Analyzing the Trends in Greenhouse Gas Emissions with Energy Consumption by Sector

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1 Introduction

Climate change has become a critical global issue, necessitating a deeper understanding of its contributing factors. The relationship between greenhouse gas emissions and energy consumption across various sectors is particularly important. This report seeks to analyze this relationship to identify trends, correlations, and insights. Our goal is to support policy decisions and climate action plans by providing a comprehensive analysis of the data.

2 Data Used

The data for this project was sourced from the Eurostat database, a comprehensive repository of statistical information provided by the European Union.

2.1 Data Sources

The primary datasets used in this analysis are:

1. **Greenhouse Gas Emissions**: Detailed information on net greenhouse gas emissions across various countries, spanning the years 2011 to 2022.

2. **Total Energy Consumption by Sectors**: Data on total energy consumption by sectors such as industrial, commercial, household, and transport, covering the years 2011 to 2022.

2.2 Data Licenses and Compliance

Both datasets are publicly available from the Eurostat API in TSV format and were chosen due to their relevance to the project question. The data structure of both datasets is tabular, with rows representing observations for different time periods and columns representing variables such as country, year, and emission values. The quality of the data is generally reliable, although missing values were present, which were handled during the data cleaning process. The datasets are licensed under the European Union Public License (EUPL), which allows for the reuse of the data under certain conditions. We are allowed to use the data for analysis and reporting purposes, provided we attribute Eurostat as the data source. We plan to fulfill our obligations by including appropriate citations and acknowledgments in our final report.

3 Analysis

The project starts with setting up directories and paths, followed by downloading and loading data into DataFrames. After data cleaning, the cleaned data is saved to and loaded from an SQLite database. The process continues with data preparation, descriptive statistics, and concludes with a correlation analysis to explore relationships between greenhouse gas emissions and energy consumption across sectors.

4 Data Insights

4.1 Line Graph Analysis

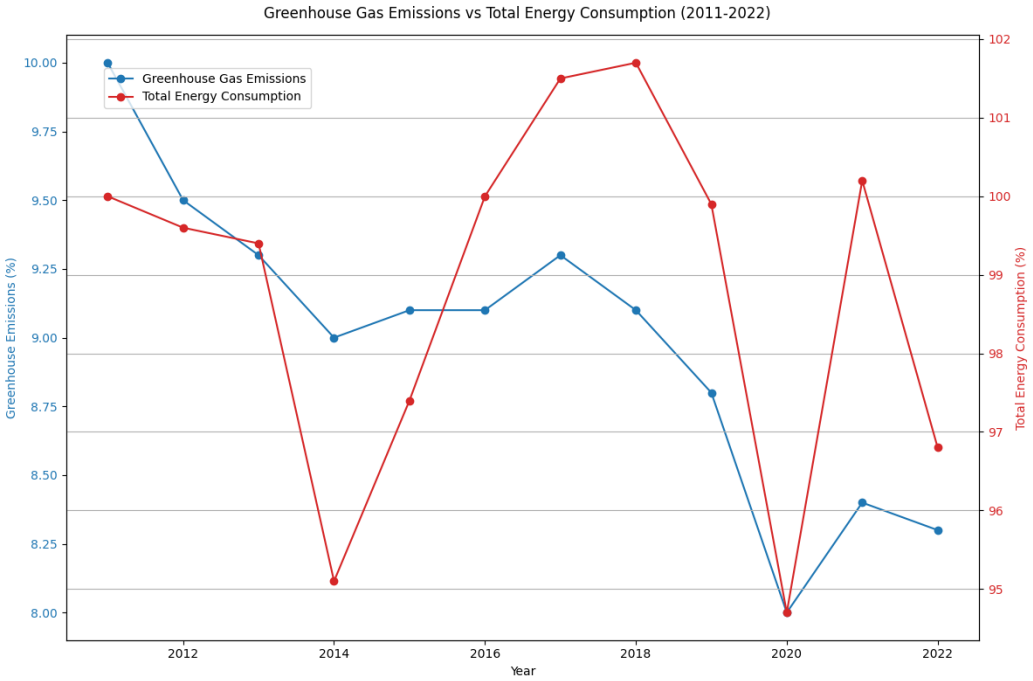

Figure 1: Line graph illustrating trends in greenhouse gas emissions and total energy consumption from 2011 to 2022.

The line graph (Figure 1) shows trends in greenhouse gas emissions and total energy consumption over the period from 2011 to 2022. Key observations include:

- **Greenhouse Gas Emissions**:
  - General downward trend with fluctuations.
  - Notable decreases in 2013-2014 and a significant drop in 2019-2020.
- **Total Energy Consumption**:
  - Fluctuating trends with peaks and troughs but no clear overall trend.

4.2 Trends in Renewable Energy Share

Analysis of renewable energy share reveals:

- **Steady Increase**:
  - Average renewable energy share increased from approximately 22% in 2013 to around 28% in 2021.
- **Growth Post-2018**:
  - Acceleration in growth rate of renewable energy share after 2018.

