ENERGY STRATEGY

471 RICHMOND ST + 38 CAMDEN ST

04/18/2019

MCW Consultants Ltd.

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1 EXECUTIVE SUMMARY

A new pair of hotels are being proposed for 471 Richmond Street West and 38 Camden St in Toronto. The buildings are 17 and 15 storeys respectively with three underground parking levels. The total above grade floor area is 16,397 m^2 and below grade floor area of 3,960 m^2. The purpose of this energy strategy is to identify strategies, at an early stage, for energy conservation, low-carbon, and energy resilience. It is anticipated that these strategies can be incorporated into the design and become part of meeting TGS requirements for energy at Site Plan Approval.

Three different energy efficiency levels are evaluated here with multiple compliant solutions given for each. Specifically, they are: Baseline (170 kWh/m^2), Higher Performance (135 kWh/m^2), and Near Zero Emissions (100 kWh/m^2). Additionally, two different low-carbon technologies (transpired solar air heating, and solar PV) are investigated in some detail. Finally, incentive programs are discussed and energy resilience strategies are suggested for this project.

2 INTRODUCTION

The purpose of an Energy Strategy is to identify and evaluate different solutions for low-carbon, energy efficient, and energy resilient building design at an early stage. The City of Toronto requires an Energy Strategy to be prepared for new developments with a gross floor area greater than 20,000 m^2 or within a Community Energy Plan area (as is the case here), as part of either an: Official Plan Amendment, Zoning By-Law Amendment, or Plan of Subdivision.

This Energy Strategy is being developed as part of the re-zoning for 471 Richmond Street West and 38 Camden St. This report will outline different design options for Baseline (TGS Tier 1), Higher Performance (TGS Tier 2), and Near Zero Emissions (TGS Tier 3) performance levels. Next, a discussion of energy resilience will be completed.

The development at 471 Richmond and 38 Camden are 17 and 15 storey hotels with an above grade total floor area of 16,397 m^2 and below grade floor area of 3,960 m^2. The design includes a parking garage below grade as well as some back-of-house service areas. The first floor includes the reception area, a kitchen, and a restaurant space. The 2nd through 14th floors are guest floors with the 17th a lounge space and mechanical/electrical rooms for 471 Richmond. The site plan and the north elevation for the development are shown below.

