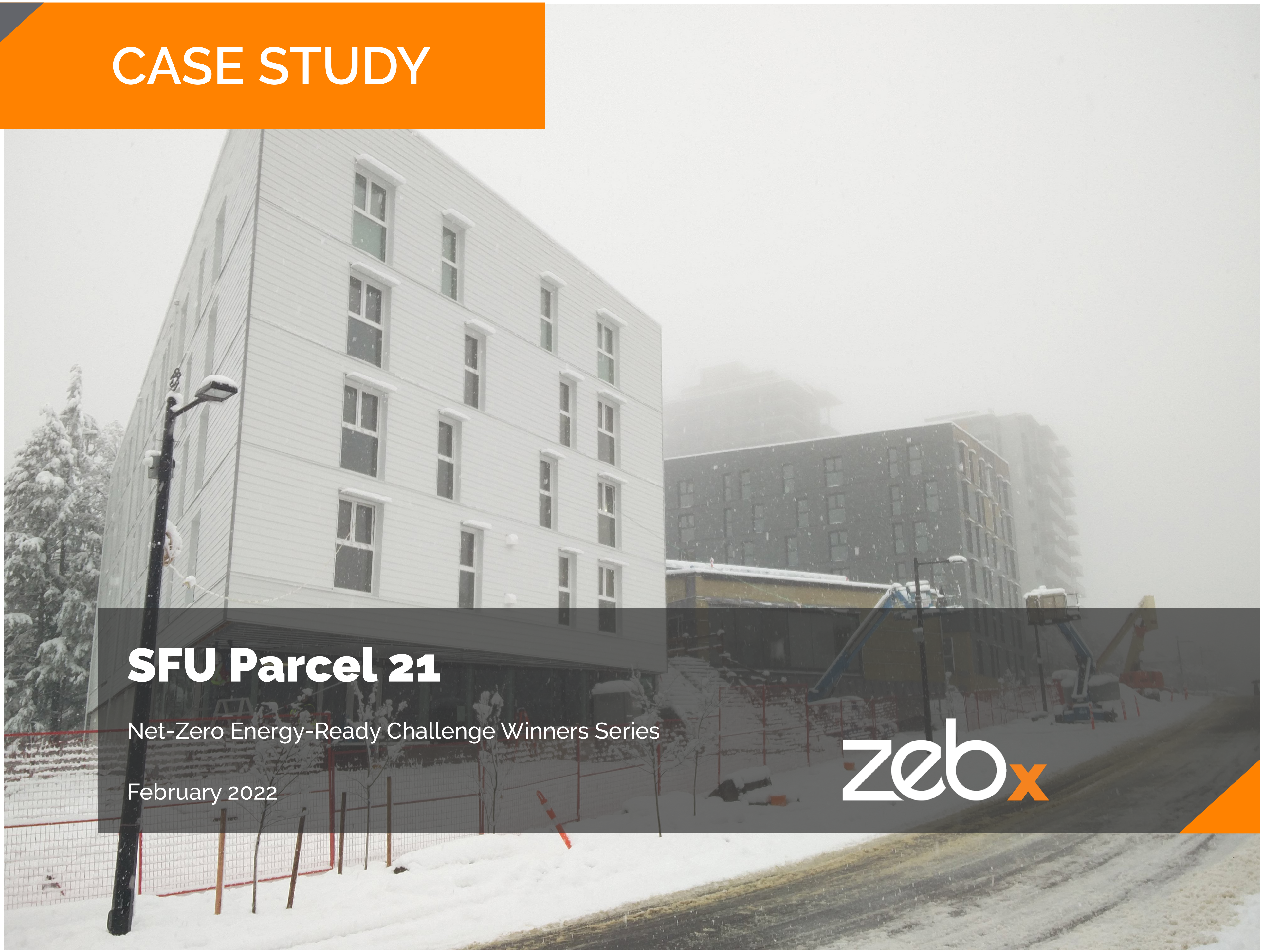
CASE STUDY



SFU Parcel 21

Net-Zero Energy-Ready Challenge Winners Series

February 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.

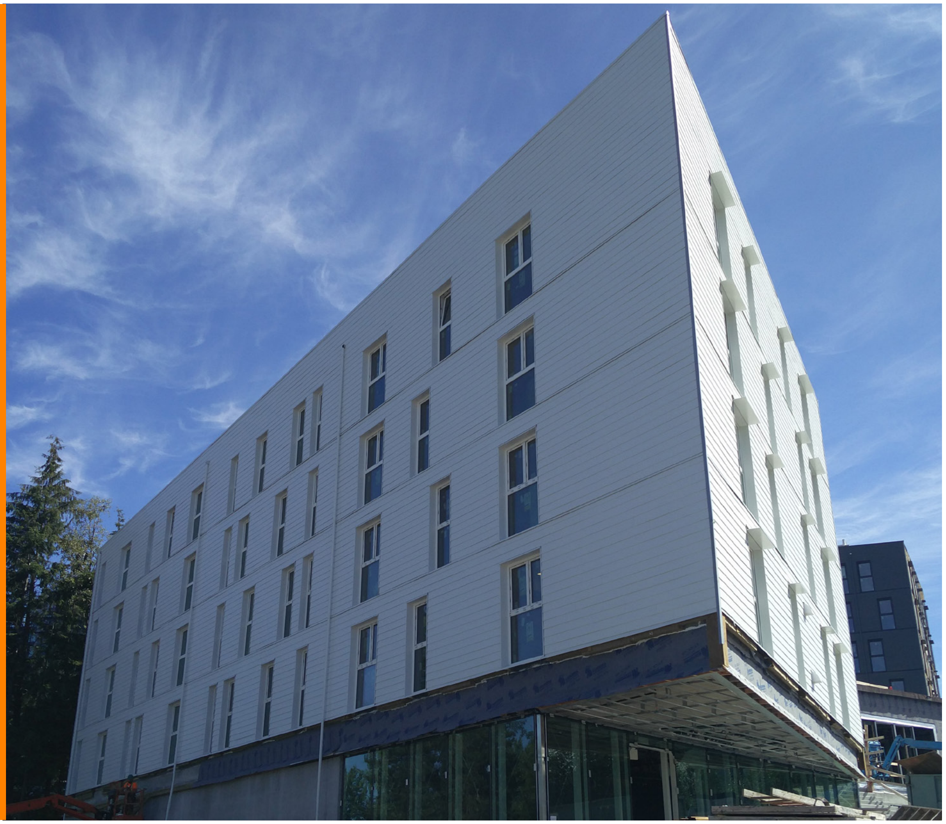
Out of over 50 applications received, a juried competition resulted in the selection of 11 winning projects that represent the best examples of NZER buildings. These projects received up to $390,000 in incentives to help cover the estimated cost premiums associated with the design and construction of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

