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DUFFERIN GROVE VILLAGE

ENERGY STRATEGY REPORT

For

Primaris REIT

Project Location

900 Dufferin St, Toronto , Ontario

Footprint Project Number:

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Date

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Executive Summary

The energy analysis for Village by the Grove presents an evaluation of the current building design and explored various energy conservation measures (ECMs) to provide a pathway to achieve better performance with intention to reduce energy use intensity (EUI), thermal energy demand intensity (TEDI) ,greenhouse gas (GHG) emissions and annual energy cost.

A base case energy model was created to represent the current design of the Village by the Grove project at rezoning stage, which is shown to be compliant with TGS V3 Tier 1 requirements. The base case design includes proposed East and West development containing four residential towers. This project includes retail, amenity and three levels of parking levels. In the base case design model, East and West development towers are analyzed separately based on standalone central heating and cooling plant. Modelling the four buildings including podium levels as one cohesive plant allows for energy conservation opportunities by offering energy balance and dual direction back-up. This has been evaluated as part of the energy conservation measures.

Under TGS Version 3, absolute target approach is adopted for this project. If this project achieves Tier 2 or higher performance, it would be eligible for development charge refund. Essential ECMs include: improved building envelope performance; LED lighting with further reduction in lighting power densities; in suite energy recovery with better efficiency; high efficiency fans with ECM motors; high efficiency pumps with VFDs; high efficiency heating and cooling plant that includes effective performance at part loads due to condensing boilers and chillers with variable speed compressors.

Moving toward higher levels for Toronto Green Standard (TGS) Version 3 targets, Additional ECMs are presented with a focus on areas with the greatest opportunity to reduce the development's loads including strategies such as ground source heat pumps, and various passive and active solar strategies. Achieving TGS version 3 – Tier 3 targets requires the higher performing wall assemblies and Triple glazing for the residential towers. Improving the air tightness of the envelope and reducing the corridor ventilation in towers results in further reduction in TEDI and EUI values.

The nature of the development density and site area do facilitate the area of PV required to be installed on existing mall roof. Approaching Net Zero' design was analyzed which incorporates advanced load reductions including improved glazing performance, reduced window to wall ratio and improved envelope design. Additionally, ground source heat pumps provide the heating, cooling, and back up domestic hot water. Solar collectors provide the primary hot water service in this option.

Appendix A contains the detailed baseline energy model input assumptions. Appendix B contains a point form summary of the energy conservation measures that include estimated performance values, impact on the energy performance and other design considerations.

Results Summary

Design Case	EUI (ekWh/m²)	TEDI (ekWh/m²)	GHGI ($kGCO_2e/m^2$)	Energy Savings	Emissions Savings	Cost Savings
Base case Design	164	60.5	20.2	-	-	-
Proposed Tier 1	153	56.6	18.7	6.9%	7.2%	6.2%
Proposed Tier 2	137	50	15	16.6%	25.4%	4.3%
Proposed Tier 3	80	12.6	4.1	51.2%	79.6%	11.6%
Approaching Net-Zero – Tier 4	<52	<12.6	<2.7	>68.1%	>86.5%	>42.5%

PROPOSED DEVELOPMENT SUMMARY TO ACHIEVE TIER 1

PROJECT DESCRIPTION

The proposed development is comprised of mixed-use commercial and residential towers:

- Residential Tower 1 and 2 -West Development : 74,924 SM (722 units) , 35 and 39 Level
- Residential Tower 1 and 2 -East Development : 39,929 SM (413 units) , 14 and 23 Level
- Retail : 11,639 SM, 2 Level
- Indoor Amenity (Total for both Blocks): 2,270 SM
- Parking: 35,828 SM, 3 Level
- Total number of residential units: 1135

ENERGY CONSERVATION DESIGN FEATURES

The design assumptions were determined from information available and with the intent of meeting the energy requirements of TGS V3-Tier 1. Detailed energy model inputs can be found in Appendix A. The following energy conservation measures are incorporated in this proposed building design:

