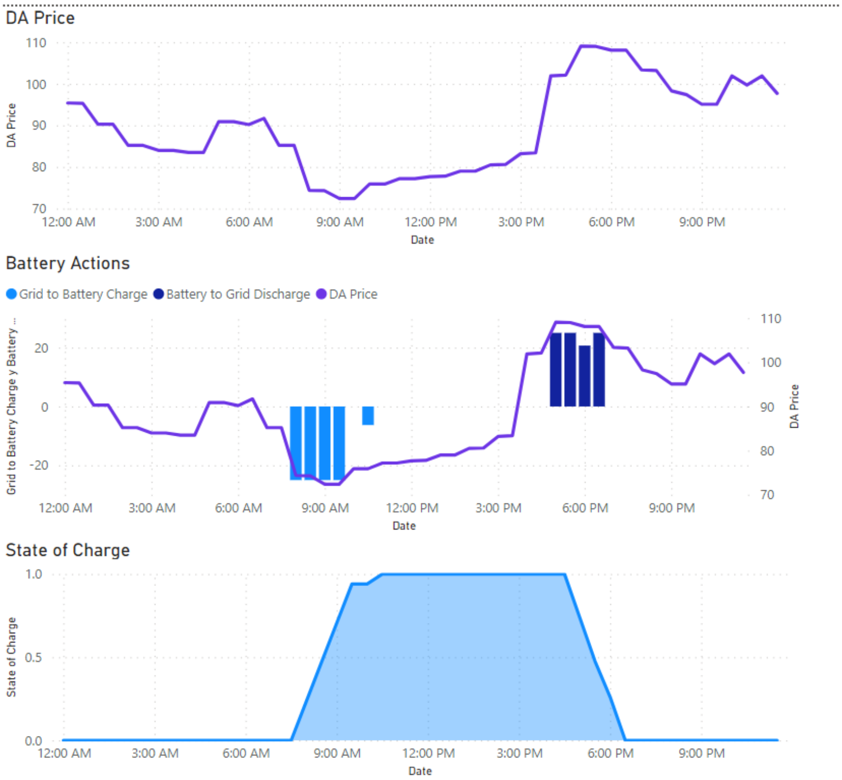


Figure 1: Battery Energy Storage System (BESS)

4. Second Step: Optimizing BESS Operations Across Day-Ahead and Balancing Markets

The **BESS maximizes its profitability** by first setting its position in the **Day-Ahead market** (left graph), scheduling charge cycles when prices are low and discharge cycles when prices are high. However, the Day-Ahead market is based on forecasts, and real-time conditions in the **Balancing Mechanism** (right graph) may offer better opportunities for revenue generation.

In the **Balancing Mechanism**, the BESS can adjust its strategy:

- It can **re-schedule** its operations to capture larger price spreads that weren't predicted in the Day-Ahead market.
- If allowed by cycle limits, the BESS can execute **additional cycles** to further benefit from price volatility.
- Conversely, if real-time price changes are less favorable than forecasted, the system can **cancel scheduled** Day-Ahead cycles to avoid financial losses.

By operating flexibly in both markets, the BESS is able to **dynamically respond** to price changes and optimize revenues from energy arbitrage.

