State-by-State Carbon Emission Trends: A Decade of Insights among U.S. States

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Abstract

This project explores carbon emissions trends across U.S. states between 2012 and 2022. Using interactive visualizations, it compares emissions across states and sectors, highlights top emitters, and analyzes the impact of policy interventions. These visualizations allow users to interact with emissions data, filter by state and year, and analyze trends over time. Our goal is to make emissions data accessible and actionable for researchers and policymakers.

1 Introduction

1.1 Background

Carbon emissions are a key driver of climate change, with each U.S. state contributing differently based on its population, industries, and energy sources. The EPA tracks these emissions through the Greenhouse Gas Reporting Program (GHGRP), offering detailed facility-level data. However, these tools often lack state-level aggregations and long-term insights, which are crucial for understanding how emissions evolve and how policies affect them. By analyzing emissions trends over a decade, this project provides valuable insights into the regional impact of emissions and sectoral contributions across the U.S.

1.2 Motivation and Objectives

The motivation for this project lies in the increasing need for accessible, actionable climate data. While policies like the Clean Power Plan and the Paris Agreement aimed to reduce emissions, their tangible impacts remain unclear. Objectives include:

- Investigating emissions trends over time.
- Evaluating sector-wise contributions to emissions.
- Analyzing policy effectiveness on emissions reduction.
- Creating an interactive tool for stakeholders to explore the data.

2 Process

2.1 Data Collection and Cleaning

- **Sources:** Data was collected from the EPA's GHGRP (2012-2022).
- **Cleaning:** Missing values were handled, column names standardized, and irrelevant data excluded to ensure consistency.

2.2 Visualization Development

- **Tools:** Python libraries (pandas, Plotly, Seaborn, Matplotlib) were used for creating interactive charts and maps.
- **Dashboard:** Built using Dash, enabling dynamic filtering and storytelling.

2.3 Challenges and Solutions

- **Data Inconsistencies:** Addressed through automated cleaning scripts.
- **Large Datasets:** Optimized processing workflows for efficiency.
- **Cohesion:** Standardized styles and themes across visualizations.

3 Results and Insights

3.1 Key Visualizations

- State-by-State Emissions Bar Chart: Displays total emissions per state.
- Sector-Wise Emissions Pie Chart: Highlights emissions distribution across sectors.
- Emissions Trends Over Time: Line charts showing sector-wise and state-wise trends.
- Choropleth Map: Visualizes emissions geographically across the U.S.
- Policy Impact Analysis: Annotated graphs showcasing changes pre- and post-major policies.

3.2 Key Insights

- Policies like the Clean Power Plan and Paris Agreement resulted in limited emission reductions.
- Certain states consistently contribute higher emissions due to industrial and energy profiles.
- Effective emission reduction demands stricter policy enforcement and broader incentives for renewable energy adoption.

4 Discussion, Conclusion, and Future Work

4.1 Discussion

This project reveals the limitations of existing policies in achieving drastic reductions in greenhouse gas emissions. It underscores the need for aggressive measures and accountability mechanisms.

4.2 Conclusion

By delivering an interactive dashboard and comprehensive visualizations, the project provides valuable tools for policymakers and researchers to understand and act on emissions trends.

4.3 Future Work

- Incorporate real-time emissions data.
- Expand analysis to include other greenhouse gases.
- Apply predictive analytics to forecast future trends.

5 References

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