# Energy Study

210-222 College Ave.

EM Guelph Developments Limited Partnership

Guelph, ON

January 8th, 2026

Revision: 0

Issued for: Official Plan Amendment and Zoning By-law Amendment

## EXECUTIVE SUMMARY

EM Guelph Developments Limited Partnership has retained EQ Building Performance (EQ) to develop an Energy Study for the 210-222 College Ave. project (the "Proposed Development"). The Proposed Development is a mid-rise residential development consisting of 10 storeys, with associated amenities, and one level of underground parking.

This report will explore how the project can achieve two levels of improvement in energy efficiency above typical Building Code performance. The Ontario Building Code was written as a pass/fail code which can make it difficult to achieve higher levels of relative savings as written. As such, this report will use a typical code performing building as a baseline and will encourage energy conservation measures, such as fuel switching to electric systems, in order to achieve higher levels of performance. For the purposes of this report, the current design performance (Scenario 1) has been evaluated in contrast with a high performance (Scenario 2) and net-zero ready (Scenario 3) performance design. The SB-10 baseline has been estimated using the City of Toronto Zero Emissions Building Framework[1]. A summary of predicted performance is available in Table i.

Table i - Project Performance for Each Scenario

| | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|
| Target Energy Use Intensity (ekWh/m²) | 190.0 | 133.0 | 76.0 |
| Total Energy Use Intensity (ekWh/m²) | 172.6 | 114.1 | 75.8 |
| Total Energy (eMWh) | 2,491 | 1,646 | 1,094 |
| % Savings vs Tier 1 | 0% | 34% | 56% |
| Target GHG Intensity (kg CO2e/m²) | 26.0 | 13.0 | 5.0 |
| GHG Intensity (kg CO2e/m²) | 22.5 | 9.5 | 3.1 |
| Total GHGs (tonnes CO2e) | 324 | 138 | 45 |
| % Savings vs Tier 1 | 0% | 58% | 86% |
| Target Thermal Energy Demand Intensity (ekWh/m²) | 77.0 | 54.0 | 31.0 |
| Thermal Energy Demand Intensity (ekWh/m²) | 74.1 | 51.8 | 25.7 |
| Total Thermal Demand (eMWh) | 1,070 | 747 | 371 |
| % Savings vs Tier 1 | 0% | 30% | 65% |

Advanced measures such as district energy systems and solar PV are recommended for further exploration, however, are only discussed at a preliminary level as it is early in design. Design options are also presented to provide enhanced resilience for the Proposed Development and should be evaluated further on a feasibility and cost basis.

This report is for the purposes of fulfilling the requirements of the Energy Study requirements. The strategies outlined in this report should be evaluated by the design team throughout design development. Using a combination of strategies from the energy strategy report, the Proposed Development can achieve its minimum energy performance requirements.

[1] https://www.toronto.ca/wp-content/uploads/2017/11/9875-Zero-Emissions-Buildings-Framework-Report.pdf

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# ACRONYMS / DEFINITIONS

Compactness Ratio – Ratio of Modelled Floor Area to exterior above-grade envelope area (window, wall, and roof). The more compact a building, the less envelope there is for heat loss.

CEDI – Cooling Energy Demand Intensity (kWh/m$^2$) – Total cooling demand within the building (primarily reliant on building envelope and ventilation loads and internal heat gain) divided by the Modelled Floor Area (MFA)

EUI – Energy Use Intensity (ekWh/m$^2$) – Total energy use within the building divided by the Modelled Floor Area (MFA).

GFA – The total floor area of a building within the external surface of the walls/structure as reported in the architectural statistics, excluding components in accordance with zoning by-laws.

Embodied Carbon GFA – The total floor area of a building within the external surface of the walls/structure as reported in the architectural statistics, excluding components such as void spaces and building services, but including parking structures, stairs, and roof assemblies.

GHGI – Greenhouse Gas Intensity (kg$CO_2$/m$^2$) – Total carbon used within the building, calculated using carbon factors from SB-10, divided by the Modelled Floor Area (MFA).

MFA – Modelled Floor Area – Total enclosed floor area of the building as reported in modelling software, excluding exterior areas and parking areas.

OBC SB-10 (2017) – Supplementary Standard SB-10 – Ontario Building Code energy requirements for Part 3 buildings.

SPA – Site Plan Application

TEDI – Thermal Energy Demand Intensity (kWh/m$^2$) – Total heating demand within the building (primarily reliant on building envelope and ventilation load) divided by the Modelled Floor Area (MFA).

# 1. INTRODUCTION

## 1.1. DEVELOPMENT SUMMARY

EM Guelph Developments Limited Partnership has retained EQ Building Performance (EQ) to develop an Energy Study for the 210-222 College Ave. project (the "Proposed Development"). The Proposed Development is a mid-rise residential development consisting of 10 storeys, with associated amenities, and one level of underground parking

The project is currently at the rezoning stage of development and design decisions are still fluctuating. Based on preliminary drawings and discussions with the team, this report assumes the following design attributes:

- GFA: 14,972 $m^2$
- 153 Suites
- Window to wall ratio of approximately 40%
- Double glazed window-wall assembly
- Spandrel opaque and precast concrete wall assemblies
- Compactness ratio of 76%
- High performance central plant with heat recovery in suites
- Hydronic heating and cooling system with variable speed circulation pumps and fans
- Low-flow plumbing fixtures
- The project is not yet committed to pursuing any voluntary higher performance standards.

Figure 1 – Proposed Development Rendering[2]

[2] Development Rendering image taken from drawings by 5468796 Architecture Inc. dated December 18, 2025

## 1.2. PURPOSE OF THIS REPORT

The purpose of the Energy Study is to identify opportunities for the project to reduce energy consumption, reduce GHG emissions, and increase resiliency. The intent of the report is designed to facilitate the following key outcomes:

- Identification of opportunities to reduce energy consumption and greenhouse gas emissions in new construction.
- Opportunity to site buildings and configure blocks to take advantage of existing or proposed energy infrastructure, energy capture and/or solar orientation at the conceptual design stage.
- Consideration of opportunities to optimize the installation of future energy systems or infrastructure.
- Consideration of opportunities to increase resiliency.
- Consideration of potential energy sharing for multi-building developments.

While some of these are outside the scope of the developer, or the project level, they have been incorporated into this report as applicable for the benefit of the design team.

Although these strategies are discussed and identified at a high level, they can be explored early in design to most effectively inform design development.

## 1.3. HOW TO READ THIS REPORT

The goal of this report is to present a roadmap of performance towards net zero by 2028 as well as additional sustainability measures that relate to energy performance. The intent of this report is not to hold developments accountable to the energy and resiliency strategies discussed within. It is worth noting that this project is in the early stages of development and that design decisions further down the line may result in the strategies in this report becoming more, or less, feasible.

Following this introduction, the report is organized into seven additional sections, each of which can be read as its own stand-alone chapter.

- SECTION 1 gives an overview of the Energy Study Terms of Reference, and the energy targets evaluated within this report;
- SECTION 2 outlines the predicted energy performance of the project in steps towards a near net-zero performance and provides an overview of the recommended design alternatives that should be considered to meet each of the scenarios reviewed as well as design best-practices such as future-proofing;
- SECTION 3 explores project specific opportunities for the project during construction and post-occupancy including connections with third party energy suppliers and the local energy provider;
- SECTION 4 explores renewable energy;
- SECTION 5 identifies how to approach embodied carbon on the development and strategies to reduce embodied carbon;
- SECTION 6 explores financial incentives;
- SECTION 7 indicates the preferred scenario, exploring operational performance, embodied carbon, and financial impacts;
- SECTION 8 provides recommended next steps;

- THE APPENDICES provide additional detail on predicted performance, additional design guidance, information on designing for resiliency, and additional higher performance considerations.

## 1.4. DEVELOPMENT SPECIFIC ENERGY TARGETS

In the City of Guelph, meeting the Building Code minimum targets are mandatory for all new developments in the city, but there are optional increased performance levels incentivized by the City.

The energy targets are divided into the following three metrics:

Energy Use Intensity – EUI – $ekWh/m^2$ – Annual building energy use, divided by modelled floor area

Thermal Energy Demand Intensity – TEDI – $kWh/m^2$ – Annual heating load, divided by the modelled floor area. TEDI excludes the effects of mechanical efficiencies (e.g. condensing boilers) but does include passive systems such as air heat recovery, solar gains, and internal gains.

Greenhouse Gas Intensity – GHGI – $kgCO_2e/m^2$ – Annual greenhouse gas emissions, divided by the modelled floor area. The annual average carbon emission factors currently listed in OBC SB-10 (2017) are used for this calculation.

This report will explore how the project can meet the Building Code baseline performance, as well as improve its performance to the following levels set out by the project team:

- High Performance Design: 30% reduction in EUI and TEDI, and 50% reduction in GHGI, relative to current Building Code;
- Net-Zero Ready Performance Design: 60% reduction in EUI and TEDI, and 90% reduction in GHGI, relative to current Building Code.

Minimum performance targets are determined by the Ontario Building Code, SB-10, Division 3 (2017). As the building code does not use absolute targets, the City of Toronto's Zero Emissions Building Framework (ZEBF)[3] has been used to determine an OBC equivalent performance. The energy metric requirements for high-rise multi-unit residential buildings (MURBs) outlined in Table 1 below.

Table 1 – Code Baseline Minimum Performance Metrics

| ZEBF SB-10 2017 Equivalent Energy Performance Metrics | | |
|---|---|---|
| EUI ($ekWh/m^2$) | TEDI ($ekWh/m^2$) | GHGI ($kg\ CO_2e/m^2$) |
| 190.0 | 77.0 | 26.0 |

[3] https://www.toronto.ca/wp-content/uploads/2017/11/9875-Zero-Emissions-Buildings-Framework-Report.pdf

Referencing OBC SB-10, a factor of 0.050 kg $CO_2e$/kWh for grid supplied electricity, and 1.899 kg $CO_2e/m^3$ for natural gas will be applied. In addition to using a modern weather file in energy analysis, projects are also encouraged to also use a predictive future weather file when using an energy model to assess changes in performance over the expected life of the building. In this report, the impact of future climate will be discussed at a high level.

The contents of this report will explore a number of design scenarios for the 210-222 College Ave. project, with details on how to achieve them, as well as benefits including increased resiliency, potential for high performance certifications, and potential mitigated carbon pricing risks.

The scenarios explored are as follows:

- Scenario 1 – Minimum – Building Code Baseline
- Scenario 2 – Enhanced – High-Performance Design (30% reduction in energy and thermal demand, 50% reduction in carbon)
- Scenario 3 – Ambitious – Net-Zero Ready Performance (60% reduction in energy and thermal demand, 90% reduction in carbon)

# 2. ENERGY ANALYSIS

## 2.1. PROJECT ENERGY PERFORMANCE

EQ has used an internally developed archetype model to prepare suggested design packages for each scenario. Predicted energy use and resulting carbon emissions for each of the design scenarios is presented in Table 2.

Table 2 - Predicted Energy, Thermal Demand and Carbon Performance[5]

| | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|
| Target Energy Use Intensity (ekWh/m²) | 190.0 | 133.0 | 76.0 |
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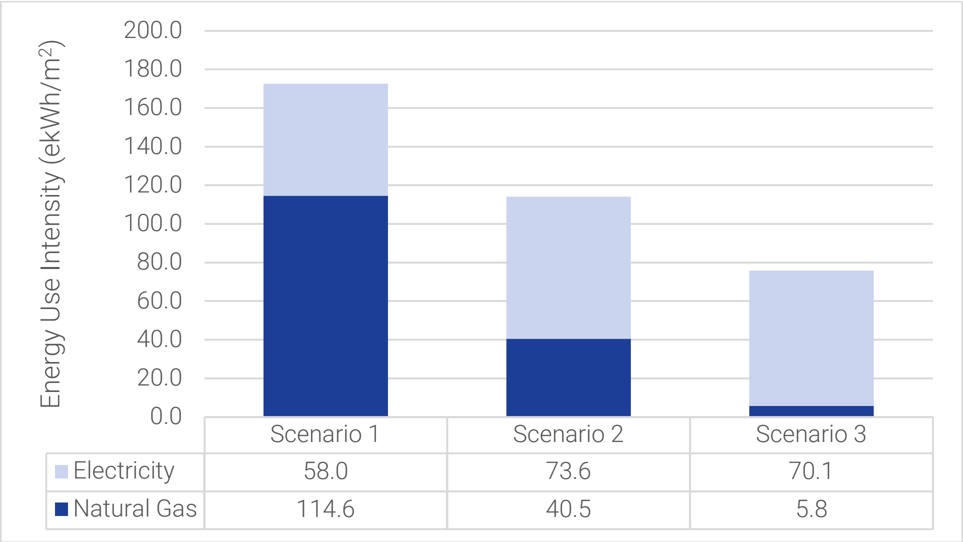



Figure 2 - Predicted Energy Consumption by End-Use

[5] Detailed calculations are available in the softcopy submission in the excel file provided with submission.

## 2.2. BUILDING LEVEL DESIGN OPPORTUNITIES

To optimize building performance, best practice is to prioritize passive design improvements to reduce thermal loads within the building. Once loads are reduced, the mechanical systems can then be designed to minimize the energy needed to meet those loads. Finally, renewable technology and carbon offsets can then be used to deliver net zero performance.

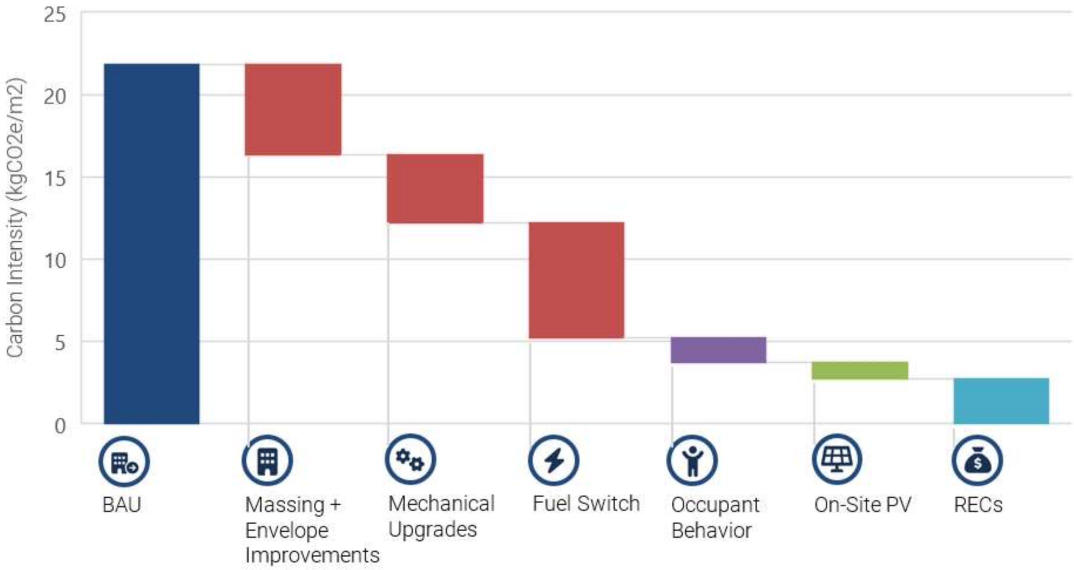



Figure 3 – Key Design Strategies

For the purposes of this report, sample design packages for each scenario have been prepared. Details of each design package can be found for review and comparison in Appendix B. Strategies to achieve each Tier will be discussed in detail below.

## 2.3. MASSING + ENVELOPE IMPROVEMENTS

As design progresses through Site Plan Approval and building code review, the design teams will need to consider a number of passive design measures. In Table 3, basic guidance on what will likely be required for the various high performance targets is outlined.

Table 3 - Passive Design Considerations

| Energy Conservation Measures | Necessity for Compliance | | | Design Decision Timing | Estimated Cost Premium |
|---|---|---|---|---|---|
| | Minimum SB-10 Compliance | High Performance | Net-Zero Ready | | |
| **Opaque Wall** | | | | | |
| Continuous insulation | + | + + + | | Design Development | $6-9/m2 |
| Massing optimization[6] | n/a[7] | | | Concept | None |
| Reduced and/or thermally broken balconies | + | + | + + + | Schematic Design | None / $285/m balcony length |
| Increased roof insulation | + | + + | + + + | Design Development | $6-9/m2 |
| Improved air tightness | n/a[4] | | | Design Development | Low |
| **Fenestration** | | | | | |
| Maximum 40% vision to wall ratio | + | | | Schematic Design | None |
| High performance double glazed assembly, thermally broken aluminum frame | + | Likely not sufficient | Likely not sufficient | Design Development | None |
| High performance double glazed, double low-e assembly, thermally broken aluminum frame | + | + + | Likely not sufficient | Design Development | $54/m2 |
| High performance triple glazed assembly with fiberglass frame | + | + | + + + | Design Development | $200-500/m2 |

Based on preliminary drawings and discussions with the 210-222 College Ave. design team, the envelope is still being designed though a 40% vision glazing ratio is expected. Double glazing is recommended.

