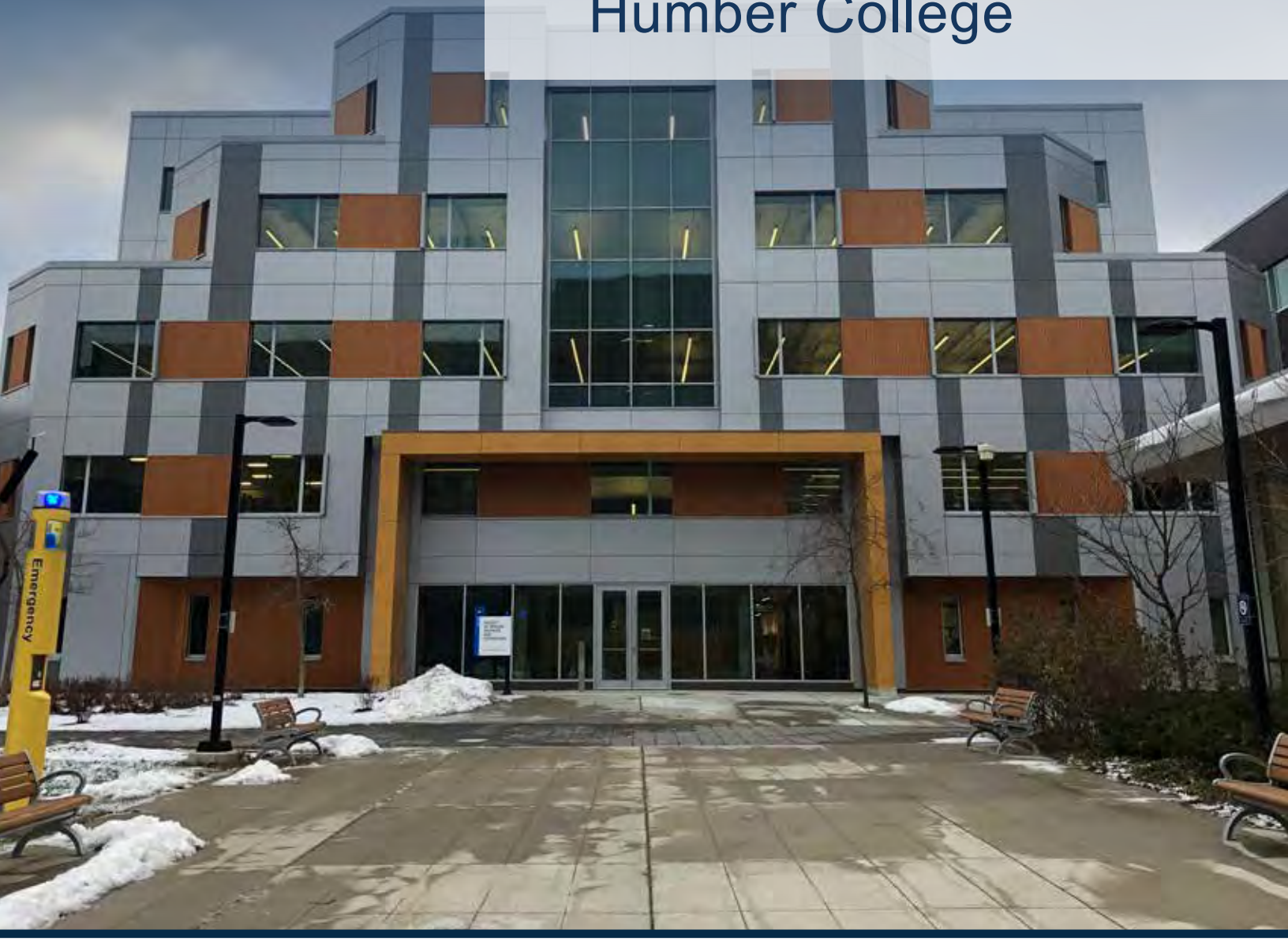
MORRISON HERSHFIELD

Building NX
Humber College



CANADIAN CONSULTING ENGINEERING AWARDS 2020
Category A – Buildings

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CANADIAN CONSULTING engineer

