Mapping Intensity of Energy Use in Boston

Mengxi Wang | Rui Chen | Jialiang Shi @Electrical and Computer Engineering, Boston University

Description

Analyze Boston's building energy usage intensity (EUI) and discover relationships between driving factors to help the University achieve its goal of becoming carbon neutral by 2040. Ideally, the analysis would help inform decisions made by sustainability@BU, the Climate Action Plan and the buildings team of Carbon Free Boston.

Main Questions

- What is the average EUI for each property type building in 2017?
- How (much) does the building's built-year affect average EUI for each property type of building?
- How (much) does structure class affect EUI of buildings?
- How do buildings with different property type vary with temperature?
- How do some variables affect EUI of multi-family/office building?

Methodology

- The methods we used includes data scraping, classification, linear regression, probability and statistics.
- In order to achieve the results, we have done the following things:

• Clean the energy consumption data among 2015-2017	• For building type /year of built /building structure: we use the data from BERDO to analyze.	• Cooling Degree Days (CDD) 2015-2017 • Heating Degree Days (HDD) 2015-2017

Data Analysis

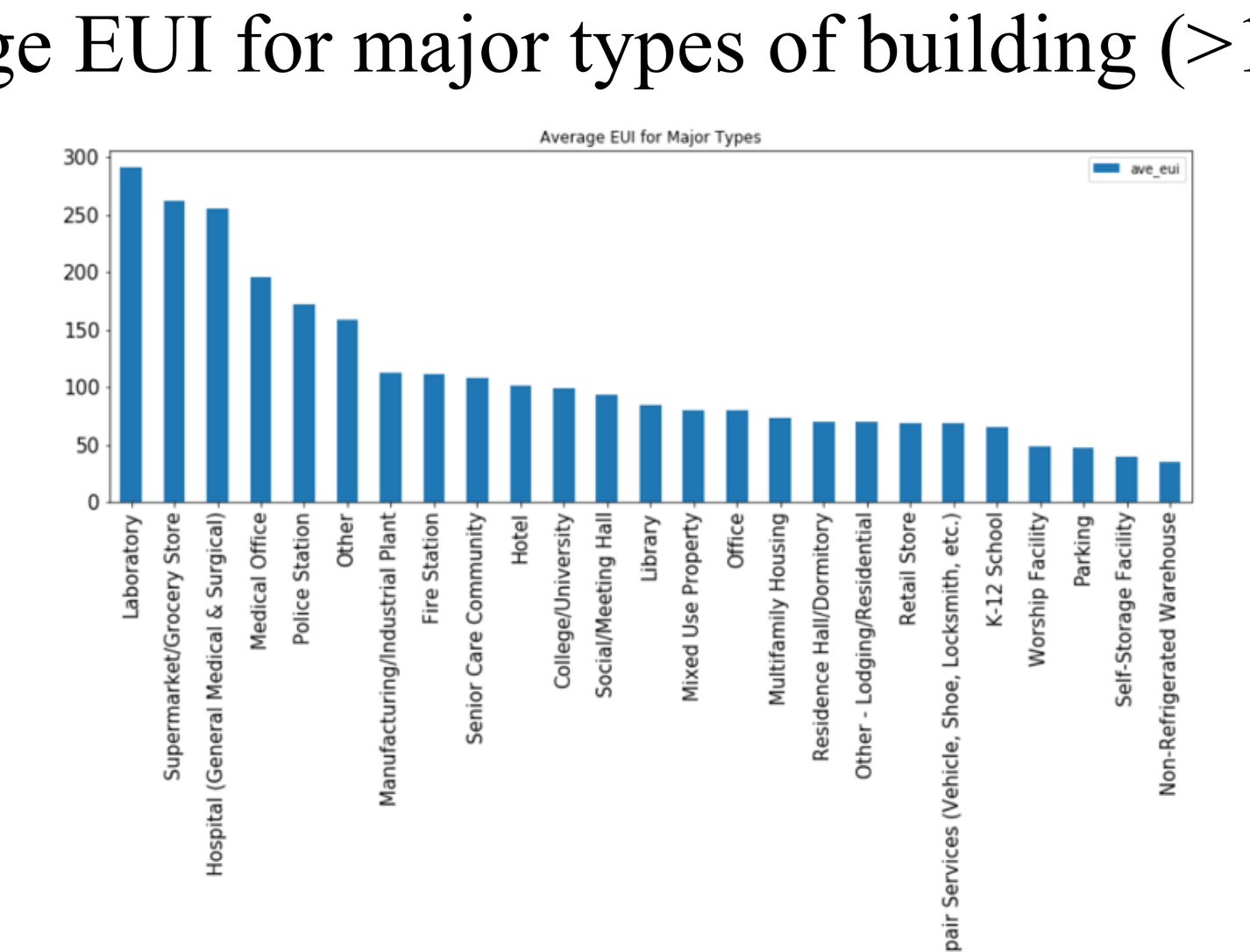
BERDO: core attribute of each building - EUI