If the project does decide to pursue higher levels of performance, the glazing ratio will need to be reduced and continuous insulation will be required. Windows will need to be upgraded to include double low-e coatings or even triple glazing. Relying on infiltration savings are only suggested for a near net-zero scenario. Infiltration savings of 25% are likely required for a net-zero ready scenario. Air tightness testing is new to the Ontario market. The design team should consider proactively doing air tightness testing and targeting 2 L/s/m$^2$ at 75 Pa. Incentives from Enbridge are available for those who conduct airtightness testing.

[6] For example, may include outset rather than inset balconies, simplified floorplate geometry, reduced setbacks, and consolidating glazing to reduce framing area.
[7] Credit can't be taken under building code, but improvements do help absolute energy and carbon performance.

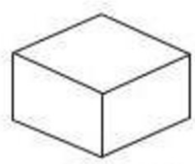
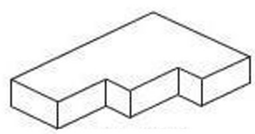
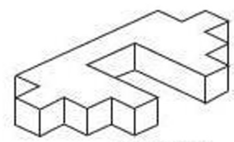
### 2.3.1 PASSIVE DESIGN BEST PRACTICES

Building Massing

Building form and complexity can influence energy use within a building by directly impacting building heating and cooling loads. While a number of design elements can be later retrofitted to reduce energy consumption, the massing of the building generally will not change post-construction. As such, it's imperative that the massing is designed with intention.

More wall area per unit of floor area translates to more thermal loss per square meter, or TEDI, a key metric for building performance. Through internal investigation, EQ has found that a difference in a building's compactness ratio of 13% lead to influencing TEDI by more than 20%.

Table 4 – Building Compactness TEDI Impact

| |  |  |  |
|---|---|---|---|
| | Compact Design | Typical Design | Articulated Design |
| Floor area : Wall area Ratio | 41% | 48% | 54% |
| TEDI (kWh/m$^2$) | 55.8 | 62.5 | 71.7 |
| Difference from Typical TEDI | -10% | - | +14% |

Based on currently available drawings, the 210-222 College Ave. project has a compactness ratio of 76%. While compactness ratio does not impact relative performance over code (as the reference building will have the same massing), it will impact the actual energy consumption of the development.

Some strategies to developing a more compact building design include:

- Create a simplified floor plate with reduced protrusions
- Minimize inset balconies, and where present limit depth
- Create larger floor plates. Tall, thin towers inherently have a higher compactness ratio (less compact)

While this report focuses on energy and carbon savings, a number of other design factors can also be impacted by building massing. The University of Toronto has released a MURB Design Guide[8] that outlines a number of massing considerations which also address access to daylight, future design flexibility, connectivity, and more. Some design decisions may increase access to daylight, but negatively impact energy performance. As such, careful consideration should be taken when designing the massing. While the study largely focuses on MURBs, many of the design considerations apply to all high-rise buildings.

[8] https://pbs.daniels.utoronto.ca/faculty/kesik_t/PBS/Kesik-Resources/MURB-Design-Guide-v2-Feb2019.pdf

*Access to Daylight*

- Orient buildings so that the longest elevation faces the south.
- Set the building back to reduce self-shading.
- External shading devices should be designed to reduce glare and overheating.
- Narrow floor plates provide more access to daylight.
- Use light shelves to reflect daylight deeper into the unit.

*Design Flexibility*

- Minimize shear walls to allow for future combined units and design flexibility.
- Provide various sizes of units/tenant spaces to attract various clientele.

*Additional Considerations*

- Organize internal space and operable window placement to optimize natural ventilation opportunities.
- Use thermal mass to self-regulate building temperatures.
- Consider enclosing balconies to create a thermal buffer and increase time that tenants can comfortably use the balcony area.

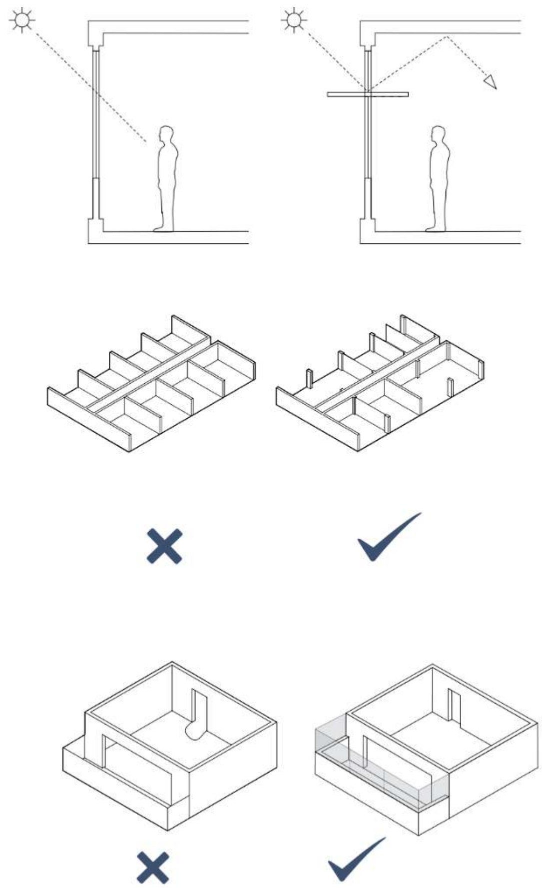
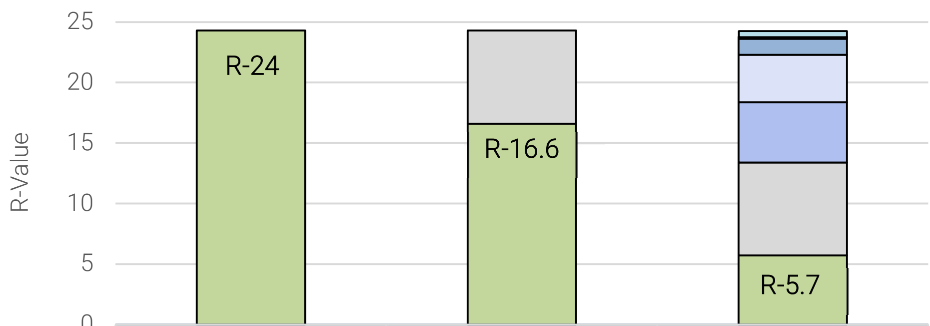


Figure 4 - Design considerations from the UofT Design Guide[6]

### Opaque Envelope

The opaque building envelope has significant impact on the passive design of the building and significantly impacts the thermal loads of, and thermal comfort within the building. Over the lifetime of a building, it is likely that only a single retrofit to the building envelope will occur. If thermal performance of the building envelope is prioritized, the extent of future retrofits can potentially be minimized.

Figure 6 demonstrates the impact thermal bridging has on opaque envelope performance. The thermal bridging impact of repetitive elements such as structural studs and spandrel back pans greatly reduce the effective performance of the wall as seen in Figure 6. However, poor envelope detailing at building interfaces, which traditionally have been ignored in energy performance codes, can be seen to have an even greater sum impact.




| | Nominal Performance | Repeated Structural Elements | All Thermal Bridging |
|---|---|---|---|
| Parapet | | | 0.5 |
| Terrace | | | 0.2 |
| Balconies | | | 1.3 |
| Slab Edges | | | 3.9 |
| Window Perimeters | | | 5.0 |
| Studs, Back-pans, etc. | | 7.7 | 7.7 |
| Modelled Performance | 24.3 | 16.6 | 5.7 |

Figure 5 - Impact of Thermal Bridging on Opaque Envelope Performance[9]

[9] The nominal performance of the building envelope is the sum thermal performance of the clear wall materials in the building envelope. It does not account for any thermal bridges.

Three key strategies to improving the opaque building envelope performance and their relative priority are:

| | |
|---|---|
| Best | **Reduce the number of thermal bridges –** The best way to lessen the impact of thermal bridging on the opaque wall is to reduce the number of bridges. Reducing protrusions eliminates corner intersections and allows for larger opaque wall areas. Reducing balcony areas by using cantilevered rather than inset balconies, or even eliminating balconies can significantly improve envelope performance. Using larger glazed areas reduces window perimeters which improves both the opaque and glazing performance. |
| Better | **Improve thermal bridge performance –** Once the number of thermal bridges has been reduced, taking effort to improve the ones remaining is important. BC Hydro has developed a *Building Envelope Thermal Bridging Guide* which includes a vast library of sample architectural details ranging from poor to efficient which can be used as a guide to improving bridge details. |
| Good | **Improve the clear wall performance with continuous insulation** – While it may seem like increasing the clear wall performance would be a priority, the building envelope is only as strong as its weakest links; namely it's thermal bridges. A poor thermal bridge will have a much more devastating effect the greater the clear wall performance is. Once the bridges have been dealt with, improving the amount of insulation, especially continuous insulation in the clear wall will truly maximize opaque wall performance. |

Special consideration should be given to the thermal bridging impact of architectural details to achieve the thermal demand requirements of higher levels of performance, which may not have been previously prioritized. Architectural details which in our experience have the biggest impact, as well as sample thermal bridging details from the *Building Envelope Thermal Bridging Guide (BETBG)* where relevant, are listed below, to provide an indication of the relative impacts of these decisions.

*Opaque Wall and Glazing Interfaces*

Glazing interfaces refers to the architectural detail where a glazing system connects to an opaque wall. In panelized systems, the glazing interface thermal bridging is already accounted for in the framing of both the spandrel and vision glazing performances. When working with non-panelized systems however, this interface can translate to significant thermal bridging on a project.

As a first step, this interface should be minimized by using larger single windows. This results in less length of glazing interface compared to multiple smaller windows, even if the same amount of glass is provided.

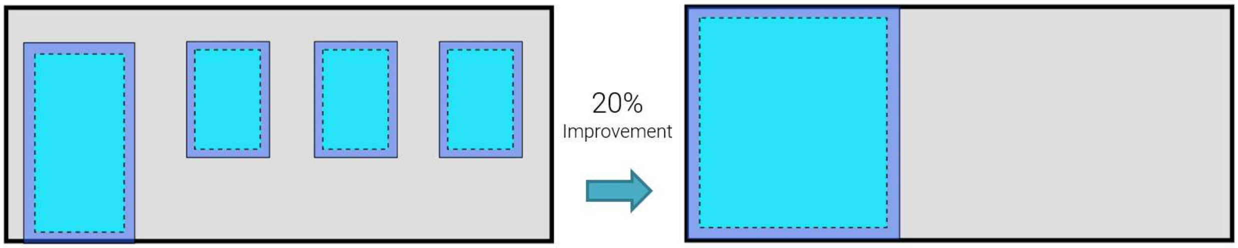
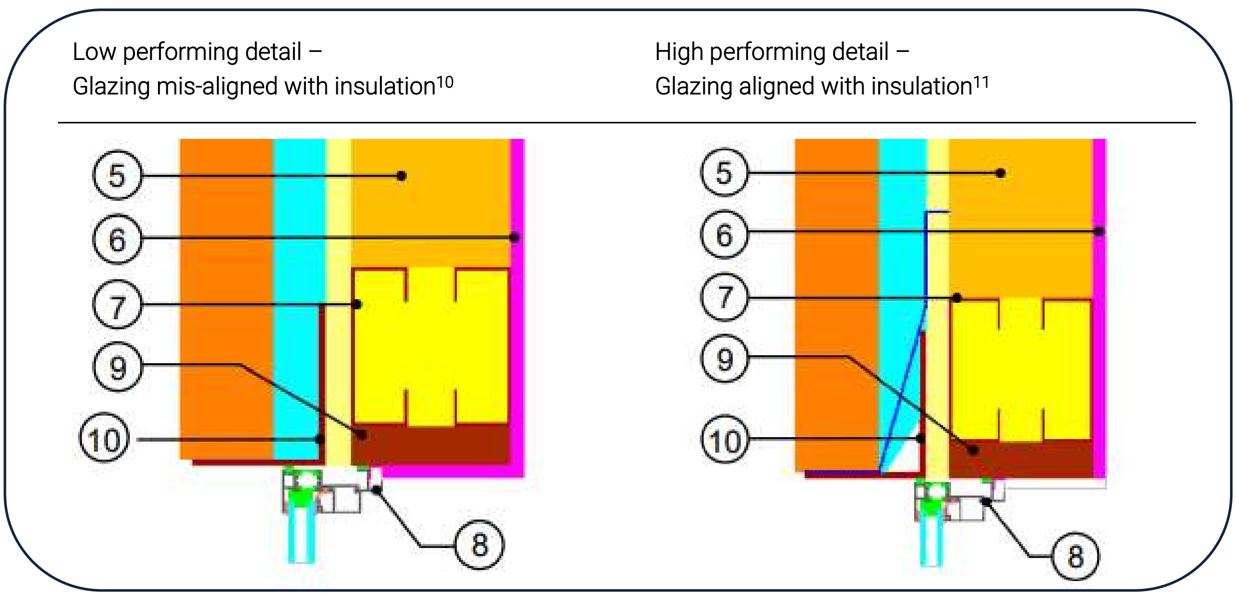



Figure 6 - Potential improvement Through Passive Glazing Design

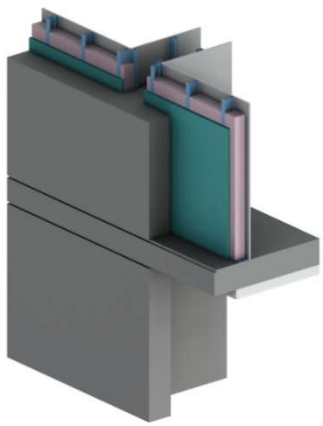
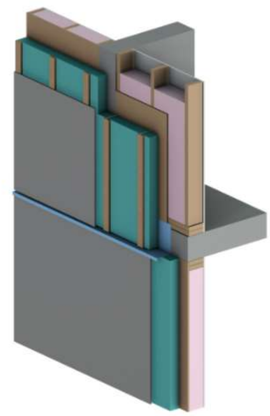
Once minimized, framing should be thermally broken, with the break aligned with the insulation layer in the opaque wall. In the sample details shown below, <u>a 66% reduction in thermal losses can be achieved by aligning glazing with insulation in the opaque wall.</u>




[10] BETBG Detail 5.3.8 – Interior Insulated Steel Frame Wall Assembly with Brick Cladding – Window Intersection
[11] BETBG Detail 5.3.9 – Interior Insulated Steel Frame Wall Assembly with Brick Cladding – Window Intersection Aligned with Insulation

*Interior and Exterior Wall Interfaces & Corners*

When detailing interior and exterior wall interfaces and corners, one of the most important things to consider is constructability. Maintaining the air barrier and continuous insulation layer along interior walls and structural elements such as columns and shear walls can lead to notable improvements in the envelope.

| Low performing detail – No insulation at interface[12] | High performing detail – Continuous insulation at interface[13] |
| --- | --- |
|  |  |

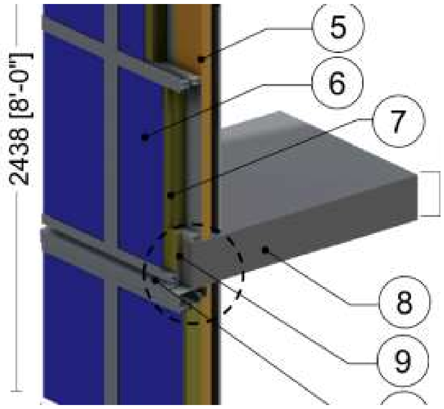
*Slab Bypasses*

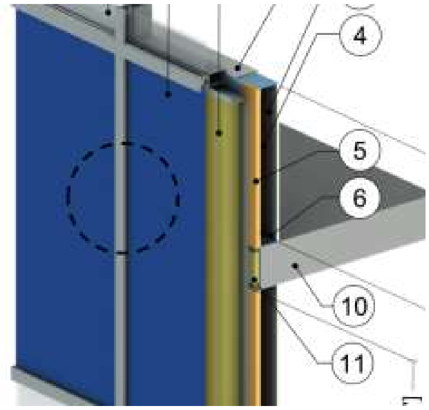
With certain wall assemblies, maintaining the insulation layer over the slab edge can be difficult, if not impossible to achieve due to how those walls are assembled. For example, in a window wall assembly, it may only be possible to fit 1-2 inches of firestop insulation between the panel and slab edge, significantly reducing the effective performance of the wall. Consideration should be given to using a curtain wall or a non-panelized system like EIFS over a window wall system, as these assemblies hang in front of the slab, resulting in additional room available to maintain the insulation layer. In the sample details shown below, a 79% reduction in thermal losses can be achieved from the high performing detail.

