

Analyzing Global CO₂ and Greenhouse Gas Emissions: First Deliverable

Rohith Nallamada

Shivathmika Neeradi

Shashank Reddy Paryada

Gowri Sankar Reddy Palnati

Thanmai Nallani

Saint Louis University

AA 5200: Visualization, Feedback and Dissemination

Shannon Parker

09/08/2025

Analyzing Global CO₂ and Greenhouse Gas Emissions: First Deliverable

Climate change is the 21st century issue of primary concern globally, fueled by the build-up of the greenhouse gases (GHGs), carbon dioxide (CO₂) as a central element, along with methane and nitrous oxide. Knowledge of historical trends and causes of emissions is essential to the creation of successful mitigation techniques, policymaking, and sustainable development (Dong et al., 2019). This project builds on a wide-ranging historical data set of the Our World in Data, which includes global CO₂ and GHG emissions since 1850, to examine trends by country, region, industry, and economic cohort. Through analysing population increase, GDP, energy use, and emission in individual sectors, the project hopes to establish high-contributing areas and areas, determine the effects of various greenhouse gases on global temperature, and underscore the potential to reduce emissions.

The research questions in this study aim to identify the connections between socioeconomic variables and emissions, monitor the industry and regional contributions with time and help policy-makers, corporate sustainability managers, and climate researchers to make decisions based on data. Through strong quantitative analysis and explicit illustrations, the project can offer actionable information that can be used to spearhead informed approaches that can curb climate change and enhance sustainable practices across the world.

Goal Statement

This project is aimed at examining the trends of global CO₂/GHG emissions patterns on a country/region/sector/year-scale with the aim of determining the major drivers of emissions, major contributors of emissions, and where mitigation can be applied.

- Specific: Concentrates on emissions worldwide, sectoral break-downs and country comparisons, taking into account population, GDP and energy consumption.

- Measurable: Measures trends per capita emissions, emissions per GDP, cumulative emissions and sectoral emissions.
- Achievable: An easy dataset provided by Our World in Data that has all needed variables to analyze.
- Relevant: Facilitates climate change studies, policymaking, energy saving mechanisms and global sustainability agenda.
- Time-bound: Compares trends during a time period (1850-present) and gives clues in making the projection to 2023.

Research Questions

1. What trends have global CO₂ and GHG emissions followed with time and which factors (population growth, GDP, energy use) have had the largest changes?
2. What are the biggest contributors of total and per capita emissions by countries and regions over time and over recent decades? What relation have these contributions to economic and demographic factors?
3. What is the contribution of various sectors (coal, oil, gas, cement, flaring, land-use changes) to national and global emissions? Do sectoral emissions patterns change with time?
4. How much did the various greenhouse gases (CO₂, methane, nitrous oxide) contribute to the past and current global temperature changes?
5. What sectors, regions or countries offer the greatest potential of emissions reduction taking into consideration trends, efficiency gains, and patterns of energy consumption?

Description of Dataset

The dataset provides historical information on global CO₂ and GHG emissions across countries, regions, sectors, and economic groups (Dangi, 2025). It includes the following types of variables:

Variable Name	Type	Range of Values	Reason for Inclusion
year	Numerical	1850 – 2023	Tracks changes in emissions and other indicators over time.
Name	Categorical	253 unique values	Identifies countries/regions for comparison and grouping.
iso_code	Categorical	218 unique values	Standardized codes for merging datasets and global comparison.
population	Numerical	215 – 8,091,734,935	Helps normalize emissions per capita and assess demographic impact.
gdp	Numerical	49,980,000 – 130T	Captures economic activity and development linkages to emissions.

primary_energy_consumption	Numerical	0 – 6.15e8 TWh	Key driver of emissions, important for energy efficiency studies.
co2	Numerical	0.0 – 37,791.57	Total CO ₂ emissions (main climate impact variable).
co2_per_capita	Numerical	0.0 – 364.7	Normalizes CO ₂ emissions for population size.
co2_per_gdp	Numerical	0.0 – 3.42	Efficiency metric: emissions relative to economic activity.
total_ghg	Numerical	0.0 – 106,123.0	Total greenhouse gas emissions.
total_ghg_excluding_lucf	Numerical	0.0 – 87,331.0	Excludes land-use changes for sector-specific analysis.
methane	Numerical	0.0 – 1660.2	Methane emissions, critical short-term climate driver.
nitrous_oxide	Numerical	0.0 – 276.5	Nitrous oxide emissions, long-term GHG contributor.

coal_co2	Numerical	0.0 – 15,609.0	Coal's contribution to sectoral emissions.
oil_co2	Numerical	0.0 – 12,945.0	Oil's contribution to sectoral emissions.
gas_co2	Numerical	0.0 – 10,949.0	Gas's contribution to sectoral emissions.
cement_co2	Numerical	0.0 – 1696.3	Cement industry emissions, industrial activity proxy.
flaring_co2	Numerical	0.0 – 505.0	Captures emissions from gas flaring.
land_use_change_co2	Numerical	-160.0 – 8015.7	Impact of deforestation and land-use change.
temperature_change_from_co2	Numerical	0.0 – 1.72 °C	CO ₂ 's estimated contribution to warming.

Prospective Audience and Use-Cases

This project is mainly targeted at policy makers, environmental analysts, corporate sustainability officers, climate researchers and international organizations like the UNFCCC and IPCC. The data in the dataset can be used by these stakeholders to make regulatory policies, corporate emission reduction, and climate research. Applications in particular use-cases would be a government official working out high-emission areas to target regulation efforts, a corporate manager developing energy efficiency and sustainability

programs, and a climate scientist predicting future emission conditions to estimate temperature effects. To give a clear and actionable insight, particularly in these professional profiles, visualizations such as line charts in time-series, stacked bar charts, heat maps, and scatter plots will be used.

Reflection and Implications

Implementation of this project has enormous consequences to climate action and sustainability decision-making. With an in-depth overview of the global and sectoral trends in emissions, it allows stakeholders to focus on areas where they can most effectively make interventions, resource allocation will be prioritized, and evidence-based policy design will be developed. Corporations have the opportunity to coordinate the strategies in operations with the sustainability objectives and researchers have the opportunity to have the good historical data to forecast and climate modelling. In general, this project can help to make informed and strategic decisions to curb climate change, increase environmental outcomes, and raise the awareness of the whole world regarding emission patterns and their effects.

Conclusion

This project has examined the past and current global CO₂ and GHG emissions with particular emphasis on drivers, top contributing regions and sectors as well as mitigation opportunities. The analysis of population, GDP, energy consumption, and sectoral input offers data to support effective data-driven decisions by policymakers, corporate sustainability officers, and climate investigators. Plots such as line charts, bar charts and heat maps show the historical trend and will be used to make future predictions. In general, the project outlines the value of informed and strategic action in reducing emission levels to ensure sustainability and deal with climate change in the most efficient way.

References

Dangi, S. (2025). CO2 emissions across countries, regions, & sectors.

<https://www.kaggle.com/datasets/shreyanshdangi/co-emissions-across-countries-regions-and-sectors>

Dong, K., Dong, X., & Dong, C. (2019). Determinants of the global and regional CO2 emissions: What causes what and where? *Applied Economics*, 51(46), 5031–5044.

<https://doi.org/10.1080/00036846.2019.1606410>

Doran, G. (1981). There's a S.M.A.R.T. way to write Management's goals and objectives.

Management Review, 70(11), p. 35. Permalink:

<https://ezp.slu.edu/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=edb&AN=6043491&site=eds-live>