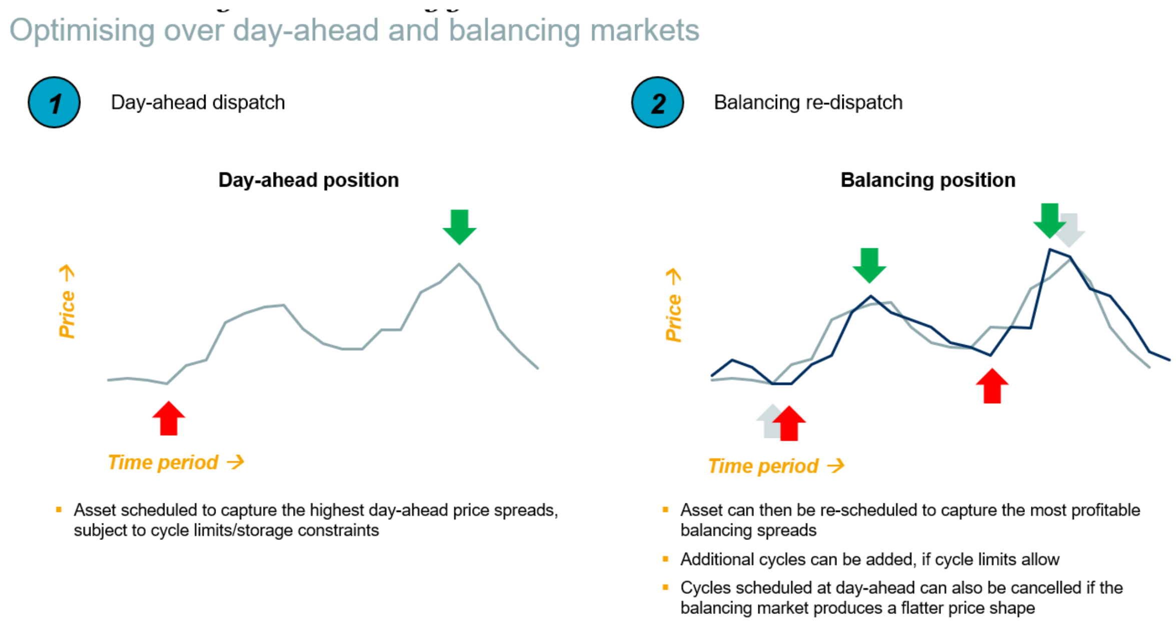


Figure 2: Battery Energy Storage System (BESS): Optimising over day-ahead and balancing markets.

<u>Detailed explanation of the two graphs (Figure 2):</u>

The two graphs illustrate how a **Battery Energy Storage System (BESS)** can shift its operational position between the **Day-Ahead market** and the **Balancing Mechanism** to maximize revenues through energy arbitrage.

1. **Graph on the left (Day-Ahead Dispatch)**:

- The **Day-Ahead market** allows the BESS to schedule charging and discharging cycles in advance, based on **predicted price fluctuations**.
- **Charging (red arrow)**: The BESS charges when the Day-Ahead prices are at their lowest. This helps store energy when it's cheapest to do so.
- **Discharging (green arrow)**: The BESS discharges and sells energy when Day-Ahead prices are at their peak, capturing the maximum price spread for arbitrage profits.
- The **system is scheduled** to capture the largest price differences (price spreads) within the Day-Ahead market, subject to limitations like battery cycle constraints and storage capacity.

2. **Graph on the right (Balancing Re-dispatch)**:

- After the Day-Ahead market, the BESS enters the **Balancing Mechanism** to further optimize its position.
- The **Balancing Mechanism** provides an opportunity to adjust previously scheduled cycles based on real-time price movements, potentially maximizing revenues beyond what was predicted in the Day-Ahead market.
- **Re-scheduling (first red arrow and last green arrow)**: The BESS can adapt its operations to capture additional price spreads that are more profitable in real-time, adjusting its charging and discharging cycles accordingly.
- **Grey arrows**: These represent the Day-Ahead cycles that were originally scheduled. However, in the Balancing Mechanism, they may no longer be optimal. The BESS can cancel or reschedule these cycles if real-time conditions suggest flatter price movements or smaller price spreads, making the original Day-Ahead strategy less profitable.
- **Additional cycles** may be added if allowed by battery constraints, further optimizing operations based on the current price environment.

5. Datathon Objective

Students are required to produce a **half-hourly forecast** consisting of 48 values for **October 1st, 2024**, predicting key metrics related to the electricity market in the UK. These forecasts will focus on two critical targets:

Target 1: System Price (ESO, Outturn)

The **System Price** is the actual price set by the **Electricity System Operator (ESO)** to balance supply and demand on the electricity grid after real-time market adjustments. This price reflects the marginal cost of balancing actions taken by the ESO during each half-hour settlement period.

<u>Target 2: Net Imbalance Volume (NIV Outturn +ve long)</u>

This metric represents the volume of the overall system energy imbalance. It is calculated as the sum of all system and energy balancing actions for the Settlement Period, including pre-Gate Closure actions reported in BSAD, netted off to reflect the total energy imbalance of the system. A positive value indicates that the system was 'long', meaning there was more supply than demand. Conversely, a negative value indicates that the supply was short and the demand was not fully met.