[12] BETBG Detail 7.7.1 – Exposed Interior Concrete Mass Wall Intersection with Non-Insulated Partition Wall Intersection and Unheated Intermediate Concrete Floor (Parking Garage). Interior Wall at Intermediate Concrete Floor

[13] BETBG Detail 8.7.1 – Exterior and Interior Insulated Wood Infill Wall Assembly with Wood Strapping and Continuous Insulation Supporting Fibre Cement Board and R-19 Batt Insulation in Stud Cavity – Concrete Wall and Intermediate Floor Intersection with Flashing Bypassing Exterior Insulation

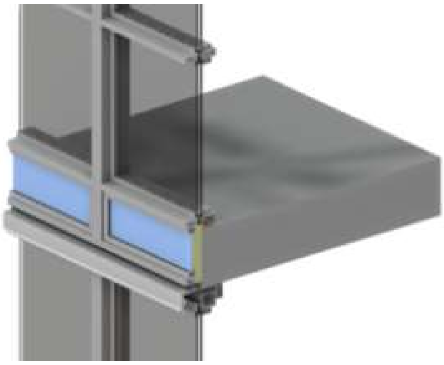
| Low performing detail –<br>Window-wall, slab edge with firestop insulation[14] | High performing detail –<br>Curtain wall, sits in front of slab edge[15] |
| --- | --- |

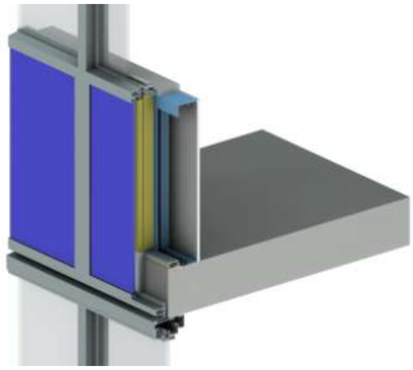



Depending on the project design, the cladding over the slab edge may be much smaller in size further reducing the panel performance. Using a larger panel can help improve performance of the slab edge condition as a whole.

| Low performing detail –<br>Minimal Slab Edge Coverage[16] | High performing detail –<br>Larger Slab Edge Panel[17] |
| --- | --- |





[14] BETBG Detail 1.2.6 – Window-Wall Bypass at Full Height Spandrel Section with Interior Spray foam Insulation
[15] BETBG Detail 4.2.2 – Spandrel Section at Intermediate Concrete Floor with High Performance Curtain-wall System with Interior Spray foam Insulation
[16] BETBG Detail 1.2.10 – Window Wall System with Full Height Vision Section – Intermediate Floor Intersection with Spandrel Bypass and no Interior Stud Cavity Insulation
[17] BETBG Detail 1.2.1 – Window-Wall Bypass at Spandrel Section without Interior Sprat foam Insulation

*Balconies & Terraces*

Balconies are often the weakest performing element of the opaque building envelope. With a poor envelope design, the decrease in R-value may seem minor, however, as clear wall R-values increase, balconies can reduce effective R-value by more than 25%. While minimizing balconies is ideal, there are some design alternatives that can be considered.

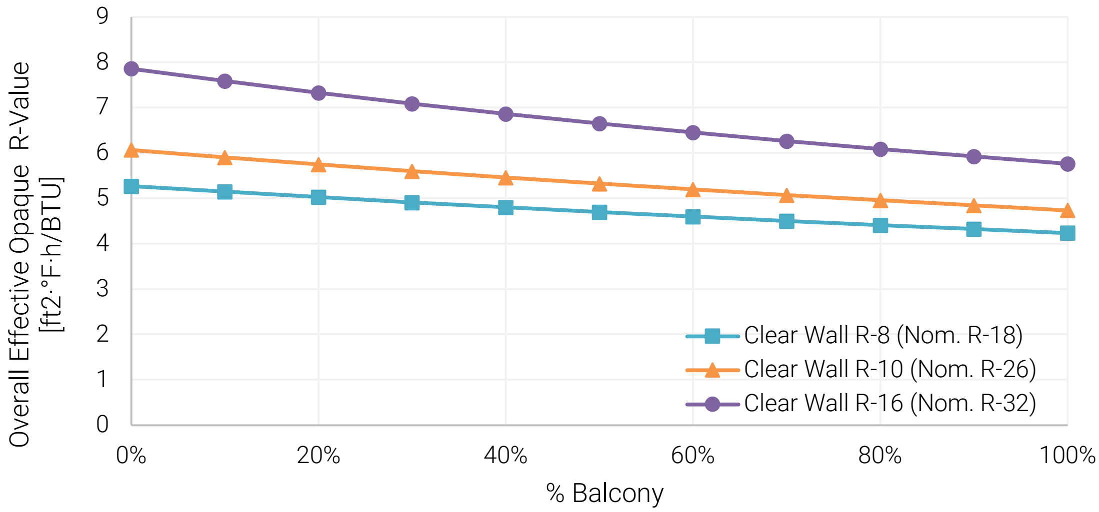
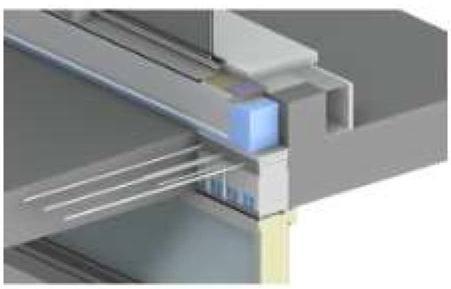



Figure 7 - Impact of Balcony on Thermal Performance

The length of balcony penetrating through the envelope can be minimized while maintaining the overall balcony area by using cantilevered balconies rather than inset balconies. This will also reduce the number of corners in the building envelope, another element of thermal loss in the opaque wall. Additionally, a thermally broken balcony design can be used. From the BETBG, a 74% reduction in thermal losses can be achieved by thermally breaking balconies.

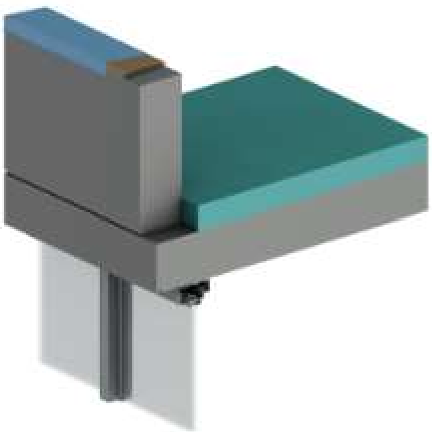
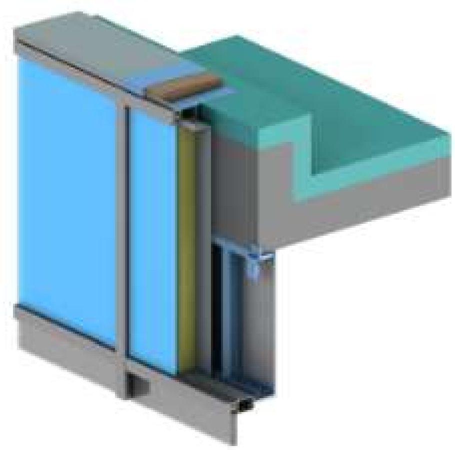
| Low performing detail – Traditional Concrete Balcony[18] | High performing detail – Thermally Broken Balcony System[19] |
|---|---|
|  |  |

[18] BETBG Detail 9.1.3 – Interior Insulated Curb and Exposed Concrete Floor at Sliding Door
[19] BETBG Detail 9.1.15 – Window Wall System with Spandrel Panels and Sliding Door – Scöck Isokorb KXT15-V6 Thermal Break at Concrete Balcony and Curb Intersection

Thermal breaks are often used to improve the performance of balconies, but they are not the only solution. Smaller buildings can consider using pillars to externally support the balconies, reducing or even eliminating the concrete penetrating through the building envelope. Prefabricated solutions can also be used as a 'bolt-on' solution to reduce the thermal losses from balconies.

*Parapet*

While parapets are typically a smaller portion of the thermal losses in an envelope, performance should still be improved where possible. In best practice, roof insulation should be wrapped around the parapet and ideally connect to the opaque wall insulation so that the insulation is continuous. At the highest levels of performance, thermal breaks can also be considered for parapets.

| Low performing detail – Uninsulated Parapet[20] | High performing detail – Fully Insulated Parapet[21] |
|---|---|
|  |  |

### Fenestration

As mentioned with the opaque envelope, over the lifetime of a building, it is likely that only a single retrofit to the building envelope will occur. Opaque wall retrofits can have significant cost implications for a project. If thermal performance of the building envelope is prioritized, the extent of future retrofits can likely be minimized.

A traditional high performance double glazing assembly will likely not be acceptable for meeting higher performance targets. Increased performance double glazed double low-e coated glazing, or triple glazing should be considered. An envelope consultant should be retained to assess differing glazing scenarios. Depending on the desired solution, design considerations may be required to avoid downdraft discomfort for taller windows and to eliminate the potential for condensation.

When choosing a glazing product, it is important to consider not only the thermal performance but the solar heat gain coefficient (SHGC) as well. A higher SHGC will result in more solar gains and allow for passive

[20] BETBG Detail 1.3.1 – Exposed Concrete Parapet at Window-Wall with Concrete Roof Deck
[21] BETBG Detail 2.2.4 – Exterior Insulated Concrete Parapet with Curtain-wall Outboard of Parapet and Concrete Roof Deck

heating, reducing the thermal demand; while a lower SHGC will reduce over-heating in shoulder seasons and reduce cooling loads in the summer.

Reduced glazing areas however will reduce both heating and cooling loads within the building. A glazing to wall area ratio of 35% to 40% is often considered optimal, and will help optimize the performance of the building envelope while maintaining occupant views, daylight access, and improved thermal comfort.

Consideration should be given to the potential changes in climate over the lifetime of the building rather than just the current climate in which the building envelope was designed. With climate change, heating loads are decreasing and cooling loads are increasing in our climate. One option to balance glazing performance may be electrochromic glazing (glass that tints in response to solar intensity or sun position), which can maximize daylighting and views in regularly occupied spaces as well as have a positive impact on the building cooling and heating loads.

### Air Tightness Testing

While there are no requirements for air tightness testing for City of Guelph developments, higher levels of performance will likely require an air tightness test to be performed. There are two types of whole-building air tightness testing; envelope testing and operational testing. Envelope testing involves sealing all external ducts, with results focused on the envelope air leakage. Operational testing keeps external ducts open and aims to give a better understanding of air leakage during day-to-day operations.

In Toronto, high performance projects are required to perform an operational test and target a leakage rate of 2.0 L/s/m2 at a 75 Pa pressure differential. Decreasing air leakage in the building leads to less heat loss, directly impacting energy performance. While there is no penalty for not meeting the target, projects are able to claim energy savings after testing verification.

There are two approaches to air tightness testing which each have their own opportunities and risks; whole building and guarded testing. For projects with staged occupancy guarded testing is generally most advantageous. A detailed summary of each approach can be found in Table 5.

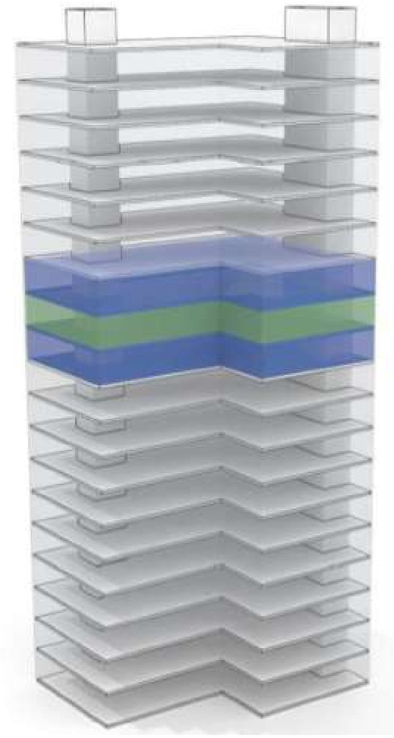


Figure 8 – Diagram of Guarded Testing[22]

[22] https://obec.on.ca/sites/default/uploads/files/newsletter/Pushing_the_Envelope_Fall2019-article9.pdf

Table 5 - Summary Overview of Air Tightness Testing Requirements

| | Whole – Building Testing | Guarded Testing |
|---|---|---|
| Construction Completion | Construction of enclosure must be complete | Only test floor and two adjacent floors need to have enclosure completed |
| Ease of implementing changes | Results aren't available until building is complete, modifications are difficult and costly | Results available as tests are done, modifications are much easier to implement |
| Occupancy requirements | Entire building cannot be occupied | Floors outside of testing can be occupied |
| Building Size | Great <25 stories, >25 stories, wind loading and stack effect can skew results | Best suited for buildings with a consistent floor plate, effective >25 stories |
| Effort | For large buildings, amount of equipment and level of effort required is significant | Effort generally not hugely impacted by building size |
| Popularity | More common and more recognized in the industry | Becoming more common |

If performing guarded testing, the price will correlate with the number of tests required. Guarded testing is required at each unique condition throughout the building – for example, a test would be required for the podium and top floor as they have notably different designs. Based on the current design, it is estimated that 3-4 tests would be required for the 210-222 College Ave. development. Projects are encouraged to read the Toronto Green Standard v3 – Tier 2-4 Guidance Document Air Tightness Testing Protocol & Process[23] for testing guidance in the Ontario market.

[23] https://www.toronto.ca/wp-content/uploads/2020/01/8742-CityPlanning_TGSV3_ATT.pdf

When planning for testing, timing is key. Construction should be far enough along that firestops between floors are installed. Depending on construction progress, temporary partitions may be required to seal off unfinished areas such as elevator shafts. This can lead to tight timelines for testing which will require coordination with trades and may require tests to be performed on weekends.

There are a number of strategies that can help projects achieve their air tightness targets.

- The more unique conditions a building has, the more detailing that will be required by the architect to ensure the air barrier is continuous. Simplified design with a focus on constructability and a clear continuous air barrier is ideal.
- Efforts to reduce mechanical penetrations, such as choosing heat pump dryers, recirculating kitchen hoods, or centralizing ventilation.
- Where mechanical penetrations are present, using mechanical dampers over gravity dampers can help to ensure that dampers stay closed when fans aren't operating, reducing leakage.

From a preliminary analysis of air tightness testing in Seattle[24], it was found that "the quality of detailing at interfaces and workmanship can have a much larger impact on the overall air leakage of a building than the air barrier type.". Training for trades and the design team can significantly improve air tightness performance. Throughout design and construction, assigning an air tightness 'champion' to ensure air leakage is a priority can help ensure success as well. As construction progresses, mock-up tests of envelope components can be used to gauge air leakage early on and allow for revisions if necessary. If construction has advanced far enough that remedial measures are limited, some aerosolized building seals are available on the market to seal leakage points.

## 2.4. ACTIVE DESIGN MEASURES

### Ventilation

Ventilation with fresh air is a significant factor contributing to building heating and cooling loads as well as building energy and carbon use. In a high-rise residential building specifically, corridor pressurization rates can vary greatly between buildings. When using lower corridor pressurization rates, ensuring a tight building envelope with reduced infiltration is required to ensure the building is properly balanced. Reducing exhaust requirements in suites will also help pressurization with lower corridor ventilation rates. This can be done through centralizing ventilation, using heat pump dryers, and installing recirculating range hoods. Once ventilation rates have been right-sized, using high efficiency heat recovery to further reduce energy use is a key design strategy in a high performing building. For non-residential areas with variable occupancies, occupancy sensors should be used to ensure spaces are not over-ventilated. Ventilation design considerations can be seen in Table 6.