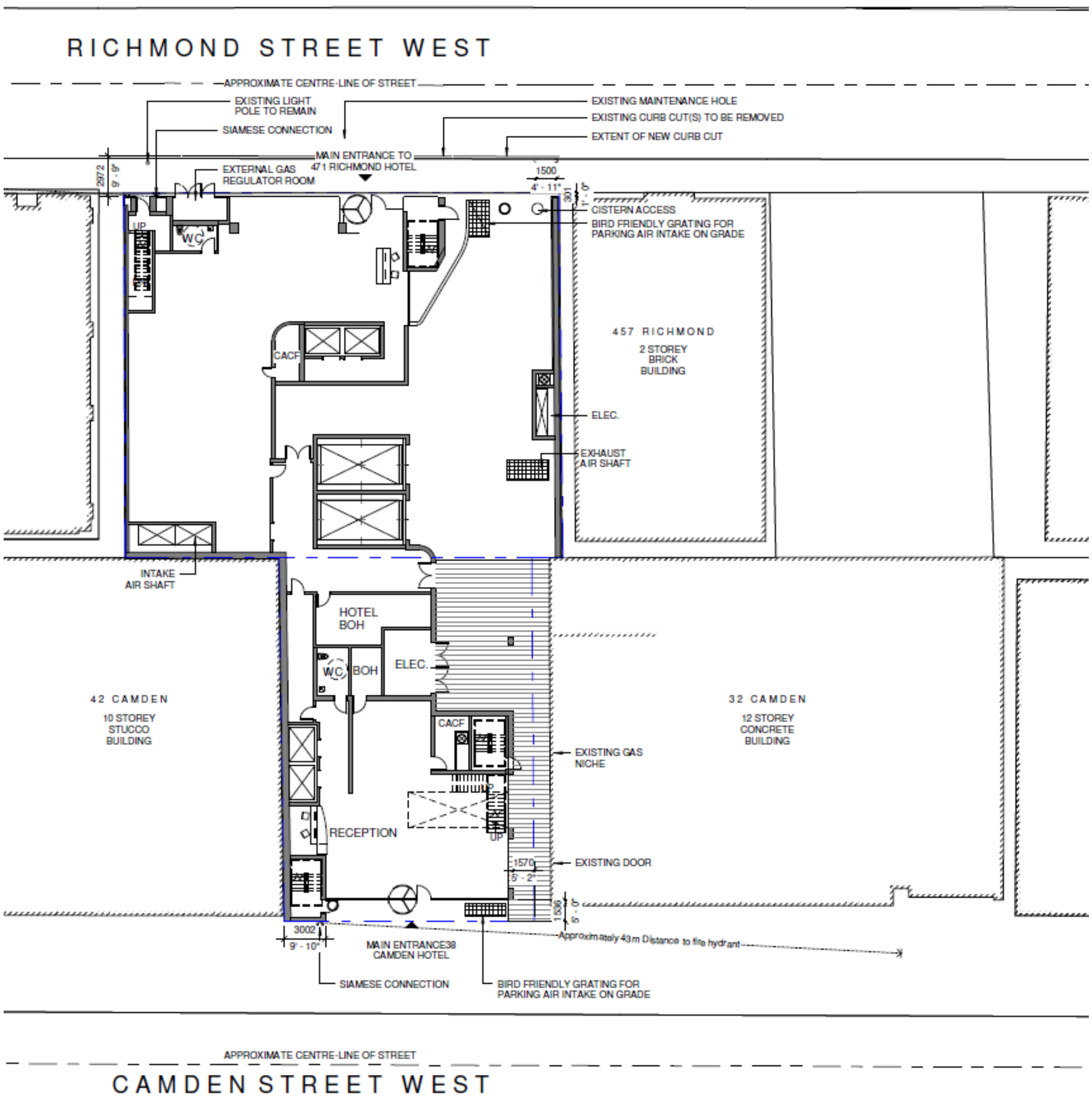

FIGURE 1: SITE PLAN FOR 471 RICHMOND ST WEST AND 38 CAMDEN ST.