BUILDING NX, HUMBER COLLEGE

LOCATION:	Etobicoke, Ontario
COMPLETED BY:	2019
TO BE ENTERED IN CATEGORY:	A. Buildings
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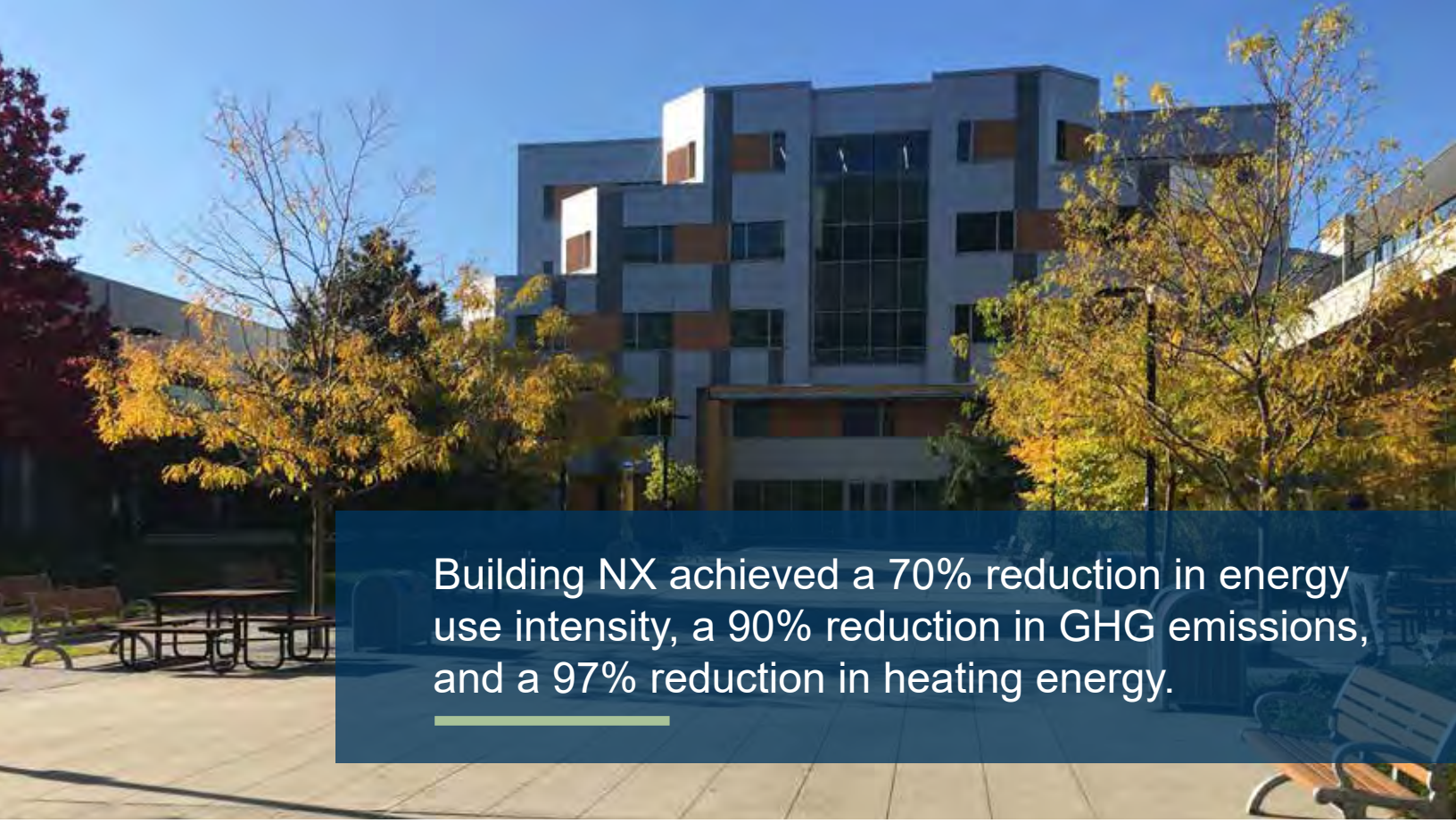
SUMMARY

Morrison Hershfield, in collaboration with Humber College and project partners, achieved a holistic deep energy retrofit of an aging Building NX, making it the first existing building retrofit in Canada to achieve Zero Carbon Building-Design Certification from CaGBC. A complete envelope retrofit, energy efficient upgrades to heating and cooling systems and lighting, and a new Solar Photovoltaic system has transformed NX into one of the most energy efficient buildings in North America.



