Data report: CO2 emissions

1. Introduction

Over the past decades, many countries have taken measures to reduce CO2 output, some with more success than others.

This report will answer the following questions:

1. What is the biggest predictor of a country's CO2 output per capita?
2. Which countries are making the biggest strides in decreasing CO2 output?
3. Which non-fossil fuel energy technology will have the best price in the future?

2. Analysis

2.1 What is the biggest predictor of a country's CO2 output per capita?

Data and analysis

To answer this question, we used the following data:

- co-emissions-per-capita, downloaded here.
- gdp-per-capita-worldbank, downloaded here.
- dietary-compositions-by-commodity-group, downloaded here.
- per-capita-energy-use, downloaded here.
- fossil-fuels-per-capita, downloaded here.
- per-capita-km-aviation, downloaded here.
- registered-vehicles-per-1000-people, downloaded here.

The analysis includes data from a total of 231 countries. Data from before 1990 was excluded. The analysis includes the following factors:

- Gross domestic product (GDP) per capita
- Energy use per: total energy use per capita, fossil fuel consumption per capita
- A diet high in meat, dairy and eggs
- Number of registered vehicles
- Air travel (km per capita)

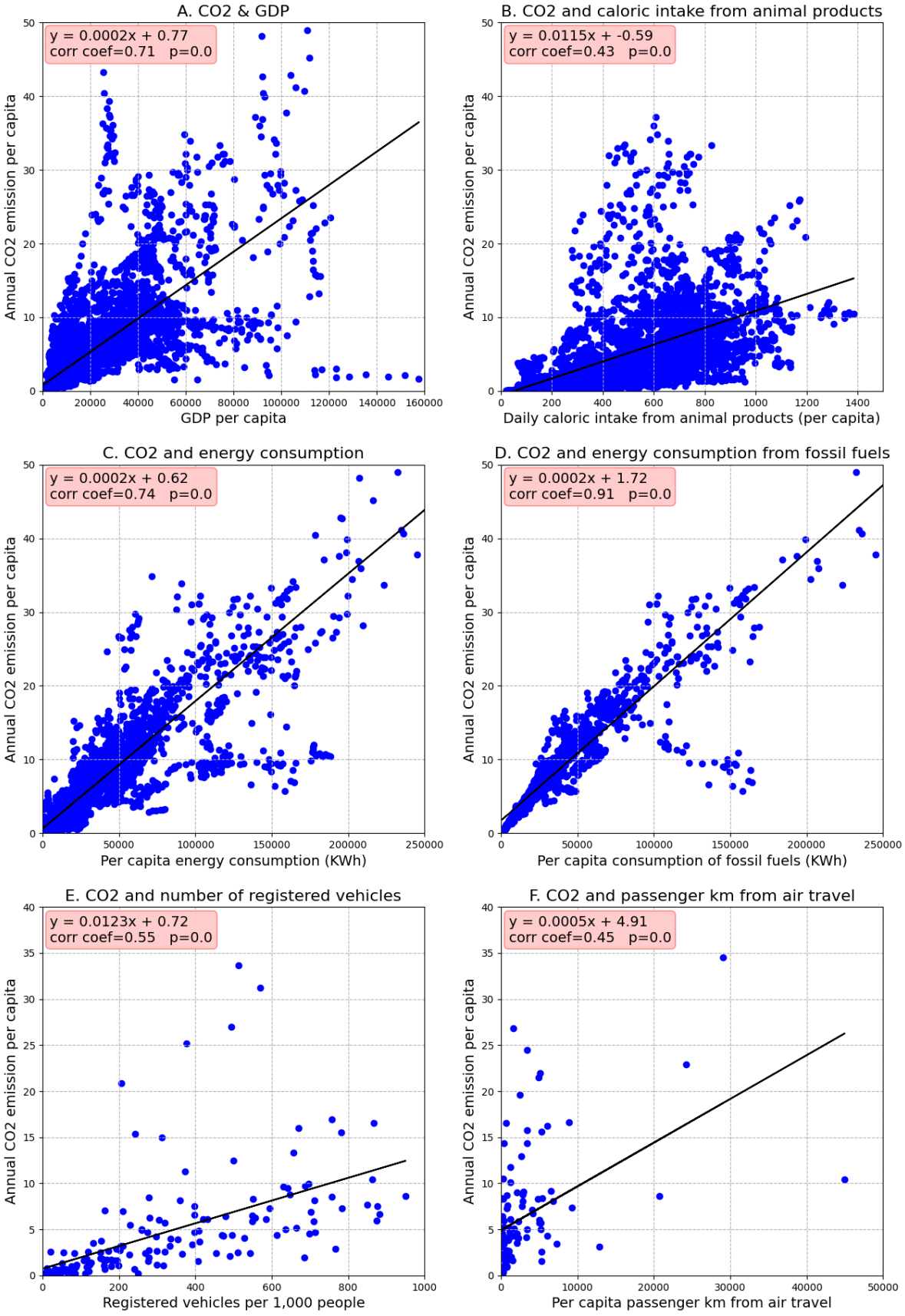
For each of these factors, simple linear regression was used to test if the factor predicted CO2 output. The Pearson correlation coefficient and p-value were calculated.