[24] https://www.airbarrier.org/wp-content/uploads/2017/12/Building-Enclosure-Airtightness-Testing-in-Washington-State.pdf

Table 6 - Ventilation Design Considerations

| Energy Conservation Measures | Necessity for Compliance | | | Design Decision Timing | Estimated Cost Premium |
|---|---|---|---|---|---|
| | Minimum SB-10 Compliance | High Performance | Net-Zero Ready | | |
| Corridor ventilation – avg 30 cfm/suite | n/a[25] | | Likely not sufficient | Design Development | None |
| Corridor ventilation – avg 15 cfm/suite[26] | n/a[24] | | + ++ | Design Development | Low |
| Corridor ventilation – code minimum- requires compartmentalization to remove pressurization requirements | n/a[24/25] | | + + + | Design Development | $130/suite savings |
| Code minimum ventilation in other areas | n/a[24] | | + + + | Design Development | Low |
| Recirculating range hoods | n/a[24] | | +++ | Design Development | Low |
| Ductless dryers | n/a[24] | | +++ | Design Development | Low |
| 65% Efficient air side heat recovery in suites | + | Likely not sufficient | | Design Development | None |
| 80%+ Efficient air side heat recovery in suites | + | + + | + + + | Design Development | $1,800-2,400 / suite |
| Corridor heat recovery | - | - | + + + | Design Development | High |

Ventilation design is not typically explored until the SPA stage of design. While ventilation is modelled at minimum flow rates for code compliance, ventilation should be carefully considered for real life building operations. To achieve the project targets, ventilation rates throughout the building should be as close to minimum ASHRAE 62 ventilation rates as possible. In amenity spaces this may require demand-controlled ventilation to be used. In residential corridors, EQ recommends pursuing 20 cfm/door for pressurization. In all spaces aside from residential corridors, premium-efficiency heat recovery should be used, ideally via remote ERV with a minimum 80% effectiveness. For high-performance and net-zero ready design, corridor ventilation should be lowered to 15 cfm/door.

### Domestic Hot Water

Domestic hot water use in high-rise residential buildings is typically one of the largest energy and carbon uses and savings that need to be targeted to achieve a high performance design. While domestic hot water loads can be reduced through low flow plumbing fixtures, there are limitations to how much impact this can have. At higher performance levels, a transition to a high efficiency electric heat pump heating source, or incorporation of sewage or drain water heat recovery may need to be considered in order to meet the corresponding carbon and energy targets.

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[25] Credit can't be taken under building code, but improvements do help absolute energy and carbon performance.
[26] In order to maintain proper building pressurization, improved air tightness in the building envelope will be required.

Table 7 – Domestic Hot Water Considerations

| Energy Conservation Measures | Necessity for Compliance | | | Design Decision Timing | Estimated Cost Premium |
|---|---|---|---|---|---|
| | Minimum SB-10 Compliance | High Performance | Near Net Zero | | |
| 20% reduction in plumbing fixtures flow | n/a[27] | + | Likely not sufficient | Design Development | None |
| 35% reduction in plumbing fixtures flow | n/a[26] | + + | + + + | Design Development | None |
| Sewage / Drain Water Heat Recovery | - | - | + + + | Schematic Design | $1,700 / suite |
| Central domestic hot water heat pump | - | + + | + + + | Design Development | High |
| DHW Preheat from geothermal loop | +[28] | | | Schematic Design | Low |

Traditional domestic hot water design for large building uses a central natural gas plant, which would be sufficient for the baseline and high-performance scenarios for this project. For net-zero ready performance, 90% of the domestic hot water demand will need to be electric with air source heat pumps.

### Mechanical and Other Opportunities

As design progresses, a preliminary energy model will be developed to evaluate different design opportunities to ensure an optimized active design. As minimum requirements and design goals shift towards low-carbon targets, high efficiency systems and electrification of designs will be required.

Some advanced design measures have been highlighted in the table below, and are more thoroughly detailed in Section 2.4 - Low-Carbon Energy Solutions; of this report.

[27] Credit can't be taken under building code, but improvements do help absolute energy and carbon performance.
[28] Heavily dependent on building load profile and balance.

Table 8 - Active Design Considerations

| Energy Conservation Measures | Necessity for Compliance | | | Design Decision Timing | Estimated Cost Premium |
|---|---|---|---|---|---|
| | Minimum SB-10 Compliance | High Performance | Near Net Zero | | |
| **Mechanical System** | | | | | |
| Fan Coil system | +/-[29] | Only if electrification occurs elsewhere | Likely not sufficient | Schematic Design | None |
| Water Source Heat Pump system | +/-[28] | + + | + + + | Schematic Design | Low |
| Water-source VRF system | +/-[28] | + + | + + + | Schematic Design | Medium |
| Air-source heat pump / VRF system | +/-[28] | + + | + + + | Schematic Design | Medium |
| District Energy[30] | varies[31] | | | Schematic Design | Low |
| On-site Renewable Energy Generation | n/a[32] | + | + + + | Design Development | Low |
| Geothermal Energy | +/-[28] | + + + | | Schematic Design | Low/High |
| **Other Considerations** | | | | | |
| EnergySTAR appliances | n/a[28] | + | + + + | Design Development | None |
| 30% reduction in lighting power density | + | + | + + + | Design Development | Low |
| 50% reduction in lighting power density[33] | + | + + + | + + + | DD | Medium |

For minimum building code performance, a fan coil or water loop heat pump system is sufficient, while packaged in-unit air-source heat pumps would be recommended for a high-performance scenario, which are new on the market and available with integrated ERVs. The project should also incorporate EnergySTAR appliances and some moderate lighting savings. Geothermal would also be a solution for a net-zero ready scenario.

[29] For code compliance, HVAC system selection is neutral – generally the HVAC system used in the base design is identical in the reference building.
[30] See Section 3 of this report for details on district energy analysis.
[31] Impact of district energy system is highly dependent on system efficiency and carbon factors
[32] Credit can't be taken under building code, but improvements do help absolute energy and carbon performance.
[33] Achieving lighting reductions in this range may require design changes to ensure minimum lighting levels are achieved such as strategic window placement and light coloured interior surfaces

### 2.4.1 LOW-CARBON ENERGY SOLUTIONS

Many municipalities have begun to pursue net-zero solutions for new developments. The design team is encouraged to incorporate design and construction strategies in line with this goal, which are designed to reduce electrical demand, carbon emissions and conserve energy compared to a more conventional design.

In near net zero design, fuel switching occurs by replacing natural gas with electric heat pump based heating and domestic hot water in order to achieve the emissions reductions requirements, as well as aggressive improvements in building envelope thermal and air tightness performance. This is reflective of the higher GHG intensity of natural gas compared to the relatively low-carbon electricity grid in Ontario.

At this stage of design, low-carbon solutions are still under consideration. If a heat pump or VRF system is used, the high efficiencies achieved with these systems in combination with their electric heat pump based heating components will reduce the building's carbon use by relying on the relatively clean Ontario electricity grid. This would represent a fundamental shift in the primary heating energy source of the building and the resulting carbon impact. Back-up boilers for these systems should be high performance condensing or near-condensing technology, which will reduce carbon compared to traditional systems. Low-flow plumbing fixtures can also be used to minimize the domestic hot water boiler load, further reducing carbon use.

Several advanced energy design measures are listed for consideration below.

District Energy Systems

District energy system may be categorized as one of two types: High Temperature and Low / Ambient Temperature.

A High Temperature district energy plant provides heating and/or cooling to the building at the temperature required to meet the load, and involves using heat exchangers or coils *within* the building for distribution of heating and cooling, similar to a typical high rise design. This approach is amenable to district technologies such as Deep Lake Water Cooling (DLWC) and central steam or hot water plants, as well as central Combined Heat and Power (CHP) systems.

- Equipment in building may be minimized (boiler/chiller reduced to a heat exchanger)
- Distribution piping requires insulation
- Heating demand met by gas fired equipment or recovered waste heat
- High temperatures can be augmented by CHP / heat recovery
- Separate loops required for heating and cooling

In comparison, a Low / Ambient Temperature district thermal system takes its design philosophy from a water-loop heat pump (WLHP) HVAC system in a high rise residential building. The ambient temperature system relies on heat pumps or VRF units located in the space. These units connect to an ambient temperature (typically 12 to 30°C) distribution loop through which the heat pumps can reject or absorb heat. This approach is amenable to incorporating boreholes at a community level for ground source heat pump technology or low grade solar thermal.

- Heat pump equipment required in building to generate temperature for space conditioning
- No insulation needed / heat exchange with ground encouraged
- Heating demand met by terminal electric heat pump / VRF, and central gas fired or renewable sources
- Low temperatures amenable to ground loops / low grade solar thermal
- Heating and cooling provided by one loop

The decision to pursue either of these district energy options relies on several factors, including the availability of each type of system, willing partners (e.g. local public/private utilities), space constraints, and project goals.

Geothermal: A piping network which takes advantage of stable earth temperatures to provide heating in the winter and cooling in the summer typically coupled with heat pumps or VRFs in the space. As geothermal developments rely on balanced load profiles, a geothermal system may need to be supplemented to meet all loads. Installing geothermal could result in a reduction in thermal *energy* by approximately 50%. It is also a useful technology for decarbonization as it requires a fuel switch from gas to electricity for heating/DHW; helping immensely with the GHGI target.
Additional benefit to installing a geothermal system could include:

- Elimination of plant equipment, leading to lower maintenance and reserve fund costs
- Elimination of cooling tower water/chemicals as no cooling tower is required
- Reduction of utility costs

Air Source VRF: A high efficiency fully electric HVAC system that can operate at wider temperature ranges than a typical air source heat pump and utilize electric heating as a back-up source when required.

Sewage Heat Recovery: A specialized water-to-water heat pump that recovers energy directly from wastewater and uses this energy to preheat domestic hot water.

Solar Thermal: Rooftop mounted solar collector for thermal energy which is typically used to offset heating of domestic hot water loads in residential buildings. Similar to the constraints listed for solar PV panels, available rooftop space may be a constraint.

Solar Air Heater: Draws incoming air through a transpired solar collector for pre-heat of the central air handling unit, reducing the ventilation heating load. Integrated into the building envelope, they are typically located on mechanical penthouses for visual purposes and for proximity to the MPH. As such, available area may be limited.

Battery Storage: Can be utilized in buildings to provide zero carbon backup power, and empower owners to draw from the grid at off-peak times. Paired with renewable energy, battery storage can extend the utilization of renewables promoting a renewable, resilient grid.

Earth Tubes: Draws incoming air through tubing in the ground for pre-heating and cooling, reducing ventilation loads.

Off-site Renewable Energy Procurement: Aside from on-site renewable technologies, any development may procure off-site renewable energy generation credits to offset their carbon footprint.

## 2.5. ACTIVE DESIGN BEST PRACTICES

While designing the building to achieve a high level of performance is a requirement, actually achieving that high performance is neither regulated, nor guaranteed. There are many possible design solutions that can achieve the targeted level of performance and some additional strategies that can help safeguard both the initial delivery and ongoing operational performance of a high performing building.

### Future-Proofing

While some of these solutions are ideally incorporated into the building during initial design, that may not be feasible for every project. Where it isn't feasible, the City of Toronto has produced a *Mechanical System*

*Design Guidelines for Low Carbon Buildings*[34], which provides a summary of design strategies to future-proof building designs for the changing climate. Some of these solutions include:

- Install heating and cooling plant equipment on the lower levels for easier integration into a future district system, or provide for future connection points into the building's thermal piping at ground level
- Provide adequate space at or below ground level for a future energy transfer station
- Provide an easement between the mechanical room and the property line to allow for thermal piping
- Provide two-way pipes placed in the building to carry thermal energy from the district energy network to the section in the building where the future energy transfer station would be located
- Size heating and cooling risers to convey the design load from the penthouse to the below grade chiller plant
- Install a low temperature hydronic heating system (e.g. heat pump loop) that is compatible with a district energy system in order to reduce the pipe sizes and associated valves, fittings, etc.
- Where a below-grade chiller plant isn't feasible, allocate additional roof space, structural support, and power supply for the future allowance of air-source heat pumps.

Incorporating these elements into the initial design can improve efficiency in the near-term and future-proof the building for later retrofit opportunities.

[34] https://www.toronto.ca/wp-content/uploads/2022/02/9441-2021-11-29Low-Carbon-Thermal-Energy-Ready-Buildings-AODA.pdf

### Cooling Energy Demand Intensity

Given that Guelph is in a cold climate, current passive building design practices emphasize reducing heating loads. Further investigation into the Cooling Energy Demand Intensity (CEDI), however, has revealed that buildings also have significant cooling loads that, if left unattended, can have as large an impact on thermal comfort as TEDI.

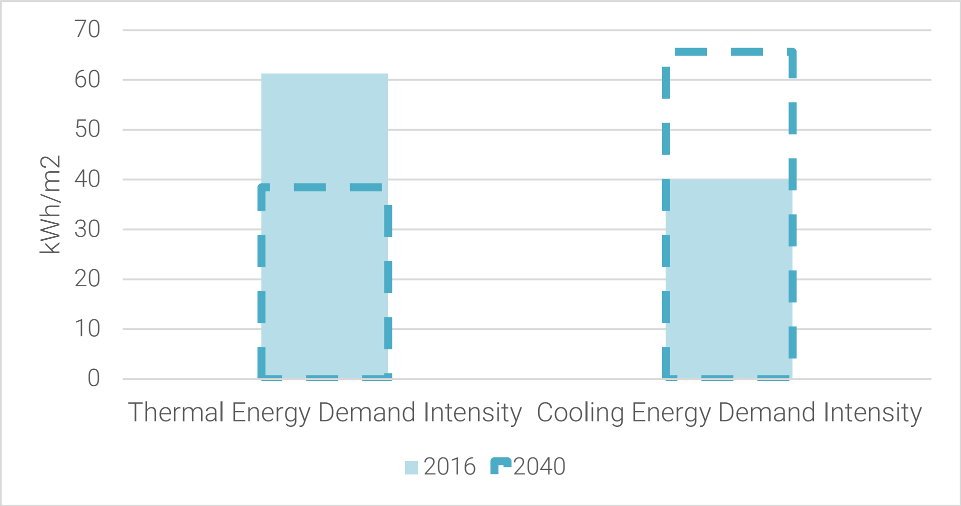



Figure 9 – Sample Comparison of Modelled Heating (Thermal) and Cooling Energy Demand Intensities over Time

EQ undertook an investigation of the impacts of TEDI and CEDI by looking at a sample set of our modelled buildings in Toronto, and comparing how the building use energy under both the current weather patterns and the future weather patterns anticipated for the 2040s. In doing so, it became apparent that the climate in Ontario will shift to a cooling-dominated environment. For this sample set of modelled buildings, the TEDI decreased by 35% and CEDI increased by 70% over the lifetime of the building. This shift indicates that heating equipment will become over-sized, potentially leading to performance issues and redundancy. Cooling equipment will conversely become undersized and require replacement sooner to increase capacity, or run the risk of potential thermal comfort issues.

Some challenges for reducing/controlling CEDI in MURBs are:

- Lighting and tenant plug-loads provide internal heat gains to the space and are typically dependent on tenant lifestyle, rather than building design and performance
- An improved opaque envelope may actually increase the cooling load of the building by trapping more heat when it's not desirable (e.g. shoulder seasons)
- Factors such as reducing the solar heat gains through glazing will simultaneously improve CEDI but negatively impact the TEDI

Although CEDI is a relatively novel metric to assess building performance, it is one that should not be overlooked as it has a notable impact on thermal comfort and will become more influential as the climate warms. When an energy model is developed for the project, the design team should consider additionally evaluating building performance using the predicted 2040 weather patterns.

### Commissioning during and after construction

Even the best-designed buildings don't always perform as expected. Commissioning is a quality assurance process that helps convert design intent into actual building performance results. By using a combination of testing, verification, and documentation, the commissioning process can improve system and equipment operations, avoid unnecessary maintenance, and extend equipment service life, all while helping ensure the designed savings are realized. Best practice commissioning begins in the design phase and continues through construction and occupancy. Commissioning doesn't need to, nor should, end there; ongoing and re-commissioning can help identify many low and no cost measures to maintain or even boost building performance. Commissioning is one of the most cost-effective and low-risk strategies for reducing utility consumption, utility costs, and GHG emissions for both new and existing buildings

### Building Management Systems and Services

To manage day-to-day operations, building management software (BMS) may be desirable. Many building operators do not know how best to optimize building performance, or if they are knowledgeable, may not have time to dedicate to fine tuning operations. Using a building management software can help to ensure maintenance schedules are maintained and send alerts if equipment is acting in unusual ways or out of design ranges, allowing the building to be proactive rather than reactive to equipment operations and tenant concerns.

