Report on Energy Consumption and Efficiency in Calgary

Introduction

This report analyzes various data visualizations to identify key trends in energy consumption and efficiency in Calgary, Canada. The analysis focuses on energy use intensity (EUI), greenhouse gas (GHG) emissions, property types, and seasonal variations.

Data Cleaning and Extraction

Regular expressions (Regex) were employed to clean specific text-based data columns.

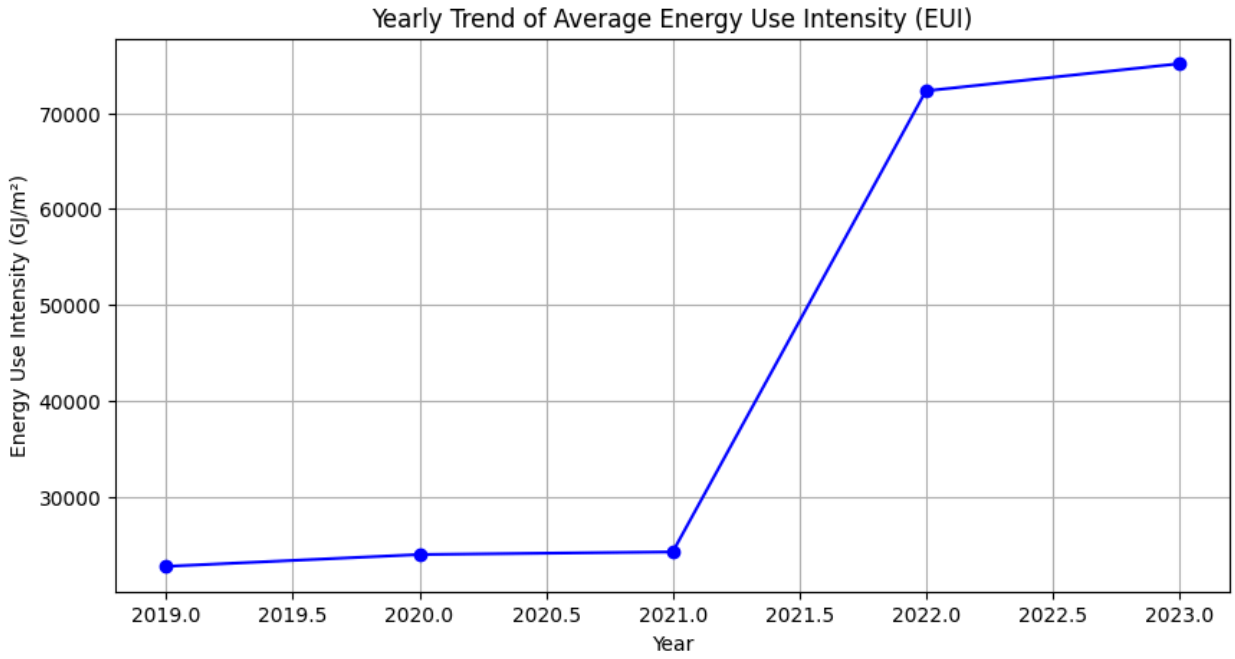
- **Extracting Numerical Values from Columns:**
    - Regex pattern `r'\d+'` is used to find all occurrences of digits within the specified columns (`Property GFA - Self-Reported (m²)`, `Total GHG Emissions (Metric Tons CO2e)`, `Source Energy Use (GJ)`).
    - The first occurrence of digits is extracted and converted to a float using `float(re.findall(r'\d+', x)[0])`.
    - If no digits are found, `np.nan` is assigned to the value.
- **Cleaning Property Names:**
    - The `re.sub(r'[^a-zA-Z0-9 ]', '', x)` pattern removes any character that is not a letter, number, or space from the `Property Name` column, resulting in a cleaner and more uniform property name.
- **Standardizing Postal Codes:**
    - The `re.sub(r'(\w\d\w)[-\s]*(\d\w\d)', r'\1 \2', x)` pattern standardizes the postal code format by removing any hyphens or spaces between the first three characters and the last three characters.
    - `df['Postal Code'] = df['Postal Code'].str.upper()` converts the postal codes to uppercase for consistency.

