2024

CITY OF VICTORIA | Climate Action

Building All-Electric in Victoria

Climate Friendly Buildings Case Studies

Zero Carbon Step Code

CITY OF VICTORIA

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Introduction

The City of Victoria is committed to becoming a low carbon city, adopting innovative approaches to reduce greenhouse gas emissions. In 2023, Victoria became one of the first municipalities to implement B.C.'s Zero Carbon Step Code, requiring new buildings to minimize carbon emissions. This report highlights four new Part 3 buildings in Victoria that meet the Zero Carbon Step Code by using electric heating systems for space and water heating, as well as a domestic hot water heat pump retrofit. Overall, these case studies highlight the following:

1. **A climate friendly building is all-electric.**

   The Zero Carbon Step Code requires all new buildings to use all-electric air and water heating systems, powered by B.C.'s low carbon electricity. By adopting the highest level of the Zero Carbon Step Code, new buildings in Victoria will emit 75 per cent fewer emissions than the average recently constructed building in the City.

2. **Building all-electric is increasingly common.**

   Twenty-five per cent of all large buildings built in Victoria between 2018 and 2023 already meet the highest requirement of the Zero Carbon Step Code, thanks to using primarily all-electric heating systems. Whether for the simplicity of design or to reduce buildings' carbon footprint, the industry was already moving towards all-electric prior to the onset of the Zero Carbon Step Code.

3. **All-electric systems don't significantly increase construction costs, but electric resistance heating can increase utility costs for tenants.**

   Developers of these case study buildings did not view using all-electric systems as a significant cost increase compared to other project factors. Electric resistance heating for air or water can save costs while building, though it can mean higher costs for tenants. However, this approach allows building occupants to see and manage their own energy use more effectively than with centralized systems.

4. **Embodied emissions are the next frontier in low carbon building.**

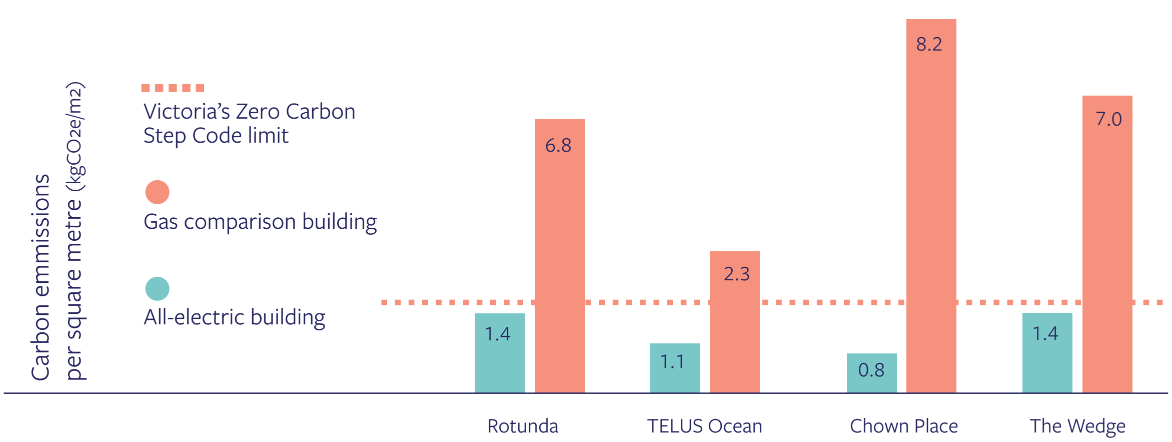
   With all-electric systems in place, emissions associated with a building's materials become the building's biggest source of emissions over its lifecycle, highlighting the need for efficient design, lower carbon materials and new policies to reduce the embodied carbon of new buildings.

These case studies aim to support industry professionals through this transition by demonstrating the feasibility of meeting the requirements of the Zero Carbon Step Code.