6. The Datasets

You are given four datasets to work on this challenge. The information contained in each one is detailed in this section. All datasets have half-hourly data, ranging from 1/1/2018 up until the end of 30/09/2024.

1. **Price_data:** Contains electricity pricing information relevant to market dynamics. It includes 'Day Ahead Price', which indicates the price agreed for electricity to be delivered the next day, and 'Intraday Price', reflecting real-time trading values on different exchanges such as EPEX and APX. The data has half-hourly granularity with 48 records per day.

GMT Time	Day Ahead Price (EPEX half-hourly, local) - GB (LC/MWh)	Intraday Price (EPEX Outturn, APX, MID) - GB (£/MWh)
2018-01-01T00:00:00	46.73	47.27
2018-01-01T00:30:00	50.11	48.57
2018-01-01T01:00:00	56.6	52.32
2018-01-01T01:30:00	51.83	51.18

- **Day Ahead Price**: The price at which electricity is agreed to be bought or sold for delivery on the next day, determined in the day-ahead energy market.
- **Intraday Price (EPEX Outturn, APX, MID)**: Prices in the intraday electricity market as observed on different exchanges (EPEX, APX), indicating real-time trading values.

Variable name source	Unit	granularity	records per day
Day Ahead Price	GBP/MWh	half hourly	48 records per day
Intraday Price (EPEX Outturn, APX, MID)	GBP/MWh	half hourly	48 records per day

2. **Generation_data:** Provides detailed insights into actual aggregated power generation by type (e.g., Biomass, Fossil Gas, Wind, Solar). Each entry records the net generation output from various energy sources across Great Britain, measured in megawatts (MW) with half-hourly updates, totaling 48 records per day.

GMT Time	Actual Aggregated Generation By Type - Biomass - GB (MW)	Actual Aggregated Generation By Type - Fossil Gas - GB (MW)	Actual Aggregated Generation By Type - Fossil Hard Coal - GB (MW)	Actual Aggregated Generation By Type - Fossil Oil - GB (MW)	Actual Aggregated Generation By Type - Hydro Pumped Storage - GB (MW)	Actual Aggregated Generation By Type - Hydro Run-of-River and Poundage - GB (MW)	Actual Aggregated Generation By Type - Nuclear - GB (MW)	Actual Aggregated Generation By Type - Solar - GB (MW)	Actual Aggregated Generation By Type - Wind Onshore - GB (MW)	Actual Aggregated Generation By Type - Wind Offshore - GB (MW)
2018-01-01T00:00:00	710	5190	1143	0	0	352	7263	0	4950.3	3777.01
2018-01-01T00:30:00	749	5574	1308	0	0	351	7268	0	5004.55	3824.89
2018-01-01T01:00:00	756	5753	1461	0	206	355	7260	0	4878.41	3831.16
2018-01-01T01:30:00	757	5616	1587	0	0	349	7258	0	4969.68	3811.42

Actual Aggregated Generation By Type: The actual aggregated net generation output per production type (Solar, Wind, Coal, etc)

Variable name source	Unit	granularity	records per day
Actual Aggregated Generation By Type - Biomass - GB (MW)	MW	half hourly	48 records per day
Actual Aggregated Generation By Type - Fossil Gas - GB (MW)	MW	half hourly	48 records per day
Actual Aggregated Generation By Type - Fossil Hard Coal - GB (MW)	MW	half hourly	48 records per day
Actual Aggregated Generation By Type - Fossil Oil - GB (MW)	MW	half hourly	48 records per day
Actual Aggregated Generation By Type - Hydro Pumped Storage - GB (MW)	MW	half hourly	48 records per day
Actual Aggregated Generation By Type - Hydro Run-of-River and Poundage - GB (MW)	MW	half hourly	48 records per day
Actual Aggregated Generation By Type - Nuclear - GB (MW)	MW	half hourly	48 records per day
GB Actual Aggregated Generation By Type (Solar)	MW	half hourly	48 records per day
GB Actual Aggregated Generation By Type (Wind Onshore)	MW	half hourly	48 records per day
GB Actual Aggregated Generation By Type (Wind Offshore)	MW	half hourly	48 records per day

3. **Demand_load_data**: Captures metrics related to electricity demand and load probabilities. This includes 'Loss of Load Probability', which contains the likelihood of demand exceeding supply, and 'Actual Total Load', representing the total power generated minus exports and adjustments for storage. Data granularity is half-hourly, providing 48 entries per day.