2. Data Cleaning Functions

- **`clean_property_name(name)`:**
    - Removes special characters and extra spaces using the `re.sub(r'[^\w\s]', '', name)` pattern.
    - Converts the property name to title case by capitalizing the first letter of each word.

- **`clean_address(address)`:**
    - Removes special characters using `re.sub(r'[^\w\s\.,-]', '', address)`.
    - Standardizes street number format by removing extra spaces between the number and the street name using `re.sub(r'(\d+)\s+(\w+)', r'\1 \2', cleaned_address)`.
    - Standardizes street type abbreviations by replacing variations of "St", "Ave", "Rd", etc., with their standard abbreviations using multiple `re.sub()` operations.

1. Yearly Trend of Average Energy Use Intensity (EUI)



1.1 Key Observation:

The line graph titled "Yearly Trend of Average Energy Use Intensity (EUI)" reveals a clear upward trend in average EUI over the four years. There is a period of relative stability in the first two years, followed by a significant increase in year 3 and continued growth in year 4.

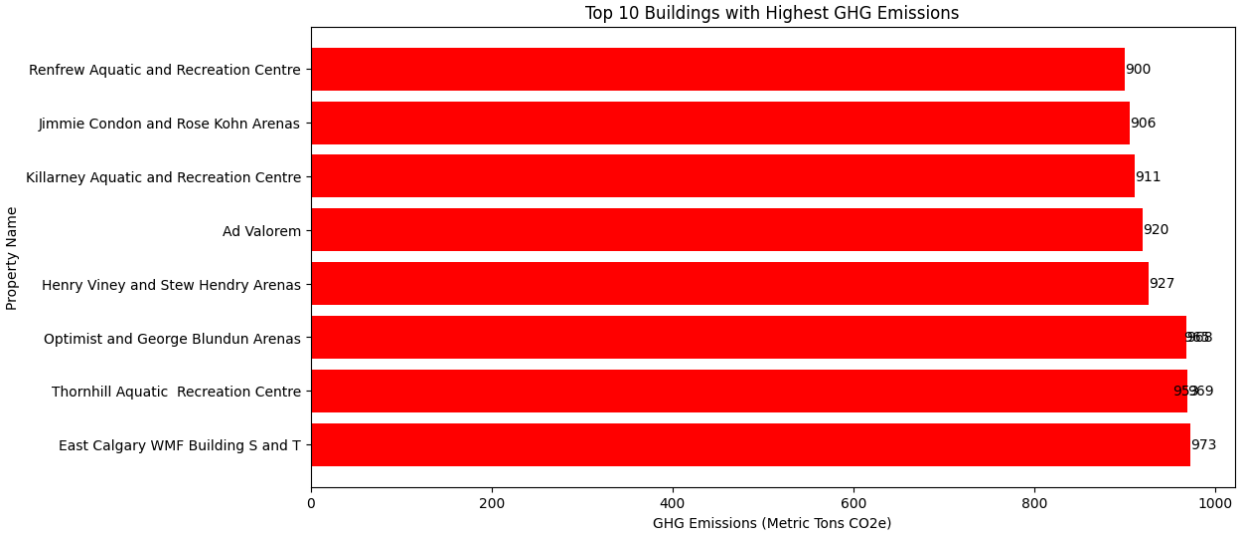
1.2 Possible Explanations:

- **Economic Growth:** Increased economic activity and population growth likely contribute to higher energy demand.
- **Climate Change:** Changing climate patterns, such as hotter summers and colder winters, may necessitate increased energy use for cooling and heating.
- **Technological Advancements:** The introduction of energy-intensive technologies or equipment in buildings could also contribute to higher EUI.

1.3 Recommendations:

- **Energy Efficiency Programs:** Implement and strengthen energy efficiency programs for buildings, including incentives for upgrades and retrofits.
- **Renewable Energy Adoption:** Promote the adoption of renewable energy sources like solar and wind power to offset increasing energy demand.
- **Data Collection:** Continuously monitor EUI trends to identify the drivers of energy consumption and adapt strategies accordingly.

2. Top 10 Buildings with Highest GHG Emissions



2.1 Key Observation:

The bar graph titled "Top 10 Buildings with Highest GHG Emissions" highlights the significant GHG emissions from specific buildings, particularly aquatic and recreation centers and industrial facilities.

