Energy Strategy Report

2343 Eglinton Ave W
23-368
2025-03-26

INVIRO ENGINEERED SYSTEMS LTD.

CONTENTS

1.0 EXECUTIVE SUMMARY

An Energy Strategy (Net Zero Emissions Strategy) explores opportunities for new developments to achieve net zero emissions in keeping with the Transform TO and the Toronto Green Standard Council-approved targets. The goal of the strategy is to identify and evaluate opportunities to reduce energy consumption and carbon emissions, and to create developments resilient to climate change. INVIRO Engineered Systems was commissioned to undertake an Energy Strategy for 2343 Eglinton Avenue W, a development located in Toronto, Ontario. The proposed development is 46,841m^2 with 44,632m^2 devoted to residential spaces, 1,331m^2 for amenity space and 878m^2 for retail.

Both Energy Models and Life Cycle Assessments were conducted evaluating the energy performance and carbon emissions associated with the building's construction. Energy models were completed using eQuest 3.65 and simulations were created for the proposed building at three different performance tiers as per the Toronto Green Standard (TGS) requirements. Life cycle assessments were conducted using Athena Impact Estimator for Buildings 5.5., and baseline and proposed scenarios were drafted adhering to the requirements outlined by the Toronto Energy Strategy.

The report outlines opportunties for integrating various energy and carbon solutions into the projects design and provides various performance scenarios aimed at illustrating how these scenarios can influence the projects total energy performance and carbon emissions. Please see Figure 1: Energy Strategy Diagram for a brief overview of the contents of the energy strategy report.

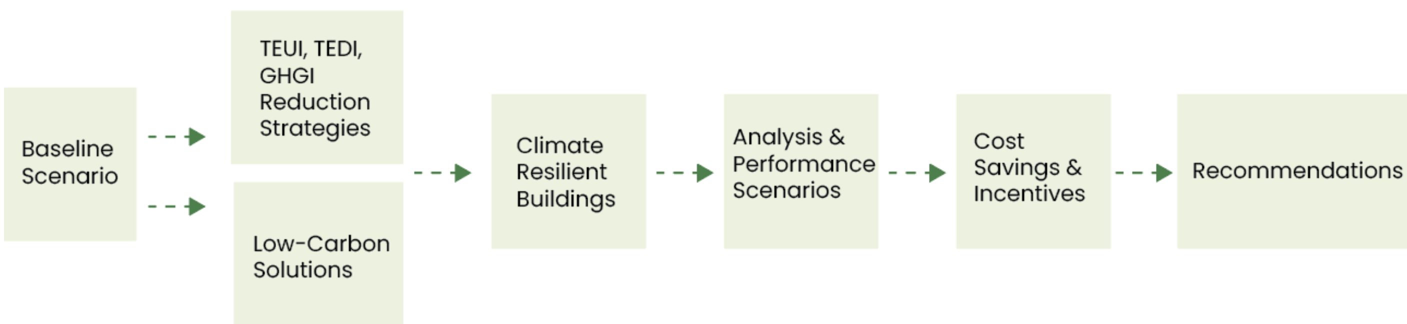

Figure 1: Energy Strategy Diagram

Note: The analysis and the results present modelled performance metrics (TEUI, TEDI and GHGI) for the proposed building design in comparison to performance limits of TGSv4. The calculations are applicable only for determining compliance with TGSv4 requirements (as referenced by the Energy Strategy Terms of Reference) and for option comparison. They are not predictions of actual energy use or costs of the proposed design after construction. Variations such as occupancy, building operation and maintenance, energy use are not covered.

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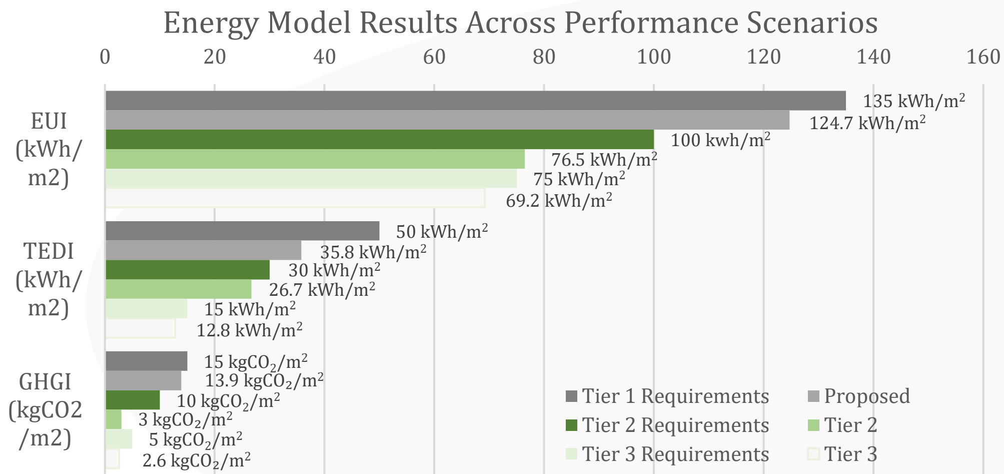
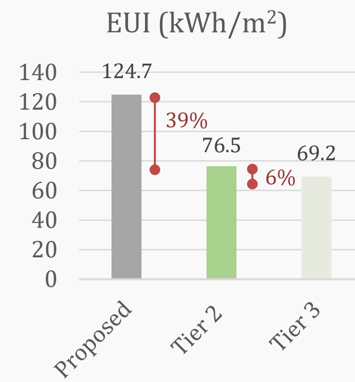
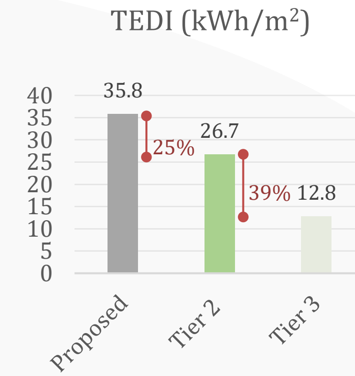
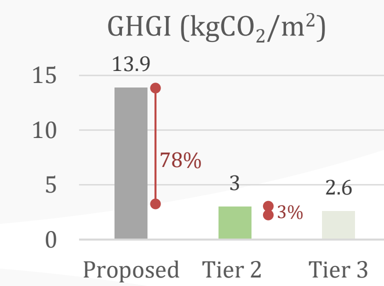
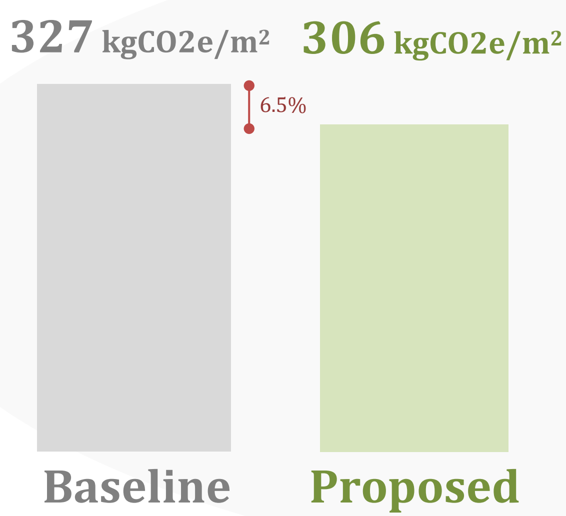








The proposed building was modeled under three performance scenarios. The red markings represent the % savings that will be expected between different performance tiers. For more information about modeling inputs used for each tier please see Appendix A.



Baseline Total Embodied Carbon (kgCO2e): **15,330,453**

Baseline Upfront Embodied Carbon (kgCO2e) A1-A5: **14,907,111**

Proposed Total Embodied Carbon (kgCO2e): **14,332,502**

Proposed Upfront Embodied Carbon (kgCO2e) A1-A5: **13,909,160**

2.0 INTRODUCTION

December 2021, Toronto's City Council adopted an ambitious goal under its TransformTO Net Zero Climate Action Strategy to reduce community-wide greenhouse gas (GHG) emissions to Net Zero by 2040[1]. With the deadline now 10 years earlier than initially proposed[2], even more aggressive climate action is needed. Buildings are the largest emitting sector in Toronto, contributing 57% of its community-wide emissions in 2019, in particular, the combustion of natural gas for space heating made up 92% of Toronto's building sector emissions[3]. Achieving Toronto's GHG goals therefore necessitates a focus on buildings, particularly on reducing space heating energy demand and transitioning to alternative, low-carbon energy solutions.

The City of Toronto requires buildings with a total gross floor area of 20,000 square meters or more, OR for developments within a Community Energy Plan area approved by Council to conduct an Energy Strategy. The City of Toronto Energy Strategy Terms of Reference requires buildings to meet various performance criteria as well as explore opportunities for zero emissions. The performance criteria are outlined in the Toronto Green Standard (TGS) and consist of three tiers, each with increasingly stringent energy use intensity (EUI), thermal energy demand intensity (TEDI) and greenhouse gas intensity (GHGI) requirements. Tier 1 is a mandatory performance threshold for planning approval, while higher tiers qualify the project for potential financial incentives under the Development Charge Refund Program and other incentive programs. TGS Version 4 is currently in effect and will be updated in 2025 and 2028 to reflect new energy requirements as per the City's sustainability and net zero targets.

The energy strategy provided will facilitate the main key outcomes:

- Building design and construction options that optimize daylighting and solar radiation, maximize envelope thermal performance and durability, and minimize embodied carbon in material selection.
- Opportunities for on-site renewable electricity (e.g. solar PV) and low carbon thermal energy sources, including geo-exchange, sewer heat recovery, and low carbon thermal energy networks (i.e. district energy).
- Provide material alternatives for reducing embodied carbon emissions associated with building construction.
- Climate resilience considerations, including location of critical equipment, and backup power during extended grid disruptions.
- Partnerships with energy developers (i.e. third-party utilities), and electricity distribution options offered by Toronto Hydro.
- Capital cost premiums, operating cost savings, and potential incentives in order to recommend technically and financially viable solutions for implementation

The final decision regarding which TGS tier to pursue and the specific design measures to investigate remains with the project owner and developer.

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[1] Environment and Energy Division - City of Toronto, "Design Guideline for District Energy-Ready Buildings," 2016

[2] Environment & Climate Division - City of Toronto, "TransformTO," [Online]. Available: https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-cityinitiatives/transformto/.

[3] Live Green Toronto, "City of Toronto Greenhouse Gas Emissions Inventory 2019," City of Toronto.

3.0 BACKGROUND

3.1 Proposed Development

The proposed development is 46,841m^2 with 44,632m^2 devoted to residential spaces, 1,331m^2 towards amenity space and 878m^2 for ground floor retail. This multi-unit residential building will have two main towers and an adjoining podium section. One of the two towers will be 43 stories, and the second will be 13 stories with the landing reaching seven stories in height. There are two floors of underground parking proposed for the site, reaching a total of 184 parking spaces and over 576 indoor bike parking spaces. The building's total height is 138.5m tall with the main entrance on the north facing side of the building.

Figure 2: Building Entrance Render

3.2 Neighbourhood

2343 Eglinton Avenue W is located in Toronto Ontario in the Eglinton West district. The building is located near Prospect Cemetery which serves as a large walking park and cemetery area. The building is surrounded by primarily residential buildings with some commercial buildings located on Eglinton Avenue. Within close proximity to 2343 Eglinton is Westside Mall which houses a large variety of retail uses. The tallest surrounding building is a multi-unit residential building reaching approximately 19 stories located on Gabian way approximately 450m from the site.

The site is located near multiple east west train routes and has quick access to the Caledonia GO train station. The site location has a walking score of 87, meaning most errands can be accomplished by foot for residents living in this area.

Figure 3: Context Render

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4.0 METHODOLOGY

Energy Model Proposed Building

- Draft energy model of the proposed development that satisfies the Ontario Building Code (OBC) Supplementary Standard SB-10 2017 and compare to a baseline that satisfies the TGS v4 Tier 1 operational emissions and energy requirements.

TEUI, TEDI, GHGI Reduction Strategies

- Discuss construction options that optimize daylighting, solar radiation, envelope thermal performance, efficient equipment and appliances, waste heat recovery, commissioning, metering and airtightness.
- Identify opportunities for low carbon heating and cooling systems, on-site PV electricity production, connections to an existing thermal network, integration to large-scale thermal energy storage sources, and potentials for microgrids.

Low Embodied Carbon

- Draft whole building LCA using Athena Impact Estimators for Buildings v5.5, calculating the total embodied carbon in kilograms of carbon dioxide present in kgCO2e/m2 for lifecycle stages (A1-A5) for the proposed development.
- Conduct a contribution analysis by building assembly or material type for the proposed building.

Embodied Carbon Reduction Strategies

- Conduct a Material Emissions Assessment for the structure and for the upfront carbon lifecycle stage (A1-5). Identify low-carbon sustainable material alternatives to the proposed structure or envelope.
- Complete the Embodied Carbon Reporting Template
- Identify opportunities for reuse of demolition waste; and assess embodied emissions from materials.

Climate Resilient Buildings

- Identify and evaluate opportunities for climate resilience, including location of critical equipment and backup power during extended grid disruptions, and future-proofing opportunities.

Improved Scenario Analysis

- Model improved scenarios for the proposed building meeting TGS v4 Tier 2 and Tier 3 performance requirements, indicating EUI, TEDI, GHGI and embodied carbon.
- Estimate the contributions of identified on-site and off-site low-carbon solutions towards achieving net zero emissions.

Cost Saving and Incentives

- Estimation of capital cost premium and operational cost savings for scenarios over 30 years, including any partnerships with energy developers.
- Evaluate potential incentives including the Partial Development Charge refund for achieving Toronto Green Standard Tier 2 or better.
- Evaluate potential grants, loans or other financing supports.

Recommendations

- Final recommendations to the project team, and the preferred scenario with next steps to facilitate implementation.
- Retrofit strategies to achieve net zero by 2040.

4.1 Performance Metrics

To evaluate the buildings performance, various metrics were used in alignment with the Energy Strategy requirements, including Total Energy Use Intensity (TEUI), Thermal Energy Demand Intensity (TEDI), and Greenhouse Gas Intensity (GHGI). Requirements for each of the listed metrics are outlined in Table 1: Performance Requirements. Tier 1 is the easiest threshold to achieve and is a requirement for the building, Tier 2 has more stringent energy requirements, and Tier 3 represents the most difficult energy performance threshold to achieve.