Building NX achieved a 70% reduction in energy use intensity, a 90% reduction in GHG emissions, and a 97% reduction in heating energy.

Q.1
INNOVATION

Building NX at Humber College is the first retrofit in Canada to achieve the Canada Green Building Council's (CaGBC's) Zero Carbon Building –Design certification, and it is on track to achieve the first Passive House EnerPHit Certification for a non-residential building in Canada. A deep energy retrofit, achieved while the building remained fully occupied, transformed NX into the most energy efficient building on campus, and one of the most energy efficient buildings in North America.

Building NX was experiencing a number of systematic building failures, such as air infiltration, water penetration, condensation and temperature fluctuations, resulting in a less than ideal indoor environment for building occupants. Through innovative design and methodologies, Building NX achieved a 70 percent reduction in energy use intensity (now 64 kWh/m^2), a 90 percent reduction in GHG emissions, and a 97 percent reduction in heating energy. To put this heating achievement into perspective, this 5-storey, 4,500 m^2 building now has a peak heating demand similar to a single family home.

Highly Insulated & Airtight Enclosure

The team maximized passive design strategies for the building enclosure to significantly reduce the amount of heating and cooling required for the building systems. Acute attention was paid to the air tightness and thermal continuity of the building envelope, now featuring an ultra-high-performance skin, engineered transitions for superior air control to mitigate thermal bridging (especially at wall-to-window, wall-to-wall, and wall-to-roof points), and new super-performance, triple glazed windows. Robust testing and commissioning procedures were implemented throughout construction to ensure Building NX would achieve the Passive House Institute's (PHI's) performance requirements.

The existing Building NX was suffering from air infiltration, water penetration and condensation issues.

Efficient Building Systems

The innovative HVAC system is based on a dedicated outdoor air system with local heating and cooling and heat pumps for space conditioning and Demand Controlled Ventilation for CO^2 differential control. It offers unparalleled value by decoupling the ventilation air from the building heating and air conditioning, while maintaining exceptional fresh air distribution throughout.

Another important strategy was to decouple Building NX from the campus' central utility plant. To do this, an air-source Variable Refrigerant Flow (VRF) heat recovery system is used to recover and transfer heat between zones. It works like a water-source VRF, but exchanges heat with the ambient air instead of the plant's water loop.

Two new air-cooled VRF heat pumps and fan-coil units were installed for each thermal zone to keep the temperature consistent across the building. An electric radiant flooring system was installed to accommodate the colder winter months.

The heating energy use for NX is projected to be less than 5 percent of total building energy use (compared to 50 percent for the average Canadian building).

Lighting System Upgrades

All lighting luminaires within the building were replaced with energy efficient LED luminaires. An Osram Encelium lighting control system was installed to replace the existing control system, which was limited to On/Off ceiling mounted photosensors. The new upgraded Encelium system uses a smart digital, data driven and networked approach. Wireless modules and sensors were installed. These devices communicate data back to the wireless manager through a mesh network based on the Zigbee protocol. Hence lighting usage was adjusted with changing occupant needs and requirements, optimizing illumination and maximizing energy savings.

