Energy Strategy Report

145 Wellington Street West

Toronto, ON

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Executive Summary

H&R Reit - 145 Wellington has retained EQ Building Performance (EQ) to develop an Energy Strategy Report for 145 Wellington Street West (the "Proposed Development"). The Proposed Development consists of a podium with a residential tower. The podium will contain retail and office space, with the tower consisting of residential areas. The site is located on the corner of Wellington St W and Simcoe St in downtown Toronto.

The Proposed Development is subject to the energy requirements of the Ontario Building Code Supplementary Standard SB-10 as well as the newly implemented Toronto Green Standard version 3. It is also subject to the requirements of the Downtown Energy Strategy. EQ has predicted the energy use, thermal demand, and expected carbon impact of the project in compliance with these requirements, outlined in Table i below. The development team is committed to creating a high performing community in line with TGS version 3 Tier 1 performance requirements.

Toronto Green Standard version 2 formerly required performance levels over the building code, while version 3 uses an absolute target approach for the most predominant building archetypes – high-rise residential, low-rise residential, retail, and office. This project falls within these archetypes, and the City of Toronto Zero Emissions Building Framework has been used for energy analysis.

Energy, thermal demand, and carbon emissions are predicted for TGS v3 Tier 1 and TGS v3 Tier 2 levels of performance. In addition, a 'Towards Net Zero' scenario is presented, predicting how the development would need to perform to achieve near net zero levels of performance, in line with TGS v3 Tier 4.

Table i - Predicted Energy, Carbon, and Thermal Demand Performance Summary

	TGS V3 Tier 1	TGS V3 Tier 2	Towards Net Zero
Total Energy Intensity – (ekWh/m^2) EUI	**171.4**	**133.5**	**72.1**
% Savings vs Tier 1	**-**	22%	58%
GHG intensity (kg CO_2e/m^2) - GHGI	**20.0**	**15.0**	**4.7**
% Savings vs Tier 1	-	25%	76%
Thermal Energy Demand Intensity (ekWh/m^2) - TEDI	**70.0**	**44.2**	**15.0**
% Savings vs Tier 1	-	37%	79%

If the project were to pursue Tier 2 or higher performance, it would be eligible for up to **$1,250,035 as a development charge refund.**

This report outlines design strategies to achieve each of the presented targets. Advanced measures such as district energy systems and solar PV are recommended for further exploration, however further detailed analysis is outside the scope of this report as it is not expected to be completed at this stage of development. If advanced measures are pursued, they can be explored using the energy model developed for Site Plan Approval. Design options are also presented to provide enhanced resilience for the Proposed Development and should be evaluated further on a feasibility and cost basis.

The strategies outlined in this report will be evaluated by the design team throughout design development. Using a combination of strategies from the energy strategy report, the Proposed Development will achieve Toronto Green Standard v3 Tier 1 performance levels.

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1 INTRODUCTION

The Proposed Development consists of a podium with a residential tower. The podium will contain retail and office space, while the tower will consist of residential areas. The site is located on the corner of Wellington St W and Simcoe St in downtown Toronto. The project is early in the design process, with a number of alternatives currently being considered.

Currently, the project will at a minimum meet Toronto Green Standard Tier 1 requirements, but will use this report to explore opportunities for a higher performance design.

Figure 1 - Building Rendering

2 PURPOSE

The City of Toronto has developed a number of sustainability policies in order to address climate change, with particular focus on net-zero development and energy resilience. For buildings greater than 20,000 sq.m. or within a Community Energy Plan area approved by Council, the City of Toronto has recently introduced the requirement for an Energy Strategy Report. The intent of the report is outlined in the Energy Strategy Terms of Reference and encourages projects to:

- Take advantage of existing or planned energy infrastructure, passive design, and renewable energy
- Consider energy sharing for multi-building developments
- Consider increased resiliency such as strategic back-up power capacity
- Identify innovative solutions to reduce energy consumption
- Explore engaging private investment in energy sharing systems

In 2018, the City of Toronto also introduced the Downtown Secondary Plan which requires a Complete Community Assessment. As part of this assessment, a **Downtown Energy Strategy** is required. While most of the aspects of the Downtown Energy Strategy are identical to the requirements of the Energy Strategy Terms of Reference, the following additional aspects are introduced:

- Work with thermal energy network owners and operators to reduce GHG emissions from existing thermal energy networks
- Promote residential buildings retrofits, focusing on conservation and energy efficiency initiatives on existing multi-unit residential buildings Downtown
- Encourage development applicants to salvage and reuse materials through the higher levels of the TGS through the Energy Strategy Report

While some of these are outside the scope of the developer, or this project, they have been incorporated into this report as applicable so that the Downtown Energy Strategy requirements can be met.

While all of the strategies discussed are identified during re-zoning, they are developed during the Site Plan Application process in combination with Toronto Green Standard (TGS) requirements to inform design.

The current version of TGS is Version 3, came into effect in May 2018 and requires further energy efficiency than TGS v2. In Version 3, TGS consists of four performance tiers, Tiers 1 - 4. Tier 1 is mandatory for all developments, while Tiers 2 - 4 are optional and currently incentivized by a partial development charge refund. The various Tiers were established to demonstrate to the building industry the step changes that will be required to drive toward zero emission buildings. The City of Toronto's Zero Emissions Building Framework describes the various tiers, where Tier 4 compliance is roughly aligned with a Net Zero Ready level of performance.

At this stage, the Proposed Development is currently applying for rezoning. During SPA, the Proposed Development will need to comply with TGS version 3, Tier 1 performance.

3 DESIGN OPPORTUNITIES

3.1 PASSIVE DESIGN MEASURES

At this point in design, the materiality of the building envelope is still under consideration. Given the surrounding built area, metal panels/ spandrel panels and a moderate window to wall ratio are anticipated in the building. While it is too early in design for envelope interface details to be developed, the project team will carefully consider these details as design progresses. Under previous building code requirements, only limited thermal bridging accounting is required to account for major structural elements such as spandrel back-pans, steel studs, and balconies. Previous requirements also allow up to 2% of the building envelope major thermal bridges (such as balconies) to be excluded from effective thermal performance calculations. Under the new TGS v3 modelling requirements, however, all thermal bridges will need to be accounted for. This introduces new focus on architectural elements that may not have been considered in detail under current building code or previous TGS v2 requirements, including:

- Opaque Wall and Glazing Interfaces
- Interior and Exterior Wall Interfaces

- Slab bypasses
- Balconies
- Parapet and terrace details

By fully accounting for all thermal bridges, a more accurate representation of thermal performance of the envelope can be used in the model, reflecting more accurate energy use estimation. While each project will have different performance values, EQ has completed these calculations on some similar projects using metal/ spandrel panels. A typical metal/ spandrel assembly with insulation in both the back-pan and back-up wall may have a nominal R-20 performance which would currently be modelled as an effective R-9 with minimal thermal bridging accounting. With full thermal bridges accounted for, this effective performance typically drops closer to R-4; a significant decrease in performance. Considering these details early in design can significantly improve the envelope performance and overall energy performance in a passive way. BC Hydro has developed the *Building Envelope Thermal Bridging Guideline*[1] which is a useful resource to evaluate interface details early in design. This guide shows a number of different approaches to detail the building envelope in order to reduce thermal bridging. While this additional thermal bridging accounting is only currently required under the absolute targets required by TGS v3, these calculations are expected to become part of building code and other high performance standards over time as they are more accurate to the real life performance of the envelope.

In terms of glazing for the project, a high performance product with a low solar heat gain coefficient will be encouraged. This will provide daylight while reducing over-heating in shoulder seasons and cooling loads in the summer. Moving to higher Toronto Green Standard Tiers and other energy standards become stricter, targeting a 40% window to wall ratio will be needed in the future to improve the overall envelope performance. The Proposed Design will aim to achieve a balance of daylighting and a high energy performance for the building envelope.

The orientation of the building has been defined by the nature of the site, limiting opportunities for optimization. Throughout design, the design team will explore options for control of solar gains via external overhangs and shading to limit overheating as appropriate for each building elevation. Electrochromic glazing (glass which tints in response to solar intensity or sun position) can also serve this purpose, while maximizing daylighting and view in the residential spaces. It is expected these measures will have a positive impact on the building cooling and heating loads.