Total Energy Use Intensity (TEUI): the total amount of energy used by the project in one year divided by its GFA, expressed in kilowatt-hours per square meter per year [kWh/m2/year].
Thermal Energy Demand Intensity (TEDI): the amount of heating energy delivered to the project divided by its GFA, expressed in kilowatt-hours per square meter per year [kWh/m2/year].
Greenhouse Gas Intensity (GHGI): the amount of greenhouse gases emitted by energy related services divided by the project's GFA, expressed in equivalent kilograms of carbon dioxide (CO2) per square meter per year [kg CO2e/m2/year].

The project has mixed uses containing both residential and retail uses, 45,963m² (98%) is devoted to residential space and 878m² (2%) is devoted to retail. Thus, the performance metrics the building is required to meet are for the archetype, "Multi-unit Residential Buildings ≥4." The performance criteria TEUI: 135 kWh/m², TEDI 50 kWh/m², and GHGI 15kg CO2/m² are required to be met. The table below outlines the varying performance requirements for the varying performance tiers.

Table 1: Performance Requirements

Building Type	Total Energy Use Intensity (kWh/m²)			Thermal Energy Demand Intensity (kWh/m²)			Greenhouse Gas Intensity (kgCO2/m²)		
	Tier 1	Tier 2	Tier 3	Tier 1	Tier 2	Tier 3	Tier 1	Tier 2	Tier 3
Multi-unit Residential Buildings (≥ 4 Storeys)	**135**	**100**	**75**	**50**	**30**	**15**	**15**	**10**	**5**
Multi-unit Residential Buildings (< 4 Storeys)	130	100	70	40	25	15	15	10	5
Commercial Office Buildings	130	100	65	30	22	15	15	8	4
Commercial Retail Buildings	120	90	70	40	25	15	10	5	3
Mixed Use Buildings (90% residential, 5% retail, 5% commercial)	134	100	74	49	29	15	15	10	5
All Other Building Types	Tier 1: ≥25 per cent improvement above SB-10, 2017, Tier 2: ≥35 per cent improvement above SB-10, 2017								

*Note Tier 1 minimum performance requirements have been revised such that the GHGI target of 10kg/m² will apply in 2025, and 5 kg/m² in 2028.

5.0 ENERGY AND CARBON MODELS

5.1 Summary

eQUEST 3.65 was the software used to develop energy models for the building. The software is a fully featured dynamic simulation tool for computing the various energy flows in a building during a typical meteorological year. The project used the Toronto CWEC Toronto, ON / Climate Zone 5 weather file.

The energy model for the proposed model is based on the Architectural CAD files and drawings received October 18th, 2024. Modelling inputs that are not provided in the drawings were set to match NECB 2015 modified by OBC SB10 2017, as specified in the City of Toronto Energy Modeling Guideline. As the project is in early design and many details are currently not determined, only preliminary architectural drawings are available to describe the development. Mechanical and electrical design drawings have not been prepared, rather, mechanical and electrical basis of design documents were used to formulate the proposed building. For more information regarding the inputs used for the Proposed, Tier 1, Tier 2, and Tier 3 simulation models, please see Appendix A.

The building is designed to be heated by high efficiency boilers and cooled via a water-cooled chiller. Each suite shall have heating and cooling with four pipe fan coil units and an energy recovery ventilator. Retail areas will also have four pipe fan coil units for heating and cooling. Corridors and common areas are heated by make-up air units with direct expansion cooling and furnace heating.

The Morrison & Hershfield Building Envelope Thermal Bridging Guide v1.6 was used to estimate an effective R-value for the walls when accounting for heat flows through clear field and interface details. Balconies, opaque window transitions, corners, and slab transitions, were accounted for when calculating the building's effective R-value.

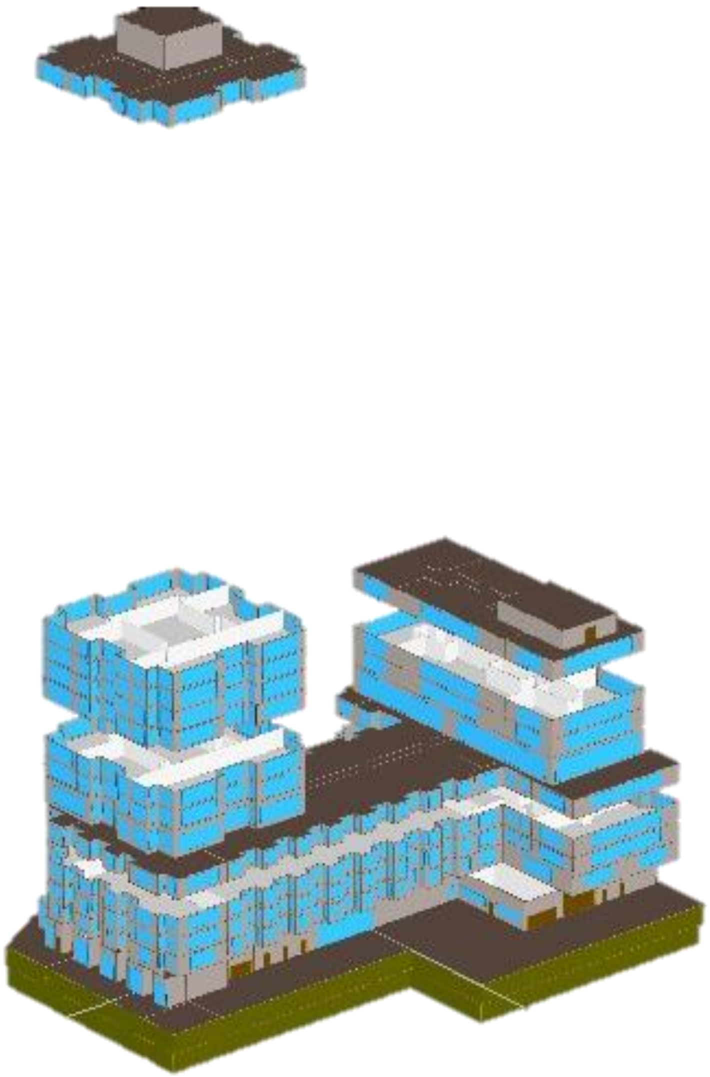


Figure 4: eQuest Model Simulation

5.2 Tier 1- Requirements

It is important to establish a reference scenario for the proposed development. The case selected for the purpose of this analysis is a building architecturally identical to the proposed development that adheres to the minimum requirements of Toronto Green Standard v4.0 Tier 1 performance requirements. The Tier 1 requirements include a maximum TEUI of 135 kWh/m², a maximum TEDI of 50 kWh/m² and a maximum GHGI of 15 kgCO2e/m². Please see Figure 5: Energy Strategy Tier 1 Requirements vs Proposed Case Results, for a summary of the buildings proposed performance against the requirements.

5.3 Proposed Case

The proposed development's energy performance is summarized in Figure 6: Proposed Estimated Annual Energy Use Breakdown (kWh**).** The **Total Energy Use Intensity (TEUI) for this scenario is 124.7 kWh/m²**. The associated **Thermal Energy Demand Intensity (TEDI) is 35.8 kWh/m²** and the **Greenhouse Gas Intensity (GHGI) is 13.9 kgCO2e/m²**. These performance metrics meet the minimum requirements of the Toronto Green Standard v4.0 (Tier 1). The proposed development shows 7.6% decrease in TEUI, a 28.4% decrease in TEDI and a 7.3% decrease in GHGI from the tier one requirements. The design characteristics of the proposed building and the subsequent improved scenarios are summarized in Appendix A.

Please see Figure 6: Proposed Estimated Annual Energy Use Breakdown (kWh), for an estimated breakdown of the energy use for the building's proposed case. A majority of the building's energy consumption will be derived from space heating from gas boilers.

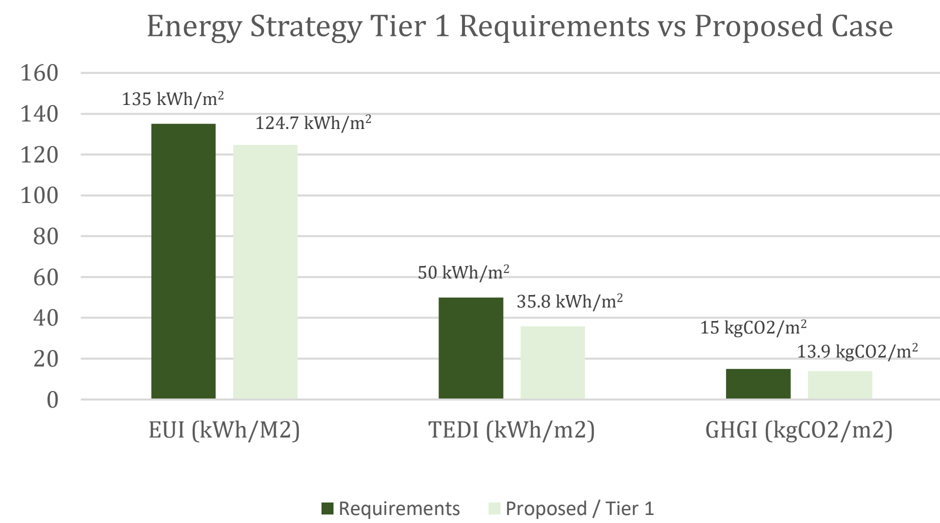


Figure 5: Energy Strategy Tier 1 Requirements vs Proposed Case Results

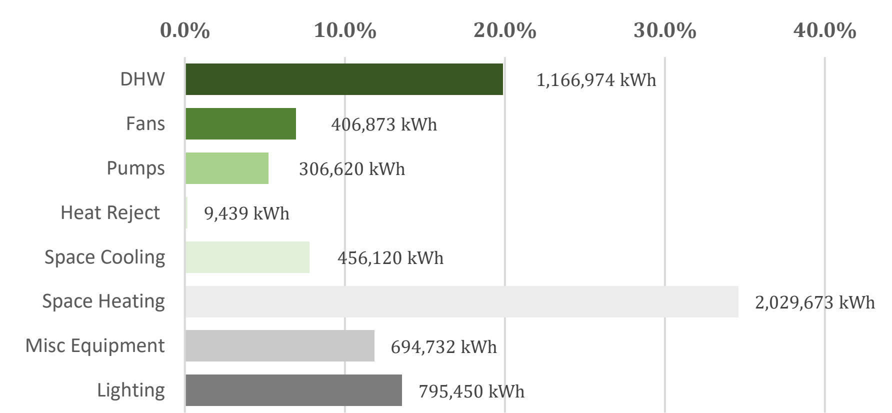


Figure 6: Proposed Estimated Annual Energy Use Breakdown (kWh)

5.4 Life Cycle Assessment Scope

Reducing carbon emissions is important in the fight against climate change and towards meeting the sustainability goals outlined by the City of Toronto. As a result, the City of Toronto Energy Strategy requires a Life Cycle Assessment (LCA), which tracks the building's environmental impact across its entire lifespan. An LCA was conducted for 2343 Eglinton Avenue in accordance with the CaGBC Zero Carbon Building Standard Version (as required) to quantify the building's total embodied carbon, including its upfront embodied emissions.

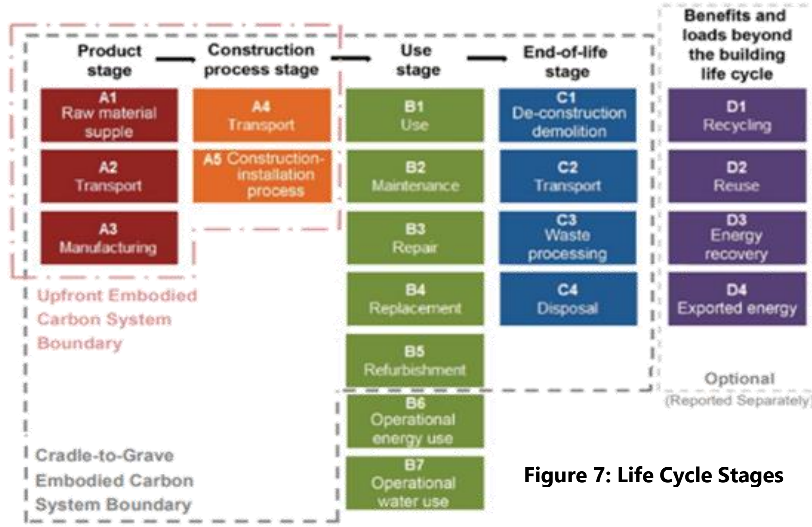


Figure 7: Life Cycle Stages

Embodied carbon represents the total greenhouse gas (GHG) emissions associated with the building's structure and enclosure materials, while **upfront emissions** refer specifically to those generated during the A1 to A5 stages of the life cycle assessment. These stages encompass product selection and construction processes, which typically account for the majority of a project's total embodied carbon. Once constructed, the embodied carbon of building materials is unchangeable. Due to this locked-in nature, it is imperative that materials are thoughtfully selected upfront to reduce the embodied carbon emissions of a building over its lifespan.

The LCA was conducted using OneClick LCA, using the Life Cycle Carbon North America Metric Tool. The LCA data sets are complaint with EN 15804 or ISO 14040/14044 and version 4.0.8 of OneClick LCA was used assuming a building service life of 60 years. The life cycle assessment includes: envelope and structural elements including footings and foundations, complete structural wall assemblies (from cladding to interior finishes, including basement), structural floors and ceilings (not including finishes), roof assemblies, stairs, and parking structures. For the results from the life cycle assessment, please see Appendix B.

**Note -Due to the early and preliminary nature of the LCA, some key assumptions were made:*
- Materials selected for wall and roof assemblies are based on preliminary assemblies provided by the Architect, 2024-10-18.
- Mixes selected for structural concrete and rebar types were selected based on Structural Embodied Carbon report provided 2025-03-10.
- Stair concrete volumes are based on estimated volumes from the Structural engineer, provided 2025-03-14.
- Insulation types used are based on estimated types provided from the Architect, 2025-03-12.
- Steel framing was not included in the LCA as the Structural Engineer noted it was too early to estimate these material quantities. Steel carbon emissions are therefore likely under-represented in the report.
- Green roof assemblies were not provided, thus not included in the LCA.
- Roof "R2" from the architectural assemblies was assumed for the roof as roof assembly locations were not determined at the time of the assessment.

5.5 Life Cycle Assessment Results

The main findings from the Life Cycle Assessment conducted for the building is that concrete will contribute the most to the buildings embodied carbon. Any efforts to reduce concrete use or optimize mix designs will contribute significantly to embodied carbon reductions at 2343 Eglinton Avenue W.

