

# Visualizing World Greenhouse Gas Emissions Over Time

## Objective

The primary goal of this project is to develop an interactive and comprehensive data visualization that enables users to explore and analyze global greenhouse gas (GHG) emissions across different dimensions. By focusing on emissions data from energy production, economic activity, and emission sources, the visualization aims to uncover patterns and trends in GHG emissions over time.

- How do GHG emissions vary between countries and over time?
- What is the relationship between economic growth, measured by GDP, and carbon emissions?
- Which countries and regions demonstrate progress in decoupling economic growth from emissions?
- How have the sources of emissions evolved historically, and what does this mean for future energy transitions?

To achieve these goals, the project uses advanced visualization techniques to present data in an accessible and engaging manner, enabling users to gain deeper insights into the factors driving global GHG emissions. This approach facilitates a better understanding of how countries can work toward more sustainable development while addressing the pressing challenge of climate change.

## Data Source

The project relies on the Our World in Data dataset, recognized for its comprehensive and regularly updated [CO<sub>2</sub> and Greenhouse and Gas Emissions](#) metrics. The dataset includes:

- Annual, per capita, cumulative, and consumption-based CO<sub>2</sub> emissions.
- Greenhouse gas emissions from various sources, such as fossil fuels and industrial processes.
- Energy mix metrics, including the share of coal, oil, gas, and renewable energy in energy production.
- Economic indicators such as GDP, are adjusted for inflation and purchasing power parity (PPP).

By integrating emissions data with economic metrics, the dataset provides the foundation for examining the interplay between emissions and economic development. This enables users to explore trends in carbon efficiency and progress toward decarbonization.

## Data Visualization

The project uses D3.js to create three interactive visualizations, each offering unique perspectives on the data:

