CASE STUDY

BUILDING INNOVATION

BC HOUSING RESEARCH CENTRE

This series shares BC Housing's lessons learned as it moves towards requiring low carbon, more resilient, affordable housing in B.C. Topics feature building to the BC Energy Step Code, Passive House, and more.

This case study reviews cost and energy performance of 38 BC Housing buildings, highlighting 3 in greater detail.

Does High Performance Construction Cost More?

The Data Says: High Performance Does Not Have to Cost More

Building Codes at the City of Vancouver, Province of B.C., and the Federal Government all indicate that buildings will move to net-zero energy ready performance levels by 2032 at the latest. In B.C., all Part 3 buildings (typically anything over three stories) need to achieve Step 2 of the BC Energy Step Code, and will need to achieve Step 3 by 2027 and Step 4 or Passive House standard by 2032.

BC Housing is requiring higher performance levels: all Part 3 buildings need to be Step 3 or higher, and Step 4 is required for Part 3 buildings up to six stories in Climate Zone 4. All Part 9 buildings need to be built to Step 4.

Housing affordability is a major challenge in B.C., so there are concerns that higher performance requirements will lead to higher costs. Zero Emission Building Exchange (ZEBx) performed a costing evaluation of five Step 4 and two Passive House mid-rise MURBs constructed in different B.C. locations. The study found that the Passive House buildings cost six percent and 11 percent more than conventional. The Step 4 buildings ranged from 32 percent less cost to 22 percent more than conventional with an average of four-point-one percent less cost than conventional. This ZEBx study, performed in 2021, had a small sample size. To provide more data to support this discussion, BC Housing looked at the energy performance and cost of 38 buildings. These buildings became operational between the middle of 2018 to early 2021. Of the buildings being presented in this case study, 31 achieved Step 3 of the BC Energy Step Code, three achieved Step 4, and four were rated Passive House. This case study highlights the overall results of 38 buildings, with special attention to the design and performance of three specific buildings, one Step 4 and two Passive House.

Photo: Lance Sullivan

Cautionary Note: *The cost and performance data presented on the 38 BC Housing projects represent overall trends. Many other factors influence cost and energy performance including building type from llow-rise to high-rise, construction year, location, building amenities such as commercial kitchens, etc. Step 3 and Step 4, used throughout this document, refer to the steps of the BC Energy Step Code.*

Disclaimer: In this study, "cost" refers to the average expenses associated with buildings constructed between 2018 and 2021.

Photo: BC Housing

BUILDING 1

Five-storey multi-unit residential building (MURB) over a ground floor commercial space.

BUILDING 2

Two-storey, wood-framed townhouse development incorporating traditional Indigenous cultural elements into living spaces.

Photo: Lance Sullivan

Photo: BC Housing

BUILDING 3

Three-storey, wood framed MURB on concrete raft slab foundation, built using a mix of on-site and off-site construction.

Thirty-Eight BC Housing Projects

This case study reviews the cost and energy performance of 38 BC Housing buildings with three buildings being highlighted in more detail. The construction and performance details of the three buildings are highlighted in Table 1.

Table 1: Construction and Performance Details of Buildings

	BUILDING 1	BUILDING 2	BUILDING 3
Client	Mixed use development	Low Income Individuals and Families	Homeless & At-Risk of Homelessness
City	Langford	Nanaimo	Merritt
Operational Start	2020	2018	2018
Floor Area (m^2)	6,338	2,465 in 3 buildings	1,806
Total Units	Three-bedroom: 5 Two-bedroom: 18 One-Bedroom: 9 Studios: 3	Three-bedroom: 12 Two-bedroom: 3 One-bedroom: 6 Studios: 4	Units: 30 Accessible: 4 Studios: 19 One-bedroom: 11
Energy Level	Step 4	Passive House	Passive House
Construction Cost[i]	10% below average	38% below average	20% below average
Modelled TEDI[ii]	12.4 kWh/m^2	15.9 kWh/m^2	14.3 kWh/m^2
Modelled TEUI[iii]	77.7 kWh/m^2	49.9 kWh/m^2	75.5 kWh/m^2
Actual TEUI	87.8 kWh/m^2	87.3 kWh/m^2	95.2 kWh/m^2
Actual GHGI[iiii]	0.9 $kgCO_2e/m^2$	0.9 $kgCO_2e/m^2$	1.0 $kgCO_2e/m^2$
Heating & Cooling System	Electric baseboard heating, no cooling	Electric resistance duct heaters for heating, no cooling	VRF heat pump system for heating and cooling
Ventilation System	Central 85% efficient ERV with recirculating range hoods, including thermal bypass and filtration	Individual 92% efficient HRV with recirculating range hood, including thermal bypass and filtration	Seven central ERVs, (6 at 84%, one at 92% efficiency), including thermal bypass and filtration
Hot Water System	In-suite electric tanks	CO_2 based air to water heat pump	Two CO_2 based air to water heat pump and solar hot water heating
Other Amenities	Commercial rental units, bike storage	Laundry room	Consulting rooms, laundry room on each floor, multi-purpose room with kitchen, central elevator. Solar PV and solar hot water.