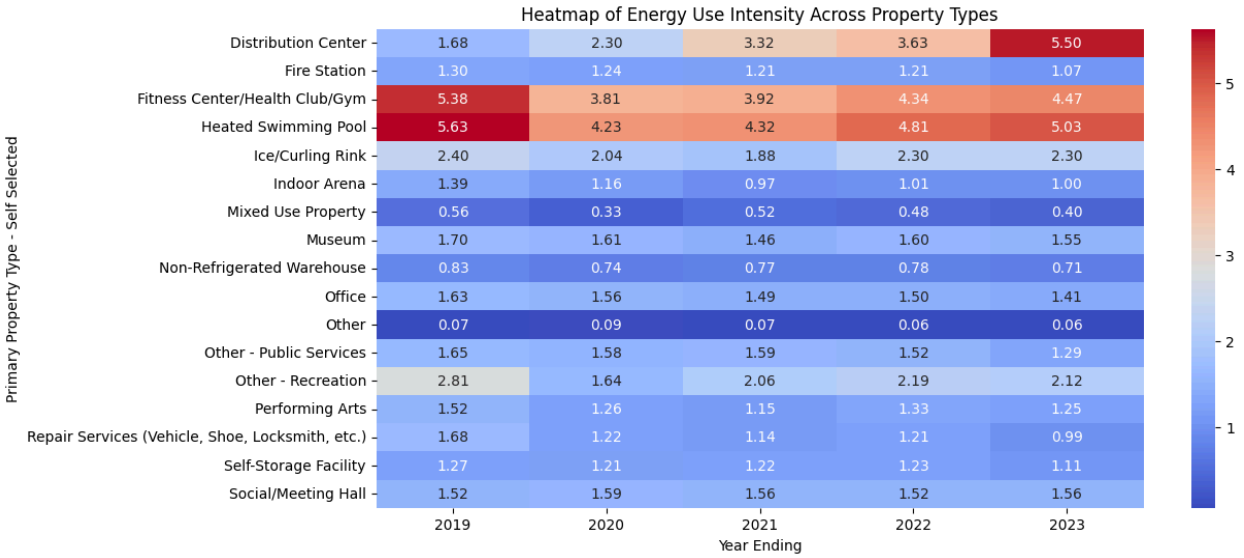
2.2 Possible Explanations:

- **Energy-Intensive Operations:** These facilities often require high energy consumption for heating pools, maintaining ice rinks, and powering industrial processes.
- **Equipment Usage:** Outdated or inefficient equipment can contribute to higher energy use and GHG emissions.

2.3 Recommendations:

- **Energy Audits:** Conduct thorough energy audits in these buildings to identify areas for improvement.
- **Equipment Upgrades:** Invest in energy-efficient equipment, such as high-efficiency boilers, chillers, and lighting systems.
- **Operational Optimization:** Implement operational measures to reduce energy consumption, such as optimizing HVAC systems and adjusting operating hours.

3. Energy Use Intensity Across Property Types



3.1 Key Observation:

The heatmap titled "Heatmap of Energy Use Intensity Across Property Types" reveals significant variations in EUI across property types. Distribution Centers, Fitness Centers, and Heated Swimming Pools consistently exhibit higher EUI values.

