REPORT

1373-1389 GORDON STREET

ENERGY STRATEGY REPORT: ISSUED FOR OFFICIAL PLAN AMENDMENT AND ZONING BY-LAW AMENDMENT

PROJECT #2200802
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SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI was retained by Reid's Heritage Properties to prepare an energy strategy report for the 1373-1389 Gordon Street development in Guelph, Ontario. The project consists of a multi-unit residential building with top level commercial office and at-grade commercial retail (see Figure 1). The proposed total gross building area is 10,673 m^2.

This assessment was completed to support the Official Plan Amendment and Zoning By-Law Amendment submissions and show alignment with the Community Energy Initiative.

RWDI has explored how differing energy efficiency strategies may be of benefit to the project. The intent of this exploration is to provide strategic energy options for the project at an early stage, and to identify the steps that should be explored to reduce energy use, ultimately striving towards a near-zero emissions level of performance.

This report should act as a roadmap towards enhanced levels of performance. Particular focus was placed on absolute performance targets for total building energy use, thermal energy demand, and greenhouse gas emissions. These are important metrics in achieving a net zero carbon community by 2050. In addition to energy saving strategies, this report has provided recommendations on how to implement climate resilient design to account for the expected changes in the local microclimate.

This energy strategy identifies a number of interesting opportunities that will continue to be explored by the project team. However, pursuit of opportunities will need to be balanced with the risks of implementing non-traditional development solutions. As such, the implementation of identified opportunities will likely require a collaborative effort between the developers of this project and the City to de-risk the less-conventional development solutions.

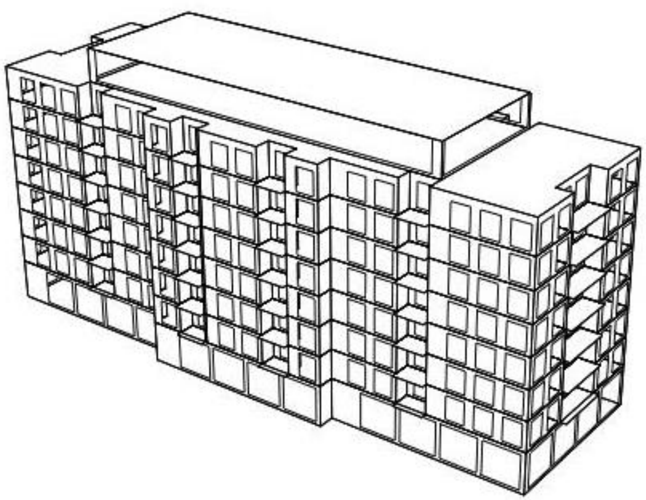

Figure 1: Model of proposed 1373-1389 Gordon Street project

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1. INTRODUCTION

1.1 PLANNING FOR A SUSTAINABLE FUTURE

More than ever before, climate change and greenhouse gas (GHG) emissions are a priority on the agenda at all levels of government in Canada. In October 2019 the City of Toronto declared a climate emergency, accelerating its commitment to becoming net-zero before 2050. Similarly, the City of Guelph through the Community Energy Initiative has set a net zero carbon community goal by 2050. As the goals align, this report follows a pathway laid out by the City of Toronto's Green Standard to set metrics and pathways to achieve this low carbon goal. While not directly applicable or required for developments in Guelph, are nonetheless a helpful point of reference for this development moving forward.

In 2017, buildings in Toronto were responsible for 7.9 million tonnes of equivalent carbon emissions (CO_2e), as reported in the TransformTO Implementation Update. This represents 52% of the City's GHG emission inventory and quantifies the important role that buildings will play in Toronto's goal to become a low-carbon city.

Further, the Implementation Update notes that natural gas consumption accounts for 94% of the building-related emissions (see Figure 2). The link between a low-energy development and a low-carbon development is the GHG intensity (i.e. CO_2e/kWh) of the fuels consumed. In Ontario, the GHG intensity of natural gas is four times greater than that of electricity. While the electricity grid continues to reduce its GHG intensity by increasing its renewable and low-carbon energy sources, the GHG intensity of natural gas remains unchanged.

This energy strategy report will explore opportunities for the proposed development to reduce its energy use and GHG emissions. The focus on carbon will be balanced, however, by the economic challenge presented by the fuel-cost disparity: the cost of electricity is over five times greater than that of natural gas.

Beyond GHG emissions, it is important to consider that buildings designed today will have to accommodate an alternative climate future. Renewable energy and climate resilience will have to become part of the design process.

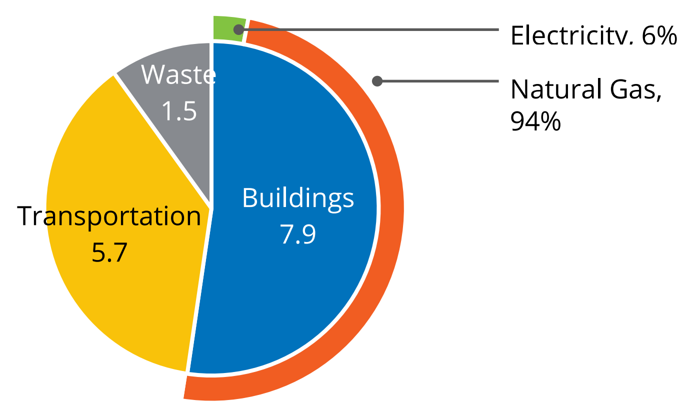


Figure 2: City of Toronto GHG Emissions in 2017 (in million tonnes CO_2e)

1.2 GREEN DEVELOPMENT STANDARD

The Toronto Green Standard (TGS) Version 3 and Zero Emissions Building Framework outline the sustainable design requirements for all new developments in Toronto. The energy efficiency requirements of TGS are aligned with the City of Toronto's 2050 GHG emission reduction targets (see Figure 3), ensuring that low-carbon design principles are integrated into new developments.

There are four tiers of performance under the TGS V3. Tier 1 is a minimum requirement for all new planning applications, while

Tiers 2 through 4 incentivize higher performance on a voluntary basis. The Tiers are projected to become increasingly stringent over the next ten years as the TGS is renewed, shown in Table 1.

As the proposed design progresses, additional energy modelling will be required to ensure alignment with the absolute performance targets in effect at the time of the development's Site Plan Control Application submission.