Baseline Total Embodied Carbon ($kgCO_2e$): **15,330,453 $kgCO_2e$**

Baseline Upfront Embodied Carbon A1-A5 ($kgCO_2e$): **14,907,111 $kgCO_2e$**

Embodied Carbon Intensity ($kgCO_2e/m2$): **327 $kgCO_2e/m^2$**

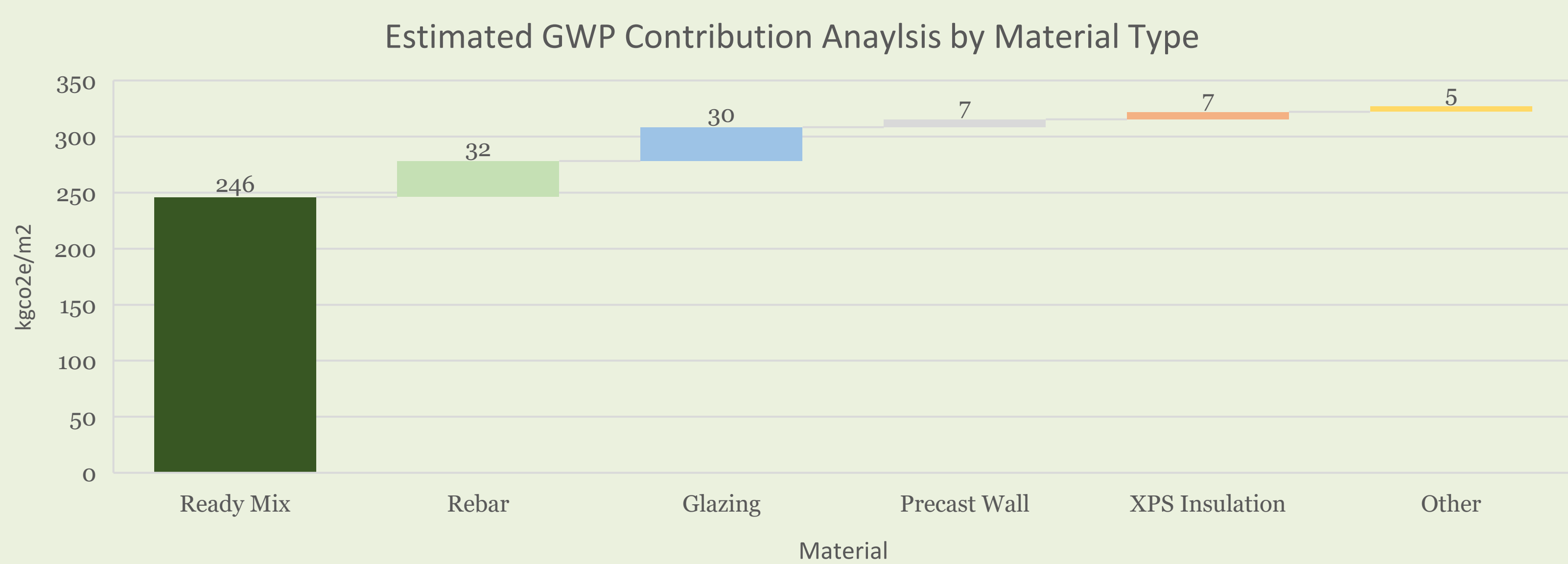


Figure 8: Estimated GWP Contribution Analysis by Material Type for Baseline Case

6.0 ENERGY AND CARBON REDUCTION STRATEGIES

6.1 TEUI, TEDI, GHGI Reduction Strategies

6.1.1 Massing and Form

The mass, shape, and size of a building significantly influences its energy performance. By carefully considering a building's form, orientation, and massing, it is possible to optimize solar gains, enhance natural ventilation, and employ passive strategies to reduce energy loads and carbon emissions. Simple, compact shapes, such as squares and rectangles, are particularly effective because they minimize surface area, reducing heat loss. In contrast, complex building forms introduce additional junctions, which increase the risk of thermal bridging and air leakage.

2343 Eglinton Avenue W features a design that combines a large rectangular podium with two towers of varying heights. The use of rectangular and square forms enhances the building's energy performance. Additionally, glazing along the building's perimeter allows for ample natural light, and sun warmth to enter the building reducing the need for artificial lighting during the day and heating during cool months. Software like Ladybug and EvoMass[4] are simulation programs that allows architects and designers to quickly create massing models to assess how different forms can influence energy performance. By utilizing these software programs early in the design process, optimized building forms can be selected which reduce reliance on mechanical and electrical systems.

Reducing corners and jut-out spaces in building designs is an effective strategy for minimizing heat loss. These architectural features often create weak points in the thermal envelope, allowing heat to escape more readily compared to flat, continuous surfaces. For instance, in Figure 8: Ground Floor Balcony Diagram, the circled areas highlight potential problem zones where leakage may occur. By streamlining the design to eliminate such irregularities, the overall energy efficiency of the building can be improved, reducing heating demands and enhancing occupant comfort.

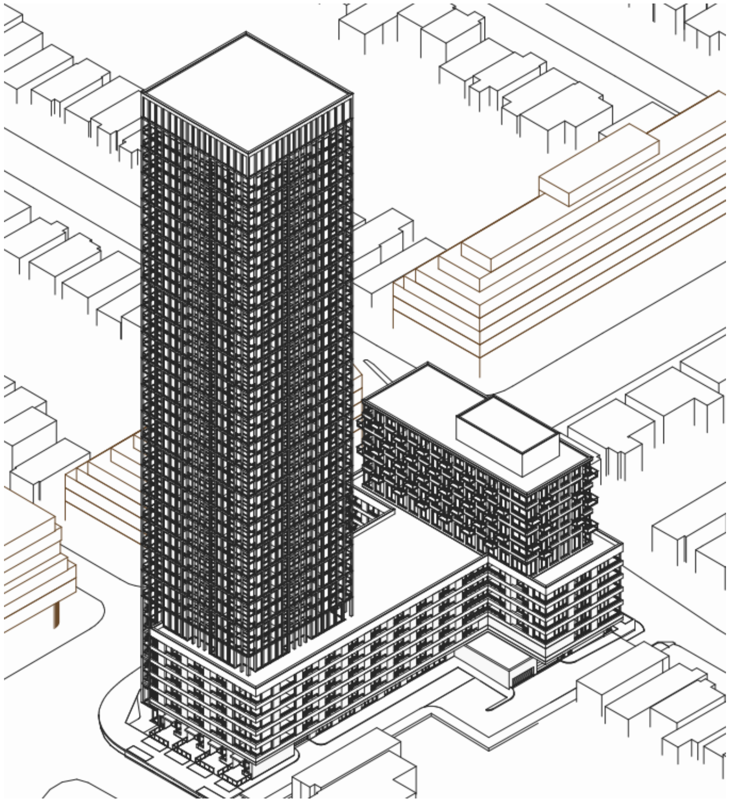


Figure 9: Building SW Render

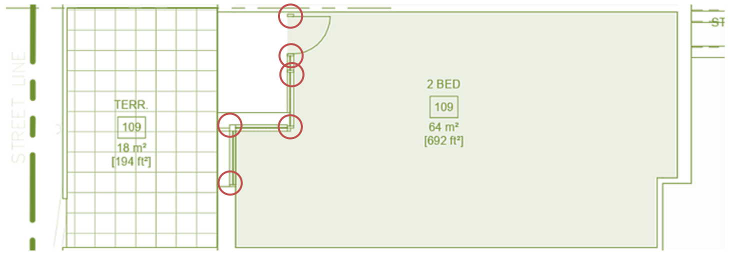


Figure 10: Ground Floor Balcony Diagram

[4] https://www.sciencedirect.com/science/article/pii/S2095263524000797

6.1.2 Enclosure Design and Construction

Thermal bridging refers to the phenomenon where heat transfers more readily through certain materials in a building's enclosure due to their higher thermal conductivity. Typically, thermal bridges occur where building materials such as metal or wood framing members interrupt the continuity of insulation within walls, roofs, and floors. These bridges create pathways for heat to escape, creating localized areas of significantly higher heat flow than the surrounding areas.[5] Effective building design and construction practices can minimize the impact of thermal bridging and improve overall thermal performance.

- **Continuous Insulation:** Installing a layer of continuous insulation (CI) across the building envelope reduces the impact of framing members by creating an uninterrupted thermal barrier.
- **Thermal Breaks:** Using materials with low thermal conductivity, such as foam or fiberglass spacers, between conductive materials like steel or concrete, reduces heat flow.
- **Advanced Framing Techniques**: Techniques like reducing framing members (e.g., two-stud corners, fewer headers) allow for more insulation and less conductive material, which decreases thermal bridging.
- **Reduced Air leakage:** By ensuring continuity and careful detailing for doors, windows, corners and edges of the building, air leakage can be reduced.

Window-to-wall ratio (WWR) is the fraction of the gross exterior envelope area that is transparent. As windows are usually much more thermally conductive than opaque envelope sections, WWR has a significant impact on space conditioning energy use.

The project team is encouraged to reduce WWR while ensuring that sufficient daylight is provided to occupants. Additionally, if possible, the size of windows on the south side of the building should be maximized to take advantage of solar gains to offset space heating loads, while north-facing window area should be minimized as these windows receive very little direct sunlight.

High Performance Windows:

Including low-e coatings and argon filled windows, other measures can be utilized to further enhance energy performance.

- **Thermally broken frames with alternative framing material:** To reduce the thermal bridging impacts of window frames, it is recommended to install thermally broken frames with embedded insulation that are constructed of alternative materials like vinyl, or fiberglass, which have higher thermal resistance than aluminum.
- **Heavy gas fill:** heavier gases like argon and krypton transmit less heat than air. Filling gaps between glass panes with these gases decreases heat transfer.
- **Low-E coatings:** low-E coatings allow visible light to be transmitted through glass while reflecting ultraviolet and infrared radiation. This reduces unwanted heat gain in the summer, and radiative heat loss in winter.
- **Triple Pane:** Triple pane glass comes at a premium; however, is another means to reduce heat loss.

[5] https://www.owenscorninglibrary.ca/wp-content/uploads/2020/02/501023-CDN-Thermal-Bridging-Guide-EN-HR.pdf

6.1.3 Recovery of Waste Heat

At 2343 Eglinton Avenue W, heat recovery is already in place with each residential unit equipped with Energy Recovery Ventilators (ERVs). These systems capture heat from exhausted air and reuse it, significantly reducing the building's heating loads. Selecting ERVs with higher efficiencies—such as those capable of recovering 90% of waste heat compared to 75%—can further enhance energy savings.

In addition to ERVs, stack economizers offer another effective method for recovering waste heat. These devices capture heat from hot boiler flue gases and use it to preheat water within the building. The close proximity of the main heating boiler and domestic hot water (DHW) tanks enhances the feasibility of this approach. Economizers are installed near the boiler's flue outlet, where they extract heat from the flue gases, this recovered heat is typically used to preheat DHW, reducing the amount of fuel required to bring the water to its desired temperature.[6] By integrating stack economizers into the building's energy strategy, the overall fuel consumption will be reduced contributing to lower energy costs and carbon emissions.

6.1.4 High Efficiency Equipment and Appliances

High Efficiency Equipment Outlined in Mechanical Basis of Design	Additional Strategys for Energy Efficiency
• Condensing hydronic heating boilers to be high-efficiency units. • Common area corridor fresh air supply units are equipped with variable frequency drive blowers to allow for turndown during nighttime for additional energy savings. • Parking garage system with CO2 control system to exhaust air only when required. Additional fresh air intake louvres serving the garage are left open to allow for garage ventilation and removal of generated heat from cars. • Domestic hot water supply includes two gas fired domestic hot water boilers at 90% efficiency. • Make-up air shall be provided with variable speed monitor control via a time switch to control the flow of air to the building. Air flow will be less during off-peak hours. • Low flow plumbing fixtures.	• Conversion to electric water heaters over gas with 90%+ efficiencies. • Residential units to use Water Sense labelled, low-flush/flow faucets, toilets and showerheads. • ENERGY STAR or equivalent appliances installed, including microwaves and dryers. • Improved lighting controls for tenants including occupancy sensors, personal tuning (dimmers) and daylight harvesting sensors.

[6] https://natural-resources.canada.ca/maps-tools-and-publications/publications/energy-publications/energy-efficiency-publications/heat-recovery-boiler-stack-economizers/5931

6.1.5 Best Practices for Commissioning, Metering and Airtightness Testing

Commissioning equipment by following equipment-specific start-up and functional testing scripts, as well as implementing routine recommissioning protocols for mechanical and electrical systems on-site are critical steps to ensure equipment is operating as it is intended to. These processes verify that equipment functions as designed, operates smoothly, and is not wasting energy. Routine checks and timely replacements further prevent inefficiencies, breakdowns, or potential safety hazards. Ensuring that trained personnel thoroughly understand how the equipment is intended to operate and be maintained extends the equipment's lifespan and improves the overall efficiency of active systems within the building. It is recommended that a qualified professional with commissioning experience on similar projects is retained and that commissioning process activities are carried out in accordance with ASHRAE Guideline 0-2005 and ASHRAE Guideline 1.1-2007.

To fully understand energy allocation within a building, sub-metering key energy end uses can be very useful. Measuring the energy consumed by end uses such as lighting, ventilation, heating, cooling, and plug loads enables building owners and tenants to identify where energy is being used and make informed decisions to reduce consumption and operational costs. Ensuring that individual readings for the building's boilers and chillers are available is important as these systems will provide a majority of the energy consumption at the building. By metering and sub-metering building equipment, not only are there insights into overall building efficiency and performance, but it can also help the owner identify inefficiencies/maintenance requirements for critical building systems. This can help save energy and operational costs.

Airtightness testing is a critical diagnostic measure for identifying points of air leakage and vulnerabilities in the building envelope. This process pinpoints areas where energy efficiency can be compromised, contributing to higher operational costs and diminished indoor comfort. Regular testing and retesting can reduce heating and cooling losses and improve indoor environmental quality. To identify disparities between the envelope and air tightness, testing, such as thermographic analysis and blower door tests can be performed. Thermal imaging focuses on detecting temperature differences between surfaces, which are invisible to the human eye. The thermal analysis will scan the building and examine the envelope to measure the temperature of difference surfaces and the relative temperature from one object to another. Thermal anomalies ("problem areas") can then be identified, which are signs that remediation may be required. The cost for a thermal analysis ranges based on building size, however, should be considered once the building is constructed to understand where potential heat loss may be occurring.

