30538 Final Project: Group 33

Partern 1: Dale Jin (Github ID: dalejin86): data cleaning and choropleth plot

Partern 2: Katherine Tu (Github ID: kattu1): data cleaning and dynamic plots

Partern 3: Yuliana Zhang (Github ID: YuejiuZHANG): coding adjustment, writeup and repository management

Research Question

In 2008, Chicago adopted the Chicago Climate Action Plan (CCAP) to reduce greenhouse gas emissions by 25% from 1990 levels by 2020. Initially, adaptive strategies like green and reflective roofs were implemented to reduce heat absorption and provide urban cooling. These measures were temporary, leading to the launch of the Chicago Retrofit Roadmap in 2020—a three-year project to cut emissions at their source.

To evaluate the effectiveness and necessity of Chicago's evolving climate policies, our research aims to answer:

- Did the 2008 CCAP continually reduce Chicago's greenhouse gas emissions before 2020?
- Can the Chicago Retrofit Roadmap further reduce emissions and provide long-term solutions?

Research Method And Coding Instructions

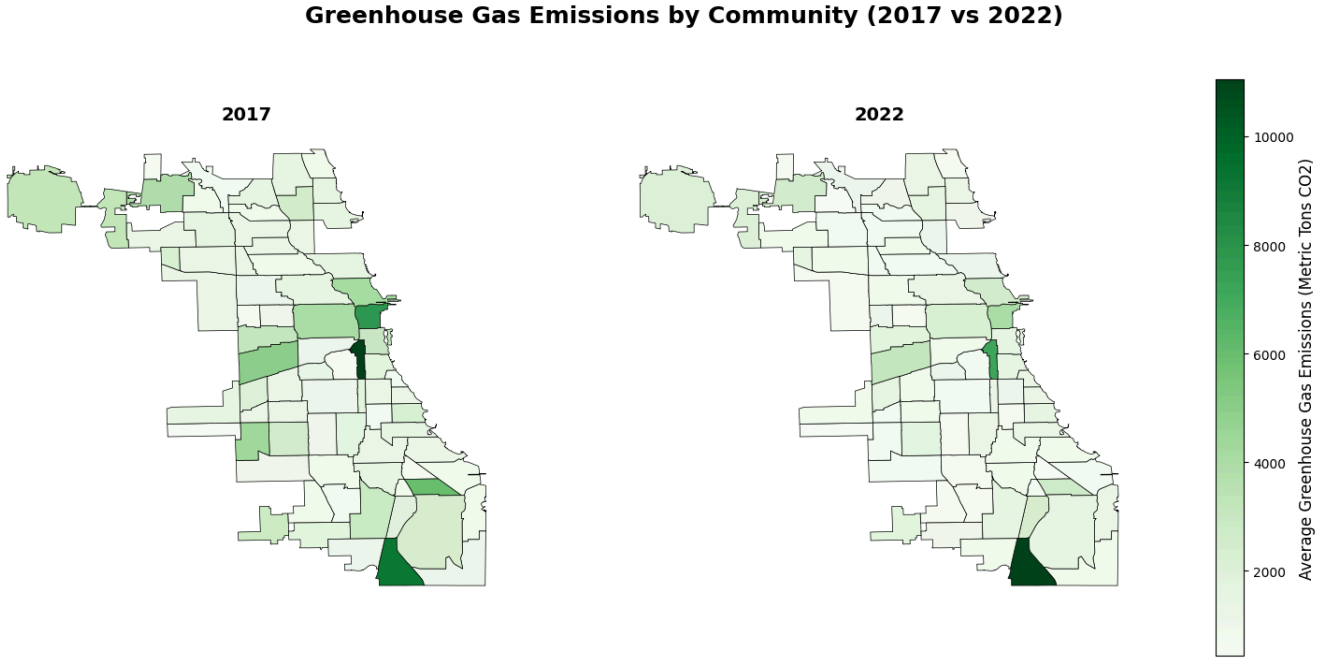
To address these questions, we analyzed trends in greenhouse gas emissions, electricity use, and natural gas use in Chicago, focusing on data from 2017 to 2022 to assess the impact of CCAP before 2020 and the Retrofit Roadmap after.