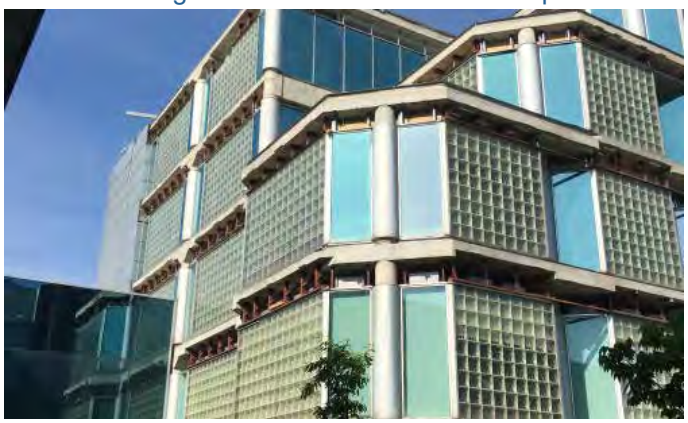
Solar Photovoltaic System

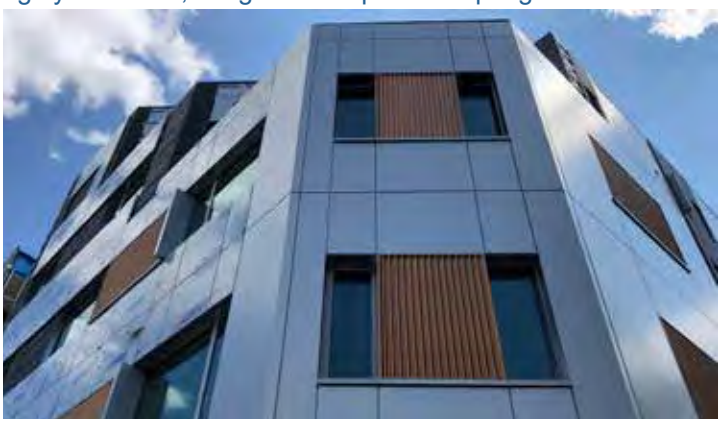
It is estimated that the new photovoltaic (PV) system mounted to the roof will generate approximately 31,500 kWh per year. Any excess energy will be fed upstream, to be used by other buildings.

Canadian Solar, a local manufacturer, built the high efficiency poly-crystalline PV modules. The inverter was selected with maximum power point tracking capability to maximize power production at any time of day.

New wall system with a major increase in insulation value and reduced thermal bridging.

>> Inefficient glass block construction was replaced with a highly insulated, airtight envelope with triple glazed windows.





>> An air-source VRF system was implemented to accommodate drastically reduced mechanical loads. Passive House certified DOAS (Dedicated Outdoor Air System) and main heat pumps pictured here

Q.2

COMPLEXITY

Designing to and achieving extremely stringent energy efficiency standards (EnerPHit Passive House standard and Zero Carbon Building) is challenging for a retrofit project, since the relative impact of thermal bridging and envelope transitions is amplified in low energy buildings.

For Building NX, it was not practical to change things like window locations due to structural wall openings, or building form and envelope articulations. Nor was it feasible to insulate the existing floor slab, resulting in a performance penalty in the Passive House planning software. To compensate for this, and achieve greater improvements elsewhere, the retrofit includes a new highly insulated and airtight envelope, energy efficiency upgrades to heating and cooling systems and lighting, and a new 25kW Solar Photovoltaic system that will generate an estimated 31,500 kWh per year.

Envelope solutions included excavating to install exterior below grade insulation, removing an inefficient skylight, installing an ultra-high-performance skin and high performance triple glazing in Passive House certified window frames and curtain walls, and engineering transitions for superior air control to mitigate thermal bridging. An extensive Building Envelope Commissioning (BECx) program was also implemented from the component level of cladding supports to the Whole Building Air Leakage (WBAL) test necessary for Passive House Institute (PHI) certification.

Careful coordination and staging of work mitigated procurement challenges, like the availability and cost of products, lead time, equipment and specialized trades necessary to achieve certification.

An added challenge was a limited construction window (with the bulk occurring during summer months.) Building NX remained open and occupied during construction, which required careful coordination and staging during the execution of the work. For example, the BECx program included an assembly mockup, where windows were installed out of normal sequence, and the air leakage performance of the assembly was tested. This provided confidence that the high performance standards could be met if material supply challenges altered the preferred installation sequence.

Whole Building Air Leakage Testing was required for PHI certification.

Employees and students now experience a healthier indoor environment with ideal temperatures, improved air quality and ample daylight.