### Metering

Metering can be a valuable tool in analyzing building energy usage trends and encouraging tenant conservation. When creating a metering plan, it is important to be mindful of the desired outcomes.

Building level utility meters allow buildings to benchmark their performance. While commissioning and monitoring can help with ensuring a building performs as intended, energy benchmarking allows comparison to similar buildings to see where performance is falling short. It can also allow comparisons between buildings within a portfolio.

While electric sub-meters are required in new residential units by law, using electrical meters in non-residential spaces as well as thermal, hot water, and cold water sub-meters can also be included for tenants. When tenants are directly responsible for and aware of their consumption, they are much more likely to take conservation efforts. This can have an added benefit to building operators as well through distributing utility costs to tenants leading to reduced common area fees. When developing a metering plan, it should be noted that revenue meters can be used for measurement and verification as well as revenue and vice versa.

Sub-meters can also be used throughout the building to help set utility rates for sub-metering, monitor operating efficiencies, identify atypical consumption, identify retrofit opportunities and to verify the impact of retrofits. If sub-meters are used for cost recovery, whole-building bulk bills are typically paid for by the condominium corporation and are recovered by charging the tenant directly or through a third-party sub-metering company where feasible. Certain services are sometimes blended into condo fees based on a ratio-utility billing system (RUBS), often allocating amenity costs based on square footage. While RUBS is a suitable method for allocating fees based on shared amenities and maintenance, it is not recommended for utilities. With RUBS there is no financial incentive for tenants to conserve energy and is not fully accurate which may result in significant over and under-estimating of consumption.

Some complications can arise with sub-metering. Due to the complex nature of load sharing, it can be difficult to accurately measure thermal energy use in a heat pump building. When using thermal meters, a greater temperature differential allows for improved accuracy, thus if a low-temperature system is used, this decrease in accuracy should be considered. To avoid any issues, all central equipment should be thermally metered to account for all thermal energy injected/rejected into the building loops. Meters should also be monitored on an ongoing basis. While metering technology is constantly improving, they can still fail and the quicker issues are resolved, the smaller the data loss will be.

# 3. PROJECT SPECIFIC ENERGY OPPORTUNITIES

## 3.1. GEOTHERMAL + OTHER LOW CARBON OPPORTUNITIES

While a description of low-carbon systems has been provided in Section 2.5, not all of these design solutions will be appropriate for the 210-222 College Ave. development. There are a few different options to explore when considering geothermal and these paths have differing financial implications, primarily directly financing the entire design and construction or partnering with a third party supplier.

With a third party, some contracts may have both the developer and geo supplier have investment/shared ownership interest in the system which would allow the developer to have a share in cash flow. Having a third party supplier come on board to design, build, finance, and operate the field can be advantageous as it reduces the upfront building costs to the developer, and ensures the asset will be properly managed over the lifetime of the contract. The geothermal supplier will make back their invested money into the geothermal infrastructure by charging the building tenants a service fee as part of their utility costs.

### Energy Conservation & Demand Reduction

Using the City of Toronto as an example, the electricity grid is becoming increasingly stressed. The electricity distribution infrastructure is already constrained in the areas anticipating the most growth, and an estimated 22% increase in electricity demand due to projects currently in approvals will pose additional challenges. Furthermore, cooling demand for buildings will increase with rising temperatures, which means that the 22% estimated increase is conservative. Broader electrification from sources such as electric cars will further increase electrical demand. The IESO has estimated the increase in peak demand shown in Figure 11 which suggests the current grid capacity will not meet future demands.

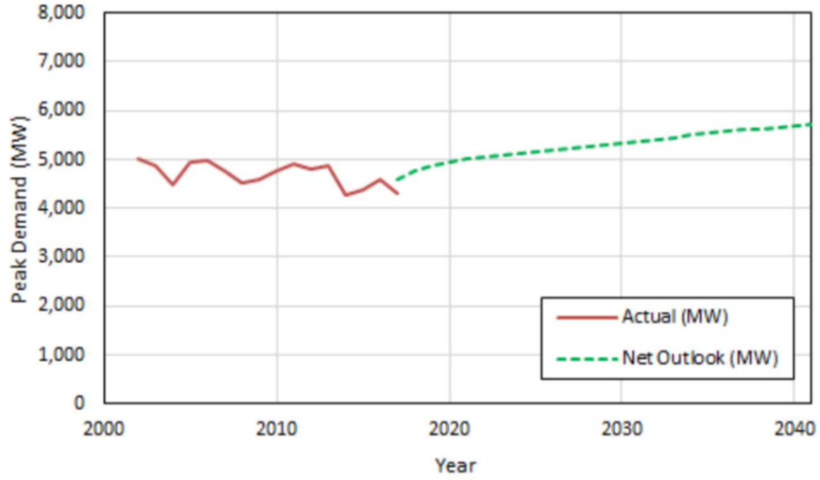



Figure 10 – Aggregated actual demand and net outlook by year[35]

With increasingly strict carbon targets, building designs will be encouraged towards electrification of heating and hot water systems, which will likely further strain the electrical grid. Consequently, energy conservation and peak demand reduction in buildings is becoming increasingly important to ensure a resilient, stable grid in the future. Some advanced strategies to reduce grid demand and energy consumption include:

- Solar photovoltaics combined with battery storage
- Local energy generation
- Connecting to district energy systems
- Heat recovery from sewage infrastructure
- Large-scale geothermal systems

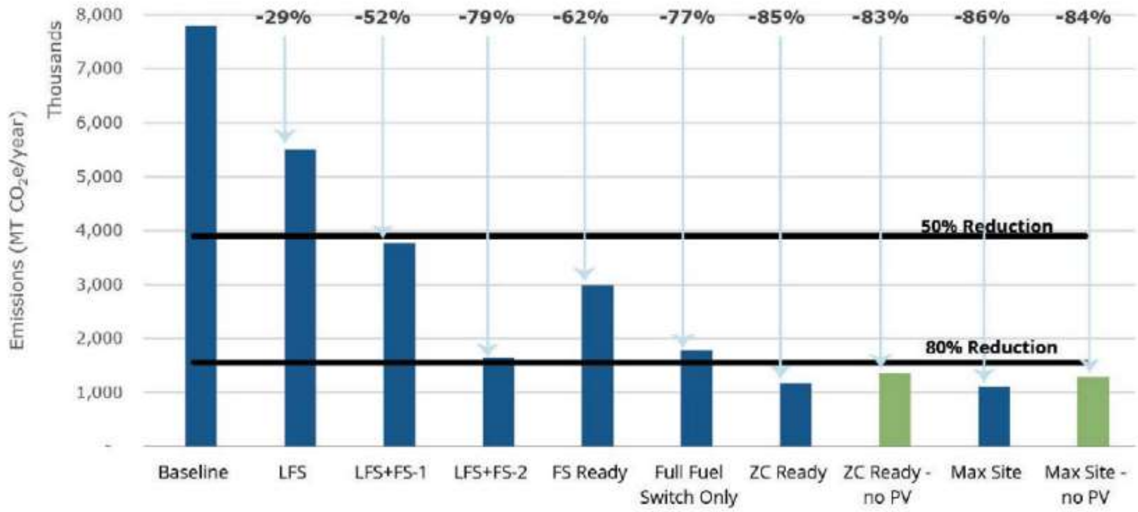
If the project were to pursue partial or full electrification in order to meet the higher performance targets, the electrical service distribution provided would need to increase. This could cost in excess of $500 per suite.

## 3.2. FUTURE RETROFIT STRATEGIES

At the current stage of design, the project team is not intending to pursue a net-zero emissions design. As such, the building may need to retrofit to a net-zero design during its lifetime. Future-proof design elements have been discussed earlier in this report which, if implemented, will aid de-carbonization through retrofits.

As part of the City of Toronto's Climate Strategy, a *Net Zero Existing Buildings Strategy*[36] has been released which can guide developments throughout Ontario. It outlines a number of scenarios for building retrofits to assess what will be required to achieve net zero. Figure 12 demonstrates the carbon reduction strategies explored in the study. Using 'like-for-similar' (LFS below) strategies do result in notable carbon savings, but are not sufficient to reach the net-zero target. Fuel switching (FS below) makes significant contributions to carbon savings, but alone also does not meet the net-zero targets. Each of the scenarios that did meet the net-zero targets required a more holistic approach that improved all aspects of the building design.

[35] Retrieved from: IESO Integrated Regional Resource Plan, August 9, 2019
[36] https://www.toronto.ca/wp-content/uploads/2021/10/907c-Net-Zero-Existing-Buildings-Strategy-2021.pdf




LFS – Like for Similar - Represents not just a simple replacement with same, but with a better level of performance (ex. double glazed windows with triple glazing

FS – Fuel Switch – Level 1 represents a reasonable effort of fuel switch for buildings where financial or space limitations limit fuel switching opportunities (an example may be swapping natural gas boilers for electric boilers). Level 2 may not be feasible for all projects and represents best-in-class HVAC retrofits.

PV – Photovoltaics – On-site renewable energy generation with solar.

ZC Ready – Zero Carbon Ready – Represents a project that achieves a minimum 80% reduction in carbon emissions and a complete or near-complete fuel switch to electricity or other low-carbon fuel source.

Figure 11 - Citywide Emissions Reduction Packages

Based on the CAGBC study *Decarbonizing Canada's Large Buildings: A Path Forward*[37], retrofitting existing buildings to achieve net zero can be cost effective across a number of archetypes and vintages, including MURBs and offices. The analysis was performed over a 40-year timeline and is based on currently available technologies. With technological advances over time, it is likely that the business case for retrofits will improve over time.

When exploring retrofit opportunities, measures that reduce energy loads (envelope, lighting, and plug load improvements) will ideally be done prior to HVAC system upgrades. Prioritizing envelope upgrades will reduce building loads allowing for reduced equipment sizes for later mechanical retrofits.

An example of this might be replacing natural gas boilers with electric boilers. While doing a simple fuel switch can lead to significant carbon savings, electric boilers are only minimally more efficient than natural gas boilers. Performing envelope upgrades first would reduce boiler sizing and reduce the electrical supply requirements which may save significant capital costs. While carbon reductions have the greatest impact on

37 https://www.CAGBC.org/wp-content/uploads/2022/04/Decarbonizing-Canadas-Large-Buildings-Report-w.-Appendices-Final-Revised-Copy_with-formtting_2022-04-25.pdf

the environment today, efforts should also be made to reduce total energy consumption where possible to protect against future changes in utility carbon intensities and costs.

Incorporating a full building retrofit to net-zero emissions at one time would typically be expensive and difficult to do while the building is occupied. A better strategy is to time retrofits with end-of-life with equipment.

Envelope upgrades may only occur once in a building lifetime, but significant load reductions can be achieved. Likely upgrades to consider are triple glazing with thermally broken frames, replacement of window wall systems, addition of significant rigid insulation attached with thermally broken clips, and additional roof insulation. When performing these retrofits, special consideration should be made to avoid risk of condensation and avoid overheating.

Electrification of space heating and water systems will have the greatest impact on carbon reductions, with high efficiency systems preferred. Heating and cooling plants of existing projects can be retrofitted to accommodate air source heat pumps or connect into a future district energy system. If there is room on site to accommodate borefield drilling, ground source heat pumps could be added at the basement level of the building to meet a portion of the peak demand capacity. While they have higher capital costs, they have a much higher efficiency than air source solutions. If upgrades are able to use existing ductwork and piping with retrofits focused on plant and air handlers, significant capital cost savings might be achieved.

Project teams should review CAGBC studies for additional guidance on retrofit strategies.

# 4. RENEWABLES

## 4.1. SOLAR PV

Solar PV is rapidly becoming an economically viable strategy for energy generation at the individual building level, thanks to the price reductions in solar panels over the last several years. As such, it is an important design consideration of low carbon and net zero buildings. Several developments of all types, including residential, institutional, and commercial have already incorporated PV into their designs or retrofitted existing buildings to take advantage of their long-term economic benefits.

There are two predominant types of solar PV technologies in the market today; rooftop and building-integrated PV. In the current market, rooftop PV is likely most feasible to integrate into the development. Given the approximate total roof area of the development, it is estimated that at most 380 $m^2$ may be available for solar energy production considering shading, minimum outdoor amenity areas, and mechanical requirements, resulting in the following levels of production in Table 9.

Table 9 - Predicted Solar PV Production Potential

| | |
|---|---|
| System Size (kW) | 170 |
| System Size ($m^2$) | 980 |
| Annual production (kWh) | 195,500 |
| % of energy requirement (Scenario 1) | 7.8% |
| % of energy requirement (Scenario 3) | 17.9% |

Effective rooftop solar PV installations require access to adequate sunlight as well as the space needed to house the panels. The 210-222 College Ave. development is constrained in this regard, given that the limited roof area is predominantly used towards a rooftop amenity terrace. Given this, on-site solar PV will not be a viable solution to see significant reductions in energy use or to offset a near zero emissions development. If the 210-222 College Ave. development were to achieve net-zero ready performance levels, a minimum of 5,287 $m^2$ of rooftop solar PV area would be required.

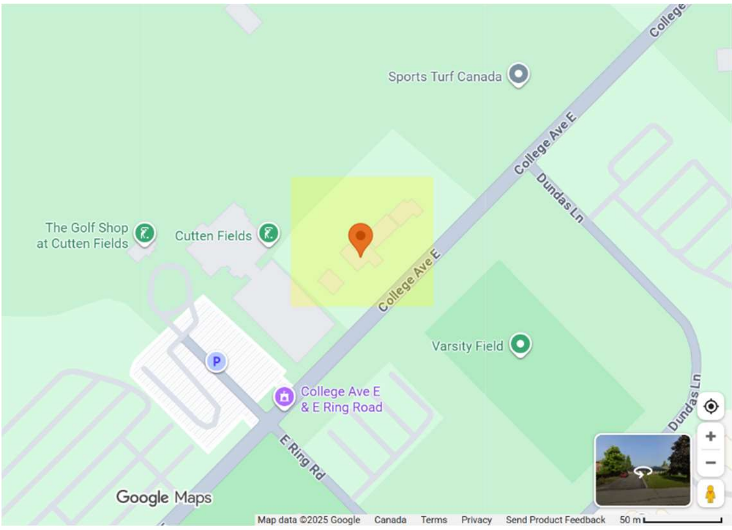



Figure 12 – Rooftop Solar PV Area Required to Offset Highest Performance Energy

Building integrated PV (BIPV) can be integrated into a number of envelope components including skylights, cladding, shading structures, and balcony railings. BIPV technology has made advances in both efficiency and appearance and is a viable way for architects to create a beautiful building while reducing energy consumption. One of the advantages of BIPV is the significant increase in potential area on a building compared to rooftop PV. Estimating production potential can be more complex with BIPV than with rooftop solar as there are a number of potential approaches and a more complex shading risk from adjacent buildings or envelope conditions (such as balconies).

If solar is not incorporated into the design, the project is encouraged to design the building to be solar-ready. Solar ready features that should be incorporated into design include:

- Designate a portion of the roof for future solar PV and/or solar thermal
- Provide adequate structural capacity in the roof
- Install conduit to the roof from the main electrical room to accommodate future systems
- Designate wall area in the electrical rooms or future system controls
- Where possible, place HVAC or other rooftop equipment to avoid shading of future systems
- Consult NREL's Solar Ready Buildings Planning Guide

## 4.2. RENEWABLE ENERGY CERTIFICATES + CARBON OFFSETS

Achieving net-zero design on-site can be difficult to achieve, leading a number of projects to purchase renewable energy certificates (RECs) or carbon offsets. While RECs and carbon offsets are sometimes both referred to as offsets, they are actually quite different.

Offsets are based on the carbon content of energy use and can be used for both natural gas and electricity consumption. RECs are only used for electricity and represent the production of renewable electricity. Both are beneficial and have their place, and should be used as appropriate to achieve each project's goals. As the carbon content of the electric grid in Ontario is low, offsets are typically a more affordable option in the local market.