Table 1: City of Toronto's TGS plan for energy targets

	Tier 1	Tier 2	Tier 3	Tier 4
	Minimum Performance	Incentivized Higher Performance		
Current	V3 Tier 1	V3 Tier 2	V3 Tier 3	V3 Tier 4
2022	V3 Tier 2	V3 Tier 3	V3 Tier 4	
2026	V3 Tier 3	V3 Tier 4		
2030	V3 Tier 4			

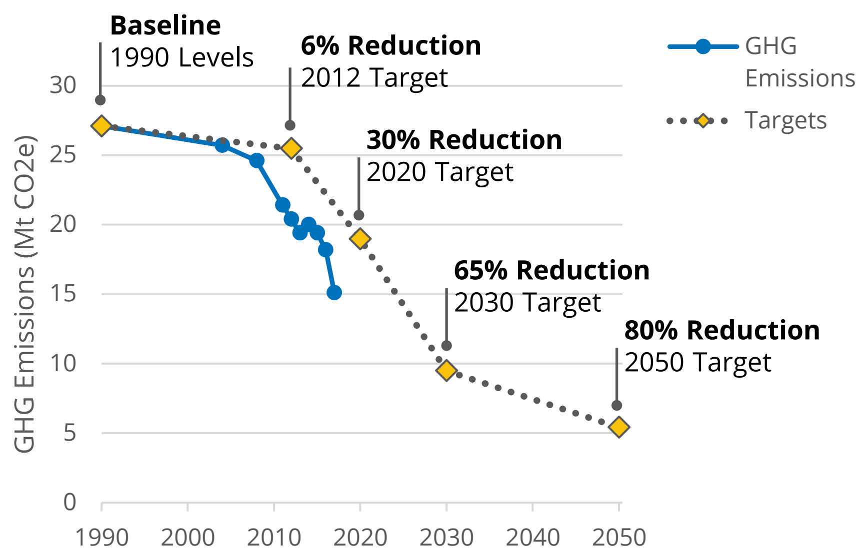


Figure 3: City of Toronto GHG Emissions and Targets

1.3 TGS PERFORMANCE METRICS

There are three metrics used by the TGS to indicate a building's absolute energy performance:

- **Total energy use intensity (TEUI)**: This metric measures the energy consumed by the building each year (in ekWh) normalized by the conditioned floor area (in m^2). A lower TEUI indicates a more energy efficient building.
- **Thermal energy demand intensity (TEDI):** This metric measures the annual heating energy required for a building to maintain a stable, pre-defined interior temperature (in kWh) normalized by the conditioned floor area (in m^2). A lower TEDI is achieved by designing a high-performance building envelope and using energy recovery ventilation units.
- **Greenhouse gas intensity (GHGI):** This metric looks at the annual GHG emissions of a building (in kg CO_2e) based on the fuel-specific emission factors, normalized by the conditioned floor area (in m^2). This metric encourages the use of highly efficient, lower-carbon emitting fuels.

TGS V3 identifies performance targets at each Tier level, based on the following building use types: High Rise Residential, Low Rise Residential, Commercial Office, or Commercial Retail. Energy performance targets for this development have been calculated using an area-weighted average of the relevant building use types. The resulting targets for the development are listed in Table 2; these targets have been used for the development of this energy strategy.

Table 2: TGS v3 Energy Performance Targets for 1373-1389 Gordon Street

	TEUI ($ekWh/m^2$)	TEDI (kWh/m^2)	GHGI ($kg\ CO_2e/m^2$)
Tier 1	170	70	20
Tier 2	134	48	15
Tier 3	100	29	10
Tier 4	74	15	5

1.4 METHODOLOGY

The following key steps were applied by RWDI in preparing this energy strategy:

1. **Develop and utilize archetype energy models** representative of the proposed project. The proposed development is comprised of the following building archetypes, as shown in Figure 4:
   1. High Rise Residential
   2. Commercial Office
   3. Commercial Retail

2. **Identify the top Energy Conservation Measures (ECMs)** that should be considered for the project to achieve three levels of performance:
   I. Baseline Performance – equal to Tier 1 of TGS v3;
   II. High Performance – equal to Tier 2 of TGS v3; and
   III. Near-zero Emissions – equal to Tier 4 of TGS v3.

   Quantify the impact of these ECMs on site-wide energy and greenhouse gas emissions.

3. **Consider low-carbon opportunities for the project,** including on-site renewable energy and district thermal energy networks.

4. **Make recommendations based on the results of the analysis.**

This energy strategy was prepared using the preliminary density and built form concepts using '1373-1389 Gordon Street_Floor Plans' dated Oct 25th, 2021 . RWDI has used the energy modelling tool IES Virtual Environment 2018 to develop this analysis. A summary of the energy modeling inputs can be reviewed in Appendix A.

Note that "actual experience will differ from these calculations due to variations such as occupancy, building operation and maintenance, weather, energy use not covered by this standard, changes in energy rates between design of the building and occupancy, and precision of the calculation tool." [ASHRAE 90.1 - 2016, 11.2 Informative Note].

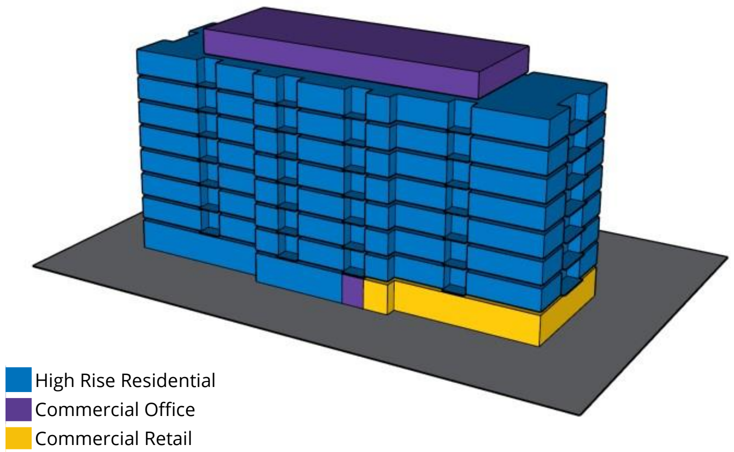


Figure 4: Project Geometry with Modelled Archetypes

2. PROJECT ANALYSIS

2.1 BASELINE PERFORMANCE: ENERGY CONSERVATION MEASURES AND RESULTS

An initial goal of a new development should be to meet the energy performance targets of TGS v3 Tier 1 across all three performance metrics: TEUI, TEDI, and GHGI. This is therefore considered the baseline level of performance for the development.

A package of design strategies and energy conservation measures has been employed in the energy model to achieve this baseline performance. The energy conservation measures included in this package have been selected to prioritize low-cost upgrades and best practice design in Ontario. The results for each of the TGS metrics are shown in Figure 5, below.

The key strategies in this package are:

1. Optimize window placement to achieve a gross window-to-wall ratio of 50%.
2. Specify high-performance mechanical plant equipment including condensing boilers, variable frequency drive centrifugal chiller, and cooling tower with variable speed drive fan.
3. Use heat recovery ventilation units with 65% sensible effectiveness to provide pre-conditioned fresh air to Residential suites.