Due to limited public data, we only used the Chicago Energy Benchmarking Report, which provides annual self-reported energy data for Chicago buildings since 2014. Since the dataset only contained 8,113 parcel-level observations—about 1% of Chicago's buildings—we concentrated on identifying overarching trends, using an efficiency metric derived from the available data.

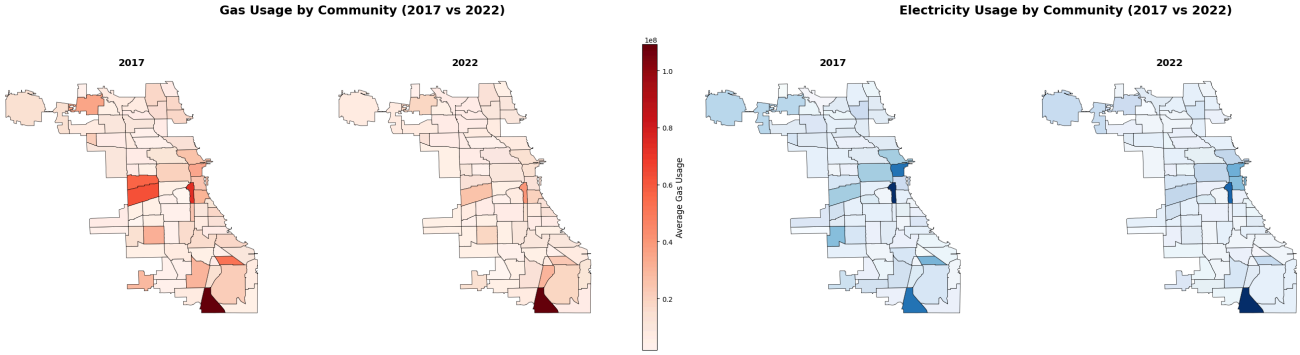
We began by merging datasets, cleaning data, and standardizing variables for easier analysis. Data cleaning involved handling missing values, standardizing community names, and creating efficiency metrics. We binned geographic coordinates to facilitate spatial analysis.

After cleaning, we created maps to visualize changes in greenhouse gas emissions, gas consumption, and electricity usage between 2017 and 2022, and dynamic plots to explore yearly trends by community and property type. A major challenge was dealing with data inconsistencies, requiring substantial preprocessing to ensure accuracy. Besides, due to the complicated data collecting process itsself, we could not sum up any trends by property type. Thus, to further explore patterns, we identified the 500 least efficient buildings and mapped their property types to highlight areas of concern.

