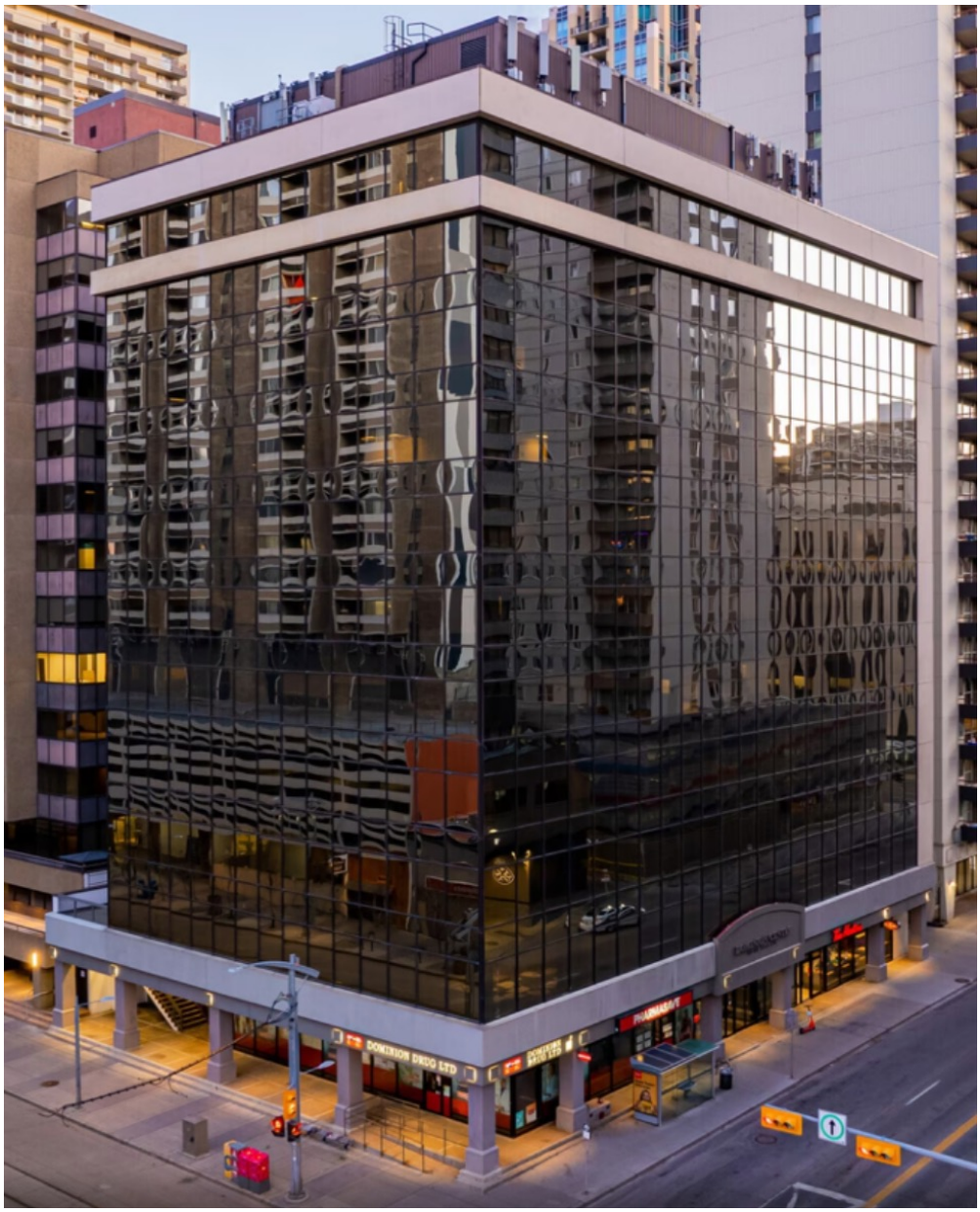
Calgary

Downtown Retrofit Challenge

Case Study #1: Design Phase



Dominion Centre

665 8 STREET SW, CALGARY AB

Office to Residential Conversion Project

Contents

Land acknowledgment

Calgary, where the Bow and Elbow rivers meet, was historically a place of confluence where the sharing of resources, ideas and opportunities naturally come together. Long before Settlers named it Calgary, the original Indigenous Nations of this area had their own names for the land. In the Blackfoot language, it is called Moh-kins-tsis. The Îethka Nakoda Wîcastabi First Nations refer to this place as Wicispa Oyade and the people of the Tsuut'ina nation call it Guts-ists-I. The Métis call the Calgary area Otos-kwunee.