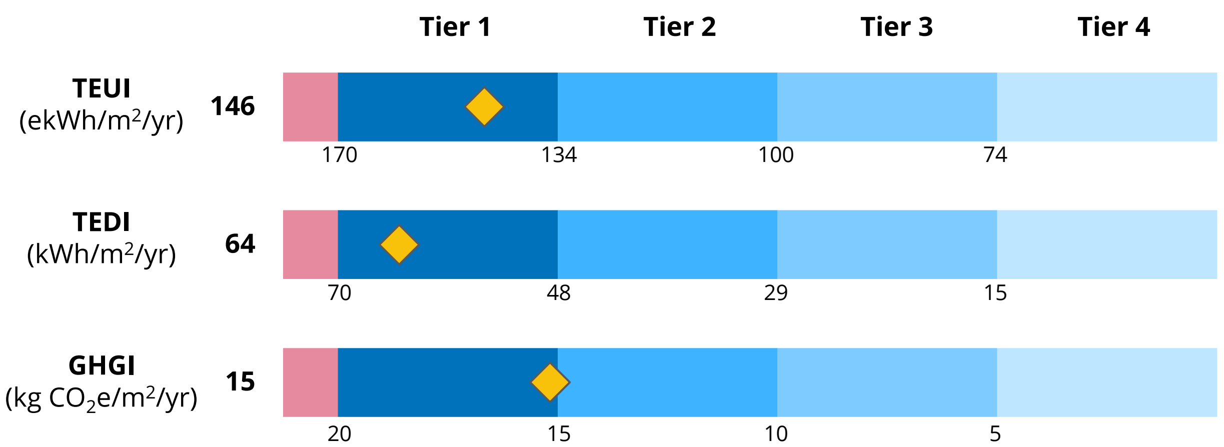


Figure 5: Baseline Performance Package Results

2.2 HIGH PERFORMANCE: ENERGY CONSERVATION MEASURES AND RESULTS

Performance beyond TGS Tier 1 is incentivized through partial development charge refunds. Reaching the energy performance targets of Tier 2 across all performance metrics will require the building design to go beyond typical practice in Ontario. A development that achieves the Tier 2 targets is therefore considered High Performance.

A package of design strategies and energy conservation measures has been employed in the energy model to demonstrate this high performance. The results for each of the TGS metrics are shown in Figure 6, below.

The key strategies in this package are:

1. Switch Office and Retail systems to dedicated outdoor air system with zone-level fan coil units. Ventilation to be provided via energy recovery ventilation (ERV) units with 65% sensible and 60% latent effectiveness.
2. Upgrade Residential in-suite ventilation units to ERV with 75% sensible and 70% latent effectiveness. Demand control to reduce on corridor make-up air during off-peak hours.
3. Enhance envelope performance, including increased thermal break in window frame systems.
4. Specify best-in-class electronically commutating (EC) motors for ERV and fan coil unit fans in residential suites.

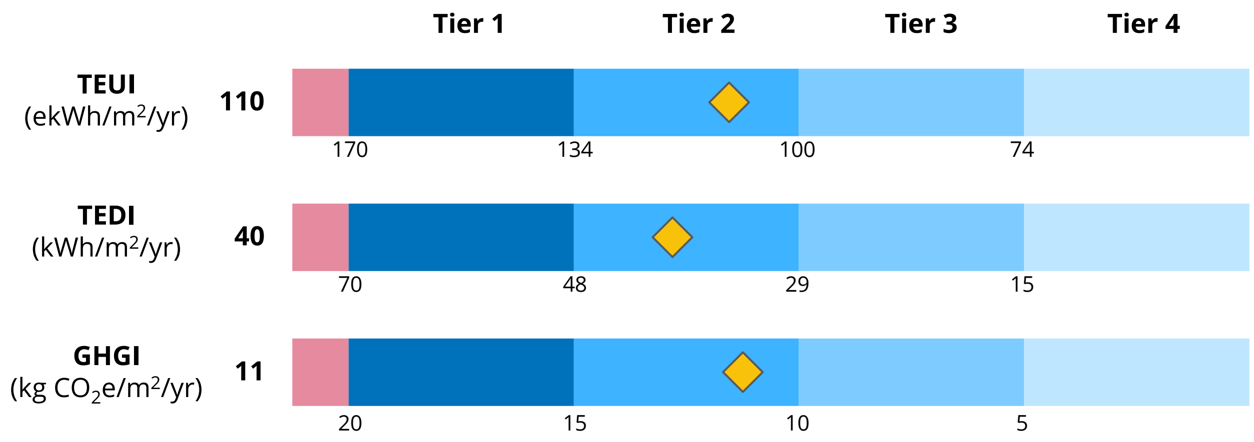


Figure 6: High Performance Package Results

2.3 NEAR-ZERO EMISSIONS: ENERGY CONSERVATION MEASURES AND RESULTS

Moving the building design toward a near-zero emissions level of performance requires fuel-shifting away from natural gas in favour of Ontario's low-carbon electricity grid. In addition, energy efficiency measures must be considered a priority in all aspects of the building design to reach the TGS Tier 4 targets. This level of performance would position the development as a leader in decarbonization in Ontario.

A package of design strategies and energy conservation measures has been employed in the energy model to demonstrate this near-zero emissions performance. The results for each of the TGS metrics are shown in Figure 7, below.

The key strategies in this package are:

1. Switch to a variable refrigerant flow (VRF) system with heat recovery for all building heating and cooling systems (Commercial, Retail, and Residential), achieving seasonal COPs of 3.0 and 4.5 respectively.
2. Maximize the building envelope performance with a focus on air tightness in enclosure details and during construction.
3. Design Office and Retail ventilation systems to maximize distribution of fresh air to the occupied zone using displacement ventilation.
4. Preheat domestic hot water (DHW) using a drain water heat recovery system, and switch DHW heating to an air-source heat pump unit.

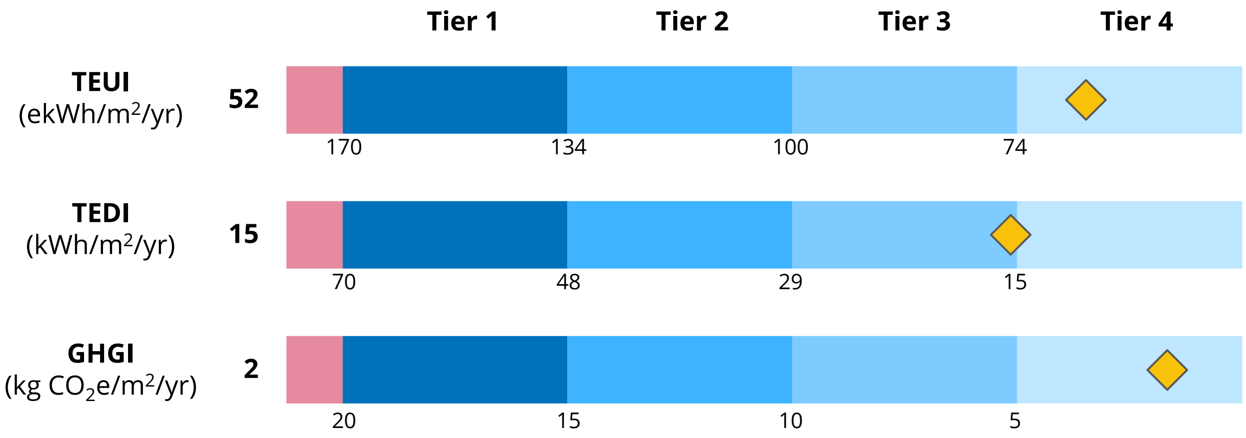


Figure 7: Near-Zero Emissions Package Results

2.4 SUMMARY OF RESULTS

The results from the energy conservation and demand management strategies presented in the previous pages are visualized on the following pages. The detailed assumptions used for each package are listed in Appendix A. The GHG emission factors and unit energy costs used to develop these results are listed in Table 3.