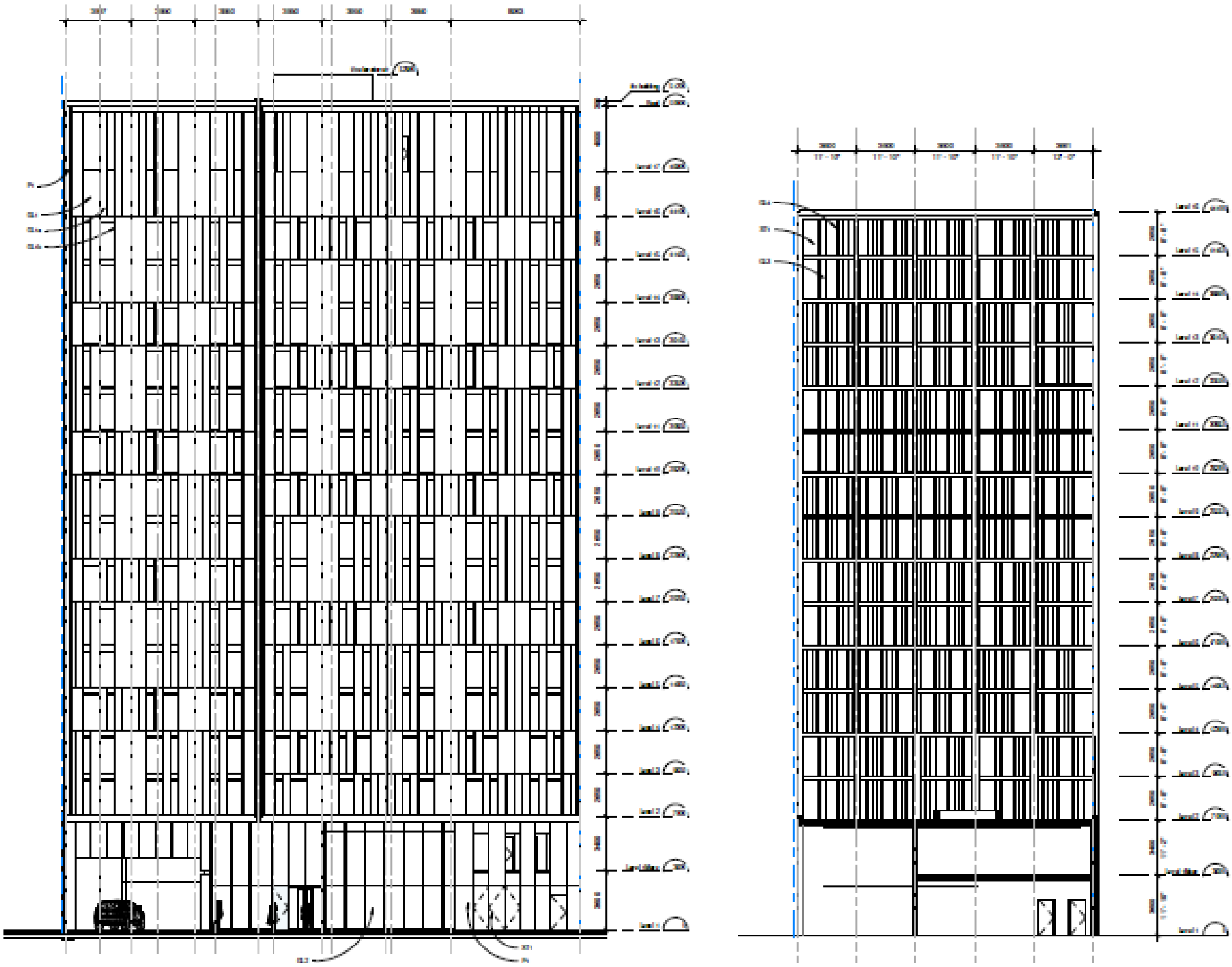

FIGURE 2: NORTH ELEVATION FOR 471 RICHMOND ST WEST (LEFT) AND 38 CAMDEN (RIGHT)

2.1 METHODOLOGY

This energy strategy is being prepared at a very early stage in order to influence the design. Early architectural drawings including floor plans and elevations have been provided and were the basis of the analysis. Because detailed design has not started, a number of different solutions were evaluated in achieving the various energy targets (TGS Tiers 1, 2, and 3). With this in mind, a parametric optimization tool is very useful for this type of analysis. For this study cove.tool (www.covetool.com) was used for energy analysis. Cove.tool uses details of building massing (floor, wall, roof areas), proposed HVAC systems, lighting systems, etc to determine energy usage. From there, a wide variety of parameters can be varied to achieve certain objectives via optimization. Cove.tool is not a full hourly energy model simulation of the building, and as such an IES <VE> model of the building was also created in order to validate the cove.tool model. This type of analysis lead to sets of optimal energy efficiency measures.

Additionally, low-carbon renewable technologies were evaluated to move further towards Zero-Emissions. Next, opportunities for energy resilience were explored and available incentive programs reviewed. Finally, recommendations based on this analysis were made.

3 TOWARDS ZERO EMISSIONS DEVELOPMENT

The TGSv3 requirements for a high-rise multi-unit residential building (also appropriate for a hotel) for the various tiers and their attendant scenarios are shown below for the absolute modelling path and hence no Reference Building (ASHRAE90.1 or NECB) is required. TGS requirements are summarized in Table 1 below.

TABLE 1: TORONTO GREEN STANDARD VERSION 3 ENERGY BENCHMARKS

TGSv3 Tier	Scenario	EUI (kWh/m2)
Tier 1	Baseline	170
Tier 2	Higher Performance	135
Tier 3	Near Zero Emissions	100
Tier 4	Not considered here	75

3.1 ENERGY CONSERVATION MEASURES

A number of different energy conservation measures were investigated for a range of different values for each parameter which leverages the capabilities of cove.tool to investigate the parametric space and optimize performance.