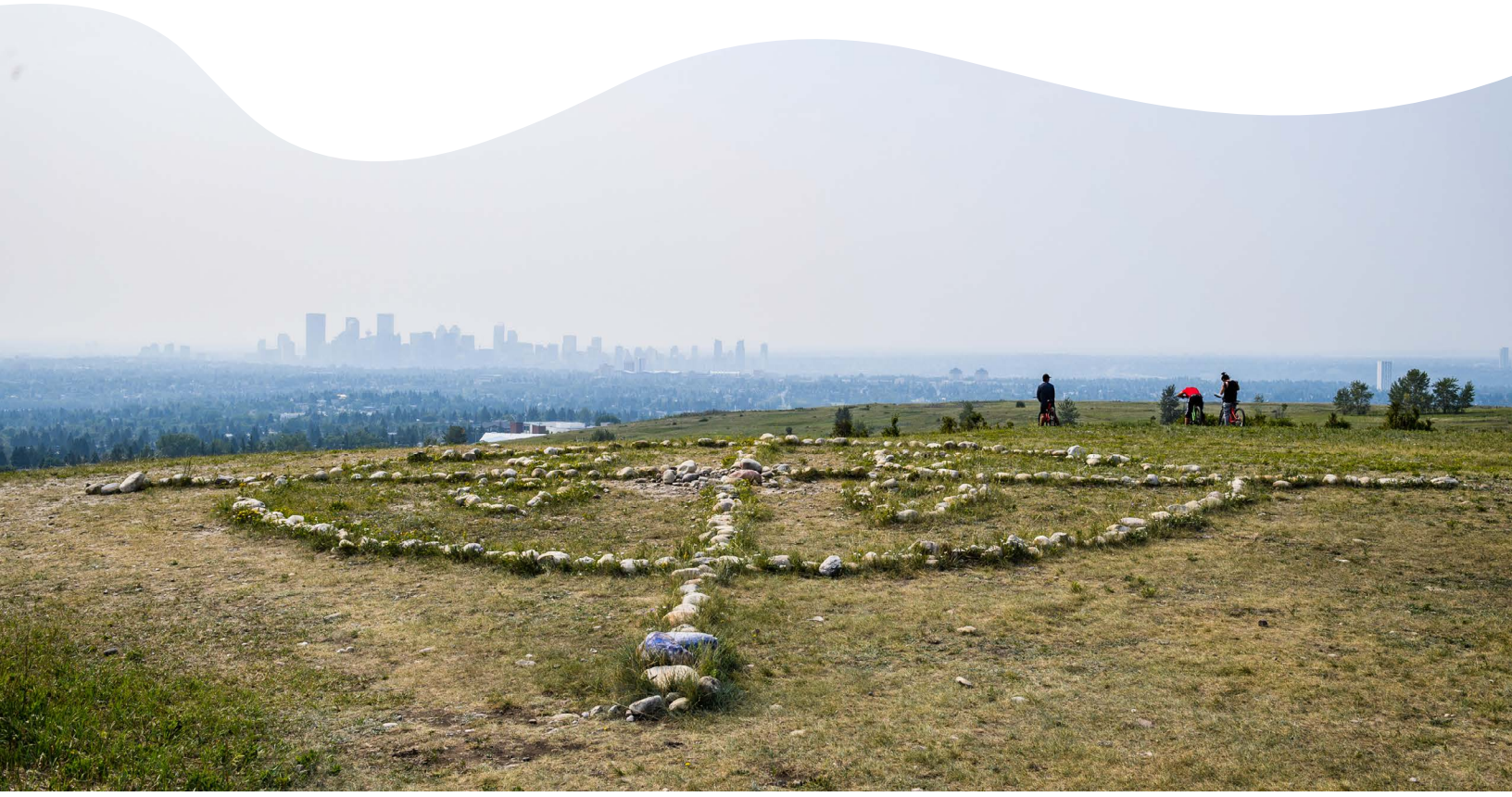
We would like to take this opportunity to appreciate and acknowledge that we are gathered on the ancestral and traditional territory of the Blackfoot Confederacy, made up of the Siksika, Piikani, Amskaapipiikani and Kainai First Nations; the Îethka Nakoda Wîcastabi First Nations, comprised of the Chiniki, Bearspaw, and Goodstoney First Nations; and the Tsuut'ina First Nation. Calgary is also homeland to the Otipemisiwak Métis Government, Nose Hill Métis District 5 and Elbow Métis District 6. We acknowledge all Indigenous people who have made Calgary their home.

LEARNING FROM INDIGENOUS PEOPLES

To align with the recommendations of *Reconciliation and the Intersections of Indigenous Peoples and Climate*[1] and honour the *Truth and Reconciliation Commission* and the *White Goose Flying Report calls-to-action*[2], Calgary's actions to address climate change must reflect:

- Consideration of Indigenous matters of historical and contemporary significance and respect for the oral transmission of language and knowledge.
- Inclusion of Indigenous science, ethical space, philosophies and governance processes when engaging with Indigenous Peoples.
- Inclusion of Indigenous Ways of Knowing, including engaging and building relationships that lead to the development of equitable partnerships.

The City of Calgary (The City) is incorporating the Four Ways (Knowing, Engaging, Relationships, Equity) principles to guide planning and implementation of Calgary's climate actions, beginning with a commitment to achieve a diverse array of social and economic outcomes for Indigenous Peoples.



[1] Fox, P. and Hatcher, A. 2022. Reconciliation and the Intersections of Indigenous Peoples and Climate. Literature Review. Prepared by Harmony Walkers Inc. Environmental Consultants and Alexandra Hatcher Consulting for The City of Calgary.
[2] Calgary Aboriginal Urban Affairs Committee (CAUAC). 2016. White Goose Flying Report: A Report to Calgary City Council on the Indian Residential School Truth and Reconciliation, Calls to Action. Available online: *white-goose-flying-calls-to-action-report (1).pdf*.

Definitions

BUILDING ENERGY MODELLING AND PERFORMANCE ANALYSIS

A process of creating virtual models which can simulate the important thermal dynamics of the building and energy performance characteristics of mechanical, electrical, and plumbing systems.

CONDENSING BOILER

A condensing boiler burns natural gas to create heat and captures additional heat from the resulting combustion exhaust by condensing water vapor around a heat exchanger.

EFFECTIVE R-VALUE

The nominal R-value derated by repetitive thermal bridges within the wall such as studs, clips brick ties, etc.

ENERGY USE INTENSITY

The total annual energy consumption of the building divided by the total gross floor area.

FACADE

Any face of a building given special architectural treatment.

GREENHOUSE GAS EMISSIONS INTENSITY

The total annual greenhouse gas emissions of the building divided by the total gross floor area.

HEAT RECOVERY VENTILATION

Heat recovery ventilation (HRV), also known as mechanical ventilation heat recovery (MVHR) or energy recovery ventilation (ERV), is a ventilation system that recovers energy by operating between two air sources at different temperatures.

LATENT HEAT

The heat required to convert a solid into a liquid or vapour, or a liquid into a vapor, without change of temperature.

