

# **CS506 Project Initial Analysis Report**

Topic: Mapping the Intensity of Energy Use Across Boston University

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## **Topic Description and General Questions:**

For this project, we aim to analyze the BU's building energy consumption data such as electricity and gas usage and figure out relationships between energy usage distribution and some potential energy consuming factors. After having a discussion with project partners from [Sustainability@BU](#), we predicted several potential key factors that might affect energy use at BU, which are:

- Months: the energy usage in different months.
- Building Directions: the face of direction to the sun.
- HVAC Efficiency: energy usage depending on different types of furnaces
- Windows: the number of windows and the existence of [French Windows](#)
- Building Age: the year in which the building was built.
- Human Occupancy(**TBD**): the number of people that use energy within buildings at different phases of academic years

## **Datasets used in this report**

We provided several data sets in the proposal. In this report, we used the [Building Energy Reporting and Disclosure Ordinance \(BERDO\)](#) data, which is the major data set for the project. This data set is provided by [Analyze Boston](#), and it contains reported buildings' energy usage data of the year 2015, 2016 and 2017 in Boston area. In each year's BERDO data set, it has around 1500 data entries(buildings); each of the entry contains properties such as site Energy Use Intensity(EUI), percentage of electricity/natural gas/steam used, etc.

## **Hypothesis and Questions Answered in this report**

To execute the analysis, we planned to use monthly BU building energy consumption data. Since BERDO data set only provides yearly energy consumption data, we need to split the data in monthly basis.

We made an initial assumption that since BU locates in Boston where cold weather spreads over half of the year, the energy usage between November and April surges greatly compared to other months. Also, we presumed that heating takes the highest percentage of BU's energy use.

We originally expected to get the monthly distribution of steam EUI as well, but it turns out that there are not many buildings reporting their steam EUIs. Therefore, we deleted several buildings that use steam as energy. Hence, based on the hypothesis we made, the main question that we investigate in our current work is to find the distribution of BU's monthly energy usage in electricity and natural gas.

## **Methods**

We used the distribution of yearly energy consumption over gas/electricity provided by Kevin Zheng from [Sustainability@BU](#). Then we did some simple matrix calculation to figure out the distribution of gas/electricity separately.

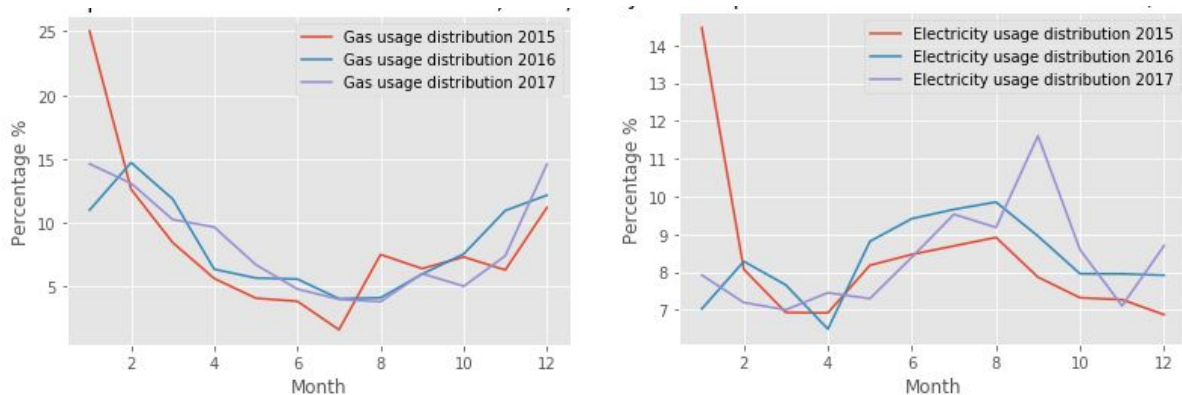
Then, we filtered the BERDO data to get the BU properties energy consumption data. We used [BERDO data map](#) and [BU map](#) to select building by hand. Then use data frame methods to filter out non-BU properties.

Finally, we generated the monthly energy data for each BU properties by multiplying the monthly distribution and the yearly data and get the result.

The code for this report is [here](#) and it is also attached when we submitted this report.

