

# Global Pollution Analysis and Energy Recovery

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## Objective

The goal is to analyze global pollution data and develop strategies for pollution reduction and converting pollutants into energy. The dataset will be used for both **data preprocessing** and **building regression models** to predict energy recovery from pollution levels.

## Phase 1: Data Collection and Exploratory Data Analysis (EDA)

### Step 1 - Data Import and Preprocessing

- Datasets**  
Load the dataset ([Global\\_Pollution\\_Analysis.csv](#)).
- Handle Missing Values**  
Identify missing or inconsistent data, and handle them using appropriate imputation strategies.
- Data Transformation**
  - Normalize or scale pollution indices (air, water, and soil).
  - Encode categorical features such as [Country](#) and [Year](#) using label encoding or one-hot encoding.

### Step 2 - Exploratory Data Analysis (EDA)

- Descriptive Statistics**  
Calculate descriptive statistics for numerical features like [CO2\\_Emissions](#) and [Industrial\\_Waste\\_in\\_tons](#).
- Correlation Analysis**  
Visualize the correlation between pollution levels and other features like energy consumption using a heatmap.
- Visualizations**  
Create bar charts, line plots, and box plots to explore trends in pollution over time and across countries.

### Step 3 - Feature Engineering

- Yearly Trends**  
Extract year-based trends to understand how pollution and energy recovery have evolved over time.
- Energy Consumption per Capita**  
Calculate energy consumption per capita for better analysis.

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## Phase 2: Predictive Modeling

### Step 4 - Linear Regression Model (for Pollution Prediction)

- Model Objective**  
Predict energy recovery (in GWh) based on pollution levels, industrial waste, and other features.
- Model Building**  
Train a **Linear Regression** model to predict energy recovery using features like [Air\\_Pollution\\_Index](#), [CO2\\_Emissions](#), and [Industrial\\_Waste\\_in\\_tons](#).
- Evaluation Metrics**  
Use **R<sup>2</sup>**, **Mean Squared Error (MSE)**, and **Mean Absolute Error (MAE)** to evaluate model performance.

## Step 5 - Logistic Regression Model (for Categorization of Pollution Levels)

- Model Objective**  
Classify countries into pollution severity categories (Low, Medium, High).
  - Model Implementation**  
Use **Logistic Regression** to classify pollution severity based on features like **Air\_Pollution\_Index** and **CO2\_Emissions**.
  - Evaluation Metrics**  
Evaluate using metrics like **Accuracy**, **Precision**, **Recall**, **F1-score**, and plot the **Confusion Matrix**.
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## Phase 3: Reporting and Insights

### Step 6 - Model Evaluation and Comparison

- Compare **Linear Regression** and **Logistic Regression** models based on their performance and metrics.
- Visualize results using **confusion matrices** and **classification reports**.

### Step 7 - Actionable Insights

- Provide insights on how different pollution levels affect energy recovery and suggest countries that could benefit from improvement.
  - Offer recommendations for **reducing pollution** and **improving energy recovery**.
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## Final Deliverables

- Jupyter Notebook (.ipynb)** containing the entire code and analysis.
  - Data Visualizations** in image format or embedded in the notebook.
  - Final Report** summarizing key findings, model evaluations, and actionable recommendations.
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