Alternatively, a blower door is a powerful fan that mounts inside the frame of exterior doors. The fan pulls air outside of the building, lowering the pressure inside so that the higher outside air pressure then flows in through all unsealed cracks and openings. The cost for a blower door test ranges based on building size.

6.2 Low Carbon Solutions

6.2.1 Low Carbon Heating and Cooling- GeoExchange

The current mechanical basis of design and baseline reports assume heating to be supplied via hydronic heating boilers. To reduce energy consumption and emissions associated with space heating, the use of geoexchange systems or ground source heat pumps (GSHP) should be considered.

In simple terms, geoexchange systems transfer energy between underground borefields and the building's heating and cooling system. A ground source heat pump extracts heat from the ground to heat the building in the winter and reverses the process to cool it in the summer. GSHPs are efficient, reduce carbon emissions, and eliminate the need for gas-based systems, which pose risks related to air quality, carbon monoxide, and rising gas costs. Boreholes for geoexchange systems are typically drilled from 400 to 1,500 feet below the surface, depending on building needs.[7] These holes can be integrated into the construction process during building foundations. Diverso is one of many Toronto based companies that provide geoexchange systems for buildings looking for more sustainable heating and cooling practices.[8]

Diverso offers Energy-as-a-Service (EaaS) financing models which shift the upfront capital costs to an operational expense, allowing organizations to avoid large upfront investments. Diverso removes the upfront cost of expensive chillers and boilers, however, they own and operate the energy generated from the geoexchange system. A monthly energy charge is provided that is comparable to typical building systems at an average of 9.5c/month per sqft. [9]

Additionally, removing the mechanical penthouse equipment provides additional floor area that can be utilized as amenity space for building tenants. With additional amenity space for occupant use, this may increase the desirability and the prices of the units.

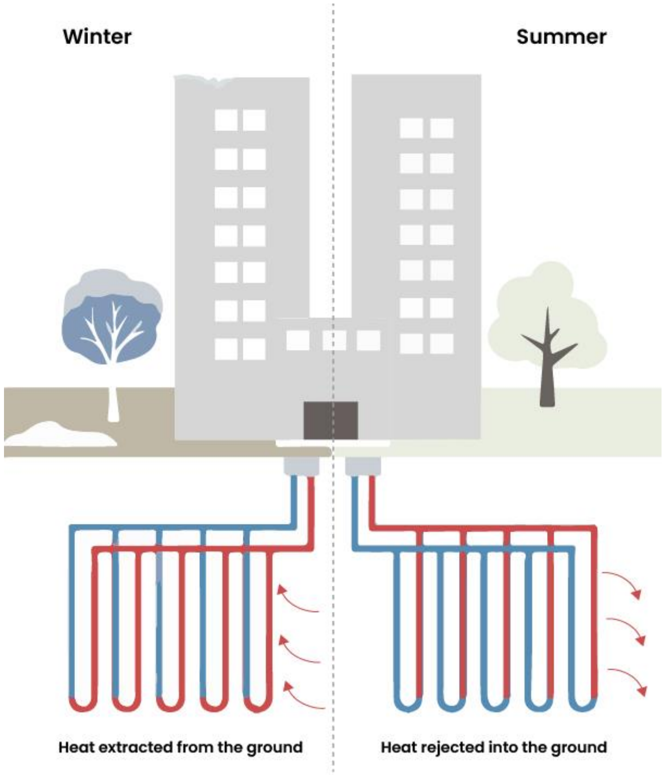


Figure 11: GSHP Diagram

[7] https://facilities.princeton.edu/sites/g/files/toruqf5436/files/geoexchange-flyer.pdf
[8] https://diversoenergy.com/our-process/
[9] Diverso Energy - Unpublished presentation.

6.2.2 Low Carbon Heating and Cooling- Air to Water Sourced Heat Pumps

The mechanical basis of design proposes a hydronic system with rooftop plants for chillers and boilers that will then administer treated water throughout the building for heating and cooling. An alternative to this option that frees up rooftop space and can be more sustainable would be an Air to Water Source Heat Pump. Air-to-Water source heat pumps can be more energy-efficient due to their ability to recover heat and operate with smaller temperature differences. Air-to-Water source heat pumps usually offer a coefficient of performance (COP) value from 2.0 to 5.4 at temperatures of 8 °C and range from 1.1 to 3.7 at temperatures of -8 °C.[10] Traditional boilers have a COP that ranges from 0.7 to 0.96 depending on the efficiency of the system used. Effectively, Air-to-Water source heat pumps can provide 1.1 - 5.4 units of heating for every unit of energy consumed where the boiler counterpart is much less.

Feature	Proposed Site - Hydronic System (Boiler + Chiller)	Air-to-Water Source Heat Pump
Heat Source	Boilers use gas, chillers use refrigerants to cool water	Extracts heat from ambient air
System Design	Centralized system with a boiler and chiller linked to fan coils	Outdoor unit heat pump and water distribution inside the building
Energy Efficiency	Moderate	High
Carbon Emissions	Medium to high	Low
Operating Costs	Typically higher	Typically lower
Initial Cost	Typically lower	Typically higher
Space Requirements	Centralized plant room for boiler and chiller, plus indoor water piping.	Outdoor unit required, plus indoor water piping.

For additional information regarding heat pumps, see the City of Toronto footnote dedicated to how they operate, grants, savings, and additional resources.[11]

[10] https://natural-resources.canada.ca/energy-efficiency/energy-star-canada/about/energy-star-announcements/publications/heating-and-cooling-heat-pump/6817
[11] https://www.toronto.ca/services-payments/water-environment/net-zero-homes-buildings/heating-cooling-with-a-heat-pump/

6.2.3 Onsite PV Electricity Production

Due to the mandated green roof requirements for this building, 60% of the roof area must be dedicated to green roof space, significantly limiting the available space for other uses. The remaining roof area will be allocated for mechanical equipment and tenant-accessible spaces, making the installation of rooftop solar PV systems impractical. However, solar PV cladding has become increasingly viable in recent years, with several buildings in Ontario adopting this technology. For example, the University of Toronto's SAMIH building features an active façade that generates over 420,000 kWh annually. Another notable example is 1451 Wellington Street in Ottawa, which also utilizes this innovative technology. [12]

Mitrex panels provide a wide variety of panel designs that generate solar energy that is integrated into the cladding system of the building. A sample study was conducted to estimate the cost and total electrical output for 2342 Eglinton Avenue W. In alignment with the design renders, a brick panel was selected that generates roughly 14W/sqft. The south side of the building was then analyzed, and panels were provided for different areas of the building façade, please see the figure to the right for the proposed solar paneling layout.

For the paneling demonstrated by the picture on the right, an approximate total of 1,468m^2 of paneling would be provided. This roughly equates to 221.30 kWs using 14w/sqft brick panels from Mitrex. For the site location, a 221.30kW solar system can be estimated to provide roughly 263,100 kWh per year.

Solar cladding panels from Mitrex cost roughly $130 per sqft, this would mean the total cost for the illustrated panels on the right would be approximately $2,055,000. The Canadian Clean Technology investment tax credit can provide up to 30% of the capital cost of clean technology, this would equate to approximately $616,500. Similar to Diverso, EaaS financing models are available for Mitrex panels. This shifts the upfront capital costs to an operational expense. The third-party provider would install, own and operate the energy system and the customer would pay a fixed or variable rate over a long term contract.

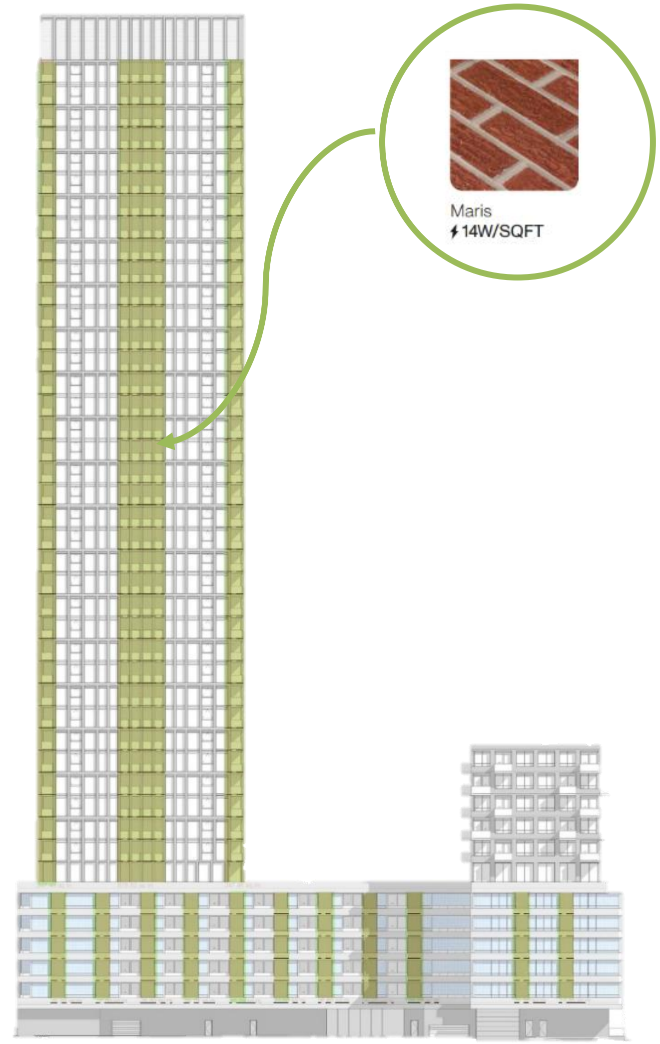


Figure 12: Mitrex Panel Elevation

[12] MITREX Panels - Unpublished presentation.

6.2.4 Solar Thermal

Where solar PV panels generate electricity that can help power buildings and reduce peak loads, solar thermal uses sunlight to generate heat and this heat can be used for various heating applications. Typically used in conjunction with water heaters, solar thermal panels capture the sun's heat and transfer it to a heat-conducting liquid which then heats water in cylinder. Because the rooftop boilers and domestic hot water tanks are planned to be located in mechanical rooms on the roof. The solar thermal panels can help offset the energy required to heat the water for these systems. Solar thermal panels can preheat boilers or hot water tanks and reduce energy required. This will ultimately reduce gas use and GHG emissions.

Hydro Solar is a company that provides this type of technology in Canada.[13] See the figures below for various examples of a solar water heating configurations. The cost can vary depending on the sizing of the system and the configuration; however, assuming the split solar water heating system, a 20 piece vacuum tube solar panel kit with 30 tubes and supporting attachments costs roughly $36,300. Assuming the 30 tube HYDROLSOL VT5830[14] and a 30° tilt angle and 30 degree solar azimuth – an estimated 2,139 annual kWh is predicted to be produced annually. This multiplied by 20 panels purchased equates to roughly 42,780 kWh. It is recommended that the Hydro Solar team complete a preliminary investigation to determine if this system, or an alternative system and configuration is appropriate for the project.

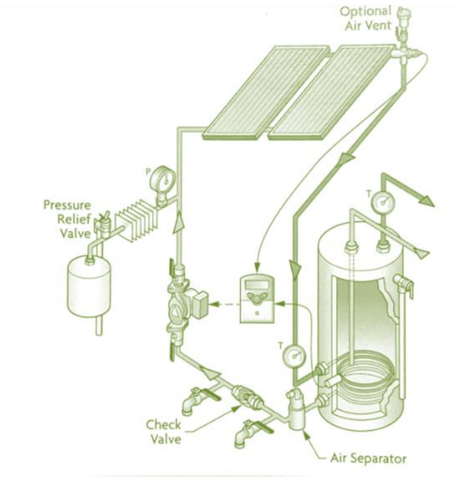


Figure 13: Split Solar Water Heating

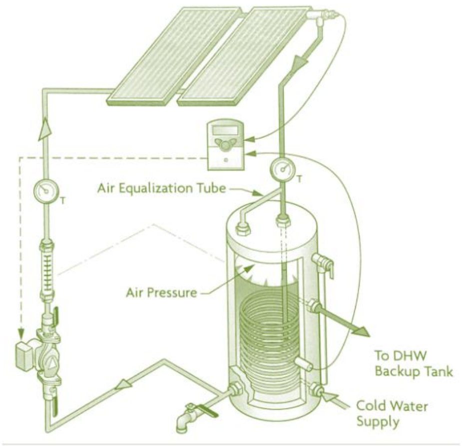


Figure 14: Pressurized Drain Back

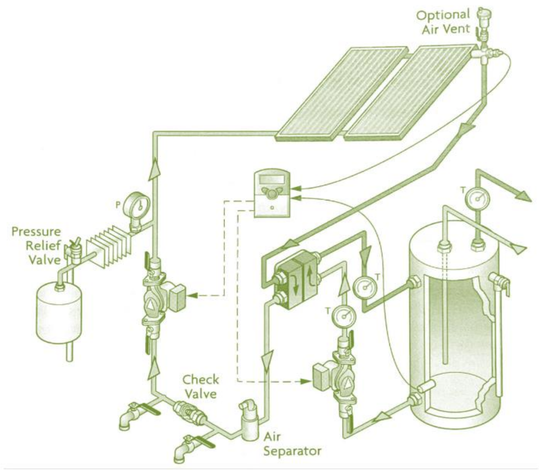


Figure 15: Split Solar with External Heat Exchanger

[13] https://hydrosolar.ca/blogs/news/how-do-hydronic-solar-water-heating-works
[14] https://hydrosolar.ca/pages/xkph58-30-heat-generation-sheet

6.2.5 District Energy Systems

A District Energy System (DES) is a strategy for distributing thermal energy across multiple buildings within a specific area. Typically, a DES includes a centralized heating and/or cooling facility and a network of pipes that connect the buildings. This system leverages economies of scale by providing shared resources, reducing the need for individual energy systems in each building. By doing so, DES lowers greenhouse gas emissions and eases demand on energy infrastructure. Additionally, DES can integrate advanced technologies like geo-exchange, combined heat and power, and lake water cooling for more efficient space conditioning.

The City of Toronto encourages buildings near existing or potential DES nodes, that are (1) within a community energy planning area, or (2) part of a development over 20,000m², to be district energy ready. This entails building mechanical infrastructure that enables connection to a future DES when it becomes available. Please see the image to the right for the site's location and the closest DES nodes. Yellow stars indicate potential DES nodes and orange stars indicate already existing DES nodes. The project is between two potential DES nodes, one located at Eglinton and Black-Creek drive (1.7km from site) and the other is located at Eglinton and William R Allen Road (2.3km).