The energy use of each ECM package is shown broken down by energy end-use intensity in Figure 8 below. Table 4 expresses the results in terms of four key metrics: total energy consumption, TEUI, GHGI and TEDI. Figure 9 on the following page further breaks down the results according to the development phases that have been identified in the site plan and statistics.

This combination of metrics and visualizations allow the project team to balance goals and priorities across energy conservation opportunities to find a strategy that is optimal for the development. As well, understanding the contribution of each building type within the whole development guides prioritization towards the opportunities with greatest potential impact.

Table 3: Analysis Factors by Fuel-Type

Factor	Electricity	Natural Gas
GHG Emissions Factors*	0.029 kg CO_2e/kWh	0.162 kg CO_2e/kWh

*GHG Emission factors are based on 2016 inventory being completed as part of the Community Energy Initiative update, and the subject of the City of Guelph's Energy and Greenhouse Gas Emissions report.

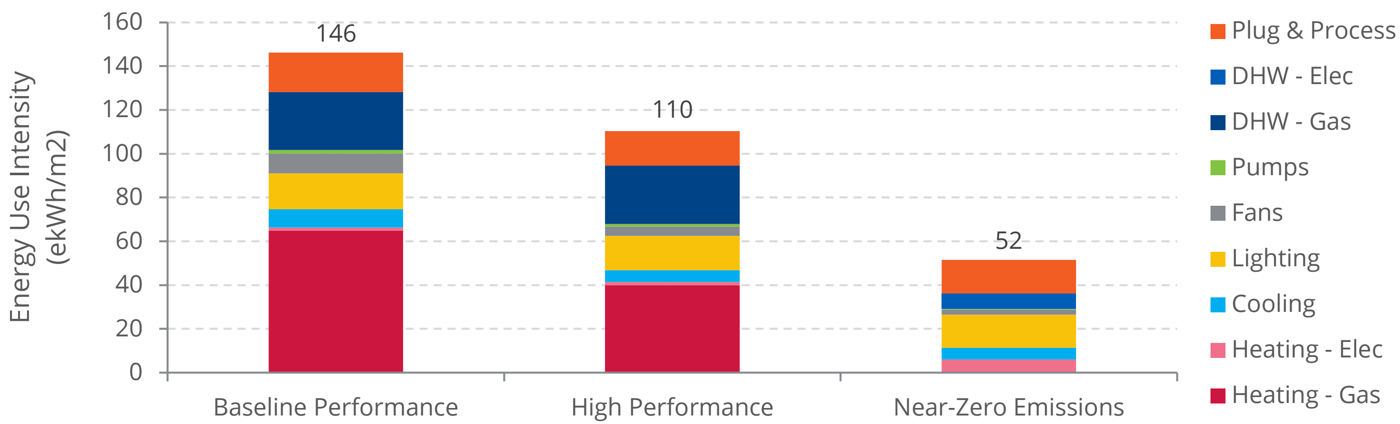


Figure 8: Energy End-Use Breakdown

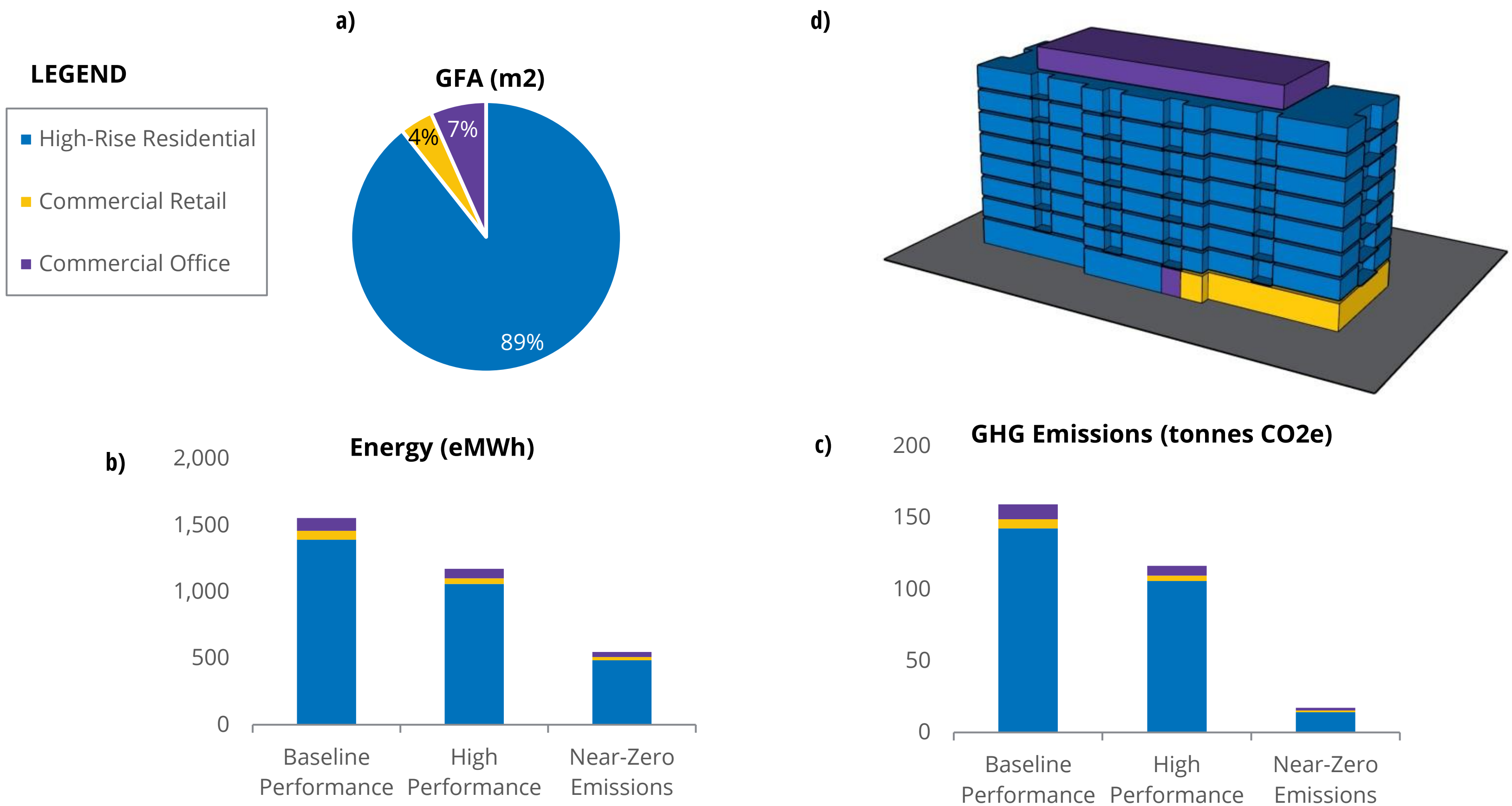
2.4 SUMMARY OF RESULTS

Table 4: Site-level Performance Results

Performance Metric	Unit	Baseline Performance	High Performance	Near-Zero Emissions
Total Energy	ekWh	1,555,000	1,173,100	548,100
TEUI	ekWh/m^2/yr	146	110	52
Energy Savings	%	--	25%	65%
TEDI	kWh/m^2/yr	64	40	15
TEDI Savings	%	--	37%	76%
GHGI	kg CO_2e/m^2/yr	15	11	2
GHGI Savings	%	--	27%	89%
TGS v3 Performance Tier		Tier 1	Tier 2	Tier 4

2.4 SUMMARY OF RESULTS

Figure 9: a) Breakdown of Development Site Gross Floor Area by Archetype, b) Energy Results, c) GHG Emissions Results, d) Modelled Geometry by Archetype

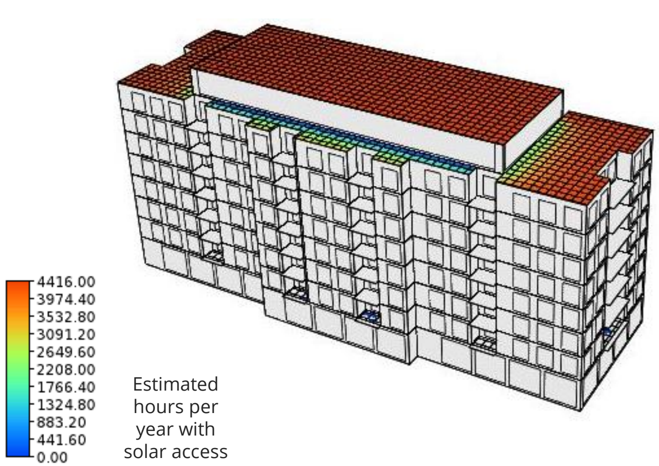


3.1 ON-SITE RENEWABLES

After reducing the total energy consumption requirements for the building by 65% over the Baseline Design, this energy strategy now considers the application of renewables to offset the remaining energy use of the Near-Zero Emissions model.

