2026 CANADIAN STATA CONFERENCE

Energy Efficient or Carbon Efficient?

Examining Building Performance in British Columbia

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INTRODUCTION

Buildings that consume less energy are often considered more environmentally friendly. However, lower energy consumption does not always mean lower greenhouse gas emissions, especially in British Columbia, where electricity and natural gas have very different emissions factors.

Two common measures of building performance are Energy Use Intensity (EUI), which measures energy consumption per square metre, and Greenhouse Gas Intensity (GHGI), which measures emissions per square metre.

Understanding how these measures compare is important when deciding which buildings should be prioritized for upgrades. Relying on energy consumption alone could overlook buildings where changes in heating systems or energy sources would produce larger emissions reductions.

RESEARCH QUESTION

To what extent do EUI and GHGI tell the same story about building performance in British Columbia, and what building characteristics may explain differences between them?

HYPOTHESIS

Buildings with higher EUI are expected to have higher GHGI. However, differences in heating fuels, building types, and mechanical systems may cause buildings with similar energy consumption to have different carbon emissions.

DATA & METHODOLOGY

This study uses publicly available building and energy data from three sources:

* **Edalatnia and Das (2024):** EUI and GHGI measurements for 23 social and affordable housing buildings in BC, using 2020 observations.
* **Building Benchmark BC:** Published building-type averages and five-year energy and emissions trends.
* **BC Community Energy and Emissions Inventory:** 2022 residential electricity and natural gas data for Abbotsford, Surrey, Vancouver, and Victoria.

An Ordinary Least Squares (OLS) regression was estimated to examine the relationship between building-level EUI and GHGI:

$$GHGI_i = \beta_0 + \beta_1 EUI_i + \varepsilon_i$$

Additional analysis compared building categories, energy sources, and changes over time. Electricity consumption was converted into comparable energy units, while annual trends were indexed to 2020 = 100. All analyses were completed in R, with each dataset examined separately.

REFERENCES

Edalatnia, S., & Das, R. R. (2024). *Energy and Buildings, 313*, 114259.
Building Benchmark BC. *Annual Reports 2024 & 2025.*
Government of British Columbia. *Community Energy and Emissions Inventory (CEEI), 2022.*

RESULTS & ANALYSIS

The following analyses compare energy and carbon performance across buildings, energy sources, and time.

BUILDING-LEVEL REGRESSION

An OLS regression examines EUI and GHGI across 23 BC housing buildings. The shaded band shows the 95% confidence interval for the fitted mean.

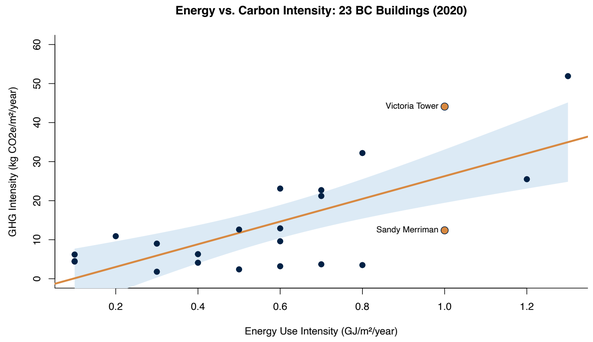


Figure 1. Building-level EUI and GHGI, 2020. Source: Edalatnia & Das (2024).

A positive relationship exists, but similar energy use can still produce very different emissions.

The association is significant (β = 29.067, R^2 = 0.509, p = 0.000132). Yet Sandy Merriman and Victoria Tower report the same EUI of 1.0 GJ/m²/year but GHGI values of 12.4 and 44.1 $kgCO_2e/m^2$/year.

BUILDING-TYPE COMPARISON

Average EUI and GHGI are compared across eight BC building categories.

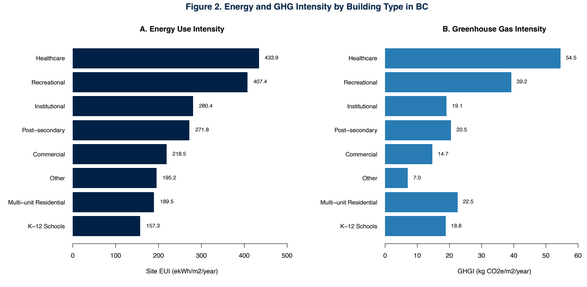


Figure 2. Building-category averages. Source: Building Benchmark BC, Annual Report 2024.