4.3 Trends in Greenhouse Gas Emissions

Analysis of greenhouse gas emissions indicates:

- **Overall Decrease**:
  - Average greenhouse gas emissions index decreased from around 80% in 2013 to approximately 77% in 2021.
- **Volatility**:
  - **Increase till 2018**: Sharp increase in greenhouse gas emissions from 2016 to 2018.
  - **Sharp Decrease in 2019-2020**: Significant drop in greenhouse gas emissions during 2019-2020.
  - **Rebound in 2021**: Noticeable rebound in greenhouse gas emissions in 2021.

5 Correlation Analysis

To gain deeper insights into the relationships between variables, a correlation analysis was conducted. The analysis reveals strong positive correlations between total energy consumption and specific sectors: Energy Industrial (0.85), Energy Commercial (0.89), Energy Household (0.65), and Energy Transport (0.63). This indicates that increases in total energy consumption are closely related to consumption within these sectors. Furthermore, greenhouse emissions show moderate to strong correlations with energy consumption in the industrial (0.64) and commercial (0.66) sectors, highlighting these sectors as significant contributors to emissions.

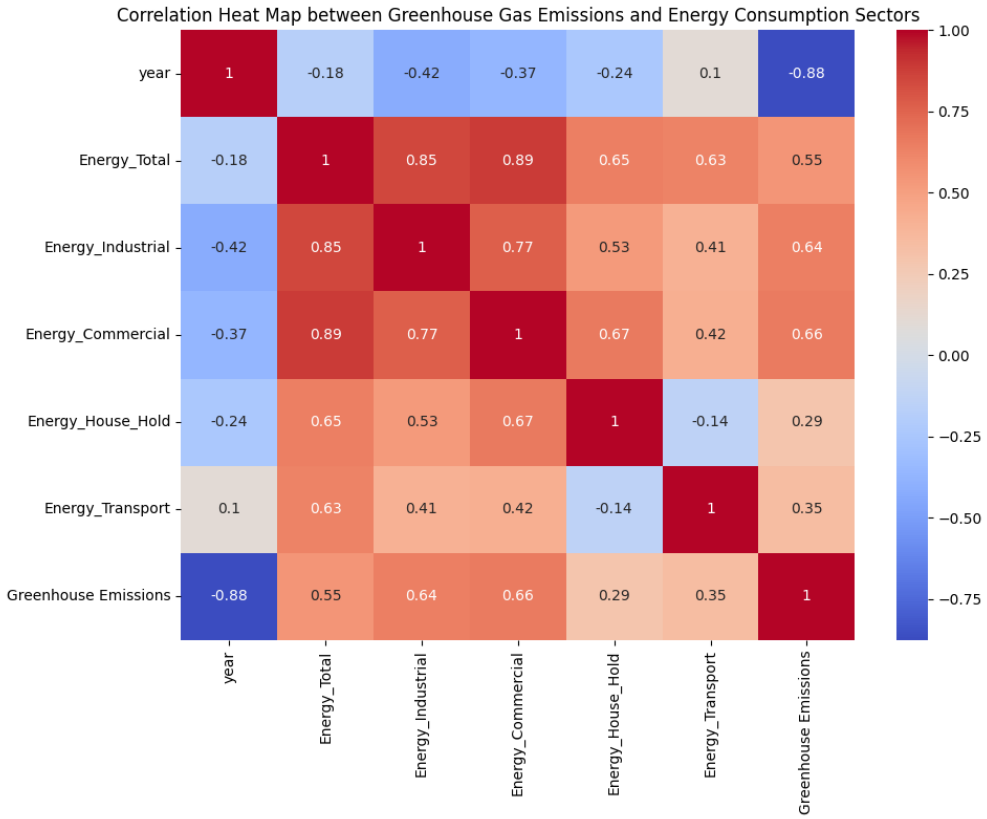

Figure 2: Correlation heatmap illustrating relationships between variables.

6 Results

- **Greenhouse Gas Emissions Trends**: There is a general downward trend in greenhouse gas emissions from 2011 to 2022, with fluctuations. Notable decreases occurred in 2013-2014 and a significant drop in 2019-2020, likely due to global events such as the COVID-19 pandemic.
- **Total Energy Consumption Trends**: The total energy consumption shows fluctuating trends with peaks and troughs but no clear overall trend from 2011 to 2022.
- **Correlation Insights**: The correlation analysis reveals that total energy consumption has strong positive correlations with specific sectors: Energy Industrial (0.85), Energy Commercial (0.89), Energy Household (0.65), and Energy Transport (0.63). This indicates that increases in total energy consumption are closely related to consumption within these sectors. Greenhouse emissions show moderate to strong correlations with energy consumption in the industrial (0.64) and commercial (0.66) sectors, highlighting these sectors as significant contributors to emissions.

7 Conclusion

- **Greenhouse Gas Emissions**: There is an overall decreasing trend in greenhouse gas emissions from 2011 to 2022, despite some fluctuations. Significant drops are linked to global events like the COVID-19 pandemic.
- **Energy Consumption**: Energy consumption trends are inconsistent, with no clear upward or downward trend over the analyzed period. The consumption varies significantly across different sectors.
- **Sector Contributions**: The industrial and commercial sectors are major contributors to greenhouse gas emissions, as evidenced by their strong correlations with total energy consumption.
- **Policy Implications**: The insights highlight the need for targeted policies that address energy consumption in specific sectors, particularly industrial and commercial, to effectively reduce greenhouse gas emissions. Further, the impact of global events on both emissions and consumption trends underscores the need for resilient and adaptable energy policies.