TABLE 2: ENERGY CONSERVATIONS MEASURES SHOWING PARAMETRIC RANGES

Measure	Range	Units
Wall performance	0.2-0.28	U-(W/m^2K)
Roof performance	0.15-0.18	U-(W/m^2K)
Window thermal performance	1.6-2.2	U-(W/m^2K)
Window solar performance	0.25-0.45	SHGC
In-room ERV effectiveness	0.6-0.7	-
Reduced infiltration	0.25-0.15	l/s/m^2 façade
Higher efficiency lighting	5 or 6	W/m^2
Low-flow plumbing fixtures	30	% reduction
Air-source VRF conditioning system	On/Off	-

3.2 DISTRICT ENERGY

District energy (DE) networks can allow for low-carbon energy to be provided to the building thereby reducing emissions. One option, if available, is to connect directly to an existing district energy network. However, if such a network does not yet exist the building can still be designed with rough-in for future connection to a future network or the expansion of an existing network. In order to make a development "district energy-ready" the District Energy (Thermal Network) Ready Guidelines recommend at minimum:

- Providing space for delivery of thermal energy (just below ground level)
- Provide space for an Energy Transfer Station (below grade or on roof)
- Design building HVAC systems to be DE compatible, specifically hydronic systems with high temperature drops

The map below shows a number of existing a potential DES node throughout Toronto. With respect to 471 Richmond and 38 Camden the nearest district energy nodes under development include an Enwave connection at Spadina and Front and a project at King and Portland.

