

Visualizing the Impacts of Renewable Energy on City-Wide Emissions

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Introduction

This project will visualize how changing the makeup of a city's energy sources can lead to a change in greenhouse gas emissions. This project will promote positive examples of cities taking steps to improve the condition of the Earth, highlight areas where attention is needed, and provide empirical evidence of which methods of renewable energy have the greatest impact on emissions. The project will present city-level emissions data, as well as the make-up of their energy sources. By visualizing how these data sources connect, interact, and changes over time, users will be able to see the impacts, and make decisions about how to better the planet.

Motivation

“Human activities (primarily the burning of fossil fuels) have fundamentally increased the concentration of greenhouse gases in Earth's atmosphere, warming the planet.”¹ Because of this, it is critical that we, as a society, make systematic changes to reduce our impact. In order to understand what steps need to be taken, educating decision-makers is critical. Changes need to be made at the individual level, all the way up to the corporate and national level. By looking at city-level data, the project will hopefully represent a happy medium between individual decisions to go green and urban planning efforts to increase sustainability.

The intended audience of this visualization project is broad. Ideally², decision-makers at a local level will use it as a reference as they examine their energy use and environmental impact. When deciding to increase their proportion of energy use that comes from renewable sources, they will have real examples of similar efforts, and they will be able to estimate their impact by looking at cities of similar size. Individuals will also benefit from this visualization. They will gain an understanding of how their city is contributing to the ecosystem, and decide whether they need to push leaders to change, or re-align their energy use to match the makeup of their city.

Data

Data for this project will be primarily obtained from The Carbon Disclosure Project (CDP)³, a global non-profit that gathers data and reports on the environmental impacts of companies, cities, and regions. Provided is a list of data sources, with a brief description of how they will be utilized.

1. City-Wide Emissions (2019, 2020, 2021) – This data set contains geographic information about reporting cities, basic information about the governmental structure, and statistics about total Direct and Indirect emissions of CO₂, CH₄, and N₂O. This set will be the primary data source, and the project will visualize how those numbers have changed over time.
2. City-Wide Percentage Energy Mix (2019, 2020, 2021) – This data set contains information about the energy sources of global cities. It is in the form of a percentage breakdown of Coal, Gas, Oil, Nuclear, Hydro, Biomass, Wind, Geothermal, Solar, and Other. By examining the changes to the percentage breakdown, and comparing it to the emissions data, this project can paint the picture of the impacts of energy sources on emissions.

¹ <https://climate.nasa.gov/causes/>

² The Use of Climate Knowledge in Urban Planning, Ingegärd Eliasson, Landscape and Urban Planning, Volume 48, Issues 1–2, 2000, Pages 31-44

³ <https://data.cdp.net/>

3. Population information (The World Bank) – There is an assumption that as a population grows, the energy use will grow as well. By incorporating population data for the selected cities, the project can account for that assumption.

Data Notes

- All data is available in .CSV format, and can be cleaned and combined to form a single dataset.
- Once all data has been gathered, some proxy data will need to be created. Examples of this would be total emissions, city- and region- level averages, percentage change from year to year, etc.
- The scope of the project is flexible, due to the amount of data available from CDP. Though it will be adjustable in the visualization (see below), limiting the cities examined is possible.
- Correlation does not imply causation. This is intended to paint a picture of global trends in emissions and efforts to go green. Any statistical analysis performed, such as linear regression, should be understood in this context.

Visualization Overview

The core of the visualization will be node-based. Each city in the dataset will have a corresponding node. Its' size and color will be determined by its energy impact (Emissions Data), sustainability score (Percentage Mix Data), on an optional per capita scale (Population Data). Users can click on each to see a simple visualization on how 'green' the city is. Information will also be displayed on whether their emissions have been increasing or decreasing, in a directly represented relationship on whether their sustainable makeup has increased or decreased. It can be displayed on a map, but it may not be necessary for this project.

There will also be customization options that will allow the user to cater the display to their needs. Upper and lower limits on population can be set, and users can select which energy source they want to emphasize. Each city will also have a corresponding region, so some can be filtered out. By setting the resource toggle to 'Wind,' for example, they can view the cities that have increased or decreased their wind usage the most, and their corresponding environmental impact. This project relies on rich, clean data, and will serve as a gateway for the user to visualize it according to their needs.