Toronto Design Guidelines for District Energy-Ready Buildings:[15]

•Ability to supply thermal energy from ground level;

•Adequate space at or below ground level for a future energy transfer station;

• An easement between the mechanical room and the property line to allow for thermal piping;

•Two-way pipes placed in the building to carry the thermal energy from the district energy network to the section in the building where the future energy transfer station will be located;

•A low temperature hydronic heating system that is compatible (i.e. large temperature differential or ΔT) with a district energy system in order to reduce the pipe sizes and associated valves, fittings, etc.; and

•Appropriate thermal energy metering.

Figure 16: District Energy Locations

[15] https://www.toronto.ca/wp-content/uploads/2018/01/96ab-District-Energy-Ready-Guideline_October-2016.pdf

6.2.6 Microgrid

A microgrid is a self-sufficient electrical system that can generate and distribute electricity, either in conjunction with or independently from the main power grid. Typically, microgrids combine renewable energy sources like solar panels with backup generators and can incorporate battery storage to manage electricity during outages or times of high grid demand.

Schneider Electric offers microgrid solutions through both traditional upfront payments and innovative Energy-as-a-Service (EaaS) financing models. EaaS shifts the cost from an upfront capital expenditure to an operational expense, allowing organizations to avoid large upfront investments. Schneider Electric can finance, design, build, own, operate, and maintain these microgrids, making the implementation of a microgrid seamless and affordable.[16]

The benefits of microgrids include:

- Reducing stress on the main electrical grid,
- Providing power during outages,
- Lowering costs by avoiding peak electricity rates,
- Decreasing greenhouse gas emissions and supporting the use of sustainable energy,
- Potentially qualifying for government incentives to help with financing,

6.2.7 Large Scale Thermal Energy Storage

Large-scale thermal energy opportunities include innovative solutions such as lake water cooling, trunk sewer heat recovery, and waste heat from data centers. While Lake Ontario powers a deep lake water cooling system in Toronto, its location is too far from this facility to be a viable option.
Trunk sewer heat recovery leverages the flow and temperature of sewage to extract heat for reuse in large buildings. Properties located near trunk sewers can connect to district energy systems, enabling them to harness this renewable energy source. To support such initiatives, the City of Toronto provides a wastewater energy map that identifies potential sewers near a project site. This map outlines sewer pipe locations, approximate temperatures, flow rates, and heating capacities. [17] For this project, the map indicates a trunk sewer approximately three blocks away at Montcalm Ave and Bowie Ave, presenting a potential opportunity for integration into the district energy system.

[16] https://www.se.com/ca/en/work/solutions/microgrids/
[17] https://www.toronto.ca/services-payments/water-environment/net-zero-homes-buildings/wastewater-energy-projects/wastewater-energy-transfer-map/#location=2343%20Eglinton%20Ave%20W&lat=43.692749042&lng=-79.462559576&zoom=11

7.0 LOW EMBODIED CARBON – MATERIAL EMISSIONS ASSESSMENT

As an early metric for understanding how various building materials impact embodied carbon emissions at 2343 Eglinton Ave W, the Athena Building Pathfinder Tool[18] was used. This software provides an early estimation for the total Global Warming Potential (GWP) and embodied carbon emissions from life cycle stages A1-A5 and allows users to select the site's location, building type, and alter the materials used to see the associated GWP. Notably, the pathfinder tool is great at comparing estimated GWP between different building assemblies; however, it has limitations when estimating total GWP. Because the tool estimates GWP from building area opposed to using precise material quantities, the GWP values are likely to vary from an LCA conducted for the building. Furthermore, as the building assemblies at 2343 Eglinton Avenue W become finalized and material selections are made, increases in the GWP reported in sections 5.5 and 9.3 are expected.

The Pathfinder Tool estimates the proposed building to produce between 590 kgCO2e to 850 kgCO2e depending on the building material inputs selected, please see Figure 16: Proposed Estimated GWP A1-A5. The green lines indicated in the figure show material alternates that are more eco-friendly and have a lower GWP/embodied carbon emission. The lowest embodied carbon emissions without altering the building construction too drastically is achieved when hollow core concrete floors, polyisocyanurate roof insulation, TPO roofing, 30% SCMs in concrete and no underground parking is chosen. Note one limitation to this tool is multiple assemblies can't be chosen, i.e., a building with multiple cladding types or wall insulations cannot be selected; rather, only one input is permitted.

The Pathfinder tool is highly effective at comparing estimated carbon from large scale design changes. Reducing a building's embodied carbon emissions will come largely from reducing concrete used in the structural components of the building including walls, floors, exterior panels and beam constructions. An alternate building construction with very similar inputs; however, using steel beams, columns and floors was illustrated, see Figure 17: Alternate Building Construction GWP A1-A5. Replacing concrete for steel beams, columns and floors would produce embodied carbon emissions between 291 kgCO2e and 493 kgCO2e compared to the initial proposed case.

The last computation illustrates an optimized design that would require many changes to the building design and construction; however, would provide the lowest GWP. See Figure 18: Optimized Building Construction GWP A1-A5, for the optimized construction methods focusing primarily on CLT construction, wooden beams, triple glazed windows, street parking and 40% SCMs, yields a GWP of 201 kgCO2e to 228 kgCO2e.

Note: the software has an error within the parking level category as acknowledged by the software developer.

[18] https://www.athenasmi.org/news-item/free-web-app-for-exploring-embodied-carbon/

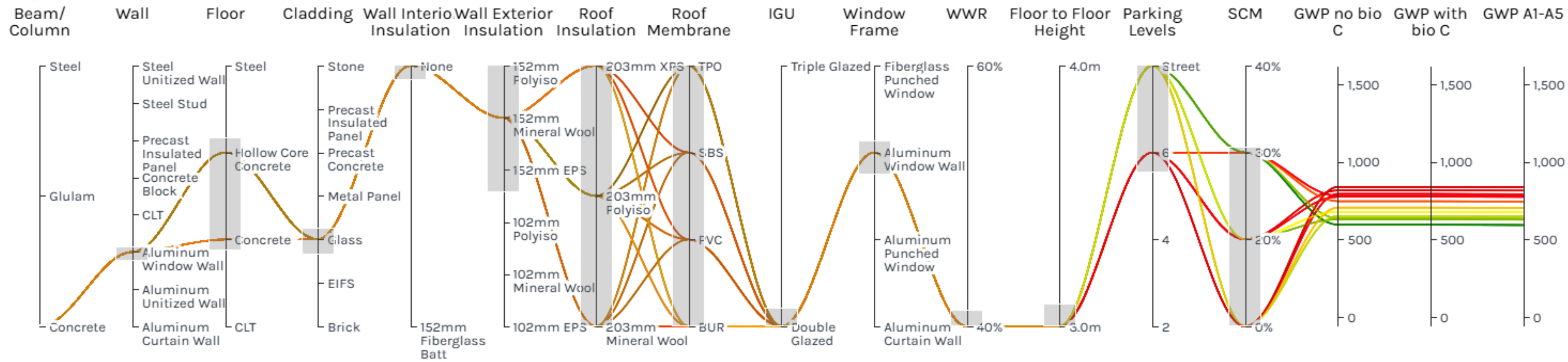


Figure 17: Proposed Estimated GWP A1-A5

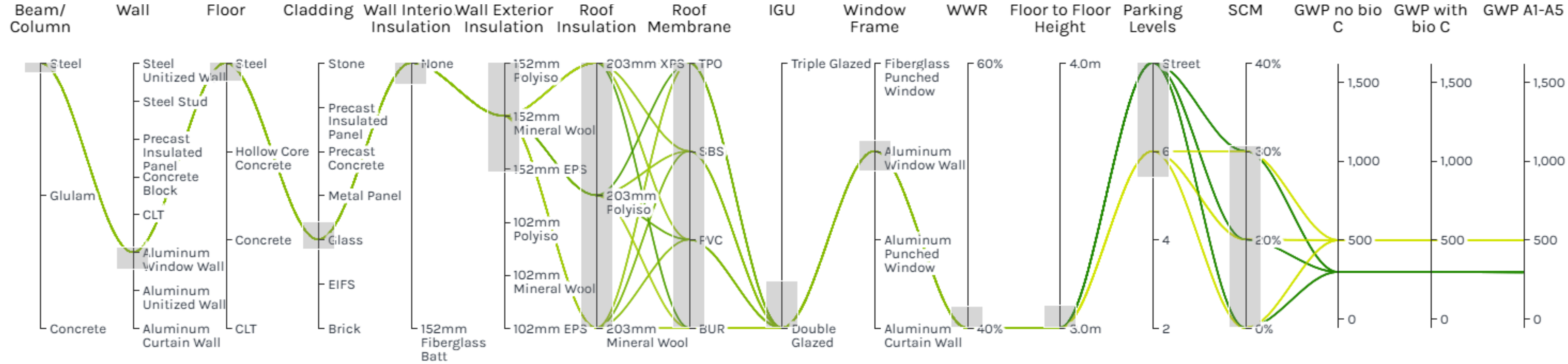


Figure 18: Alternate Building Construction GWP A1-A5

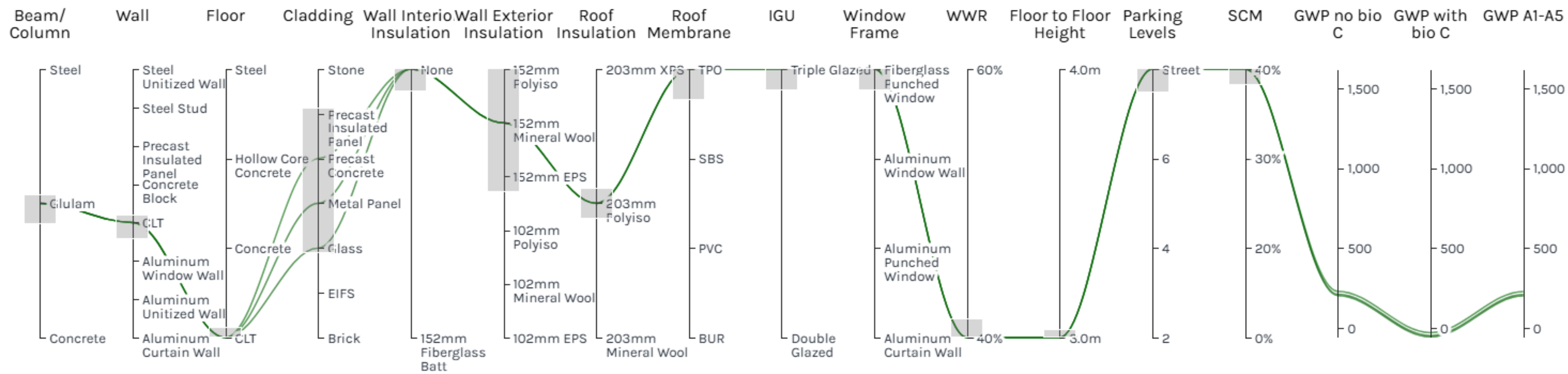


Figure 19: Optimized Building Construction GWP A1-A5

7.1 Embodied Carbon Reduction Strategies

Please refer to Appendix B for a summary of the Embodied Carbon Reporting template from the Zero Carbon Building – Design v3 Workbook. The fields indicated in the table below represent strategies that were implemented at 2343 Eglington W to reduce embodied carbon. Because design has not been finalized yet, there are many strategies that could be utilized to further reduce the embodied carbon emissions, see the "additional strategies" from the table below.

Table 2: Material Assessment

Low Carbon Strategies	Proposed Case	Additional Strategies
Material Reuse		-Reuse aggregate from the demolition scope
Material Swap		-Procure steel/metals with high recycled content, favour electric arc furnace (EAF) over basic oxygen furnace (BOF) -Use polyisocyanurate (ISO) or expanded polystyrene over extruded polystyrene (XPS) insulation for roofing -Use fiberglass batt and semi-rigid insulation over mineral wool batt and semi-rigid insulation for wall insulation -When choosing between materials, choose those with a lower kgCO2e when possible
Alternate Structural System		-Use steel as a structural system over concrete where possible to reduce carbon emissions.
Structural Biobased Materials		-Consider cross-laminated timber (CLT) or timber building construction
Non-structural Biobased Materials		-Use timber or wood for framing of the interior walls
Structural Element Optimization		-Reduce the quantity of concrete used: strategies include using hollow core concrete for slabs or using prestressed post tensioned concrete slabs. -Consider using higher concrete strengths to reduce thickness required for columns. -Reduce bay sizing, column and beam spacing, if feasible
Concrete Mix Optimization	-Minimum 15% supplementary cementitious materials (SCMs) for mixes -Targeted 10% reduction from baseline in upfront carbon emissions by selecting low-carbon concrete mixes	-Plan mix pours for the summer to reduce long setting times for high SCM mixes in the winter -Increase minimum SCMs for mixes to 30% -Use GUL cement over GU standard mixes
Exterior Envelope Optimization		-Favour window and panel assemblies that use less materials
Other Reductions		-Minimize underground parking from 2 floors to 1 floor, or street level parking only -Reduce concrete balcony sizes

7.2 Demolition Waste Reuse Opportunities

Ouroboros is a Toronto based company focused on finding ways to re-use materials from site demolition. Materials are salvaged through thoughtful deconstruction of a project site and sold or reused. Construction and demolition waste account for more than 40% of today's landfill and Ontario landfill capacity is expected to be reached by 2032[19]. For these reasons, reuse opportunities from demolition are an important initiative to consider for the project's site. Reclamation audits can cost from $15,000 to $35,000 depending on the project size and scope. This includes site visits, meetings with design team members, and embodied carbon calculations.

Additionally, when choosing building materials for construction, considering materials that can more easily be deconstructed can expand the circularity and life expectancy of a material. For example, reducing spray foam insulation can allow studs and other adjacent materials to be reused, or reducing lime in binders can allow for bricks to be more easily removed from one another.

The current site is occupied by a Shoppers Drug Mart, which includes a designated area for parking. As the proposed project is still in its initial stages and far from the construction phase, we recommend early planning to maximize resource efficiency and minimize environmental impact. One strategy is to reuse crushed aggregate generated during the demolition process. By repurposing this material on-site, the project can significantly reduce the need to source raw materials externally, leading to cost savings. This approach aligns with sustainable construction practices, as it reduces waste sent to landfills, lowers transportation emissions associated with importing new materials, conserves natural resources and ultimately reduces embodied carbon. Early planning for such resource reuse should be considered.