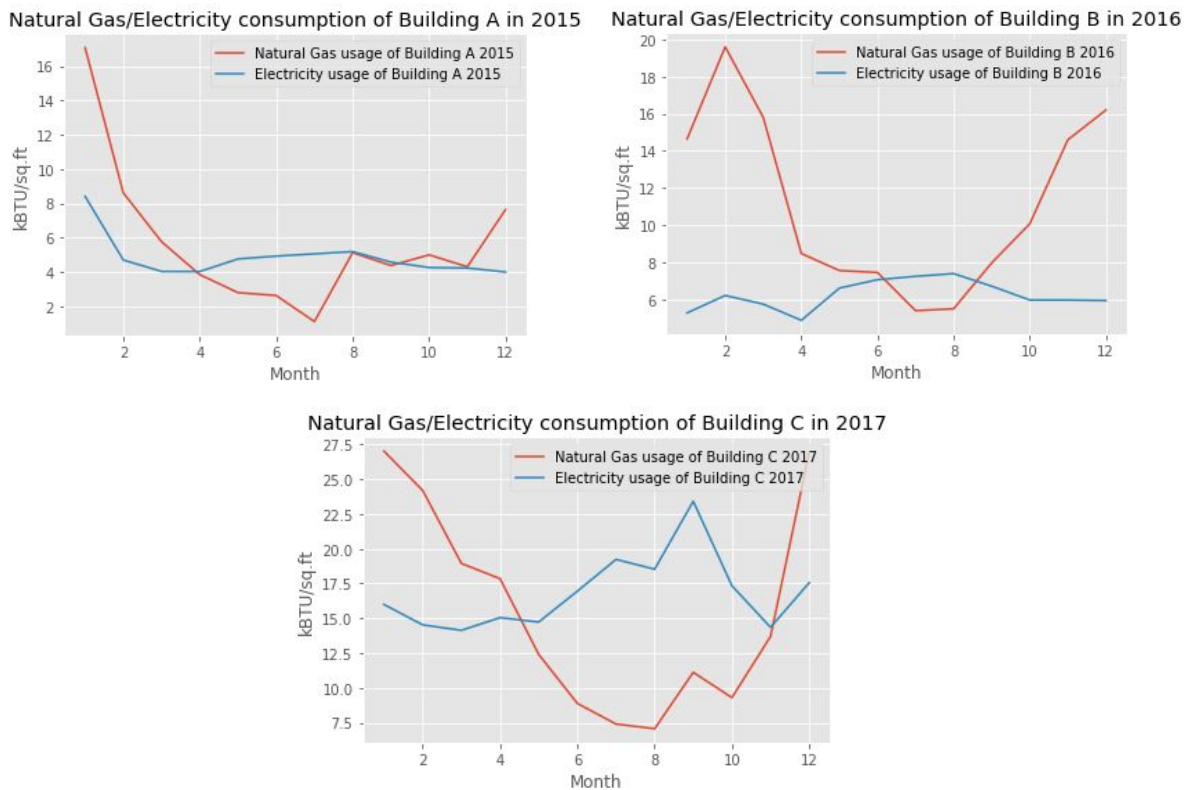
## **Results from Analysis**

Here are the monthly electricity/gas distribution visualizations:



As shown in figures above, for all of the three years, gas EUIs are relatively high between November and April because of continuously cold weather that people need heat to survive. On the contrary, gas EUIs are relatively low starting from May to September because these five months are the only ones that Bostonians will not suffer from cold weather.

After splitting the data into monthly basis, we get the distribution of gas EUI and electricity EUI for each BU buildings of year 2015, 2016 and 2017 and the visualizations are the following:



We detected some anomalies from the visualizations. As we can see above, both gas and electricity EUIs are extremely high in January 2015, and as we are aware of, during the start of the year 2015 there are snow storms that chilled out Boston in fairly severe ways and made massive destructions in Boston and even the entire New England. The snowfall of that year even broke the record of the past century; the day that BU canceled classes also outnumbered other years. Also, for September 2017, electricity usage is extremely high. However, according to [weather recap](#), September 2017 was an exceptional chill month in summer, thus this observation seems odd since other results are precise.

## **Conclusions**

According to results and analysis above, BU tends to use more gas when the weather is relatively cold since gas takes the role of heating up the university. As for electricity, it is normally most be used on warmer days because the community needs to turn up ACs and fans to cool down the temperature. Also, despite the first few months of the year 2015, the tendency of gas figure and electricity figure turned out to be in opposite directions, which formed situations that where there is a high usage of gas, electricity usage tends to be low, and low usage of gas reflects high usage of electricity. Based on the results we obtained, our initial

assumption which energy usage between November and April are comparatively high to other months stands true and heating does take most part of BU's energy.

### **Plans for Future Work**

For rest of this project, we will continue exploring some of the remaining factors which are more likely to find appropriate data including:

1. HVAC Efficiency: energy usage of different types of furnaces.
2. Building Age: the year in which the building was built.

Depending on the possibility of obtaining data and other approaches like collecting the data related to building direction on our own by walking across the campus, we might continue to explore the relationship between BU energy usage across the campus and following factors:

1. Building Directions: the face of direction to the sun.
2. Windows: the number of windows and the existence of [French Windows](#).
3. Human Occupancy(TBD): the number of people that use energy within buildings at different phases of academic years.