825 Pacific Street (Credit: IBI Group Architects Ltd.)

OSO (Credit: Vidorra Developments)

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

Project Overview



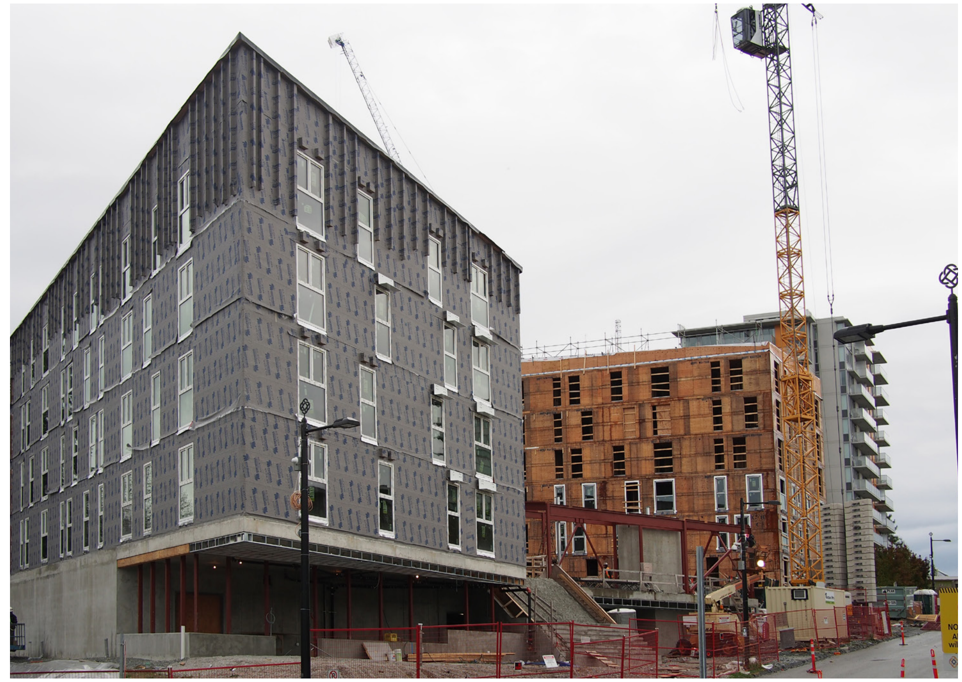
Parcel 21 is Simon Fraser University's (SFU) most recent housing development, primarily targeting mature students with children - a demographic that is typically underserved by universities. This below-market rental complex is SFU's first student housing building in the growing UniverCity community on Burnaby Mountain. It consists of a community pavilion in a courtyard flanked by two residential buildings to the east and west.

In 2014, SFU engaged an architect and set out to establish a new precedent for residential complexes on its campuses. To meet the energy performance target associated with this objective, SFU decided to target the Passive House standard for the two residential buildings. To guide the building design, energy performance was modeled using the Passive House Planning Package (PHPP) software. As the design progressed, however, industry-wide construction costs continued to escalate and pushed the estimated construction cost beyond the budget allocated for the project. As a result, SFU decided to target the highest level of the BC Energy Step Code instead, while maintaining many of the design details and strategies typically associated with Passive House buildings.

> "The Parcel 21 project on Burnaby Mountain will be an exemplary project of great architecture, smart decision making, and commitment to construction budgets. Upon completion, this project should be one of the most energy efficient buildings in British Columbia, with extremely high envelope performance in excess of the top tier of the new Step Code. More importantly, it will have been done on an entirely conventional construction budget."
>
> — DALE MIKKELSEN, CHIEF OPERATING OFFICER, SFU COMMUNITY TRUST