Q.3

SOCIAL AND/OR ECONOMIC BENEFITS

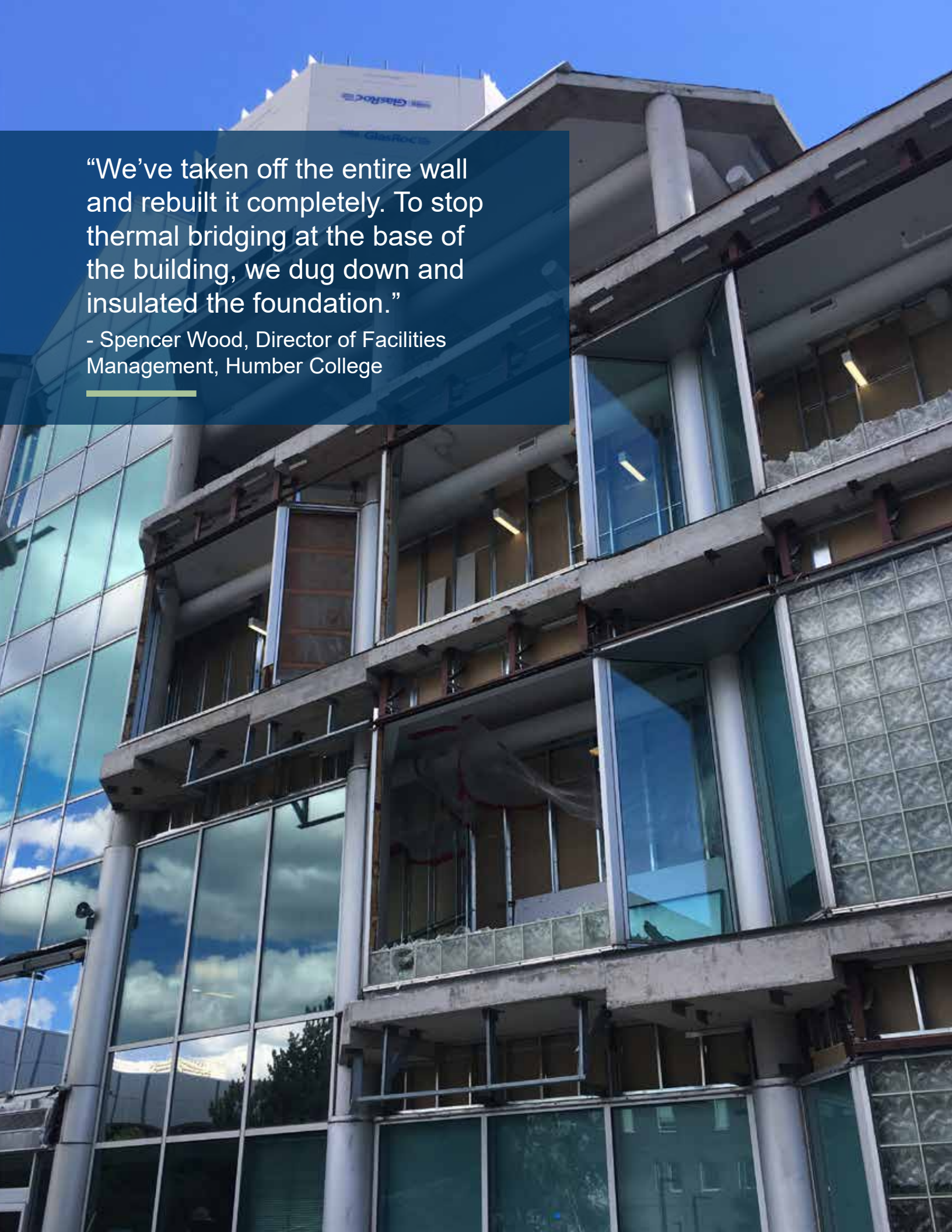
As the first Passive House retrofit of its type in Canada, the Building NX project offers great insight to engineers, architects and facility owners.

Building NX showcases Canada's readiness to retrofit buildings to zero carbon and make a positive contribution to global climate change efforts. It demonstrates the value of investing in industry-leading energy efficiency methodologies, like Passive House and Zero Carbon Building standards, to achieve long term benefits.