Case Studies Summary

Case Study	Description	As-Designed System (All-Electric)	Comparison Gas System
Chown Place	Multi-unit residential; four-storey plus below-grade storage and utility rooms	Electric baseboards and central electric resistance domestic hot water system	Gas for domestic hot water and corridor ventilation, gas cooking, electric base boards in suites and common areas
TELUS Ocean	10-storey office with ground floor commercial; three storeys of below-grade parking	Central air sourced heat pump and chiller; hydronic radiant ceiling (offices) and four-pipe fan coil units (retail)	Similar configuration but gas hot water and gas as back-up
Rotunda	Four storey wood-frame building with concrete podium and parking at grade	Mix of heat pumps and electric baseboard heating with electric hot water tanks	Gas for domestic hot water, electric baseboards in suites
The Wedge	16-storey concrete rental housing tower, underground parking, street-level commercial space	Electric baseboards and in-suite resistance domestic hot water storage tanks	Gas for domestic hot water and common spaces, with electric baseboards in suites
Capital Park Retrofit	Domestic hot water retrofit of two five-storey, LEED Platinum certified, AA-class office and retail building	Three carbon dioxide heat pumps, existing storage tank, added swing tank with electric resistance	Two gas-fired boilers, one storage tank

All-Electric Buildings Bring Big Carbon Reductions



ZERO CARBON STEP CODE

Case Study #1

Chown Place

All-Electric Non-Market Rental Housing

Building Description	Four-storey non-market rental with storage and utility rooms underground
Zero Carbon Step Code	Zero Carbon Performance
Energy Step Code	Level 4
Number of units	49 one-bedroom, seven two-bedroom and two three-bedroom
Floor area	4,073 square metres
Heating Systems	Electric baseboards and central electric hot water system
Cooking	Electric appliances
Above Grade Walls	Batt-insulated 2 x 6 wood stud walls with 1.5 inch continuous exterior mineral wool insulation
Below Grade Walls	R-16 spray-insulated concrete walls below grade, R-10 rigid perimeter insulation to top of footing
Windows	High-performance double pane vinyl windows
Main Roof	Above patio: R-40 continuous insulation above roof deck. Roof below patio: R-25 sprayed joist cavity and R-12 insulation above roof deck

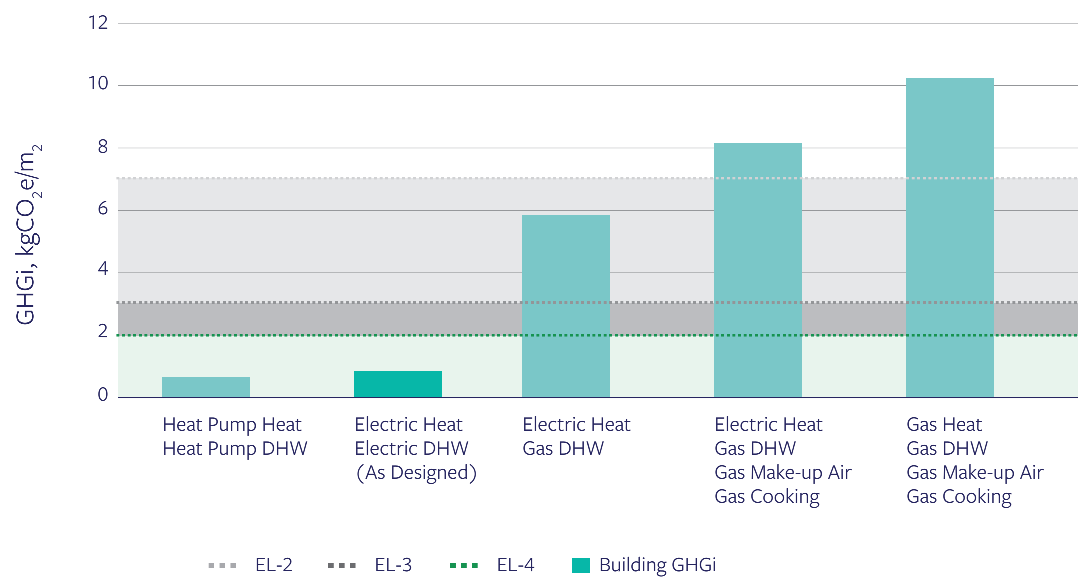
Project Summary

Located in the Burnside neighbourhood of Victoria, Chown Place is a new non-market housing project with almost zero carbon emissions. It is the first building in a long-term plan to redevelop older affordable housing for seniors and families in the area. This case study looks at how its all-electric design performs compared to a similar building that uses gas for heating and hot water.

