Adoption of renewable energy sources affecting green house gas emmissions in europe.

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1 Question to be answered ?

How has the adoption of renewable energy sources impacted greenhouse gas emissions in Europe over the last decade?

1.1 Problem Overview:

In recent times, many countries are focussing towards renewable energy sources as primary sources of energy. In this project we will try to find out whether adopting renewable energy source in mainstream energy pipeline will affect green house gas emmission across Europe, if it does affect then whether it is direct correlation or there are many other factors affecting the reduction in green house gas emmission in europe.

2 Data Sources:

- **CO2 Emissions Data:** This datasource is provided by European Environment Agency which is watchdog organization for environment related issues in Europe. This datasource contains information about CO2 emissions by countries in Europe. The datasource is available in CSV format.

- **Renewable Energy Share Data:** This datasource is provided by Eurostat which responsible for providing statistical information to the institutions of the European Union (EU). This datasource contains information about CO2 emissions by countries in Europe.This datasource contains information about share of renewable energy sources in total energy production in europe. The datasource is available in CSV format.

3 Licensing:

All the data sources used in this project are available under the Standard Open Data License (Creative Commons) CC which encourages the use of the data

for both commercial and non-commercial purposes. However, it is necessary to indicate the source of data which is used for any mentioned purpose.

4 Methodology

4.1 Data Preprocessing

- **Data Preparation:** We combined all data sources into one table using 'Country' and 'Year' as common columns. We removed duplicate entries and replaced missing values with averages. No data normalization was needed as the values were already uniform across all tables.

4.2 Exploratory Data Analysis

- **Descriptive statistics:**

	CO2 Emissions	Renewable Share
mean	6232.49	25.21
std	13703.35	16.05
min	-8.98	1.85
25%	227.07	14.62
75%	5492.40	31.73
max	81561.13	83.72

- Time series visualization of CO2 emissions and renewable share. Here is the time series visualization of both data sources ,
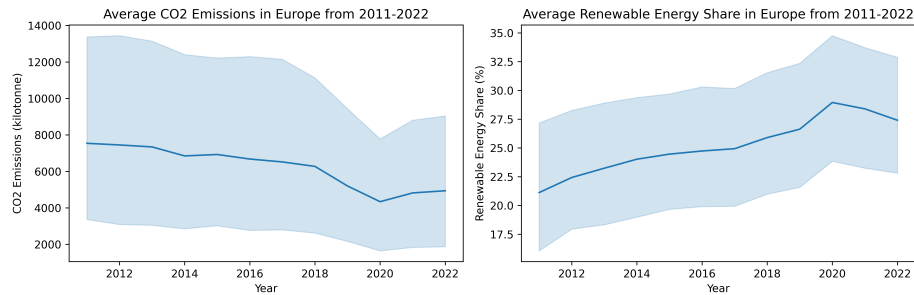

Figure 1: Average CO2 emissions and Renewable energy share

4.3 Statistical Analysis

- We performed correlation analysis and simple linear regression to establish relationship between CO2 emission and renewable energy share.

	CO2 Emissions	Renewable Energy Share
CO2 Emissions	1.0000	-0.2382
Renewable Energy Share	-0.2382	1.0000

5 Results

5.1 Overall Trend

The overall trend shows that as countries use more and more renewable energy sources, there is reduction in CO2 footprints in those countries. This results in higher renewable energy adoption tend to lower CO2 emissions. However the evidence is not strong enough to prove this hypothesis suggesting other factors involved in this.
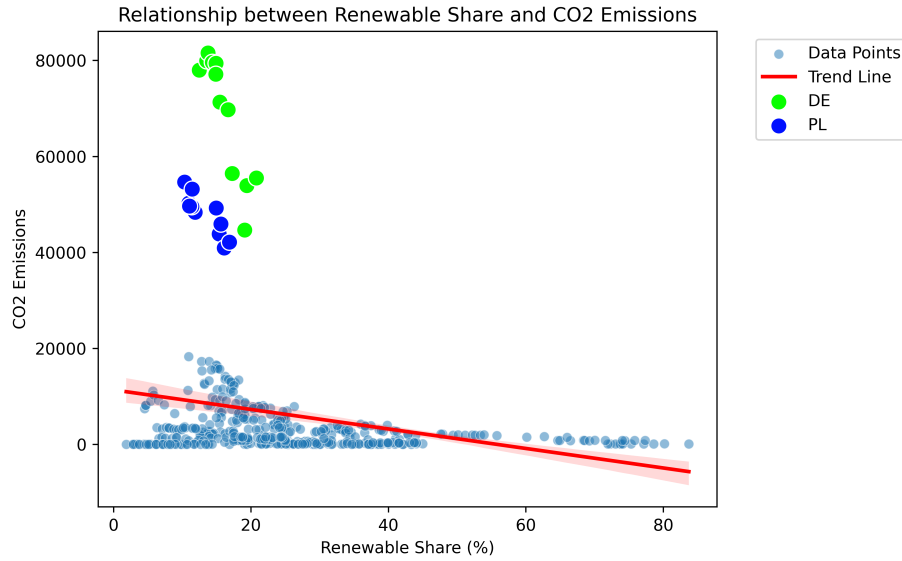

Figure 2: Correlation between CO2 emissions and Renewable energy share

5.2 Outlier Analysis

There are several outliers such as Germany and Poland with very high CO2 emissions and relatively low renewable energy share. This is due to significant reliance on coal and gas for energy production.

5.3 Time Series Analysis

- **CO2 emissions:** Most countries show a gradual decrease in emissions over the 10-year period, with the steepest declines observed after 2018,

possibly due to increased climate change mitigation efforts.

- **Renewable energy adoption:** There is a clear upward trend across most European countries, with rapid increases observed in countries like Denmark, Sweden, and Portugal.

5.4 Top Performers

- Countries with the highest increase in renewable share: Sweden (+18.37%), Denmark (+18.2%), and Finland (+15.34%)

- Countries with the largest reduction in CO2 emissions: Estonia (-115%), Portugal (-99%), and Latvia (-89%)

6 Discussion

Our analysis reveals a complex relationship between renewable energy adoption and CO2 emissions in Europe. There is a general trend of decreasing emissions with increasing renewable energy use but relationship is not very strong . This suggests that other factors, such as overall energy demand, economic structure and energy efficiency measures are crucial factors in determining emission levels.

The outliers countries identified in our analysis with high emissions despite moderate renewable adoption highlights the challenges faced by nations with historically coal-dependent energy sectors. These underscore the importance of concrete energy transition strategies that go beyond just increasing renewable capacity.

7 Conclusion

This study provide insights about how increased renewable energy adoption is generally associated with lower CO2 emission in EU countries, the relationship is influenced by many other factors which are not covered in this study. This might be due to various factors such as country specific action plans which is suited accordingly with nation's unique circumstances and resource management.

8 Future Work

Our analysis was limited by the granularity of the data, which was at the country-year level. Future studies could benefit from more detailed data, including:

- Sector-specific emissions and renewable energy use

- Information on energy efficiency measures

- Data on economic indicators to control for economic cycles