NOMINAL R-VALUE

Material value of the insulation product based on testing from the manufacturer.

SENSIBLE HEAT

Thermal energy transfer to or from a substance that results in a change of temperature but not a change in phase, pressure, or volume.

USI

USI stands for "U-value and Solar Heat Gain Coefficient Index". It is a measure of the energy efficiency of windows, glass doors, and skylights. The lower the USI value, the more energy-efficient the fenestration product is.

VARIABLE FREQUENCY DRIVES

A type of AC motor drive that controls speed and torque by varying the frequency of the input electricity (voltage or current)

VENTILATION RATE

The ventilation rate is a function of the minimum air changes per hour required, which is the total number of times the total air volume in the building is completely replaced.

WHOLE-BUILDING LIFECYCLE EMISSIONS

The combined embodied carbon and operational GHG emissions resulting from each stage of the building lifecycle, including the of the production and construction stages, the use stage, the end-of-life stage, and externalized impacts beyond the system boundary.

WHOLE WALL R-VALUE

The effective R-value derated by thermal bridging losses due to heat flow through different system interfaces such as the wall to window/door perimeters, slab edges, parapets, etc.

99% DESIGN COMPLETION

Final design that is used to create plans and reports prior to submitting a building permit application. Modifications at this stage can still be made pending the building code and building permit review processes.

Executive summary

On November 8, 2023, the *Downtown Development Incentive Program* announced the Dominion Centre as one of three approved projects approved for funding to undergo an office-to-residential conversion. At the same time, the Dominion Centre was announced as the winner of the *Downtown Retrofit Challenge*; a $1.2 million grant program to support a conversion project in achieving low carbon and climate resilient building design, construction, and operation.

In their Downtown Retrofit Challenge application, the Dominion Centre project team proposed that the converted residential building could achieve an energy performance of 26 per cent better than the NECB 2017 through key building upgrades such as a full building façade replacement and the addition of a central *heat recovery ventilation system*.

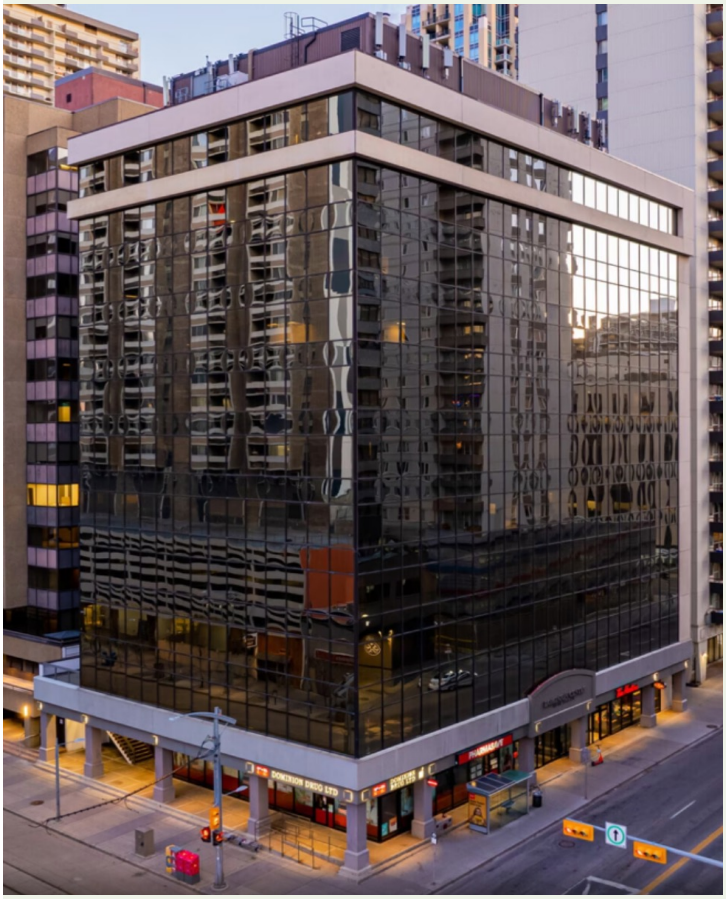
In October 2023, the project team participated in a design workshop hosted by the City of Calgary and *Sustainable Buildings Canada*. This workshop provided an alternative list of energy conservation measures that could be applied to the building design to achieve an energy performance of 25 per cent better than the NECB 2017 reference building. From this, an optimized list of energy conservation measures was recommended, which included a new high-performance curtain wall system with a reduced window-to-wall ratio, high-efficiency heating and domestic hot water systems, and a full light-emitting diode (LED) lighting system.

In December 2023, the Dominion Centre project team presented a 99 per cent design completion energy model report to The City of Calgary. This design achieved a 6 per cent reduction in energy use and a 10 per cent reduction in GHG emissions compared to the NECB 2017 reference building. Despite not meeting the 25 per cent improvement target set in the Downtown Retrofit Challenge, the design still achieved an **Energy Use Intensity (EUI) of 0.85 GJ/m^2/year and a GHG intensity (GHGi) of 75 kgCO_2e/m^2/year**, which is very similar to the modelled EUI and GHGi of the Workshop building. Compared to the original office building, the new residential building is modeled to achieve a **51 per cent reduction in energy use and a 40 per cent reduction in GHG emissions**.

The Dominion Centre project team also conducted an embodied carbon lifecycle assessment (LCA) for the building materials required for the building façade upgrade. The associated embodied carbon for these materials amounts to 236 tCO_2e (or 24 kgCO_2e/m^2), approximately 5 per cent of the estimated carbon in the existing building (4,820 tCO_2e). **By reusing core elements in the Dominion Centre, embodied carbon savings of 4,584 tCO_2e is achieved.** A Climate Risk Screening Assessment was also prepared to assess climate hazards relevant to the Dominion Centre (such as extreme heat and high-intensity rainfall), determine the associated risks, and ensure implementation of the proper adaptation measures.