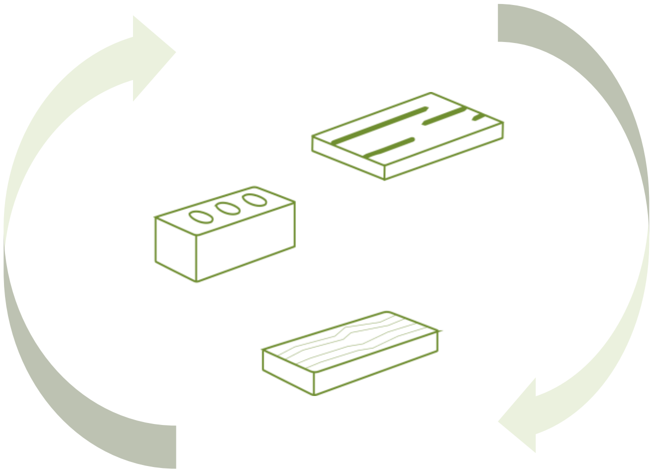


Figure 20: Reuse Materials Diagram

Figure 21: Project Site

[19] https://www.ccme.ca/en/res/crdguidance-secured.pdf

8.0 CLIMATE RESILIENT DESIGN STRATEGIES

8.1 Back-Up Power

Finding opportunities for backup power helps improve resilience during area-wide power outages and is important for the safety and security of Toronto residents. Extreme weather events are expected to increase in frequency and severity and improving backup power in multi-unit residential buildings (MURB) will provide safety and comfort to vulnerable populations and reduce the demand for public services during emergency situations.[20] Toronto's MURBs must meet minimum life safety requirements that ensure a two-hour emergency power supply to support occupant evacuation. However, current codes and standards for emergency power have seen minimal updates over the last 30 years. As a result, these standards do not address the needs of residents during prolonged, area-wide power outages, leaving buildings unprepared to provide residents with any degree of comfort under such conditions. While current regulations focus on supporting safe building evacuation, they fall short in addressing the demands of extended power interruptions.

The City of Toronto released a guideline for improving resilience in MURBs and highlight powering essential loads beyond life safety requirements, ensuring backup power provisions and using gas generators as opportunities.[9] The additional essential loads listed include:

- At least one elevator in addition to the firefighter's designated elevator should be backed up for resident use during a power outage. Especially if the building reaches a height of 43 stories, elevator access during these outage events is essential. For new buildings, backing up a second elevator for resident use can cost $20,000 to $25,000; however, costs decrease for additional elevators such that a third would only cost an additional $10,000. [9]
- Being able to provide water to units for drinking, washing and flushing is essential during extended power outages. Providing both domestic water booster pumps for domestic water costs approximately $15,000.[9]
- Space heating - because the building's proposed design includes boilers, backing up hot water boilers and pumps costs on average $50,000 and can provide substantial value as residents may not need to leave their home during outages.[9]
- Common refuge area: If providing electricity to the entire building is infeasible, providing refuge areas where people can cook, or charge phones is recommended. [9]

Backup power sources, such as battery storage systems are important for running essential components during extended power outages. Battey storage systems can be kept fully charged using electricity from the grid or can be charged via renewable sources. Choosing a battery storage system that is capable of sustaining the building's critical operations and comfort for sustained outages is important. A gas generator with sufficient capacity to meet code regulations and supply all safety equipment is included in the electrical basis of design.

[20] https://www.toronto.ca/wp-content/uploads/2017/11/91ca-Minimum-Backup-Power-Guideline-for-MURBs-October-2016.pdf

8.2 Critical Equipment

The critical equipment at 2343 Eglinton Avenue W will be on the building's roof, enclosed in a mechanical penthouse. Heating boilers, domestic hot water boilers, domestic hot water storage tanks with circulating pump expansion tanks, and chemical treatment stations will be located in the mechanical penthouse of the building. The building's main cooling tower will be located on the roof adjacent to the mechanical penthouse.

Since both systems are located on the roof penthouses, it is essential to insulate the mechanical spaces to prevent extreme heat or cold from impacting the performance of the building's critical equipment. Given the flat roof design, effective drainage is also crucial. Installing robust seals or water barriers around the mechanical penthouses will help prevent water accumulation and protect equipment rooms from potential leaks during heavy rainfall and snowfall. Finally, reinforcing the penthouse structure to withstand high winds, heavy snowfall, and other severe weather events can also ensure the building is implementing climate resilient design strategies. This may involve strengthening the roof and walls or installing wind-resistant doors to ensure the mechanical penthouse remains secure and critical equipment is protected.

8.3 Futureproofing

With the rising temperatures and higher storm levels due to climate change, buildings should be futureproofed to ensure they are protected against adverse weather events. See the Projected Temperature Statistics by 2025 figure to the right for weather events that buildings in Toronto should be equipped to handle.[21]

Projected Temperature Statistics by 2050

- Average annual temperature increases of 4.4. °C.
- Average winter temperature increases by 5.7 °C.
- Mean maximum daily temperature ranges from 33 °C to 44 °C from 2040-2049.

Futureproofing includes investing in energy efficient systems with high performance envelopes and renewable energy. It also entails creating buildings that are climate resilient and can manage floods/ storms via effective building barriers and elevation equipment, and effective drainage systems. Futureproof buildings incorporate passive cooling and heating strategies such as: natural ventilation, the use of materials that naturally absorb heat that can be slowly released to maintain temperature, shading devices, or glass coatings that help restrict direct heat. Futureproof buildings are prepared for extreme weather events with backup power systems, emergency water supplies and designated spaces that can be heated in the case of power outages. Regarding mechanical equipment, the largest opportunity to futureproof and contribute to net-zero building strategies are to remove gas using boilers and chillers and replacing these with more sustainable electrical systems. For additional information on building for resiliency, please visit the Resilience Planning New Construction Checklist [22]

[21] https://www.toronto.ca/legdocs/mmis/2013/pe/bgrd/backgroundfile-55152.pdf
[22] https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/toronto-green-standard/toronto-green-standard-version-3/mid-to-high-rise-residential-all-non-residential-version-3/energy-ghg-resilience-for-mid-to-high-rise-residential-all-non-residential-development/

INVIRO ENGINEERED SYSTEMS LTD.

9.0 IMPROVED ENERGY AND CARBON ANALYSIS

9.1 Tier 2 – Higher Performance Scenario

The case selected for the purpose of this analysis is a building architecturally identical to the proposed development and meets the minimum requirements of the current Ontario building code energy regulations as outlined in SB-10 2017 and meets the Toronto Green Standard v4.0 Tier 2 requirements.

The Tier 2 requirements of TGS v4.0, are a TEUI of 100 kWh/m², a TEDI of 30 kWh/m² and a GHGI of 10 kgCO₂/m². The designed Tier 2 achieved a **TEUI of 76.5 kWh/m²**, a **TEDI of 26.7 kWh/m²** and a **GHGI of 3 kgCO₂/m²**. See Figure 22: Energy Strategy Tier 2 Requirements vs Results, for a summary of the Tier 2 energy model results graphed against the requirements outlined by TGS.

The main design changes from the proposed case include more thermally efficient wall and roofing insulation, from a R 6.9 overall exterior envelop efficiency to R 10; and an original R 30 roof to R 50. The window to wall ratio (WWR) was reduced from 51.5% to 30%. Additionally, the building's primary heating and cooling system was changed from high-efficient boilers & chillers to ground source heat pumps (GSHPs) with a COP of 4.0. For more information regarding the changes made from the proposed case to the Tier 2 Performance scenario please see Appendix A. Note, items highlighted in green indicate a change from the previous tier.

Please see **Figure** 23: Tier 2 Estimated Annual Energy Use Breakdown (kWh), for an estimated break down of the energy use for the Tier 2 performance scenario.

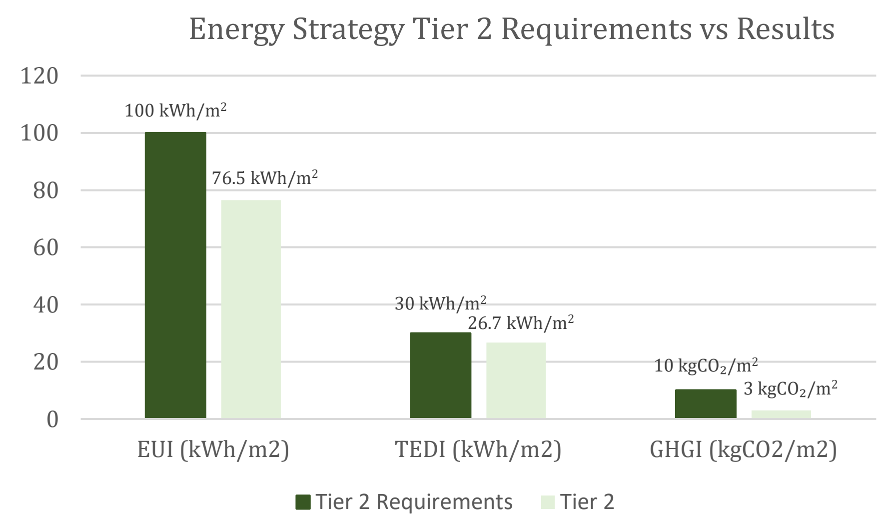


Figure 22: Energy Strategy Tier 2 Requirements vs Results

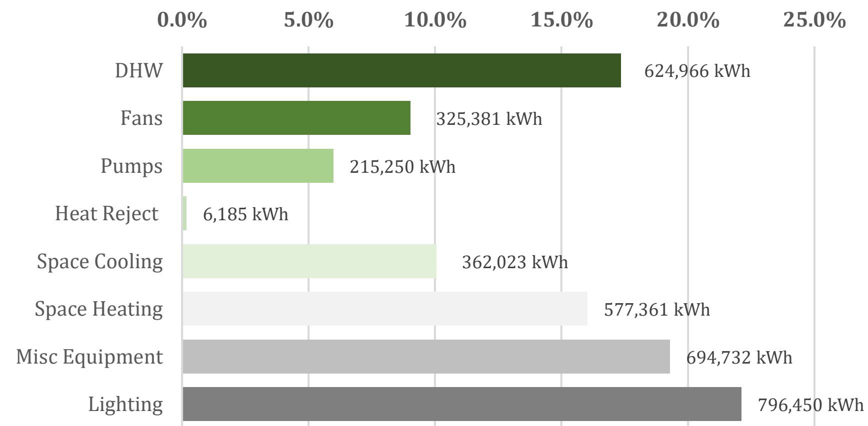


Figure 23: Tier 2 Estimated Annual Energy Use Breakdown (kWh)

9.2 Tier 3 – Near Zero Emissions Scenario

The Near Zero Emissions case selected for the purpose of this analysis is a building architecturally identical to the proposed development and meets the minimum requirements of the current Ontario building code energy regulations as outlined in SB-10 2017 and Toronto Green Standard v4.0 Tier 3 requirements.

The Tier 2 requirements of TGS v4.0, are a TEUI of 75 kWh/m², a TEDI of 15 kWh/m² and a GHGI of 5 $kgCO_2/m^2$. The designed Tier 2 achieved a **TEUI of 69.2 kWh/m²**, a **TEDI of 12.8 kWh/m²** and a **GHGI of 2.6 $kgCO_2/m^2$**. See Figure 24: Energy Strategy Tier 3 Requirements vs Results, for a summary of the tier two energy model results graphed against the requirements outlined by TGS.

The main design changes from the Tier 2 case include more thermally efficient walls, from R 10 overall exterior envelop efficiency to R 25. The building optimized infiltration levels, reducing the amount of heat loss by 50%. Additionally, the building's primary heating and cooling system becomes more efficient with COP values increasing from 4.0 to 5.0 for the ground source heat pumps (GSHPs). Additionally, GSHPs now are used to heat and cool corridors and common area spaces opposed to previously used make-up air units. For more information regarding the changes made from the Tier 2 to the Tier 3 Performance scenario please see Appendix A. Note, items highlighted in green indicate a change from the previous tier.

Please see Figure 25: Tier 3 Estimated Annual Energy Use Breakdown (kWh, for an estimated break down of the energy use for the tier 3 performance scenario.