Energy and Emissions

Energy modeling predicts that this all-electric building will produce approximately 3.26 tonnes of carbon dioxide equivalent per year, meeting the highest level of the Zero Carbon Step Code. A comparison building using common systems with electric baseboards, gas heating for hot water and ventilation and gas ovens and stoves is estimated to produce 10 times more carbon emissions than the all-electric design.

GHG Intensity of Different Fuel Use Options



Key Takeaways

1. Design of all-electric systems needs to balance up-front costs and operating costs. The large electric domestic hot water heater that provides hot water for all suites was significantly less cost than a heat pump system but added significant operating costs. If this building used heat pumps, its annual energy costs would be reduced by 30 per cent.
2. Building owners and operators should be made aware of any increased utility costs in the design phase so it isn't a surprise when the building is first occupied.
3. Increased operating costs can be shared with tenants by using in-suite hot water heaters that are billed to each suite.
4. With warmer summers and new cooling requirements for buildings, future buildings should use in-suite heat pumps to meet emissions targets and cooling needs alongside reducing tenants' utility costs.

Project Team

- **Client:** Gorge View Society
- **Architect:** Number TEN Architectural Group
- **General Contractor:** Kinetic Construction
- **Electrical Engineer:** Triumph Electrical
- **Electrical Contractor:** Canem Systems
- **Controls Commissioning:** Island Temperature Controls
- **Mechanical Engineer:** Avalon Mechanical Consultants
- **Mechanical Contractor:** Highland Plumbing, Accurate Air
- **Mechanical Commissioning:** Flotech Mechanical Systems Specialists

ZERO CARBON STEP CODE

Case Study #2

TELUS Ocean

All-Electric Office & Commercial

Building Description	10-storey office with ground floor commercial and three storeys of below-grade parking
Zero Carbon Step Code	Zero Carbon Performance
Energy Step Code	Level 3
Floor area	13,000 square metres
Heating Systems	Central air source heat pump, chiller, radiant ceilings in offices and fan coil units in commercial space
Envelope	Insulated triple pane glass curtain wall and aluminum panels

Project Summary

For this building, TELUS chose the Zero Carbon Building Standard early in the project to support climate action. TELUS' corporate sustainability goals, including getting 100 per cent of its energy from renewable or low emissions sources by 2025, made it easy to get support from all levels of senior leadership at TELUS. "It all starts with corporate culture and a clear objective to create sustainable, high-performance real estate assets," said James Bell, TELUS' Manager of Real Estate Development.

Energy and Emissions

This all-electric building is projected to reduce its greenhouse gas emissions by over 50 per cent compared to a similar building with a gas back-up system used only 10 per cent of the time.

Key Takeaways

1. First define the sustainability goals you are trying to achieve and then choose certifications that help reach those goals. This approach provides a framework to stay on track through the design phase and ensures the building supports the broader corporate vision. “Adopting an all-electric approach is easier with clear guidelines from the beginning of the project,” said James.
2. Have the primary consultant responsible for sustainability targets also design the systems essential to achieving these targets, such as the mechanical and electrical systems.
3. Make sure the low-carbon energy system can handle the building’s full heating needs or use an electric boiler for peak times.
4. Design the system to provide simultaneous heating and cooling operations to maximize waste heat recovery from the chilled water loop.
5. Preheat domestic hot water with the central plant or use dedicated air source heat pumps or electric water heaters.
6. Perform a Life Cycle Cost Analysis to support decisions for electrification.

Project Team

- **Owner & Developer:** TELUS Communications Inc.
- **Architect:** Diamond Schmitt Architects Inc.
- **Structural:** RJC Ltd.
- **Mechanical, Electrical, Energy Modelling and Sustainability:** Introba Canada LLP
- **Building Envelope:** RDH Building Science Inc.
- **Landscape:** PFS Studio
- **Code:** LMDG Building Code Consultants Ltd.
- **Commissioning:** CES Engineering Ltd.
- **Civil:** J.E. Anderson & Associates
- **Geotechnical:** Ryzuk Geotechnical Ltd.
- **Construction Manager:** EllisDon Corporation