Full thermal bridging calculations not only better reflect the energy usage in a building, but also give a better representation of the thermal comfort within a space. With a poor performing envelope, the first few feet of a space adjacent to the exterior wall can be unusable due to thermal comfort issues. Improving the performance of the wall can increase occupant comfort significantly and can allow for mechanical equipment to be downsized. Additionally, as interior spaces are better able to maintain their temperature set-points, HVAC run times and system cycling can be reduced leading to increased HVAC system life times. Passive design measures

[1] https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/power-smart/builders-developers/building-envelope-thermal-bridging-guide-1.1.pdf

can also effect the resilience of a building. Additional information on this is available in *Section 7 – Energy Resilience* of this report.

As design progresses through Site Plan Approval and building code review, the design team will consider a number of passive design measures. A description of measures for each analyzed Tier, as well as estimated cost premiums provided by the City of Toronto *Zero Emissions Building Framework (Appendix D)* have been provided below. Cost premiums should be evaluated independently as part of a full feasibility study by the design team.

Minimum Design Suggestions (Tier 1)

Estimated 13.8% envelope cost premium over code (1.5% total construction cost premium for Tier 1)

- High performance opaque building envelope, continuous insulation within the assembly (Typical design has little to no continuous insulation)
- Low window to wall ratio - 40% vision (Typical design 40-60% vision)
- 'OK' thermal bridging performance at envelope interfaces (Typical design does not consider these fully)
    - Reduced balconies (<2% of building envelope area)
    - One large window is better than multiple small windows of the same total area
- High performance double glazing with low-e coating (Typical overall performance U-0.40, SHGC 0.35)

Upgraded Design Suggestions (Tier 2)

Estimated 21.9% envelope cost premium over code (3.5% total construction cost premium for Tier 2)

Design improvements from Tier 1 plus:

- 'Regular' thermal bridging performance at envelope interfaces
    - Thermally broken or no balconies recommended
    - Enhanced or thermally broken cladding attachments
- Standard triple glazing with low-e coating, thermally broken aluminum framing
- Improved infiltration, typically achieved with improved detailing and confirmed with whole building air tightness testing

Advanced Design Suggestions (Tier 4 – Towards Net Zero)

Estimated 28.8% envelope cost premium over code (3.6% total construction cost premium for Tier 4)

Design improvements from Tier 1 and Tier 2 plus:

- Extensive continuous insulation in exterior wall (ex. spray foam), spandrel would be very difficult or not possible to use
- 'Improved' thermal bridging performance at envelope interfaces

  - No balconies recommended
- High performance triple glazing with low-e coating, fiberglass framing
- Significantly improved infiltration, typically achieved with improved detailing and confirmed with whole building air tightness testing

3.2 Active Design Measures

At the current design stage, mechanical systems have been considered only at a conceptual level. Typical design for similar buildings in the Toronto area includes a dedicated mechanical heating and cooling via a gas-fired hot water boiler and electric chilled water plant. As design progresses, a preliminary energy model will be developed to evaluate different design opportunities to ensure an optimized active design. During this process, the design team will consider a number of active design measures. A description of measures for each analyzed Tier, as well as estimated cost premiums provided by the City of Toronto *Zero Emissions Building Framework (Appendix D)* have been provided below. Cost premiums should be evaluated independently as part of a full feasibility study by the design team.

Minimum Design Suggestions (Tier 1)

Estimated 1.8% M+E cost premium over code (1.5% total construction cost premium for Tier 1)

- Corridor pressurization ventilation rate – 30 cfm/suite (Typical design 30-60 cfm/suite)
- Outdoor air in remaining areas close to ASHRAE 62.1 levels (Typical design 10-50% higher)
- Variable speed fans– allows central make up air fans to reduce flows during low activity periods (Typical)
- Variable speed pumps– allows pumps to vary flow and reduce consumption (Typical)
- Air side heat recovery – suggest 65% efficiency (Typical)
- Fan coil or water source heat pump system (Typical)
- High-efficiency LED lighting, daylight and occupancy controls – recommend 30% reduction from code in common areas (Typical design aligns with code requirements)
- 20% reduction in domestic hot water energy use – Recommend low-flow plumbing fixtures for hot water fixtures 5.7 LPM lavatories, 5.7 LPM sinks, 6.8 LPM showers (Code maximum flow rates 8.3 LPM lavatories, 8.3 LPM sinks, 7.6 LPM showers)

Upgraded Design Suggestions (Tier 2)

Estimated 13% M+E cost premium over code (3.5% total construction cost premium for Tier 2)

Design improvements from Tier 1 plus:

- Corridor pressurization ventilation rate – 15 cfm/suite
- EnergySTAR appliances
- Air side heat recovery – suggest 75% efficiency

- 30% reduction in domestic hot water energy use – Recommend lower-flow plumbing fixtures for hot water fixtures –1.9 LPM lavatories, 3.8 LPM sinks, 6.8 LPM showers, or sewage heat recovery, or a central heat pump domestic hot water heater
- Fan coil or water source heat pump systems likely acceptable, consider higher performance systems such as water source VRF

Advanced Design Suggestions (Tier 4 – Towards Net Zero)

Estimated 4.5% M+E cost premium over code (3.6% total construction cost premium for Tier 4)

Design improvements from Tier 1 and Tier 2 plus:

- Corridor ventilation rate per ASHRAE 62.1 – requires compartmentalization to remove pressurization requirements
- Demand Control Ventilation in non-residential areas
- Air side heat recovery – suggest 85% efficiency
- 50% reduction in domestic hot water energy use – Recommend lower-flow plumbing fixtures *and* sewage heat recovery or central heat pump domestic hot water heater
- Central domestic hot water heat pump
- High-efficiency LED lighting, daylight and occupancy controls – recommend 50% reduction from code in common areas, may require changes in architectural / interior design to maximize lighting levels
- Air Source Heat pump / Variable refrigerant flow (VRF) systems – electricity based (low carbon), high efficiency mechanical systems to replace HVAC design
- Geothermal system

4 ENERGY ANALYSIS

4.1 TORONTO GREEN STANDARD - TOWARDS NET ZERO DEVELOPMENT

Version 3 of the TGS came into effect on May 1, 2018. The energy requirements for Mid to High-Rise Residential & All Non-Residential development are outlined in the published City of Toronto Zero Emissions Building Framework[2]. In this document, future versions of the TGS will become more stringent over time in terms of energy use, thermal demand, and carbon emissions. The goal of this framework is to require near zero emissions levels for all new developments by 2030 by increasing performance levels every 4 years, starting with version 3 of the TGS. In all cases, Tier 1 is mandatory for all new developments in the city, while Tier 2, 3 and 4 are optional increased performance levels incentivized with a development charge refund.

Current energy standards in Ontario use a 'reference' building approach for compliance, comparing the proposed building as designed to a reference building designed with minimum code requirements. This allows

[2] http://www1.toronto.ca/City%20Of%20Toronto/City%20Planning/Developing%20Toronto/Files/pdf/TGS/Zero%20Emissions%20Buildings%20Framework%20Report.pdf

buildings to more easily trade off deficient performance in one area with superior performance in others (i.e. a less effective building envelope with higher performance mechanical systems).

Version 3 of the TGS replaces this current approach by using three new *absolute* targets. The intent of moving to *absolute* targets is to encourage all buildings to meet the same standards of performance regardless of design. In contrast, actual performance may vary dramatically between buildings when using the reference building approach. The Zero Emissions Building Framework proposed the following three targets:

1. **Energy Use Intensity – EUI – kwh/m^2**: Annual building energy use, divided by the conditioned floor area.
2. **Thermal Energy Demand Intensity – TEDI – kWh/m^2**: Annual heating load, divided by the conditioned floor area. TEDI excludes the effects of mechanical efficiencies (e.g. condensing boilers) but does include passive systems such as air heat recovery, solar gains, and internal gains.
3. **Green House Gas Intensity – GHGI – kgCO$_2$e/m^2**: Annual greenhouse gas emissions, divided by the conditioned floor area. The annual average carbon emission factors currently listed in OBC SB-10 are used for this calculation.