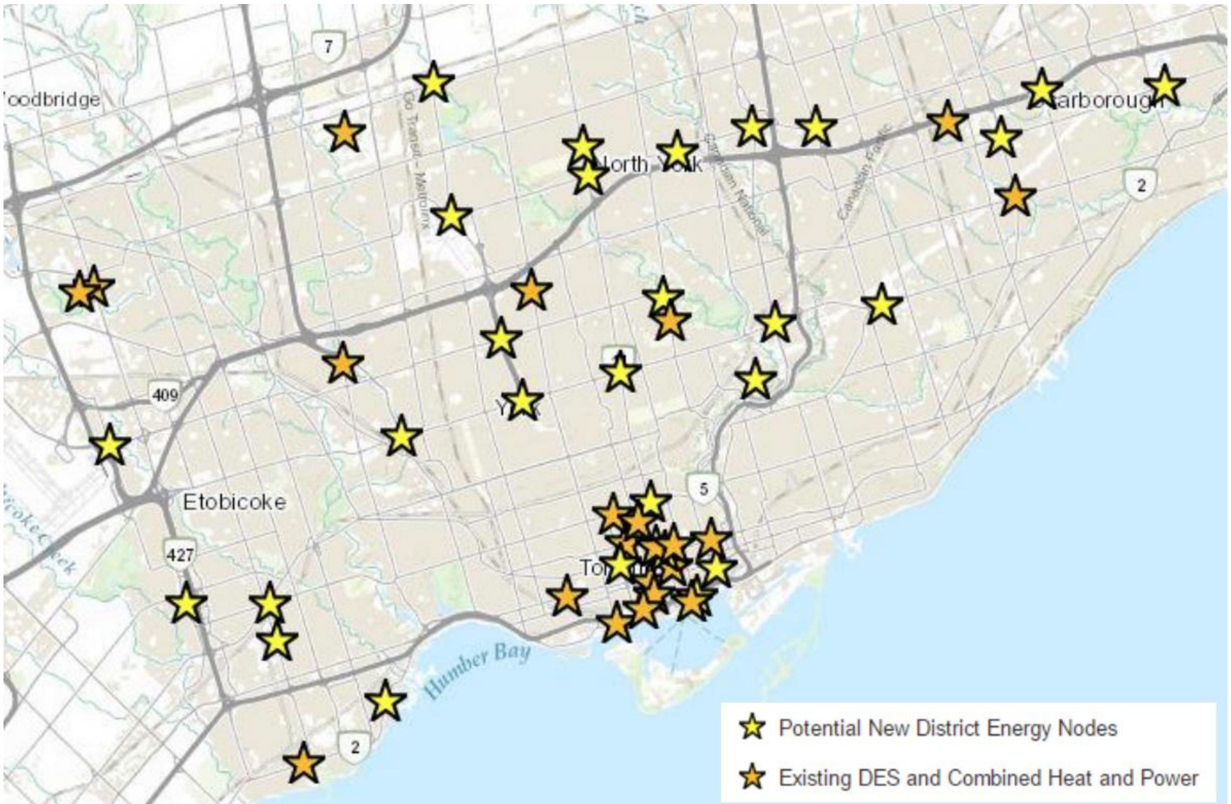

FIGURE 3: EXISTING AND POTENTIAL DES NODES (FROM CITY OF TORONTO DESIGN GUIDELINE FOR DISTRICT ENERGY-READY BUILDINGS)

Given the proximity of these two developments and the extensive nature of the Enwave system there may be a good opportunity to connect 471 Richmond and 38 Camden to a DES system, either at the time of construction or in the future. This will depend on future expansion of the Enwave network which may bring the system closer to the 471 Richmond and 38 Camden site. In terms of current expansion plans the Enwave network will not be close enough to the site to provide a connection. This may change at any time however, therefore it is recommended that the developer contact Enwave so that a connection to the network is not ruled out if timing allows.

The advantages of a DES connection include access to low-carbon technologies such as deep water cooling (Enwave) as well as a reduction in equipment required (boilers and chillers) for the development. This has both first cost and ongoing maintenance and energy cost implications.

3.3 TRANSPIRED SOLAR

Transpired solar, or solar air heating, is a simple technology that uses solar energy to pre-heat incoming ventilation air. This is accomplished through a special cladding system made of perforated panels which allows the air to pass into an air cavity, this air is heated by solar energy as it moves up to the roof before entering the building ventilation system. In addition to solar energy, the system can also capture building heat loss. Ideally the wall being utilized would be a south facing wall, however other orientations are possible. The design has a large windowless east facing façade that could be utilized in this way. The ventilation system would be required to be a central make-up air system rather than in-room ERVs.

The RETScreen modelling tool was used to predict the energy savings of a transpired solar wall comprising the entire east wall.

3.4 SOLAR PV

Solar PV panels capture solar energy from the sun and convert it into usable electricity. For 471 Richmond and 38 Camden the assumed capacity is 144kW which would use approximately 50% of the roof area, allowing for roof area to be used for other equipment if needed.

3.5 OTHER LOW CARBON SOLUTIONS

Ground Source Heat Pumps

Ground source heat pumps use a borehole field to allow heat to be rejected to the ground in summer and captured from the ground in winter. This allows for a water-loop heat pump system that requires less, if any, supplemental heat from a boiler. This fuel switching technology uses electricity for heating as opposed to natural gas reducing carbon dioxide emissions greatly. However, there are increased capital and ongoing energy costs due to the price-gap between natural gas and electricity. For 471 Richmond and 38 Camden the buildings have a relatively small footprint limiting the size of the borehole field, and is relatively tall compared to buildings which would normally have such a system. This limits the capacity of the borehole field and relies much more on boilers and fluid coolers to maintain water temperatures.

Wind

Wind power is a renewable energy technology that typically relies on unobstructed areas to capture wind. 471 Richmond and 38 Camden are located in downtown Toronto and would not be generally suitable for the installation of wind turbines.

Solar Thermal

Solar thermal uses solar collectors to help satisfy domestic hot water needs for the building. Domestic hot water needs for the building will be high and so this could present an opportunity for 471 Richmond and 38 Camden, however it is expected that roof space may be at a premium.

Co-generation

Co-generation or combined heat and power uses a natural gas or even biomass electrical generator to supply building electricity. Waste heat from the system is used for hot water uses such as space heating and domestic hot water heating. The energy efficiency of such technology can be as high as 80%, much higher than that achieved by a typical natural gas power plant. These systems usually only start to payback when there are consistently high electrical and heating loads. In the case of 471 Richmond and 38 Camden the large capital costs of such a system are unlikely to provide payback.