3.2 Possible Explanations:

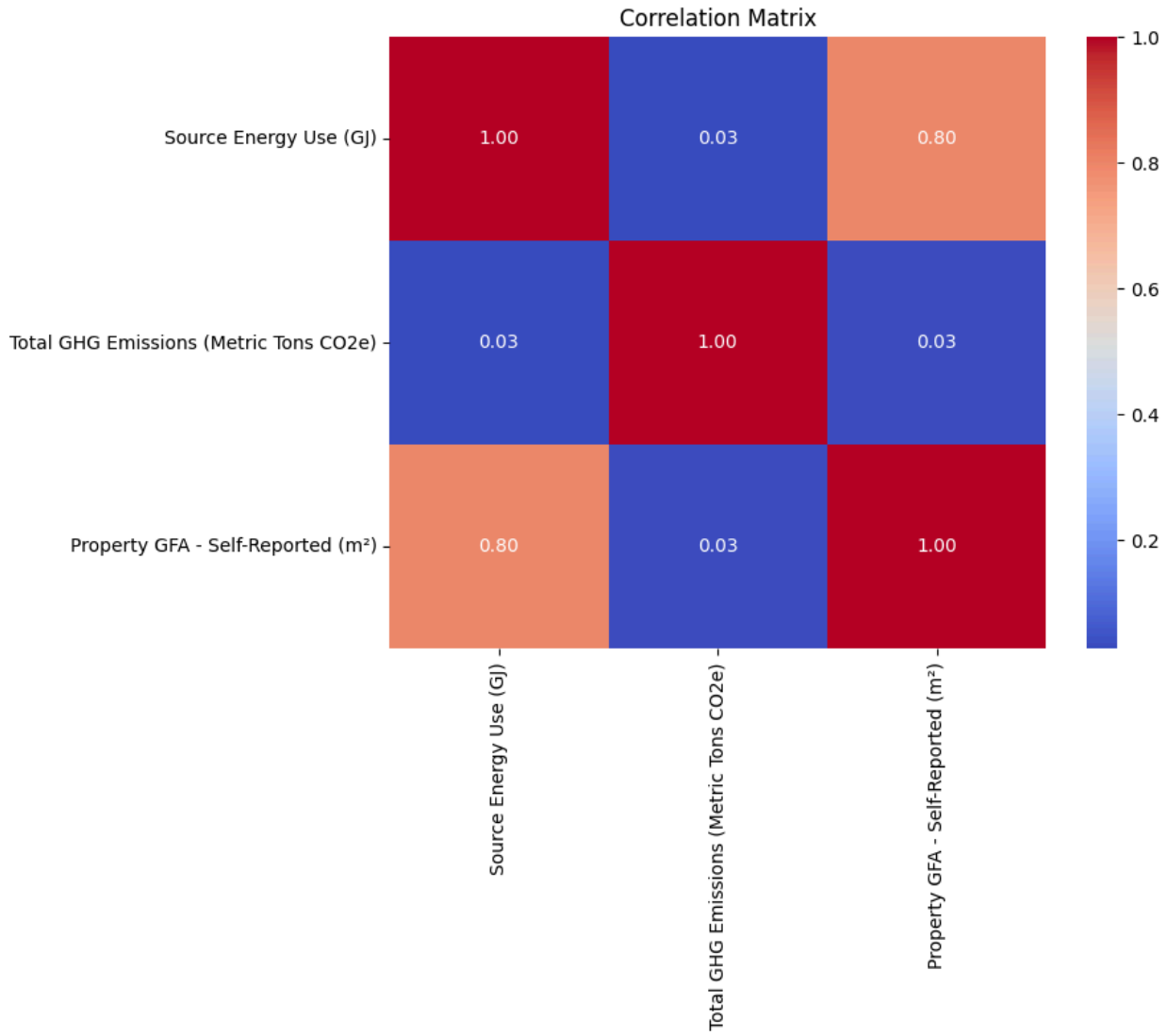
- **Operational Requirements:** Some property types, by their nature, have higher energy demands (e.g., manufacturing facilities, data centers).
- **Building Design and Construction:** Differences in building design, insulation, and window glazing can significantly impact energy performance.

3.3 Recommendations:

- **Tailored Strategies:** Develop and implement energy efficiency strategies specific to each property type.
- **Building Codes and Standards:** Strengthen building codes and energy standards to ensure new construction and renovations are energy-efficient.

- **Technology Adoption:** Encourage the adoption of energy-efficient technologies and building materials.

4. Source Energy Use and Property GFA



4.1 Key Observation:

The correlation matrix shows a strong positive correlation between Source Energy Use and Property GFA (Gross Floor Area), indicating that larger buildings generally consume more energy. Weak correlations were observed between Source Energy Use and Total GHG Emissions, and between Total GHG Emissions and Property GFA.