The Downtown Retrofit Challenge aimed to assess the real-world costs of enhancing building energy, emissions, and resiliency performance during an office-to-residential conversion project. The Dominion Centre project is expected to achieve operational energy savings of 8,413 GJ/year and GHG emissions savings of 437 tCO_2e/year when compared to the old office building. **Over a 25-year life span, the project is expected to save 10,925 tCO_2e with an adjusted cost of performance of $877/t$CO_2$e saved.** Beyond emissions, the $37 million investment into the Dominion Centre yields significant energy cost savings, embodied carbon reductions, climate resiliency, and creates 132 new residential suites in Calgary's downtown core.

The Dominion Centre



Building address	665 8 Street SW, Calgary AB
Climate zone	7A
Year of construction	1978
Building height	11 stories
Building Footprint	1,052 m^2
Total Building Area	12,495 m^2
Modelled Floor Area	9,640 m^2
Original function	Retail (ground floor only), 13 office units
New function	Retail (ground floor only), 132 residential units

Downtown retrofit challenge

On May 5th, 2023, the Dominion Centre project team applied to the Downtown Retrofit Challenge, a competition-styled funding program for approved projects of the Downtown Development Incentive Program. Their application included a preliminary energy modelling analysis that identified potential energy efficiency and GHG emission reduction retrofit options that could be implemented with support through additional funding. Three primary measures were included to address the predominant role that heating and ventilation play in the Dominion Centre's energy performance: a *facade* replacement, a heat recovery ventilation system, and the option to upgrade to new *condensing natural gas heating boilers*.

With these measures included in the energy model along with a handful of additional energy efficiency strategies such as LED lighting and low-flow water fixtures, the following performance improvements for the Dominion Centre were calculated a:

- 50 per cent reduction in energy consumption relative to the existing office building
- 26 per cent reduction in energy consumption relative to a NECB 2017 reference building.

This level of potential performance improvement, combined with relative scale and expected timing of the project, placed the Dominion Centre as a front-runner during the evaluation of applications for the Downtown Retrofit Challenge.

On November 8th, 2023, the City of Calgary announced that the Dominion Centre had been formally approved for funding to undergo an office-to-residential conversion project through the Downtown Development Incentive Program. At the same time, the project was announced as the successful proponent of the Downtown Retrofit Challenge, awarding the project an additional $1.2 million to help offset the incremental costs to design, construct, and verify the performance of a low-carbon and climate resilient building.

Deep energy and emissions retrofit projects require significant changes to existing building systems including the building envelope, interior wall systems, and heating and cooling systems. When a building converts from office to residential use, many primary building systems must be altered to meet the needs of residential tenancy, such as an increased need for natural and mechanical ventilation and additional demand on electricity, water, and sewer services. A conversion project is therefore an opportune time to apply energy efficiency and GHG emission reduction best practices. Along with this, reusing the core elements of the building significantly decreases the embodied carbon impact of the project compared to demolition and redevelopment.

Retrofit project design phase

INFORMATION GATHERING, SITE WALKTHROUGH, AND THE DESIGN WORKSHOP

As part of the Downtown Retrofit Challenge, the Dominion Centre project team agreed to participate in a *building energy modelling and performance analysis* workshop (the "Workshop") hosted by the City's contractor, Sustainable Buildings Canada (SBC). SBC gathered and reviewed information such as the high-level plan for the office-to-residential conversion project, all recent building condition assessments, energy audits, feasibility studies, and as-built or proposed retrofit drawings, and conducted a walkthrough to collect additional building information. Following the walkthrough, a virtual meeting was held with all parties to discuss energy modelling assumptions, approaches, and specific measures that would be examined on the day of the Workshop.

BUILDING ENERGY MODELLING AND PERFORMANCE ANALYSIS

The half-day Workshop was held on October 5th, 2023, with representatives from the Dominion Centre project team, SBC, and the City of Calgary. The primary goal of the Workshop was to identify building-system designs and technologies suitable for implementation in the office-to-residential conversion project, while targeting a 25 per cent reduction in energy use relative to the National Energy Code of Canada for Buildings (NECB 2017). Such reductions are anticipated to result in significant decreases in both total *energy use intensity (EUI)* and *greenhouse gas emissions intensity (GHGi)*.

The Workshop allowed the project team to explore alternative sustainable design strategies and test energy efficiency concepts that may not have been initially considered. Primary focus was given to the building enclosure components and the active mechanical systems within the building. The full list of energy conservation measures (ECMs) identified during the Workshop can be found in *Table 1*. The list of ECMs used to obtain a 25 per cent reduction in energy consumption relative to the NECB 2017 reference building is shown in *Table 2*.

Building Enclosure Components	Active Building Systems
• Airtightness • Fenestration and thermal comfort • Heat loss through framing • Glazing design and performance • Passive solar design • High performance windows • Fibreglass curtain wall technologies	• Space conditioning • Ventilation • Lighting, electrical, and appliances • Hot and cold-water efficiency

EMBODIED CARBON LIFECYCLE ASSESSMENT

In addition to exploring energy conservation and GHG emission reduction measures through the Workshop, the project team conducted an embodied carbon lifecycle assessment (LCA) on the building materials required for the building envelope upgrade. The embodied carbon associated with these materials is 236 tCO_2e (or 24 $kgCO_2e/m^2$), which is approximately 5 per cent of the estimated carbon in the existing building (4,820 tCO_2e). Through the adaptive reuse of the Dominion Centre, an estimated embodied carbon savings of 4,584 tCO_2e is achieved. A summary of the embodied carbon by material type is found in *Table 3*.

