TIMES GROUP CORPORATION

ENERGY STRATEGY REPORT

5800 YONGE STREET, TORONTO

AUGUST 20, 2019

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WSP
2300 YONGE STREET
SUITE 2300
TORONTO, ON
M4P 1E4

T: 416-487-5256
F: 416-487-9766
WSP.COM

SIGNATURES

PREPARED BY

Hassan Bokhary, E.I.T., CEM, LEED GA
Performance Analyst

REVIEWED BY

David Rulff, MASc, LEED AP BD+C
Technical Lead

Sean Herszkowicz, LEED AP BD+C
Project Manager

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1 EXECUTIVE SUMMARY

Times Group Corporation retained WSP to undertake an Energy Strategy Study for a proposed new residential development in Toronto. The site is located on 5800 Yonge Street, north of Hendon Avenue.

The proposed development is scheduled to be completed in two phases. Both phases consist of two residential towers. Phase 1 includes Tower 1 – 38 storeys, Tower 2 – 35 storeys and a 3 storey podium for a total of 771 units. Phase II includes Tower 3 – 44 storeys and Tower 4 – 38 storeys for a total of 787 units. The development will also include a four storey underground parkade beneath both phases. The total gross floor area of the development is 124,873 m^2 (including the parkade).

The purpose of this Energy Strategy Study is the early identification of opportunities to integrate design solutions that meet the following guiding principles outlined in the City of Toronto's Energy Strategy Terms of Reference. A holistic integration of these principles can help contribute to improved triple-bottom line outcomes (environment, economy, society).

To provide a contextual basis for this study of imagining what is possible, the following chart summarizes key metrics and performance benchmarks developed by the City of Toronto. The metrics include Energy Use Intensity or EUI (total energy used per building area), Greenhouse Gas Intensity of GHGI (based on the current Ontario electricity grid) and Thermal Energy Demand Intensity (a new metric reflective of the thermal performance of the envelope). The chart shows the current Baseline (2017 Ontario Building Code), the likely minimum target and the maximum likely performance potential.

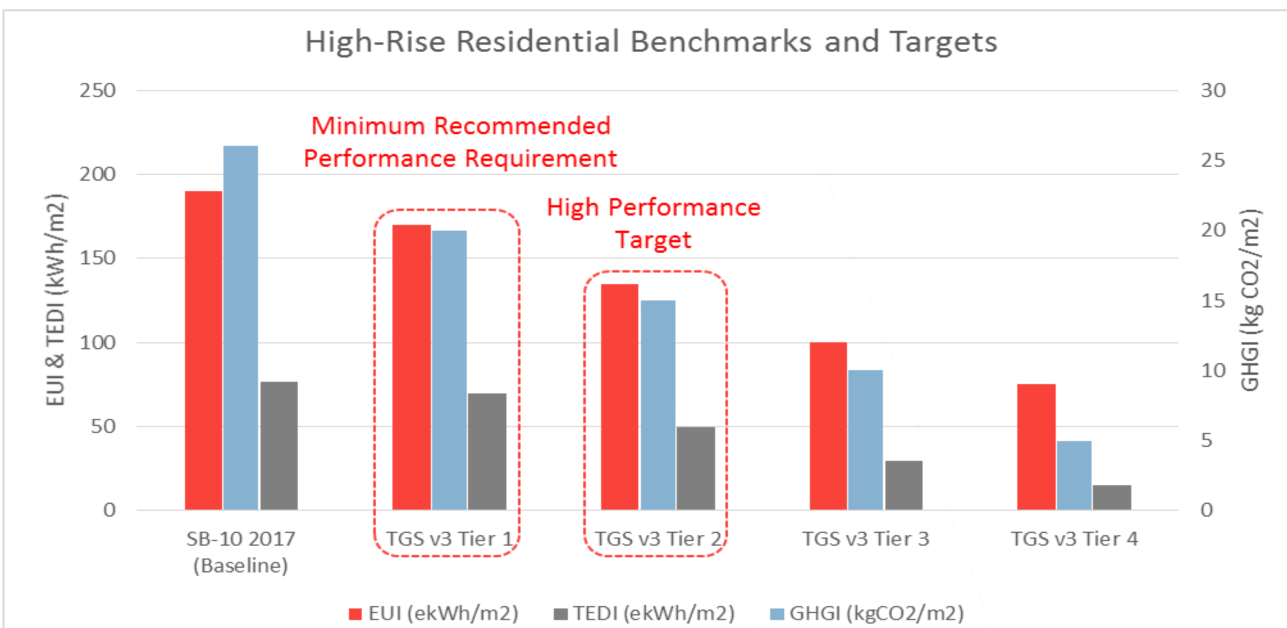


Figure 1: Energy Strategy Performance Benchmarks and Targets

We considered 30 energy, carbon, and resilience strategies of potential benefit for the proposed development. These were compared using a matrix analysis approach. 18 strategies were analyzed in more detail using high-level performance analysis tools to estimate potential energy, utility cost and GHG reduction potential. These measures include:

— Low Window-to-Wall Ratios

— Improved Envelope Performance

— Air Tightness Design and Testing

— LED Lighting + Daylight Harvesting

— Plug Load Reduction

— Improved Heat Recovery Effectiveness

— DHW Fuel-Switching

— Reduced Domestic Hot Water Fixture Flows

— Low-Carbon HVAC Systems (i.e. Air-Source Heat Pumps, Ground-Source Heat Pumps, etc.)

— Transpired Solar Thermal Collection

— Building Integrated Solar Photovoltaic Panels (BIPV)

As shown in the Figures below, together these strategies are estimated to have the potential to significantly reduce building energy use and GHG emissions. Due to much lower natural gas prices, measures which reduce carbon (such as switching to electric heating and DHW) do so at the expense of utility costs. As such, the utility costs are reduced to a lesser extent. All of the measures should be implemented using the Integrated Design Process which can yield additional capital cost and schedule reductions.

Based on our analysis, packages of energy conservation measures could be implemented to achieve TGS Tier 2 (Higher Performance) or even Tier 4 (Near Zero Emissions). This will make the project eligible for Development Charge rebates as well as Energy Incentives through programs like Savings By Design.

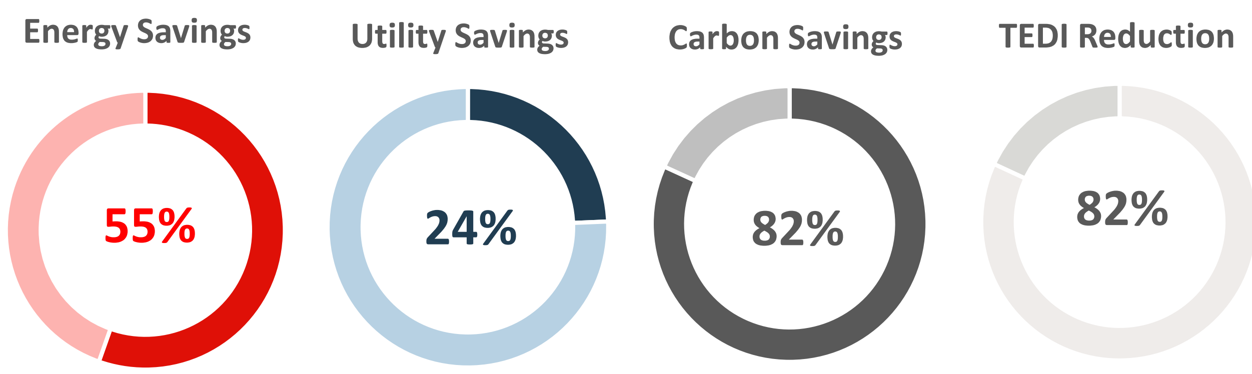


Figure 2: Maximum Potential Savings from All Measures

There are some trade-offs possible that can optimize the mix of energy, utility and carbon savings. In particular, fuel-switching has a dramatic impact on optimizing utility savings vs. carbon savings. For example, the above graph shows that switching to all-electric heating can reduce both energy use and carbon emissions. However, some isolated fuel-switching measures can reduce utility costs, but increases carbon emissions. Therefore, if carbon savings are more desirable, switching to electric heating can increase the total carbon savings to 80%, but reduce utility cost savings compared to gas heating.

The individual impact of all 18 measures is shown in the next Figure to highlight the differences in energy, utility and carbon savings as compared to a TGS v3 Tier 1 baseline. A summary of the savings from all measures that were quantitatively analyzed is presented in Section 5.3.15.

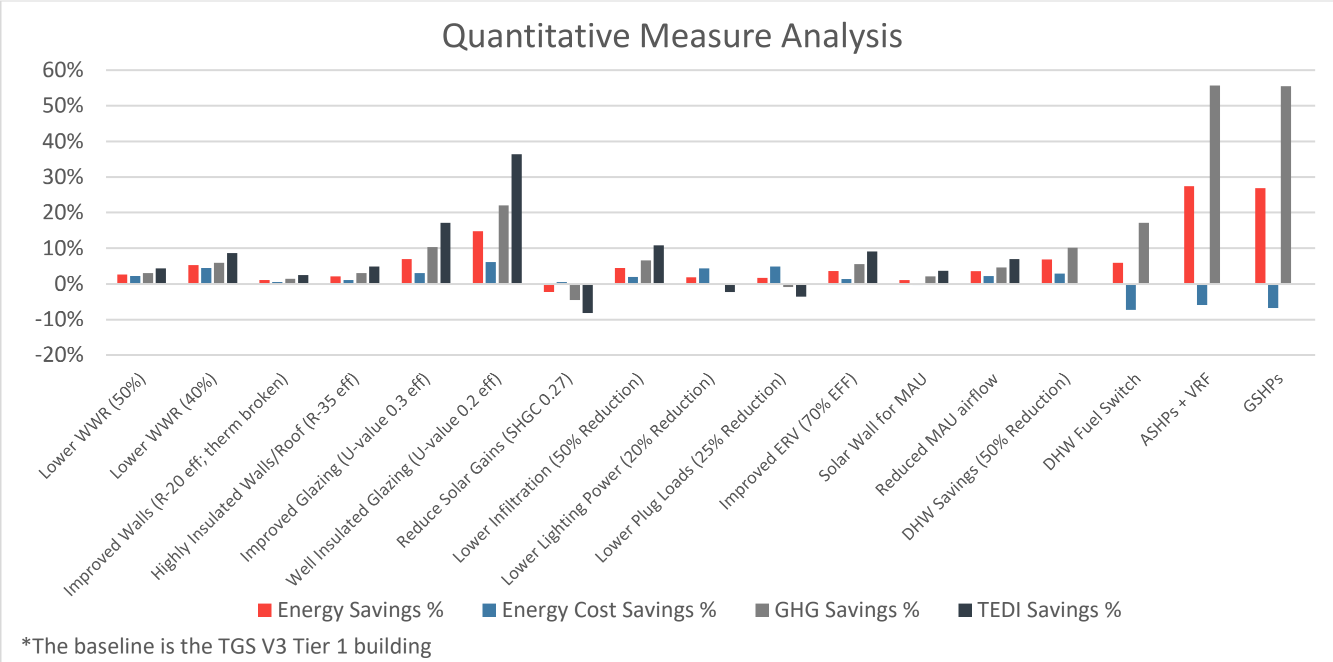


Figure 3: Savings from Individual Measures

BUNDLE 1 – TGS V3 TIER 1 BASELINE	BUNDLE 2 – TGS V3 TIER 2 HIGHER PERFORMANCE	BUNDLE 3 – TGS V3 TIER 4 NEAR ZERO EMISSIONS
60% WWR	50% WWR	40% WWR
R-12 (effective) Spandrel	Address Thermal Breaks	R-35 Walls/Roof
U-0.4 Glazing	U-0.3 Glazing	U-0.2 Glazing
SHGC 0.35	SHGC 0.27	SHGC 0.27
OBC SB-10 Lighting	80% LPD; EnergyStar Appliances	80% LPD; EnergyStar Appliances
50% Eff ERV	Improved 70% Eff ERV	High Performance 90% Eff ERV
	Oversized Solar Wall MAU	Oversized Solar Wall MAU
		50% DHW Savings; ASHP
		GSHP

Based on these findings, we recommend several next steps towards a low energy/carbon development. The contents of this report are intended to provide opportunities for further exploration during the Schematic and Design Development phases of the project. Final decisions on what level of performance to target for the development and which measures are explored and implemented remain with the Developer.