4 ENERGY RESILIENCE

Several design features can increase energy resiliency. First, backup power improves the resilience of the building to area-wide power outages. The capacity of the backup power generator would need to meet at least:

- All life safety and emergency power requirements
- Elevator service
- Domestic hot and cold water
- Space heating, lighting and receptacle power to the lobby areas

Further resilience can be achieved through an improved building enclosure which will allow the building to maintain comfortable conditions for longer in the event of a loss of conditioning. This resilience is also useful towards ensuring that the design is appropriate for the expected future climate of Toronto.

5 ANALYSIS

5.1 BASELINE PERFORMANCE– TGS TIER 1

The Baseline Performance targets are based on fan coils in rooms with condensing boiler, an air-cooled chiller, and ERVs for ventilation heating. Otherwise, a variety of solutions exist trading off ERV performance, lighting power reductions, and envelope performance as seen below in Table 3. An IES <VE> model of the building validated the Baseline Performance results.

TABLE 3: BASELINE PERFORMANCE DESIGN OPTIONS WITH RESULTS

HVAC System	Roof U-Value (W/m^{2}K)	Glazing Performance	Wall U-Value (W/m^{2}K)	Heat Recovery Effectiveness	Lighting (W/m^2)	EUI (kWh/m^2)
Fan coils with boiler and chiller	0.17	U-1.6 / SHGC-0.45	0.2	0.65	5	171
Fan coils with boiler and chiller	0.17	U-1.6 / SHGC-0.4	0.2	0.6	6	171
Fan coils with boiler and chiller	0.17	U-1.6 / SHGC-0.45	0.22	0.6	5	170
Fan coils with boiler and chiller	0.17	U-1.6 / SHGC-0.45	0.2	0.7	5	168

5.2 HIGHER PERFORMANCE – TGS TIER 2

The Higher Performance targets are also based on fan coils in rooms with condensing boiler, an air-cooled chiller, and ERVs for ventilation heating. However, heat recovery effectiveness as well as envelope performance is generally greater leading to lower EUI values compared to the Baseline Performance. Again a variety of solutions are available for costing to determine the best options for implementation.

TABLE 4: HIGHER PERFORMANCE DESIGN OPTIONS AND RESULTS

HVAC System	Roof U-Value (W/m^2K)	Glazing Performance	Wall U-Value (W/m^2K)	Heat Recovery Effectiveness	Lighting (W/m^2)	EUI (kWh/m^2)
Fan coils with boiler and chiller	0.15	U-1.6 / SHGC-0.45	0.24	0.7	6	139
Fan coils with boiler and chiller	0.15	U-1.8 / SHGC-0.45	0.22	0.65	5	139
Fan coils with boiler and chiller	0.16	U-1.8 / SHGC-0.45	0.22	0.7	5	139
Fan coils with boiler and chiller	0.15	U-1.6 / SHGC-0.45	0.28	0.7	5	139
Fan coils with boiler and chiller	0.16	U-1.6 / SHGC-0.4	0.22	0.6	5	137

5.3 NEAR ZERO EMISSIONS – TGS TIER 3

In order to achieve the Near Zero Emissions targets a change in the HVAC system was required. Air-source VRF was chosen as this allows for higher energy efficiency due to a higher efficiency for heating energy.

TABLE 5: NEAR ZERO EMISSIONS DESIGN OPTIONS AND RESULTS

HVAC System	Roof U-Value (W/m^2K)	Glazing Performance	Wall U-Value (W/m^2K)	Heat Recovery Effectiveness	Lighting (W/m^2)	EUI (kWh/m^2)
Air-source VRF	0.16	U-2.5 / SHGC-0.35	0.24	0.6	5	106
Air-source VRF	0.15	U-2.2 / SHGC-0.45	0.24	0.65	5	105
Air-source VRF	0.16	U-2.0 / SHGC-0.4	0.24	0.65	5	104
Air-source VRF	0.18	U-2.0 / SHGC-0.45	0.22	0.6	5	104
Air-source VRF	0.16	U-2.0 / SHGC-0.4	0.28	0.65	5	104
Air-source VRF	0.18	U-2.0 / SHGC-0.45	0.2	0.65	5	103
Air-source VRF	0.15	U-1.6 / SHGC-0.45	0.26	0.6	5	102

5.4 TRANSPIRED SOLAR

The RETscreen tool for estimating transpired solar system performance, assuming minimal shading from surrounding buildings and a black Conserval SolarWall product installed the following annual performance was predicted. This equates to an energy reduction of 7.4 kWh/m^2.