CLIMATE RISK SCREENING ASSESSMENT

To support the Dominion Center in improving resilience with respect to changing climate, a high-level Climate Resiliency Screening Assessment (CRSA) was completed to identify the risks posed by climate change and extreme weather events. The CRSA informs the City of Calgary, the design team, and other stakeholders of the projected changes in climate and the associated risks to the construction, operation, and maintenance of the new residential facility. Additionally, the CRSA details adaptation and mitigation strategies included in the design and provides further adaptation and mitigation measures to be considered.

Based on the findings of the CRSA, the highest risk climate hazards relevant to Dominion Center are:

- Extreme Heat
- Wildfire Smoke
- Short Duration High Intensity Rainfall
- Severe Storms

The full list of climate resilience measures slated for implementation into the Dominion Centre Project are found in *Table 4*.

The Downtown Calgary Development Incentive Program is a cornerstone of The City's *Downtown Strategy* and a major driver of the vision and goals of Calgary's *Greater Downtown Plan*. The program supports downtown property owners to redevelop or remove underused office space and bring in a greater mix of amenities and services that support a thriving and resilient downtown community.

Impact on the final design and modelled building performance

DESIGN WORKSHOP

On December 5, 2023, the project team presented the City of Calgary with the 99 per cent design completion energy model report. The design shows a 6 per cent reduction in energy use and 10 per cent reduction GHG emissions compared the NECB 2017 reference building. *Table 5* shows the primary ECMs from the 99 per cent design completion energy model report.

Interestingly, this design does not achieve the target 25 per cent improvement over the NECB reference building, yet still achieves an EUI of 0.85 GJ/m^2/year and a GHGi of 75 kgCO_2e/m^2/year, which is a very similar to the performance calculated for the proposed building from theWorkshop. This anomaly arises from the fact that different ventilation rates were used for the 99 per cent design completion reference building and the Workshop reference building.

The difference in the energy model inputs between the two scenarios promotes taking a different perspective to assess the energy and emissions performance of the final design of the Dominion Centre retrofit. The final design includes a partial building envelope improvement with improved wall insulation and new glazing with modern performance ratings, the installation of a central heat recovery ventilation system, upgraded 95 per cent efficient domestic hot water heaters, a fully upgraded LED lighting system, and temperature-controlled thermostats in all suites and commercial retail units. When compared to the original office building, the retrofit residential building is modelled to achieve a 51 per reduction in energy use and 40 per cent reduction in GHG emissions, which should be touted as a significant achievement.

Table 6 shows a summary of building system scenarios for the existing building, NECB 2017 reference building, the proposed Workshop building, and the 99 per cent design completion building. *Table 7* compares the energy performance results of those scenarios.

In assessing the impact of the Workshop on the final design of the Dominion Centre conversion project, it's important to note that the glazing replacement and the heat recovery ventilation system were proposed in the original Downtown Retrofit Challenge application. Many of the additional ECMs that were identified in the Workshop were not included in the final design, which indicates that the Workshop had only a marginal impact on the final design of the Dominion Centre conversion project.

CLIMATE RISK SCREENING ASSESSMENT

The Climate Risk Screening Assessment compelled the project team to assess the relative climate hazards that a building may experience, document the risks associated with those hazards, and determine the necessary mitigating strategies that should be applied to reduce or eliminate the risk. The project team confirmed that the mechanical, plumbing, and electrical systems remaining in place through the conversion project are of adequate capacity to manage extreme heat and short-duration, high intensity rainfall events now and into the future. Any new equipment potentially impacted by these hazards will have mitigating strategies applied.

One of the greatest opportunities for improving the Dominion Centre's climate resiliency lies within the building envelope upgrade component of the project. The installation of glazing across the entire building will help minimize heat transfer to the inside of the building during extreme heat events, and air tightness testing can be used to confirm that air leakage rates are low enough to allow the chiller system to maintain a safe and comfortable indoor air temperature for occupants. To fend off building system damage from penetrating rains, water and mold resistant materials can be used with industry-standard drainage details. Throughout the demolition and construction phase, the project team is highly encouraged to maintain a climate-resiliency focus to ensure proper implementation of the measures and to identify and incorporate any additional mitigating measures that arise.

COST OF EMISSIONS PERFORMANCE

One of the primary functions of the Downtown Retrofit Challenge is to elucidate the real-world costs of improving building energy and emissions performance through the course of an office-to-residential conversion project. Gaining this insight is fundamentally challenging because the baseline, lowest cost scenario is not typically costed out, which means a comparison of the lowest cost estimate to the actual cost estimate is not possible. So, the baseline scenario for this case study is instead the Dominion Centre remaining in its office form, continuing to operate without investment into the building systems. This scenario is given a cost of performance of \$0/tCO_2e saved.

The Class A cost estimate for the conversion project, presented on June 3, 2024 was \$37 million (see the project cost breakdown in *Table 8*). Using the results of energy model from the 99 per cent completion report, this investment will lead to an operational energy savings of 8,413 GJ/year and GHG emissions savings of 437 tCO2e/year. Over a 25-year period, GHG emissions savings will be 10,925 tCO_2e with an overall cost of performance of \$3,378 tCO_2e saved.

However, most of the project costs do not have a material impact on the emissions performance of the building, therefore; when considering only the cost of building system components that impact the emissions performance of the building (\$9.5 million), the adjusted cost of performance is \$877 tCO_2e saved.

The benefits of investment into the Dominion Centre project go beyond carbon savings, including an energy cost savings of \$3.9 million over 25 years, embodied carbon savings of 4,584 tCO_2e, and the creation of 132 new residential suites in Calgary's downtown core during a housing affordability crisis.

Next Steps: Construction Phase

At the time of writing, the Dominion Centre project has begun interior renovations and is soon to commence on the exterior demolition and renovation. The City intends to meet with the project team on a quarterly basis to monitor and document construction progress and learn of any instances that may lead to significant design changes and impact the implementation of ECMs and climate resilience measures.