Property Assessment dataset : other attributes

Building types

Data processing:

- Remove the unavailable EUI. The total number of building data reduced from 1800 to 1664. Detect and Remove Outliers
- Count the top most property types of buildings.
- Average EUI for major types of building (>10 samples)



Data analysis:

- TOP3 energy-consuming types of building: laboratory, supermarket/grocery store and hospital (general medical & surgical)
- Hypothetical conclusion: Public facilities & energy-consuming devices

Year of built

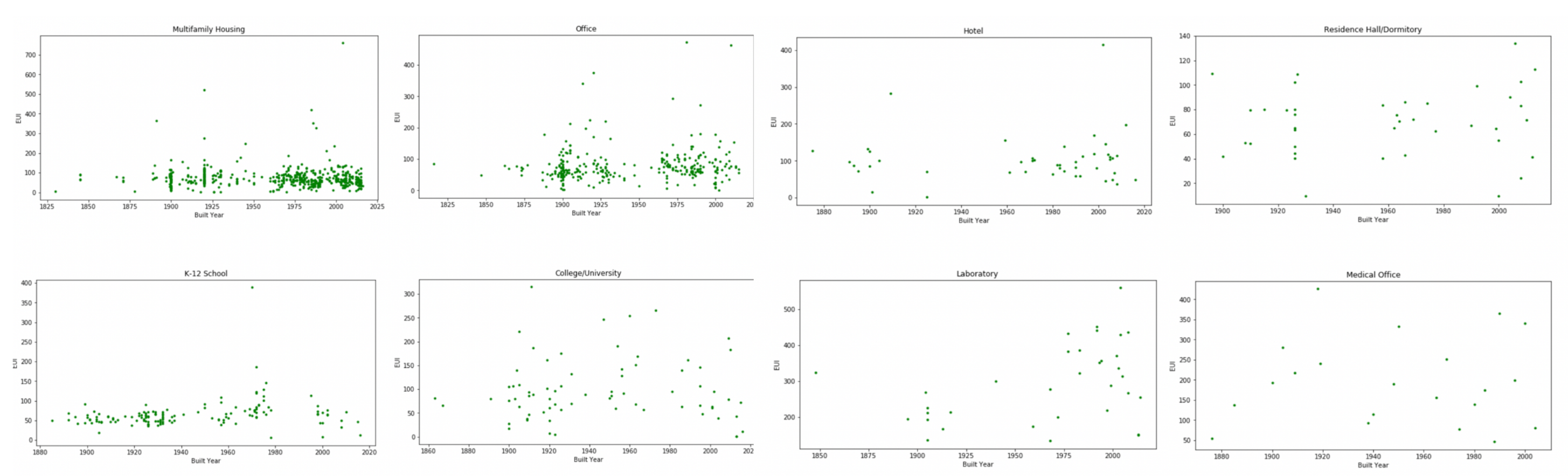
Data processing:

- How (much) does average EUI vary with the built year of the following types of buildings?