A strategic priority of Humber College is to provide national leadership in developing sustainable campuses. The retrofitted Building NX is a forward-thinking facility, better prepared to face rising climate and energy costs. It achieved a 70% reduction in energy use intensity (now just 64 kWh/m2), a 90% reduction in GHG emissions, and a 97% reduction in heating energy, illustrating the role of post-secondary institutions in advancing the green building industry.

The Building NX retrofit demonstrates to building owners everywhere the benefits of applying Passive House principles to increase building resilience, reduce energy needs, optimize occupant comfort and lower operational costs.

>> The retrofitted Building NX is better prepared to face rising climate and energy costs.



"We've taken off the entire wall and rebuilt it completely. To stop thermal bridging at the base of the building, we dug down and insulated the foundation."

- Spencer Wood, Director of Facilities Management, Humber College

Q.4

ENVIRONMENTAL BENEFITS

Globally, buildings are responsible for 40 percent of annual energy consumption and up to 30 percent of all energy-related greenhouse gas emissions. Because of the huge stock of existing buildings around the world, retrofits to existing buildings have tremendous potential to substantially cut GHG emissions and positively impact climate change. However, challenges such as the cost of using emerging technologies and non-standard building practices as well as disruptions can deter some building owners.

Humber College is investing in industry-leading energy efficiency methodologies and new performance benchmarks (Passive House and Zero Carbon Building Standards) to achieve ambitious sustainability goals by 2034, including cutting its energy and water use in half, and reducing its GHG emissions by 30 percent.

Humber wanted the Building NX project to exemplify how to perform deep, net-zero carbon, energy efficiency retrofits in Ontario's climate, and show how a deep energy retrofit can contribute positively to Canada's climate.

According to the CaGBC it now serves "as a national example of how to retrofit to zero carbon."

Spencer Wood, Humber's Director of Facilities Management, highlights that "… the average energy use by commercial buildings is calculated to be 335kWh/m^2. Due to the successful application of new envelope materials and assembly processes, the energy consumption of the Humber College NX building has been reduced to only 64kWh/m^2, with an estimated energy saving of 70 percent overall." The long term environmental benefits and return on investment is clear.

Low carbon retrofit buildings like NX are vital to meeting Humber's sustainability goals, and essential to achieving Canada's international targets for GHG reductions. Projects like this illustrate the College's commitment to lead the charge on sustainable, energy efficient buildings and campuses.

Excess energy produced by the new 25 kW solar PV system will be fed upstream for other buildings.