— Establish overall performance targets, and include these in a Basis of Design document to instruct the Design Team on the desired development outcomes;

— Select the design strategies to further investigate on this development, using the list provided;

— Adopt integrated design methodologies and set standards for reporting during design, construction and operation to ensure buildings meet or exceed the targets;

— Explore high efficiency solutions in more detail to develop a menu of solutions that will work together to meet or exceed the targets set; and

— Validate and adjust design strategies using whole-building energy simulation during the SPA process.

— If Tier 2 is pursued, review envelope design and impact on TEDI achievability.

2 INTRODUCTION

2.1 PURPOSE

The purpose of the Energy Strategy is the early identification of opportunities to integrate local energy solutions that are efficient, low carbon and resilient. The findings will inform later studies including the Toronto Green Standard Energy Modelling Report.

The report is intended to align with the City of Toronto's new Energy Strategy requirement which applies to new development including residential, non-residential and/or mixed use and may apply to industrial development:

- With a total gross floor area of 20,000 square metres or more; or
- Within a Community Energy Plan area approved by Council.

It is required in association with the following application types:

- Official Plan Amendment;
- Zoning By-Law Amendment; or
- Plan of Subdivision.

We understand that the proposed development meets these criteria, and so an Energy Strategy Study is required as part of the application for OPA and zoning by-law amendment.

The Energy Strategy is intended to contribute to achieving the City's objectives to reduce energy consumption and GHG emissions and become more resilient. Official Plan policy 3.4.18 states that "innovative energy producing options, sustainable design and construction practises ... will be supported and encouraged in new development … through: d) advanced energy conservation and efficiency technologies and processes that contribute towards an energy neutral built environment".

Undertaking an Energy Strategy at the application stage for a Plan of Subdivision, Official Plan or Zoning Bylaw Amendment facilitates the following key outcomes:

- Opportunity for site buildings to take advantage of existing or proposed energy infrastructure, energy capture and/or solar orientation at the conceptual design stage.
- Consideration of potential energy sharing for multi-building development and/or neighbouring existing/proposed developments.
- Consideration of opportunities to increase resiliency such as strategic back-up power capacity.
- Identification of innovative solutions to reduce energy consumption in new construction and retrofit of existing buildings (if part of new development).
- Exploration of potential to attract private investment in energy sharing systems.

The contents of this report are intended to provide options for consideration during the schematic and design development phases of this project. Final decisions on what measures are explored and implemented remain with Times Group.

3 BACKGROUND

3.1 PROPOSED DEVELOPMENT

Times Group plans to develop a new residential development in Toronto. The site is located on 5800 Yonge Street, north of Hendon Avenue.

The proposed development is scheduled to be completed in two phases. Both phases consist of two residential towers. Phase 1 includes Tower 1 – 38 storeys, Tower 2 – 35 storeys and a 3 storey podium for a total of 771 units. Phase II includes Tower 3 – 44 storeys and Tower 4 – 38 storeys for a total of 787 units. The development will also include a four storey underground parkade beneath both phases. The total gross floor area of the development is 124,873 m^2 (including the parkade).

Below is the proposed concept rendering and site area.

Figure 4: Site Area for the Proposed Development

3.2 NEIGHBOURHOOD

The subject site is located eastern edge of a residential neighbourhood consisting of single family houses. Yonge Street bounds the site to the East. To the east of the site, there are a variety of building types ranging from retail stores, office buildings and a concentration of apartment towers. The Finch Station is located approximately 300m south of the site. The West Lot of the station is located directly south of the project site.

A new public road will be constructed just South of the site which will connect with the Beecroft Road extension. A new private road will be developed just north to fully enclose the site as seen in the proposed concept rendering.

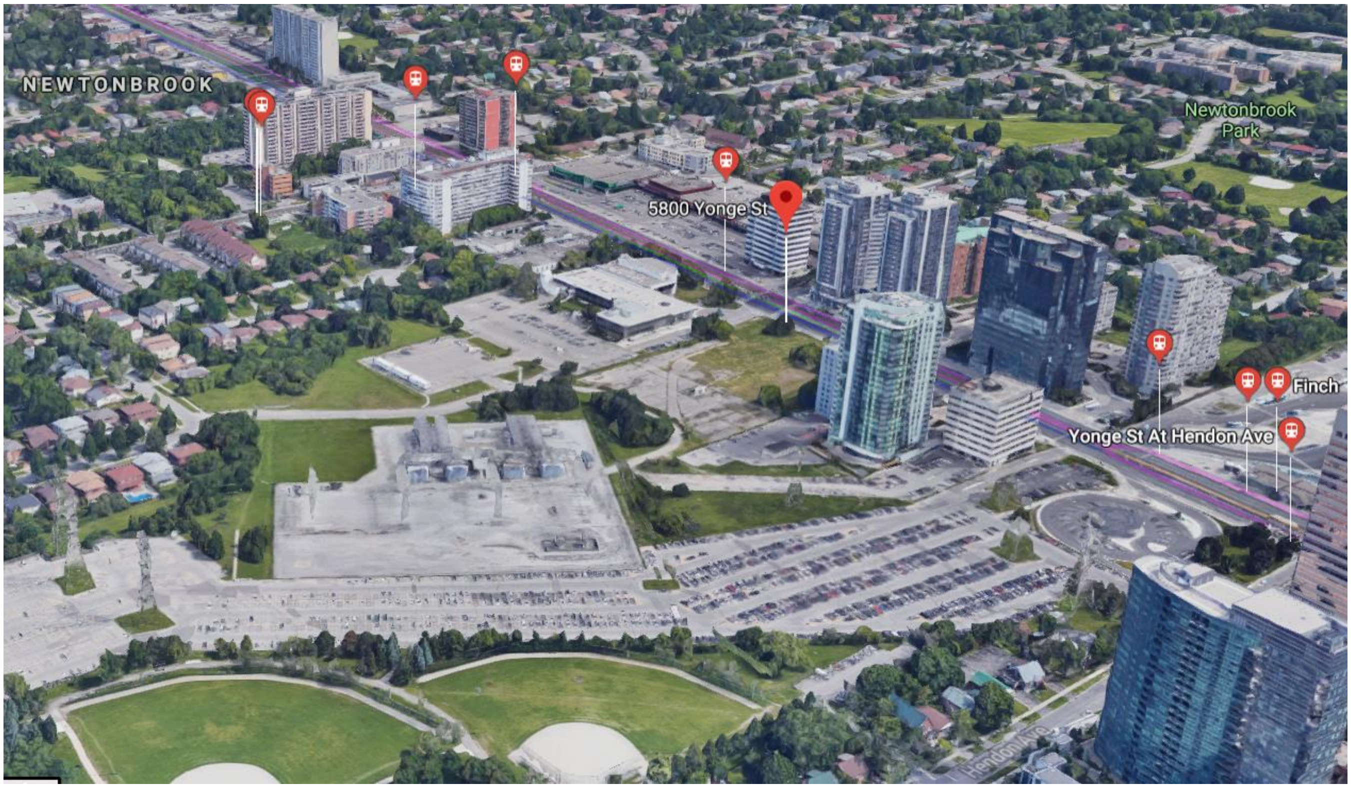


Figure 5: Nearby Buildings (North East View)

3.3 UTILITIES

The site is serviced by Toronto Hydro for electricity, Enbridge for natural gas, and by the City for domestic potable water. An understanding of Ontario-specific factors affecting costs of and carbon emissions from, electricity and natural gas is important for decision-makers when selecting site energy strategies.

To simplify calculations, we have prepared this report using the emissions factors and costs for utilities found in the table below. We have not accounted for the cost savings associated with load-shifting & demand response strategies using on-peak and off-peak consumption pricing and emissions factors, which would in reality account for decreased demand charges and the cleaner electricity generation mix associated with load-shifting & demand response strategies.

Table 1: Emissions Factors and Energy Prices Used in this Report

	G CO_2e/kWh	$/kWh
Electricity (Average)	50	0.16
Natural Gas	183	0.04

This table highlights the competing goals of carbon and energy cost (utility) savings. In general, measures which save electricity have high utility savings but only moderate carbon savings (since the electricity grid is relatively clean). Natural gas measures show much lower cost savings (since natural gas is almost 4 times less expensive), but show much higher carbon savings (natural gas is almost 4 times more GHG-intensive). Fuel switching from gas to electricity will therefore greatly reduce carbon emissions, but will likely increase utility costs. It is important to note that this analysis does not account for future carbon taxes which might change the current economic conditions.

4 ENERGY PERFORMANCE BENCHMARKING

4.1 BASELINE CASE

Energy Benchmarking is a critically important exercise during the initial planning and design stages of a project. It provides context behind energy reduction strategies, compares the proposed design against industry/market peers, and establishes potential performance targets.

The Baseline case selected for this report is a building meeting Ontario's current code requirements (SB-10 2017) and Toronto Green Standard Version 3 Tier 1 (key inputs can be found in Section 4.3). Energy and greenhouse gas emissions savings presented throughout the report are in reference to the TGS v3 Tier 1 Baseline.

Figures 6 and 7 show the estimated energy and greenhouse gas end-use breakdowns, based on a baseline model built to TGS v3 T1 standards. This prototype is in line with our understanding of current residential development in Toronto.

As can be seen from the figures below, heating and domestic hot water (DHW) have a large impact on GHG emissions (due to natural gas being about 3.7 times more carbon-intensive compared to current grid electricity). Carbon reductions therefore must be focused on reducing heating and domestic hot water loads. However, electricity is more expensive than natural gas, which means certain systems which reduce carbon, may negatively impact utility costs.