GMT Time	Loss of Load Probability - Latest - GB ()	Actual Total Load - GB (MW)	Demand Outturn (ITSDO) - GB (MW)
2018-01-01T00:00:00	0	30303	26413
2018-01-01T00:30:00	0	31096	27130
2018-01-01T01:00:00	0	30599	27378
2018-01-01T01:30:00	0	29402	26746

- **Loss of Load Probability**: The likelihood that demand will exceed available supply, indicating potential risks of blackouts. Many of them have a value of zero.
- **Actual Total Load**: Actual total load is the sum of power generated by plants on both TSO/DSO networks, minus the balance (export-import) of exchanges on interconnections between neighbouring bidding zones and the power absorbed by energy storage resources.
- **Demand Outturn(ITSDO):** The half-hour average GB demand produced by NETSO. This takes into account Transmission Losses, Station Transformer Load, Pumped Storage Demand and Interconnector Demand.

Variable name source	Unit	granularity	records per day
Loss of Load Probability	%	half hourly	48 records per day
Actual Total Load	MW	half hourly	48 records per day
Demand Outturn (ITSDO)	MW	half hourly	48 records per day

4. **Balancing_data:** Focuses on the balancing mechanisms and adjustments used to maintain supply-demand equilibrium in the electricity grid. It includes variables like 'System Price', reflecting the cost of balancing actions, and 'NIV Outturn (+ve Long)', which indicates the net energy imbalance. Metrics related to bids and offers during balancing mechanisms are also tracked half-hourly, with 48 records each day.

GMT Time	System Price (ESO Outturn) - GB (£/MWh)	NIV Outturn (+ve long) - GB (MW)	BM Bid Acceptances (total) - GB (MW)	BM Offer Acceptances (total) - GB (MW)	Total BSAD Volume - Turn Up - GB (MW)	Total BSAD Volume - Turn Down - GB (MW)	Total BSAD Volume - Total - GB (MW)	Intraday Volume (EPEX Outturn, APX, MID) - GB (MWh)
2018-01-01T00:00:00	55.94	-77.05	-1833.86	1910.98	1104	-900	204	781.35
2018-01-01T00:30:00	55.94	-334.76	-1443.78	1778.09	1104	-900	204	655.4
2018-01-01T01:00:00	62.94	-219.78	-1580.12	1799.9	1104	-900	204	821.5
2018-01-01T01:30:00	31	286.63	-1699.05	1413.04	1104	-900	204	815.2

- **System Price (ESO Outturn):** The **System Price** is the actual price set by the **Electricity System Operator (ESO)** to balance supply and demand on the electricity grid after real-time market adjustments. This price reflects the marginal cost of balancing actions taken by the ESO during each half-hour settlement period

- **NIV Outturn (+ve Long):** This metric represents the volume of the overall system energy imbalance. It is calculated as the sum of all system and energy balancing actions for the Settlement Period, including pre-Gate Closure actions reported in BSAD, netted off to reflect the total energy imbalance of the system. A positive value indicates that the system was 'long', meaning there was more supply than demand. Conversely, a negative value indicates that the supply was short and the demand was not fully met.

- **BM Bid Acceptances Total:** The total volume of bids (MW) that were accepted during the balancing mechanism for a settlement period.
- **BM Offers Acceptances Total:** The total volume of offers (MW) that were accepted during the balancing mechanism for a settlement period.
- **Total BSAD volume (Turn Up)**: The total Balancing Services Adjustment Data volume used to increase generation or reduce demand.
- **Total BSAD volume (Turn Down)**: The total BSAD volume used to decrease generation or increase demand.
- **Total BSAD Volume Total:** This is the total volume of electricity (in megawatt-hours, MWh) that is impacted by balancing actions such as the procurement of reserve power, contracting for generation adjustments, or demand-side management
- **Intraday Volume (EPEX Outturn, APX, MID)**: The volume of electricity traded in the intraday market on different platforms.