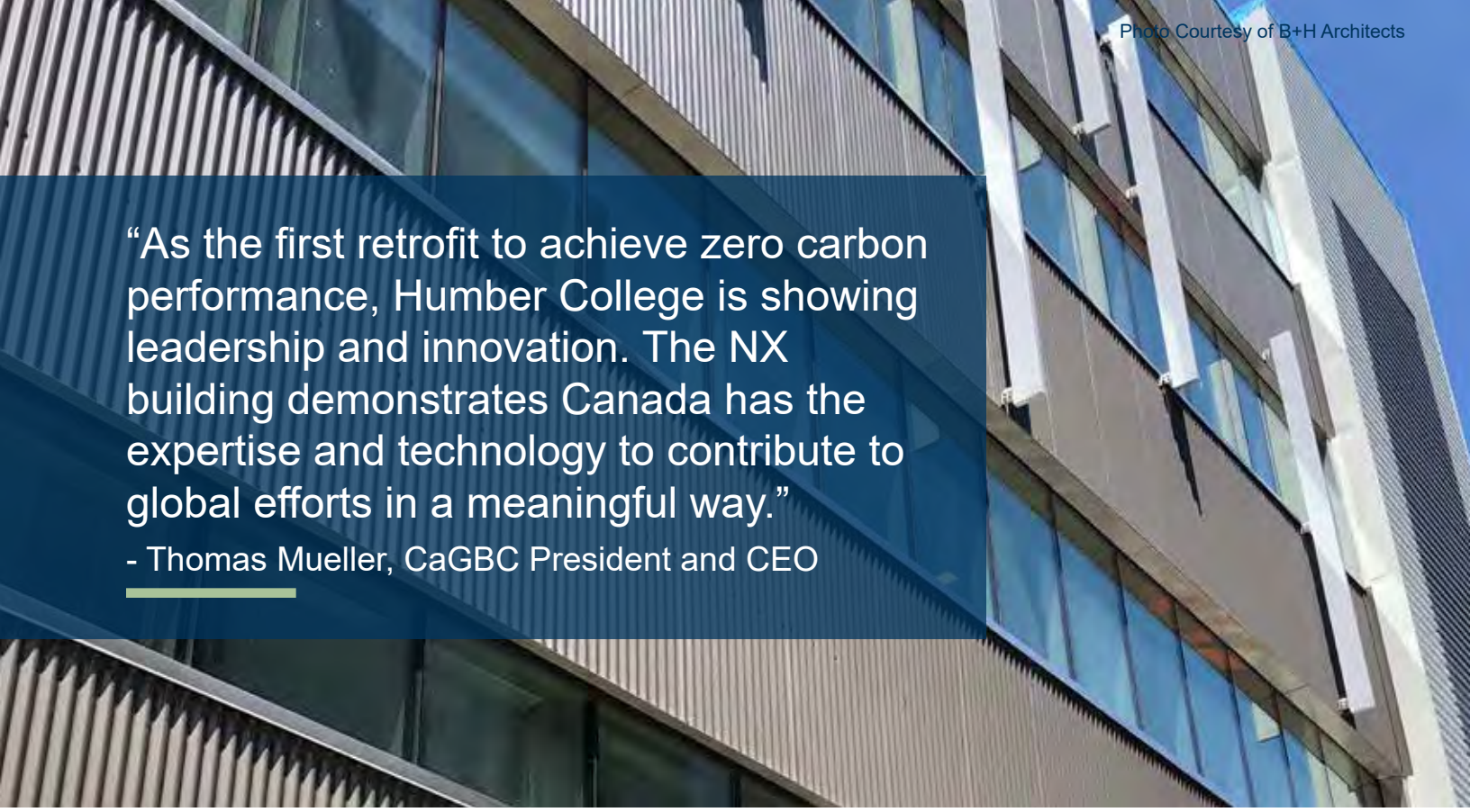


Photo Courtesy of B+H Architects

"As the first retrofit to achieve zero carbon performance, Humber College is showing leadership and innovation. The NX building demonstrates Canada has the expertise and technology to contribute to global efforts in a meaningful way."

- Thomas Mueller, CaGBC President and CEO

Q.5

MEETING CLIENT'S NEEDS

Building NX suffered from air infiltration, water penetration and condensation issues, resulting in poor performance and a less than ideal indoor environment for occupants Humber sought to provide an example to the Canadian design and construction industry of how to perform deep, net-zero carbon ready, energy efficiency retrofits in Ontario's climate, to encourage similar projects in the future.. A deep energy retrofit transformed the building, and according to the CaGBC, it now stands as "an example of how retrofitting to zero carbon should be done."