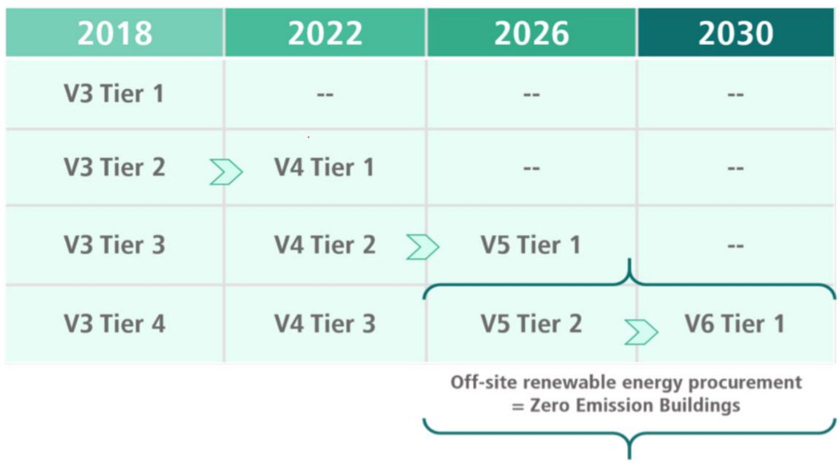

Figure 2 - Zero Emissions Buildings Framework Path to Net Zero (City of Toronto, 2017)

Energy use intensity, thermal energy demand intensity and greenhouse gas intensity will be reviewed and estimated in this report. A reduction in thermal demand will be reflected in a focus on passive design elements and heat recovery options for both heating and cooling use in the analysis below.

Note that an alternative pathway to comply with TGS v3 Tier 1 by demonstrating a 15% improvement over the current Building Code is also available, however is expected to require equivalent performance to the absolute targets. This alternative compliance is expected to only be available for the first 2 years of TGS version 3, and is only available for projects pursuing Tier 1 or outside the defined building archetypes.

As this project contains a large amount of institutional space, which is outside the defined archetypes, this portion of the building will need to meet a relative performance metric. For Tier 1, this would require a 15% improvement while Tier 2 will require a 25% improvement. Relative performance targets have not been set for Tier 3 or Tier 4, but the CaGBC Zero Carbon Building Standard or Passive House certification are both acceptable alternative compliance paths.

In addition to changing targets, two key differences in energy modeling approach are proposed for version 3 in comparison to current TGS and Ontario Building Code requirements:

Table 2 - Changes to TGS Energy Modeling Requirements

	Current	Proposed
Ventilation	Modeled at minimum ventilation requirements (ASHRAE 62.1 levels)	Modeled as per design
Thermal Bridging	Some accounting for thermal bridging, allows for thermal bridging up to 2% of the building envelope to be excluded	Full accounting for all thermal bridging

In mid-high rise construction, these proposed changes typically result in a lower performing effective building envelope in comparison to current calculation methods and increased outdoor air volumes in the model.

4.2 Energy Targets

The Proposed Development will be required to meet TGS version 3 Tier 1. Tier 1 performance will be evaluated, and design solutions will be suggested in order to achieve this high performance target. Tier 2 level of performance will also be estimated as a point of comparison.

Should the Proposed Development choose to pursue a higher tier of the Toronto Green Standard (Tiers 2 – 4), the benefits include:

- A **Development Charge refund of up to $1,250,035** could be received[3];
- The approvals process has the potential to be streamlined, which could save time and money for the project;
- Increased resiliency of the building;
- Projects that achieve Tier 2 and above are recognized as leaders in their field;

In addition to these cases, a *Towards Net Zero* level of performance will also be explored, reflecting a development built to achieve near net zero energy use. This design reflects the 2030 TGS levels of performance, or Tier 4, as outlined in the *Zero Emissions Buildings Framework.* To achieve full net-zero status, the remaining energy use identified in this scenario would be provided by renewable energy sources.

Table 3 - Performance Levels Analyzed

Scenario		Notes
1	TGS version 3 Tier 1	Baseline level of performance
2	TGS version 3 Tier 2	Enhanced level of performance
3	*Towards Net Zero*	Aspirational performance, reflecting TGS 2030 / net zero targets

[3] Based on Tier 2 Caps published by the City of Toronto, as well as 145 Wellington Street West Statistics Sheet prepared by Turner Fleischer Architects Inc., dated 2019/07/04.

In line with Greenhouse Gas Intensity requirement of the TGS, predicted greenhouse gas emissions as well as predicted energy use will be presented. Referencing the Ontario Building Code (OBC), a factor of **0.050 kg CO_2e/kWh** for grid supplied electricity, and **1.899 kg CO_2e/m^3** for natural gas will be applied.

4.3 PREDICTED ENERGY USE[4]

The City of Toronto *Zero Emissions Building Framework* outlines sample designs that were used in setting the targets for future versions of the TGS, including anticipated annual energy use for each version of the TGS until 2030, by end use and by building type. This information has been used to predict the energy use of the Proposed Development, and verified against EQ's extensive database of modeled buildings.

The *Zero Emissions Building Framework* has set performance targets for high-rise residential, low-rise residential, office, and retail end uses. As such, it has been used to estimate the energy performance of the 145 Wellington Street West project.

Predicted energy use and resulting carbon emissions for each of the three design options is presented below.

Table 4 - Predicted Energy, Thermal Demand and Carbon Performance

	TGS V3 Tier 1	TGS V3 Tier 2	Towards Net Zero
Electricity - Space Cooling	6.3	7.0	13.7
Electricity - Space Heating	2.1	2.8	4.5
Electricity - DHW Heating	0.0	0.0	4.1
Electricity - Base loads	63.3	59.0	48.2
Gas - Space Heating	69.8	36.8	0.5
Gas - DHW / Base Loads	28.6	25.5	0.6
Total Energy Intensity - (ekWh/m^2)	**171.4**	**133.5**	**72.1**
Total Energy (eMWh)	8,669	6,751	3,645
% Savings vs Tier 1	-	22%	58%
GHG intensity (kg CO_2e/m^2)	**20.0**	**15.0**	**4.7**
Total GHGs (tonnes CO_2e)	1,011	758	238
% Savings vs Tier 1	-	25%	76%
Thermal Energy Demand Intensity (ekWh/m^2)	**70.0**	**44.2**	**15.0**
Total Thermal Demand (eMWh)	3,538	2,234	758
% Savings vs Tier 1	-	37%	79%

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

TGS version 3 Tier 2 results in an anticipated **22%** reduction in energy use, **25%** reduction in carbon emissions and **37%** reduction in thermal energy demand when compared to anticipated Tier 1 levels of performance. The *Towards Net Zero* design strategy results in a **58%** energy reduction, **76%** carbon emissions reduction and **79%** thermal energy demand reduction.

Improved levels of thermal demand from Tier 1 to Tier 2 are indicative of a strategy focused on **passive design improvements**, in turn reducing heating energy use. For example, one strategy may be to improve the exterior envelope enough so that mechanical equipment can be downsized. The switch to absolute targets requires a shift in how energy performance is measured and requires energy modelling and passive design exploration to happen in a serious way early in design. TGS version 3 Tier 2 has set aggressive performance targets that require early design and coordination to be achieved.

In the Toward Net Zero design option, fuel switching occurs by replacing natural gas with electric heat pump based heating and domestic hot water in order to achieve the emissions reductions requirements, as well as aggressive improvements in building envelope thermal and air tightness performance. This is reflective of the net zero emissions mandate outlined by future version of the TGS, as well as the higher GHG intensity of natural gas compared to the relatively low-carbon electricity grid in Ontario. A focus on heating reduction is also evident in Figure 4 and 5.