Following completion of the renovation, the project team will submit a Post-Construction Report to detail how the $1.2 million Downtown Retrofit Challenge grant supported the implementation of ECMs and climate resiliency measures, and what the impact of those measures was on building performance. After one-year of operating under full occupancy, a Building Performance Report will be prepared to verify the real-world energy use and GHG emissions performance of the Dominion Centre in its new residential form.

Closing Remarks

The City of Calgary would like to thank the Dominion Centre project team for their participation in the design phase of the Downtown Retrofit Challenge, and for their punctuality and transparency in sharing building-level data and energy performance modelling results. The modelled energy use and emissions savings are commendable, and the design phase of the Downtown Retrofit Challenge has provided important information that can inform the development of future iterations of adaptive reuse incentive programs. Four recommendations for improving the efficacy of this type of municipally led initiative are provided in *Table 9*.

Table 1
List of energy conservation measures from the workshop

List of Energy Conservation Measures from the Workshop	Building System
1. Improve thermal performance of the external above ground wall to an effective R-25	Opaque Wall
2. Improve roof insulation to an effective R-40 when the existing roof reaches end of useful life	
3. Improve the whole wall R-value to an effective R-10	
4. Reduce infiltration by 10% to 0.78 L/s·m^2	Air Tightness
5. Reduce infiltration by 50% to 0.49 L/s·m^2	
6. Utilize existing aluminum frame with a pultruded fiberglass pressure plate – USI: 2.99, Solar Heat Gain Coefficient 0.26	Fenestration
7. Utilize existing aluminum frames with a pultruded fiberglass pressure plate, replace glass and include aluminum awning operators (8% of curtain wall area) – USI 3.14, Solar Heat Gain Coefficient 0.26	
8. Utilize existing aluminum frames with a pultruded fiberglass pressure plate, replace glass and include fibreglass awning operators (8% of curtain wall area) – USI 2.75, Solar Heat Gain Coefficient 0.26	
9. Replace curtain wall façade with hybrid aluminum window wall	
10. Replace curtain wall façade with high-performance fiberglass curtain wall, triple glazing – USI 0.85, Solar Heat Gain Coefficient 0.26	
11. Replace existing boiler with 97% efficient condensing boilers	Mechanical
12. Install heat recovery from chiller condenser to pre-heat DHW in the summer	
13. Add a shoulder season air-source energy recovery heat pump	
14. Install variable frequency drives on the primary heating and cooling circulation pumps	
15. Install a central energy recovery ventilation system at 75% sensible/70% latent effectiveness	
16. Install low-flow water fixtures: Lavatory 2.5 litres per minute (LPM), kitchen faucet 4.5 LMP, shower 5.7 LPM	Water
17. Install high-efficiency condensing DHW boilers (97% efficiency)	
18. Install an intelligent DHW recirculation pump and set recirculation schedule to reduce optimize runtime	
19. Install a 50% efficient DHW recovery system for showers	
20. Install an intelligent cold-water booster pump system with variable frequency drives	
21. Install LED lighting to reduce lighting power density to target levels	Electrical
22. Install heat pump dryers in the laundry room(s)	

Table 2
Priority energy conservation measures from the workshop

Energy Conservation Measures	Building System
1. Upgrade windows for residential suites, USI 0.85, Solar Heat Gain Coefficient 0.30	Opaque Wall & Fenestration
2. Improve overall wall thermal performance to R-15	
3. Reduce window-to-wall ratio to 35%	
4. Install a 4-pipe fan coils in and energy recovery ventilators in residential suites, upgrade to 97% efficient condensing boilers	Mechanical
5. Utilize heating system fluid additive to improve heat transfer	
6. Install a 97% efficient DHW heater with low flow fixtures and heat recovery	Water
7. Install LED lighting specified to target lighting power densities	Electrical

Table 3
Embodied carbon by material type

Material	Embodied Carbon (kg CO_2e)
Double Pane Insulated Glass	124,783
Spray Polyurethane Foam Insulation	48,116
Aluminum Extrusions	24,458
Steel Studs	18,808
Gypsum Boards	17,856
Mineral Wool Batt Insulation	2,770
Total	**236,791**

Table 4
Summary of climate resilience risks and measures

Hazard	Risk Level	System Impact	Building System
Extreme Heat	Extreme	Mechanical and Plumbing Systems	• The existing chiller is 235 tons while the existing loads for the building based on present day design temperature is 160 tons, allow an additional 75 tons of cooling based on a 2050 profile. • An analysis for the cooling loads for the building based on a 2050 profile has not been performed by CGM Engineering.
	Extreme	Power & Electrical Systems	• Existing service has space for any future cooling loads. • Existing generator to remain in case of heat induced power outage. • Building has existing utility meter. No additional change to electrical service layout. • No change to electrical service layout. No concern for overloading. • Existing generator load to remain life safety only. • Elevator connected to generator in case of emergency indued power outage. • Connect lighting in critical building areas and evacuation routes/hallways to backup power. This is done as per code.
	High	Architectural	• Replace 60% of existing glazing with higher efficiency glazing. Existing glazing is very poor with a U Value of 3.70, this is being replaced with a U Value of 1.85. NECB calls for a U Value of 1.9. • Low E Dual Glazing by border glass. Caps and operables are by Reynaers Aluminum Master Line 8. • Increase the R Value of Spandrel components in the wall by replacing the existing R5 with R10. • Retaining the Light grey roof instead of a dark-coloured roof to mitigate heat gain. • Use higher albedo building envelope materials with the spandrel panel and light grey concrete. • Emphasize cross ventilation by installing one small operable window in each suite. Return and exhaust ducts are on the opposite side of the room as the window will pull air through the room. • A roller shade system has been provided for every window to prevent heat and sunlight entry to the building. • Complete an energy model to ascertain future risks and vulnerabilities. Energy model completed by Entuitive. • Perform envelope testing to ensure sealing and air tightness. • Minimal work is being conducted on the exterior, but where work is happening, careful attention has been dedicated to improve membrane continuity and moisture protection.
Short duration high intensity rainfall	Medium	Mechanical and Plumbing Systems	• Most of the mechanical equipment in the building is suspended from the structure at high level. Larger equipment installed in the penthouse will be installed on curbs within the building.
	Medium	Power and Electrical Systems	• Electrical system is protected within the building from flood waters.
	Medium	Architectural	• Select high performance water and mold-resistant building envelope materials.