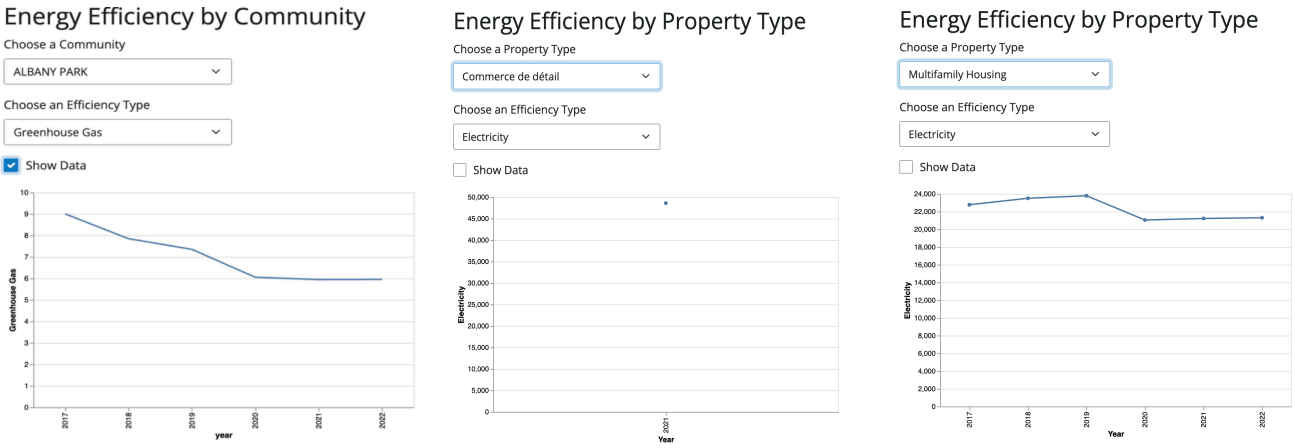
Results



Our main focus, the greenhouse gas emissions map, demonstrates a decrease in emissions from 2017 to 2022 across various communities, especially in areas like the Loop. This suggests that the 2008 CCAP and the Chicago Retrofit Roadmap initiatives to curb emissions have been somewhat effective, though several communities still need more targeted interventions to achieve substantial reductions. Similar results can also be drawn from gas and electric consumption. These three independent variables have almost the same pattern between the graphs from 2017 and 2022.



We built two Shiny apps to explore energy efficiency trends across different communities and property types in Chicago. After selecting a specific community and an efficiency type (Electricity, Gas, or Greenhouse Gas), we can observe the corresponding line chart, which shows the yearly changes in efficiency metrics from 2017 to 2022. The app also provides a data table next to the graph, displaying each year's efficiency values.



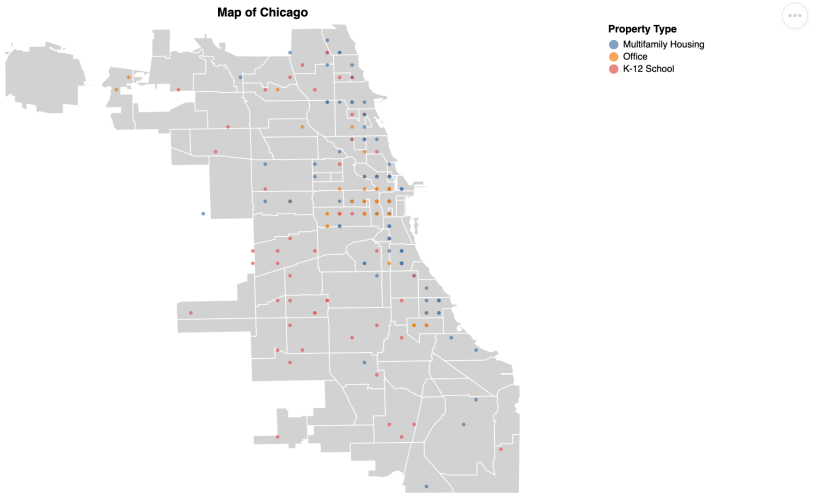
From these two Shiny apps, we observed that most of the communities' GHG emissions were reduced from 2017 to 2022, and 2020-2022 reduced more sharply than 2017-2020. This implicated that both the 2008 CCAP and Chicago Retrofit maps work. Besides,as the second Shiny app cannot clearly show the patterns as it lacks data on some property types, and most trends are increasing, we filtered the top 500 least efficient buildings. Through this new Shiny app, we can clearly see that multifamily housing, offices, and K12 Schools are the top 3 least efficient property types.

Distribution of the Top 3 Least Efficient Building Types in 2022

Select Efficiency Metric

Greenhouse Gas

Show Data



Top 10 Property Types	Count (Out of 500 Least Efficient Buildings)
Multifamily Housing	102
Office	75
K-12 School	55
Hotel	49
Supermarket/Grocery Store	35
College/University	35
Senior Living Community	25
Hospital (General Medical & Surgical)	16
Laboratory	14
Retail Store	14

Further Discussion for Furture Work

For future improvements, we plan to expand our dataset to include more building types and data beyond 2022 to further explore the impact of the Chicago Retrofit Roadmap. Additionally, we aim to acquire 1990 data to assess whether the 2020 levels of emissions and energy usage are indeed 25% of those in 1990, as outlined in Chicago's climate goals. Furthermore, we need to develop a more sophisticated model to better distinguish the effects of the 2008 CCAP and the Chicago Retrofit Roadmap, ensuring that we can accurately attribute observed changes to each initiative. This will help us more precisely evaluate the effectiveness of these policies and provide more targeted recommendations for future climate action.