CASE STUDY

OSO

Net-Zero Energy-Ready Challenge Winners Series

October 2022

The NZER Challenge

The Net-Zero Energy-Ready (NZER) Challenge is a provincial CleanBC incentive program for large buildings (multi-unit residential, office, retail, commercial, institutional, etc.) launched in late 2018. In addition to providing financial support for developments targeting NZER levels of performance, the program aims to celebrate, promote and learn from these innovative and energy-efficient projects.

Out of over 50 applications received, a juried competition resulted in the selection of 11 winning projects that represent the best examples of NZER buildings. These projects received up to $390,000 in incentives to help cover the estimated cost premiums associated with the design and construction of NZER buildings.

UBCO Skeena Residence (Credit: Andrew Latreille)

Carrington View Building A (Credit: Skyline Living)

UVic Student Housing and Dining (Credit: Perkins & Will)

Project Overview

In 2018, with some high-performance building projects underway in Pemberton, Vidorra Developments, a developer and builder, embarked on another development in the heart of Golden, British Columbia. OSO, which means bear in Spanish, is a mixed-use development consisting of two buildings with commercial units on the ground floor and residential units above. Some small standalone amenity and commercial buildings are located between and behind the two larger buildings.

The units in one of the two buildings will be sold as condominium and commercial units while the units in the other building will be rented or leased. The design and construction strategies applied to the OSO development are a culmination of many lessons learned in designing and constructing high-performance buildings, as well as extensive research by the British Columbia Institute of Technology's Building Science Centre of Excellence (BSCE). Similar to its previous developments in Pemberton, Vidorra's goal is to complete this development for less than what it would cost to build a code-minimum equivalent development.

> "OSO is exceptional because the construction details, mechanical design, and the equipment and materials used are all simple, readily available, and easy to put together. Vidorra's goal is to have any contractor in Canada review the plans and specifications and easily understand them. For this development, there was no extra training required for any tradesperson on the job site. Every detail was familiar to them and part of their standard trade skill set. For widespread adoption of high-performance buildings, this approach is essential.."
>
> — ROD NADEAU, CO-OWNER, VIDORRA DEVELOPMENTS LTD.

Artist project render. (Credit: Ryan Nadeau)

Project Specs

PROJECT INFORMATION	
Address	East: 612 7th Street N, Golden, BC West: 606 7th Street N, Golden, BC
Climate Zone	6
Ownership Type	East: Purpose-built rental West: Condominium
Residential Units	East: 30 West: 28
Levels	4 (no underground parking)
All-Electric Building	Yes
Minimum Building Code Requirement	2012 B.C. Building Code (NECB 2011)
Canadian Construction Documents Committee (CCDC) Contract	N/A (developer/builder)
Gross Floor Area	East: 2,896 m^2 (31,174 ft^2) West: 2,981 m^2 (32,087 ft^2)
Modelled Floor Area[1]	2,250 m^2 (24219 ft^2)
Window to Wall Area	21%
Form Factor[2]	0.94
Construction Start	June 2020
Expected Substantial Completion	East: January 2023 West: September 2022

Total Energy Use Intensity[3]	83 kWh/m^2 yr
Thermal Energy Demand Intensity[3]	7.7 kWh/m^2 yr
Annual Cooling Demand[3]	1.4 kWh/m2yr
Greenhouse Gas Intensity[4]	0.9 $kgCO_2eq/m^2$ yr

1 The energy model included only one building.
2 The form factor is the ratio of the building envelope area (all areas where heat loss can occur) divided by the gross floor area.

3 Based on the eQuest 3.65 modelling which includes an airtightness value of 0.6 ACH (50 Pa).
4 Calculated using BC Hydro's 2021 emissions factor of 9.7 kgCO2eq/kWh.