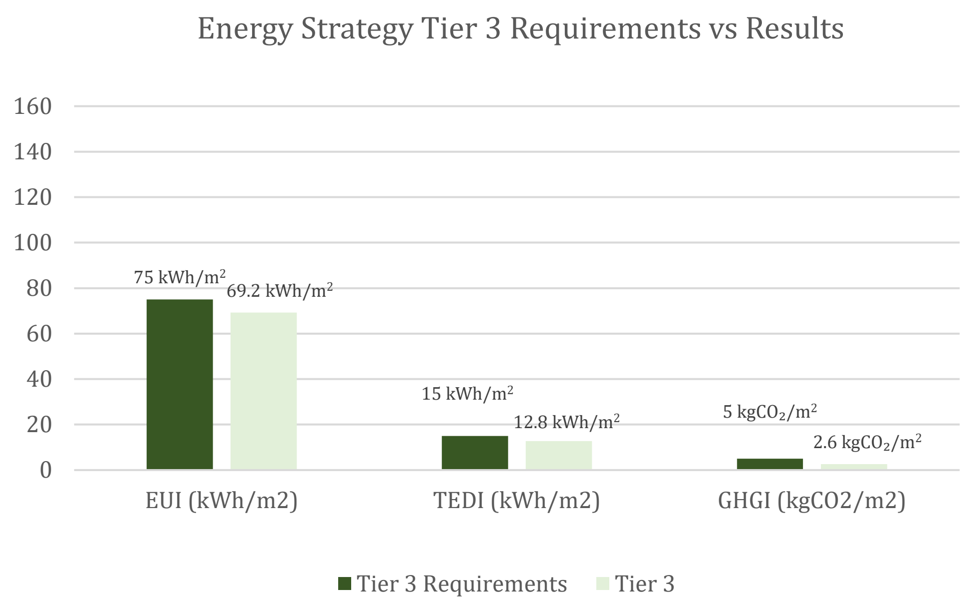


Figure 24: Energy Strategy Tier 3 Requirements vs Results

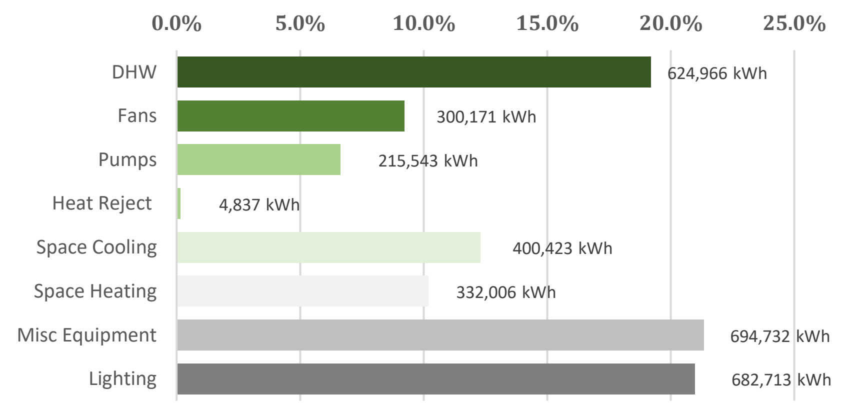


Figure 25: Tier 3 Estimated Annual Energy Use Breakdown (kWh

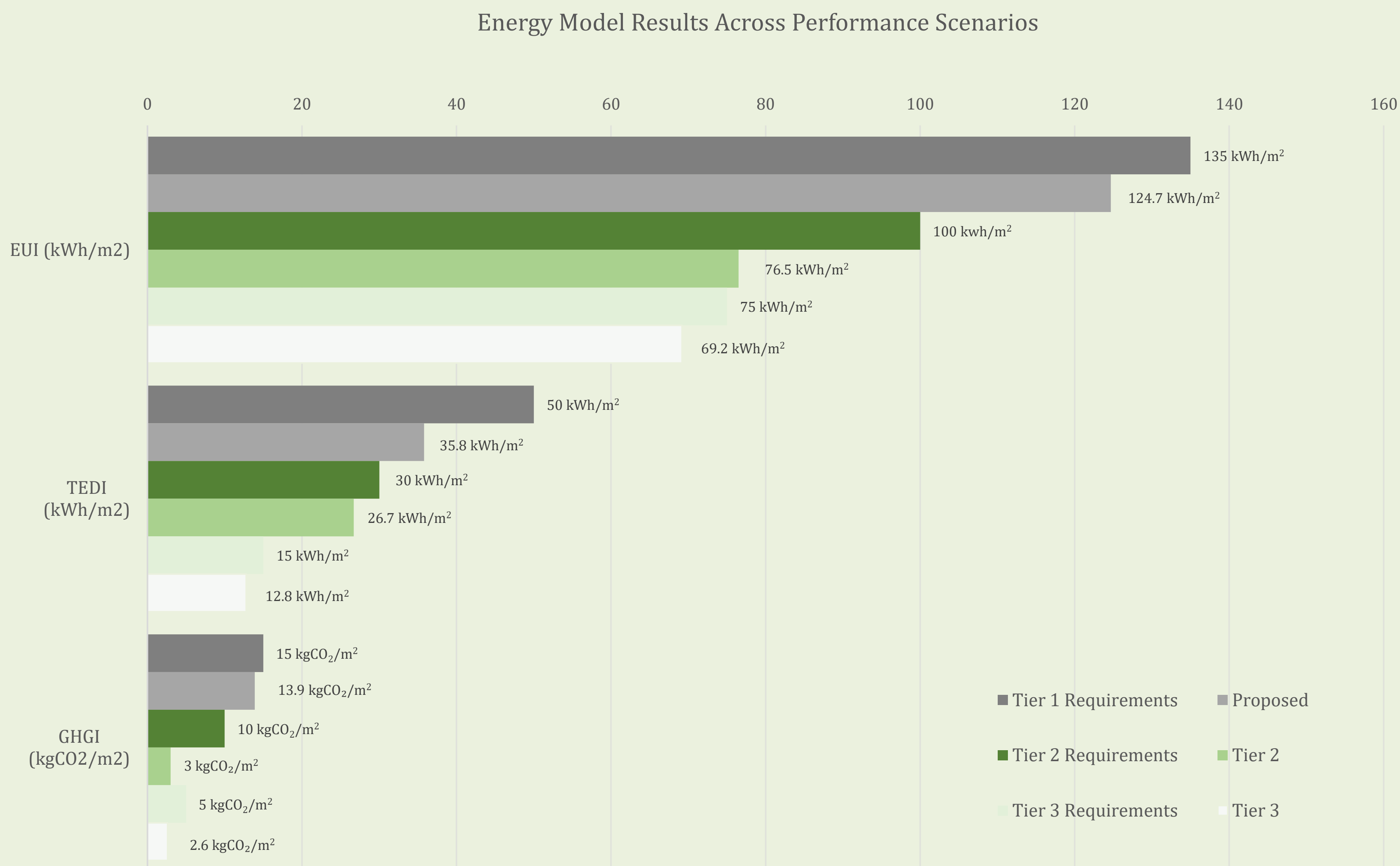


Figure 26: Energy Model Results Across Performance Scenarios

9.3 Proposed Life Cycle Assessment Results

A life cycle assessment was conducted for the proposed building, see below for the total embodied carbon associated with the building ($kgCO_2e$) and the average upfront emissions represented below for stages A1-A5. The proposed case is equivalent to the baseline case with changes made as highlighted in section 7.1 of the report. The main difference between the proposed and baseline case is the use of SCMs in the project's concrete mixes. Please see Appendix B for the results of the proposed LCA conducted for the building.

Proposed Total Embodied Carbon ($kgCO_2e$): **14,332,502 $kgCO_2e$**

Proposed Upfront Embodied Carbon A1-A5 ($kgCO_2e$): **13,909,160 $kgCO_2e$**

Proposed Carbon total ($kgCO_2e/m^2$): **306 $kgco2e/m^2$**

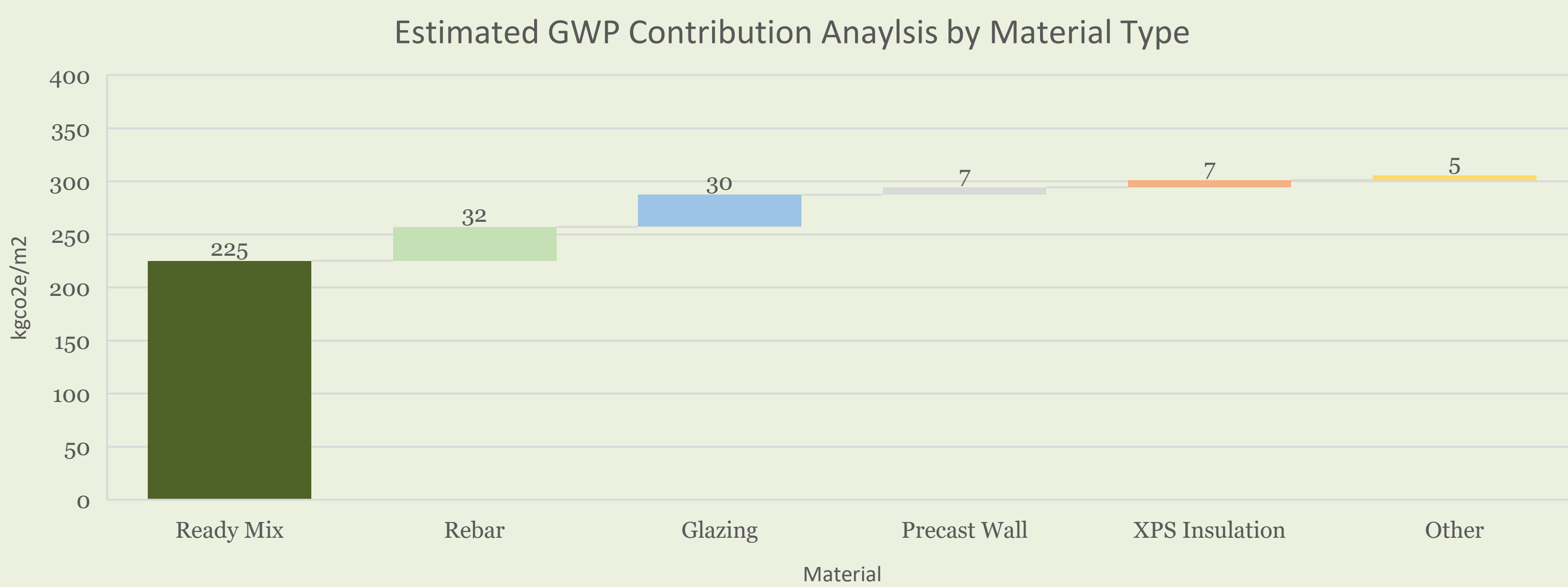
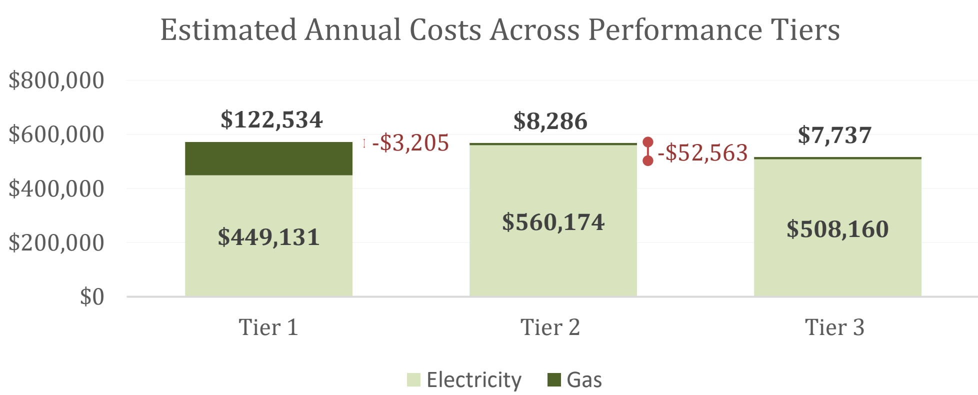


Figure 27: Estimated GWP Contribution Analysis by Material Type for Proposed Case

10.0 COST SAVINGS

10.1 Cost Savings Across Performance Scenarios

Please see the analysis below for an estimation of cost savings across performance scenarios. Figure 28: Performance Tier Associated Operational Costs, shows the annual estimated utility costs associated with each performance tier. As the date of construction is unknown the utility rates applied to the model are an estimate for the cost of electricity and gas for the site; however, rates will change. An average gas rate from Enbridge Gas of 1.1236 $/therm, and electricity rate from Toronto Hydro of 0.1611 $/kwh were selected and added to the energy model to provide estimated operational costs. As shown from the figure below, the highest operational costs are from the Tier 1 performance scenario with an estimated annual cost of $571,665. As Tier 2 relies on heat pump technologies, Tier 2 reduces its reliance on natural gas use and increases its electricity use. Tier 2's annual operational cost is estimated to be $568,460. While the price of electricity is currently higher than gas, it is important to note that the price of natural gas is anticipated to increase with national net zero goals, which would result in higher costs in the Tier 1 performance scenario. When moving from Tier 2 to Tier 3, the building utilizes more thermally efficient assemblies reducing the amount of electricity required to maintain heating and cooling. Tier 3's annual operational cost is estimated to be $515,897. The savings extrapolated over a 30 year period would equate to approximately $96,150 from Tier 1 to Tier 2 and approximately $1,576,890 from Tier 2 to Tier 3.



**Utility rates applied to the model are estimates of the cost of electricity and gas for the site and may not accurately reflect the actual rates for a multi-unit residential building as utility rate structure and energy usage patterns may differ. Market fluctuations, adjustments, and carbon-reduction related policies may also impact utility rates and cost projections.*

Figure 28: Performance Tier Associated Operational Costs

10.2 Development Charge Refund Program

The City of Toronto's Development Charge Refund Program is an initiative aimed to encourage energy efficient development and growth within the City of Toronto. The Development Charge Refund program aims to refund part of the development costs to buildings that build in alignment with the City's goals of zero emissions sooner than 2030[23]. For projects that meet Toronto Green Standard (TGS) Tier 2 or higher, partial refunds are available. Different tiers are associated with different energy and performance goals, and achieving those goals are associated with increasing refund values. See the table below for the estimated refund available for 2343 Eglinton Ave W for meeting Tier 2 (T2) and Tier 3/4 (T3/4) performance goals. An estimated $2,940,743 is available for Tier 2 levels, and $3,528,912 is available for Tier 3/4 levels.

Table 3: Development Charge Refund Costs

Residential	Number of units	Refund per unit (T2)	Refund per unit (T3/4)	2343 Eglinton Ave W Estimated Refund (T2)	2343 Eglinton Ave W Estimated Refund (T3/4)
Single detached and semi-detached	0	$8,336.25	$10,003.51	$0.00	$0.00
Apartment - two bedroom and larger	290	$5,318.71	$6,382.46	$1,542,425.90	$1,850,913.40
Apartment - one bedroom and bachelor	348	$3,627.77	$4,353.31	$1,262,463.96	$1,514,951.88
Multiple (all multiples)	0	$6,760.26	$8,112.33	$0.00	$0.00
Dwelling room	0	$2,258.90	$2,701.99	$0.00	$0.00
Non-Residential	**Ground floor area (m2)**	**Refund per m2 (T2)**	**Refund per m2 (T3/4)**	**2343 Eglinton Ave W Estimated Refund (T2)**	**2343 Eglinton Ave W Estimated Refund (T3/4)**
All uses	2,209.00	$61.50	$73.81	$135,853.50	$163,046.29
Total Refund:				**$2,940,743.36**	**$3,528,911.57**

*Note Tier 2,3 and 4 projects must be third-party verified by a certified registered project evaluator, these evaluators must be hired and retained by the owner at the sole expense of the owner by 50% construction documentation stage. Please see the City's website for the full list of eligibility requirements.

[23] https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/toronto-green-standard/development-charge-refund-program/

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10.3 MLI SELECT

MLI select is a nationwide initiative aimed at offering developers and investors favourable mortgage terms for projects that enhance affordability, accessibility and environmental sustainability. MLI Select uses a point based system where properties are scored based on meeting criteria in three areas. The program offers low borrowing costs, amortization periods, and higher loan-to-value ratios. A minimum of 50 points is required to qualify for the MLI select program that can be achieved through rent agreements, energy efficiency and GHG reductions, or through accessibility measures. Please reference the MLI Select website for point distribution criteria.[24]

For a project to qualify for MLI select, there must be a minimum of 5 units and non-residential space must not exceed 30% of the gross floor area nor 30% of total lending value. 2343 Eglinton Ave W meets both of these eligibility requirements. For a full list of requirements please visit the MLI Select website.[23] Please see the table below for a brief summary of the energy and GHGI savings projected for the project. While the Tier 1 performance path would not be able to claim MLI Select points from energy and GHGI reductions, the Tier 2 performance path would qualify the project for 50 points. The 50 points alone would qualify the project for up to 40 year amortization. Note: energy modelling work done for this report does not reference the same version of NECB as referenced by MLI Select so savings may differ.