Project Specs

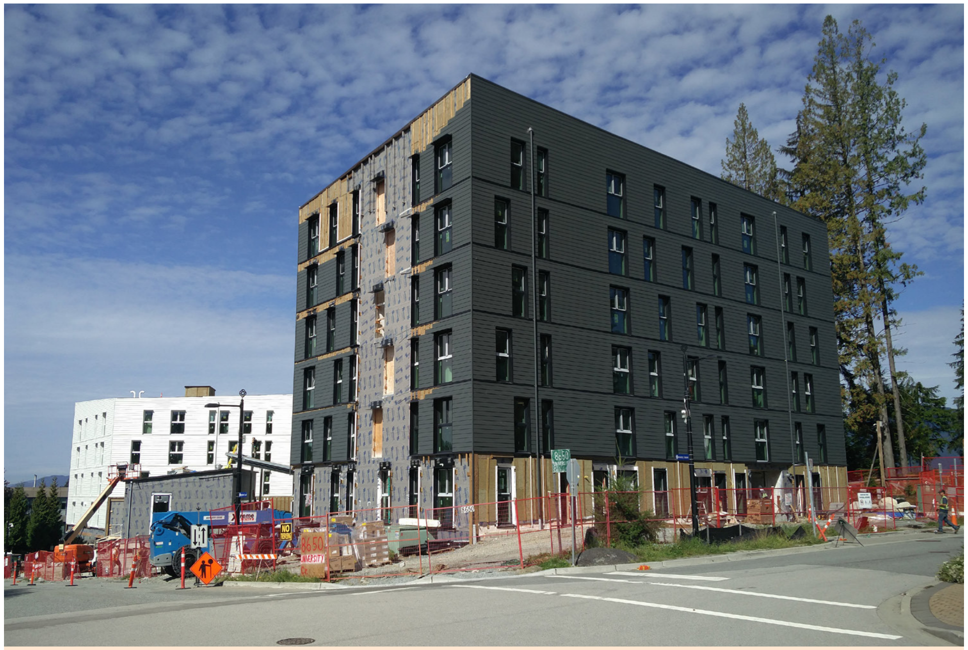
Address	*East:* 8650 University Crescent *West:* 8989 Highland Court, Burnaby BC
Climate Zone	4
Ownership Type	University-Owned Affordable Rental Housing
Levels	*East:* Six storeys *West:* Four storeys over a single-level parkade
Residential Suites	*East:* 47 *West:* 43
All-Electric	Yes[1]
Minimum Building Code Requirement	2012 B.C. Building Code (NECB 2011)
Performance Target	B.C. Energy Step Code - Step 4
Canadian Construction Documents Committee (CCDC) Contract	5B (Construction Management Contract for Services and Construction)
Gross Floor Area	*East:* 3,213 m^2 (34,584 ft^2) *West:* 2,572 m^2 (27,685 ft^2) *Parkade:* 1,704 m^2 (18,342 ft^2)
PHPP Treated Floor Area	*East:* 2,458 m^2 (26,458 ft^2) *West:* 1,950 m^2 (20,990 ft^2)
Window to Wall Area	*East:* 27% *West:* 24%
Form factor[2]	*East:* 0.88 *West:* 0.83
Construction Start	October 2019
Expected Substantial Completion	February 2022



Primary Energy Renewable (PER)[3]	*East:* 120 kWh/m^2 yr *West:* 138 kWh/m^2 yr
Final Energy Demand (PHPP)[3]	*East:* 80.1 kWh/m^2 yr *West:* 91.3 kWh/m^2 yr
Annual Heating Demand[3]	*East:* 19.8 kWh/m^2 yr *West:* 22.3 kWh/m^2 yr
Greenhouse Gas Intensity[3,4]	*East:* 2.4 $kgCO_2eq/m^2$ yr *West:* 2.0 $kgCO_2eq/m^2$ yr
Airtightness at 75 Pa	*East:* 1.15 L/s.m^2 (1.37 ACH_{50}) *West:* 0.21 L/s.m^2 (0.31 ACH_{50})

1. Energy used for the domestic hot water supply is generated by the Burnaby Mountain District Energy Utility, owned and operated by Corix® Utilities. The utility uses a low-carbon biomass central energy plant, with peaking and back-up thermal energy supplied by natural gas boilers.
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. Using the treated floor area from PHPP for the calculation would result in a higher form factor.
3 Based on the PHPP modelling which incorporates the final airtightness test results.
4 Calculated using the PER x (TFA/GFA) and an emissions factor of 0.011 $kgCO_2e$/kWh for electricity and 0.074 $kgCO_2e$/kWh for the district energy system.

Project Highlights



PROJECT TEAM	
Developer	SFU Community Trust
Owner	SFU Residence Services
Project Manager	JLL
General Contractor	Peak Construction Group
Architect	Local Practice Architecture + Design
Building Envelope Consultant	RDH Building Science
Passive House Consultant and Energy Modeller	Tandem Architecture Écologique
Structural Engineer	Associated Engineering
Mechanical Engineer	Rocky Point Engineering
Electrical Engineer	Associated Engineering

Reducing Costs

The initial performance target for the project was to achieve Passive House certification. During the design development phase, construction costs escalated and cost-saving measures had to be implemented to keep the project within budget. To do this, two key approaches were taken. The first involved a continuous analysis of the cost-effectiveness of thermal performance strategies. By evaluating energy efficiency related design choices with thermal modelling coupled with a costing analysis (supported by a construction manager), the design team was able to omit the less cost-effective thermal performance strategies. For this project, these included:

- reducing the amount of below-grade insulation
- specifying windows that were not Passive House-certified
- specifying long screws instead of thermal cladding attachment brackets (made possible by using ¾" thick plywood cladding),
- omitting structural thermal breaks between wood framing and the concrete structure, and
- using smaller, slightly less efficient HRVs instead of fewer, more efficient and larger HRVs.