Table 10 - Basic Differences between Offsets and Recs[38]

| | Offsets | RECs |
|---|---|---|
| Unit of Measure | Metric tons of $CO_2$ or $CO_2e$ | Megawatt hours (MWh) |
| Source | Projects that avoid or reduce greenhouse gas emissions to the atmosphere – may include methane abatement, reforestation, etc. | Renewable electricity generation |
| Purpose | Represents a reduction in GHG emissions, support for emissions reduction activities, and to lower the costs of GHG emissions mitigation. | Convey use of renewable electricity generation; underlie renewable electricity claims, expand consumers' electricity service choices, and support renewable electricity development. |
| Consumer Environmental Claims | Can claim to have reduced or avoided GHG emissions outside the organization's operations. | Can claim to use renewable electricity from a low or zero emissions source. |

RECs and carbon offsets are ideally purchased locally (within the province of Ontario) and should come from a certified provider. The CAGBC Zero Carbon Building Standard (ZCB)[39] suggests pursuing offsets with one of the following criteria:

- Green-e Climate certification or equivalent
- Certified under one of the following high-quality international programs:
    - Gold Standard
    - Verified Carbon Standard (VCS)
    - The Climate Action Reserve
    - American Carbon Registry

When purchasing RECs and offsets, projects should also strive to ensure they are high quality. The ZCB suggests that projects ensure that the purchased emissions reductions will not be cancelled over time or result in increased emissions elsewhere.

[38] Simplified from https://www.epa.gov/sites/default/files/2018-03/documents/gpp_guide_recs_offsets.pdf
[39] https://portal.CAGBC.org/CAGBCdocs/zerocarbon/v2/CAGBC_Zero_Carbon_Building_Standard_v2_Performance.pdf

With the current project design, the 210-222 College Ave. development would need to offset an estimated 324,170 kg of carbon to achieve net-zero. While costing for RECs and offsets vary from project to project, EQ estimates that to fully offset building consumption would cost between $5,300-$7,900 annually[40].

Table 11: Estimated Annual Cost of Green Power

| | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|
| Annual Cost of Carbon Offsets | $5,300 | $2,300 | $800 |
| Annual Cost of RECs + Offsets | $7,900 | $9,600 | $9,000 |
| Carbon offsets | $16.14 per Ton CO2e | | |
| RECs | $8.81 per MWh | | |

## 5. EMBODIED CARBON

While energy efficiency of buildings has improved and operational carbon has decreased, the relative importance of embodied carbon has increased. Embodied carbon refers to the greenhouse gas emissions arising from the manufacturing, transportation, installation, maintenance and disposal of building materials. Conducting a material emissions assessment of the building can be used as a tool to calculate the embodied carbon in current building design and identify low carbon strategies. Embodied carbon is a significant percentage of global emissions and requires urgent action to address it.

There are numerous strategies that can be used to reduce embodied carbon in a building, many of which can be accomplished for no additional cost and minimal performance impacts. The intention of this analysis is to better understand these strategies and provide a project specific carbon impact benchmark at an early design stage.

As per Figure 14 and 15 below, the proportion of embodied carbon in this analysis is consistent through the lifetime of the building, while the operational carbon gradually increases as the demands of the building increase. As the embodied carbon represents a bulk of the lifetime carbon emissions, the embodied carbon assessment reviews opportunities to benchmark and reduce carbon between upfront carbon to end of life carbon.

[40] Uncertainty in carbon content of the electrical grid will impact the price of carbon offsets. The grid is expected to have a higher carbon content in Ontario in the future as load previously met by some nuclear plants will have to be met by natural gas generators.

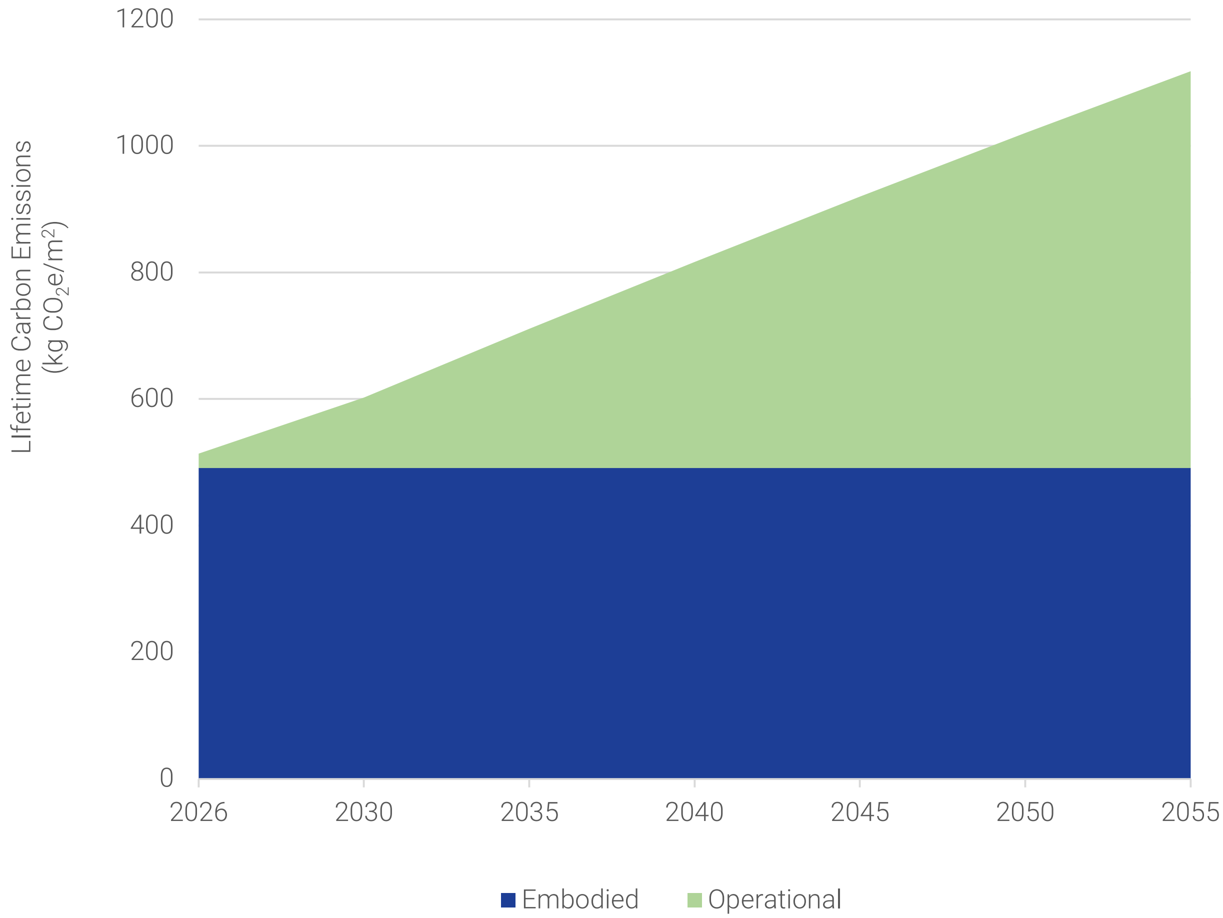



Figure 14 - Embodied versus Operational Carbon

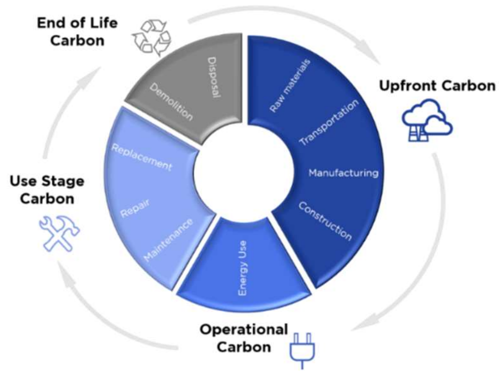



Figure 15 - The Carbon Cycle

## 5.1. SYSTEM BOUNDARY

The system boundary defines which life cycle activities are included in the embodied carbon analysis. The system boundary of this embodied carbon assessment follows life cycle stages identified in EN 15978[41]. The below figure identifies all life cycle stages in the embodied carbon lifecycle equation. The system boundary of this assessment is A1 to A5. A1 to A5 identifies the upfront carbon portion of the full embodied carbon emissions equation. Upfront carbon is emitted before a building is in operation and significantly outweighs operational carbon. At rezoning stage, many use stage and end-of-life stage inputs are unavailable, and therefore exempt from the assessment.

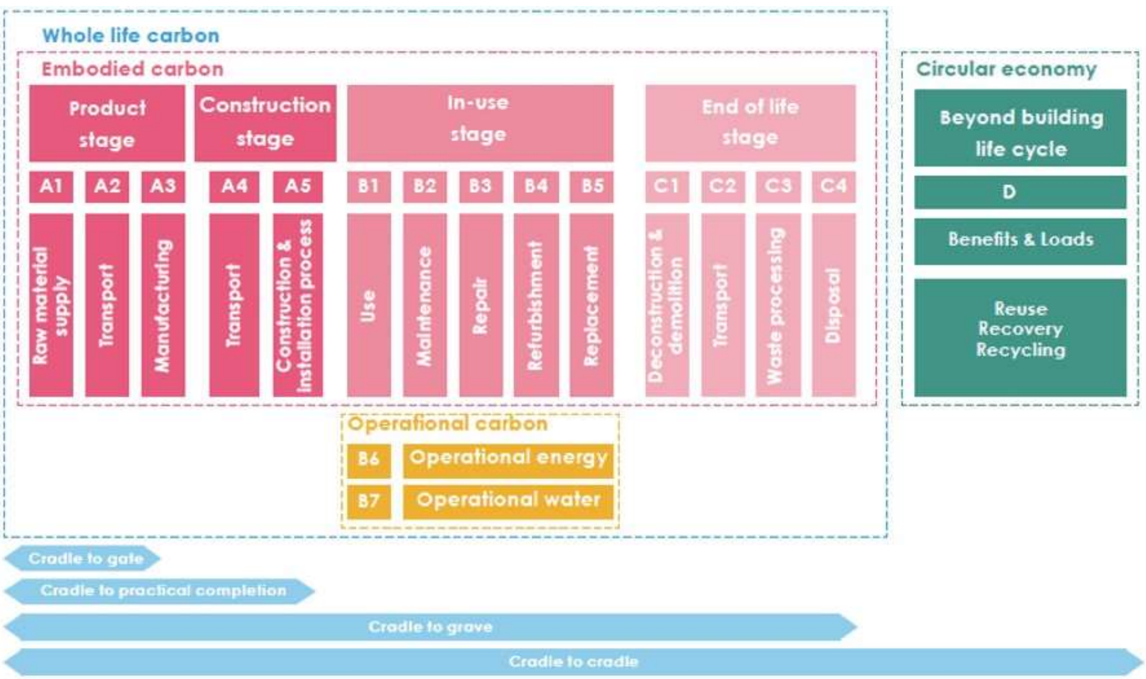



Figure 16 – Required Inclusions for Carbon Analysis at Rezoning[42]

[41] https://www.greenbooklive.com/filelibrary/EN_15804/PN326-BRE-EN-15978-Methodology.pdf
[42] https://www.greengage-env.com/life-cycle-assessment/

## 5.2. GENERAL PROJECT INFORMATION

The following is a list of the software used, relevant general project information and building components analyzed.

Table 12 – Analysis Statistics

| | |
|---|---|
| Software | One Click LCA Materials Selection |
| Project Life | 60 year |
| Assessment Timing | Schematic Design |
| Embodied Carbon Gross Floor Area ($m^2$) | 17,643.1 |
| Components Analyzed | Foundation/Substructure<br>• Foundation<br>• Columns<br>• Slabs<br>• Structural Wall<br>• Wall<br>• Enclosure<br>Above Grade Structure<br>• Columns<br>• Beams<br>• Slabs<br>• Structural walls<br>Envelope<br>• Opaque wall<br>• Insulation<br>• Windows<br>• Roof Assembly |

## 5.3. CARBON RESULTS AT UPFRONT CARBON STAGE

A summary of the breakdown of the life cycle stage breakdown of the building from A1-A5. Based on the construction area listed above, the baseline carbon emissions from current design with 491 $CO_2e/m^2$, for the upfront carbon life cycle stage. This is representative of the new construction portion of the development.

Table 13 – Preliminary Results by Stage

| Life-Cycle Stage | | | Carbon Emissions from Materials (kg CO2e) |
|---|---|---|---|
| Upfront | Product | A1 - Raw Material Supply<br>A2 - Transport (to factory)<br>A3 - Manufacturing | 7,123,863 |
| | Construction | A4 - Transport (to site) | 1,156,203 |
| | | A5 - Construction & Installation | 386,113 |
| | Total Upfront Carbon | | **8,666,179** |

82% of the carbon is attributed to raw material supply, transport to factory and manufacturing of the product stage. The remaining 18% of carbon is attributed to transport to site and construction & installation during construction stage, as can be seen in Figure 17. The vast majority of emissions are included in the A1-A3 product life stage, with approximately over 80% of embodied carbon captured within upfront carbon (A1-A5). Therefore, the best way to reduce embodied carbon is to address the production of materials required for the development.

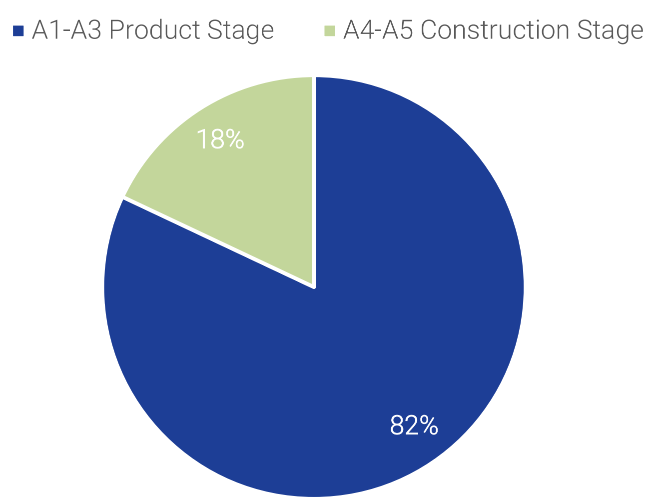



Figure 17 – Life Cycle Stage Breakdown of Carbon Emissions in kg $CO_2e$

## 5.4. CONTRIBUTION ANALYSIS

As discussed previously, the most significant portion of embodied carbon emissions are in the upfront carbon emissions of material extraction, product and manufacturing. Table 14 a summary of top carbon emission assemblies' contributors within the building, and applicable material components.

Table 14 - Contribution Analysis

| Building Assemblies/Materials | Carbon Emissions (kg CO2e) |
|---|---|
| Beams and Columns | 811,565 |
| Floors | 1,271,742 |
| Foundations | 622,686 |
| Roofs | 459,506 |
| Walls | 3,334,918 |

## 5.5. REDUCTION MEASURES CONSIDERED

In order to reduce the amount of carbon in the building, below are some targeted measures that can achieve a total reduction of up to 21% of total building carbon.

Lower Carbon Concrete (GUL and 30-40% SCM)

A key component to reducing the carbon impact in a concrete structure building is reducing the carbon impact of concrete. Two ways of doing this are increasing the supplementary cementitious materials (SCM) and limestone components.

Supplementary cementitious materials are natural or industrial byproducts that exhibit cementitious behaviours when included in the mix. In particular, fly ash is a type of SCM that can be used to replace portions of Portland cement. The benefit to using an SCM is its lower carbon factor compared to traditional Portland cement. The environmental product declaration for Canadian general use ready mix concrete published in January 6, 2017 states that an average 30MPA ready mix concrete product with 15-29% fly ash versus 30-40% fly ash without air entrained has a 12% reduction in product stage carbon. [43]

General use cement (GU), also known as Portland cement is the ingredient typically used for binding in concrete mixes. Approved by the CSA standard A3001-08, up to 15% of limestone to cement can be incorporated producing what is known as general use limestone cement (GUL), also known as Portland limestone cement[44]. Incorporating limestone reduces the amount of Portland cement in the mix, and can contribute approximately 8% to the carbon reduction of a building.

The total carbon reduction for this project for both measures is together would reduce the carbon impact of the project by roughly 8%.