Buildings with higher energy intensity do not always rank higher in carbon intensity.

Commercial buildings have higher EUI than multi-unit residential buildings (218.54 versus 189.47 ekWh/m²/year), but lower GHGI (14.68 versus 22.49 $kgCO_2e/m^2$/year).

RESIDENTIAL FUEL SOURCES

Electricity and natural gas consumption and emissions are compared across four BC cities in 2022.

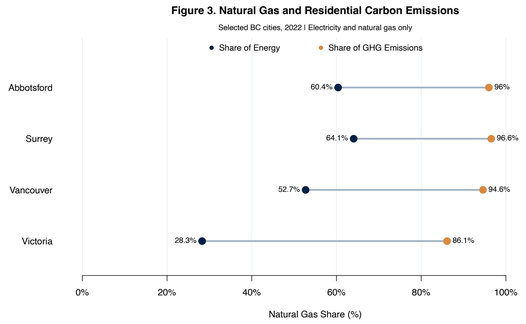


Figure 3. Natural gas shares of electricity-plus-gas energy and emissions. Source: BC CEEI (2022).

Natural gas accounts for a much larger share of residential utility emissions than its energy use.

In Victoria, natural gas accounts for 28.3% of the combined electricity and natural gas consumption, but 86.1% of the emissions from these two energy sources. This shows how energy sources affect emissions.

ENERGY AND EMISSIONS TRENDS

Indexed trends compare energy consumption and emissions across 707 buildings from 2020 to 2024.

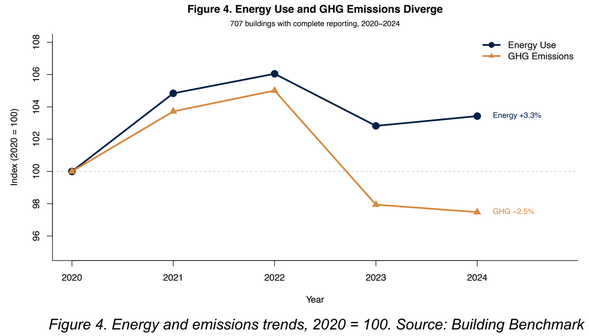


Figure 4. Energy and emissions trends, 2020 = 100. Source: Building Benchmark BC, Annual Report 2025.

Total energy consumption increased while greenhouse gas emissions declined.

Energy use increased by 3.3%, while greenhouse gas emissions decreased by 2.5%. The report explains that divergence was due to changes in energy use, the types of energy being used, and emissions factors.

DISCUSSION

Why might energy and carbon performance differ?

The results suggest that energy consumption alone does not fully describe a building's carbon performance. An important factor is the energy source. Electricity in BC generally has a lower emissions intensity than natural gas, meaning buildings with similar energy consumption can produce different levels of emissions.

Edalatnia and Das (2024) also identify building age, floor area, and mechanical systems as factors associated with building performance. Older gas-fired boilers, building envelopes, and ventilation requirements may help explain differences between properties.

These explanations are consistent with the observed patterns, although our regression did not independently test the impacts of these building characteristics.

For building owners and policymakers, the findings suggest that retrofit decisions should consider both energy efficiency and carbon emissions, rather than relying on only one measure.

LIMITATIONS & FUTURE RESEARCH

The regression uses a small sample of 23 social and affordable housing buildings, with rounded EUI values and no controls for heating fuel, age, size, or location. Supporting datasets cover different years and populations.

The results show associations rather than causation. Future research could use a larger building-level dataset and multivariable regression to examine the separate effects of building characteristics.

CONCLUSION

While EUI and GHGI showed a significant positive relationship (R^2 = 0.509), energy intensity alone did not fully account for differences in carbon emissions. Across 707 BC buildings, energy consumption even increased by 3.3% while emissions declined by 2.5%.

These findings challenge the idea that reducing energy use automatically means reducing carbon emissions.

So, if the goal is decarbonization, success cannot be measured by energy savings alone. Building owners and policymakers must consider both energy and carbon intensity, alongside the fuels used to power buildings.