TABLE 6: ENERGY PERFORMANCE OF SOLARWALL INSTALLATION ON EAST FAÇADE	
Solar Energy Captured	91 MWh
Building Heat Loss Captured	30 MWh
Total Energy Saved	121 MWh

5.5 SOLAR PV

The PVWatts online tool, appropriate for early stage feasibility of PV arrays was used to predict the energy savings shown below. In total the savings equate to 3.1 kWh/m^2.

TABLE 7: ENERGY FROM A 144 KW INSTALLED SIZE PV ARRAY USING PVWATTS.NREL.GOV

Month	Solar Radiation (kWh/m^2/day)	AC Energy (kWh)	Value ($)
January	2.44	2,644	$424
February	3.62	3,454	$552
March	4.47	4,622	$740
April	5.26	5,038	$806
May	6.15	5,862	$938
June	6.41	5,844	$936
July	6.55	5,948	$952
August	6.12	5,542	$886
September	5.17	4,694	$752
October	3.46	3,376	$540
November	2.33	2,370	$380
December	2.02	2,156	$344
Annual	**4.50**	**51,550**	**$8,250**

6 INCENTIVE PROGRAMS

There are a variety of incentive programs for commercial property developments to achieve energy savings over Ontario Building Code. Several of which would be achievable for this development if TGS Tier 2 levels of energy performance are achieved.

6.1 SAVINGS BY DESIGN CANADA (SBD)

The Savings By Design Program, from Enbridge Gas, uses an Integrated Design Process ("IDP") to identify technologies to maximize energy efficiencies. This process involves a design charrette with subject matter experts and live energy modelling to test a variety of technologies during the charrette. The costs of this charrette are covered by the program. Additionally, $15,000 is available for projects which exceed the OBC SB10 requirements by greater than 15% based on the technologies selected during the charrette. These technologies need not be incorporated in the final design. However, if they are and an as-built energy model demonstrates those 15% savings a $15,000 commissioning incentive is also available.

6.2 TGS TIER 2

The City of Toronto will rebate the Development Charge for projects achieving TGS Tier 2 or better. In addition to the Tier 2 energy requirements discussed here, there are further requirements in order to achieve Tier 2. These include measures such as:

- Urban Heat Island Reduction: At-Grade
- Energy Systems
- Commissioning and Reporting
- Stormwater Retention and Reuse
- Water efficiency
- Light Pollution
- Construction Waste Management.

7 RECOMMENDATIONS

The Higher Energy Performance scenario in line with TGS Tier 2 is a feasible path. Here we have provided a number of different design options that can become part of a costing exercise to ensure a cost effective solution is chosen. The additional measures of PV panels and transpired solar should also be considered in the design with further, more in-depth analysis to solidify the business case for these measures.

The TGS Tier 3 design solutions rely on using electric heating via air-source VRF systems in order to switch from fossil-fuel heating to more energy efficient electric heating. The downside to such a system is that both the initial first cost and ongoing utility costs would be much higher than the TGS Tier 2 design options.

A connection to a district energy system may be a viable solution towards achieving a lower carbon design. Several new developments in the area are connecting to district energy systems however it may not be possible to connect given current expansion plans.

8 ADDITIONAL MODELLING NOTES

8.1 DISCLAIMER

It is important to note that this study is based on the limited information due to the early stage of the design. **It is not a prediction of actual energy consumption or costs of the proposed design after construction.** Actual experience will differ from these calculations due to variations such as occupancy, building operation and maintenance, weather, energy use not covered by the ASHRAE 90.1 standard, changes in energy rates between design of the building and occupancy, and precision of the calculation tool.

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