The notebook can be accessed via this link.

Results

Results are presented in figure 1. All included factors significantly correlate with CO2 emission. However, the strongest predictor of CO2 output is energy consumption from fossil fuels (correlation coefficient = 0.91, p value < 0.001).

Figure 1. Correlation between CO2 emission and (A) GDP, (B) diet high in animal products, (C) energy consumption, (D) consumption of energy from fossil fuels, (E) number of registered vehicles, and (F) air travel.



2.2 Which countries are making the biggest strides in decreasing CO2 output?

Data & analysis

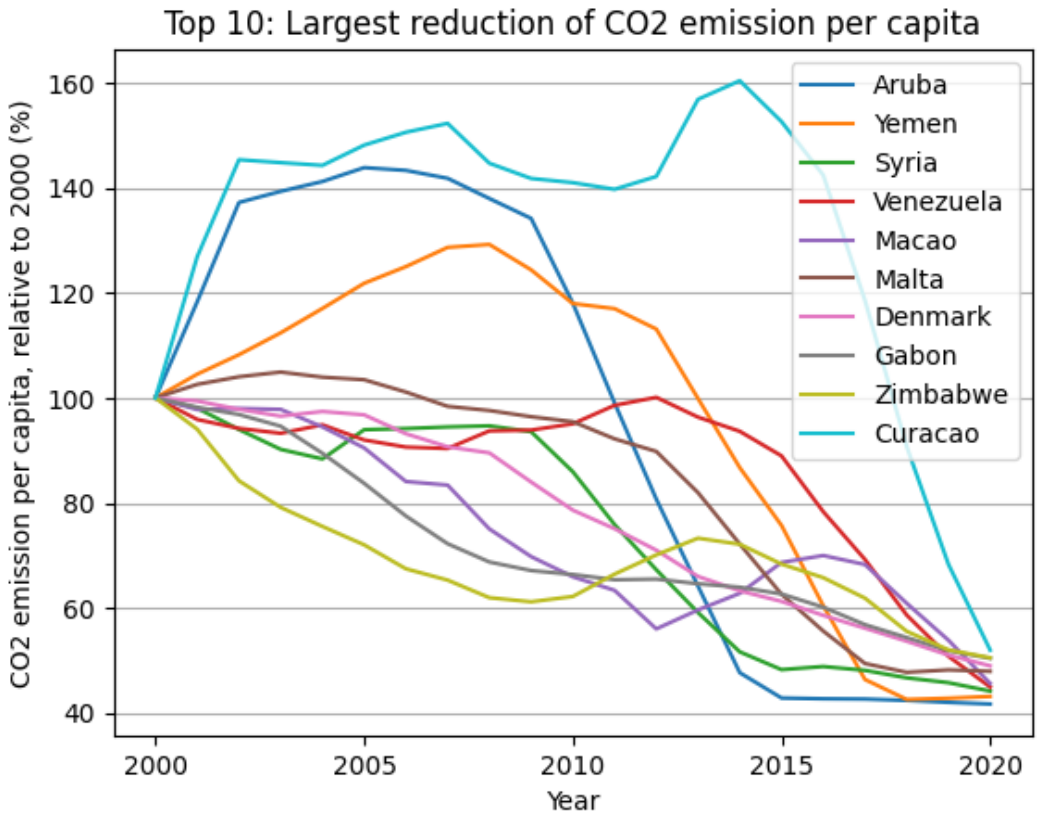
We used the following data: co-emissions-per-capita, downloaded here.

We analyzed the per capita CO2 output per country between 2000 and 2020. To eliminate the influence of short-term fluctuations, we calculated the 5-year moving average for the CO2 output data. Using the 5-year moving average, we calculated the change in CO2 output relative to the year 2000.

Results

The results of the top 10 countries with the largest decrease in per capita CO2 output since 2000 are Aruba, Yemen, Syria, Venezuela, Macao, Malta, Denmark, Gabon, Zimbabwe and Curacao. Results are presented in figure 2.

Figure 2. Per capita CO2 emission as a percentage of the per capita CO2 emission in the year 2000. The figure shows results for the 10 countries with the largest reduction in per capita CO2 emission in the year 2020 compared to 2000.