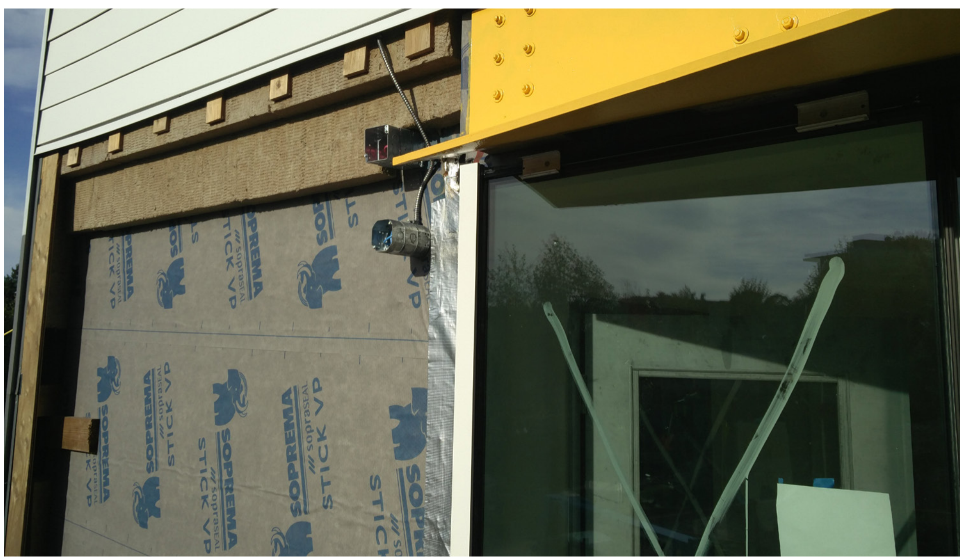
The second approach related to reducing the perceived complexity and risk that general contractors associated with Passive House construction at the time. Because the Passive House standard was still a very new design approach in the region, most general contractors charged a premium to compensate for the perceived risk and complexity of building to this standard. To counter this, the design team maintained many of the Passive House design strategies, but removed the term "Passive House" from the bid documents, including the requirement for Passive House certification.

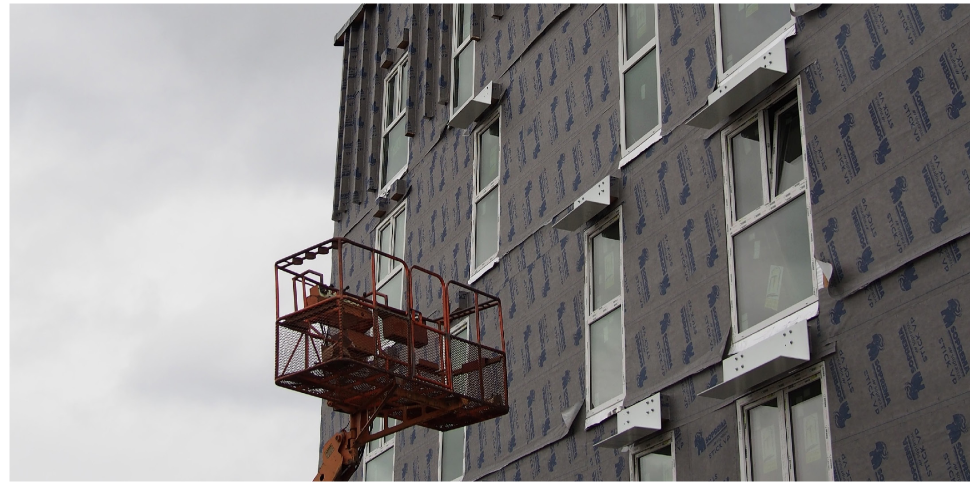
Staying Cool

While the majority of winning projects in the Net-Zero Energy-Ready Challenge include active cooling, the developer and design team for SFU Parcel 21 opted to rely on passive cooling design strategies. These included:

- installing operable windows with a low solar heat gain coefficient,
- adding fixed sunshades above the windows on some of the elevations, and
- selecting HRVs with a bypass mode that can be used to cool the building in the summer months (when the outside temperature is below the indoor temperature).

The PHPP modelling does not indicate that the average indoor temperature for the buildings will exceed 25°C, but this is based on historical climate data from Environment Canada and it does not indicate whether individual suites will be subject to overheating. Should overheating become an issue for some suites in the future, SFU is prepared to add active cooling and/or ceiling fans.