Variable name source	Unit	granularity	records per day
System Price (ESO, Outturn)	GBP/MWh	half hourly	48 records per day
NIV Outturn (+ve long)	MWh	half hourly	48 records per day
BM Bid Acceptances (total)	MWh	half hourly	48 records per day
BM Offer Acceptances (total)	MWh	half hourly	48 records per day
Total BSAD volume (Turn Up)	MWh	half hourly	48 records per day
Total BSAD volume (Turn Down)	MWh	half hourly	48 records per day
Intraday Volume (EPEX Outturn, APX, MID)	MWh	half hourly	48 records per day
Total BSAD volume (Total)	MW	Half hourly	48 records per day

C. THE SUBMISIONS: Technical content to be delivered.

1. General Information.

In this section, the contents of the technical deliverables that students must complete to participate in this challenge are described. **Any violation of the delivery criteria will result in the disqualification of the team.**

1. **The code** developed to address the problem (ideally with comments, or in Jupyter Notebooks or Google Colab, alternating between code and text explanations). The outputs of the execution must be visible.

2. The **output file containing the predictions for the two target metrics** (via Google Forms). Note that if you make more than one submission, only the last one will be considered for evaluation
3. The **performance metrics** of the two models (via Google Forms). Note that if you make more than one submission, only the last one will be considered for evaluation

Please note: Access to the Google Form is restricted to users with an IE email account.

2. Output file with your predictions

The output file must contain predictions for **two target variables**: 'System Price (ESO, Outturn)' and 'Net Imbalance Volume (NIV Outturn +ve long),' specifically for October 1, 2024. The predictions are to be provided with half-hour granularity, resulting in a total of 48 records per day. Additionally, each record must include a **'GTM time' variable**, which indicates the time in GMT for each 30-minute interval, ensuring precise time alignment for each prediction.

The output dataset, which should contain your forecast, must be structured as described above and saved in CSV format.

COLUM NAME	DESCRIPTION
GTM_TIME	This is a date-time variable. It represents the exact moments in GMT time zone when the data were recorded. This format allows for precise chronological organization of the data.
SYSTEM_PRICE	This is a continuous numerical variable. It represents the system price in British pounds per megawatt-hour in Great Britain. This type of data is crucial for economic and market analysis in the energy sector.
NIV_OUTTURN	This is a continuous numerical variable. It represents the Net Imbalance Volume, measured in megawatts in Great Britain. This data is important for understanding the dynamics of supply and demand in the energy system, as well as the balancing needs of the electrical grid.

