**Data 603**

**Project Final Report**

**Energy Consumption Analysis in Calgary**



**Group: 13**

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**1. Introduction**

**1.1. Motivation**

The domain that we will be working with for this project is Energy and sustainability of Calgary. Energy plays a fundamental role in our lives; everything requires energy in one form or another. Canada is in the top five of natural gas producers in the world; two-thirds of which come from Alberta. In 2017, the energy sector made up 9.2%, or $175 Billion, of Canada’s Gross Domestic Product (GDP) whereas, in Alberta the energy sector contributed 21.61% of provincial GDP. This is signiﬁcantly more than in the rest of Canada; the oil and gas sector make up a major part of economic activity in Alberta. As one of the major cities in Alberta, Calgary has long been known as an energy city and took on a lot of initiatives to encourage in becoming more energy efficient in the long run. In 2008, the City of Calgary developed the Sustainable Buildings Partnership Program to improve the performance of existing city infrastructure and support the sustainable building policy. The purpose of this program is to identify and improve the efficiency of existing corporate infrastructure. These is proposed to be done using audits, alternative energy technologies, conservation, and energy efficiency upgrades. We focused on addressing this context and investigate into energy consumption situation at City of Calgary.

**1.2. Objectives**

In our project we would like to analyze the energy consumption situations at different structure and facilities at City of Calgary. The goal of this project is to predict future energy use for the buildings and investigate the effects of different variables. We will perform multiple linear regression and we will use R studio to analyze the topic. This study is important to assess if the energy use of buildings and structures are in aligned with the sustainable building policy. Through this investigation, we aim to understand better energy efficiency and we aim to provide new insights as to whether the energy efficiency need to be improved.

**2. Methodology**

**2.1 Dataset**

The dataset we are using for this project is **Building Energy Benchmarking Data** fromthe City of Calgary webpage. This is a open dataset and available for public use; the reference of dataset is included in the reference section of this report. This dataset is open data in tabular format collected annually, collected over period 2019-2021 with 297 rows and 23 columns.

The City of Calgary’s Commercial and Institutional Building Energy Benchmarking Program facilitates in measuring and tracking the energy performance of any commercial, institutional or non-profit organization with a building of any size that is located within the city boundary. This dataset contains building energy and greenhouse gas emission performance information for a subset of properties owned and operated by the City of Calgary. All energy and greenhouse gas emission metrics are calculated by ENERGY STAR Portfolio Manager using monthly, whole-building energy consumption data billed between January 1st and December 31st. This initiative is significant in obtaining standardized information on building energy consumption, energy costs and greenhouse gas emissions and also assisting in becoming eligible for ENERGY Star® Certification. collected from City of Calgary open data website, available for public use. In this dataset, there are 17 different types of property built from 1896 to 2018 including fire station, ice rink, office, recreation center, heated swimming pool etc.

**2.2 Approach**

We imported the data in RStudio for our analysis by first using the “read.csv” and created the ‘dataset’ data frame. The data we needed for our regression analysis included the dependent variable Site Energy as a function of twenty independent variables, we will build full model first with all these variables. Then from this point forward we will try to improve our model.

All variables in the dataset are as follows:

1. Site Energy: The annual amount of all the energy a property consumes on-site, regardless of the source, dependent numerical variable
2. Property type: We have 17 different types of properties for this dataset, each type of property has multiple buildings; among the types of properties there are 107 fire-stations, 66 office buildings, 30 ice rinks, 24 fitness centers and few other different kinds of properties at different locations. This is categorical independent variable.
3. Number of Buildings: This represents how many buildings are present at a certain property, numerical independent variable.
4. Year built: This indicates either at which year the property was constructed or at which year the most recent major renovation was done including a complete interior redesign, categorical independent variable.
5. Property GFA: This includes the total property gross floor area, numerical independent variable.
6. Energy Star Score: A measure of how well a property is performing relative to similar properties, when normalized for climate and operational characteristics. This is categorical independent variable.
7. Weather Normalized Site Energy Use (GJ): This indicates the energy use a property would have consumed during 30-year average weather conditions, numerical independent variable.
8. Site EUI (GJ/m²): The Site Energy Use divided by the property square meters, numerical variable, numerical independent variable.
9. Weather Normalized Site EUI (GJ/m²): The Weather Normalized Site Energy Use divided by the property square meters, numerical independent variable.
10. Source Energy Use (GJ): The total amount of all the raw fuel required to operate a property, including losses that take place during generation, transmission, and distribution of the energy, numerical independent variable.
11. Weather Normalized Source Energy Use (GJ): The source energy use your property would have consumed during 30-year average weather conditions, numerical independent variable.
12. Source EUI: The Source Energy Use divided by the property square meters, numerical independent variable.
13. Weather Normalized Source EUI (GJ/m²): The Weather Normalized Source Energy Use divided by the property square meters, numerical independent variable.
14. CO2 Emission: Total Emissions is the sum of Direct Emissions and Indirect Emissions, numerical independent variable.
15. CO2 Emissions Intensity: Total GHG Emissions divided by the property square meters, numerical independent variable.
16. Direct GHG Emissions: Direct Emissions of CO2 as greenhouse gas are emissions associated with onsite fuel combustion (e.g. combustion of natural gas or fuel oil), numerical independent variable.
17. Direct GHG Emissions Intensity: Direct GHG Emissions divided by the property square meters, numerical independent variable.
18. Electricity: Total annual electricity used from the grid, numerical independent variable.
19. Natural Gas: Total annual Natural Gas used annually, numerical independent variable.
20. Electricity Use – Generated from Onsite Renewable System: The total amount of energy produced by onsite solar/wind), numerical independent variable.
21. Year Ending: The last day of the 12-month reporting period, numerical independent variable.

**References**

Canada Energy Regulator-Energy in Canada [Online]. Available at: <https://www.cer-rec.gc.ca/en/about/publications-reports/annual-report/2018/energy-in-canada.html#:~:text=Canada%20is%20currently%20ranked%20the,and%20future%20needs%20of%20Canadians> (Accessed November 6, 2022)

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