Project Highlights

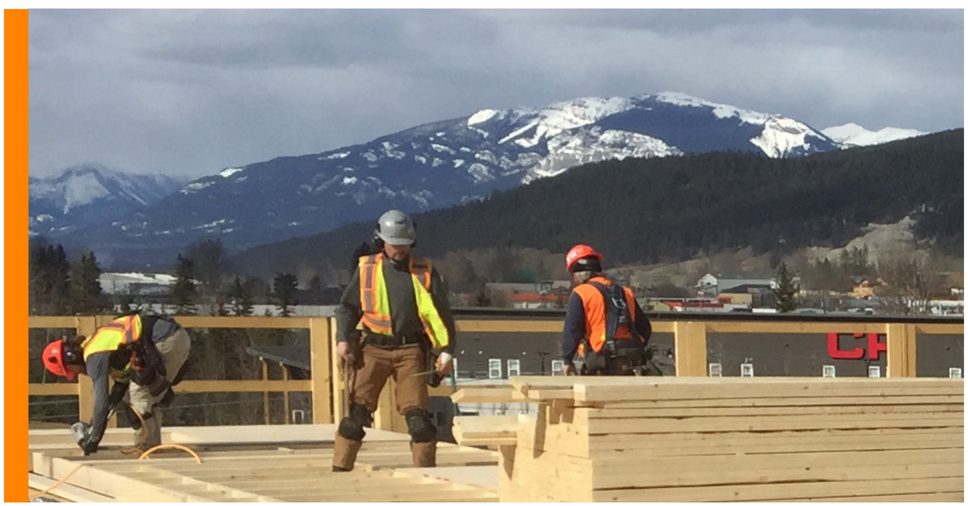
PROJECT TEAM	
Owner/Developer	Vidorra Developments
General Contractor	Innovation Building Group
Architect	Dennis Maguire Architect
Building Envelope Consultant	Richard Kadulski Architect
Energy Modeller	BCIT BSCE
Structural Engineer	Valley Engineering
Mechanical and Electrical Engineer	SRC Engineering Consultants

Cost-Effectiveness

Vidorra Developments and Innovation Building Group are two parts of the same company. For each project, they engage the same design team, with occasional exceptions. This results in a project team that is focused on development and construction considerations, and in particular, cost-effectiveness. With some clear and simple design strategies already in-hand based on past projects, Vidorra engaged the design team to assist it in achieving its goals in a simple, and consequently, cost-effective way. Having constructed some high-performance buildings recently, Vidorra was able to bring considerable knowledge to the project and keep a solid grasp on construction costs, despite having to deal with pandemic-induced supply chain issues. Although it may be too soon to tell whether developer/builders hold the key to constructing cost-effective, high-performance buildings, there's no doubt that they have the potential to lead the building industry in this regard.

Climate Resilience

Multi-family buildings of the future will be climate-friendly buildings - highly energy-efficient buildings with virtually no operational emissions. They must also be resilient by providing residents with a comfortable home, sheltered from the consequences of climate change. In Golden, BC, these consequences include heat waves, smoke from forest fires and flooding. To ensure that the buildings provide a comfortable environment in a warming climate, all the units are provided with active mechanical cooling through a centralized ventilation system. If a building is designed to be highly energy-efficient, integrating the heating and cooling system with the ventilation system is not only feasible, but economical as well. To deal with forest fire smoke, the ventilation system filters outdoor air using MERV 13 filters and carbon filtration bags can also be added temporarily for additional filtration. This allows occupants to close their windows during the summer when the outdoor air quality is poor and still be supplied with filtered and cooled outdoor air through the HVAC system. To mitigate the risk of flooding, there is no underground parking and the floor slab of the ground floor is approximately half a metre above the the area's 200-year flood plain. The ground-floor units and parking stalls are all located above-grade.