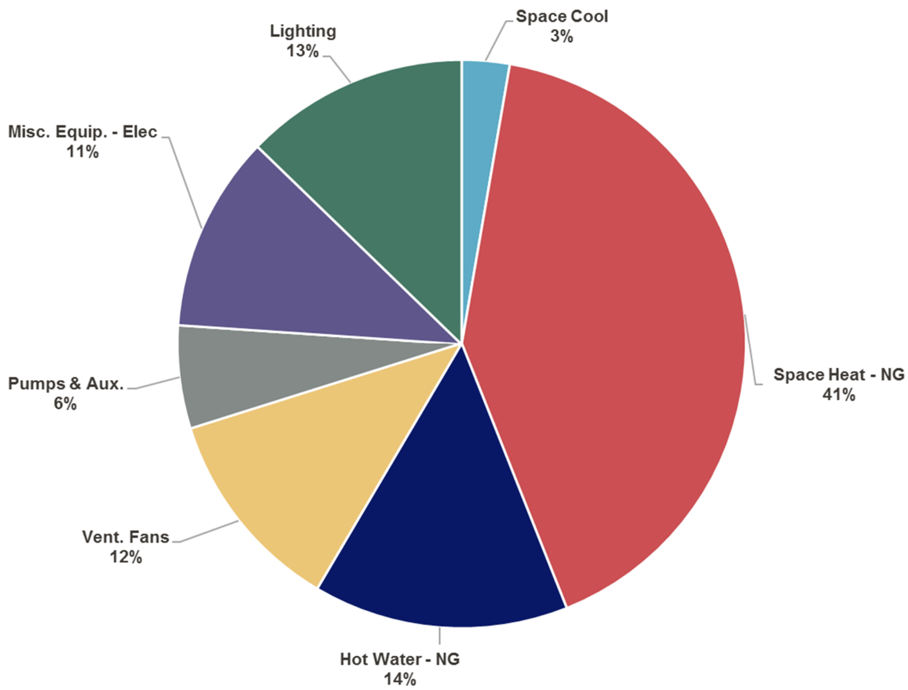
- Opaque envelope performance with overall R15 external walls and R30 roofs
- Glazing performance: Double glazed low-e, argon fill, 19mm thermal break
- 40% Window to Wall Ratio (WWR) for residential towers.
- In suite ventilation energy recovery provided for dwelling units - 65% efficient
- Low-flow lavatories, showerheads and faucets
- High efficiency condensing boilers
- High efficiency condensing domestic water heaters
- High efficiency chillers, with variable speed compressors
- Variable speed control on all fans and pumps

ENERGY PERFORMANCE

The EUI of the proposed design for each towers are shown below, targeting TGS version 3 – Tier 1 target for total EUI, TEDI and GHG emissions.

- Emissions determined from SB-10 2017
- Using current average prices: Electricity \$0.15/kWh & Natural gas = \$0.25/m^3

Design Case	Current Design			Tier 1 Minimum Performance		
	EUI (ekWh/m²)	TEDI (ekWh/m²)	GHGI ($kGCO_2e$/m²)	EUI (ekWh/m²)	TEDI (ekWh/m²)	GHGI ($kGCO_2e$/m²)
Proposed Tier 1	153	56.6	18.7	170	70	20



BASE BUILDING DESIGN DESCRIPTION

MASSING AND ORIENTATION

The nature of the site and purpose of the proposed development lends itself to a large amount of occupied perimeter spaces

The window-to-wall ratio (WWR) for the residential towers is assumed at 40% in the base case model.

THERMAL PERFORMANCE

Thermal performance values are defined based on rezoning drawings. Where there is missing information, SB10 prescriptive values are considered.

- Exterior wall performance: R15 overall
- Residential Tower Roof- R30
- Glazing System U value – 0.35 Btu/h. ft² °F.
  - Windows Frames: aluminum frames, with 19mm thermal break, insulating spacer
  - Windows Glass: double glazed air filled and triple glazed air filled, soft low-e coating on surface 2 and 3.
  - Unitized Curtain wall system

LIGHTING

The baseline lighting targets is set equal to or better than the 2017 SB-10 requirements. LED lighting fixtures are required in the baseline design to achieve these lighting power density targets.

Occupancy sensor lighting control will be provided to office, amenity, storage, public restrooms and parking garage spaces. Occupancy sensor for corridor will control 50% of the corridor fixtures.

DAYLIGHTING

The proposed building's form and function promote daylighting mainly for residential suites; However in a residential development, the occupant behavior will drive the savings far more than automated controls. Therefore, no credit has been taken in the energy models for daylighting for residential, as it is inherent in the ASHRAE default residential lighting schedules.