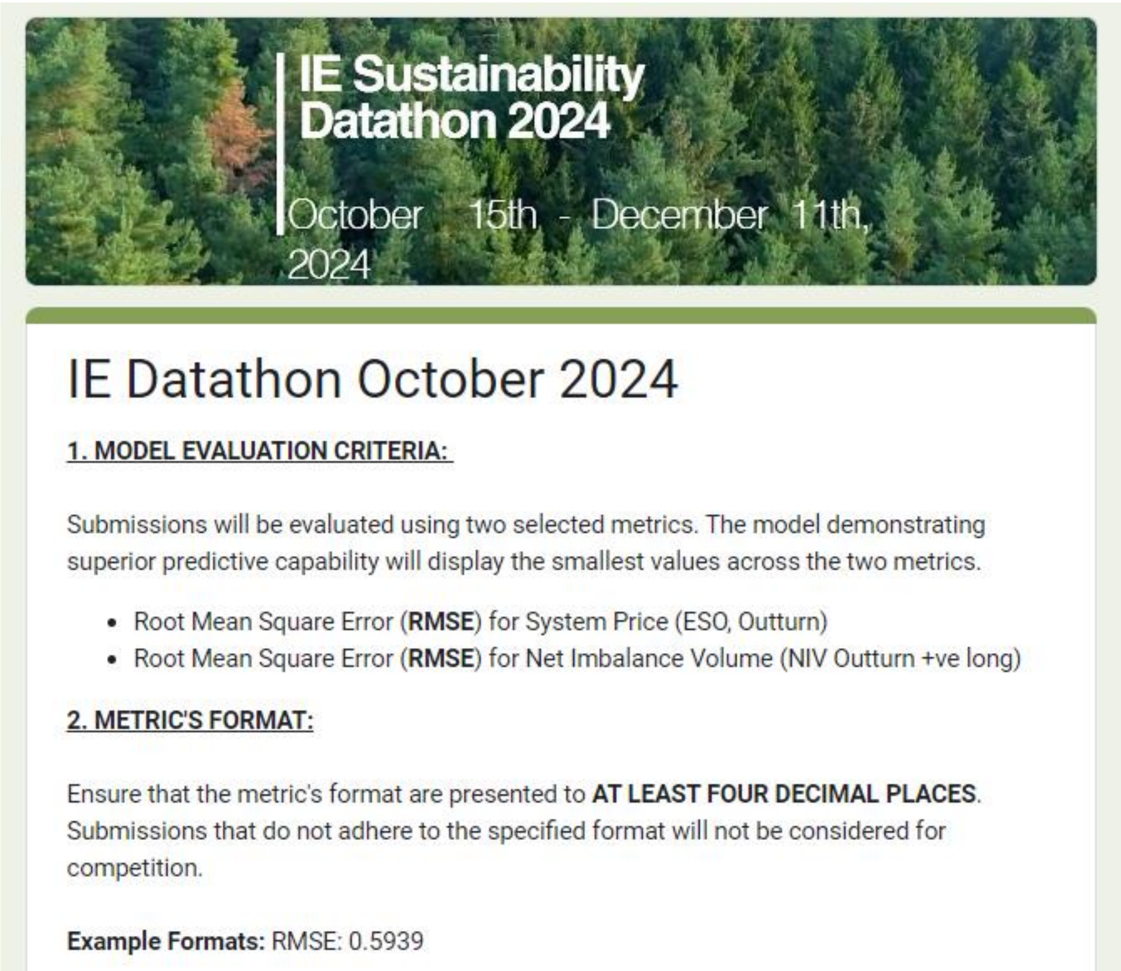
3. The model performance metrics.

You are required to provide the following performance metrics for the two target variables, each with **at least four decimal places**, for the predictions of October 1, 2024, with half-hour granularity:

1. Root Mean Square Error (RMSE) for System Price (ESO, Outturn)
2. Root Mean Square Error (RMSE) for Net Imbalance Volume (NIV Outturn +ve long)

The **superior predictive model** will be determined by the smallest RMSE values for each target variable. **Please note that this is just one of the aspects considered in the technical evaluation of the projects.**

You must submit these **two performance metrics** along with the **output file** containing your predictions via [Google Forms](), following the provided instructions. **Please note: Access is restricted to those using their IE email account.**



IE Sustainability Datathon 2024

October 15th - December 11th, 2024

IE Datathon October 2024

1. MODEL EVALUATION CRITERIA:

Submissions will be evaluated using two selected metrics. The model demonstrating superior predictive capability will display the smallest values across the two metrics.

- Root Mean Square Error (**RMSE**) for System Price (ESO, Outturn)
- Root Mean Square Error (**RMSE**) for Net Imbalance Volume (NIV Outturn +ve long)

2. METRIC'S FORMAT:

Ensure that the metric's format are presented to **AT LEAST FOUR DECIMAL PLACES**. Submissions that do not adhere to the specified format will not be considered for competition.

Example Formats: RMSE: 0.5939

4. How to check RMSE metrics and compare your performance metrics with other teams

By accessing the same **Google Forms** where submissions are made, you gain two additional features to help track your progress in the challenge:

- You can see how well you are doing in comparison to other teams by accessing the **"Link to Rankings"**. In this file, you can review the RMSE metrics for all submissions made by all teams.

- Additionally, you can check your RMSE metrics by accessing the **"Link to RMSE Calculator"**. In this Sheets file, you can input two columns with your predicted target metrics and calculate the RMSE for October 1, 2024.

Please note: Access is restricted to those using their IE email account.