Table 5
Energy conservation measures from the 99 per cent design completion report

Energy Conservation Measures	Building System
1. Upgraded spandrel to effective R-17, derated to R10	Opaque Wall
2. Upgraded window glazing – USI 1.85	Fenestration
3. Installation of a central heat recovery ventilator 88.1%/68.1% (sensible/latent) with no preheat	Mechanical
4. Installation of a 95% efficient condensing gas fired DHW heater	Water

Table 6
Summary of building system scenarios

Building System		Existing Building	NECB 2017 Reference Building	Proposed Workshop Building	99% Design Completion Building System
Building Envelope	Roof System	Modified bitumen, R-7 effective	R-35*	Modified bitumen, R-7 effective	Modified bitumen, R-7 effective
	Concrete panel wall	R-12 effective	R-27*	Whole-wall R-15 effective*	R-22 effective (estimate)* 2" closed cell spray foam to backpans*
	Spandrel Panel	R-5	R-27*		46%
	Window-to-wall ratio	46% vision glass	33%*	35%*	USI 1.85 w/m²·K with dual clear vision glass, dual spandrel, and operable windows in existing aluminum curtainwall framing*
	Fenestration	Aluminum frames USI 3.70 w/m²·K Solar Heat Gain Coefficient 0.54	USI 1.90 w/m²·K*	USI 0.84 w/m²·K* Solar Heat Gain Coefficient 0.30*	
Mechanical Systems	Cooling	Central Screw Chiller – Twin Compressor 380 kW Capacity	None*	Central Screw Chiller – Twin Compressor 380 kW Capacity	Central Screw Chiller – Twin Compressor 380 kW Capacity
	Space Heating and Humidification	Three Natural Gas-fired atmospheric boilers 585 kW Capacity 84% overall thermal efficiency Perimeter hydronic space heating	Non-condensing Gas Fired 83%* Two x Single-Stage Boilers* Total Capacity = 586 kW* Hydronic baseboard*	Hydronic 4-pipe fan coils in and energy recovery ventilators in residential suites* 97% efficient condensing boilers*	Three Natural Gas-fired atmospheric boilers 585 kW Capacity 84% overall thermal efficiency Hydronic 4-pipe fan coils in residential suites* Ecobee thermostats in all suites and commercial retail units with programmed comfort range*
	Domestic Hot Water (DHW) Heating	Two Natural Gas-fired DHW Heaters 750,000 BTU/h Capacity 80% overall thermal efficiency	Gas Fired 80%*	97% efficient DHW heater with low flow fixtures and heat recovery*	95% efficient condensing gas-fired DHW heater
	Heating Pumps	5 HP (Constant Speed)	Not Provided	5 HP (Constant Speed)	5 HP (Constant Speed)
	Ventilation	Displacement Outdoor Air Unit with Condensing Furnace 1200 cfm/floor	Gas-fired PSZ rooftop units with baseboard hydronic heating* Constant Volume Supply Fan* Sized to meet load* Supply fan power = 640 Pa @ 40% eff*	Displacement Outdoor Air Unit with Condensing Furnace 1200 cfm/floor	Displacement Outdoor Air Unit with Condensing Furnace 1200 cfm/floor Central heat recovery ventilator 88.1%/68.1% (sensible/latent) with no preheat*
	Lighting	6.2 W/m²	6.5 W/m²*	LED System - 5.1 W/m²*	LED System - 7.3 W/m²*

*System component change from existing building

Table 7
Summary of building performance scenarios

Building Performance	Existing Building	NECB 2017 Reference Building	Proposed Workshop Building	99% Design Completion Building
Total Annual Energy Use (GJ)	16,675	8,818	8,604	8,262
Energy Use Intensity (GJ/m^2/year)	1.73	0.91	0.89	0.85
Total Annual GHG Emissions (tonnes CO_2e)	1,162	815	724	725
GHG Emissions Intensity (kgCO_2e/m^2/year)	124	85	75	75
EUI vs. Existing Building	N/A	-47%	-48%	-51%
GHGi vs. Existing Building	N/A	-31%	-36%	-40%
EUI vs. NECB 2017 Reference	+37%	N/A	-30%	-6%
GHGi vs. NECB 2017 Reference	+43%	N/A	-8%	-11%
EUI vs. BenchmarkYYC Average for Multifamily Residential Buildings (2021) 1.2 GJ/m^2/year	N/A	- 24%	-26%	-29%
GHGi vs. BenchmarkYYC Average for Multifamily Residential Buildings (2021) 76 kgCO_2e/m^2/year	N/A	+12%	-1%	-1%