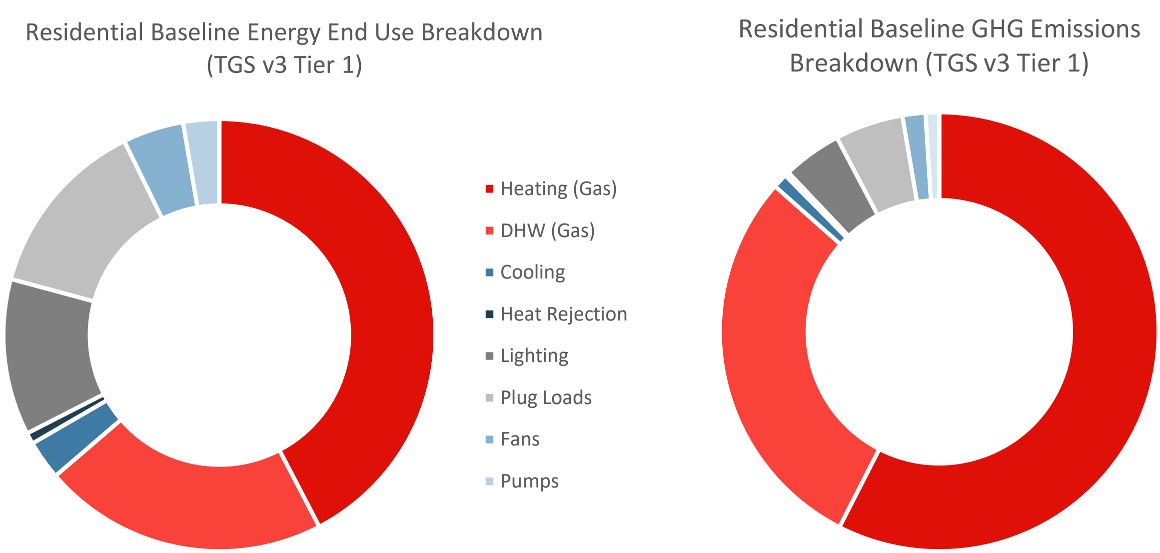


Figure 6: Baseline Energy End-Use Energy Breakdown and Figure 7: Baseline GHG End-Use Breakdown

The next series of Figures summarize the energy and GHG end-use breakdown for several progressive benchmarks and targets based on work done by the City of Toronto, which is seeking a path towards zero-carbon development in 2030.

The Figures show the current Baseline (TGS Version 3 Tier 1) followed by ratcheting Tiers in the program. According to the City's framework, the intent is to continue updating the minimum level of compliance every 4 years. Therefore, it is important to contemplate what will be "acceptable" in the market by the time this proposed development is in time for building permit application. For example, the current Version 3 voluntary Tier 2 level will be mandatory in 2022.

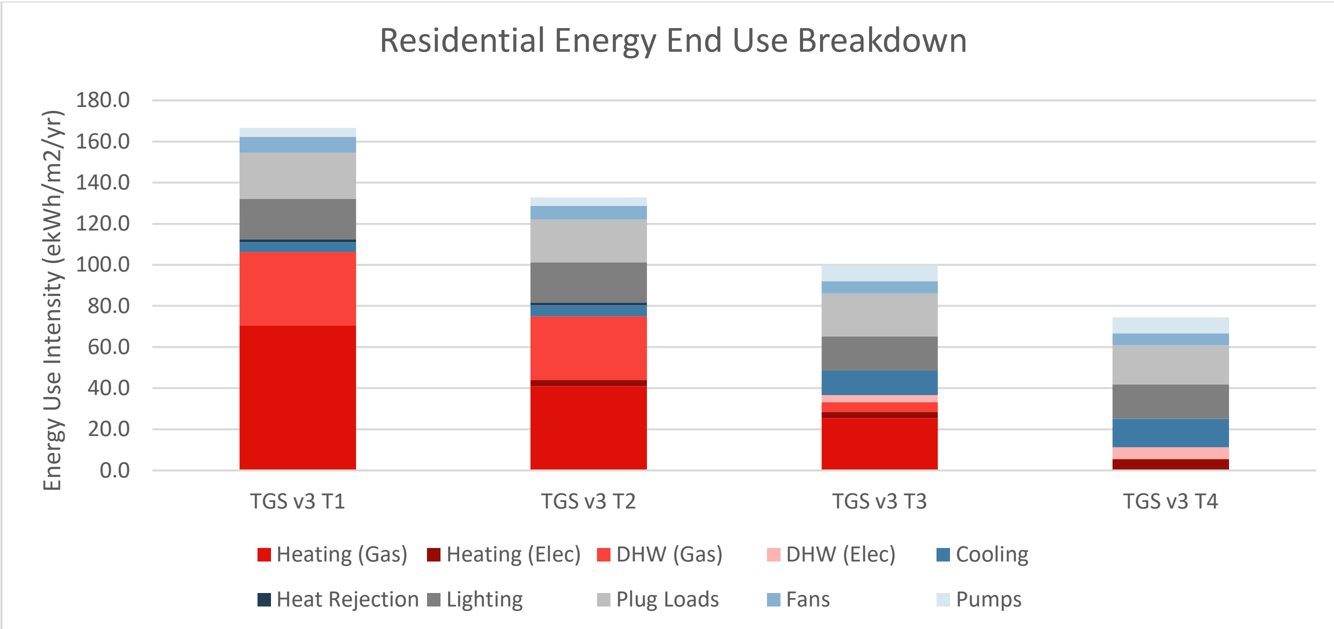


Figure 7: Energy End-Use Breakdown Benchmarks

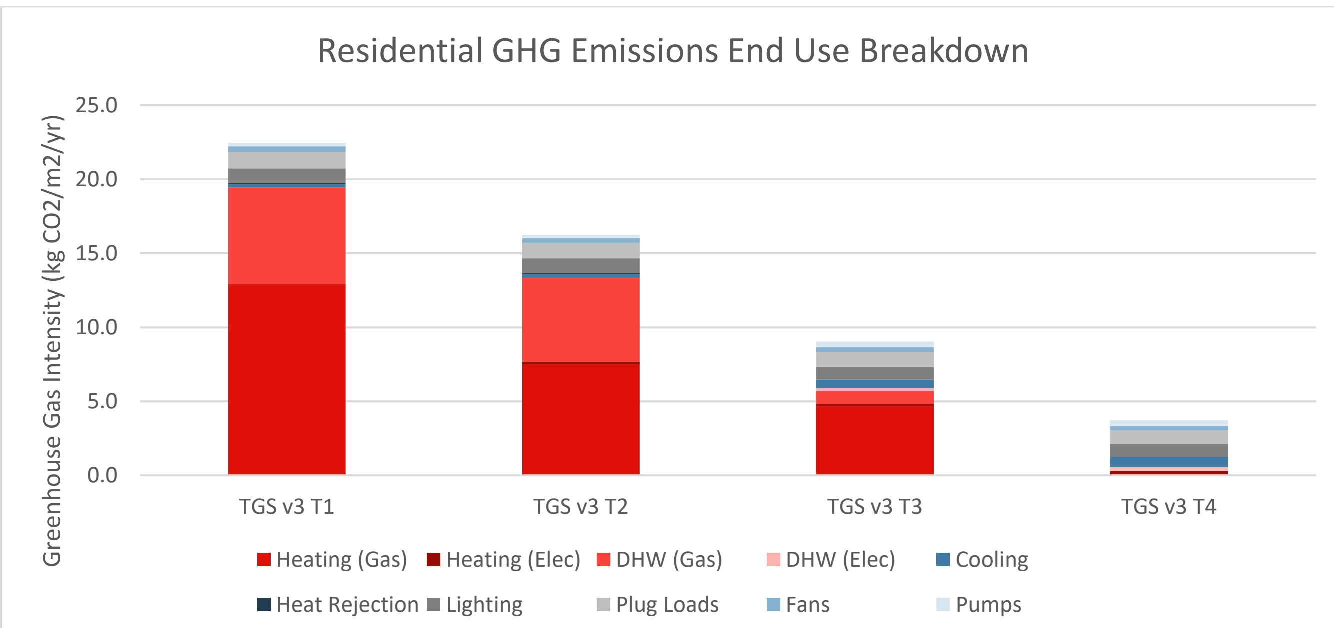


Figure 8: GHG Emissions End-Use Breakdown Benchmarks

A number of insights can be extracted from this benchmarking analysis:

— Residential building uses the vast majority of energy on space and DHW heating. Since the most common heating fuel in Ontario is natural gas, which is carbon-intensive, the GHG impact of heating is even higher. While heating represents 60% of total Baseline energy use, it accounts for more than 80% of total GHG emissions.

— The Baseline occupant loads (plug loads and lighting) are significant (they account for 25% of total energy use). The future Tiers envision significant improvements in the envelope and HVAC system. As a result, the share of occupant loads grows disproportionately to nearly 50% of the total at Tier 4 (this assumes that reductions in user loads are difficult to influence by Design and Development teams).

- The GHG profile stays relatively constant (and overall emissions relatively high) until Tier 3 and Tier 4 targets come into effect (in 2026 and 2030 respectively). At this point, the expectation is that the heating system fuel will switch to electricity using HVAC systems such as heat-pumps (Air, Water or Ground Source). Buildings that switch to electricity heating earlier will therefore see more significant GHG reductions earlier and be more likely to comply with future targets.
- Since the future targets assume super-insulated building and since lighting and plug loads are not reduced to the same extent, the future targets imply that buildings will become more cooling-dominated (since high internal heat gains cannot escape the envelope).

Overall, this benchmarking analysis suggests that in order to reduce energy use and GHG emissions, the following strategies should be prioritized:

- Space heating reductions (lower glazing ratios, better performing windows and walls)
- Reductions in domestic hot water fixture flows
- Switching to electric-based HVAC systems
- Reducing "rogue" energy use due to infiltration (improving air sealing)

4.2 POTENTIAL ENERGY REDUCTIONS

To illustrate potential energy and carbon reductions, we primarily referenced the City of Toronto Zero Emissions Buildings Framework and complemented the analysis with recent projects, energy studies and energy models.

As shown in the Figure below, the new Version 3 of the TGS will be fundamentally different compared to the current Version 2. Most notably, the intent is to replace the current requirement of % saving *relative* to Code with 3 new *absolute* metrics in v3:

- Energy Use Intensity or EUI (total energy used per building area)
- Greenhouse Gas Intensity or GHGI (based on the current Ontario electricity grid)
- Thermal Energy Demand Intensity or TEDI (a new metric reflective of the thermal performance of the envelope)

As per the latest Community Energy Planning requirements for the City of Toronto, the minimum target for baseline performance of a new building is the TGS Version 3 Tier 1, with a higher performance building target of Tier 2. Compared to OBC SB-10 2017, this will already significantly reduce utility costs, and will result in a much more resilient and durable building envelope and improved thermal comfort for occupants. However, to achieve this performance there would be a cost premium upfront.

The City of Toronto had a grandfathering period allowing the performance path for Tier 1 buildings (15% better than current code SB-10 2017); however, it is set to expire in 2020.