IE Datathon October 2024

1. MODEL EVALUATION CRITERIA:

Submissions will be evaluated using two selected metrics. The model demonstrating superior predictive capability will display the smallest values across the two metrics.

- Root Mean Square Error (**RMSE**) for System Price (ESO, Outturn)
- Root Mean Square Error (**RMSE**) for Net Imbalance Volume (NIV Outturn +ve long)

2. METRIC'S FORMAT:

Ensure that the metric's format are presented to **AT LEAST FOUR DECIMAL PLACES**. Submissions that do not adhere to the specified format will not be considered for competition.

Example Formats: RMSE: 0.5939

3. OUTPUT FILE FORMAT (CSV):

The output file must contain predictions for two target variables: 'System Price (ESO, Outturn)' and 'Net Imbalance Volume (NIV Outturn +ve long),' specifically for October 1, 2024.

The predictions are to be provided with half-hour granularity, resulting in a total of 48 records per day. Additionally, each record must include a 'GTM time' variable, which indicates the time in GMT for each 30-minute interval, ensuring precise time alignment for each prediction.

- **GTM_Time:** This is a date-time variable.
- **System_Price:** This is a continuous numerical variable
- **NIV_outturn:** This is a continuous numerical variable.

The output dataset, which should contain your forecast, must be structured as described above and saved in CSV format.

4. CHECK YOUR RESULTS:

- LINK TO RMSE CALCULATOR
- LINK TO RANKINGS

D. EVALUATION CRITERIA

1. Introduction

Having described all the details of the challenges, including the dataset descriptions and technical delivery requirements in previous sections, we now proceed to explain the evaluation criteria in this section.

2. Evaluation Criteria

The evaluation criteria for this competition encompass both technical (70% of the final grades) and business aspects (30% of the final grades).

- **Technical criteria** (**70% weight on the final grades**) are meant to assess the general ability of the teams to handle, interpret, and understand the data, build predictive models for the given problem and evaluate their performance according to an objective metric.

- **Business criteria (30% weight of the final grades**) are more general in scope, and they involve the ability to devise what value can be extracted from this data, formulate relevant business questions and try to find answers to them in the data. The quality of the presentation and the ability to communicate clear and powerful ideas on the final pitch will also be part of the business criteria. ***Please be aware that the announcement of finalists will not occur until shortly before the closing ceremony, <u>thus everyone should be prepared to present</u>.***

Teams are required to submit both technical and business materials:

1. **Technical materials**: As described in the previous sections, the technical materials consist of:
    - **The code** developed to address the problem (ideally with comments, or in Jupyter Notebooks or Google Colab, alternating between code and text explanations). The outputs of the execution must be visible.
    - The **output file containing the predictions for the two target metrics** (via Google Forms). Note that if you make more than one submission, only the last one will be considered for evaluation
    - The **performance metrics** of the two models (via Google Forms). Note that if you make more than one submission, only the last one will be considered for evaluation

2. **Business materials**:
    - An executive summary (3-5 pages) with their inspection strategy and value propositions.
    - Final Presentation in case your team is chosen as one of the 5 finalist. The presentation should last a maximum of 5 minutes.

The **<u>technical criteria</u>** will be assessed on the basis of the **first submission**, and the performance metrics obtained by the best model **submitted by** [Google Forms](). **<u>Business criteria</u>** will be assessed mostly from the executive summary.

3. Technical criteria (70% weight on the final grades)

The models submitted will be evaluated based **not only on the performance metrics but also taking into account additional considerations** described in this section:

A. **Overall understanding of the problem**
B. **Exploratory data analysis**
C. **Feature engineering**
D. **Predictive models performance**

In addition to this, the code should be clearly structured and results should be interlaced with explanations in jupyter notebooks, Google Colab, etc. The notebooks should be clearly written, and explain the process followed starting from the raw dataset, cleaning and preprocessing, exploratory data analysis, model formulation, hyperparameter tuning (if needed), final metrics and discussion. **The results of the execution must be visible to verify their correctness and quality.**

A. Overall understanding

Ensure that you understand the meaning of each predictor variable in the different datasets: what it means, in which units is it expressed, how is this data registered, at which moment in the time or day, could it contain errors? could it contain outliers ? can we trust the data ? Using common sense, will a given predictor variable be useful to predict our target?