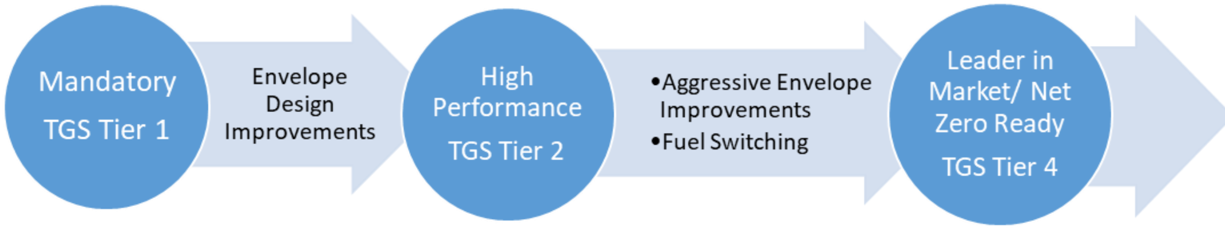

Figure 3 - Key Design Features

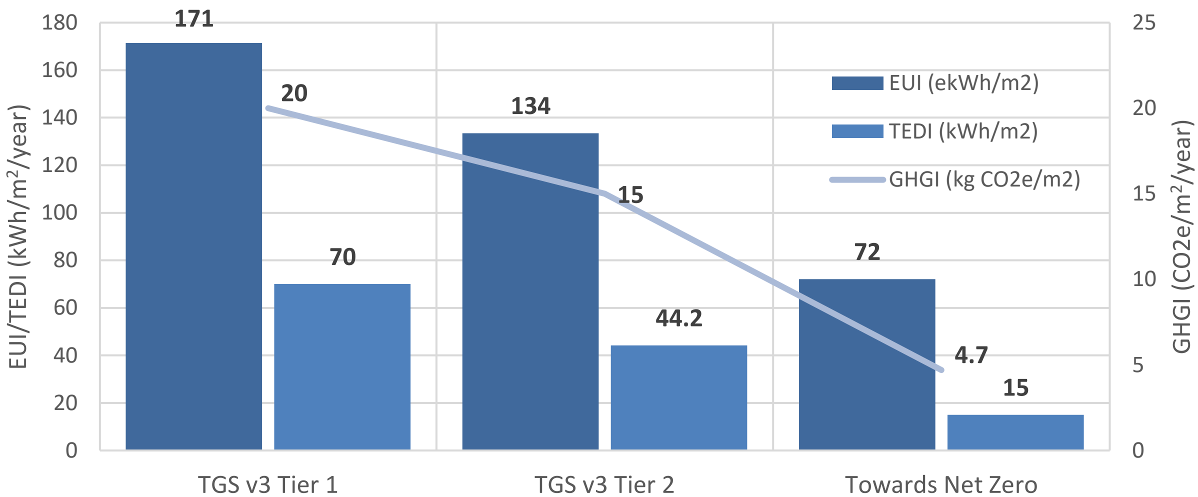

Figure 4 - Predicted Energy, Thermal Demand and Carbon Performance

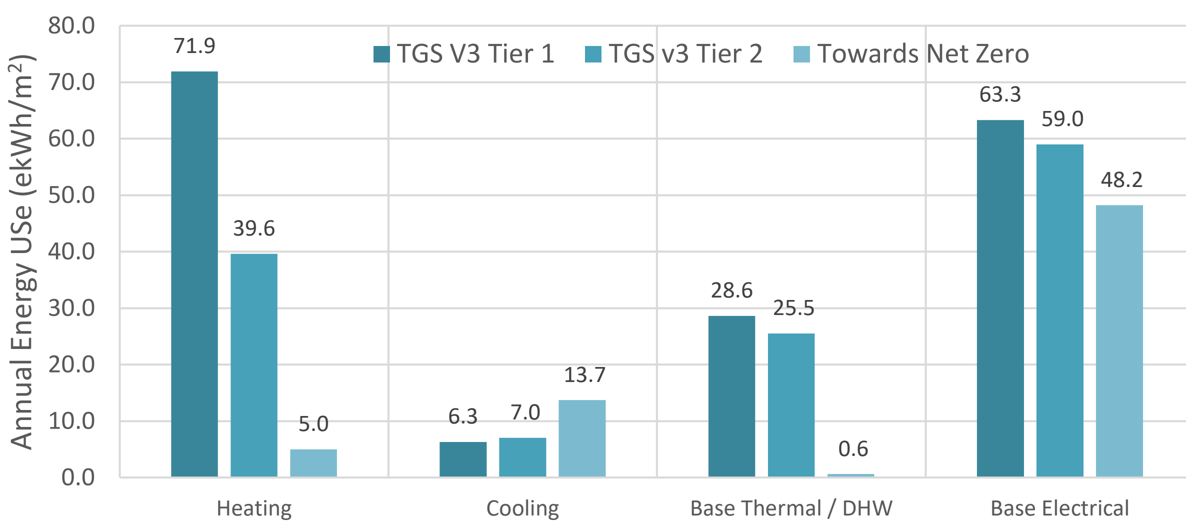

Figure 5 - Predicted energy consumption by end use

Potential design strategies intended to achieve Tier 1, Tier 2, and a Towards Net Zero design have been presented in Section 2 and Section 3, but are also jointly summarized in Appendix A. It should be noted that designs presented reflect one of many possible design solutions which will be verified and optimized during the energy modeling process.

5 Towards Net Zero Development

The City of Toronto's ambitious net-zero goal for buildings has been analyzed in this report as a third scenario, with anticipated performance noted above. While this aggressive goal may not be achieved on this project, the design team is encouraged to incorporate design and construction strategies in line with this goal, designed to help reduce electrical demand and carbon emissions and conserve energy, compared to a more conventional design.

5.1 Energy Conservation & Demand Reduction

With the constant stream of development within the City of Toronto, the electricity grid is becoming increasingly stressed. With electricity distribution infrastructure already constrained in the areas anticipating the most growth, an estimated 22% increase in electricity demand due to projects currently in approvals will be a major challenge. Furthermore, cooling demand for buildings will increase with rising temperatures, which means that the 22% estimate is conservative. Broader electrification from sources such as electric cars will further increase electrical demand. At the project site specifically, the local grid is expected to be 95% capacity by 2019[5]. Ensuring that the design has reduced energy consumption and a reduced peak demand can help to avoid capacity problems in the future.

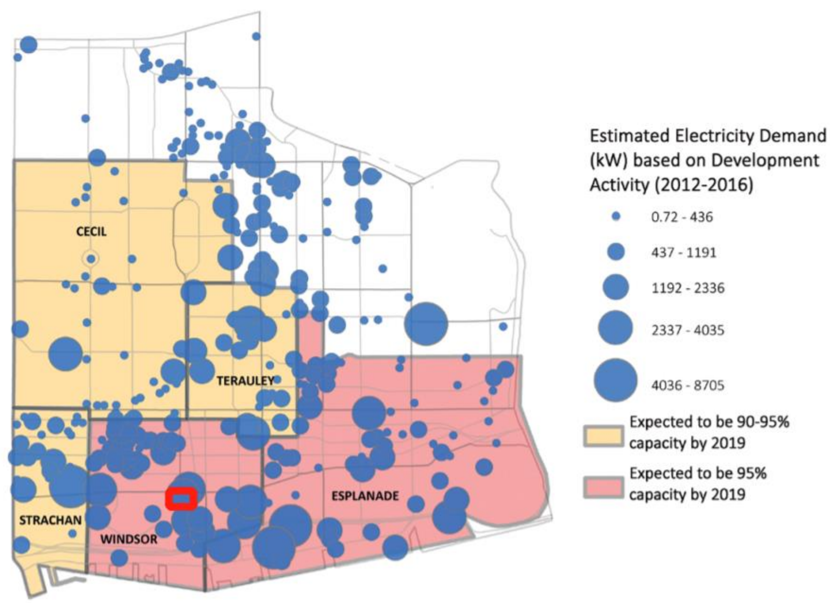

Figure 6 – Estimated Downtown Toronto Electricity Demand

With a better performing building envelope and reduced thermal bridging, the thermal demand and energy consumption of the net zero building will be significantly reduced. This will not only passively reduce the

[5] https://www.toronto.ca/wp-content/uploads/2018/04/9585-city-planning-tocore-energy-strategy.pdf

thermal loads within the building, but will also allow active mechanical systems to be downsized. In addition, a better envelope leads to more comfortable spaces for occupants.

By selecting an appropriate solar heat gain coefficient for each façade, daylighting can also be maximized to reduce internal lighting loads while maintaining thermal comfort. Reduced lighting and cooling loads will mitigate peak electrical demand within the building, specifically through the use of LED lighting and daylighting / occupancy sensors. The use of more advanced strategies like electrochromic glazing will reduce cooling loads, maximize passive winter heat gain, and maximize daylight potential and views.

The resulting energy demands of the project will be met with high performance HVAC and lighting systems. High HVAC plant and system efficiencies combined with heat recovery and variable speed drives will significantly reduce electrical demand and consume energy only when required or called on. The remainder of the energy use in a net-zero building is intended to be supplied by renewable energy sources. Some advanced strategies to reduce grid demand and energy consumption include:

- Solar photovoltaics combined with battery storage
- Local energy generation
- Connecting to district energy systems, such as deep-lake water cooling
- Heat recovery from sewage infrastructure
- Large-scale geothermal systems

5.2 Low Carbon Solutions

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

Additional low-carbon solutions such as renewable energy and district energy (discussed in more detail in section 6.1) have not yet been ruled out, and are undergoing further analysis.