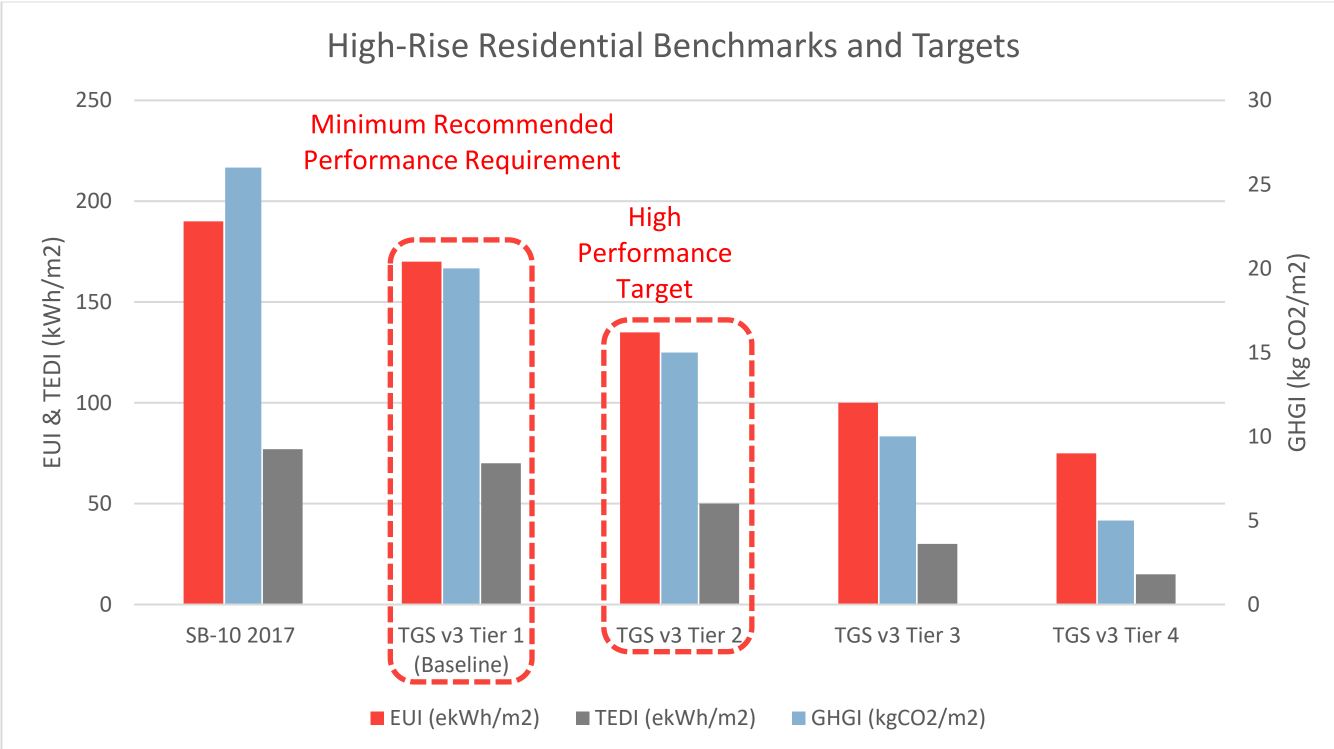


Figure 9: High-Rise Residential Benchmarks and Targets

The Tier 3 baseline further represents a 50% reduction from the OBC guidelines which is a significant achievement. This level of performance requires significant improvement in the thermal performance of the envelope (historically not a significant area of focus for high-rise residential development) and fuel-switching or electrification of HVAC systems (moving away from using natural gas for space heating and domestic hot water).

The next section will focus on translating the above benchmarks into potential design strategies.

4.3 INDICATIVE DESIGN CHARACTERISTICS

The following tables summarize "indicative" design characteristics for the benchmarks and targets discussed earlier. This is just one of infinitely many combinations of design characteristics that can achieve the various performance characteristics. Many modern buildings have considerably more glazing and are constructed from poorer-performing curtainwall systems; they must look for alternative opportunities to balance the negative impacts of glazing and curtainwall.

Table 2: Indicative Design Parameters

Parameter	Baseline SB-10 2017	TGS v3 Tier 1	TGS v3 Tier 2	TGS v3 Tier 3	TGS v3 Tier 4
Glazing Ratio	40%	40%	40%	40%	40%
Roof R-Value (effective)	R-34.5	R-20	R-20	R-20	R-20
Wall R-Value (effective)	R-20.8	R-10	R-10	R-10	R-20
Window U-Value	0.38	0.4	0.3	0.2	0.14
Wall + Window R-Value	R-7.7	R-4.5	R-5.6	R-7.1	R-11.6
Window SHGC	0.40	0.35	0.35	0.35	0.35
Infiltration Savings	N/A	N/A	25%	50%	75%
HVAC System	Fan-coils	Fan-coils	Fan-coils	Fan-coils	Fan-coils
HVAC Plant	Condensing Boiler Centrifugal Chiller	Condensing Boiler Scroll Chiller	Condensing Boiler Scroll Chiller	50% ASHP 50% Gas	90% ASHP 10% Electric
Heating Efficiency	90%	96%	96%	4.15 COP	4.15 COP
Cooling COP	3.5	5.0	5.0	3.15	3.15
Heat Recovery (units)	55%	65%	75%	80%	85%
Fan Power	0.3 W/CFM Fan-coils 1.0 W/CFM ERV	0.3 W/CFM Fan-coils 0.5 W/CFM ERV	0.3 W/CFM Fan-coils 0.5 W/CFM ERV	0.3 W/CFM Fan-coils 0.5 W/CFM ERV	0.3 W/CFM Fan-coils 0.5 W/CFM ERV
Pumps	Variable	Variable	Variable	Variable	Variable
Lighting Savings	0.68 W/sf	~20%	~20%	40%	40%
Plug Load Savings	0.46 W/sf	N/A	10%	10%	20%
DHW Efficiency	80%	96%	96%	96%	Electric
DHW Flow Savings	0	20%	30%	40%	50%

4.4 FUTURE READY DESIGN

Toronto's Future Weather and Climate Driver Study, produced in 2011, predicts possible increases in hot weather; heat waves, and daily rainfall. One way to assess how the proposed development will perform over time is to include an assessment of future, as well as current energy and stormwater management performance referring to climate change models to ensure that the development will be low impact the year it is occupied, and, at the end of the mechanical systems' lifespans. While this analysis goes beyond the scope of this study, it is recommended for the Schematic Design phase of the project.

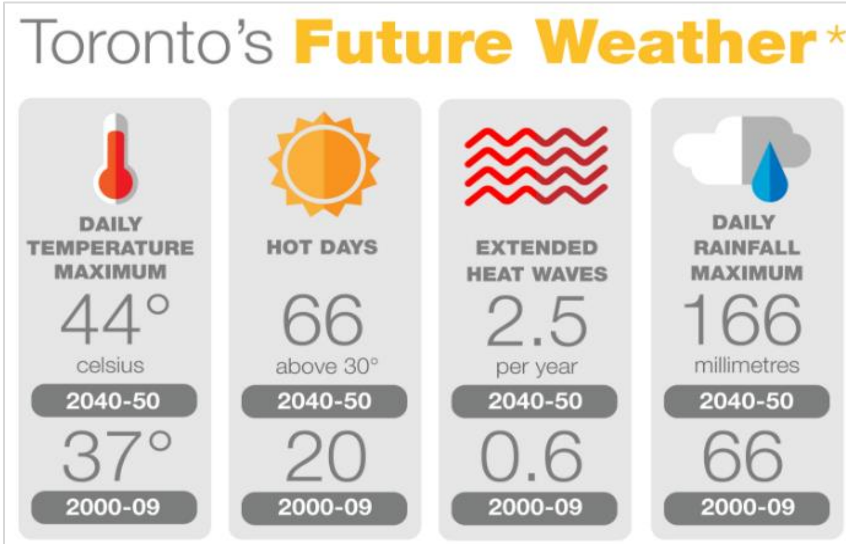


Figure 10: Toronto's Future Weather (source: City of Toronto website and "Toronto's Future Weather and Climate Driver Study, 2011")

5 HIGH PERFORMANCE DESIGN OPPORTUNITIES

5.1 EVALUATION CRITERIA

The following criteria were used to assess the effectiveness of potential measures with respect to meeting the City of Toronto goals for this study:

- **Reduced Energy Use and/or Peak Demand:** Opportunities which have the potential to achieve lower energy use intensities (EUIs) and reduced energy demand, through passive as well as active system design.
- **Reduced Carbon Solutions:** Opportunities which have the potential to result in building reduced greenhouse gas emissions during operation.
- **Health and Wellbeing:** Opportunities which have the potential to improve occupant health, including positive impacts on features including: temperature and humidity control, reduced drafts and local temperature fluctuations, indoor air quality, access to daylight and views, and reduced glare.
- **Energy Resilience and Durability:** Opportunities to improve the building's resilience to area-wide power outages. This includes meeting all emergency power (life safety) requirements, as well as providing for 72 hours (at a minimum):
  - Domestic water (hot and cold);
  - "Cool rooms (and/or heating rooms)";
  - Elevator service; and
  - Space heating, lighting and receptacle power to the central common area/amenity space/lobby, where applicable.

5.2 QUALITATIVE ASSESSMENT OF POTENTIAL MEASURES

The following high-performance building strategies were considered, to identify how the development might achieve the evaluation criteria noted:

— **Building Form and Passive Elements:** Integrated Design, Life Cycle Assessment, Massing: Tower Form & Orientation, Daylighting, Low Window-to-Wall Ratios, High performance Windows, Wall and Roof insulation, Air Tightness Design and Testing, Transpired Solar Thermal Collectors.

— **HVAC and Lighting Design:** Plug and Process Load Management; Minimizing Parking Conditioning; High Efficiency lighting; High Efficiency HVAC; On-site Waste Heat Recovery; Reduced MAU Airflows; Air Source Heat Pumps & Variable Refrigerant Flow systems (VRF); Geo-Exchange Systems; Thermal Energy Storage; High-Efficiency Combined Heat and Power; Biomass Heating; Battery Storage; Solar Thermal Water heating; Photovoltaic Collectors; and, Low-Flow Fixtures.

— **Shared Services and District Connection:** Shared HVAC & Backup Power Service; District-Thermal Energy Network; District Deep Lake Water Cooling Systems; District Energy Steam Systems, Wastewater Heat Recovery; and Micro-Grid(s) for islanding.

Viability of each measure was evaluated within the context of the Subject Property using the selected criteria. A summary of this viability is provided below. Measures were dismissed (shown in grey text) if they were considered infeasible, or would impede the development from achieving one of the criteria. Measures that are considered an integral part of current design practices were labelled 'Fundamental'.

Table 3: Qualitative Matrix Assessment of Opportunities

Strategy	Feasible	Impact				
		Reduced Energy	Reduced Carbon	Health and Well-Being	Resilience & Durability	Financial Viability
Table Legend	**More Positive Impact**					**More Negative Impact**
	+++	++	+	-	--	---
Building Form & Passive Elements						
Integrated Design	Y	Fundamental	Fundamental	Fundamental	Fundamental	+++
Life-Cycle Assessment of Design	Y	+	+	+	+	+
Massing: Tower Form & Orientation	Perhaps	+	+	+	+	++
Daylighting	Y	Fundamental	+	Fundamental	Fundamental	
Low Window-to-Wall Ratios	Y	Fundamental	Fundamental	+	+	+++
High performance windows	Y	Fundamental	Fundamental	++	Fundamental	+
Wall and roof insulation	Y	Fundamental	Fundamental	+	Fundamental	
Air Tightness Design and Testing	Y	Fundamental	Fundamental	Fundamental	Fundamental	+++
Transpired solar thermal collection	Y	+	++	+	+	++
HVAC & Lighting Design						
Plug and Process Load Management	Y	Fundamental	Fundamental		+	++
High efficiency lighting	Y	Fundamental	Fundamental	+	+	+++
High efficiency HVAC	Y	Fundamental	Fundamental	+	+	++
Ventilation Heat Recovery	Y	Fundamental	Fundamental			
Air sourced heat pumps and VRF	Y	+	+			
Geo-exchange systems	Y	+	+		+	

Strategy	Feasible	Impact				
		Reduced Energy	Reduced Carbon	Health and Well-Being	Resilience & Durability	Financial Viability
Peak Shifting Thermal energy storage	Y	+	+++		++	+
High-efficiency Natural-Gas Combined Heat, Cooling and Power Generation	N	+	--		++	++
Central Biomass Combined Heat & Power Generation	N	+	+++		+	--
Battery storage	Perhaps	+	+		+	+
Solar thermal water heating	Perhaps	+	+		+	-
Photovoltaic collectors	Perhaps	+	+		+	+
Low-flow fixtures	Y	+	++		+	+
Shared Services & District Connections						
Shared HVAC & backup power service	Y	++		+	+	
District Energy: Thermal Energy Network	N	++	+		++	++
District Energy System: Deep Lake Water	N	+	+			+++
District Energy System: Steam	N	-	--			+
District Wastewater Heat Rejection Systems	N	++	++			-
Micro-grid(s) for islanding	Perhaps	+	+		++	
Renewable Energy Certificates (RECs)	Y	++	++			-
Renewable Natural Gas	Perhaps		+++		-	--

5.3 QUANTITATIVE ANALYSIS OF SELECTED MEASURES

Many of the identified strategies that will be necessary to achieve a high performance development are already well established in good design and construction practice (e.g. high efficiency lighting), or are considered as a matter of course as Code and Toronto Green Standard compliance is investigated (e.g. building insulation measures). These strategies should be implemented, but do not require further detail regarding viability. As such, they are not further developed in this report.