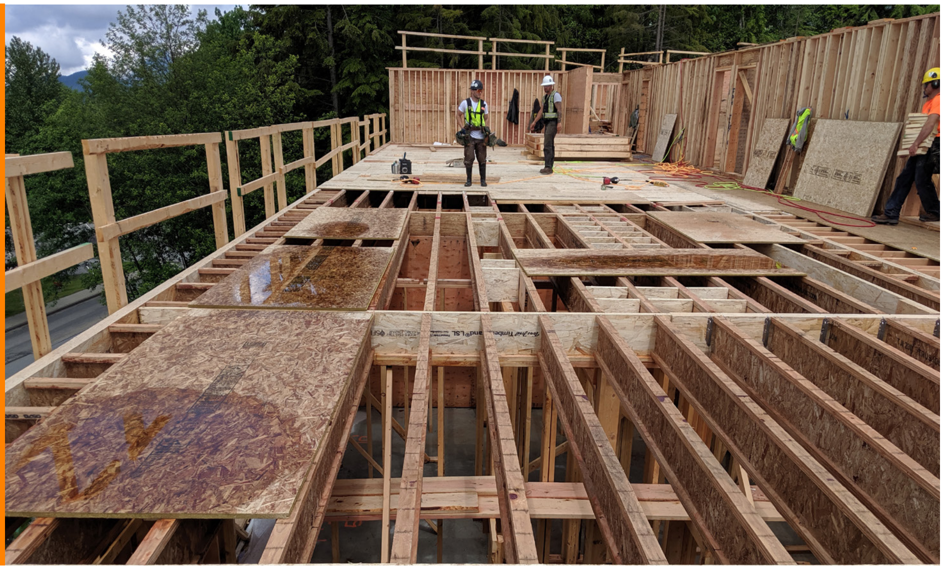


Keeping It Tight

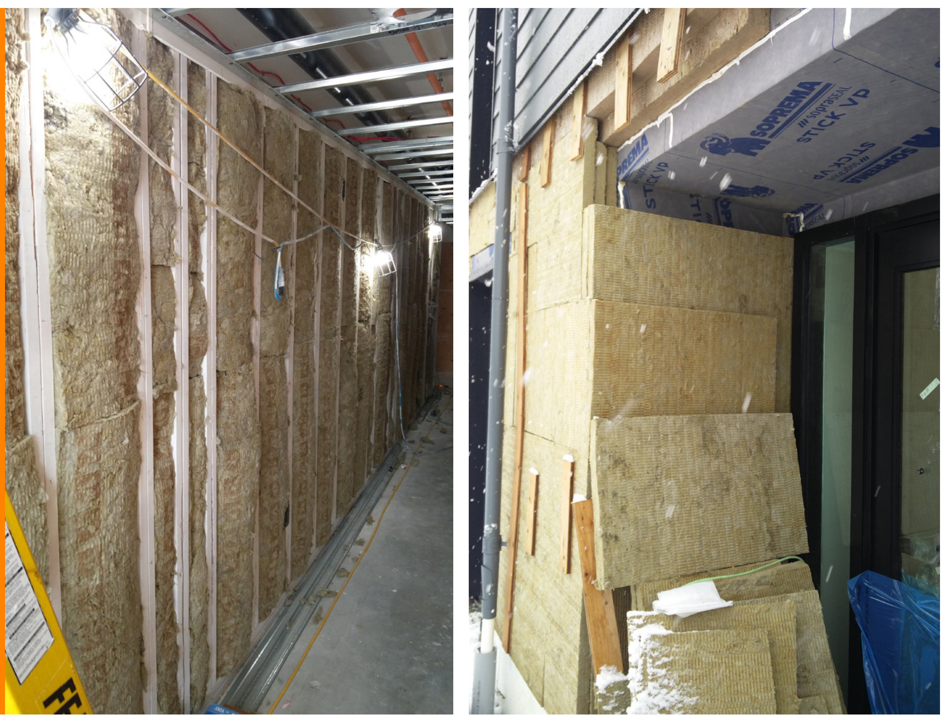
Given the importance of airtightness for highly energy-efficient buildings, the project team made significant efforts to set the air barrier up for success. After the first few windows were installed, the window installation was tested for airtightness to ensure that the installation process (and window) would allow the building to meet SFU's requirement of a maximum air leakage rate of 2.0 L/s·m^2 (at 75 Pa), and ideally meet the Passive House airtightness target of 0.6 ACH (at 50 Pa). This was critical given the number of windows in the building envelope.

The results of the test were used to fine-tune the installation process. A fully-adhered air barrier on a 19 mm (¾") thick plywood substrate was chosen for the design. A very simple building geometry was chosen for a number of good reasons, including to reduce complexity of the air barrier detailing. The general contractor provided constant field supervision of the trades involved in the envelope details. The air barrier and other building elements related to airtightness were inspected thoroughly throughout the construction process and redone where required. The end result was an airtightness for the west building that exceeded Passive House requirements and an airtightness for the east building that exceeded SFU's requirements.

Technical Details



Wood-framed floor structure (Photo credit - Associated Engineering)



Interior (left) and exterior (right) insulation.

Structure

The structures consist of wood framing over a concrete raft slab (east building) and a conventionally reinforced, single-level concrete parkade (west building). The floor and roof structures were constructed with pre-engineered TJI® joists and plywood sheathing. Wood-framed, load-bearing walls and Parallam® PSL columns were used to support the roof and floor structures above the ground floor. The exterior and shear walls were prefabricated as panels, with bottom plates, wood studs, top plates and sheathing on one side.