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[43] https://static1.squarespace.com/static/586aea28b3db2bcdc4426405/t/59089fb517bffc913c625a92/1493737421917/CRMCA+EPD+20170317.pdf

[44] https://www.cement.org/docs/default-source/cement-concrete-basics-pdfs/csa3000e-ct041-new-canadian-standard.pdf

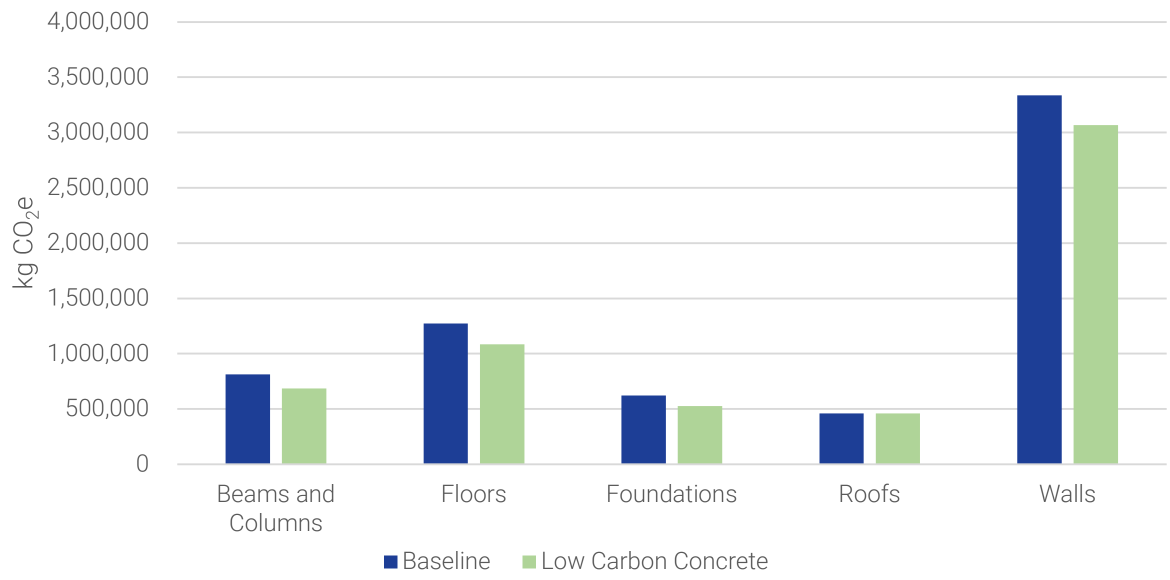


Figure 18 – Low Carbon Concrete – 30-40% SCM and GUL

### Prolonged Shear Wall Cure Time

Certain building components such as below grade slabs, walls and columns, as well as core shear walls may be able to tolerate a longer cure time than 28 days in the construction schedule. For relevant components for this design, a 56-91 cure time can be considered to reach full strength. Best practice would be to advise the concrete supplier at the tendering process of potential components that can accept a longer cure time without a delay in the construction schedule, and the supplier can advise if they have products to support the requirement. In comparison to Canadian industry standard general use concrete, 40MPA @ 56-day cure time is approximately a 50% carbon reduction.[45] This is due to the reduced amount of cement added to the mix, resulting in a longer cure time. Compared to the baseline design, using a 56-day cure time mix results in an 8% reduction in total building carbon.

### Less Carbon Intensive XPS Insulation

Where applicable in the assembly, considering substituting to an XPS insulation with low carbon intensity. For the purpose of this assessment, an industry leading XPS was selected to replace exterior insulation in the envelope where applicable. The reported embodied Global Warming Potential (GWP) is 2.07, which is approximately half of the industry average. Compared to the typical XPS used, lower impact XPS could result in a 4% reduction in total building carbon. Due to its nature, XPS Insulation is a passive product requiring no utilities or maintenance over its useful life. Nevertheless, provided the XPS foam is used as intended, during the use phase, reductions in a building's energy consumption and releases of blowing agents do occur. Although both of these can be attributed to the use of XPS foam insulation, only the environmental impacts due to the blowing agent emissions have been included within the system boundaries since diffusion of the blowing agent occurs whether or not the XPS foam is used for thermal insulation to affect these subsequent energy savings.

[45] Lafarge Environmental Product Declaration Ready Mix Concrete Mix Name: RMPS255511X

## 5.6. RESULTS SUMMARY

A summary of building carbon baseline results and potentials for GWP reduction in the scope of A1-A3 are summarized below.

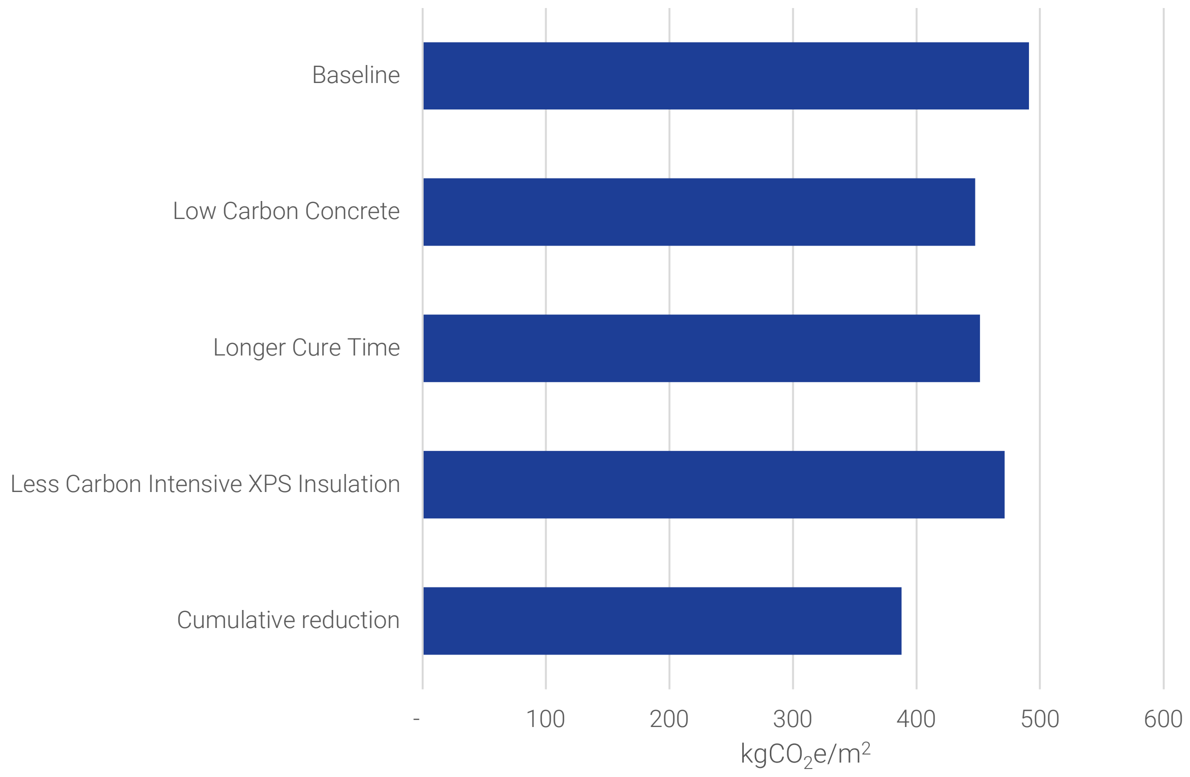


Figure 19– Embodied Carbon Reduction Summary Graph

# 6. FINANCIAL INCENTIVES

Canada Infrastructure Bank (CIB) Incentives

The CIB offers a range of incentives via offering long-term, below market interest rates to projects which focus on deep energy and GHG emission savings. The incentives are part of the CIB's $10 Billion Growth Plan, aiming to strengthen the Canadian economy and stimulate job creation through infrastructure investments.

The CIB's Commercial Buildings Retrofit Incentive (CBRI) provides financing for large sale retrofits which decarbonize existing privately owned commercial buildings. Applicants become eligible with a minimum investment of $25 million and a minimum carbon savings of 30% across a portfolio (with a minimum 25% carbon or energy savings for each individual building).

The CIB also offers incentives to projects which focus on Clean Power, for example though low carbon district energy systems with a particular focus on reducing GHG emissions.

CMHC MLI Select

CMHC has a number of incentive programs such as MLI Select and ACLP, which provide insurance incentives based on a point based system related to affordability, accessibility and energy efficiency. Rental projects which demonstrate increasing levels of energy efficiency and GHG reductions will achieve higher scores and become eligible for increasingly flexible financing options, and lower premiums. Options are available for both new construction projects demonstrating energy and GHG reductions over the NECB 2017/2020 energy code, as well as existing buildings demonstrating energy and GHG reductions over current performance.

# 7. PREFERRED SCENARIO AND RECOMMENDATIONS

## 7.1. OPERATIONAL PERFORMANCE

Based on discussions with the client team, the 210-222 College Ave. development will achieve the Baseline Building Code requirements. This performance will change over the life of the building as the climate warms. A summary of the building targets as well as projected 2050 performance is summarized in Figure 21.

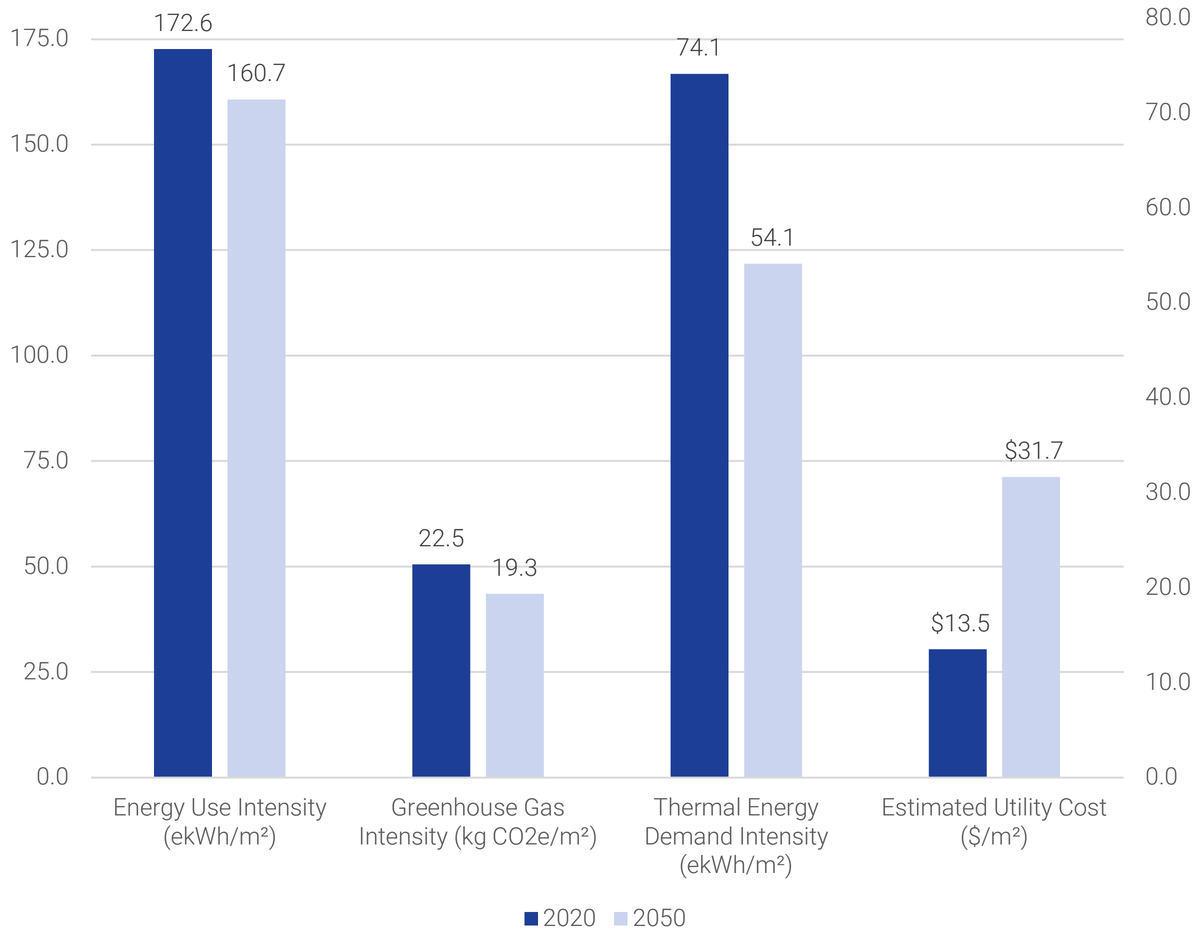


Figure 21 - 2020 and 2050 Targeted Performance

As the climate warms, heating loads will decrease and cooling loads will increase. With the current design intent, this would lead to reduced natural gas use and increased electrical consumption. This can be most clearly seen through the decrease in operational carbon and increase in utility costs over time. Additional costing information can be found later in this section of the report which details escalation rates and carbon pricing that has been included in the estimate.

## 7.2. LIFECYCLE CARBON ASSESSMENT

We recommend pursuing any or all of the three options for embodied carbon reduction outlined in Table 16. Many of these changes can be reviewed with the contractors or material suppliers at the tendering process and where costing adjustments can be made accordingly. Best practice is to engage consultants, suppliers, and contractors as early as possible in the decarbonization process to identify possibilities for reduction.

Table 16 - Embodied Carbon Reduction Summary

| Description of Embodied Carbon Reduction Measure | Building Carbon (kg CO2e/m²) | GWP Reduction (%) |
|---|---|---|
| Baseline | 491 | 0% |
| Low Carbon Concrete | 448 | 8% |
| Longer Cure Time | 451 | 8% |
| Less Carbon Intensive XPS Insulation | 471 | 4% |
| Cumulative Reduction | 388 | 21% |

## 7.3. UTILITY COSTS

Electricity prices in Ontario are currently almost five times higher than natural gas[46]. This encourages building owners to target electricity savings to minimize operating costs. When comparing to carbon emissions however, the opposite trend is seen with natural gas having more than six times the carbon intensity than electricity[47]. In order to meet increasingly rigorous carbon targets, a shift away from natural gas and towards electricity will inevitably be required. Depending on how the project's energy targets are met, this will likely lead to relatively minor cost reductions when compared to the deep energy and carbon savings achieved.

To understand the utility costs associated with the project over its life, EQ has performed a 30-year utility cost estimate. To perform this work, the assumptions listed in Table 18 have been used.

[46] Based on 2022 estimates of $36.11/GJ [$0.13/kWh] vs. $7.37/GJ [$0.28/m³] for electricity and natural gas respectively, inclusive of the current Carbon tax.
[47] 50.22 kg $CO_2$e/GJ vs 8.33 kg $CO_2$e/GJ for natural gas and electricity respectively, based on Environmental and Climate Change Canada's National Inventory Report (NIR)

Table 18 - Cost Projection Estimates

| | Escalation Rate |
|---|---|
| Consumer Price Index | 2% |
| Electricity | 3% |
| Natural Gas | 3% |
| Carbon | 10-30% annually through 2030 based on latest Liberal plan to hit $170/ton by 2030[48]; aligned with CPI thereafter |
| | |
| Assumed 30 Year Period | 2026 - 2055 |
| Climate Assumptions | Toronto CWEC 2020[49] – 2026 weather<br>Toronto 2050[50] – 2055 weather<br>Assumed linear scaling over the 30 year period |

The estimates in this report are based on modelled performance and will differ from actual utility costs once the building is in operation. Typical weather files, standard occupant behavior assumptions, and the model assuming perfect building operation lead to these estimates, showing an idealized performance. It is also worth noting that the comparison reflects the current utility rates and carbon emission factors and escalations available which may fluctuate over time, for example, with increasing carbon pricing or changes to the fuel supply mix of the electricity grid. Based on this analysis, the 210-222 College Ave. project annual energy costs will be approximately $200,299 in 2026, escalating to $467,549 in 2055, as shown in Figure 22.

