1. Project Overview

Title: Analyzing Renewable Energy Trends in Europe Using Python

Objective:

To analyze renewable energy production and consumption trends across European regions (NUTS 1 and NUTS 2) using real-world datasets. The project explores how renewable energy sources (solar, wind, hydro, and biomass) have evolved over time and differ across regions, using Python for data analysis and visualization.

Tools and Technologies:

Python for data analysis and visualization, Flask for web app development, and libraries such as Pandas, NumPy, Matplotlib, Plotly, and Seaborn.

2. Key Learning Outcomes

• Python Programming Proficiency: Learn to write structured Python programs using functions, classes, and libraries for data analysis.

• Data Collection and Integration: Gain experience in accessing, importing, and combining datasets using APIs or CSV/Excel files.

• Data Cleaning and Preprocessing: Develop skills to handle missing data, transform variables, and prepare datasets for analysis.

• Exploratory Data Analysis (EDA): Apply Python to summarize, group, and visualize renewable energy data across regions and years.

• Data Visualization and Storytelling: Use libraries like Matplotlib, Plotly, and Seaborn to create clear, interactive, and meaningful visual representations of data.

• Web App Development: Build a simple Flask-based web application that allows users to interact with the data through filters and charts.

3. Project Steps

The project steps should follow an adapted version of the CRISP-DM/POST-DS methodology. A suggested structure is provided below.

Step 1: Understanding the Problem and the Data

Access renewable energy datasets (through APIs or downloads) from sources such as:

• https://ec.europa.eu/eurostat/databrowser/view/nrg_ind_ren/default/table?lang=en (Share of renewable energy)

• https://ec.europa.eu/eurostat/databrowser/view/nrg_bal_s/default/table?lang=en (Energy balance data)

Explore the data structure, identify key variables (e.g., region, year, energy type), and check for missing or inconsistent values.

Step 2: Data Preparation

Clean and organize the data for analysis:

• Handle missing values and normalize time-series data.

• Merge datasets when necessary (e.g., combining production and consumption data).

• Label geographic regions correctly using NUTS codes.

• Create summary tables by region, energy source, or year.

Step 3: Data Analysis

Perform exploratory analysis using Pandas and NumPy:

• Identify overall trends in renewable energy growth over time.

• Compare different energy sources (solar, wind, hydro, biomass).

• Evaluate which regions are leading or lagging in renewable adoption.

• Correlate energy trends with simple indicators such as GDP or population (optional).

Step 4: Data Visualization

Create visualizations to make findings clear and engaging:

• Line charts: Show changes in renewable energy share over time.

• Bar charts: Compare renewable energy sources across regions.

• Heatmaps: Visualize regional energy intensity.

• Interactive maps (Plotly): Display renewable energy adoption by region.

• Animations (optional): Show how energy trends evolve year by year.

Step 5: Building a Flask Web App

Develop a basic web application that allows users to:

• Select a region or energy type;

• View related charts and key statistics;

• Explore trends interactively through embedded visualizations.

Include a simple dashboard that highlights the main insights from the analysis.

Step 6: Deployment

Deploy the Flask app using Heroku or PythonAnywhere to make it accessible online.

4. Extensions and Optional Features

• Add filters for users to compare countries or energy types.

• Include short explanatory texts or tooltips in the visualizations.

• (Optional) Implement simple forecasting models to estimate future renewable energy shares.

• Add a download option for filtered data or charts.

5. The final report structure and Format

Authors and Affiliation (ISEG or other)

Abstract

An abstract is a summary of the project.

1. Introduction

Provide an overview of the project objectives, motivation, and relevance of studying renewable energy trends in Europe. Briefly explain how Python and data science can contribute to analyzing sustainability challenges.

2. Theoretical Framework

Summarize the concepts of renewable energy, data-driven decision-making, and the importance of data science in sustainability studies. Present the **CRISP-DM/POST-DS methodology** as the conceptual foundation guiding the project, [1]

3. Methodological Approach

Explain how the CRISP-DM/POST-DS phases were applied.

4. Results (Description of Steps and Their Outcomes)

Describe and illustrate the main analytical steps and their outputs:

- Data cleaning and preparation results (tables or summaries).

- Visualization of trends and comparisons (time-series, bar charts, maps).

- Flask app screenshots and an interactive description. Discuss patterns observed, correlations, and any regional differences.

5. Conclusions

Summarize the main insights gained, reflecting on regional disparities, growth trends, and lessons learned from the data analysis. Suggest possible extensions (e.g., predictive modeling or policy analysis).

References

Include all references to datasets, documentation, and the main paper:

[1] C. J. Costa and J. T. Aparicio, *"POST-DS: A Methodology to Boost Data Science,"* 2020 15th Iberian Conference on Information Systems and Technologies (CISTI), Seville, Spain, 2020, pp. 1–6, IEEE doi: 10.23919/CISTI49556.2020.9140932.

[2] … Eurostat energy datasets and any other data or academic sources used.

6. Submission

Create a folder named ProjectXX (where XX is your group number) and upload:

• All Python and/or Jupyter Notebook files;

• A short report (PDF <u>and</u> DOC/DOCX);

• The link to your deployed Flask app.

7. Evaluation Criteria

• Code Quality: Clear structure, comments, and efficient use of libraries.

• Data Visualization: Clarity, design, and interactivity of plots.

• Web App Functionality: Simplicity, usability, and smooth interaction.

• Analysis Quality: Depth of insights and logical interpretation of data.

• Report and Presentation: Organization, clarity, and completeness. References are mandatory, including the reference presented on methodology.

• All the students must be in class and present their project.

• Students must attend the presentations of their colleagues not only for a question of respect but also to evaluate them..

8. Why This Topic Appeals to Students

• Practical and Relevant: Renewable energy is one of Europe's top priorities, offering a rich and timely dataset for analysis.

• Data-Driven: Students apply Python skills to analyze real data and generate actionable insights.

• Hands-On: The project combines coding, analysis, and web development in one coherent, applied exercise.

• Flexible: Each group can explore different energy types, time periods, or regions according to their interests.