i: Average refers to the average expenses associated with the 38 buildings constructed between 2018 and 2021 in this study.
ii: TEDI is the thermal energy demand intensity reported with kWh/m2/year
iii: TEUI is the total energy use intensity reported in kWh/m2/year
iiii: GHGI is the greenhouse gas intensity related to the energy consumption in kgCO2e/m2

Average Costs for High Performance in Same Range as Standard Construction

On average, buildings consumed 56 percent more energy than modelled, with a range of 50 percent less to 273 percent more. Nine had lower than modelled consumption, whereas 29 had more.

There are a range of reasons why buildings consume more energy than predicted:

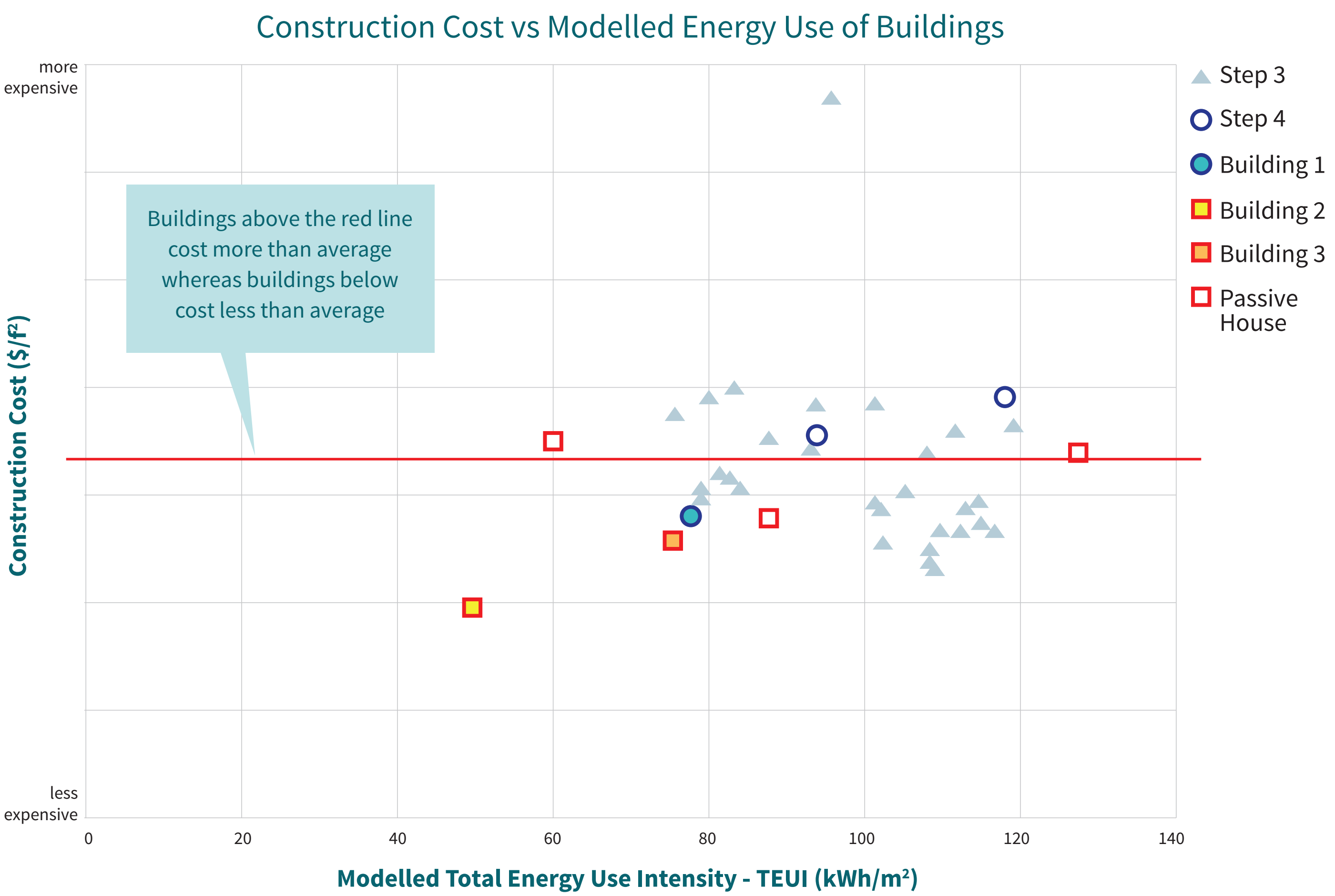
- **Operational Efficiency:** It's possible that the system might not be operating as efficiently as predicted.
- **Historic Weather:** Energy models use normalized and historical weather data, which is different than the climate experienced in the monitored year.
- **Different Occupancy than Modelled:** Energy modelling for code compliance often requires the use of standard occupancy schedules and loads and it may not reflect the reality.