48 https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/carbon-pollution-pricing-federal-benchmark-information/federal-benchmark-2023-2030.html
49 https://climate.weather.gc.ca/prods_servs/engineering_e.html
50 https://www.pacificclimate.org/data/weather-files

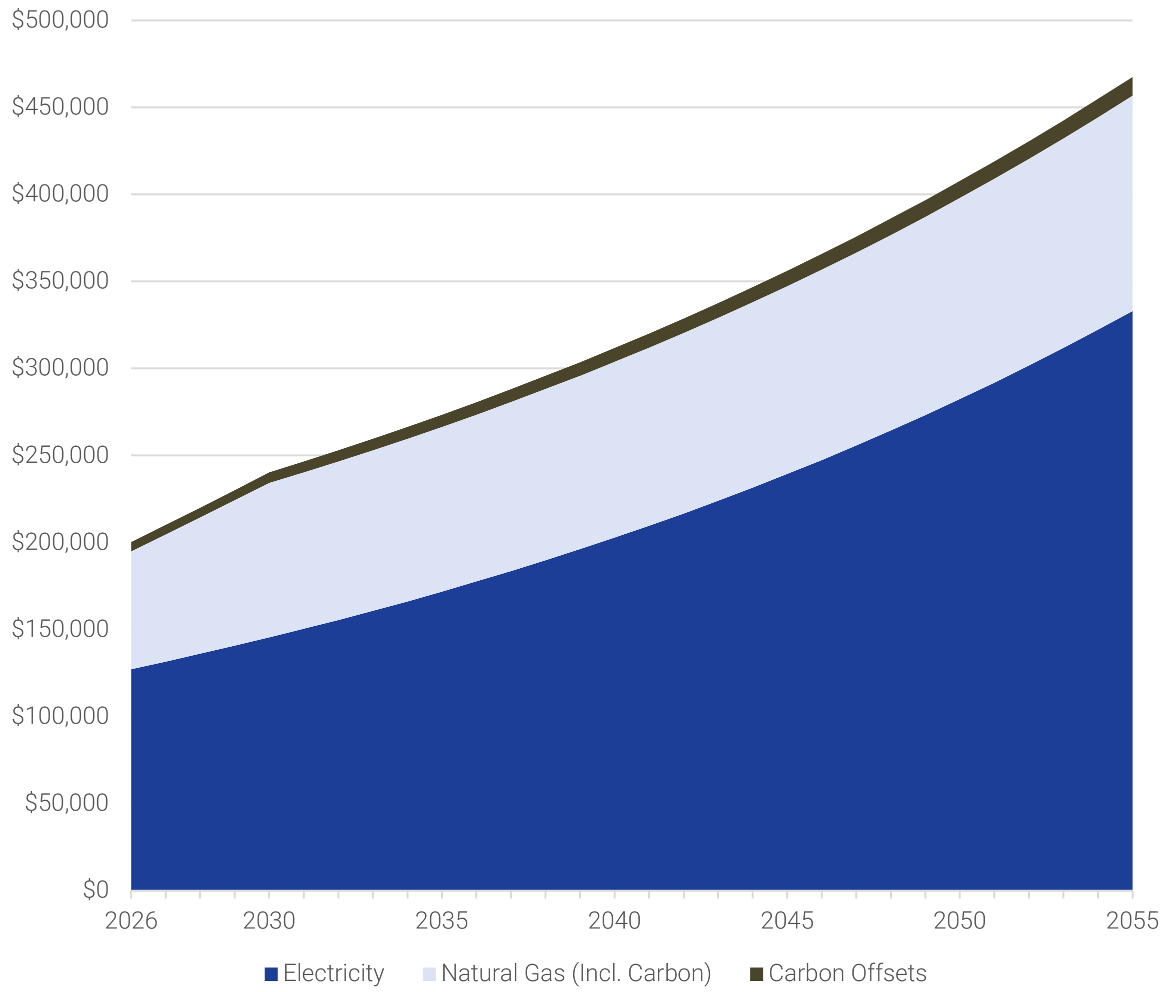


Figure 22 – 30 Year Utility Cost Projection

## 8. CONCLUSIONS

The 210-222 College Ave. project preferred scenario is to achieve the minimum Typical Building Code requirements (Scenario 1). A summary of the estimated performance is in the table below.

Table 19 - Preferred Scenario Estimated Performance

| | Proposed Development |
|---|---|
| Energy Use Intensity | 172.6 ekWh/m² |
| Greenhouse Gas Intensity | 22.5 $kgCO_2e/m^2$ |
| Thermal Energy Demand Intensity | 74.1 ekWh/m² |
| Embodied Carbon | 491.2 $kgCO_2e/m^2$ |
| Utility Cost | $13.51 /m² |
| Cost Premium (over TGS v3 Tier 1) | $0 |
| Annual Carbon Offset to Achieve Net Zero | $5,300 |

From preliminary analysis, some design considerations the project team might want to explore include:

- Improving the effective performance of the opaque building envelope
- Look for opportunities to reduce glazing areas and improve glazing performance
- Reducing domestic hot water natural gas consumption by using enhanced low flow fixtures
- Exploring options to de-carbonize space and domestic hot water heating by electrification and heat pump technologies

As the project is not being designed to achieve net-zero carbon, efforts should be made to future proof the design to more easily accommodate future net-zero retrofits. Some aspects could include locating the mechanical plant at or below grade, or ensuring the roof structure will be able to support future air source heat pumps.

The project team is encouraged, though not required, to explore the feasibility of higher tiers of energy and carbon performance, as well as draw on the *Near Zero Emissions* building design strategies to create a truly sustainable development. The design alternatives, renewable energy, resilience, and advanced energy solutions discussed in this report are recommendations only, and the decision to incorporate them into the final design is up to the discretion of the project team. These measures have been included in this report at a high level and a detailed cost and feasibility analysis should be conducted prior to incorporation.

# APPENDIX A – DETAILED EXPECTED ENERGY PERFORMANCE

Table 20 – Detailed Energy Performance Breakdown

| | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|
| | Typical Code | High-Performance | Net-Zero Ready |
| Gas Use (eMWh) | 1,654 | 584 | 83 |
| Gas Intensity (ekWh/m²) | 114.6 | 40.5 | 5.7 |
| Electricity Use (MWh) | 838 | 1,062 | 1,021 |
| Electricity Intensity (ekWh/m²) | 58.0 | 73.6 | 70.7 |
| Target Energy Intensity (ekWh/m²) | 190.0 | 133.0 | 76.0 |
| Total Energy Intensity (ekWh/m²) | 172.6 | 114.1 | 76.5 |
| Total Energy (eMWh) | 2,491 | 1,646 | 1,104 |
| % Savings vs Typical Code | 0% | 34% | 56% |
| Target GHG intensity (kg CO2e/m²) | 26.0 | 13.0 | 5.0 |
| GHG intensity (kg CO2e/m²) | 22.5 | 9.5 | 3.2 |
| Total GHGs (tonnes CO2e) | 324 | 138 | 46 |
| % Savings vs Typical Code | 0% | 58% | 86% |
| Target Thermal Energy Demand Intensity (ekWh/m²) | 77.0 | 54.0 | 31.0 |
| Thermal Energy Demand Intensity (ekWh/m²) | 74.1 | 51.8 | 25.5 |
| Total Thermal Demand (eMWh) | 1,070 | 747 | 368 |
| % Savings vs Typical Code | 0% | 30% | 66% |

# APPENDIX B – DESIGN GUIDANCE

Energy Study Performance Packages

Table 21 – Sample Performance Packages

| Performance Packages | | | |
|---|---|---|---|
| EUI / TEDI / GHGI | Typical Code<br>172.6 / 74.1 / 22.5 | High-Performance<br>114.1 / 51.8 / 9.5 | Net-Zero Ready<br>76.5 / 25.5 / 3.2 |
| Wall R-Value | R-5 | R-8 | R-10 |
| Glazing Type / Performance | Double-Glazed<br>U-0.35 / SHGC 0.35 | Double-Glazed, Double Low-E<br>U-0.28 / SHGC 0.35 | Triple-Pane, Non-Metal Frames<br>U-0.2 / SHGC 0.35 |
| WWR | 40% | 40% | 30% |
| Infiltration | Per Code | Per Code | 25% Reduction |
| Suite Heat Recovery | 80% | 80% | 80% |
| Corridor Ventilation | 20 cfm/door | 15 cfm/door | 20 cfm/door |
| Corridor Heat Recovery | None | None | 70% |
| Primary HVAC System Type | Fan Coil Unit (FCU) System | Distributed Air-Source Heat Pump System | Geothermal Heating/Cooling System |
| Lighting | Per Code | Per Code | Per Code |
| Plumbing Fixtures | Low Flow | Enhanced Low Flow | Enhanced Low Flow |
| Domestic Hot Water System | Gas Heating at minimum 90% efficiency | Gas Heating at minimum 90% efficiency | DHW Heat Pump sized for 90% of annual load – COP 3.5 |
| Sewage Heat Recovery | None | None | None |

## Resilience

Resilient design is the intentional design of buildings in response to vulnerabilities to disaster and disruption of normal life. In the long term, global warming is rapidly increasing temperatures and more extreme weather events. Designs will need to accommodate these changes over the lifetime of the building. In the short term, the goal should be to keep residents in place during extreme weather events by using passive design measures, backup power, and areas of refuge.

### Climate Resiliency

In 2011, the City of Toronto produced, in collaboration with SENES Consulting, the Toronto Future Weather and Climate Driver Study. Within this report, it was shown that while the Toronto climate has already changed from climate zone 6 (Ottawa) to climate zone 5 (meaning that our climate is getting warmer), this trend is expected to continue with Toronto moving to climate zone 4 (Washington DC) by the year 2040.

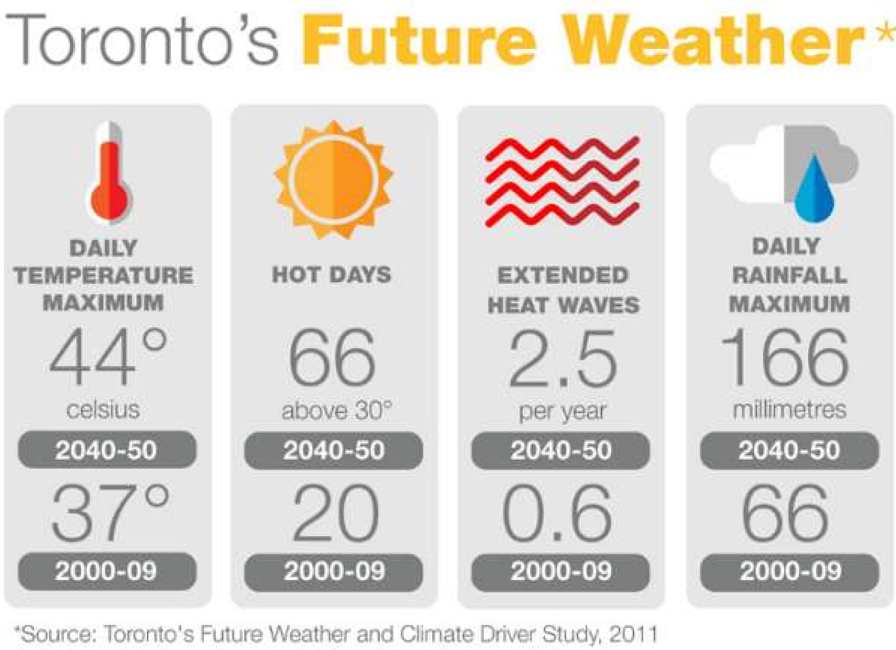


Figure 24 - Toronto Predicted Future Weather Patterns

This shift can lead to lower heating and higher cooling loads over the life of the building. Using up to date, or even predicted, weather data when doing early analysis can allow the design team to consider how the design will perform over the life of the building.

### Resilient Design

While increasing back-up power capabilities can improve resiliency, passive design is vital to ensuring that occupants are able to stay in the building during a power outage. The better a building is able to maintain its temperature without mechanical conditioning, the longer people will be able to remain in place. Energy modelling can be used to estimate how a building's interior temperatures will respond to an extended power failure. The *Zero Emissions Building Framework* analyzed this impact for each TGS performance tier, for a high-rise residential building. The results are summarized in Figure 23 below and show a stark difference in maintained interior temperature between the various performance tiers[51]. Indoor temperatures are analyzed at 72 hours and 2 weeks following a power outage, and show that indoor temperature drop significantly in lower performance scenarios, while the near net zero performance maintains an indoor temperature of 18.3°C even after 2 weeks without power. While a two-week outage is likely an extreme, improved resilience will have a major effect on vulnerable populations

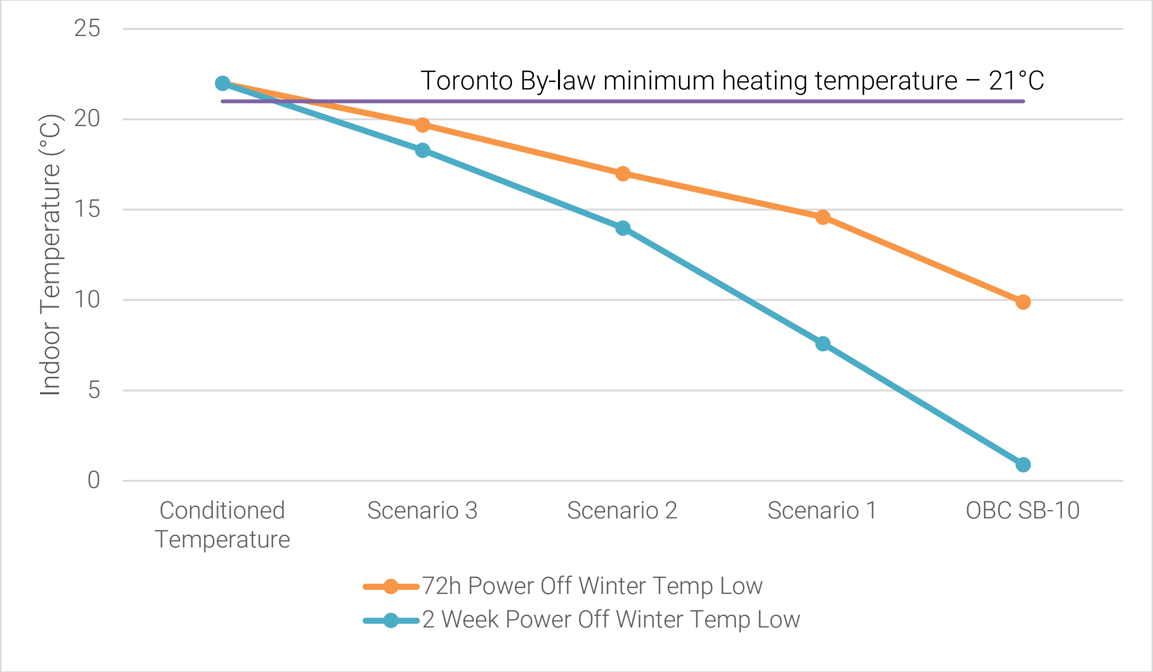


Figure 25 - Indoor Temperature in the Event of a Power Outage

The building envelope is an important factor in maintaining livable temperature in spaces during a power outage, but improved design can also allow spaces to be more comfortable during normal operations. With a poor performing envelope, the first few feet of a space adjacent to the exterior wall can be unusable due to thermal comfort issues. Additionally, as interior spaces are better able to maintain their temperature set-points, HVAC run times and system cycling can be reduced, leading to increased HVAC system life times.

Another strategy to improve resilience for residents is to provide an area of refuge within the building. The designated space would need to provide minimum levels of heating, cooling, lighting, potable water, and power during power outages for a minimum of 72 hours. This would allow residents to remain in the building during a power outage and to keep warm or cool, store medicine, charge communication devices and share updates. The development team is encouraged to review the *Minimum Backup Power Guidelines for Multi-Unit Residential Buildings*[52] for additional guidance. Projects are encouraged to consider resilience early in design so that measures can be more easily incorporated.

[51]https://www.toronto.ca/311/knowledgebase/kb/docs/articles/municipal-licensing-and-standards/investigation-services/bylaw-enforcement-low-heat-no-heat-air-conditioning-air-conditioner-units-residential-properties.html#:~:text=Heating%20(Minimum%20temperatures),June%201%20of%20each%20year
[52]https://www.toronto.ca/wp-content/uploads/2017/11/91ca-Minimum-Backup-Power-Guideline-for-MURBs-October-2016.pdf

Key items from checklist: flooding events, extreme heat and cold, power outages, future weather files, back-up generation, batteries, manager and tenant preparedness.

### Back-Up Power

With increasing global temperatures, extreme weather events require designs to carefully evaluate back-up power solutions. Typical design intent is to include back-up power via a generator that will supply all emergency (life safety) requirements. Passive design measures such as a relatively low window-wall ratio, high thermal mass elements within the building, and high R-value building insulation would assist in maintaining building temperature in the event of heating/cooling system failure.

To increase building resiliency, the project could elect to include back-up power in addition to emergency power on the generator. In general, the difference between these loads is as follows:

Table 23 - Emergency vs. Back-up Power Requirements

| | Emergency Power | Back-up Power |
|---|---|---|
| Purpose | Minimum life safety requirements (firefighter and evacuation) | Non-life-safety requirements for occupant wellbeing |
| Duration | 2 hours – building code requirement | 72 hours – based on federal emergency preparedness guidelines |
| Loads | Fire pumps, fire elevator, stair pressurization fans, alarm system | Water supply, minimal space heating, power to a common refuge area, domestic booster pumps, additional elevators |

Including back-up power on the generator has the potential to increase costs in order to increase the size of the generator, but this can be reduced through the use of a load management system with load selection capability. When the system detects it is no longer in an emergency, it can divert generator resources to back-up power allowing tenants to remain safe and comfortable in their homes during a power outage.