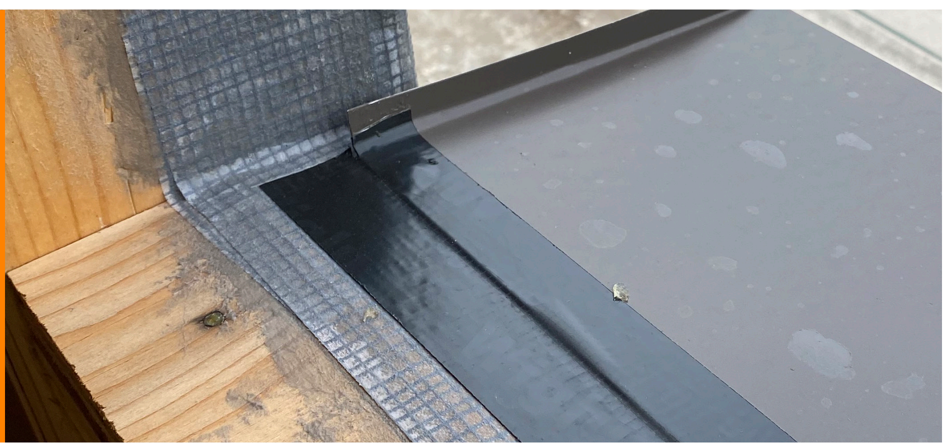
Data-Driven Evolution

Applying lessons learned from a previous high-performance building project is critical in achieving cost-effective results for developers, builders and the design team. Although most developments are unique in many respects, much of the experience gained in the past can be applicable. For its Radius multi-family development in Pemberton, BC, completed in 2018, Vidorra had engaged BCIT's BSCE to help it find the most economically optimal design strategies for a high-performance, wood-framed building envelope. The extensive analysis included energy modelling and cost analysis for a variety of wall and roof assemblies. It also included the installation of sensors in the building for measurement and verification. Many of the findings from the comprehensive analysis were applied to the design of the OSO buildings. In essence, the OSO development benefitted from both past experience and extensive data analysis. Continuing with the same data-driven approach, Vidorra has engaged BCIT to install energy monitors on the large energy-consuming components to monitor their energy performance. The Technical Details section below provides information on the most economically optimal design solutions for this project.

Technical Details

Structure

Both buildings have virtually identical structures. The foundations consist of insulated concrete foundation (ICF) walls and concrete piers which are set on concrete strip and pad footings. Wood posts and beams at the ground-floor level support the floor assembly for the second level. At ground level, the floor is a concrete slab-on-grade and all suspended floor assemblies above it consist of pre-engineered wood joists, plywood sheathing and concrete topping. The roof structure consists of parallel chord trusses with plywood roof decking. Above the ground-floor level, the floor and roof assemblies are supported by interior and exterior wood-stud walls. The ground-floor walls were constructed using 203 mm (8”) wood studs and the floors above were constructed using 152 mm (6”) wood studs. The wood-stud walls were prefabricated on-site and lifted into place with a crane. The elevator shafts was constructed with concrete blocks. The balconies are supported by cantilevered, glue-laminated beams and the ground-floor canopies (which also double as the second-level balconies) are constructed with site-built, nail-laminated timber panels.



Installation of the window sill flashing.

Hoisting of the prefabricated wall panels.

Fenestration

Because energy-efficient buildings require high-performance windows, Justa Softline 82 windows (European) were chosen for the development. The vinyl-framed windows include triple-glazed insulating glass units with two low-emissivity coatings and a solar heat gain coefficient of 0.42 to reduce the cooling load. The operable windows for the residential units are tilt-and-turn windows. Without accounting for the thermal bridging that will occur around the window, the overall effective U-value of the windows ranges from 0.71 to 0.85 W/m2·K. The U-value for the aluminum-framed patio swing doors is 0.9 W/m2·K. Some window shading is provided by balcony decks above.

Installation of the EIFS's liquid-applied air and weather-resistive barrier.

Airtightness

To achieve the targeted air tightness of 0.6 ACH, the design includes an ADEX-RS exterior insulation and finish system which uses a liquid-applied air and weather-resistive barrier. All exterior penetrations and the plywood joints at the roof trusses were sealed with VISCONN® using an AEROFIXX spray and seal gun. The ½ lb urethane spray foam insulation in the roof assembly is the the air barrier for the roof. Siga Wigluv® and Fentrim® tape were used to ensure airtightness around the windows. A conventional 6-mil air and vapour barrier was installed below the ground-floor slabs-on-grade. Mechanical penetrations through the roofs and exterior walls can jeopardize airtightness and increase the time, material and consequently, the cost required to achieve a high level of airtightness. This is one of the reasons why Vidorra chose to use a centralized (and integrated) heating, cooling and ventilation system. This was also one of the reasons why ductless heat pump dryers were chosen for the units.

Thermal Bridging

In one of its previous developments, Vidorra had engaged BCIT's BCSE to help it identify cost-effective strategies for the design and construction of high-performance building envelopes. The analysis confirmed the key role that thermal bridging plays in achieving the goal. Because it has a significant impact on the thermal performance of the building envelope, a number of strategies were used to minimize it. As opposed to a typical spacing of 406 mm (16") on-centre, the wood studs of the exterior walls were installed at 610 mm (24") on-centre. Using fewer wood studs results in less thermal bridging through the exterior walls. The EIFS installed on the exterior walls wraps over the window frames to reduce the thermal bridging around the windows. The EIFS was adhered to the exterior walls. By avoiding fasteners, which are often used to install insulation and cladding, the thermal bridging was avoided. Mechanical penetrations through roofs and exterior walls are potential thermal bridges. For this reason, as well as the negative impact on airtightness, Vidorra chose to install a centralized (and integrated) heating, cooling and ventilation system as well as ductless heat pump dryers.

Supply (insulated) and return ventilation ducting.