Insulation

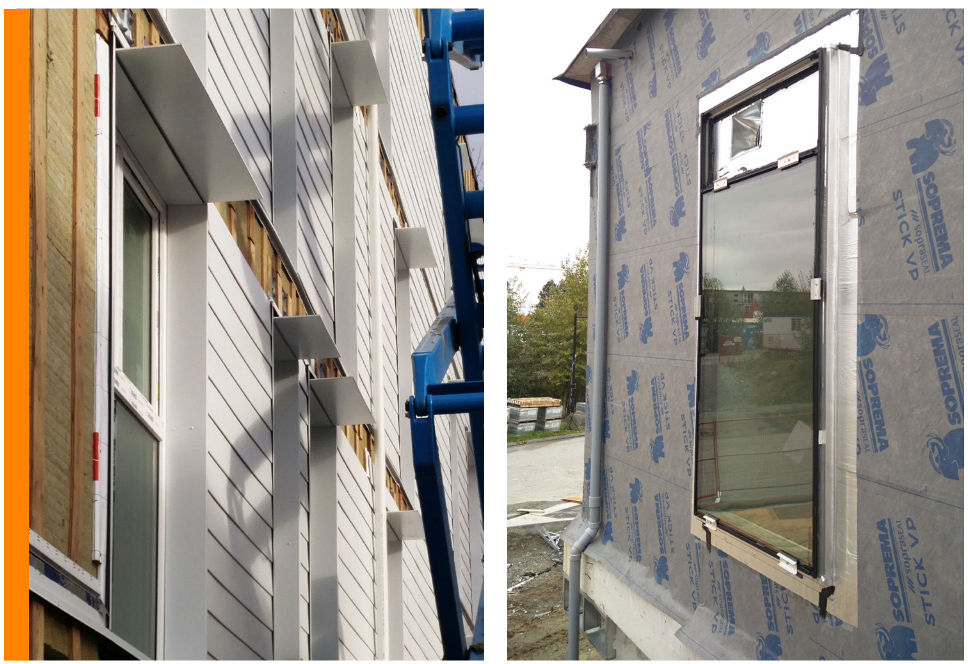
As with all high-performance buildings, the building envelope required considerable insulation. The typical above-grade, exterior walls were designed to achieve a thermal resistance of RSI 7.9 m^2K/W (R-45) using 140 mm (5 ½") thick mineral wool batt insulation between the wood studs, installed at 400 mm (16") on-centre and 152 mm (6") thick semi-rigid exterior mineral wool insulation. Because the exterior plywood sheathing is 19 mm (¾") thick, long screws and plywood strapping were used to secure the exterior insulation (instead of cladding attachment brackets). The roofs were designed to achieve a thermal resistance of RSI 14.27 m^2K/W (R-81) using a layer of 102 mm (4") thick mineral wool insulation over a layer of 102 mm thick polyisocyanurate insulation with 254 mm (10") thick mineral wool batts installed in the roof cavity (between the joists). The sloped polyisocyanurate insulation package, which ranges in thickness from 12 mm (½") to 191 mm (7½"), is not included in the energy modelling. The insulation under the east building's raft slab consists of 127 mm (5") thick expanded polystyrene (XPS) insulation, providing a thermal resistance of RSI 4.8 m^2K/W (R-27). The insulation installed above the west building's ground-floor (suspended) slab consists of 178 mm (7") thick extruded polystyrene (EPS) insulation, providing a thermal resistance of RSI 4.9 K/W (R-28).

Fenestration and Shading

High-performance buildings require high-performance windows. Euroline 4700 ThermoPlus™ vinyl-framed windows (with a tilt-and-turn upper leaf) were installed for the suites, while an aluminum-framed Kawneer 1600 Wall System® curtain wall was installed at the entrance lobbies. The windows include an argon-filled, triple-glazed insulating glass unit (IGU) with two low-emissivity (low-E) coatings and a very low solar heat gain coefficient (SHGC) of 0.17 to reduce the likelihood of overheating in the summer months. The curtain walls include an argon-filled, double-glazed IGU with a SHGC of 0.4. The overall effective U-value of the windows is 0.91 W/(m²K), but taking into account the thermal bridging between the windows and surrounding wall, the effective U-value increases to 0.94 W/(m²K). The curtain wall has an overall effective U-value of 1.987 W/(m²K). Fixed sunshades were installed over the windows on the south elevation of the east building and the south and east elevations of the west building. The west elevation of the west building is shaded by large trees.

Thermal Bridging

Because thermal bridging can have a significant impact on the thermal performance of the building envelope, a number of strategies were used to minimize it. Special attention was paid to the most repetitive details which constituted the most linear transmittance, such as those for the window head, jamb and sill, intermediate floor-to-wall connections, and parapets. The number of penetrations through the exterior walls and roofs was kept to a minimum. Plumbing stacks were combined into one penetration at each roof, and insulated for the first 3 m into the building. Long screws were used in place of thermally-broken cladding attachment clips. For through-wall flashings, a self-adhered membrane was selected instead of the more typical sheet metal flashing. Both supply and exhaust ducts between the HRVs and the building envelope were insulated. At the west building, exterior insulation was installed down past the parkade's suspended slab. Sunshades were installed on wood block spacers rather than directly on the exterior sheathing. THERM modelling was used to assess the performance of most thermal bridging mitigation measures.