From the potential strategies considered, the following were selected for deeper analysis. These are considered to have potential to influence a low/no-carbon development strategy at the Subject Property, or, are of interest to understand relative impact. These are:

- Low Window-to-Wall Ratios
- Improved Envelope Performance
- Air Tightness Design and Testing
- LED Lighting + Daylight Harvesting
- Plug Load Reduction
- Improved Heat Recovery Effectiveness
- DHW Fuel-Switching

— Reduced Domestic Hot Water Fixture Flows

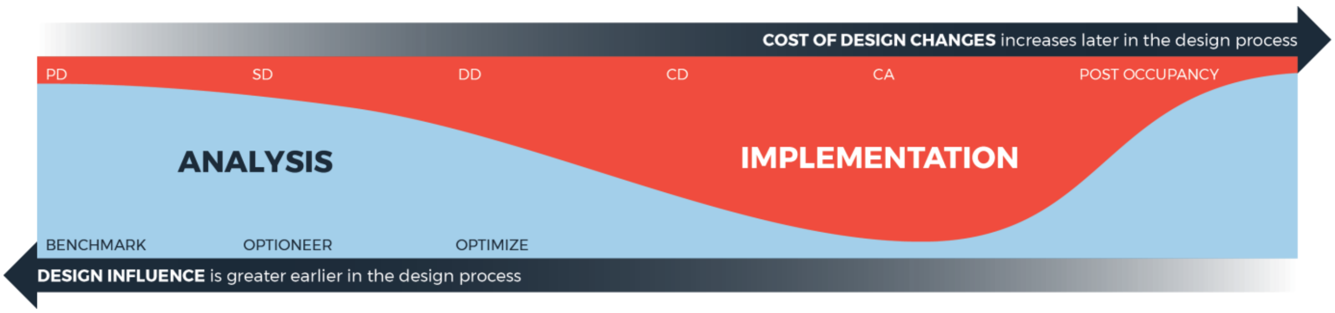
— Low-Carbon HVAC Systems (i.e. Air-Source Heat Pumps, Ground-Source Heat Pumps, etc.)

— Building Integrated Solar Photovoltaics (BIPV)

We analyzed the potential for each measure, reporting energy, carbon, and energy cost benefit of each.

5.3.1 INTEGRATED DESIGN

Integrated design is an approach and process which differs from conventional development but has been integral to the success of the majority of low-carbon buildings. The reason integrated design works is that it adds time and energy at the outset of the project, inclusively welcoming ideas to identify design synergies for the project: design solutions which add value for several systems at once without increasing costs. This approach is outlined in the figure below.



Integrated Design Process		Conventional Design Process
Inclusive from the outset	VS	Involves team members only when essential
Front-loaded — time and energy invested early	VS	Less time, energy, and collaboration exhibited in early stages
Decisions influenced by broad team	VS	More decisions made by fewer people
Iterative process	VS	Linear process
Whole-systems thinking	VS	Systems often considered in isolation
Allows for full optimization	VS	Limited to constrained optimization
Seeks synergies	VS	Diminished opportunity for synergies
Life-cycle costing	VS	Emphasis on up-front costs
Process continues through post-occupancy	VS	Typically finished when construction is complete

Figure 11: Contrasting Integrated Versus Conventional Design (BC Green Building Roundtable, 2007)

The next steps in ensuring integrated design can help bring world-class sustainability and deliver performance will be:

— Inclusive Project Team: Review who is at the table today, and when the team plans to include these project team members and stakeholders, and ensure that parties who will be needed later have the opportunity to contribute to the project early.

— Project Visioning: Agree on sustainability goals to be adopted by all project stakeholders.

— Concept Design / Optioneering: Past project experience and high-level energy and daylight modelling support setting a target energy use intensity (EUI) in conjunction with studying a suite of project-specific massing, enclosure, passive systems, HVAC delivery and plant options. Simultaneously, feasible photovoltaic (PV) and renewable energy system are evaluated. The two exercises are brought together using a life-cycle cost analysis to determine the best balance of generation and conservation.

— Schematic Design: With broad concepts agreed upon, more detailed analysis tools clarify key design parameters such as window-to-wall ratio, shading system types and geometry, HVAC controls approaches, geothermal well-field sizes, and the overall conservation and generation balance is refined through value-engineering. Setting performance-based requirements and involving the construction trades optimizes the cost-effectiveness and constructability of the facility.

5.3.2 LOWER WINDOW-TO-WALL RATIOS

The window-to-wall ratio of the buildings are one of the most influential elements in determining overall building energy use. Windows have a high energy impact because:

- Glass allows heat transfer not only by conduction, but also by radiation. It lets in the sun's heat in summer, and in winter allows objects in the room to radiate to the exterior.
- Metals have the highest thermal conductivity rates of any building material. They are so conductive that in window systems, the glass ends up functioning a bit like a cooling (or heating) fin, with energy 'short circuiting' around the glazing, through the frame. Window frames have the highest heat loss of any regular part of a building envelope. (As a side note, this phenomenon also significantly de-rates the insulation value of spandrel panels.)

The Figure below shows how, as window-to-wall ratio increases, the ability of the design team to create a high performance (well-insulated) building envelope is significantly reduced. Architectural details can maintain a glazed look-and-feel while increasing wall R-value.

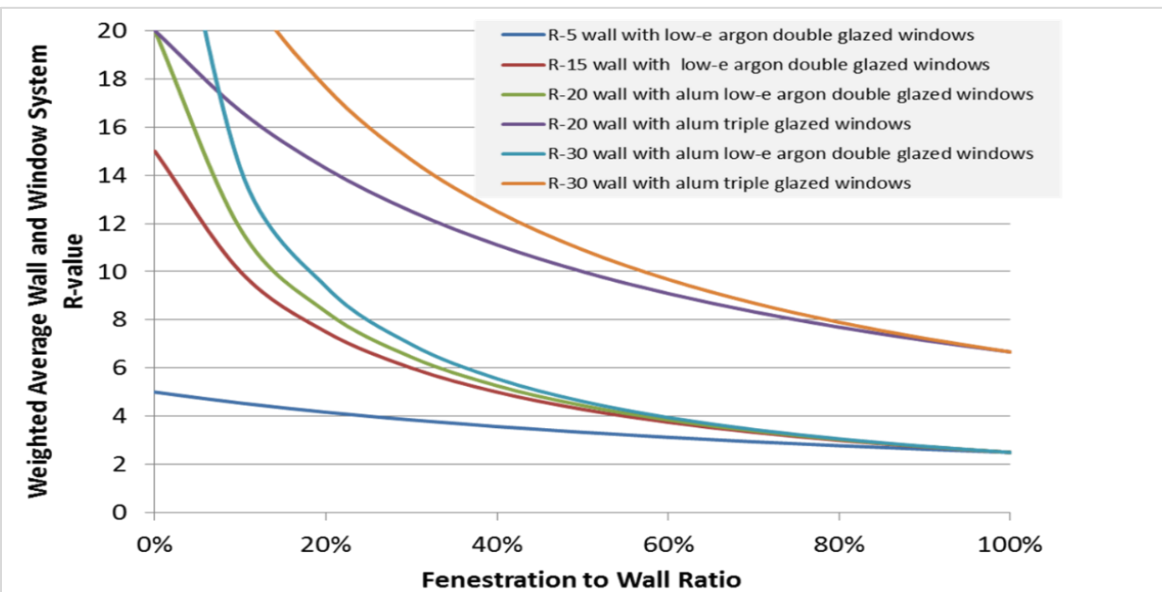


Figure 12: Influence of Window to Wall Ratio on Possible Thermal Envelope

The table below shows the potential energy impact of moving from a more modestly glazed façade (a 40% window-to-wall ratio in the Baseline) to a highly glazed one. Because glazing systems are high cost, this is typically a design decision that can be made without adding significant construction costs. Absolute savings will vary based on the actual reduction.

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
Increase Glazing Ratio to 50%	3%	2%	3%	4%

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
Increase Glazing Ratio to 60%	5%	4%	6%	9%

5.3.3 HIGH PERFORMANCE WALL

Modern high-rise buildings are often constructed using curtainwall systems. While they are easy to construct and provide savings due to standardization, they are one of the two least energy-efficient components of modern buildings (in addition to high glazing percentages). Compared with other assemblies, curtainwall systems have a high energy impact because the framing materials (aluminum typically) are poor insulators and curtainwall systems have a lot of thermal bridging (metal connections that reduce the benefit of insulation).

A simple comparison of wall insulation options illustrates the point:

WALL TYPE	NOMINAL R-VALUE (STATED IN PRODUCT LITERATURE)	EFFECTIVE R-VALUE (ACCOUTNING FOR THERMAL BRIDGING)
Precast Panel With 4” Continuous Rigid Insulation	R-20	R-20
Typical Curtainwall Spandrel Panel With 4” Of Insulation In The Back-Pan	R-20	R-5

We analyzed the potential impact of lower and higher performing envelopes against the baseline (concrete wall with 5” insulation, a total effective R-20.8). Note that in order to achieve R-20 effective thermal performance will require something other than conventional curtainwall (i.e. punched window wall, metal panel, or additional insulation inboard of the spandrel mullions), and attention to interface and thermal bridging details (e.g. balcony slabs, party wall edges, window/wall interfaces, etc.).

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
Improved Walls (R-20 eff; thermally broken)	1%	1%	1%	2%
Passive House Wall R-35	2%	1%	3%	5%

5.3.4 HIGH PERFORMANCE WINDOWS

Windows are the lowest performing component of an envelope. A typical double-glazed, argon-filled window might have an effective thermal performance of about R-2.5 (accounting for framing impacts). Compared to a typical masonry wall with exterior insulation that can achieve R-20, this is 8 times worse. Windows therefore have the greatest potential to impact energy performance (for better or worse). This also means that there is very little benefit to improving the opaque wall performance if the windows will not be improved (the poor performing windows will negate any improvements to the wall). Similarly, by improving the windows, less investment is needed on the opaque walls.

We analyzed the potential impact of using high-performance triple-glazed windows in high-performance, thermally-broken frames with a thicker-than-typical thermal break (effective U-value of 0.2) compared with the Baseline U-value of 0.38 (curtain wall) and 0.45 (operable windows), and SHGC of 0.4.