### 1. Bar Chart Race

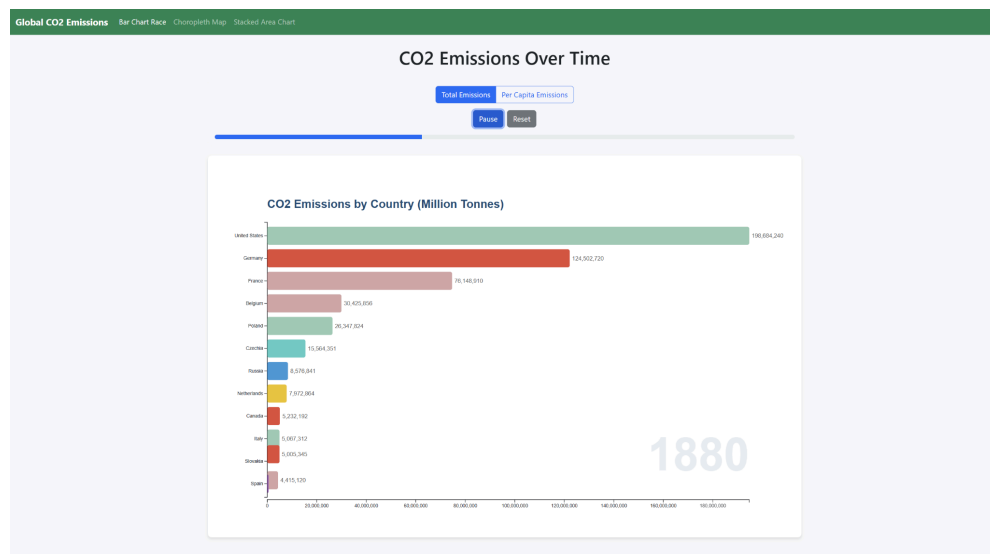


Figure 1. *Bar Chart Race of CO2 Total Emissions*

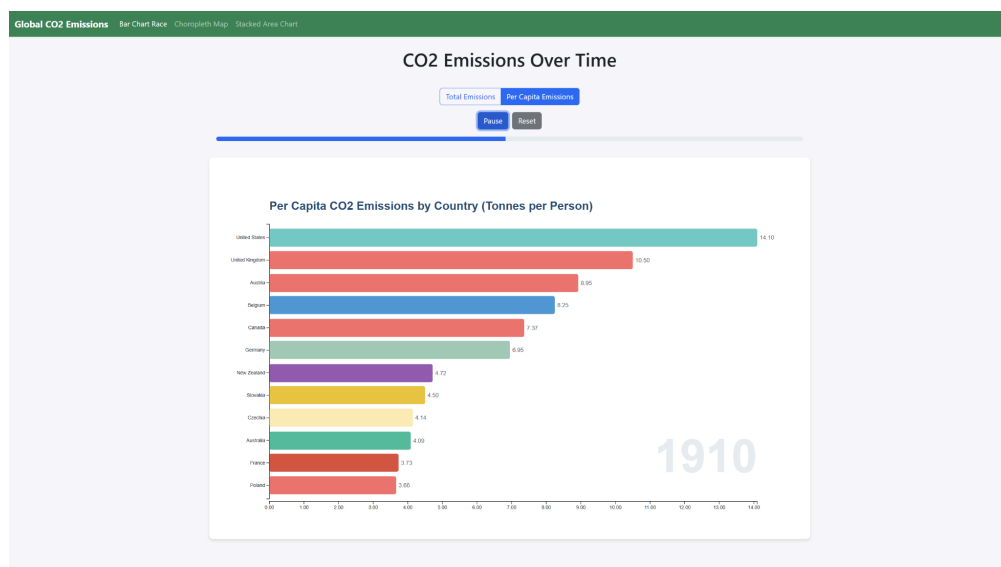


Figure 2. *Bar Chart Race of CO2 Per Capita Emissions*

- This visualization presents a dynamic ranking of countries based on their annual CO<sub>2</sub> emissions, offering views of both total emissions and per capita emissions.
- Functionality:
  - The chart animates changes over time, allowing users to observe historical shifts in emissions rankings.
  - Users can track the rise and fall of emissions by country, gaining insights into periods of industrialization and economic expansion.
- Insights:
  - Developed nations were historically the highest emitters, but emerging economies like China and India have risen in rankings in recent decades.
  - Per capita emissions highlight disparities in carbon footprints across nations, revealing unequal contributions to global emissions.

## 2. Choropleth Map

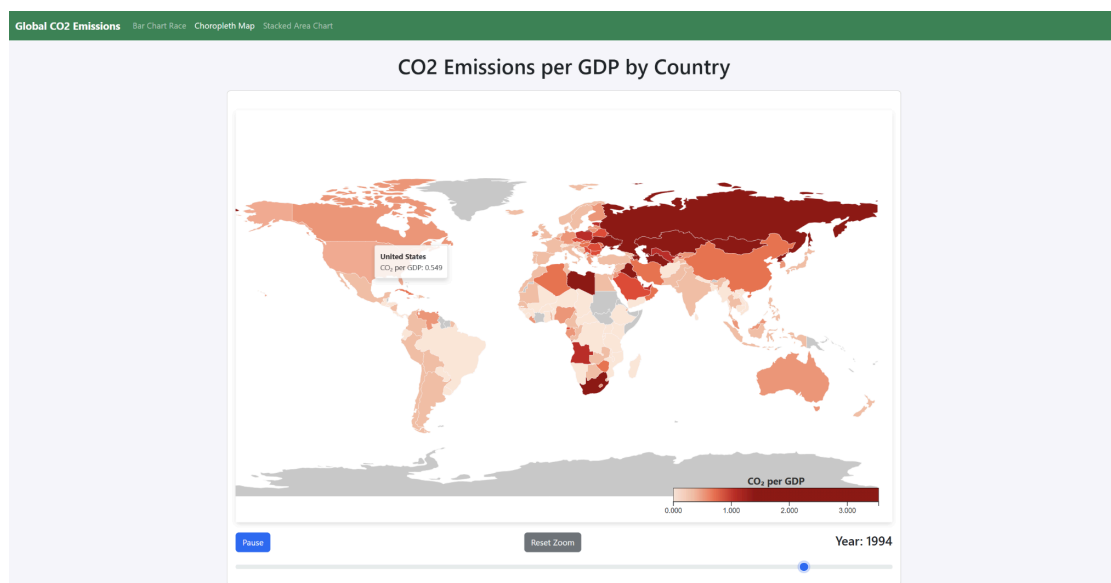


Figure 3. *Choropleth Map of CO<sub>2</sub> Emissions per GDP by Country*

- The map highlights the relationship between CO<sub>2</sub> emissions and economic output (GDP) for each country and visualizes carbon efficiency.
- Functionality:
  - Darker colors represent higher emissions per unit of GDP, indicating less efficient economies.