Figure 1 compares the modelled energy use intensity to actual construction costs and shows there is no trend between the cost of construction and modelled performance. The fact that there is no clear correlation or relationship between cost and performance is an important finding.

Cost vs Performance: No Relationship Between Higher Performance and Higher Cost

The fact that there is no clear correlation or relationship between cost and performance is an important finding. In fact, the average cost for the Step 3 buildings was seven percent higher than for the Step 4 and Passive House buildings. Building 2 had the lowest construction costs and the lowest modelled energy use. Part of its lower cost can be attributed to the fact that Building 2 is a row-house building, which is typically less expensive than larger Part 3 MURBs.

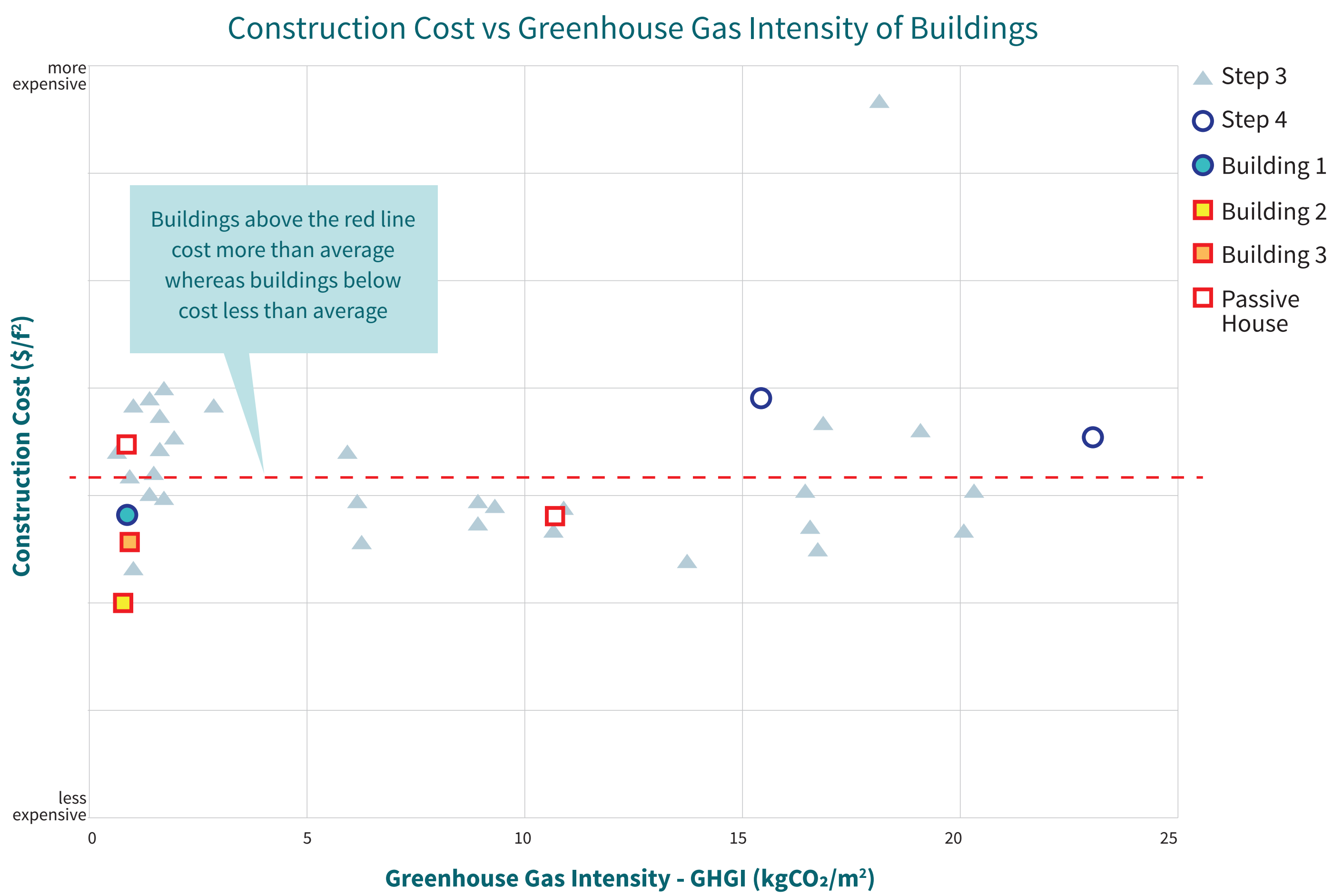
Figure 1: Comparing modelled energy use intensity to actual construction costs



One of the main objectives of increasing energy efficiency requirements is to decrease greenhouse gas (GHG) emissions from buildings. Figure 2 looks at how construction costs vary with GHG emissions. The cluster of points on the left of the figure with low GHG emissions represent all-electric buildings.

There is no trend between construction costs and GHG emissions. The average cost of buildings with a greenhouse gas intensity (GHGI) under five was three percent lower than the average cost, whereas those with a GHGI above five were two percent higher than the average cost. A single outlier was an exception with significantly higher costs.

Figure 2: Cost Compared to Greenhouse Gas Intensity



There is no clear correlation or relationship between cost and performance.

Sustainability & Resilience