(*Types listed: Multifamily Housing; Office; School; College/University; Hotel; Residence Hall/Dormitory; Laboratory; Medical Office)*

Data analysis:

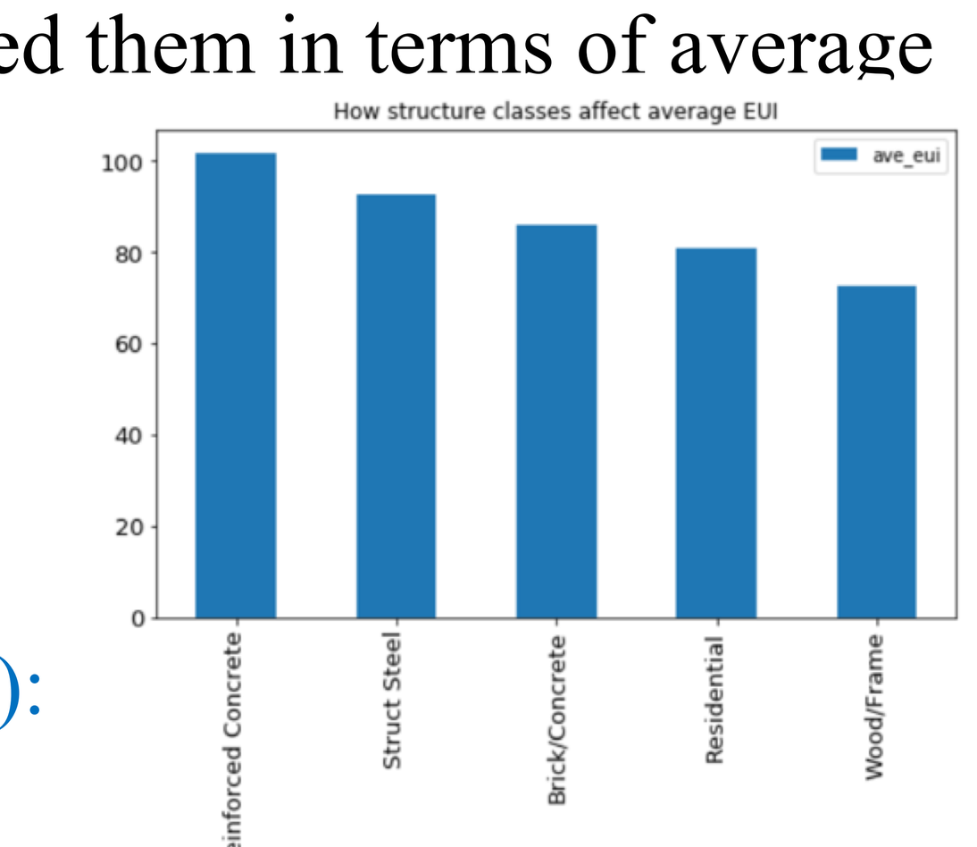
- The year of built do not affect EUI as much as we expected.
- Newly-built buildings are designed under the consideration of energy-saving, but they may be used in modern ways which consume more energy than we expected.
- Older buildings are designed without energy-saving consciousness, but are used in outdated and traditional ways which consume less energy.



Building structures

Data processing:

- For all 5 types of structure classes, we sorted them in terms of average EUI as follow.



Data analysis:

- Reinforce concrete buildings (Highest EUI):

Synthetic material

Poor performance in heat preservation and thermal insulation

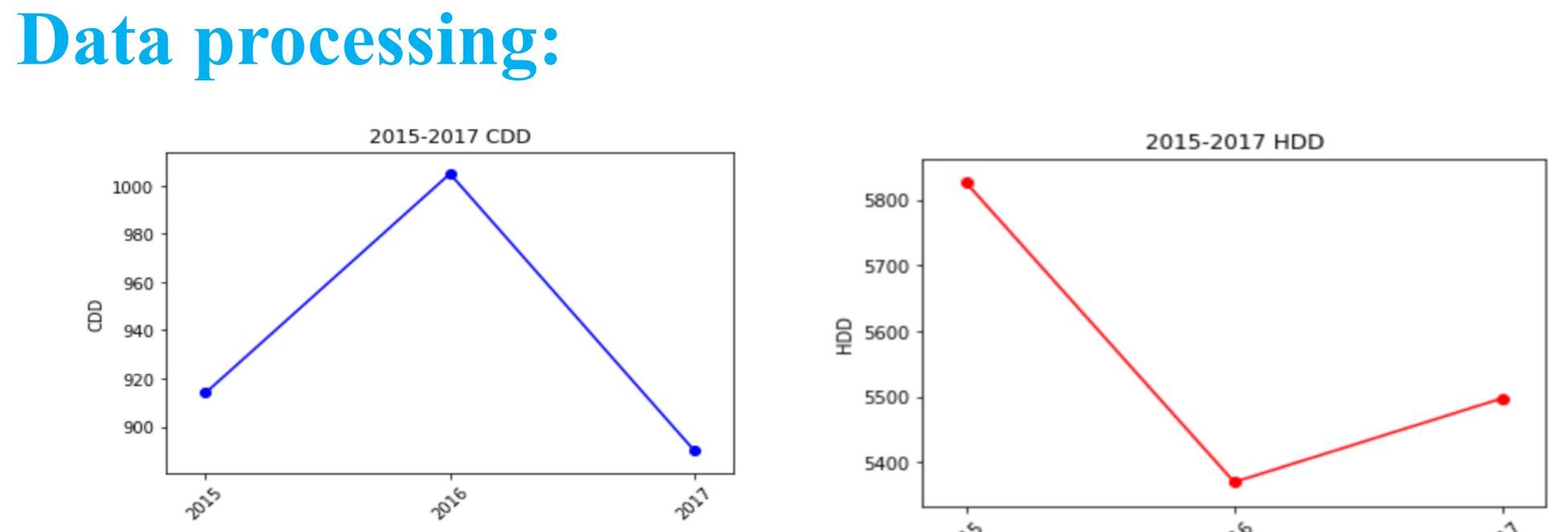
- Wood/frame buildings (Lowest EUI):