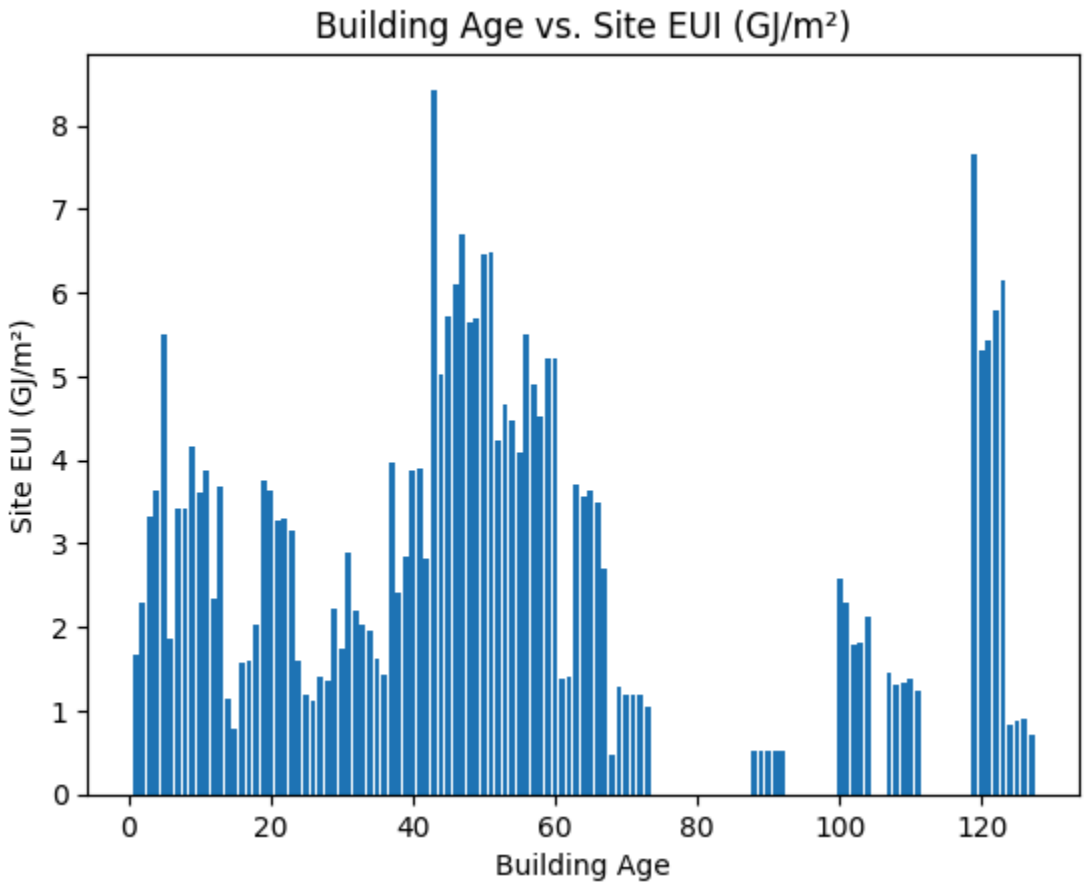
4.2 Possible Explanations:

- **Energy Efficiency Gap:** The weak correlation between energy use and GHG emissions suggests that current energy efficiency measures may not be effectively reducing GHG emissions. Other factors, such as the type of energy source used, may play a significant role.

4.3 Recommendations:

- **GHG Emission Reduction Strategies:** Develop and implement strategies to directly target GHG emissions, such as promoting renewable energy sources and reducing reliance on fossil fuels.
- **Comprehensive Analysis:** Conduct further research to understand the factors influencing GHG emissions and develop more effective mitigation strategies.

5. Building Age vs. Site EUI



5.1 Key Observation:

The bar graph titled "Building Age vs. Site EUI" shows a general trend of increasing EUI with increasing building age, although with many exceptions.

5.2 Possible Explanations:

- **Older Buildings:** Older buildings may have less efficient building envelopes, outdated equipment, and less efficient systems compared to newer, more energy-efficient buildings.

5.3 Recommendations:

- **Retrofitting Programs:** Implement programs to incentivize and support the retrofitting of older buildings to improve their energy efficiency.
- **Building Code Updates:** Regularly update building codes to incorporate the latest energy efficiency standards.

Overall Conclusions and Recommendations

- **Multi-pronged Approach:** A multi-pronged approach is needed to address energy consumption and GHG emissions in Calgary. This should include a combination of energy efficiency measures, renewable energy adoption, and policy interventions.
- **Data-Driven Decision Making:** Continuous monitoring, data analysis, and evaluation of implemented measures are crucial for effective energy management and GHG reduction.
- **Public Awareness and Engagement:** Raising public awareness about energy efficiency and encouraging public participation in energy conservation efforts are essential.

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