Electricity Usage in Toronto's Public Facilities: Analyzing the Impact of Building Size on Energy Consumption*

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September 24, 2024

This study examines the relationship between building size(GFA) and electricity consumption in Toronto's public facilities. Data from over 500 buildings, including schools,libraries, and hospitals, show a consistent positive correlation between GFA and eletricity usage. Larger facilities, particularly healthcare centers, demonstrate higher energy consumption per square meter. These results help inform efforts to improve energy management in Toronto's public buildings.

1 Introduction

Public infrastructure, including schools, libraries, healthcare centers, and government offices, forms the backbone of urban services in any modern city. As Toronto continues to expand, managing electricity usage in public buildings becomes increasingly critical. Energy efficiency in public facilities not only reduces operational costs but also contributes to environmental goals, such as carbon reduction and climate change mitigation(Droege 2018).

One of the primary determinants of electricity consumption is building size, commonly measured as Gross Floor Area (GFA). Larger buildings tend to consume more energy for lighting, heating, cooling, and equipment operations, but this relationship is influenced by other factors such as building type, operational hours, and energy management systems (**hong2019occupant?**). As such, it is crucial for policymakers to understand how building size and other factors influence electricity consumption in Toronto's public facilities (**li2011managing?**).

Several studies have shown that energy efficiency measures in public buildings can lead to significant reductions in electricity consumption. For example, retrofitting large government

*Code and data are available at: https://github.com/zilin1017/Toronto_annual_energy_consumption.git.

buildings or healthcare facilities with modern energy management systems can reduce energy use, while smaller buildings like libraries and schools often exhibit lower per-square-meter energy consumption (**eto2012impact?**; **santamouris2016innovative?**).

This paper explores the relationship between Property GFA (m^2) and electricity usage (kWh) in over 500 public facilities in Toronto. The study aims to identify patterns in electricity consumption and provide insights for optimizing energy use in Toronto's public sector.

2 Data

Some of our data is of penguins (**?@fig-bills**), from Horst, Hill, and Gorman (2020).

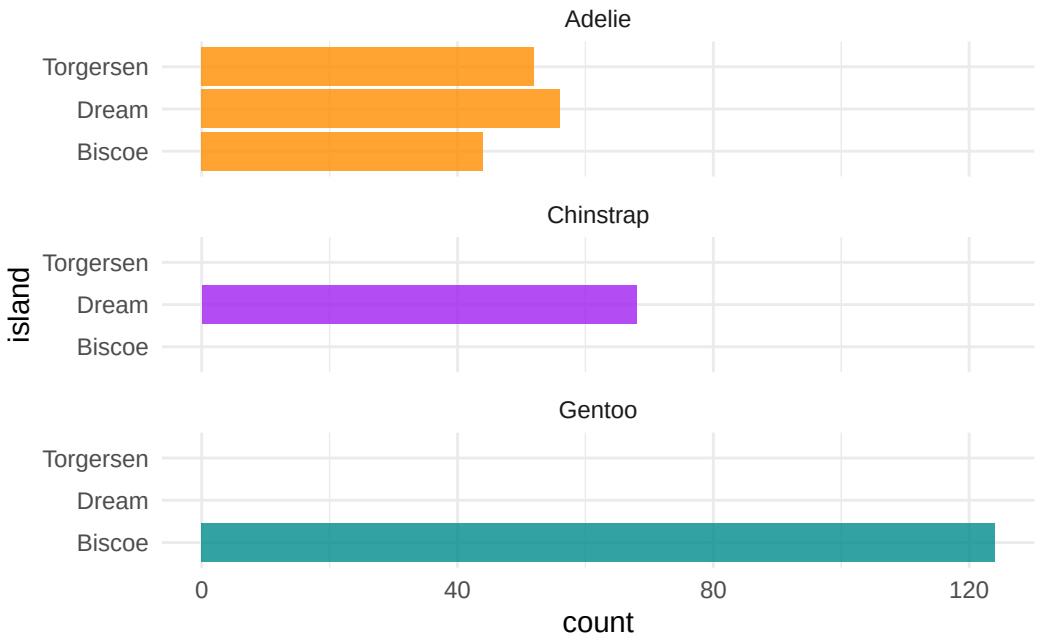

Figure 1: Density Plot for Property Area in Toronto

Talk more about it.

And also planes (**?@fig-planes**). (You can change the height and width, but don't worry about doing that until you have finished every other aspect of the paper - Quarto will try to make it look nice and the defaults usually work well once you have enough text.)

Talk way more about it.