Rooftop solar photovoltaic (PV) potential was explored using the National Renewable Energy Laboratory's (NREL) PVWatts Calculator. This strategy assigns the mechanical penthouse and general rooftop area to solar PV array for a conservative total area of 665 m^2 (Figure 10). Using site-specific solar radiation information and the PVWatts calculator it was estimated that 166,411 kWh of energy could be generated on-site, annually. While this is significant, it would still only offset 30% of the Near-Zero Emissions model's total energy use (548,100 kWh) and is therefore insufficient to reach a net-zero level of performance using on-site renewable generation.

PV Suitability Analysis



Viable PV Locations Highlighted

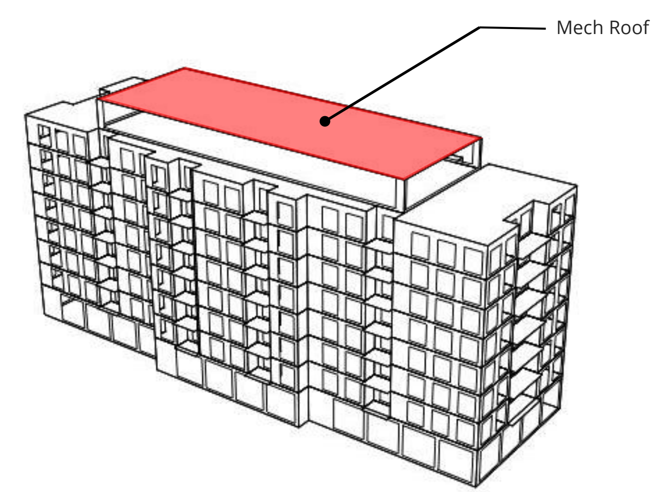


Figure 10: Solar radiation potential on the building

3.2 OFF-SITE RENEWABLES

Although on-site solar PV generation will not generate sufficient energy for the development to reach a net-zero level of performance, off-site carbon offset strategies could also be considered.

The area of solar generation that would be required to fully offset the energy requirement and carbon emissions of the development can be determined by comparing the PV system size to the total energy requirement of the building.

The PVWatts calculator results for on-site solar PV suggest a generation potential of 250 kWh/m^2–year in the Guelph climate. The quantity of solar PV required to offset the remaining energy consumption of the Near-Zero Emissions model (381,689 kWh) can then be calculated by dividing the energy consumption by the generation potential. This equates to a solar PV system area of 1,526 m^2.

This is not an insignificant area, and it would not likely be feasible to install this much solar capacity in downtown Guelph, yet the area is comparable to existing solar farms in rural Ontario. An example of such a solar farm is presented in Figure 11. Developments like this could consider taking advantage of Ontario's abundant rural areas where large-scale solar farms are possible to achieve a net-zero carbon level for the project through off-site solar generation. At present, however, there are minimal incentives to encourage developments to consider such large scale strategies, making their pursuit unlikely to be feasible.

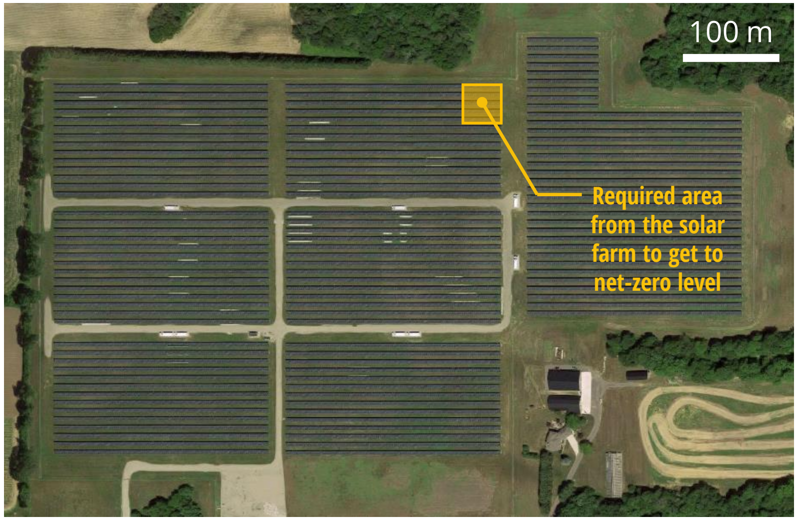


Figure 11: The area of off-site generation required by the development (yellow rectangle) overlaid on the Silvercreek Solar Park, found near Aylmer Ontario (image Courtesy of Google Earth™).