2.3 Best future price for non-fossil energy

Data & analysis

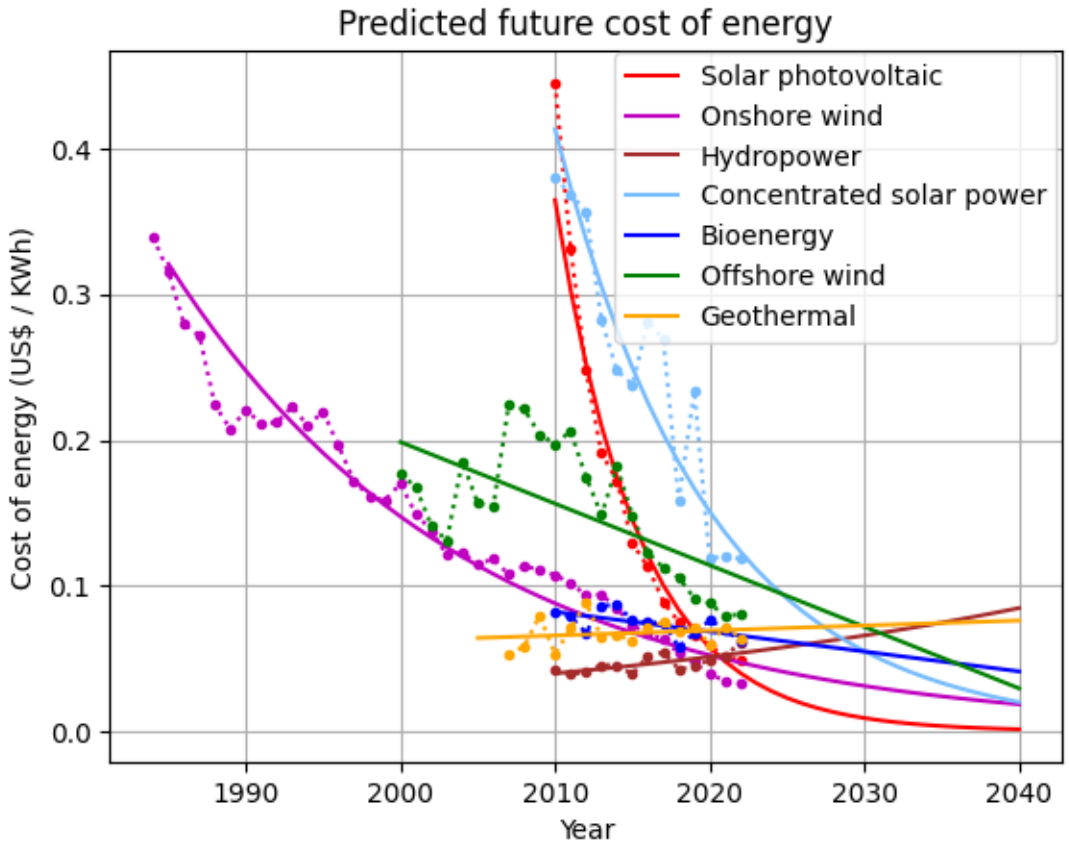
We used the following data: levelized-cost-of-energy.csv, downloaded here.

The analysis includes data on the average cost of energy worldwide for different non-fuel energy sources between 1985 and 2022. Energy prices up to 2040 were predicted using linear or exponential regression, whichever best fitted the data.

Results

Results are presented in figure 3. Based on the results from our regression analysis, we predict that in the 4th decade of the 21st century, the cheapest energy source will be solar photovoltaic power, followed by onshore wind and concentrated solar power. The amount of data is however limited and it is important to keep in mind that future developments may influence price development.

Figure 3. Predicted future cost of different non-fuel energy sources. Dots represent available data between 1985 and 2022. Solid lines represent the fitted regression curves.



3. Conclusion and discussion

In this report, we presented an answer to the following questions:

1. What is the biggest predictor of a country's CO2 output per capita?
2. Which countries are making the biggest strides in decreasing CO2 output?
3. Which non-fossil fuel energy technology will have the best price in the future?

The results show that the strongest predictor of CO2 output is the use of fossil fuels as a source for energy. It seems likely that countries can reduce CO2 emission by reducing the use of fossil fuel energy. This can be achieved by switching to non-fossil fuel energy sources.

Aiding this transition, the cost of many non-fossil fuel energy sources has decreased over the past decades, and will likely further decrease in future. Currently, solar photovoltaic power and onshore wind are the cheapest non-fossil fuel sources for energy. We predict that the price will drop even further in future. In addition, concentrated solar power is currently relatively expensive, but we predict that the price will decrease rapidly.

It can be helpful to look at countries that have been successful in reducing CO2 emission. The 10 countries that have achieved the largest CO2 remission since 2000 are: Aruba, Yemen, Syria, Venezuela, Macao, Malta, Denmark, Gabon, Zimbabwe and Curacao. The analysis does not answer the question in how far CO2 reduction in these countries is a consequence of targeted policy. CO2 reduction may also be caused by other factors, such as economic decline.