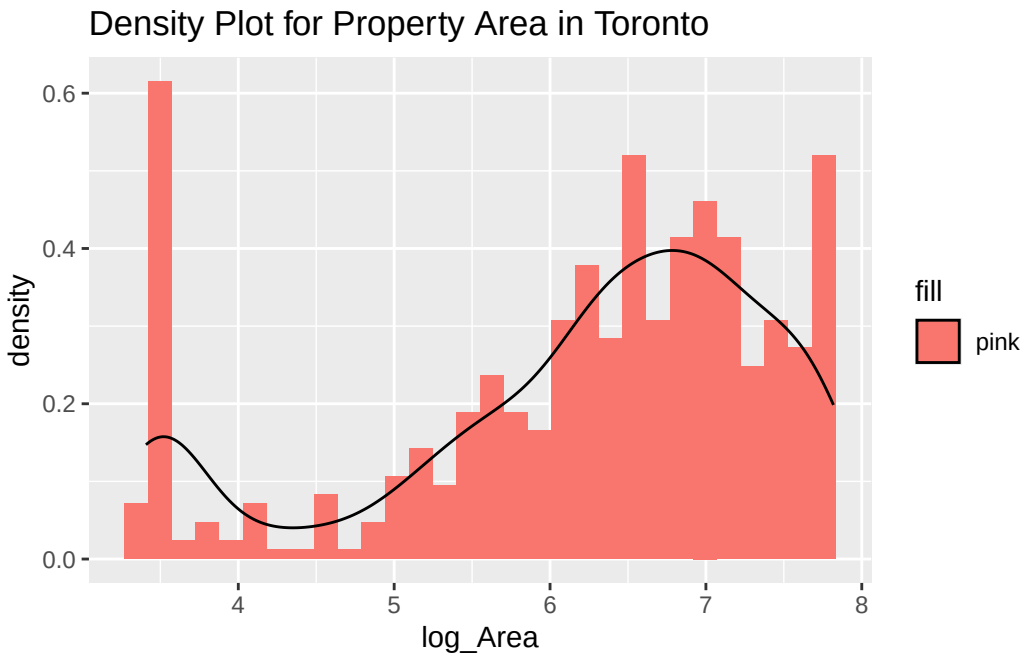

Figure 2: Relationship between wing length and width

3 Model

The goal of our modelling strategy is twofold. Firstly,...

Here we briefly describe the Bayesian analysis model used to investigate... Background details and diagnostics are included in Appendix B.

3.1 Model set-up

Define y_i as the number of seconds that the plane remained aloft. Then β_i is the wing width and γ_i is the wing length, both measured in millimeters.

Table 1: Explanatory models of flight time based on wing width and wing length

$$y_i|\mu_i, \sigma \sim \text{Normal}(\mu_i, \sigma) \tag{1}$$
$$\mu_i = \alpha + \beta_i + \gamma_i \tag{2}$$
$$\alpha \sim \text{Normal}(0, 2.5) \tag{3}$$
$$\beta \sim \text{Normal}(0, 2.5) \tag{4}$$
$$\gamma \sim \text{Normal}(0, 2.5) \tag{5}$$
$$\sigma \sim \text{Exponential}(1) \tag{6}$$

We run the model in R (**citeR?**) using the `rstanarm` package of Goodrich et al. (2022). We use the default priors from `rstanarm`.

3.1.1 Model justification

We expect a positive relationship between the size of the wings and time spent aloft. In particular...

We can use maths by including latex between dollar signs, for instance θ.

4 Results

Our results are summarized in Table 1.

5 Discussion

5.1 First discussion point

If my paper were 10 pages, then should be be at least 2.5 pages. The discussion is a chance to show off what you know and what you learnt from all this.

5.2 Second discussion point

5.3 Third discussion point

5.4 Weaknesses and next steps

Weaknesses and next steps should also be included.

Appendix

A Additional data details

B Model details

B.1 Posterior predictive check

In **?@fig-ppcheckandposteriorvsprior-1** we implement a posterior predictive check. This shows…

In **?@fig-ppcheckandposteriorvsprior-2** we compare the posterior with the prior. This shows…

Examining how the model fits, and is affected
by, the data

B.2 Diagnostics

?@fig-stanareyouokay-1 is a trace plot. It shows… This suggests…

?@fig-stanareyouokay-2 is a Rhat plot. It shows… This suggests…

Checking the convergence of the MCMC algo-
rithm

References

Droege, Peter. 2018. *Urban Energy Transition: Renewable Strategies for Cities and Regions*. Elsevier. https://books-scholarsportal-info.myaccess.library.utoronto.ca/en/read?id=/ebooks/ebooks0/elsevier/2009-12-02/1/9780080453415.

Goodrich, Ben, Jonah Gabry, Imad Ali, and Sam Brilleman. 2022. "Rstanarm: Bayesian Applied Regression Modeling via Stan." https://mc-stan.org/rstanarm/.

Horst, Allison Marie, Alison Presmanes Hill, and Kristen B Gorman. 2020. *Palmerpenguins: Palmer Archipelago (Antarctica) Penguin Data*. https://doi.org/10.5281/zenodo.3960218.