3.3 DISTRICT ENERGY & CHP

District energy systems (DES) use a centralized plant to generate and distribute energy for many buildings, in the form of thermal energy for heating and cooling, and/or electricity. By collaborating, a group of buildings can find an economy of scale that may provide the following benefits:

1. Increased efficiency at the plant level;
2. Reduced energy consumption by sharing waste thermal energy between buildings with different load profiles;
3. Potential reduction in capital costs;
4. Streamlined maintenance and future equipment upgrades with one central plant instead of several smaller plants; and
5. Flexibility to divide energy generation across a number of energy sources, and add future capacity as required.

There are a number of existing district energy systems in Guelph (downtown core and Hanlon Creek Business Park). Although these are not accessible by the current project, DES connection should be considered if the opportunity presents itself.

Some examples of low carbon intensity energy sources for a DES include a central geothermal field, a combined heat and power plant, and bio-fueled boilers.

Importantly, district energy should not be confused with renewable energy or low-CO_2e energy sources. Unless the fuel choice at the district central plant has a lower carbon intensity than that which is proposed at the building level, there is no CO_2e benefit to considering a district energy approach. In fact, there may be a penalty as a result of distribution losses.

Figure 12 below illustrates that there is no potential DES near the proposed site.

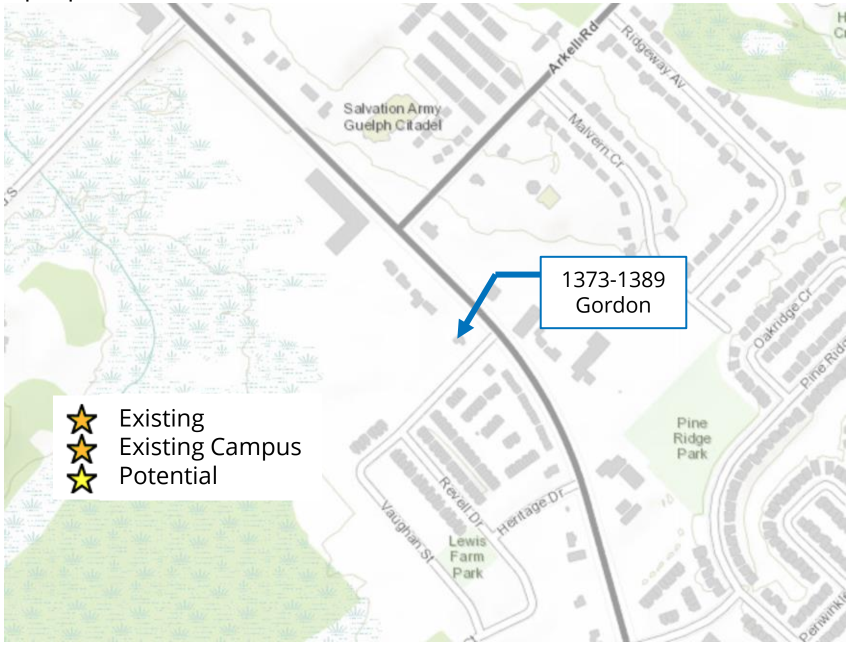


Figure 12: Nearby DES Infrastructure

3.4 EMBODIED CARBON

It is important to note that this GHG inventory only considers the operational GHG emissions of the building, and does not account for the emissions associated with the construction of buildings – known as the "embodied carbon".

The UN Environment 2018 Global Status Report calculated that building materials and construction were responsible for 11% of global GHG emissions in 2017, listed as 'Construction industry' in Figure 13. Therefore it is critical to take a look at both low-carbon design and low-carbon operation in any new development.

There are a multitude of design options available for the design team to reduce the overall embodied carbon of the development. Some strategies include:

1. Evaluating the structural design strategy of the buildings to optimize for minimal embodied carbon. Consider using structural timber when local FSC-certified wood is available.
2. Replacing portland cement with supplementary cementitious materials, such materials include fly ash or ground granulated blast furnace slag (GGbF).
3. Using materials with a high recycled content or materials that are easy to recycle when the building has reached end-of-life.
4. Using materials that have been sourced locally to decrease carbon emissions from transport.

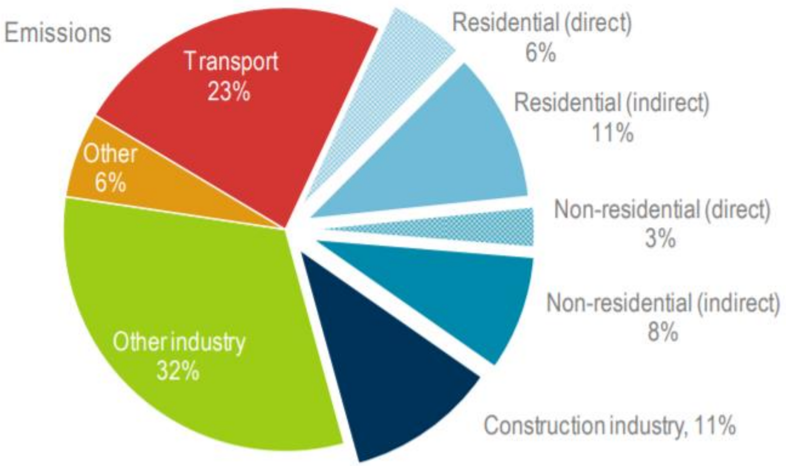


Figure 13: Global GHG Emissions by Sector, 2017

4.1 CLIMATE CHANGE

Historically, Southern Ontario has been considered to have a heating-dominated climate, categorized in ASHRAE Climate Zone 6. In the last 20 years, however, Toronto's climate has changed – the number of annual heating degree days (HDDs) has reduced below 4,000. With this weather, Toronto has been recategorized into ASHRAE Climate Zone 5. Guelph will experience similar changes.

Some of the climatic changes include:

- Increased temperatures throughout the year. This means both an increased number of Cooling Degree Days above 18°C, and an increased frequency and duration of heat waves;
- Increased temperatures throughout the year will also result in a decreased number of Heating Degree Days below 18°C;
- Increased intensity of major rain events; and
- Increased frequency of freeze-thaw events.

As the annual HDDs are forecasted to decrease, Toronto could shift into ASHRAE Climate Zone 4 between 2040 and 2049. The historical and forecasted heating degree days for Toronto Pearson International Airport are is shown in Figure 14, showing the shift from Climate Zone 6 to Climate Zone 4.

A study by RWDI demonstrated that as the climate changes, controlling summer overheating will become increasingly important for occupant comfort in Toronto buildings. Designing modular mechanical systems to allow for future increased cooling demand can help alleviate the increased risk of overheating and occupant discomfort.