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Case Study #3

Rotunda on Parry

All-Electric Mid-Rise Residential

Building Description	Four-storey wood frame building with concrete podium and ground-level parking
Zero Carbon Step Code	Zero Carbon Performance
Energy Step Code	Level 1
Number of units	12
Floor area	1,130 square metres (about twice the area of a basketball court)
Heating Systems	Mix of heat pumps and electric baseboard heating with in-suite electric hot water tanks
Cooking	Gas appliances
Envelope	Laminated veneer lumber and engineered wood joists with brick and fibre cement board cladding and rockwool insulation; high performance, vinyl framed windows

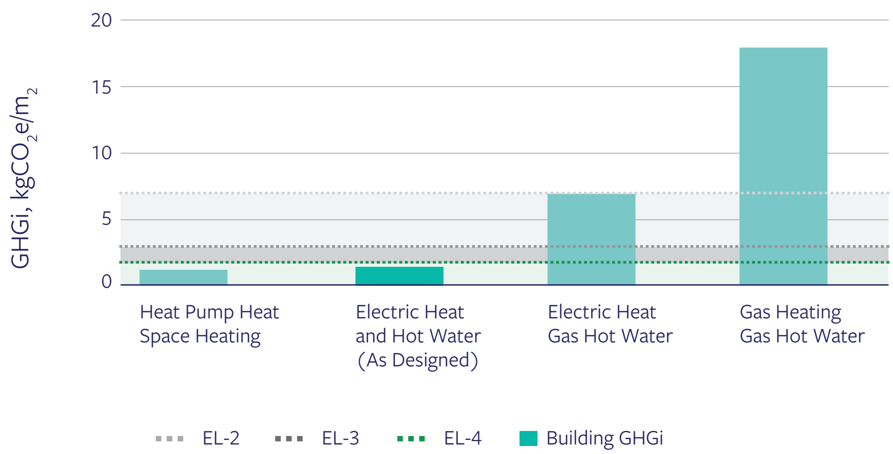
Project Summary

Completed in 2022 by ARYZE Developments, Rotunda on Parry features an open courtyard connecting the two buildings to the elevator and stairs. The building has high-performance vinyl-framed windows, efficient lighting and energy recovery ventilators in each suite. The top-floor suites have heat pumps, while the rest use electric baseboard heaters. Its design allows for double-sided ventilation, which improves thermal comfort. Each suite also has its own electric hot water tank.

Energy and Emissions

The Rotunda's use of electricity for space heating and hot water meets the highest level of the Zero Carbon Step Code. It also meets Step 1 of the BC Energy Step Code by using energy modeling, airtight construction and window testing. Emissions from gas-fired appliances were not included in this study.

GHG Intensity of Different Fuel Use Options



Key Takeaways

1. Work on the all-electric system with consultant teams early in the pre-construction phase.
2. Consider decentralized hot water or suite-level water metering in market-rate housing projects to manage potential increased operational costs of electric systems.
3. Select compact hot water tanks that fit well in the smaller mechanical spaces of each unit.
4. Although workforce availability for all-electric projects is a concern, it is likely to improve as more efficient mechanical systems are developed, which will also positively impact prices.
5. Industry is trending towards electrification, whether for EV chargers, hot water systems or heating and cooling.

Project Team

- **Owner:** ARYZE Developments
- **Architect:** D'Arcy Jones Architects
- **Structural and Energy Modelling:** RJC Engineers
- **Mechanical:** AME Group
- **Electrical:** AES Engineering
- **Landscape Architect:** Biophilia Design Collective

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Case Study #4

The Wedge

All-Electric High-Rise Residential

Building Description	16-storey concrete rental housing tower, underground parking, street-level commercial space
Zero Carbon Step Code	Zero Carbon Performance
Energy Step Code	Level 1
Number of units	93
Floor area	9,555 square metres
Heating Systems	Electric baseboards and in-suite electric hot water tanks
Cooking	Electric appliances
Roof	8″ XPS (R40+ Effective)
Walls	Insulated Spandrel Panels (R-21) and Insulated Slab Bypass (R-12); R6.5 after thermal bridging
Glazing	U-0.35