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
Improve Windows to U-0.3	7%	3%	10%	17%
Improve Windows to U-0.2	15%	6%	22%	36%
Reduce SHGC to 0.27	-2%	1%	-5%	-8%

5.3.5 AIR TIGHTNESS DESIGN AND TESTING

Air leakage can be a source of energy loss, particularly if sufficient care is not taken to ensure building construction follows air tightness details. Studies have shown that the way buildings are constructed has a significantly high impact on overall infiltration loss than the architectural details provided.

Including building envelope consultants on the project early and establishing air-tightness performance targets for building envelope and mechanical components will assure performance in this area.

We analyzed the impact of reducing air infiltration by 50% from Baseline (0.25L/s/m^2 exterior wall and roof area) through a combination of better design details, construction practices and building envelope commissioning.

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
Reduce Infiltration by 50%	4%	2%	7%	11%

5.3.6 DAYLIGHTING + LED LIGHTING

Daylight remains the illumination technology with the lowest lifecycle and operating cost. Designing buildings for daylighting, rather than artificial lighting, has the following additional benefits:

— Health benefits and increased office worker productivity.

— Daylight retail areas with daylight have been correlated with higher retail sales.

The amount of daylight received in a building can be analyzed over the course of the year to show a map of areas which have either partial or full "spatial daylight autonomy" – ability to operate completely without electric lighting during daytime hours. Modelling daylight autonomy early and adapting designs to maximize daylight autonomy will reduce the lifetime energy use of the development.

The usefulness of the light brought into the building can be analysed using glare analysis. Glare is defined as more than a 1000 lux difference between the brightest and least bright objects in the field of vision, and causes occupant discomfort. Contrary to intuition, best daylighting is not achieved through floor-to-ceiling glazing, since this tends to create glare.

By limiting the depth of floor plates, reviewing and responding with design improvements to daylighting analysis work, and incorporating façade technologies which throw light deeper into spaces, it is possible to achieve full daylight autonomy in regularly occupied space.

In the past, the only daylighting technologies available were windows, skylights, white finishes to reflect light, and light shelves. However, currently a variety of daylighting products are available to assist design teams in moving light deeper into building floorplates. These all work by creating a translucent section of the building envelope, above the vision glazing, and using highly reflective or refractive systems to redirect ambient light to the ceiling, which can increase daylight penetration from the building perimeter by 50% or more.

We analyzed the impact of reducing the apparent lighting power density by 20% from Baseline (0.68 W/ft^2) through a combination of LED fixtures, daylighting and occupancy controls.

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
Reduce Lighting by 20% (LEDs + Daylighting)	2%	4%	0%	-2%

5.3.7 PLUG AND PROCESS LOAD MANAGEMENT

In North America, the status quo standard for carbon-neutral developments includes all energy, including that used by occupants. In a typical building, plug and process loads use 20%-35% of total energy use. However, as a building approaches carbon-neutral, plug loads, if not addressed, can become the largest energy use on the site.

By planning from the beginning for occupant engagement and load management, these very significant loads can be reduced, while engaging occupants as active participants in the achievements of the property.

The following measures are examples of plug and process load management solutions:

— Energy dashboards or other transparency of personal energy use;

— Occupant performance contracts, including energy standards for equipment purchases and fit-outs;

— Occupant-level controls which default to “off”, including smart power strips, etc.;

— Master switches, allowing all lights and/or appliances to be turned off when leaving a residence;

— Vacancy sensor control of heating/cooling equipment, lighting, and plug loads.

While managing tenant energy and plug loads has been found by researchers to be one of the continuing challenges faced by many net-zero buildings in operation, significant achievements have been recorded by a number of case study buildings. The potential impact has been calculated at the lowest of the literature values (assuming 25% reduction from typical modern plug-load electricity use). The Baseline used is 0.46 W/ft^2.

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
Reduce Plug Loads by 25%	2%	5%	-1%	-4%

5.3.8 LOW-FLOW DOMESTIC HOT WATER FIXTURES

Much of the energy used can be reduced by specifying low-flow bathroom and kitchen faucet, showerheads, dishwashers and washing machines. Technological improvements in nozzle design can still maintain adequate pressure (the desirable “feel” in a shower) while still reducing flow considerably. We analyzed the impact of achieving 50% DHW fixture flow reductions compared to the Baseline. In this scenario, the DHW heating system type remains unchanged.

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
Reduce DHW Flows by 50%	7%	3%	10%	0%

5.3.9 HIGHER PERFORMING HVAC (CONVENTIONAL)

HVAC systems consume a significant percentage of the total energy use in buildings. Historically, most of the savings in "high-performance", LEED or other "green" buildings have come from investments in more efficient HVAC systems. This was largely possible due to rapid technological advances. The downside is that over-reliance on HVAC to reduce overall building energy use have made it less likely that envelope improvements are undertaken. In fact, most modern building envelope systems are significantly hurting performance (compared to Code) and most of these buildings have too much glass and poor performing curtainwall system which cannot meet the prescriptive requirements of the Code. It is only by relying on efficient HVAC systems to overcome the penalties of a poor envelope can most modern buildings be considered "green".

We analyzed the impact of improving the efficiency of heat recovery relative to the Baseline.

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
Heat Recovery (70% effective)	4%	1%	5%	9%

It is possible to increase these savings further by at least 5% by considering improvements to the distribution systems including ECM motors for the fan coils and even greater heat recovery performance, but these were not directly modelled.

5.3.10 HIGH PERFORMANCE HVAC SYSTEMS (FUEL SWITCHING)

Going beyond the conventional fan-coil, boiler and chiller system, we considered switching to a less carbon-intensive and more efficient system such as an air source heat pump which uses a reversible "chiller" (heat pump) to provide both heating and cooling to the building(s) systems being served. Heat pumps can serve a central plant, or individual equipment (including DHW). A recent version of air sourced heat pumps called Variable Refrigerant Flow systems (which use refrigerant, instead of water or glycol, as the distribution fluid) have emerged on the market with heating capacities appropriate to the Toronto climate. Air-sourced heat pumps and VRF can connect with geo-exchange systems, central plants, or distributed systems. In addition to excellent energy performance, VRF systems are all-electric which means they greatly reduce GHG emissions, though they increase reliance on the grid (decreasing resilience).

The table below shows the expected impact of various heat pump configurations, all of which include converting DHW systems to an ASHP approach. This increases energy use for cooling slightly (since ASHPs are less efficient than central water-cooled chillers), but dramatically increase heating efficiency and significantly reduces GHG emissions by switching the source of heating from natural gas to electricity.

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
Air Source Heat Pumps	27%	-6%	56%	0%
Ground Source Heat Pumps	27%	-7%	56%	0%

Handling a significant portion of the building heating and cooling loads using Ground-source heat pumps is likely feasible (depending on site conditions), and this is generally considered one of the best strategies to reduce energy and GHG use. Variable Refrigerant Flow (VRF) system are another all-electric option with very good performance characteristics (likely even better than ASHPs).

5.3.11 ELECTRIC DOMESTIC HOT WATER

Since Domestic Hot Water is typically heated with natural gas, we analyzed the impact of switching to electricity. As expected, this greatly reduces the GHG emissions, while increasing utility costs (electricity is cleaner but more expensive than natural gas).

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
Heat Pump DHW Heaters	7%	3%	10%	0%

5.3.12 PHOTOVOLTAIC COLLECTORS

Building-Integrated Photovoltaic (BIPV) panels have the potential to replace traditional building elements such as façade spandrel panels, supporting a reduced net cost. Installing on rooftop, south, and west building façades yield the best potential. Integrating a modest slope (10% from vertical) into the façade design would increase electricity output by about 10%.

The most developed versions of this technology are transparent, translucent or perforated photovoltaics that integrate directly into glazed units. These systems generate electricity and allow occupants to see through glass, while blocking solar heat gain and glare.

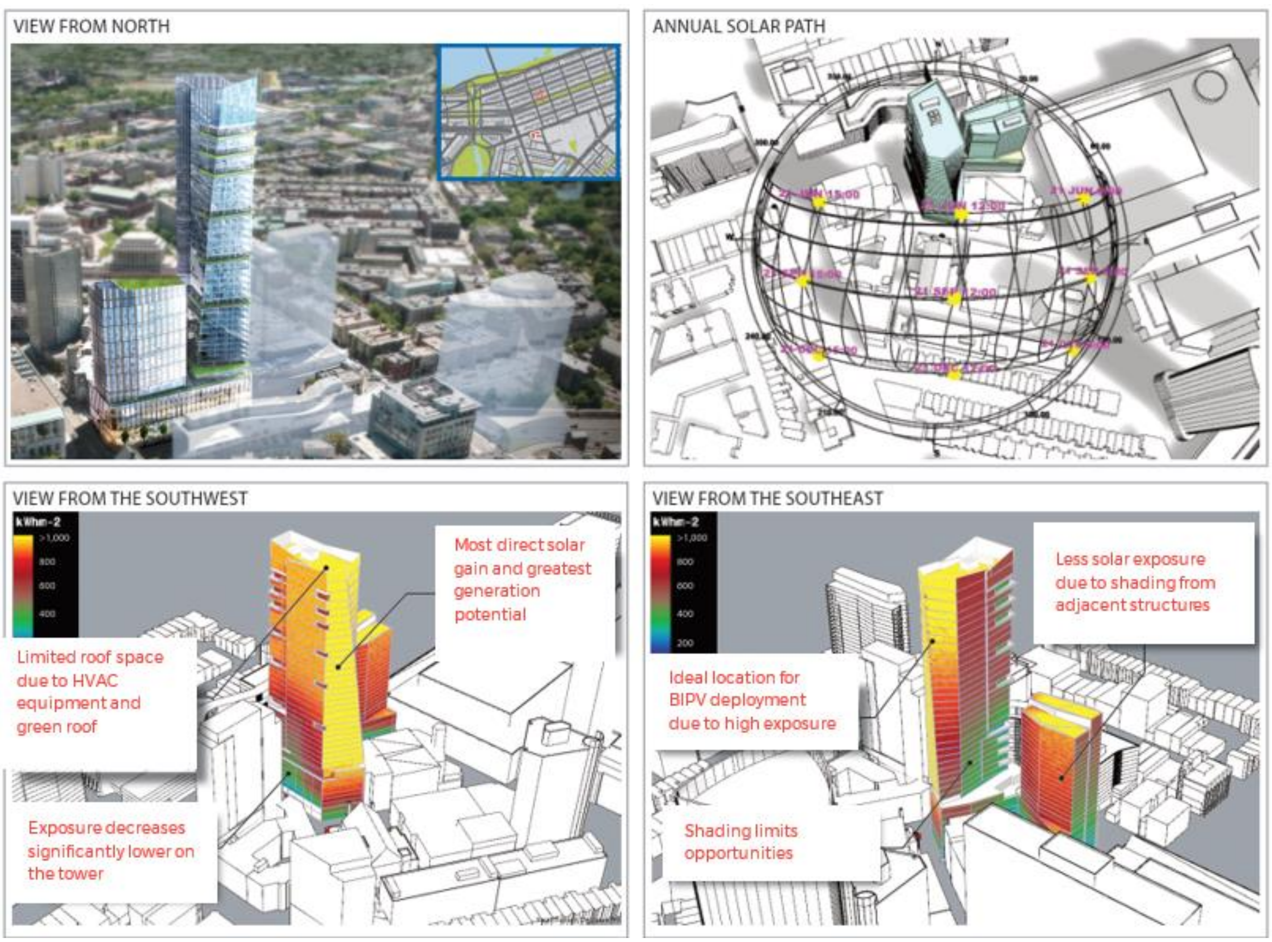


Figure 13: Sample BIPV Analysis during Concept Design

The analysis of BIPV systems is beyond the scope of this study, however, based on past experience, the following savings might be possible.