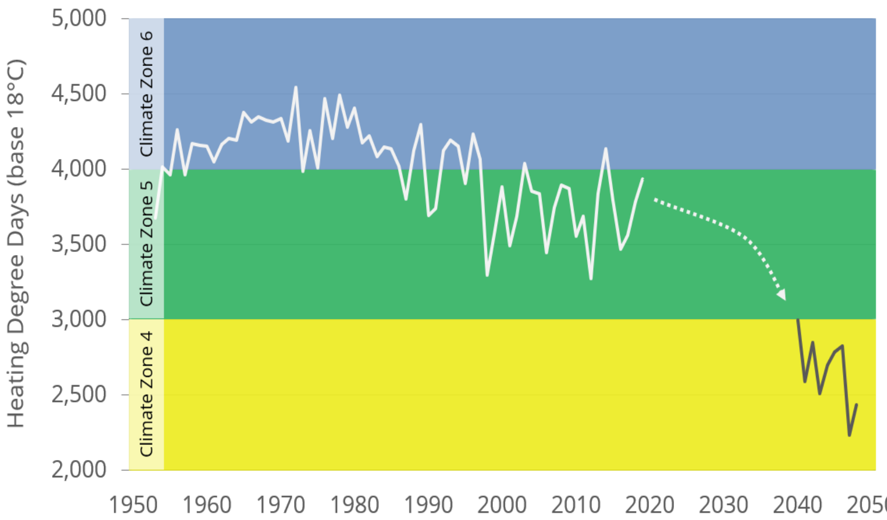


Figure 14: Historical and Forecasted Heating Degree Days at Toronto Pearson International Airport

4.2 DESIGN CONSIDERATIONS

According to the Resilient Design Institute, "resilient design" is the intentional design of buildings, landscapes, communities, and regions in order to respond to natural and man-made disasters and disturbances, as well as long-term changes resulting from climate change, including sea level rise, increased frequency of heat waves, and regional drought (Reference Link 9).

To better the prepare for the forecasted changes to Guelph's climate, this project's team will be encouraged to consider:

- Back-up power systems, which are suggested to provide at least 72 hours of support for: domestic water (hot & cold), elevator service, space heating, lighting and receptacle power.
- Design solutions that allow the buildings systems to be adapted to future climatic conditions. Examples could include: the ability to add shading devices at a future date, or additional system cooling capacity.
- Enclosure strategies like low window to wall ratios, thermal breaks at balconies, airtightness, and operable windows to improve the thermal comfort and passive survivability of the building.
- Building materials selected for durability during flooding events, and buildings designed to operate despite water incursion from major rain events, forecasted to become more frequent (shown in Figure 15).

Working resiliency in the design and equipment selection inevitably has an impact on the cost of the building. As a result, it is important to consider the business case for resiliency and how to recoup the investment. This could encompass:

- Higher perceived value because of the resilient features and the ability to market these;
- Lower operating costs from thermal envelope improvements;
- Reduced insurance premiums; and
- Increased safety.

Figure 15: Flooding of Downtown Toronto Streets in 2013 (Courtesy of user:Eastmain / Public Domain)

CONCLUSIONS AND RECOMMENDATIONS

1. To contribute to the goal of a net zero carbon community by meeting the absolute energy performance targets of TGS Tier 1, the building design will consider a combination of best practice measures, envelope upgrades and mechanical system upgrades. Additional modelling will be required as the design progresses to ensure continued alignment with these targets.

2. The potential energy use and GHG emissions reductions are impressive and demonstrate the project's potential to contribute positively towards the City's Community Energy Initiative.

3. Energy conservation measures related to occupant behavior can have significant impact on the building energy use but are challenging to predict in an energy model. These measures, including suite-level thermal sub-metering and kill switches near exits, can have greater marketability because of their visibility and direct link to the residents' utility bills. These visible measures give occupants better control of their utility bills and over the use of their space.

APPENDIX A

SUMMARY OF ENERGY MODEL INPUTS

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SUMMARY OF PRIMARY ENERGY MODEL INPUTS

The primary energy model inputs for the **High-Rise Residential Building** are shown below:

Modelled Area | Description	9,504 m² Residential High-Rise
Location	Guelph, Ontario
Primary Space Types	Residential, Amenities
Occupancy Schedule	Residential: NECB Schedule G | Non-Residential: NECB Schedule C
Set Points	Heating Set Point: 22°C, Set Back 18°C | Cooling Set Point 24°C, Residential: No Setback; Non-Residential: Set Back to Off

	Baseline Performance	High Performance	Near-Zero Emissions
Envelope			
Typical Exterior Wall Performance	RSI-1.76 (R-10.0)	RSI-1.76 (R-10.0)	RSI-3.5 (R-20.0)
Typical Roof Performance	RSI-7.0 (R-40.0)	RSI-7.0 (R-40.0)	RSI-6.4 (R-36.4)
Gross Window to Wall Ratio	50%	40%	30%
Glazing Performance	USI-2.0 (U-0.35) | SHGC 0.40	USI-1.8 (U-0.32) | SHGC 0.40	USI-1.6 (U-0.28) | SHGC 0.4
Infiltration Rate	0.25 L/s-m² of façade	0.185 L/s-m² of façade	0.125 L/s-m² of façade
System Level – Residential			
Primary HVAC Type	DOAS 4-Pipe Fan Coil	DOAS 4-Pipe Fan Coil	Water Source Variable Refrigerant Flow (VRF)
Airside Energy Recovery	In-suite HRVs, 65% sensible	In-suite ERVs, 75% sensible, 70% latent	In-suite ERVs, 75% sensible, 70% latent
Heating	Hydronic Coils | Electric Preheat	Hydronic Coils | Electric Preheat	VRF - Seasonal COP 3
Cooling	Hydronic Coils	Hydronic Coils	VRF - Seasonal COP 4.5
Outdoor Air Rates (per Unit)	42 L/s, including 14 L/s corridor pressurization	35 L/s, including 7 L/s corridor pressurization	28 L/s
Fan Power (W/CFM)	HRV: 1 | FC: 0.5 (multi-speed)	ERV: 0.5 | FC: 0.3 (multi-speed)	ERV: 0.5 | FC: 0.3 (multi-speed)
System Level – Non-Residential			
Primary HVAC Type	DOAS 4-Pipe Fan Coil	DOAS 4-Pipe Fan Coil	Water Source Variable Refrigerant Flow (VRF)
Airside Energy Recovery	65% sensible, 50% latent | Electric Preheat	75% sensible, 70% latent | Electric Preheat	75% sensible, 70% latent
Heating	Hydronic Coils	Hydronic Coils	VRF - Seasonal COP 3
Cooling	Hydronic Coils	Hydronic Coils	VRF - Seasonal COP 4.5
Outdoor Air Rates	Meet but not exceed ASHRAE 62.1-2013	Meet but not exceed ASHRAE 62.1-2013	Meet but not exceed ASHRAE 62.1-2013
Fan Power (W/CFM)	ERV: 1 | FC: 0.5 (multi-speed)	ERV: 0.5 | FC: 0.3 (multi-speed)	ERV: 0.5 | FC: 0.3 (multi-speed)
Plant Level			
Space Heating Efficiency	Condensing boiler: 95% seasonal	Condensing boiler: 95% seasonal	N/A
Space Cooling Performance	VFD Centrifugal Chiller: COP 6.5 Cooling tower with VSD speed fan	VFD Centrifugal Chiller: COP 6.5 Cooling tower with VSD speed fan	N/A
DHW Efficiency	Condensing boiler: 95% seasonal	Condensing boiler: 95% seasonal	Heat Pump – seasonal COP 2.8
Space Level			
Equipment Load	4.6 W/m² (weighted average)	4.0W/m² (weighted average)	4.0W/m² (weighted average)
Lighting Power Density (W/m²)	Res: 5.0 | Non-Residential: 5.8	Res: 5.0 | Non-Residential: 5.8	Res: 5.0 | Non-Residential: 5.8
DHW Fixture Flow Rates (W/occ)	Res: 500 | Non-Residential: 40	Res: 500 | Non-Residential: 40	Res: 500 | Non-Residential: 40
Drain Water Heat Recovery (%)	No	No	Yes (50% of shower flow)