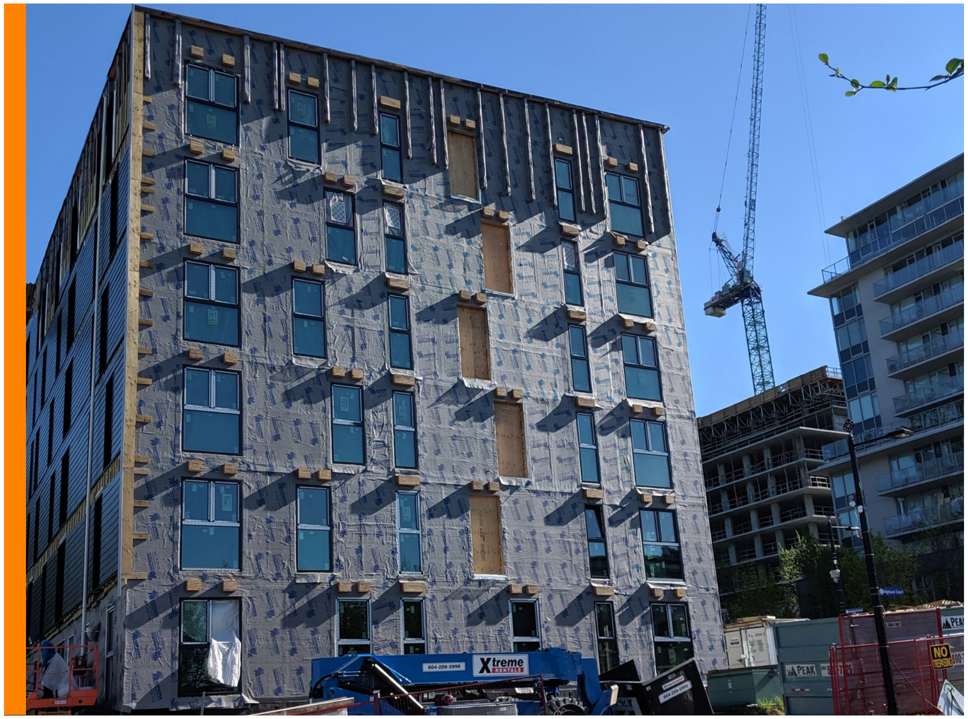


Tripled-glazed high-performance windows.

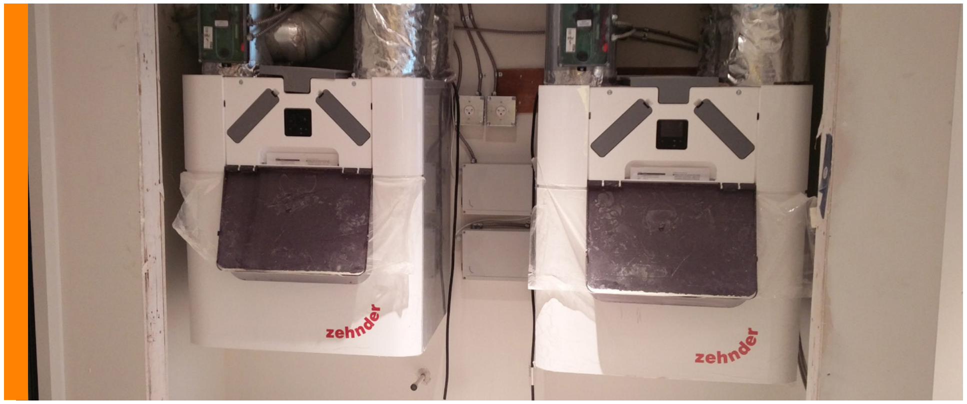
Installation of air barrier over wood block spacers.

Airtightness

The more airtight the building, the less energy is required to heat and cool it. The air barrier consists of a vapour-permeable, self-adhered membrane (Soprema® Sopraseal Stick VP) installed over the exterior sheathing, which also acts as the weather-resistive barrier for exterior walls. A foil-faced, self-adhered membrane was used for the window and door openings. The roofing assembly includes a self-adhered air and vapour membrane composed of SBS-modified bitumen (Soprema® Sopravap'r) installed on the 19 mm (¾") thick plywood roof sheathing (below the rigid insulation). Continuity of the air barrier at the roof was maintained by pre-stripping the roof's self-adhered membrane below the parapets and lapping the pre-stripping onto the self-adhered membrane of the walls. A polyethylene vapour barrier installed below the raft slab of the east building and above the 178 mm thick EPS insulation of the ground-floor (suspended) slab of the west building acts as the air barrier.



Installation of plywood sheathing and air barrier membrane.



Zehnder heat recovery ventilators.

Ventilation

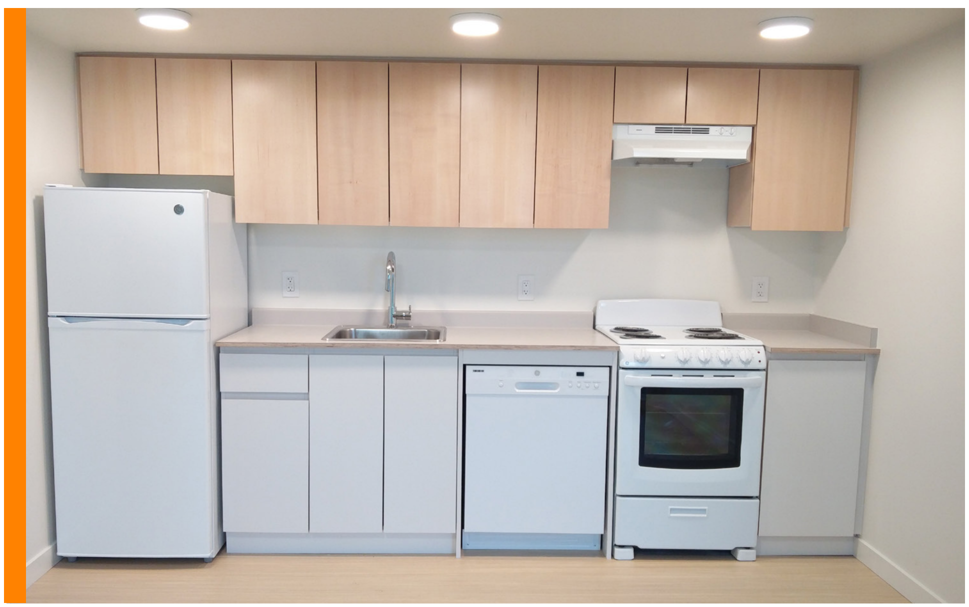
Zehnder ComfoAir 550 heat recovery ventilators (HRV) are located on the top floor of each building and each HRV serves a vertical stack of residential suites, study rooms or circulation spaces. It was a cost-effective grouping that was made possible by repetitive floor plans. All the HRV closets are accessible from common areas. A decentralized system was considered, but to avoid locating HRVs along valuable exterior wall space (to minimize HRV duct runs), a semi-centralized system was chosen instead. Ease of access and reducing tenant disruptions for maintenance and repair was also an important consideration. Locating the HRVs on the top floor minimized the supply and exhaust duct insulation required between the HRVs and the roof. Given the limitations of the HRV flow rates, only five suites could be included in each vertical stack. As a result, the six-storey (east) building required ground-level HRVs to serve the suites, laundry room and lobby area. Originally, the larger Zehnder ComfoAir Q600 HRV was included in the mechanical design for the east building, but the design team determined that using the smaller HRVs for a five-storey stack with additional HRVs for the ground-level areas was a more cost-effective option. The smaller HRV has a seasonal heat recovery efficiency of 84% (Passive House criteria) - only 3% less than the larger HRV. To assist in maintaining a comfortable indoor temperature in the summer, the bypass mode of the HRV is automatically activated by the unit's control system when the outdoor temperature can be used for free cooling.