Natural material

Better performance in heat preservation and thermal insulation aspects

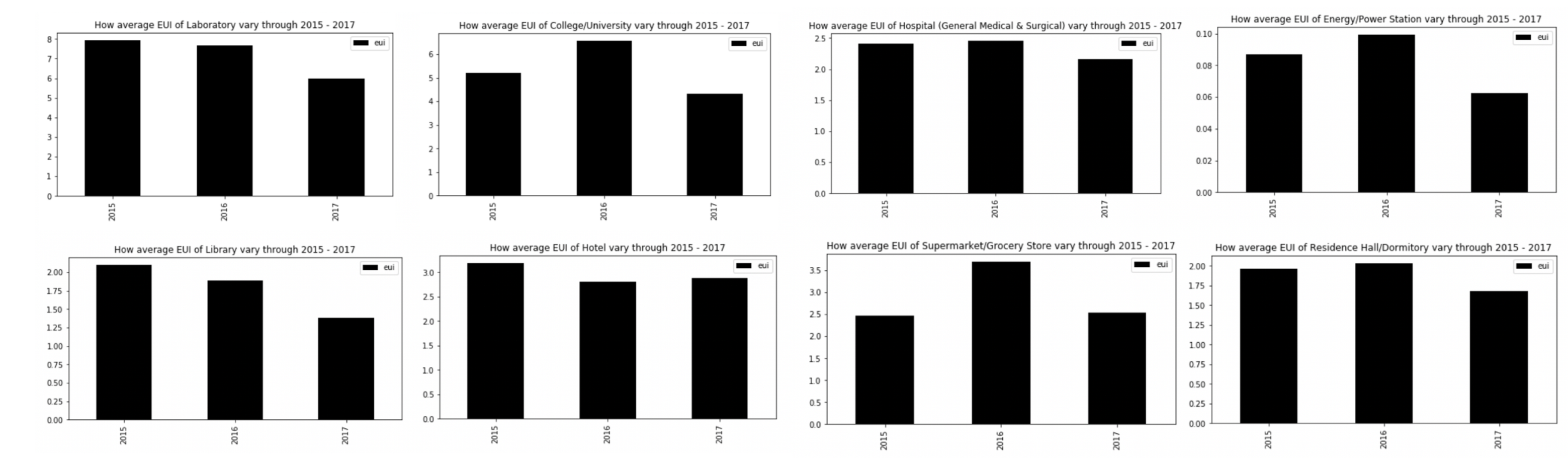
Temperature

Data processing:



- How total EUI varies through 2015-2017 for following major types of building?