- Temporal comparisons allow users to explore how economic carbon intensity has evolved.
- Insights:
  - Developed nations, such as those in the European Union, exhibit lower emissions relative to GDP, reflecting advancements in clean energy and efficiency.
  - Developing nations often display higher carbon intensity due to reliance on fossil fuels during periods of rapid industrialization.
  - The map reveals global disparities in carbon efficiency, emphasizing the need for international cooperation in achieving sustainable development.

### 3. Stacked Area Chart

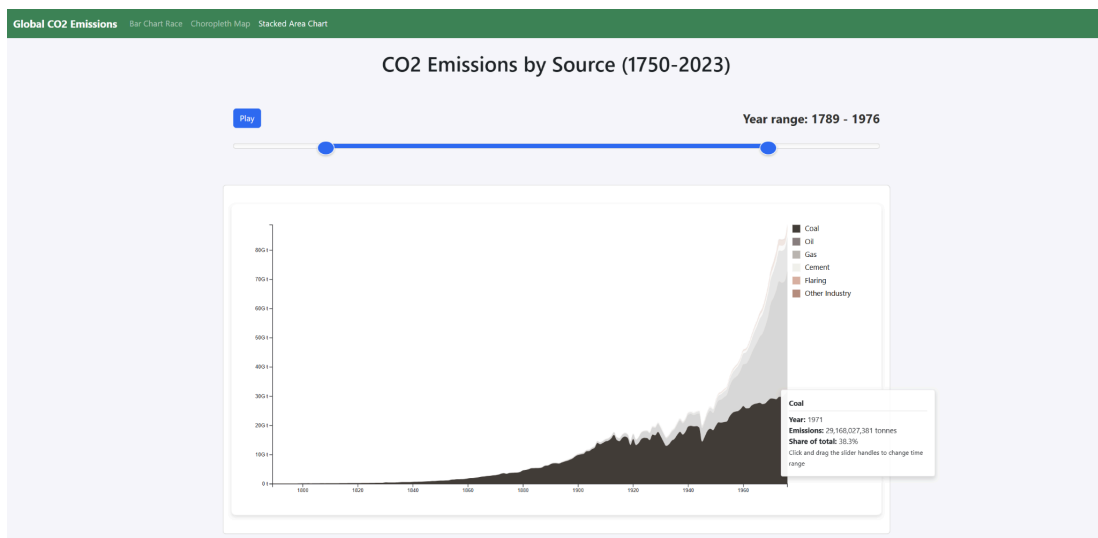


Figure 4. *Stacked Area Chart of CO2 Emissions by Source*

- This visualization captures the historical evolution of global CO<sub>2</sub> emissions, broken down by major sources such as coal, oil, gas, and industrial processes.
- Functionality:
  - Users can observe the contributions of each source to total emissions over time, from 1750 to the present.
  - The chart provides a detailed view of how human activities have reshaped atmospheric CO<sub>2</sub> levels.
- Insights:
  - The Industrial Revolution marked the beginning of significant fossil fuel-based emissions, with coal dominating early contributions.

- The 20th century saw diversification in energy sources, with oil and gas becoming major contributors.
- Despite growing climate awareness in the 21st century, fossil fuels remain the dominant sources of emissions, underscoring the challenges of transitioning to renewable energy.

## **Conclusion**

This project aims to bridge the gap between data and actionable insights, fostering a deeper understanding of the drivers and trends in global GHG emissions. By integrating economic data with emissions metrics, the visualizations highlight:

- The urgency of achieving sustainable development by reducing emissions while maintaining economic growth.
- Progress in decoupling economic growth from emissions in certain regions, offering models for others to follow.
- Historical and regional disparities in emissions, emphasize the need for equitable climate policies and international cooperation.

By providing a platform/ data visualization for exploring the complex relationships between CO2 gas emissions and per Country's GDP, the project equips policymakers, researchers, and the public with the knowledge needed to address the global challenge of climate change effectively.

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