B. **Exploratory Data Analysis**

Getting acquainted with the datasets is a first necessary step before any modelling on the data takes place. Explore the data distribution, which variables are categorical and which are numerical, do we really understand the meaning of each variable? Are there any correlations among the variables? Are there predictor variables with missing values or outliers? Can we trust the values of the data? Try to formulate hypotheses and understand your datasets before further exploration is conducted. Create good visualizations that help develop your intuition and understand the patterns. If necessary, decide how to handle missing values by either data imputation or removing rows/columns from the dataset. Experiment with various levels of data aggregation to ensure the robustness of your predictions.

C. Feature engineering

Which features will you use in your predictive model? Is it legitimate to use all the provided data? Can you imagine how the model will be used in production? Can you enrich your dataset with external information? At a minimum, you will need to combine multiple datasets and/or create new features to train models. Additionally, you should experiment with various aggregation and drill-down techniques to analyze the data effectively. Be creative: anything that you can build on the given data that might have a more direct connection to what you are trying to predict will improve your models performance.

D. Model performance

The models submitted will be evaluated based on the performance metrics for the two target variables, each with **at least four decimal places**, for the predictions dated October 1, 2024, with half-hour granularity.

1. Root Mean Square Error (RMSE) for System Price (ESO, Outturn)
2. Root Mean Square Error (RMSE) for Net Imbalance Volume (NIV Outturn +ve long)

The **superior predictive model** will be determined by the smallest RMSE values for each target variable.

Performance metrics and the output file containing predictions should be submitted via **Google Forms**. The technical content to be delivered has been explained in detail in **Section "C. The Submisions; Technical content to be delivered"**

Feel free to try different families of models, adjust their parameters, add regularization, go back to your preprocessing cycle and continue iterating, etc.

Remember that in this edition you can check how well are you doing in comparison with other teams by accessing the "**Link to Rankings**" and also check your RMSE metrics by accessing the "**Link to RMSE Calculator**" available in **Google Forms.**

4. Business criteria (30% weight on the final grades)

In this section, students are expected to demonstrate how they can extract significant value from data by applying model insights to strategic business decisions.

Business Impact and Strategy Development: Students should articulate a detailed business plan that clearly shows the potential economic impact of their proposed solutions. This plan could include, but not be limited, to precise estimations of revenue growth, cost savings, and environmental benefits. We encourage the use of external sources and theoretical models to support these estimations. Your submission should detail how the implementation of your strategies could enhance the company's financial health and promote environmental sustainability. This analysis is essential for demonstrating the real-world applicability and potential effectiveness of your proposed models.

Evaluation Focus The evaluation of your business proposal will focus on:

- **Coherence**: How well your business strategy aligns with the technical solutions provided.
- **Realism**: The feasibility of the proposed business impacts and strategies under real-world conditions.
- **Precision**: The accuracy of your impact calculations and the reliability of your data sources. Students are encouraged to use hypotheses grounded in literature and research.
- **Presentation Clarity**: The ability to communicate your ideas clearly and persuasively during the presentation.

This competition seeks solutions that are not only technically sound but also economically viable and environmentally sustainable. The broader implications of your model, including its impact on revenue, cost-efficiency, and sustainability, will be critical components of your evaluation.

Collaboration and Presentation: Participating teams are evaluated on a blend of technical (70%) and business (30%) criteria. **A model with suboptimal performance can still advance to the final round if accompanied by an exceptional business strategy.** Allocate time effectively between technical development and business strategy formulation. Collaborate and leverage the diverse expertise within your team to enhance both the technical and business aspects of your submission.

Final Pitch: Teams that advance to the final phase will present their strategies and results to a jury. While technical evaluations are based on submitted materials, the pitch provides an opportunity to articulate the practical applications of your model. Emphasize how your solution addresses the challenge, the potential business impact, and your strategic vision for real-world application. Avoid dwelling on basic technical explanations unless they are crucial to understanding your solution's value. Be prepared to present dynamically and persuasively, as finalists will only be announced shortly before the closing ceremony.

Please be aware that the announcement of finalists will not occur until shortly before the closing ceremony, thus everyone should be prepared to present.