Data Visualization: Final Project
Visualizing the Energy Consumption and Carbon Footprints in NYC

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Abstract

The project aims to provide a comprehensive and visually engaging representation of energy consumption and carbon footprints in New York City (NYC). This project will visually communicate the impact of human activities on the environment and highlight trends and patterns of energy consumption and carbon emissions in NYC. Using accurate and reliable data from reputable sources, the project will showcase energy consumption levels and carbon emissions various scales. The project aims to raise awareness, facilitate understanding, and support informed decision-making for reducing greenhouse gas emissions and promoting sustainability in NYC.

1. Introduction

Energy consumption and carbon footprints are critical topics in the context of sustainability and climate change. As the global population continues to grow, and urban areas like New York City (NYC) expand, the demand for energy rises, leading to increased energy consumption and associated carbon emissions. NYC, with its dense population, high-rise buildings, and extensive transportation systems, is a major consumer of energy and contributor to greenhouse gas emissions. The burning of fossil fuels for electricity, heating, transportation, and industrial processes is a significant source of carbon emissions, which are the main driver of climate change.

NYC has set ambitious goals to reduce its carbon emissions and transition to cleaner energy sources in line with global efforts to mitigate climate change. Understanding the patterns, trends, and impacts of energy consumption and carbon footprints in NYC is crucial for policymakers, urban planners, and residents to make informed decisions and take effective actions towards sustainability and emissions reduction.

The objective of the project is to create comprehensive and visually engaging data visualizations that depict energy consumption and carbon footprints in New York City, using accurate and reliable data from reputable sources. The project seeks to raise awareness about the impacts of energy consumption and carbon emissions on the environment and climate change, promote understanding and informed decision-making by visually communicating patterns, trends, and progress towards emissions reduction goals, and contribute to ongoing efforts towards sustainability and climate action in NYC.

2. Design and Implementation

Data Collection and Preparation: Data was collected from the NYC Energy Benchmarking for Local Law 84 dataset available on the Mayor's Office of Sustainability website, which contains the information for Energy and Water Usage Intensity, Greenhouse Gas Emissions, Electricity and Natural Gas Use for different building types, their addresses and zip codes. Data Cleaning and Preprocessing was done in Python using Jupyter Notebook. Cleaning, organizing, and preparing the data using Python data manipulation libraries, such as Pandas and NumPy, ensuring data integrity and consistency. This will include removing inconsistencies, handling missing values, and addressing outliers in the data.

Visualization Design: Data visualization was done using Tableau to create interactive dashboards. Different visualization types, such as bar charts, line charts, heatmaps, and geographic maps, were used based on the project objectives. Customized the visualizations to be visually appealing, informative, and accessible, incorporating best practices in data visualization.

Dataset

	zipcode	bldgtype	eui	wui	ghg	ess	electricity	natural_gas	gfa	year	address
0	11209	Multifamily Housing	105.2	35.16	4.76	82.0	166805.9	4833716.8	57036.0	1930	150-74th Street
2	10022	Hotel	188.2	57.84	7.49	42.0	4605159.3	13997499.9	153761.0	1963	155 East
3	10065	Hotel	239.6	81.66	8.35	45.0	16554842.3	22649785.2	320000.0	1960	540 Park Avenue
4	10037	Multifamily Housing	130.4	44.84	5.24	71.0	4222144.7	20595911.7	280358.0	1958	10 West 135th Street
5	10003	Hotel	201.5	45.12	7.88	55.0	7086038.2	3212100.4	205473.0	1901	201 Park Avenue South

Figure 1. Dataset

1. Zip Code: zipcodes of all areas in NYC
2. Building Type (bldgtype): Type of Building ranging from hotel to university etc.
3. Energy Use Intensity (eui): Total amount of the energy from all the raw fuel required to operate a property expressed in kBtu per gross square foot (kBtu/ft2)
4. Water Use Intensity (wui): The annual consumption of water in gallons per gross square foot (gal/ft2) of the property.
5. Greenhouse Gas Intensity (ghg): The total direct and indirect greenhouse gases emitted due to energy used by the property per gross square foot of the property, reported in kilograms of carbon dioxide equivalent per square foot (kgCO2e/ft2)
6. Energy Star Score (ess): A 1-to-100 percentile ranking for specified building types with 100 being the best score and 50 the median. It compares the energy performance of a building
7. Electricity: annual consumption of electricity in kWh
8. Natural Gas: annual consumption of natural gas in kBtu
9. Gross Floor Area (gfa): Gross square footage of the property, per Department of Finance records.
10. Year: year in which the building was constructed
11. Address: street address of the building

3. Demonstration

Different visualizations have been created using Tableau software ranging from tree maps, trend lines, geographic visualization and bar graphs. The users can switch between different dashboards and select different metrics. Users can change the parameters according to their use case. Changes update all other portions of the visualization.