Table 8
Summary of estimated project costs

Land costs	$	8,650,000
Closing costs	$	75,000
Total land costs	**$**	**8,725,000**
Design fees	$	1,310,000
3rd party reports	$	33,200
Course of construction insurance	$	200,000
Building permit fees	$	220,000
Property taxes	$	66,720
Broker fee	$	174,090
Lender fee	$	50,000
Interest reserve	$	1,608,000
Quantity surveying	$	30,000
Developer fee	$	1,600,000
Legal	$	75,000
Marketing/lease up	$	10,000
Appraisal	$	7,500
Total soft costs	**$**	**5,384,510**
Site supervisor	$	112,000
Site labour/pre-occupancy	$	144,000
Project manager	$	120,000
Auto, fuel, cell, radios, parking, reimbursables	$	32,000
Small tools and site supplies	$	30,000
Site office	$	5,000
Site fencing	$	5,000
Site signage	$	5,000
Site security	$	96,000
Sanitary facilities	$	5,000
Building – cam expense	$	1,182,000
Pre-occupancy clean and construction clean	$	66,000
Exterior window cleaning	$	10,000
Craning and hoisting	$	80,000
Sidewalk hoarding	$	150,000
Surveying	$	66,000
Waste management	$	120,000
Closeout requirements/testing	$	20,000
Fire safety plan and signage	$	7,000
Insurance	$	214,500
Total general requirements costs	**$**	**2,469,500**
Demolition, trade demolition, hazmat, bins	$	1,600,000
Site services – sanitary upgrade	$	237,520
Total site works and existing conditions costs	**$**	**1,837,520**
Floor leveling	$	95,000
Concrete coring	$	190,000
Total concrete costs	**$**	**285,000**
Sprinkler system	$	329,000
Hvac and controls*	$	2,464,766
Plumbing and fixtures*	$	2,798,180
Total mechanical costs	**$**	**5,591,946**
Electrical*	$	1,540,912
Light fixtures – suites (including above)		–
Light fixtures – common area and exterior*	$	75,000
Total electrical costs	**$**	**1,615,912**
Appliances	$	516,780
Appliances amenity	$	1,850
Fitness equipment	$	85,410
Total equipment costs	**$**	**604,040**
Miscellaneous Carpentry	$	60,000
Interior finish material (including suite doors)	$	262,054
Interior finish labour	$	147,459
Total woods, plastics, composites costs	**$**	**469,513**
Roofing*	$	50,000
Metal siding soffit, main*	$	240,000
Firestopping	$	165,000
Total thermal/moisture protection costs	**$**	**455,000**
Hollow metal frames and doors	$	44,722
Door hardware	$	271,782
Access doors and frames*	$	26,400
Curtain wall*	$	2,275,800
Curtain wall – winter allowance*	$	110,000
Interior glass walls	$	32,500
Total doors and windows costs	**$**	**2,761,204**
Drywall and steel studs	$	1,855,980
Spray foam and new insulation and VB north wall	$	145,511
Painting	$	382,153
Mirrors	$	33,000
Wire shelving	$	52,800
Washroom accessories	$	38,651
Shower doors	$	158,400
Flooring and tile work	$	443,502
Gym flooring	$	17,381
Tile backsplash	$	72,600
Tile shower	$	138,600
Cabinetry and countertops	$	728,725
Amenity millwork (including above)		–
Countertops (including above)		–
Window coverings	$	91,081
Exterior and interior signage	$	40,000
Total finishes costs	**$**	**4,198,384**
Bike racks	$	20,000
Mailboxes, locker system	$	25,000
CCTV security	$	15,000
Intercom system	$	5,000
Total specialties costs	**$**	**65,000**
Elevator modernization	$	75,000
Total conveyor system costs	**$**	**75,000**
Construction management	$	819,521
Contingency	$	1,491,528
Total project management costs	**$**	**2,311,049**
Total estimated project cost	**$**	**36,908,578**

*System component included in the adjusted cost of performance calculation

Table 9
Recommendations for building design workshops and municipal adaptive reuse incentive programs

Issue/Concern	Rationale	Recommendation
The Downtown Retrofit Challenge was an add-on incentive for building performance tied to the Downtown Development Incentive Program. The Downtown Retrofit Challenge intended to showcase the potential to use municipal funding programs to require builders and developers to achieve higher levels of building performance, without significantly hindering the expediency of projects.	The Downtown Development Incentive Program's Terms of Reference did not include energy use or GHG emissions performance requirements; the program's primary focus was promptly removing vacant office space from the Downtown Core.	Municipal investments into the adaptive reuse of privately-owned buildings should include stipulations for minimum energy and emission performance and climate resiliency.
In the Workshop energy model, the NECB 2017 reference building has a total energy consumption of 3,394 MWh/year but in the 99% design completion report, the reference building has a total energy consumption of 2,449 MWh/year.	A different ventilation rate was used between the two energy models.	Ensure all energy model inputs are disclosed with each simulation of the energy model. When possible, where an estimated value is used as an input, maintain that value across all simulations. This will improve comparability between the two models.
In both the design workshop and 99% completion report energy models, an infiltration rate of 0.25 L/s·m^2 is applied to the proposed and reference buildings (NECB 2017 default value). Considering advancements in construction practices and materials since the Dominion Centre was constructed, it is unlikely that the infiltration rate is 0.25 L/s·m^2. This assumption, present in both the design workshop report for the existing building and the 99% design completion report for the proposed building, leads to an underestimate of total heating demand and total annual energy consumption. The infiltration rate significantly impacts HVAC requirements.	The NECB 2017 default infiltration rate was selected for all energy model simulations because the existing infiltration rate of the Dominion Centre is unknown.	Prior to energy modelling an existing building, perform airtightness testing to verify the actual infiltration rate. Use the actual infiltration rate, when applicable, instead of the default value provided by the NECB.
The maximum budget for the Downtown Retrofit Challenge was $1.2 million to improve the energy and emissions performance of a building through the design, construction, and operation phases. Given the cost intensity of commercial-scale projects, $1.2 million is a small percentage of the total renovation costs of the Dominion Centre project. This limits the potential application of those funds to small, incremental improvement projects of which the aggregated impact on building performance can be challenging to measure.	Budget granted by Calgary City Council.	To be effective, municipal investments that promote higher levels of building performance should be scaled to offset the incremental cost of performance improvements.