APPLIANCES

All in-suite appliances have been set to Energy Star minimum requirements.

HEATING & COOLING

Each residential tower is served by a standalone boiler and chiller plant. The following list summarizes the baseline mechanical design. Detailed model inputs and performances are presented in Appendix A.

- Hot water is provided by high efficiency natural gas condensing boilers
- Chilled water is provided by water cooled chillers with variable speed compressors for residential towers and magnetic bearing chillers for the office towers.
- Fan coils provide space conditioning
- ECMs on all fan coils units

VENTILATION

In-suite energy recovery ventilators provide dwelling unit ventilation. Residential lobby and amenity ventilation as well as corridor pressurization is provided by a hydronic make up air unit. .Tempered (heated and partly cooled) ventilation/outdoor air shall be supplied to the corridors to offset local suite exhaust rates by a 100% outdoor air, constant air volume indoor air handling units.

DOMESTIC HOT WATER

Domestic hot water is provided by high efficiency condensing domestic water heaters. Low flow fixtures have been incorporated into the base design. Opportunity to further reduce the domestic hot water load is assessed as a conservation measure.

ENERGY CONSERVATION MEASURES

ECMs were determined by first examining where the base building design loads could be reduced. Many load reduction measures have been incorporated into the base design: good envelope performance, ventilation energy recovery in residential suites, enthalpy wheel for office ventilation system, variable speed chillers, condensing boilers and low flow plumbing fixtures. The following are some items that provide the most opportunity for further load reduction:

- Glazing
- Spandrel panel
- Domestic hot water
- Corridor Ventilation
- Building Air tightness

Please refer to Appendix A for details of energy conservations measures for this project.

GLAZING

Reduced Glazing Area

Heat loss and heat gains through glazing are major contributors to heating and cooling loads. Reducing the total glazed area is the most cost effective way to reduce energy consumption. Designing to achieve a lower window to wall ratio is ideal from an energy perspective as this helps reduce cooling loads and heating losses, while allowing enough glazing area to maintain daylighting and sufficient heat gain during bright winter and shoulder season days.

Improved Window Performance

Improved window performance are studied as follows;

- Triple glazing for residential tower
- Triple glazing units with argon space.
- Triple glazing unit with surface two and five low-e coating.

There is a trade-off between heating and cooling loads, as reduced solar heat gain increases heating loads. The cost of electricity is much higher than natural gas, so reducing the solar heat gain coefficient will reduce energy costs far more than energy and emissions. Reducing solar heat gain coefficients is achieved through various low-e coatings and is less expensive than improving both U-value and solar heat gain coefficient. Window U-value improvements are achieved through increasing the number of pains (i.e. triple glazed) or increasing the thermal break of aluminum frames.

DOMESTIC HOT WATER

Lower Flow Fixtures

1.9LPM lavatories should have negligible incremental capital costs and will reduce the domestic hot water load by 15%.

Drain Water Heat Recovery

Utilizing drain heat recovery entails separating toilet drain piping to capture waste heat from lavatories, showers and sinks. The savings are estimated using a recovery effectiveness of 30%.

Low flow fixtures conflict with this strategy, as separating the plumbing makes it more difficult to achieve proper waste flushing. Lower flow fixtures are a more feasible measure to reduce the total domestic hot water load.

Solar Domestic Water Heaters

Solar domestic water heaters were analyzed as an alternative to photovoltaics serving the electrical load of the building.

The solar domestic water heater was run in conjunction with lower flow fixtures to reduce initial system sizing and costs. System loads and sizing would need to be calculated during detailed design. Additionally space restraints might not allow for backup and storage equipment or the solar collectors.

CORRIDOR VENTILATION

Ventilation Energy Recovery

Ventilation energy recovery is incorporated in the dwelling units of the base design case; however, corridor make up air represents over 30% of the total ventilation provided. Ducting the exhaust air back to these units is typically not practical. The additional cost of incorporating energy recovery to the corridor ventilation units would be substantial considering the additional space and ductwork required. It is recommended that alternative strategies also be investigated to reduce the load of the corridor ventilation air.