Project Summary

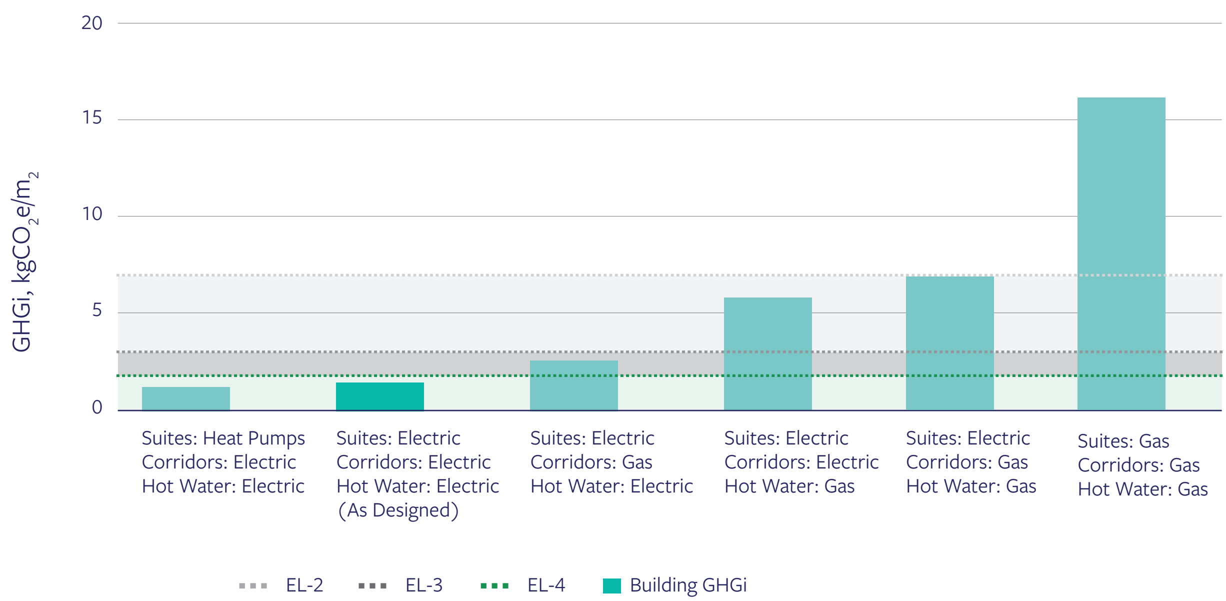
The Wedge is a 16-story tower built in 2024, featuring three levels of underground parking, 93 rental units, shared amenity spaces and street-level commercial areas. The building has a unique "lean," which maximizes space for housing while preserving a 1960s heritage chapel designed by John Di Castri. The eastern façade extends about six metres over the base, requiring special seismic analysis to ensure the tower can self-centre after an earthquake.

Energy and Emissions

The Wedge meets the highest level of the Zero Carbon Step Code due to its all-electric systems for suite space heating, corridor heating and domestic hot water. This wouldn't have been possible with the use of natural gas, common in the local industry. The project includes baseboard heating in most suites, heat pumps in select suites and energy-saving electric water heaters in each suite.

The Wedge also achieved Step 1 of the BC Energy Step Code by meeting energy requirements through energy modeling, airtightness and window testing. Key energy conservation measures include R-30 roofing, high-performance glazing systems, energy recovery ventilators in each suite, balcony slabs to reduce the envelope area and highly efficient electrical systems. Additionally, a thorough thermal comfort study and several passive cooling strategies were implemented to meet the BC Energy Step Code's thermal comfort criteria.

GHG Intensity of Different Fuel Use Options



Key Takeaways

1. All-electric systems still allow for unique architectural designs.
2. All systems (space heating, water heating, and corridor heating) needed to be electrified to meet the top level of the Zero Carbon Step Code (EL-4).
3. Distributing hot water heating into each suite lowers project costs and improves energy efficiency while incentivizing tenants to reduce their energy use to save on their utility bills.
4. Distributed electric hot water tanks are simple to replace without disrupting other tenants.