Table 4: Energy and GHG Improvement Over Baseline

	EUI Savings	GHGI Savings
Tier 1	8%	7%
Tier 2	43%	80%
Tier 3	49%	83%

New Construction - Point Distribution

Affordability – Rent Levels (10 year affordability commitment[1])			Energy Efficiency and GHGs Reductions over 2017 NECB / 2015 NBC			Accessibility[2]	
50 points	70 Points	100 Points	20 Points	35 Points	50 Points	20 Points	30 Points
10% of units at 30% of median renter income	15% of units at 30% of median renter income	25% of units at 30% of median renter income	20% above code	25% above code	40% above code	Min. 15% of the units are considered accessible in accordance with the CSA standard B651-18 **OR** Min. 15% of units are universal design. **OR** The building receives Rick Hansen Foundation Accessibility Certification (60%-79% score)	Min. 15% of units are considered accessible in accordance with the CSA standard B651-18 and Min. 85% of units are universal design. **OR** 100% of units are universal design **OR** 100% of units are accessible in accordance with the CSA standard B651-18 **OR** The building receives Rick Hansen Foundation Accessibility Certification "Gold" (score of 80% or better)

New Construction - Insurance Flexibilities

	Premium	LTC	DCR[3]	Amortization	Rental Achievement	Recourse or Limited Recourse	Replacement Reserve
Min. 50 pts	Fees and premiums at-a-glance	Up to 95%	Min. 1.1	Up to 40 years	Waived	Recourse	Discretionary
Min. 70 pts				Up to 45 years			
Min. 100 pts				Up to 50 years		Limited-Recourse	

[24] https://www.cmhc-schl.gc.ca/professionals/project-funding-and-mortgage-financing/mortgage-loan-insurance/multi-unit-insurance/mliselect

10.4 Apartment Construction Loan Program

Similar to MLI Select, the Canadian Mortgage and Housing Corporation provides incentives for residential buildings that meet particular sizing, affordability, energy efficiency and accessibility requirements. The loan offered provides a 10-year term and fixed interest rate, up to a 50-year amortization period, and up to 100% loan to cost for residential space and up to 75% loan to cost for non-residential space. At minimum 20% of the units must have rents below 30% of the median total income of all families for that area. Projects must be a minimum of 15% more energy efficient in energy consumption and GHG emissions than the applicable reference model building code. Lastly, at least 10% of the project units must meet or exceed accessibility standards as regulated by local codes. For a full list of eligibility criteria please visit the CMHC website.[25] Important to note – the program requires the project to respond to a need for rental supply, thus the units at 2343 Eglinton Avenue W must be rental apartments and not owned condominiums to pursue this program. The Canadian Mortgage and Housing Corporation (CMHC) has a full list of programs and potential funding options available that are worth exploring for more advantageous funding opportunities.

10.5 Enbridge MURB Program

The affordable multi-unit residential program from Enbridge aims to offer incentives to help buildings upgrade to high-efficiency equipment. The program is aimed towards social and municipal housing providers, shelters and co-oops and eligible multiunit residential buildings. For eligibility, the building will need to demonstrate that at least 30% of units are rented at less than 80% of the median market rent as determined by the Canadian Mortgage and Housing Corporation. The program offers up to $8,000 for on-site energy assessments to be conducted as well as up to $200,000 in incentives for energy-efficient boilers, water heaters, condensing MUAs and more.[26]

10.6 Canada Clean Economy Investment Tax Credits

The government of Canada has enacted four refundable tax credits in Canada for projects targeting clean energy and technology investments.[27] It is recommended that 2343 Eglinton Ave W pursues the following refundable tax credit program if qualifying technologies are used in the final building design: **Clean Technology (CT)**: The Clean Technology ITC aims to promote clean technology investments in Canada by offering a 30% refundable tax credit for eligible property acquired and available for use from 2023, until the end of 2034. It applies to taxable Canadian corporations, including those in partnerships, and covers equipment for renewable energy, zero-emission vehicles, and certain geothermal and nuclear fusion technologies. The Clean Technology ITC has defined timelines and consultation plans for implementation. Taxpayers can claim only one credit per eligible property, and unused credits can result in refunds.

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[25] https://www.cmhc-schl.gc.ca/professionals/project-funding-and-mortgage-financing/funding-programs/all-funding-programs/apartment-construction-loan-program

[26] https://www.enbridgegas.com/ontario/business-industrial/incentives-conservation/programs-and-incentives/retrofits-custom-projects/affordable-multi-family-housing-program#:~:text=Up%20to%20%248%2C000%20per%20building,such%20as%20heat%20reflector%20panels.

[27] https://www.canada.ca/en/revenue-agency/services/tax/businesses/topics/corporations/business-tax-credits/clean-economy-itc.html

11.0 CONCLUSIONS AND RECOMMENDATIONS

The energy strategy report investigated opportunities to reduce energy use and GHG emissions at 2343 Eglinton Avenue W, a multi-unit residential development with light retail uses located in Toronto, Ontario. The proposed model revealed that the gas use for space heating from rooftop boilers will be the largest contributor to the projects annual energy use and operational carbon emissions making it the most important system to address when considering a more efficient building. Furthermore, the assessment showed that concrete use throughout the building will be the largest contributor to total embodied carbon emissions.

The report outlines passive and active strategies to improve building performance, reduce energy consumption and reduce carbon emissions. These strategies include: connecting to potential district energy systems; renewable energy opportunities; alternative mechanical systems such as geo exchange, heat recovery, and air-to-water source heat pumps; best practice commissioning; airtightness and metering strategies; enhanced enclosure strategies for further heat retention; and massing and form changes. Material assessments were conducted to provide potential reductions in carbon emissions if low-carbon material alternates were utilized.

The building's improved performance scenarios showed that replacing the natural gas heating with more efficient heat pumps can provide significant performance improvements. Upgraded mechanical systems, reduced window to wall ratio, and more efficient/ thicker insulation can all work to improve the building performance. For the building to be Near Zero ready, on-site renewable energy strategies should be considered, as well as electrifying building equipment. The project team should further prepare the development for connection to a district energy system by following the City of Toronto's Design Guidelines for District Energy Buildings as outlined in Section 6.2.5.

The LCA conducted for the building showed how low-carbon concrete mixes can provide significant reductions in embodied carbon throughout the building's life cycle. Ultimately, any structural changes towards low-carbon materials yield the greatest opportunity for reducing embodied carbon. The report showed that concrete will ultimately contribute the most to the building's embodied carbon emissions and any strategies to reduce the amount of concrete required will reduce emissions for the building. As the building design is further developed, it is recommended to complete a more in-depth Life Cycle Assessment with product specific EPDs to better understand the building's embodied carbon emissions.

Ultimately, the building is already engaging in many sustainable design and development practices; however, to further aid in the fight against climate change, Tier 2 or Tier 3 performance tiers should be considered and material alternatives to more sustainable and less carbon intensive products should be used.

12.0 APPENDECIES

12.1 Appendix A

General			
Total Simulated Area (sqft)	596,995.40	**Schedules**	NECB 2015, Part 8 Operating Schedule A, K, G and C
Location and Weather File	Toronto, ON / Climate Zone 5 CWEC\CAN_ON_TORONTO-INTLA_6158731_CWEC.bin	**Outside Air (OA) Requirements**	As per values provided by the mechanical designer
Primary Space Types	Residential, Retail		

Model		**Proposed**	**Tier 2**	**Tier 3**
Building Envelope (Imperial Unit)				
Exterior Wall		Metal panel - R26.97 - Nominal Precast - R26.97 - Nominal Spandrel - R18.8 - Nominal Walls will be derated as per BC Hydro Building Envelope Thermal Bridging Guide **Overall Wall is R-6.9**	10	25
Roof		RSI 5.28, R30	50	50
Floors exposed to Parking		R-20	R-25	R-25
External Glazing U-Value		0.302	0.302	0.302
Overall Window - Wall Ratio (WWR) As per Architectural takeoff		51.5%	30%	30%
Solar Heat Gain Coefficient		0.4	0.4	0.4
Infiltration Rate cfm/ft2 wall and roof area at .02 in w.c. (5 Pa)		0.05 (prescribed by NECB 2015, 8.4.3.3. (3))	0.05	0.025
Plant Level				
Domestic Hot Water	Heating Source	Domestic hot water will be supplied by two 90%- highly efficient condensing gas-fired boilers. A recirculation line from each riser	ASHP (4.58 COP) preheat to 100°F + Natural Gas Boiler (80% eff.) to 140°F	ASHP (4.58 COP) preheat to 100°F + Natural Gas Boiler (80% eff.) to 140°F
	Heating Type	Tanked	Tanked	Tanked

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Flush/Flow Rates		Public Lavatory Faucet 1.9 lpm Private Lavatory Faucets 8.3 lpm Kitchen Faucets: 8.3 lpm Showerheads: 9.5 lpm The DHW load will be calculated as per NECB modified by SB-10 with a 30% reduction	Public Lavatory Faucet 1.9 lpm Private Lavatory Faucets 8.3 lpm Kitchen Faucets: 8.3 lpm Showerheads: 9.5 lpm The DHW load will be calculated as per NECB modified by SB-10 with a 30% reduction	Public Lavatory Faucet 1.9 lpm Private Lavatory Faucets 8.3 lpm Kitchen Faucets: 8.3 lpm Showerheads: 9.5 lpm The DHW load will be calculated as per NECB modified by SB-10 with a 30% reduction
System Level				
Residential Suits and Amenities	**System**	Boiler and Chiller with Four Pipe Fan Coil Units complete with ERV to provide heating and cooling to suites	Ground source heat pump complete with ERV to provide heating and cooling to suites	Ground source heat pump complete with ERV to provide heating and cooling to suites
	Heating	Hot water loop with gas boilers, 96% efficient	Ground source heat pump, 4.0 COP	Ground source heat pump, 5.0 COP
	Cooling	System Cooling Tower - Water-cooled chiller with 5.6 COP	Ground source heat pump, 5.6 COP	Ground source heat pump, 5.6 COP
	Heat Recovery	75% efficient ensuite ERVs	75% efficient ensuite ERVs	75% efficient ensuite ERVs
	Fan energy	0.000445 kW/cfm	0.000445 kW/cfm	0.000445 kW/cfm
Corridors and Common Areas	**System**	MAU furnace heating + direct expansion cooling	MAU furnace heating + direct expansion cooling	MAU furnace heating + direct expansion cooling
	Heating	Furnace 90% efficient	Condensing gas furnace 95% efficient	Ground source heat pump, 5.0 COP
	Cooling	Direct expansion cooling 3.5 COP	Direct expansion cooling 3.5 COP	Ground source heat pump, 5.6 COP
	Heat Recovery	No heat recovery	No heat recovery	No heat recovery
	Fan energy	0.000832 kW/cfm	0.000749 kW/cfm	0.000749 kW/cfm
Retail Area	**System**	Boiler and Chiller with Four Pipe Fan Coil Units to provide heating and cooling to suites	Ground source heat pump complete with ERV to provide heating and cooling to suites	Ground source heat pump complete with ERV to provide heating and cooling to suites
	Heating	Hot water loop with gas boilers, 96% efficient	Ground source heat pump 4.0 COP	Ground source heat pump, 5.0 COP
	Cooling	System Cooling Tower - Water-cooled chiller with 5.6 COP	Ground source heat pump 5.6 COP	Ground source heat pump, 5.6 COP
	Heat Recovery	No heat recovery	75% effective ERVs	75% effective ERVs
	Fan Energy	0.000832 kW/cfm	0.000749 kW/cfm	0.000749 kW/cfm

	Ventilation Control	N/A	DCV in commercial retail	DCV in commercial retail
Space Level				
Lighting Power Density (LPD)	Building Area Method with 30% reduction from SB-10 2017 Multi-Unit Residential: .48 W/ft^2 Elec/Mechanical: 0.30 W/ft^2 Lobby Other: .32 W/ft^2		Building Area Method with 30% reduction from SB-10 2017 Multi-Unit Residential: .48 W/ft2 Elec/Mechanical: 0.30 W/ft2 Lobby Other: .32 W/ft2	Building Area Method with 30% reduction from SB-10 2017 Multi-Unit Residential: .48 W/ft2 Elec/Mechanical: 0.30 W/ft2 Lobby Other: .32 W/ft2
Equipment Power Density (EPD)/ Receptacle	Residential: .46 W/ft2 Retail: .23 W/ft2 Lobby Other: .09 W/ft2 Corridors: 0 W/ft2		Residential: .46 W/ft2 Retail: .23 W/ft2 Lobby Other: .09 W/ft2 Corridors: 0 W/ft2	Residential: .46 W/ft2 Retail: .23 W/ft2 Lobby Other: .09 W/ft2 Corridors: 0 W/ft2

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12.2 Appendix B

Embodied Carbon Breakdown by Life-Cycle Stage					
Lifecycle stage			Baseline Carbon Emissions (kgCO2e)	Proposed Carbon Emissions (kgCO2e)	Improvement Over Baseline (kgCO2e)
Upfront	Product	A1 Raw Material Supply A2 Transport (to factory) A3 Manufacturing	12,509,778.38	11,550,210.13	7.67%
	Construction	A4 Transport (to site)	1,816,628.63	1,816,628.63	0.00
		A5 Construction & Installation	580,703.93	542,321.20	6.61%
Total Upfront Carbon			**14,907,110.94**	**13,909,159.96**	**6.69%**
Use		B1 Use	N/A	N/A	N/A
		B2 Maintenance	N/A	N/A	N/A
		B3 Repair	N/A	N/A	N/A
		B4 Replacement B5 Refurbishment	16,778.56	16,778.56	0%
Total Use Embodied Carbon			**16,778.56**	**16,778.56**	**0%**
End of life		C1 Demolition	N/A	N/A	0%
		C2 Transport (to disposal)	333,826.70	333,826.70	
		C3 Waste Processing	72,672	72,672	
		C4 Disposal	64.91	64.91	
Total End of Life Carbon			406,563.15	406,563.15	0%
Total			**15,330,452.65**	**14,332,501.67**	**6.51%**

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