The energy and carbon use associated with a building goes beyond the built form itself and extends to the end-user. Due to the downtown Toronto setting in a very walkable neighborhood, tenants of the Proposed Development will produce less carbon related to transportation.

6 Advanced Energy Solutions

6.1 District Energy Systems

6.1.1 Types of District Energy Systems

At a high level, district energy systems may be categorized as one of two types: **High Temperature** and **Low / Ambient Temperature**.

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

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

HIGH VS AMBIENT TEMPERATURE DISTRICT THERMAL

HIGH TEMPERATURE LOOP	AMBIENT LOOP
Equipment in building may be minimized (boiler/chiller reduced to a heat exchanger)	Heat pump equipment required in building to generate temperature for space conditioning
Distribution piping requires insulation	No insulation needed / heat exchange with ground encouraged
Heating demand met by gas fired equipment or recovered waste heat	Heating demand met by terminal electric heat pump / VRF, and central gas fired or renewable sources
High temperatures can be augmented by CHP / heat recovery	Low temperatures amenable to ground loops / low grade solar thermal
Separate loops required for heating and cooling	Heating and cooling provided by one loop

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

6.1.2 District Energy Potential

The City of Toronto Zero Emissions Buildings Framework identifies low carbon thermal energy networks / district energy systems as an important strategy in their greenhouse gas emissions reduction targets. These networks may include options such as deep lake water cooling, biofuels, solar heating or waste heat recovery.

The project is located at the corner of Wellington Street West and Simcoe Street. According to the City of Toronto DE node scan[6], the project site is very close to two existing District Energy Stations, shown below.

[6] https://www.arcgis.com/home/webmap/viewer.html?webmap=4e58774223774e4c8afaf96473f99706

Figure 7 - District Energy Map

The north station is an Enwave steam plant, and the south station is an Enwave cooling plant. As the capacity for this plant is unknown, it is unclear if connecting to the system is feasible. Enwave has also indicated that they generally are not interested in expanding their steam network, instead moving to hot water where feasible.

With more than one district energy system in close proximity to the site, the team is encouraged to engage with Enwave to explore connection opportunities.

A detailed energy model and load profile for this site is outside of the scope of this report as it is not expected during the Rezoning stage. An energy model will be required for Site Plan Approval and developed at that time. This model can be used by the design team to further explore potential district energy solutions as design progresses. Within the building, connecting to a district system can reduce the amount of space needed on site for mechanical systems, increasing useable GFA for the building, as well as potentially being a more reliable source of heating/cooling compared to a dedicated building plant due to the modular nature of district energy. Connecting to a district energy system can help to achieve significant emissions reductions at a relatively low cost due to economies of scale.

The project team is encouraged to consider connecting to a district system if the opportunity arises. In the meantime, there are ways to design the building to be district energy ready. To prepare for a future district energy connection, the City of Toronto suggests the following key items be incorporated into building design:

- Install heating and cooling plant equipment on the lower levels for easier integration into a future district system, or provide for a future connection points into the building's thermal piping at ground level
- Provide adequate space at or below ground level for a future energy transfer station
- Provide an easement between the mechanical room and the property line to allow for thermal piping

- Provide two-way pipes placed in the building to carry thermal energy from the district energy network to the section in the building where the future energy transfer station would be located
- Install a low temperature hydronic heating system (e.g. heat pump loop) that is compatible with a district energy system in order to reduce the pipe sized and associated valves, fitting, etc.
- Include provisions for appropriate future thermal energy metering

6.2 Renewable Strategies: Solar PV

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

Effective solar PV installations require access to adequate sunlight as well as the space needed to house the panels. This creates constraints for a high rise residential building, typified by a small roof area relative to total conditioned area. While wall area may also house solar PV panels, it is unlikely this area would receive adequate sunlight in an urban downtown setting.

While the Proposed Development is currently aiming to achieve Tier 1, if this project chooses to pursue Tier 2 there are some solar related requirements that must be met. The site would be required to accommodate future connections to solar PV or solar thermal technologies for 1% of the total building energy (TGS Tier 2 Credit GHG 2.1). Solar ready features that should be incorporated into their design include:

- Designate a portion of the roof for future solar PV and/or solar thermal
- Provide adequate structural capacity in the roof
- Install conduit to the roof from the main electrical room to accommodate future systems
- Designate wall area in the electrical rooms or future system controls
- Where possible, place HVAC or other rooftop equipment to avoid shading of future systems
- Consult NREL's Solar Ready Buildings Planning Guide[7]

Tier 2 also encourages the use of on-site renewable energy with credit GHG 2.2. Providing a minimum 5% of total building energy load via renewable energy sources (or 20% through geo-exchange) can meet this optional credit's requirements.

Given the approximate total roof area of the development, it is estimated that at most 554 m^2 may be available for solar energy production considering shading, minimum outdoor amenity areas, and mechanical requirements, resulting in the following levels of production. Toronto's green roof by-law provides exemptions to green roof area for roof area dedicated to solar PV.

[7] http://www.nrel.gov/docs/fy10osti/46078.pdf

Table 5 - Predicted Solar PV Production Potential

System Size (kW)	80
System Size (m^2)	554
Annual production (kWh)	92,000
% of energy requirement (TGS v3 Tier 1)	1.1 %
% of energy requirement (Towards Net Zero)	2.5 %

If rooftop solar PV is maximized, the potential PV system is predicted to be able to provide **1.1%** of the TGS v3 Tier 1 scenario annual energy consumption and **2.5%** of the *Towards Net Zero* scenario energy consumption. Combining solar production with battery storage would maximize the benefits of a solar array by allowing for load shifting and demand reduction. Given the intent of net zero development is to provide all remaining energy with renewable sources, it is evident that additional sources of on or off-site renewable energy would be required to make up the remaining energy consumption to reflect a true net zero community.

6.3 Additional Advanced Energy Solutions

Other advanced energy solutions that the Proposed Development could consider include:

Geothermal: A piping network which takes advantage of stable earth temperatures to provide heating in the winter and cooling in the summer. Coupled with Heat Pumps or VRFs in the space. Typically, expensive, though cost efficiencies may arise when developed at a community scale. Geothermal developments also rely on balanced load profiles. As this project is heavily commercial, a geothermal system may need to be supplemented to meet all loads.

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

Wind: While more common at a utility scale, wind turbines can be situated in an urban setting to generate renewable electricity locally. Size requirements may limit applicability.

Spectrally Selective Glazing: Glazing which tints in response to solar radiation, sun position, or weather conditions, reducing glare and solar gain within the building. Maximizes quality views while reducing cooling loads.

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

Wastewater Heat Recovery: A specialized heat exchanger which draws heat from outgoing waste water pipes in a building to offset heating loads. Large amounts of heat can be recovered with minimal change to conventional design.

CHP / Cogeneration: A gas fired engine used to locally generate electricity, allowing waste heat to be used to offset space and water heating. Biomass fueled CHP is a renewable source alternative to natural gas. In addition, an absorption chiller can be added to provide cooling (tri-generation).

Ice Thermal Storage: Storage of thermal energy, using electricity to create ice during low demand overnight periods to offset cooling demand during peak periods.

Solar Air Heater: Work by drawing incoming air through a transpired solar collector for pre-heating, reducing ventilation heating load.

Anaerobic Digestion Biogas: Community wide collection of organic waste for production of biogas, a renewable alternative to natural gas.

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

These solutions may be analyzed further as design progresses, and additional energy technologies can be evaluated on their merits as they emerge.