(Types listed : Laboratory; College/University; Library; Hotel; Hospital; Energy/Power Station; Supermarket/Grocery Store; Residence Hall/Dormitory)

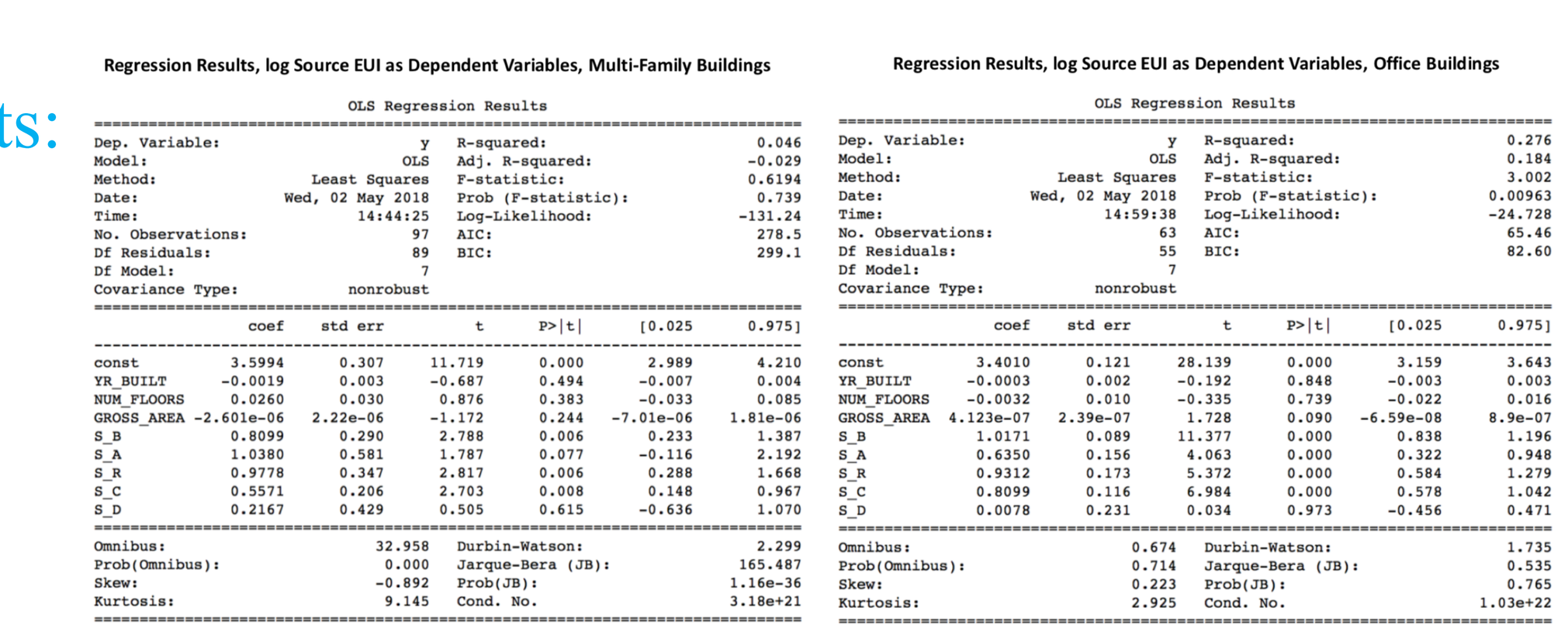


Data analysis:

- College/University, Hotel, Hospital, Energy/Power Station, Supermarket/ Grocery Store and Residence Hall/ Dormitory are proportional to CDD or HDD trend. (residence hall)
- Laboratory and Library are less sensitive to CDD or HDD trend. (non-residence hall)

Which variables significantly affect the EUI of multi-family/office building?

- Regression Results:



- Analysis:

- Older buildings are shown to be correlated with lower EUIs for both multi-family and office buildings. This finding is consistent with the results before and reinforces the link between older buildings and energy efficiency.
- There is a positive correlation between EUI and gross area for office buildings. Larger office buildings, therefore, are shown to have higher EUIs
- There is a negative correlation between EUI and gross area for multi-family buildings. Contrary to the findings for office buildings, larger multi-family buildings are found to be more efficient.
- The regression results show that the coefficients for number of floor of office buildings are negative, which means that offices with more floors are more efficient.

Future Step

- Analyze the main factors of EUI for other types of buildings like university, hotel and laboratory
- Develop a predictive model to create an energy performance benchmark or to estimate energy consumption for buildings. Method : Robust multiple regression techniques
- Try to solve the question that which structure or material should be used to construct each type of buildings to make them more efficient.