MEASURE	ENERGY SAVINGS	ENERGY COST SAVINGS	GHG SAVINGS
BIPV	1-3%	1-2%	1-2%

5.3.13 REDUCED MAU AIRFLOW

Typically, the ventilation system for a MURB is oversized and provides significantly more outside air than required as per the ASHRAE guidelines. In a colder climate, ventilation energy consumption can contribute anywhere between 20-40% of the overall energy consumption of the building. Therefore, a design strategy targeting a reduced airflow can yield significant energy, cost and greenhouse gas emissions savings.

For the baseline model, the ventilation system was sized at 40 CFM/suite. A proposed simulation was conducted with the ventilation reduced to the minimum ventilation required by code (roughly equivalent to 25-30 CFM/suite). The value was chosen as it meets the ASHRAE 62.1 minimum and maintains occupational comfort. Additionally, with the lower ventilation airflow, the oversized MAU can achieve significant fan energy savings.

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
Reduced MAU Airflow	3%	2%	5%	7%

5.3.14 TRANSPIRED SOLAR THERMAL COLLECTORS FOR MAU

Solar Wall is a system consisting of transpired solar thermal collectors that utilizes the power the sun to heat building ventilation air. It has the potential to significantly reduce energy consumption, heating costs and greenhouse gas emissions. During the heating season, a lot of energy is required to heat the colder winter air to indoor temperature conditions. On average, around 60% of the building energy is consumed by the heating systems and a large percentage of that is ventilation heating. To reduce strain on the ventilation heating systems, a solar wall preheats the outdoor air before it reaches the fresh air intake ducts of an air handling system.

Solar Wall consists of perforated metal panels that absorb radiation from the sun. The absorbed radiation causes the surface temperature of the wall to rise which consequently increases the temperature of the air surrounding the structure. The existing HVAC units draws the heated air through the perforations and connecting ductwork into its fresh air intakes.

The MAU units serving the corridor and residential units in a residential building are ideal candidates for this technology. A large portion of the ventilation heating demand can be offset during the heating season and summer bypass dampers installed within the systems ensures no unnecessary heating is done.

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
Transpired Solar Thermal Collectors	1%	0%	2%	4%

5.3.15 RESILIENT DESIGN

Resiliency is commonly defined as the ability to recover or bounce-back after a disruptive event. In the context of buildings and communities, it often means the ability to withstand or mitigate the impacts of climate change/disruption, although social and economic resilience is also a consideration for city-builders. Here we focus only on environmental resilience.

The City of Toronto has recently appointed a Chief Resilience Officer and is developing a Resiliency Checklist for future regulatory compliance. Developers can stay ahead of upcoming regulations and future-proof their buildings by incorporating resilient design strategies early in the process.

The approach to doing this can be summarized in the diagram below:

In Toronto, the list of likely threats includes extended heat waves, severe rainfall events, and power outages. These can be mitigated by the following strategies:

— Locate critical equipment above the flood plain.

— Provide emergency back-up and dedicated HVAC systems to small amenity areas to creates “cool rooms (and/or heating rooms)” during power outages causes by heat (and/or cold) waves so that vulnerable populations can shelter in place.

— Improve passive survivability with super-insulated envelopes by allowing residents to shelter in place longer during a power outage (as seen from the Figure below, once a power outage occurs, spaces with poor performing envelopes such as heavy glazing and spandrel panel will become unbearable in a few days’ time. Areas designed with better envelopes stay comfortable longer during winter and summer).

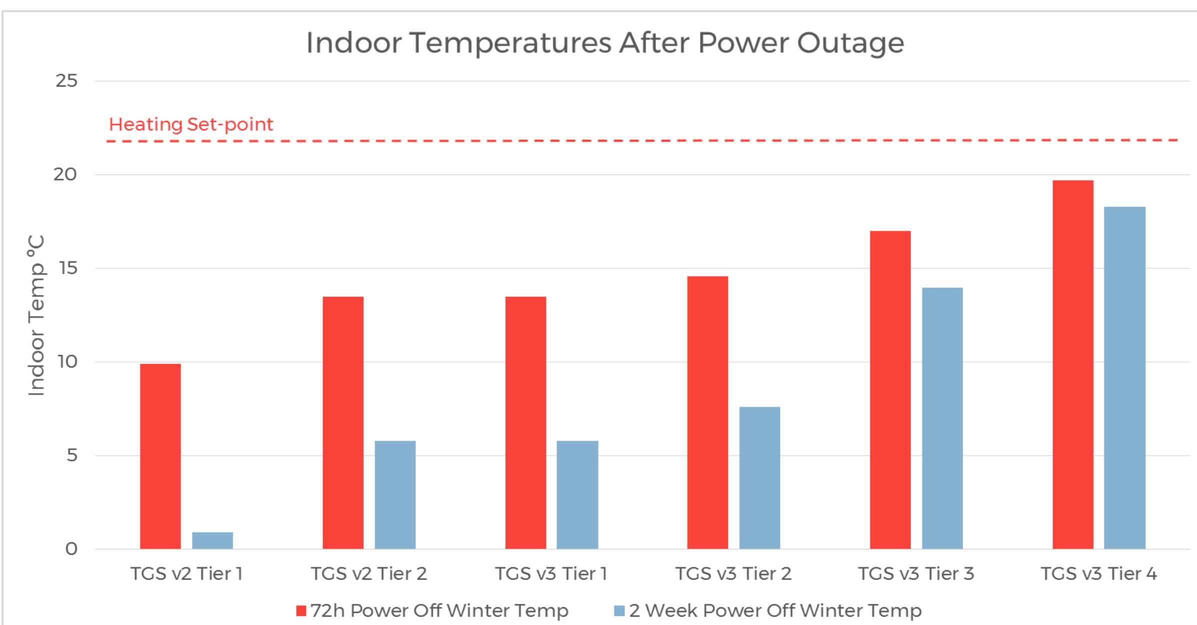


Figure 14: Impact of Envelope Performance on Space Temperatures during Power Outage

Resilient design does not explicitly contribute to energy or carbon reductions (and in fact may increase capital costs), but acts more like insurance.

5.3.16 COMBINED CUMULATIVE IMPACT

The combined measures include the following:

1 Well Insulated Glazing U-0.2

2 Glazing SHGC 0.27

3 50% Less Infiltration

4 20% Lighting Savings

5 25% Plug Savings

6 50% DHW Savings

7 DHW Fuel Switching

8 Transpired Solar Themal Collectors

9 Reduced MAU Airflow

The cumulative impact of these measures is shown below. Also shown is the final energy-end use breakdown of the combined scenario compared with the Baseline.

MEASURE	ENERGY SAVINGS	COST SAVINGS	GHG SAVINGS	TEDI REDUCTION
All Measures Combined (All Electric Heating)	55%	24%	82%	82%

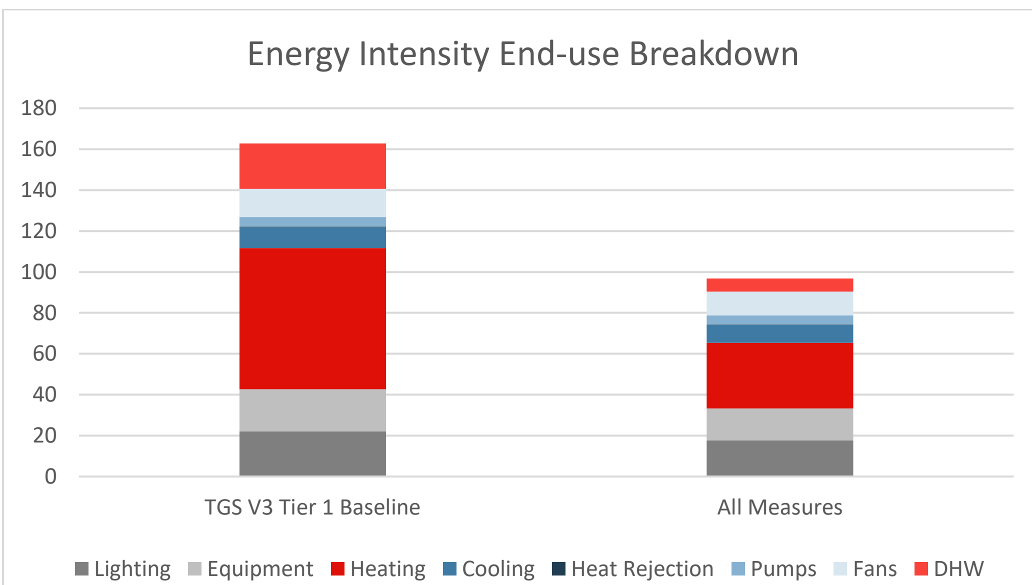


Figure 15: Energy End Use Breakdown for Combined Measures

5.3.17 SUMMARY OF MEASURES

The following Figure summarizes the quantitative analysis of all measures (% savings relative to Baseline):

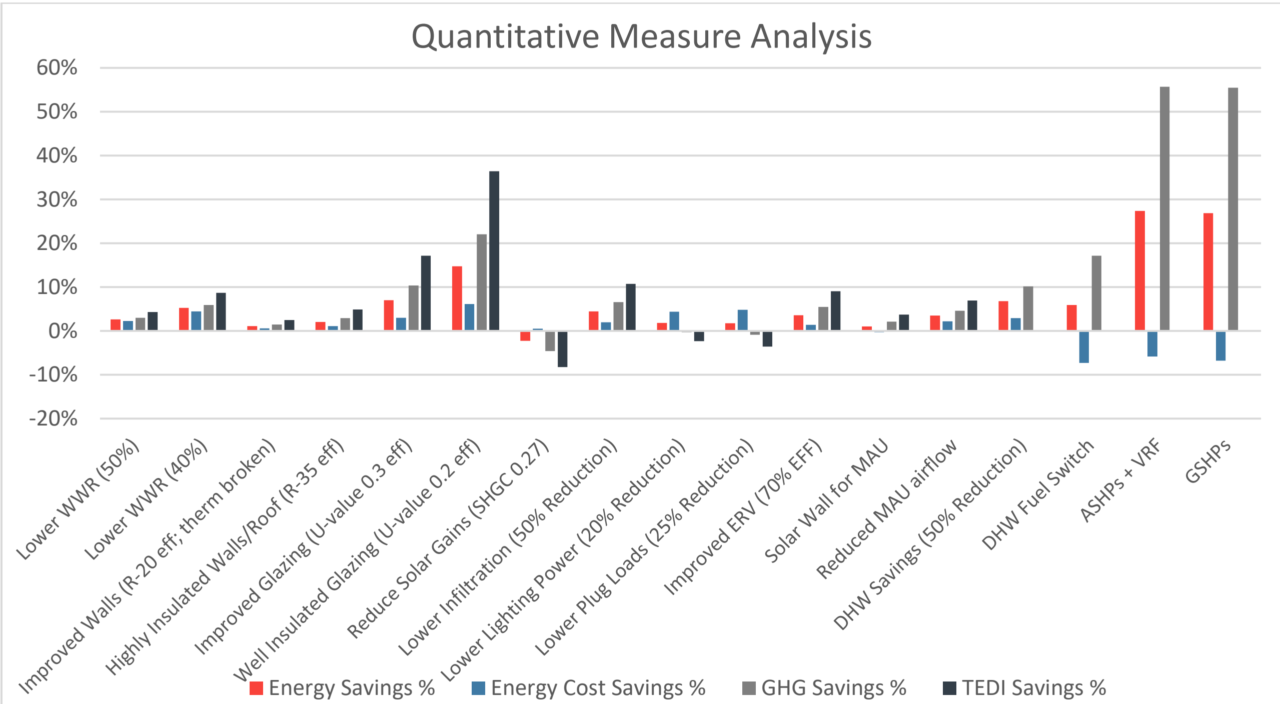


Figure 16: Summary Savings from All Individual Measures

The following Figure summarizes the energy end-use breakdown of each measure analyzed.