7 Energy Resilience

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

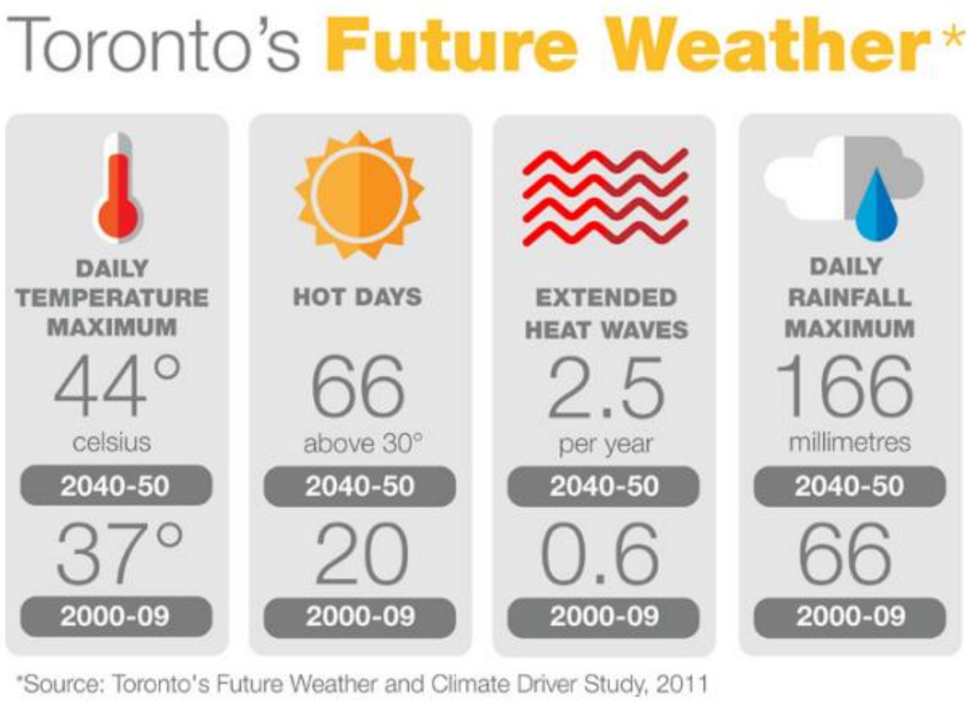

Figure 8 - Toronto Predicted Future Weather Patterns

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

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

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

Table 6 - Emergency vs. Back-up Power Requirements

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

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

While increasing back-up power capabilities can improve resiliency, passive design is vital to ensuring that occupants are able to stay in the building during a power outage. One typical criteria used in gauging building resilience in buildings is measuring the interior temperature 72 hours and two weeks after a power failure. The better a building is able to maintain its temperature without mechanical conditioning; the longer people will be able to remain in place. The *Zero Emissions Building Framework* analyzed each Tiers performance against these standards. The results are summarized in the Figure below:

Table 7 - Resilience of Various Performance Levels

Tier	72h Power Off Winter Temperature Low (°C)	2 Week Power Off Winter Temperature Low (°C)
OBC SB-10	9.9	0.9
TGS v3 Tier 1	13.5	5.8
TGS v3 Tier 2	14.6	7.6
TGS v3 Tier 4 (near net zero)	19.7	18.3

As the building envelope improves performance with increased performance Tiers (detailed suggestions in Section 3.1), the building is better able to maintain internal temperature in a power outage situation. In the case of the Tier 4 (neat net zero) scenario, the building is able to maintain an impressive 18.3 °C, even after two weeks without power. While a two-week outage is likely an extreme, improved resilience will have a major effect on vulnerable populations such as children and seniors.

Another strategy to improve resilience for residents is to provide an **area of refuge** within the building. The designated space would need to provide minimum levels of heating, cooling, lighting, potable water, and power during power outages for a minimum of 72 hours. This would allow residents to remain in the building during a power outage and to keep warm or cool, store medicine, charge communication devices and share updates.

The development team is encouraged to review the *Minimum Backup Power Guidelines for Multi-Unit Residential Buildings*[8] for additional guidance.

Connection to a District Energy System also improves the resilience of the development. District energy improves the reliability and availability of power supply by not depending on the centralized grid. This allows the building to provide energy for both emergency and non-life safety requirements during times when the grid is failing.

If the development chooses to pursue Tier 2 or higher, the development will be required to fill in a *Resilience Checklist*[9] (See Appendix C). While only required for higher performance Tiers, the design team is encouraged to review the checklist even if only pursuing Tier 1. While there is no obligation to incorporate any specific resiliency measures into the design, the checklist acts as a helpful tool to explore resiliency issues for the project.

8 EMBODIED ENERGY

While the energy used to operate the building is typically discussed throughout design, the energy required to extract, manufacture, and transport a building's materials, as well as the energy used during construction is often forgotten. This is known as embodied energy, and can be a significant amount of energy depending on the materials and methods used in construction. When a building is developed, the materials used (particularly for structure) are discarded in the demolition process which results in the loss of embodied energy. As an example, typical concrete has approximately 1,984,668 MBTU/litre of embodied energy. Comparatively, gasoline has approximately 431,728 MBTU/litre of embodied energy[10]. The is equivalent to 4600 L of gasoline for every liter of concrete poured. Steel or wood both have less embodied energy than concrete and may be a better choice of material depending on the application. In new buildings, as envelope details are improved and more passive house designs are considered, the amount of construction material can increase which would further increase the embodied energy of the building.

It is important to consider a new building's materials and how the embodied energy from the existing site can be salvaged during the early stages of design. The Athena Sustainable Material Institute has produced a free software tool that allows developers, and their consulting team to track the embodied energy associated with their design[11]. Additionally, this tool can be used to improve knowledge of the embodied energy that already exists on site, and help make informed decisions on how to reduce the loss of embodied energy for the project. While outside the scope of this report, the project team is encouraged to use this software during design to stay informed about the energy involved in building the proposed development. The project team is also encouraged to reuse or recycle existing materials on site wherever it is deemed feasible.

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

[9] http://wx.toronto.ca/inter/clerks/fit.nsf/0/3d0af0e4d40adc8b852582e500625cd3/$File/Toronto%2BGreen%2BStandards%2BVersion%2B3.0%2BChecklist%2BResilience%2BPlanning%2BNew%2BConstruction.pdf

[10] https://www.go-gba.org/embodied-energy/

[11] http://www.athenasmi.org/

9 OTHER TORONTO GREEN STANDARD V3 ENERGY, EFFICIENCY, GHG & RESILIENCE CREDITS

Under current program rules, projects that are pursuing the Toronto Green Standard Program Tier 2, 3, and 4 are eligible to receive a partial refund of development charges. Based on stats dated July 4th 2019, there are 204 one-bedroom suites, 221 two-bedroom suites, and 51 three-bedroom suites. The potential refund for this project is shown in Table 7 below.

Table 8 - City of Toronto Development Charge Refund TGS Tier 2, 3, and 4 Cap - Effective November 1 2018

Category	Amount	Project Count
Residential		
Single detached and semi-detached	$4,713	0
Apartment – two bedroom and larger	$3,007	272
Apartment – one bedroom and bachelor	$2,051	204
Multiple (all multiples)	$3,822	0
Dwelling room	$1,273	0
Non-Residential use (per square meter ground floor area)	$34.77	394.8
Maximum Estimated Development Charge Refund		**$1,250,035**

While this project is currently estimated to receive up to **$1,250,035 as a development charge refund**, this estimate is subject to change and is dependent on project statistics as well as City of Toronto approvals. The development charge refund caps have changed over time, and the project's potential refund will be based on the caps in place when fees are paid. In addition, when approving TGS v3, city council directed City Planning to explore additional financial and non-financial incentives to encourage developers to meet Tier 2[12]. To date, no changes have been made to the incentive structure but this may change in the future.

If the project chooses to pursue Tier 2 or higher, this refund would help to offset the increased costs that may be associated with design changes. The design team is encouraged to explore a full Tier 2 feasibility study to explore this opportunity.

Additional TGS v3 energy related credits that this project may consider are listed below:

<u>Mid to High Rise Residential and Non-Residential Development</u>

GHG 4.1 – Energy Benchmarking & Reporting (Core Tier 2 Requirement)

The buildings must be registered on ENERGYSTAR® Portfolio Manager for energy benchmarking. Energy and Water Reporting and Benchmarking (EWRB) requirements are currently coming into effect in Ontario which will require similar requirements. This credit should pose no increased work on the development as a whole.

GHG 4.2 – Best Practice Commissioning (Core Tier 2 Requirement)

Projects will be required to commission the project using best practice commissioning. This is an existing Tier 2 requirement and many developers routinely include commissioning on their projects.

[12] http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2017.PG23.9

GHG 4.3 – Air Tightness Testing (Core Tier 2 Requirement)

Whole building air tightness testing will be required for Tier 2 developments. This is currently only done in a very limited capacity in the Toronto market, though it has been routinely done in other North American markets with similar air tightness testing requirements (Seattle). There will be no performance level that must be achieved, though credit can be taken in As-Constructed Energy Models if the building performs below the NECB 2015 default value of 0.25 $l/s/m^2$ at 5 Pa.

GHG 4.4 – Submetering (Optional Tier 2 Requirement)

This credit requires all residential units to be equipped with thermal energy meters, and all non-residential buildings to include a thermal meter for each tenant.