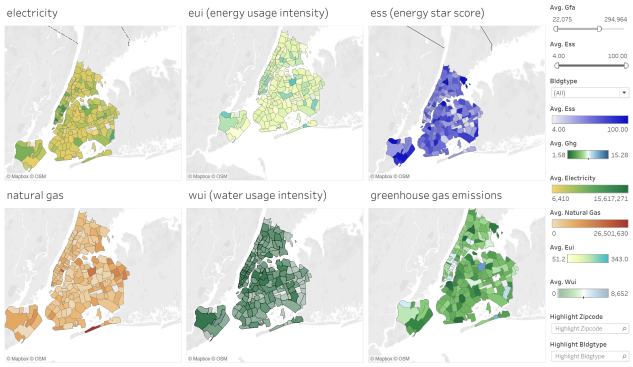

Figure 2. Geographic Map Visualization of Energy Consumption and Carbon Emissions

Figure 2 is the map of NYC and shows the electricity and natural gas consumption and users are able to switch between different metrics of interest, currently EUI, water use intensity (WUI), GHG emissions. Just below this is a search bar that allows users to query for particular buildings and zip codes. This enables finding out information about the energy consumption of a building, and to see how it compares to other buildings.

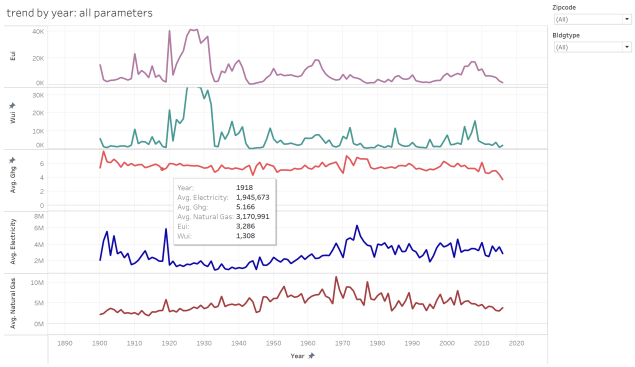

Figure 3. Trend line by year for Energy Consumption and Carbon Emissions

Figure 3 shows us a trend line by year for energy, water usage, greenhouse emissions, electricity and natural gas and we can select different metrics like zipcode or building type for comparison. Figure 4 shows the bar graphs grouped according to different buildings to understand the carbon footprint and energy usage. For example here, supermarkets consumed the highest electricity. Figure 5 displays tree maps which is a very straightforward way to see which building type consumed most energy according to different color schemes.

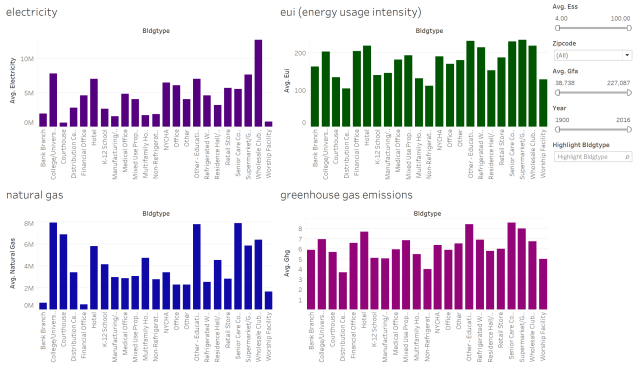

Figure 4. Bar Graph for Energy Consumption and Carbon Emissions

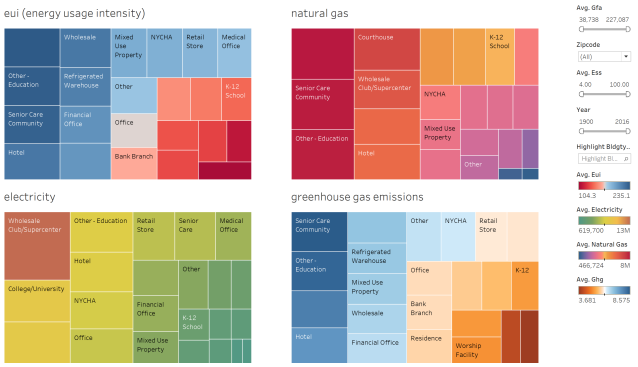

Figure 5. Tree Map for Energy Consumption and Carbon Emissions

4. Conclusion

The project visualizes energy consumption and carbon footprints in New York City, highlighting trends and patterns to raise awareness, facilitate understanding, and support informed decision-making for reducing greenhouse gas emissions and promoting sustainability.

The project's future scope includes expanding the dataset to include more detailed information about energy usage and carbon emissions, such as transportation and waste management. This would provide a more comprehensive understanding of the environmental impact of human activities in New York City.

Furthermore, the project could incorporate machine learning algorithms to predict future trends in energy consumption and carbon emissions, which would enable policymakers to plan and implement effective environmental policies. In terms of next steps, the project could involve engaging with stakeholders, including building owners and occupants, to encourage energy-efficient practices and promote sustainability. The project could also incorporate real-time data to provide up-to-date information about energy usage and carbon emissions in New York City. In summary, the project provides a valuable resource for policymakers, researchers, and the public to understand and address environmental sustainability issues in New York City.

References

Benchmarking and Energy Efficiency Rating: Dataset available from the NYC Open Data portal, provides information on energy and water consumption, as well as greenhouse gas emissions, for different buildings in the city. https://www.nyc.gov/site/buildings/codes/benchmarking.page

NYC Energy and Water Use Report: https://www.urbangreencouncil.org/new-york-citys-2020-energy-and-water-use-report/

NYC Mayor's Office of Sustainability: https://www.nyc.gov/site/sustainability/about/who-we-are.page

Climate Leadership and Community Protection Act: https://climate.ny.gov/

Energy and water performance map. Mayor's Office of Sustainability. https://www.nyc.gov/site/sustainability/codes/energy-and-water-performance-map.page

Tableau Software: https://www.tableau.com/