Heating

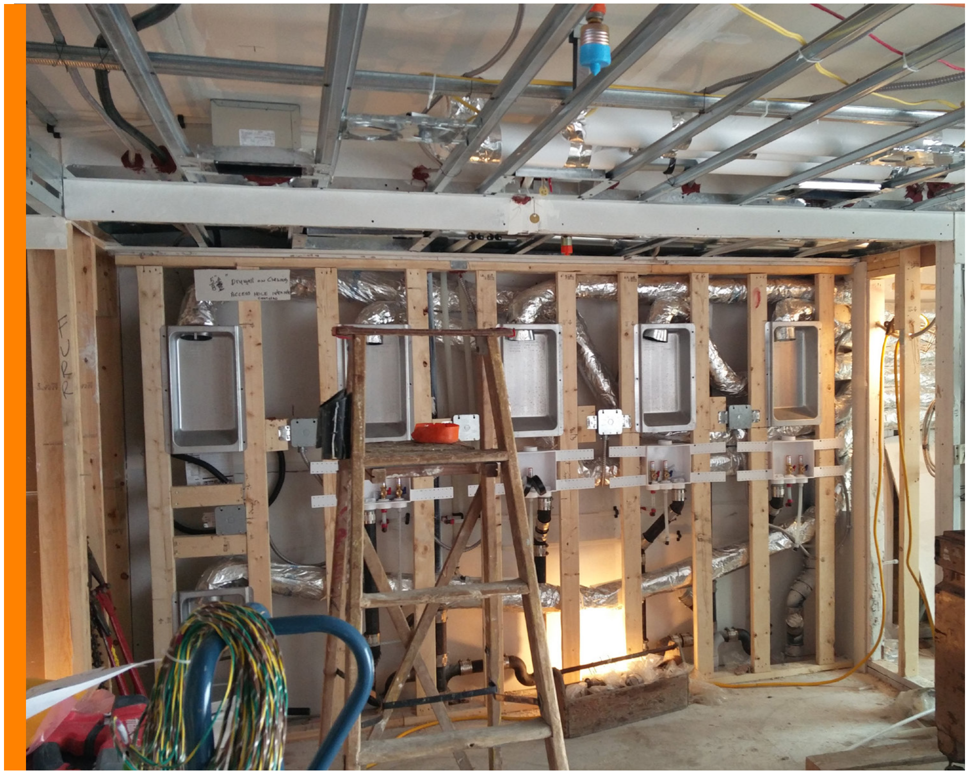
The heating systems for the east and west buildings are integrated with the ventilation systems. Thermolec electric duct heaters, ranging between 1 and 4 kW, are installed on the HRV supply ducts to provide heating for the interior spaces.

Domestic Hot Water

The Burnaby Mountain District Energy Utility provides the complex with thermal energy for its domestic hot water system. In the complex's energy transfer room, a heat exchanger (provided by the utility) transfers heat from the utility's hot water supply to the complex's domestic hot water system. The utility provides up to 79°C (175 °F) water to the heat exchanger, which generates hot water on demand. The utility did not allow the complex to have a back-up energy supply for the domestic hot water, nor storage tanks. A pump, controlled by an aquastat, recirculates the hot water in both buildings through recirculation loops which are insulated with 25 to 37 mm (1" to 1 ½") thick piping insulation, depending on the diameter of the piping.



Kitchen



Installation of the ventilation system.

Appliances

The kitchens in each suite are equipped with recirculating range hoods (to reduce heat loss), as well as ENERGY STAR®-certified refrigerators and dishwashers.

Energy Metering

A critical element to a building design's energy performance target is the ability to measure and monitor its energy consumption. The complex's electrical distribution system is designed for bulk metering, with a single BC Hydro meter. The district energy supply meter consists of a thermal energy meter that measures the water flow rate and the temperature difference between the supply and return temperatures to calculate the energy delivered to the complex.

Net-Zero Energy-Ready Challenge Winners Series

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This case study was supported by:

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