10 Conclusions/Recommendations

Through the use of a high performing envelope and high efficiency HVAC equipment, carbon, thermal demand, and energy use minimum (TGS v3 Tier 1) performance targets will be achieved.

As design progresses, the design team will engage with the energy modelling process early during Site Plan Approval to evaluate the design alternatives expressed in this report. The project team is encouraged to explore the feasibility of higher tiers of energy and carbon performance, as well as draw on the *Towards Net Zero* building design strategies to create a truly sustainable development.

Energy predictions in this report are preliminary in nature, and an energy model will be used to fully evaluate the impacts of the recommendations in this report. The design alternatives discussed in this report are recommendations only, and decision to incorporate them into the final design is up to the discretion of the project team.

If the design team chooses to pursue advanced measures such as district energy system connections and solar PV, further detailed analysis above the typical SPA modelling requirements will be needed. Design strategies that would support both of these decisions have been included in this report.

Finally, design options are presented to provide enhanced resilience for the Proposed Development and community, and should be evaluated further on a feasibility and cost basis.

Appendix A – Energy Conservation Measures Summary

Energy Conservation Measures	Energy Impact	Cost Impact	TGS Tier?
BUILDING ENVELOPE – PASSIVE MEASURES			
Opaque Wall –			
Some continuous insulation, reduced balcony area, improved thermal bridges	HIGH	LOW	1
Continuous insulation, reduced or no balcony area, improved thermal bridges	HIGH	MID	2
Maximized continuous insulation (ex. spray foam), no balcony area, greatly improved thermal bridges	HIGH	MID	4
Vision Wall			
40% vision to wall ratio	MID	LOW	1,2,4
High performance double glazed assembly, thermally broken aluminum frame	MID	LOW	1
Triple glazed assembly, thermally broken aluminum frame	HIGH	HIGH	2
High performance triple glazed assembly, thermally broken aluminum or fiberglass frame	HIGH	HIGH	4
Infiltration – Code defaults assumed, no validation with testing			
Improved air tightness – improved detailing	MID	LOW	1,2,4
Whole building air tightness testing – mandatory for Tier 2 and above, not currently widely done in Toronto	MID	LOW	2,4
MECHANICAL + ELECTRICAL – ACTIVE MEASURES			
Ventilation – 30-60 cfm/suite in corridors, 10-50% above ASHRAE 62.1 in all other areas			
Corridor ventilation - 30 cfm/suite	HIGH	LOW	1
Corridor ventilation - 15 cfm/suite	HIGH	LOW	2
Corridor ventilation – ASHRAE 62.1 levels - requires compartmentalization to remove pressurization requirements	HIGH	MID	4
ASHRAE 62.1 ventilation in other areas	MID-HIGH	LOW	1,2,4
Mechanical System – Fan coil or water-source heat pump, conventional mechanical plant			
Water-source VRF HVAC system	MID	HIGH	2,4
Air-source heat pump / VRF HVAC system	HIGH	HIGH	4
65% Efficient air side heat recovery	HIGH	LOW	1
75% Efficient air side heat recovery	HIGH	LOW	2
85% Efficient air side heat recovery	HIGH	MID	4

Energy Conservation Measures	Energy Impact	Cost Impact	TGS Tier?
EnergySTAR appliances	LOW	LOW	1,2,4
Low-flow plumbing fixtures for hot water fixtures – recommend 5.7 LPM lavatories, 5.7 LPM sinks, 6.8 LPM showers	HIGH	LOW	1
Low-flow plumbing fixtures for hot water fixtures – recommend 1.9 LPM lavatories, 3.8 LPM sinks, 6.8 LPM showers	HIGH	LOW	2,4
Sewage Heat Recovery	HIGH	MID	4
Central domestic hot water heat pump	HIGH	HIGH	4
Common Area Lighting – Code maximum lighting power densities, code minimum lighting controls			
30% reduction in lighting power density	MID	LOW	1,2
50% reduction in lighting power density	HIGH	MID-HIGH	4
Advanced Design Measures			
District Energy	LOW-HIGH	LOW-MID	2,4
On-site Renewable Energy Generation	LOW	HIGH	2,4

Appendix B – Detailed Expected Energy Performance

By Phase / Block

	145 Wellington St W		
	TGS V3 Tier 1	TGS V3 Tier 2	Towards Net Zero
	v3T1	v3T2	v3T4
Heating Gas (ekWh/m^2)	69.8	36.8	0.5
Heating Elec (ekWh/m^2)	2.1	2.8	4.5
DHW Gas (ekWh/m^2)	28.6	25.4	0.6
DHW Elec (ekWh/m^2)	0.0	0.0	4.1
Cooling (ekWh/m^2)	4.4	5.1	13.7
Heat Rejection (ekWh/m^2)	1.8	1.9	0.0
Lights (ekWh/m^2)	22.9	22.9	15.4
Plugs (ekWh/m^2)	23.7	22.5	20.1
Fans (ekWh/m^2)	9.7	6.9	5.7
Pumps (ekWh/m^2)	7.0	6.8	7.0
Electricity - Space Cooling (ekWh/m^2)	6.3	7.0	13.7
Electricity - Space Heating (ekWh/m^2)	2.1	2.8	4.5
Electricity - DHW Heating (ekWh/m^2)	0.0	0.0	4.1
Electricity - Base loads (ekWh/m^2)	63.3	59.0	48.2
Gas - Space Heating (ekWh/m^2)	69.8	36.8	0.5
Gas - DHW / Base Loads (ekWh/m^2)	28.6	25.4	0.6
Gas Use (eMWh)	4,975	3,146	56
Gas Intensity (ekWh/m^2)	98.4	62.2	1.1
Electricity Use (MWh)	3,623	3,479	3,565
Electricity Intensity (ekWh/m^2)	71.6	68.8	70.5
Total Energy Intensity (ekWh/m^2)	**171.4**	**133.5**	**72.1**
Total Energy (eMWh)	8,669	6,751	3,645
% Savings vs Tier 1	-	22%	58%
GHG intensity (kg CO_2e/m^2)	**20.0**	**15.0**	**4.7**
Total GHGs (tonnes CO_2e)	1,011	758	238
% Savings vs Tier 1	-	25%	76%
Thermal Energy Demand Intensity (ϵ	**70.0**	**44.2**	**15.0**
Total Thermal Demand (eMWh)	3,538	2,234	758
% Savings vs Tier 1	-	37%	79%

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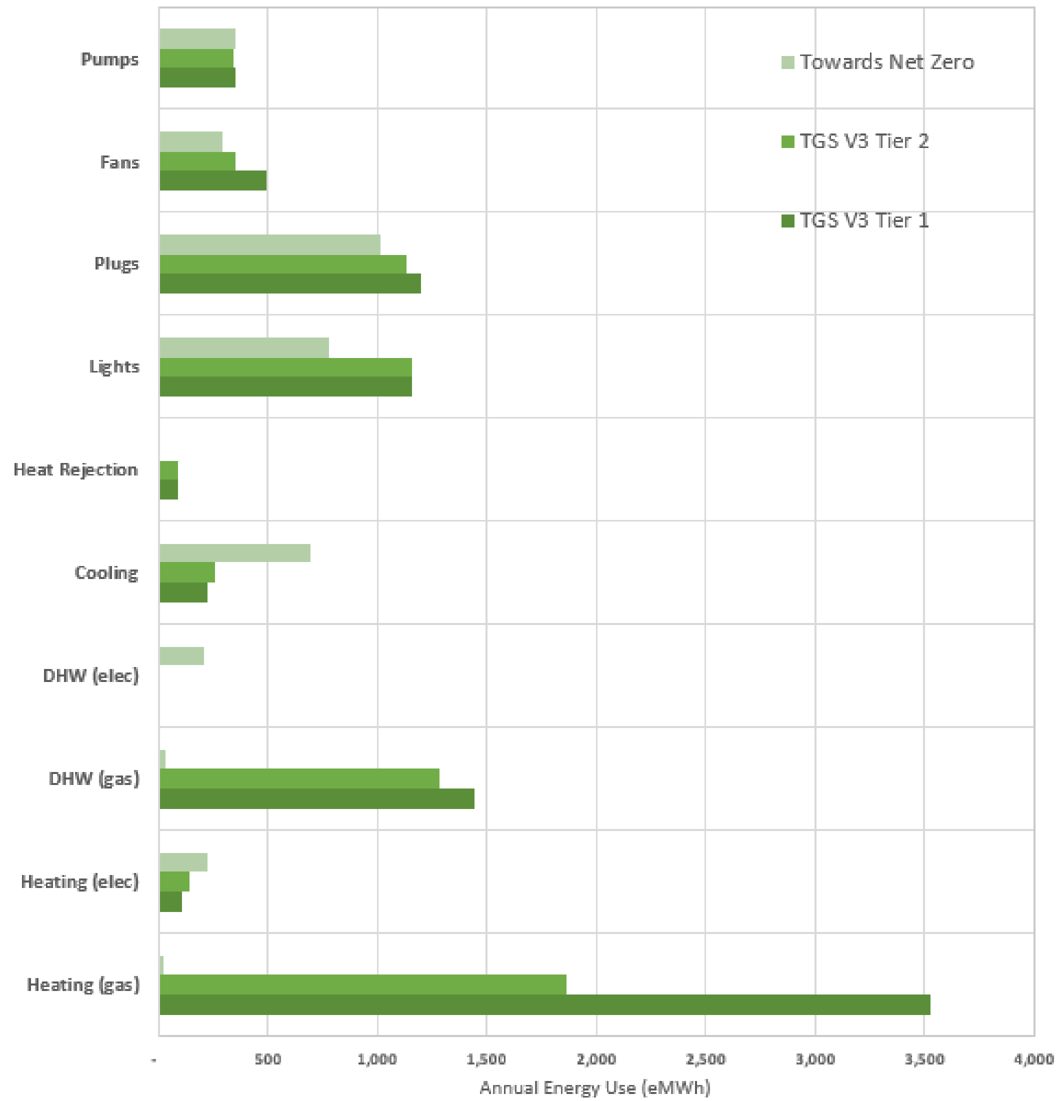