Insulation

As with all high-performance buildings, the building envelope required more insulation than a code-minimum building. The 152 mm (6") and 203 mm (8") wood-stud wall cavities are filled with fibreglass batt insulation.. The exterior insulation and finish system (EIFS) includes 152 mm (6") of expanded polystyrene insulation. The 762 mm (30") deep roof cavity is filled with 508 mm (20") of ½ lb urethane spray foam topped with blown fibreglass insulation. Filling the entire joist cavity with insulation avoided the need to add a fire suppression system within the roof cavity. The foundation walls were constructed using insulated concrete forms with 144 mm (2 5/8") thick expanded polystyrene (EPS) insulation. A 152 mm thick layer of EPS insulation was installed under the slabs-on-grade.

Swegon energy recovery ventilator connected to Mitsubishi heat pumps.

Installation of the EIFS's EPS insulation board.

Heating and Cooling

Another unique aspect of this building is the integration of the heating and cooling system with the ventilation system. This integrated system provides heating and cooling for both the units and the corridors. For a previous project, this mechanical design strategy has proven successful in keeping occupants comfortable during the June 2021 heat wave and the December 2021 cold snap. A 35 kW (10-ton) and a 28 kW (8-ton) Mitsubishi City Multi heat pump are connected to the ERV's heating and cooling coil. The heat pumps use R410a refrigerant and can provide heating in outdoor temperatures as low as -25°C. The ERV includes a boost mode which doubles the airflow rate when more cooling (or heating) energy is required. The control strategy is to maintain the return air at 22°C year-round and use the ERV's boost mode for additional cooling only. If supplemental or back-up heating is required, the occupants can rely on a 500 W electric baseboard heater installed in each room along the perimeter of the building. The ERV also has a (heat exchanger) bypass mode which allows it to cool the units with outdoor air at night when the outdoor temperature is 2°C lower than the indoor temperature. The ground-floor commercial units have mini-split heat pumps for backup heating and cooling. Their primary heating and cooling is supplied by the central ventilation system.

Ventilation

Although not specifically required by the provincial building code, Vidorra chose to use energy recovery ventilators (ERV) to exceed the building code's ventilation requirements. A Swegon Gold RX 35 ERV was installed on the roof of each building, beside the mechanical penthouse. It provides ventilation for the corridors and all the units in the building. The ERV has a heat recovery temperature efficiency of 85%. As opposed to a decentralized ventilation system with an ERV in each unit, a centralized ventilation system provides ease of access to the ERV for repairs and maintenance. Installing the ventilation ducting in the walls and floor assemblies reduced construction costs by not having to build bulkheads and dropped ceilings. All the balancing dampers for the units are readily accessible in the mechanical penthouse. Fire dampers are installed in the ducting in the mechanical penthouse as well as behind the supply and return grilles throughout the building.

Submetering

Based on its previous projects, Vidorra believes that installing one BC Hydro meter for an entire multi-family building is both economical and practical, whether for a rental or condominium building. For the OSO development, the energy cost for the rental building will be recovered through rent. For the condominium building, it will be included in the monthly strata fees. Installing a single BC Hydro meter for the entire building allows the landlord or strata corporation to pay a commercial rate for electricity. This is expected to save approximately $70,000 in construction costs and $8,000 annually in Basic Charge fees which are levied on a per meter basis by BC Hydro. Dedicated submeters are installed for the ERVs, Mitsubishi heat pumps, SANCO2™ heat pumps and DHW swing tanks. This allows the building operator to monitor the energy consumption of each system, ensure the systems are operating properly and fine-tune the performance of the systems as required.

SANCO2 domestic hot water heat pumps.

Domestic Hot Water

Each building's domestic hot water (DHW) system includes five SANCO2™ heat pump water heaters, three 454 L (120 US gal) storage tanks and one 454 L swing tank connected to a 36 kW Stiebel Eltron tankless electric water heater. The swing tank, in combination with the tankless water heater, maintains the temperature of the hot water in the recirculation loop. Given the capacity of the tankless water heater, it also serves as a back-up water heater should there be an issue with the heat pump water heaters. Four of the heat pumps are wall-mounted under the mechanical penthouse roof's overhang and the fifth is installed inside the mechanical penthouse to keep the room cool and increase the efficiency of the heat pump (by providing it warmer ambient air). The short length of water line between the four outdoor units and the penthouse's exterior wall are heat-traced and insulated to prevent freezing. The insulation thickness on the DHW piping ranges from 51mm (2") to 102mm (4"), depending on the diameter of the piping.

Appliances

To minimize heat loss, the microwave above the range includes a recirculating range hood and ductless Bosch heat pump dryers were installed in the units. The range, cooktop and dishwasher are all ENERGY STAR® appliances.

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