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Case Study #5

Capital Park

Zero Emission Domestic Hot Water Retrofit

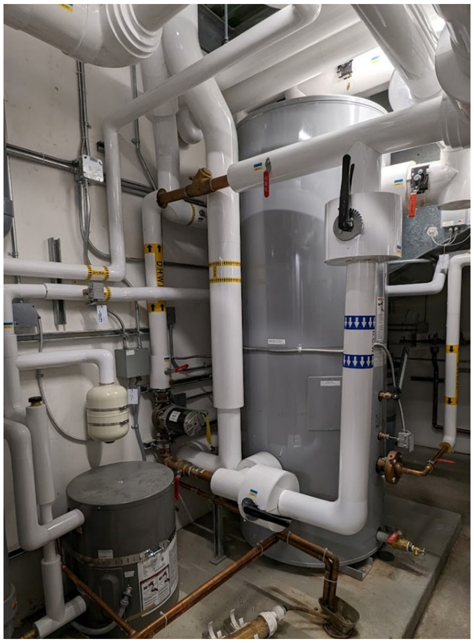
Building Description	Five-storey AA-class office and retail building.
Floor area	11,000 square metres
Original Domestic Hot Water System	Two gas-fired water tanks, one storage tank
New Domestic Hot Water System	Three SANCO carbon dioxide heat pumps, existing storage tank and added swink tank with electric resistance
Building Completion	2017
Retrofit Completion	2023

Project Summary

Capital Park includes two five-story, LEED Platinum certified office and retail buildings in James Bay completed in 2017 and 2019. To continue the project's commitment to sustainability, the failed natural gas hot water system in one building was replaced with an electric heat pump system to reduce greenhouse gas emissions.

The existing large water storage tank was used, and three heat pumps were added to the rooftop mechanical space. These heat pumps, each about the size of a residential heat pump, heat the water in large storage tank. The system also includes a swing tank with an electric resistance heater to manage heat loss from the distribution pipes while hot water isn't being used.

The three rooftop SANCO CO_2 heat pumps



Heat Pump Tech Specs	
Brand	SANCO
Model	GS4-45HPC-D
Quantity	3
Refrigerant	CO_2
Capacity (ea.)	4.5 kW (15,400 BTU)
Operating Temperature	-30 to 45°C
Coeff. of Performance	2.6 @ -8°C 4.2 @ 6°C 5.5 @ 27°C

Left: The existing large storage tank and new smaller swing tank

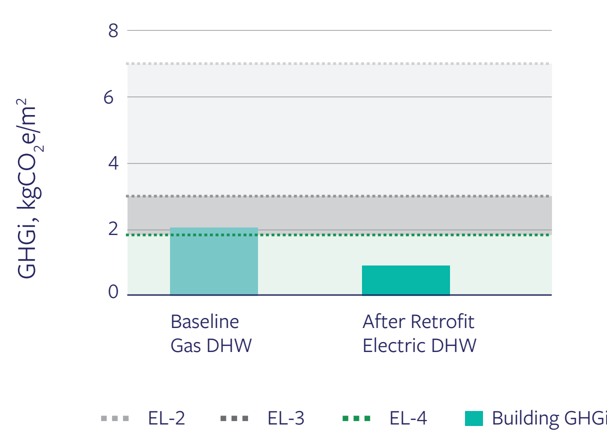
Operational Carbon Emissions

Once everything is working as designed, the upgrade will significantly cut the building's overall greenhouse gas emissions and achieve the highest performance level of the Zero Carbon Step Code. The retrofit is expected to reduce the GHG emissions intensity down to 0.9 kilograms of carbon dioxide per square metre, compared to an estimated 2.1 kilograms of carbon dioxide per square metre for a similar building still using natural gas.

Key Takeaways

1. It's possible to switch an existing gas hot water system to a heat pump at a feasible cost and without installing an entirely new system.
2. Re-using existing equipment (the existing storage tank) saved capital costs but required some trial and error for sensor and control setup.
3. An existing system retrofit may need additional work once the system is installed and is put into real-world use. This retrofit needed to adjust the scheduling and some re-commissioning to ensure hot water would be ready in the distribution piping for the first showers for early morning bike commuters.