APPENDIX C – RESILIENCE CHECKLIST

TORONTO

Checklist - Toronto Green Standards Version 3.0

Resilience Planning New Construction

Why do we need a resilience checklist?

Improving the ability of the buildings to withstand the impacts of climate change and extreme weather is an important step towards creating a more resilient city and to protecting the health, safety and economic well-being of the city's residents and businesses. The aim of this checklist is to summarize the level of resilience planning undertaken for your development project.

What responses will help improve building resilience?

The overall impact of changes in Toronto's climate on the development sector includes: higher risk of flooding events, extreme heat and cold events, and power outages. To reduce the impact of these expected changes, new developments must be constructed in such a way as to mitigate flood events, improve thermal resilience, and extend the duration of back-up power generation.

Flooding Events An increase in the overall volume of precipitation and larger individual storm events create a higher risk of flooding in certain areas of Toronto. The Toronto and Region Conservation Authority (TRCA) provides flood plain mapping resources that help identify flood-prone areas of the city. Toronto Water conducts regular servicing studies, develops and maintains the City's Wet Weather Flow Management policy and guidelines for storm water management, and institutes the City's Basement Flooding Program to ensure residents and businesses are protected from back flow and sewage disruptions.

Extreme Heat & Cold Events The risks associated with the impact of extreme heat and cold events on vulnerable populations is an increasing concern in the City of Toronto. Measures to protect at-risk residents (e.g. the elderly, socially isolated, those with pre-existing illness, and young children) and those without access to air conditioning from excessive heat will therefore be important to include into the design and operation of Toronto's buildings. Higher levels of building energy performance improve passive survivability. Buildings designed with well insulated and sealed building envelopes, lower window-to-wall ratios or other passive building design strategies help to maintain liveable indoor temperatures with less energy and for longer periods of time under power outages during winter or summer.

Power Outages The impact of a warmer climate and more extreme weather events can have an effect on the reliability of our power supply. As temperatures rise, our use of air conditioning also increases, putting stress on the ability of the power grid to deliver electricity. Periods of extreme heat are increasingly leading to brownouts and blackouts, as are events in the fall/winter such as the December 2013 ice storm. Research from past events of this nature has shown that extended back-up power, community energy systems help to reduce both the likelihood and the impact of possible power outages and help communities to recover more quickly from a disruption.

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Checklist - Toronto Green Standards Version 3.0

Resilience Planning New Construction

A. Modelling Assumptions

For expected changes in climate across the Greater Toronto Area, consult Toronto's Future Weather and Climate Driver Study

Has any enhanced modelling using future climate data been conducted for the building site?

☐ Yes ☐ No If yes, what time period was considered?

What temperature minimums/maximums were considered in building design?

Temperature Low (°C): Temperature High (°C):

What variables were assumed for extreme heat events, if any?

Temperature Max (°C): Duration of events (days):

Frequency (events/year):

What variables were assumed for extreme flooding events, if any?

Daily Rainfall Max (mm): Duration of extreme rainfall events (days):

Frequency (events/year):

Risk Assessment/modelling undertaken (Y/N), method used:

B. Thermal Resilience & Safety

For expected changes in climate across the Greater Toronto Area, consult Toronto's Future Weather and Climate Driver Study

What measures have been taken to reduce the impacts of heat waves?

Building - passive

- ☐ Higher roof R values
- ☐ Operable Windows
- ☐ Cool/green roof
- ☐ External window shading devices
- ☐ Tenant emergency preparedness guides
- ☐ Other passive ventilation strategies
- ☐ Higher envelope R values
- ☐ Window films
- ☐ High albedo envelope materials
- ☐ Triple glazed windows

Building - active

- ☐ Indoor refuge area with cooling
- ☐ Ceiling fans
- ☐ Centralized air conditioning

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Checklist - Toronto Green Standards Version 3.0

Resilience Planning New Construction

Building - site

- ☐ High albedo landscaping materials
- ☐ Soft landscaping
- ☐ External pools (eg. splash pads)
- ☐ Reduced hardscapes
- ☐ Other building shade structures
- ☐ Use of solar PV as shades
- ☐ Shade trees/shrubs
- ☐ Outdoor shaded amentiy space with seating
- ☐ High albedo hardscapes, including parking lots
- ☐ Other

Has a refuge area with cooling been provided in the building?

☐ Yes ☐ No If so, what is the total area? (m^2)

Refuge areas should be a minimum of 93 m^2 (1000 square feet), and/or 0.5m^2/occupant

What critical services are provided?

If not, what is the location of the closest emergency warming or cooling centres during an emergency?

C. Back-up Generation

Consult the City of Toronto's Minimum Backup Power Guidelines for MURBs for additional information on critical services in residential buildings.

Measures have been used to reduce the building's energy demand on the grid?

- ☐ On-site solar PV
- ☐ CHP system
- ☐ On-site solar thermal
- ☐ Ground source heat pump
- ☐ On-site battery storage
- ☐ Microgrid connected
- ☐ District energy ready
- ☐ Smart grid ready
- ☐ Building-integrated windd turbines
- ☐ Other

Describe the Back-up power/emergency generator system selected?

Is storage adequate to provide 72 hours of back-up generation? ☐ Yes ☐ No

Total storage capacity (kW): Total back-up generation fuel (units):

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Checklist - Toronto Green Standards Version 3.0

Resilience Planning New Construction

Critical services have been included into back-up power generation calculations?

- [ ] Passenger elevator(s)
- [ ] Security systems
- [ ] Unit space heating
- [ ] Unit space cooling
- [ ] Refuge area cooling
- [ ] Refuge area lighting
- [ ] Refuge area electricity
- [ ] Refuge area heating
- [ ] Sump Pumps
- [ ] Hot water boilers/pumps
- [ ] Domestic water booster pumps
- [ ] Other

D. On-site Flood Mitigation

Is the building in a known flood plain? [ ] Yes [ ] No

List any flood prevention measures used to mitigate the impact of heavy rainfall events and associated risk of flooding within the building:

- [ ] Flood proofed Electrical and HVAC Systems (located above grade or 1st floor)
- [ ] Back-up generator/fuel located above grade or 1st floor
- [ ] Ground floor electrical circuits located in ceiling
- [ ] Waste water back flow prevention
- [ ] Water tight utility conduits
- [ ] Storm water back flow prevention.

List the strategies used to accommodate heavy rainfall events under the Stormwater Retention (Water Balance) section of the TGS:

Resilience Planning New Construction

E. Manager & Tenant Preparedness

Will building management have access to a vulnerable person's list? ☐ Yes ☐ No

If so, has building management been made aware of the location of the preparedness kit? ☐ Yes ☐ No

What additional resources for emergency preparedness have been made available to building managers, operators, and/or tenants?

Completed By:

Name (First,Last):

Position Title:

Date (yyyy-mm-dd):