LOW CARBON SOLUTIONS

Ground Source Heat Pumps (Geothermal)

Ground source heat pumps use the mass of the earth to improve the performance of a vapour compression refrigeration cycle which can heat in winter and cool in summer. Glycol is passed through vertical or horizontal piping loops between the building and the ground. The fluid absorbs heat from the ground in winter months and rejects heat in the summer months. The soil remains at more constant temperatures and essentially serves as a highly efficient heat rejection medium.

In this alternative, the central chiller plant will be replaced by heat pump chillers simultaneous heating and cooling and interconnected to the heating and cooling system. Since this would be below the below grade building levels, the construction of the geothermal field would need to be coordinated with the overall building construction plan and may elongate the schedule.

It is important to note that ground source heat pumps shift the primary source of heating energy from natural gas to electricity. The discrepancy between the cost of electricity and the cost of natural gas results in a discrepancy between energy and energy cost savings. Current average electricity cost is ~0.14/kWh, whereas the average natural gas costs is $0.02/ekWh ($0.30/m³); therefore, energy cost savings will be far less significant than energy savings.

The incremental geothermal system capital costs and discrepancy in utility costs due to switching from natural gas to electric heating make it imperative to reduce the base building heating and cooling loads as much as possible. There is potential to see cost benefits associated with ground source heat pumps when the overall building loads have been reduced first.

Ground source heat pumps were analyzed in combination with load reduction measures to create the 'Approaching Net Zero' design. There is no cost benefit to ground source heat pumps as an individual measure; however, combined with decreased glazing area, improved glazing performance, as well as solar strategies that reduce the ventilation and domestic water heating load, ground source heat pumps play a key role in achieving lower energy use intensities.

Combined Heat & Power (CHP)

Combined heat and power systems (CHP) are on site electricity production systems that are specifically designed to recover waste heat from the electricity production process for the use in heating, cooling, or process applications. A properly designed CHP plant can be twice as efficient as a typical fossil fuel power plant, converting up to 80% of the energy from input fuel into electricity and useful heat.

The most successful applications for CHP involve projects where the demands for electricity and heat align. Projects with central heating and cooling plants such as university campuses, provide a good match for CHP systems because an infrastructure for distributing the heating and cooling already exist and there is generally a continuous or large demand for simultaneous electricity and heat. When electricity and heating demands are not in sync, the efficiency and feasibility of a CHP is reduced.

Photovoltaics

Photovoltaic (PV) cells capture sunlight to generate electricity. PV cells, or solar cells, are arranged together in a module to collect sunlight and convert it into usable electricity. The electricity can be used as a partial or complete supply for a building's electricity needs. Excess electricity can be relayed back to the electricity grid or stored in batteries. Larger area modules with the same efficiency will produce more electricity. PV cells are most efficient in direct sunlight and lose efficiency with shading, dirty surfaces, and heating of the cells. Therefore, the location and orientation of the panels affects their output.

The proportion of proposed building area to total site area limits the potential for onsite electricity production through PV on East and West development but Solar PV can be installed on mall roof.

Shared Mechanical Rooms for Heating and Cooling Equipment

Since the heating and cooling profiles for the retail, residential and amenity end uses are different, there is a greater quantity of hours annually with concurrent heating and cooling when the entire development is served by a single heating and cooling plant. This opportunity has further benefits that include the potential to reduce mechanical space and increase resiliency through the provision of additional equipment serving the complex. For example, if a building has one chiller that fails, the building loses cooling capacity. If all of the chillers are combined into a common system with multiple chillers, thus, a single chiller failure would not affect the complex for the majority of the days of the year and even on peak cooling days would only result in a reduced cooling capacity.

LIST OF ENERGY CONSERVATION MEASURES (ECMS)

Envelope

ECM1	Balcony thermal break
ECM2	R20 Overall Effective Wall
ECM3	R25 Overall Effective Wall
ECM4	Roof R40
ECM5	Roof R50
ECM6	Increasing SHGC on North and East facing windows
ECM7	Triple Glazed Double Coated #2,#3 , Argon space
ECM8	Triple Glazed Double Coated #2,#5 , Argon space
ECM9	Improved air tightness -Reduce Infiltration by 30%

Service Hot Water

ECM10	Lavs 1.9 LPM
ECM11	Drain Water Heat Recovery-Residential
ECM12	Heat pump for Domestic hot water