GHG Intensity of Different Fuel Use Options



Embodied Carbon

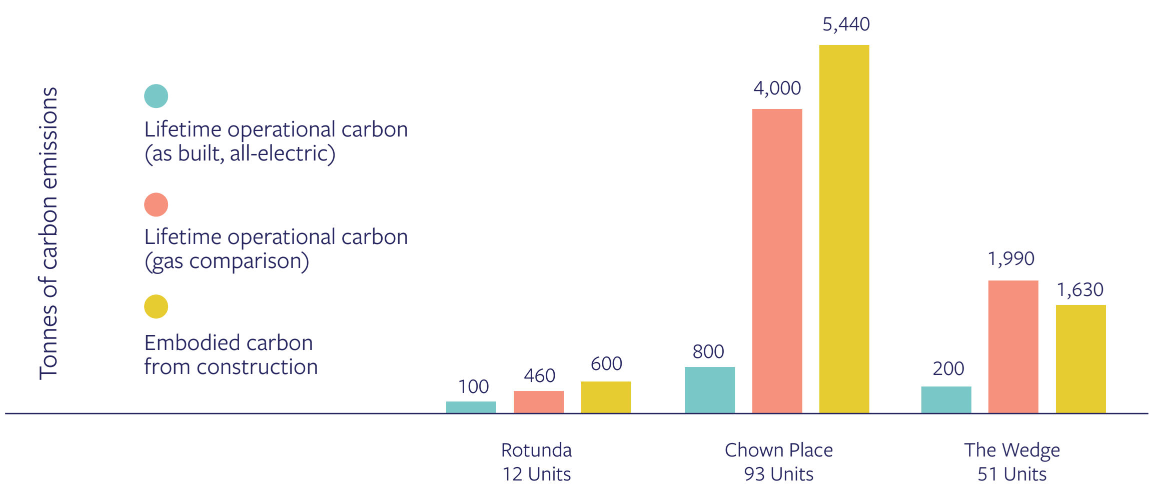
This study compares the carbon emissions from building construction (embodied carbon) to the emissions from operating the buildings over 60 years with either all-electric or gas systems. It shows that because of the energy efficiency of modern buildings and equipment, the carbon from construction can be as high or higher than the emissions from operating gas systems, both of which are much higher than emissions from all-electric systems.

The study highlights how effective all-electric buildings and policies like the Zero Carbon Step Code are in reducing operational carbon emissions. However, it also points out that embodied carbon is a big challenge that needs to be addressed to lower the climate impact of new buildings.

It's important to note that extracting, processing, leaking and transporting natural gas adds extra carbon emissions not included in this comparison. This further supports the move towards electric systems.

Reducing embodied carbon is the next step in lowering building emissions. This can be achieved with smart design, material improvements and government policy requiring lower embodied carbon in new buildings.

Embodied vs. Operational Carbon



Glossary

Air Source Heat Pump (ASHP): A heat pump that draws (i.e., sources) heat from the outside air during the heating season and rejects heat outside during the summer cooling season.

BC Energy Step Code: Provincial policy to improve the energy efficiency of new buildings, accomplished through improving building design, insulation and airtightness.

Zero Carbon Step Code: Provincial policy to reduce carbon emissions from new buildings, which can be accomplished by using all-electric systems, such as heat pumps or electric resistance.

Domestic Hot Water (DHW): Potable hot water system for showers, sinks, etc.

Embodied Carbon: The amount of greenhouse gas emissions associated with early and end-of-life stages of a product or whole building, from raw material extraction, manufacturing, transport and construction, as well as demolition, disposal, reuse or recycling.

Emissions Limit: A distinct, measurable step of carbon performance, as defined in the Zero Carbon Step Code. Ranging from EL-1 to EL-4, where higher levels are stricter, permitting fewer carbon emissions. The City of Victoria will implement EL-4 for all buildings types in 2024.

Energy Recovery Ventilator (ERV): A ventilation device that continuously replaces stale indoor air with fresh outdoor air while exchanging both heat and moisture between fresh and exhaust air.

Greenhouse Gas Emissions Intensity (GHGi): The amount of greenhouse gases emitted, divided by the floor area.

Heating, Ventilation and Air Conditioning (HVAC): Common abbreviation to describe equipment and services related to heating, ventilation and air conditioning.

Kilograms of CO_2 equivalent ($kgCO_2e$): Unit of measurement to quantify the impact of various greenhouse gas emissions (e.g., CO_2, methane and nitrous oxide) by converting them into an equivalent amount of carbon dioxide (CO_2).

Operational Emissions: The greenhouse gases (GHGs) and other pollutants released during the day-to-day functioning of a building.

The City thanks BC Hydro for their support on this project.