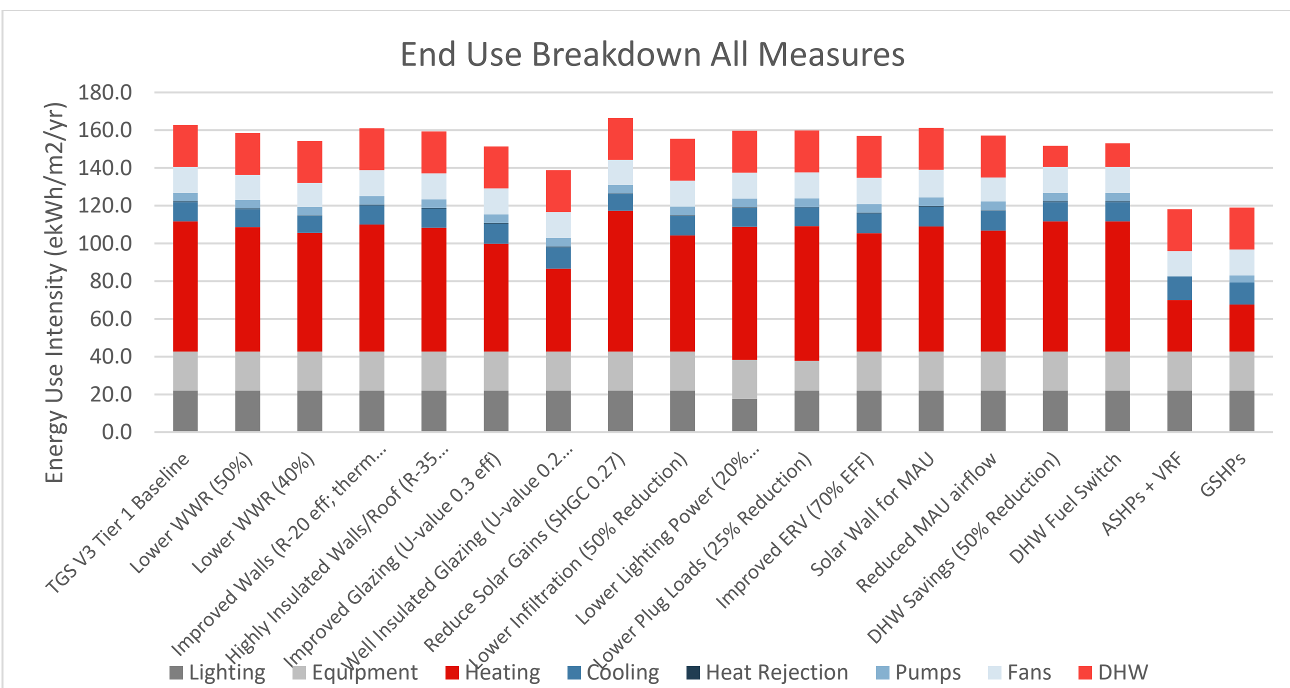


Figure 17: Energy End Use Breakdown from All Individual Measures

When all measures are deployed, the proposed development can achieve the "Maximum Performance Potential" target with 82% carbon reductions and 55% energy use savings.

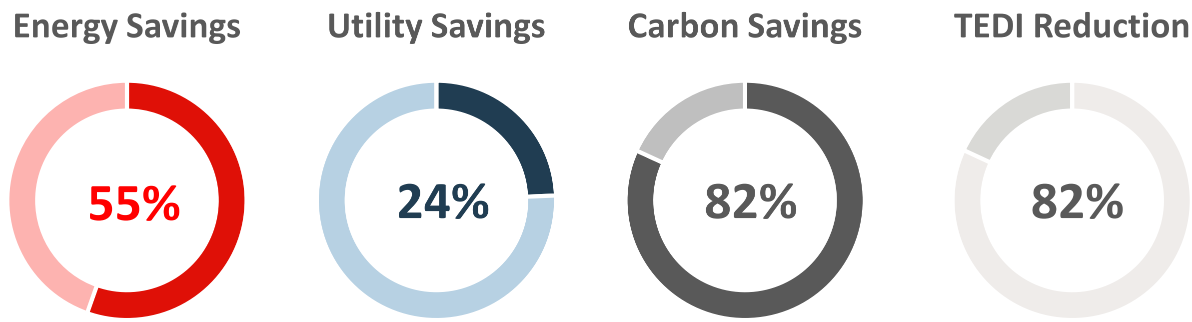


Figure 18: Maximum Potential Savings from Combined Measures

There are some trade-offs possible that can optimize the mix of energy, utility and carbon savings. In particular, fuel-switching has a dramatic impact on optimizing utility savings vs carbon savings. In general, natural gas reduces utility costs, but increases carbon emissions.

6 FUNDING OPTIONS

Many of the opportunities identified have longer paybacks than typically desired. However, funding for high-performance features may be available from several agencies. Major opportunities for funding of high performance opportunities have been described below.

6.1.1 ENBRIDGE SAVINGS BY DESIGN PROGRAM

The Savings by Design program was developed to help builders improve energy and environmental performance in new construction projects. The program is available to Ontario builders in the Enbridge Gas Distribution franchise area. There's no cost to participate.

Incentives of up to $30,000/building (over 50,000ft²) are available plus a package of free energy modelling and integrated design assistance for the design teams.

6.1.2 TORONTO GREEN STANDARD TIER 2 DEVELOPMENT CHARGE REFUNDS

Projects achieving TGS Version 3 Tier 2 or greater (which sets more stringent environmental targets) are eligible for a development charge refund when construction of the building is complete. Final submission is subject to review by a TGS evaluator; however, initial intent to apply must be expressed as part of the initial application for site plan approval.

7 NEXT STEPS

To meet the challenges of rapid urbanization and climate change, this development should further explore carbon-neutral solutions as the design for the site progresses.

We recommend the following steps be considered for further evaluation in the development of the energy strategy for this development:

- Establish targets, and include these in a Basis of Design document to instruct the Design Team on the desired development outcomes;
- Select the design strategies to further investigate on this development, using the list provided;
- Adopt integrated design methodologies and set standards for reporting during design, construction and operation to ensure buildings meet or exceed the targets;
- Explore high efficiency solutions in more detail to develop a menu of solutions that will work together to meet or exceed the targets set; and
- Validate and adjust design strategies using whole-building energy simulation.

APPENDIX

A ESTIMATES OF ENERGY USE

APPENDIX A

ESTIMATES OF ENERGY USE

We have presented a range of possible energy consumption options. Recent technology improvements allow new construction to have lower energy consumption at modest additional investment, making “average” or “typical” energy consumption inappropriate for sizing new low-carbon developments. To determine reasonable assumptions for these building energy uses, we referred to the following resources:

- **City of Toronto Zero Emissions Buildings Framework** – this comprehensive report which serves as the basis for suggested energy and carbon targets for the new Toronto Green Standard Version 3 includes design parameters and energy use breakdowns for prototypical office and other space uses.
- **Code Compliance Energy Models** – our team reviewed the results of simulation of archetype residential buildings which have been modelled to just meet Ontario Building Code (SB-10). The models reviewed were prepared using modern energy modelling software.
- **Proposed Future Code Energy Target Models** – our team reviewed the results of simulation of archetype buildings (residential, office and retail) which have been prepared using parametric energy modelling (runs with a wide variety of inputs) to show what energy use reductions could be achieved using current technologies in combination. The parametric energy modelling reviewed was prepared using Energy Plus, a modern energy modelling software.
- **Real Building Energy Use** – our team reviewed the results of measurement and verification exercises recently completed by our project team on high performance LEED Gold and LEED Platinum residential building projects.
- **New Project Energy Simulation** – our team reviewed the results of energy modelling exercises recently completed by our project team on high performance LEED Gold and LEED Platinum residential building projects.
- **Comparisons of Simulated to Real Building Energy Use** – our team reviewed the results of measurement and verification exercises completed by our project teams on a variety of building projects to estimate the likely variation between code compliance modelling results and real-world energy consumption.

Due to the variations in reliability; level of detail; age; and reductions in the number of high performance peer buildings currently in operation as we looked at higher performance levels, engineering judgement was applied to use all the references available to select reasonable targets and recommendations. (In our opinion, no single reference is appropriate to apply to the development for all performance levels.)

APPENDIX

B LIMITATIONS

APPENDIX B

LIMITATIONS

WSP Canada Inc. is the "Consultant" referenced throughout this document.

- The scope of our work and related responsibilities related to our work are defined in our project authorization ("Conditions of Assignment").
- Any user accepts that decisions made or actions taken based upon interpretation of our work are the responsibility of only the parties directly involved in the decisions or actions.
- No party other than the Client shall rely on the Consultant's work without the express written consent of the Consultant, and then only to the extent of the specific terms in that consent. Any use which a third party makes of this work, or any reliance on or decisions made based on it, are the responsibility of such third parties. Any third-party user of this report specifically denies any right to any claims, whether in contract, tort and/or any other cause of action in law, against the Consultant (including Sub-Consultants, their officers, agents and employees). The work reflects the Consultant's best judgement in light of the information reviewed by them at the time of preparation. It is not a certification of compliance with past or present regulations. Unless otherwise agreed in writing by the Consultant, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity; it is written to be read in its entirety.
- Only the specific information identified has been reviewed. No physical or destructive testing and no design calculations have been performed unless specifically recorded. Conditions existing but not recorded were not apparent given the level of study undertaken. Only conditions actually seen during examination of representative samples can be said to have been appraised and comments on the balance of the conditions are assumptions based upon extrapolation. Therefore, this work does not eliminate uncertainty regarding the potential for existing or future costs, hazards or losses in connection with a property. We can perform further investigation on items of concern if so required.
- The Consultant is not responsible for, or obligated to identify, mistakes or insufficiencies in the information obtained from the various sources, or to verify the accuracy of the information.
- No statements by the Consultant are given as or shall be interpreted as opinions for legal, environmental or health findings. The Consultant is not investigating or providing advice about pollutants, contaminants or hazardous materials.
- The Client and other users of this report expressly deny any right to any claim against the Consultant, including claims arising from personal injury related to pollutants, contaminants or hazardous materials, including but not limited to asbestos, mould, mildew or other fungus.
- Budget figures are our opinion of a probable current dollar value of the work and are provided for approximate budget purposes only. Accurate figures can only be obtained by establishing a scope of work and receiving quotes from suitable contractors.
- Time frames given for undertaking work represent our opinion of when to budget for the work. Failure of the item, or the optimum repair/replacement process, may vary from our estimate.
- Estimates of energy use, carbon emissions and utility costs in this analysis are high-level comparative figures and should not be used as predictions of future conditions. Actual performance will vary due to unpredictable variations in weather, utility rates, occupant behaviour, building operations, design and construction quality and other factors.