BC Housing continuously reviews how best to mitigate our climate and other ecological impacts while simultaneously adapting our buildings to ensure they are safe for tenants in a changing climate. Technical Bulletin No. 3 outlines increasing requirements: lower GHG intensity targets, increased filtration for wildfire smoke, and enhanced thermal safety requirement. These new requirements will not necessarily impact cost, as some buildings are already meeting them. For example, the three high-lighted buildings include a ventilation system capable of adding a Minimum Efficiency Reporting Value (MERV) 13 or better filters to address wildfire smoke. Technical Bulletin No. 3 highlights the importance of passive measures to help address thermal resilience.

Updated BC Housing Standards require any building without a full mechanical cooling system in all occupied spaces to complete a Thermal Comfort Evaluation. To ensure thermal safety, the evaluation needs to prove that the building will not exceed more than 20 overheating hours per year in any climate zone. This guideline is recommended in the City of Vancouver Energy Modelling Guidelines for buildings or spaces with vulnerable groups.

CONCLUSION

High Performing Buildings Can Be Built At or Below Cost

Building performance levels need to increase to reduce overall GHG emissions and ensure buildings are more resilient in the face of a changing climate. These higher performance levels need to be implemented without impacting the affordability challenges faced by British Columbians. This study demonstrates that although increasing performance requirements may increase the cost of individual buildings, it is not the major cost driver. High performance buildings can be built at or below the cost of lower performance buildings when higher performance is considered by an experienced design team from the start of a project.

Photo: Lance Sullivan

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