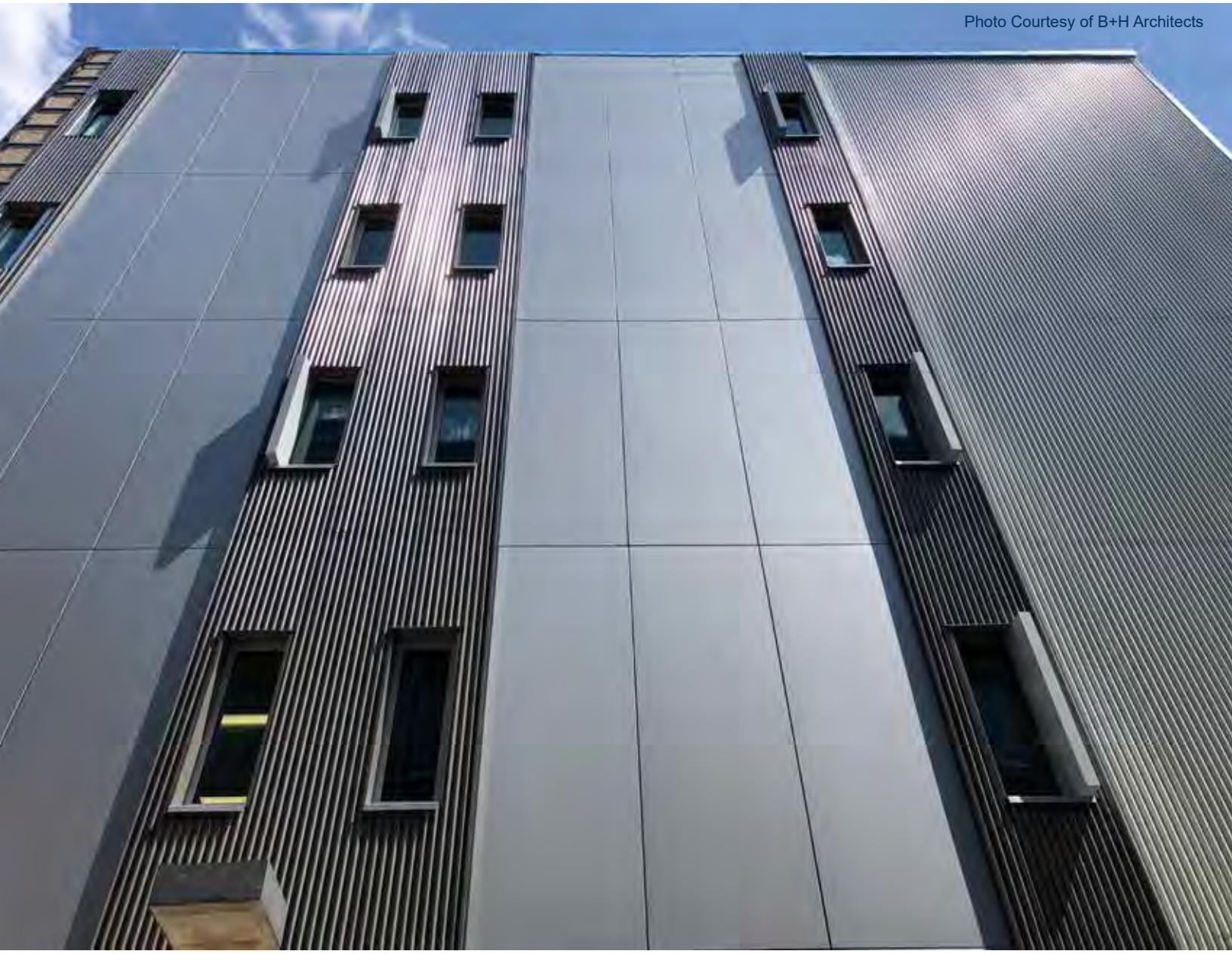
Design and procurement challenges were overcome through collaborative decision making and innovative approaches, to achieve a new highly insulated and airtight building envelope (air leakage testing revealed a performance of less than 0.6 ACH50, better than the Passive House Institute performance threshold of 0.6 ACH50 for NEW construction buildings); highly efficient HVAC systems (including water cooled VRF systems and dedicated outdoor air systems with heat recovery ventilators); upgraded lighting; and, a new solar photovoltaic system. Key design milestones were met on schedule, and building occupants now enjoy a comfortable indoor space.

A 70 percent reduction in energy use intensity, 90 percent reduction in GHG emissions, and 97 percent reduction in heating energy, makes the retrofitted Building NX the most energy efficient building at Humber College, one of the most energy efficient buildings in North America, and the most energy efficient building that Morrison Hershfield has ever worked on.

In June 2019, Building NX became the first existing building retrofit in Canada to achieve the CaGBC's Zero Carbon Building-Design certification. It is currently registered and on track to achieve the first Passive House EnerPHit Certification for a non-residential building in Canada.

High performance triple glazing in Passive House certified window frames and curtain walls.

Photo Courtesy of B+H Architects



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