APPENDIX A

SUMMARY OF PRIMARY ENERGY MODEL INPUTS

The primary energy model inputs for the **Commercial Office Building** are shown below:

Modelled Area | Description	708 m² | 1 Storey
Location	Guelph, Ontario
Primary Space Types	Office
Occupancy Schedule	NECB Schedule A
Set Points	Heating Set Point: 22°C, Set Back 18°C | Cooling Set Point 24°C, Set Back to Off

	Baseline Performance	High Performance	Near-Zero Emissions
Envelope			
Typical Exterior Wall Performance	RSI-1.6 (R-9.0)	RSI-1.6 (R-9.0)	RSI-3.5 (R-20.0)
Typical Roof Performance	RSI-3.5 (R-20.0)	RSI-3.5 (R-20.0)	RSI-7.0 (R-40.0)
Gross Window to Wall Ratio	51%	41%	41%
Glazing Performance	USI-2.15 (U-0.38) | SHGC 0.40	USI-1.80 (U-0.32) | SHGC 0.40	USI-1.60 (U-0.28) | SHGC 0.40
Infiltration Rate	0.25 L/s-m² of façade	0.185 L/s-m² of façade	0.125 L/s-m² of façade
System Level – Office			
Primary HVAC Type	VAV with Reheat	DOAS 4-Pipe Fan Coil Unit	DOAS Air Source Variable Refrigerant Flow (VRF)
Airside Energy Recovery	None	65% sensible, 55% latent | Electric Preheat	85% sensible, 70% latent | Electric Preheat
Heating	Hydronic Coil, Hydronic Reheat	Hydronic Coils	VRF - Seasonal COP 3.0
Cooling	Hydronic Coil	Hydronic Coils	VRF - Seasonal COP 4.5
Outdoor Air Rates	Per ASHRAE 62.1-2013 | Effectiveness: 0.68	Per ASHRAE 62.1-2013 | Effectiveness: 0.8	Per ASHRAE 62.1-2013 | Effectiveness 1.0
Fan Power (W/CFM)	SF: 0.67 | RF: 0.67	ERV SF: 1.0 | FCU: 0.5 (multi-speed)	ERV SF: 1.0 | FCU: 0.3 (multi-speed)
Plant Level			
Heating	Condensing boiler, 92% efficiency	Condensing boiler, 92% efficiency	Electric back-up to VRF, 100% efficiency
Cooling	VFD Centrifugal Chiller: COP 6.2 Cooling tower with VSD speed fan	VFD Centrifugal Chiller: COP 6.2 Cooling tower with VSD speed fan	N/A
DHW Efficiency	Condensing boiler, 92% efficiency	Condensing boiler, 92% efficiency	Heat Pump – Seasonal COP 2.8
Space Level			
Equipment Load	5.9 W/m² (weighted average)	5.9 W/m² (weighted average)	4.4 W/m² (weighted average)
Lighting Power Density	7.9 W/m² (weighted average)	6.3 W/m² (weighted average)	4.8 W/m² (weighted average)
DHW Fixture Flow Rates (W/Occ)	Office: 90	Office: 90	Office: 68

APPENDIX A

SUMMARY OF PRIMARY ENERGY MODEL INPUTS

The primary energy model inputs for the **Commercial Retail Building** are shown below:

Modelled Area | Description	425 m^2 | As part of Building
Location | Climate	Guelph, Ontario
Primary Space Types	Retail
Occupancy Schedule	NECB Schedule C
Set Points	Heating Set Point: 22°C, Set Back 18°C | Cooling Set Point 24°C, Set Back to Off

	Baseline Performance	**High Performance**	**Near-Zero Emissions**
Envelope			
Typical Exterior Wall Performance	RSI-1.6 (R-9.0)	RSI-1.6 (R-9)	RSI-3.5 (R-20.0)
Typical Roof Performance	N/A	N/A	N/A
Gross Window to Wall Ratio	45%	33%	33%
Glazing Performance	USI-2.15 (U-0.38) | SHGC 0.40	USI-1.8 (U-0.32) | SHGC 0.40	USI-1.6 (U-0.28) | SHGC 0.40
Infiltration Rate	0.25 L/s-m^2 of façade	0.185 L/s-m^2 of façade	0.125 L/s-m^2 of façade
System Level			
Primary HVAC Type	Packaged Single Zone Rooftop Units	DOAS 4-Pipe Fan Coil Unit	DOAS Air-source Variable Refrigerant Flow (VRF)
Airside Energy Recovery	None	65% sensible 55% latent | Electric Preheat	85% sensible 70% latent | Electric Preheat
Heating	Gas Furnace, 88% efficient	Hydronic Coils	VRF – Seasonal COP 3.0
Cooling	DX, COP 3.8	Hydronic Coils	VRF – Seasonal COP 4.5
Outdoor Air Rates	Per ASHRAE 62.1-2013 | Effectiveness 0.8	Per ASHRAE 62.1-2013 | Effectiveness 0.8	Per ASHRAE 62.1-2013 | Effectiveness 1.0
Fan Power (W/CFM)	SF: 1.0	ERV SF: 1.0 | FCU: 0.5 (multi-speed)	ERV SF: 1.0 | FCU: 0.3 (multi-speed)
Plant Level			
Heating	N/A	Condensing boiler, 92% efficiency	Electric back-up to VRF, 100% efficiency
Cooling	N/A	VFD Centrifugal Chiller: COP 6.2 Cooling tower with VSD speed fan	N/A
DHW Efficiency	Condensing Boiler, 90% efficient	Condensing boiler, 92% efficiency	Heat Pump – Seasonal COP 2.8
Space Level			
Equipment Load	1.9 W/m^2 (weighted average)	1.9 W/m^2 (weighted average)	1.4 W/m^2 (weighted average)
Lighting Power Density	11.1 W/m^2 (weighted average)	8.9 W/m^2 (weighted average)	6.6 W/m^2 (weighted average)
DHW Fixture Flow Rates	40 W/Occ	40 W/Occ	30 W/Occ