HVAC

ECM13	Residential Corridor OA - 40 CFM per Suite
ECM14	Residential Corridor OA - 30 CFM per Suite
ECM15	Residential-In-Suite ERV 75% Efficient
ECM16	Residential-In-Suite ERV 85% Efficient
ECM17	Magnetic bearing Chillers-Residential
ECM18	Central Heating and Cooling Plant
ECM19	Water-Source Heat pump
ECM20	Ground coupled heat pump system

Lighting

ECM21	Lighting power reduction-30%

Renewables

ECM22	Solar Domestic Water heater
ECM23	SolarWall
ECM24	SolarPV

Combined Designs

ECM25	TIER 1 (ECM 10+13+20)
ECM26	TIER 2 ((ECM 9+10+12+14+20)
ECM27	TIER 3 (ECM 1+3+5+8+9+10+12+14+19+20+22)
ECM28	TIER 4 (ECM 1+3+5+8+9+10+12+14+19+20+23)

RESULTS SUMMARY - ENERGY CONSERVATION MEASURES

Design Case		Elec kWh	NG kWh	Total Energy (ekWh)	EUI-elec (ekWh/m^2)	EUI-NG (ekWh/m^2)	TEUI (ekWh/m^2)	Energy Savings	TEDI (ekWh/m^2)	Emissions (kgCO_2/m^2)	Emissions Savings	Elec $	NG $	Annual Cost $/m^2	Annual Energy Cost	Cost Savings	Cost Savings
Base Design		8,370,281	10,399,209	18,769,490	73	91	164	-	60.5	20.2	-	$1,088,100	$ 248,300	11.7	$ 1,336,400	-	-
ENVELOPE																	
1	Balcony TB	8,355,451	10,284,914	18,640,365	73	90	163	0.7%	60.2	20.0	0.9%	$1,086,200	$ 245,600	11.6	$ 1,331,800	0.3%	$ 4,600
2	R20Wall	8,351,465	10,271,688	18,623,154	73	90	163	0.8%	59.5	19.9	1.0%	$1,085,700	$ 245,300	11.6	$ 1,331,000	0.4%	$ 5,400
3	R25 Wall	8,346,161	10,156,125	18,502,286	73	89	162	1.4%	58.6	19.8	2.0%	$1,085,000	$ 242,500	11.6	$ 1,327,500	0.7%	$ 8,900
4	RoofR40	8,362,016	10,343,757	18,705,774	73	90	164	0.3%	60.1	20.1	0.5%	$1,087,100	$ 247,000	11.7	$ 1,334,100	0.2%	$ 2,300
5	RoofR50	8,359,994	10,306,448	18,666,442	73	90	163	0.5%	59.8	20.0	0.8%	$1,086,800	$ 246,100	11.7	$ 1,332,900	0.3%	$ 3,500
6	High SGCH N/E	8,370,281	10,399,209	18,769,490	73	91	164	0.0%	60.5	20.2	0.0%	$1,088,100	$ 248,300	11.7	$ 1,336,400	0.0%	$ -
7	Triiple-#2and3	8,058,763	10,143,669	18,202,433	70	89	159	3.0%	58.6	19.6	2.7%	$1,047,600	$ 242,200	11.3	$ 1,289,800	3.5%	$ 46,600
8	Triiple-#2and5	8,030,920	10,036,342	18,067,263	70	88	158	3.7%	57.7	19.4	3.6%	$1,044,000	$ 239,600	11.2	$ 1,283,600	4.0%	$ 52,800
9	Airtightness	8,372,743	10,338,834	18,711,577	73	90	164	0.3%	60.1	20.1	0.5%	$1,088,500	$ 246,900	11.7	$ 1,335,400	0.1%	$ 1,000
SERVICE HOT WATER																	
10	Lavs 1.9 LPM | Kitchen 3.8 LPM	8,369,812	9,730,862	18,100,674	73	85	158	3.6%	60.5	19.1	5.3%	$1,088,100	$ 232,400	11.6	$ 1,320,500	1.2%	$ 15,900
11	Drain Water Heat Recovery	8,370,047	10,040,914	18,410,961	73	88	161	1.9%	60.5	19.6	2.8%	$1,088,100	$ 239,800	11.6	$ 1,327,900	0.6%	$ 8,500
12	Heat pump DHWH	9,270,838	7,692,351	16,963,189	81	67	148	9.6%	60.5	16.3	19.3%	$1,205,200	$ 183,700	12.1	$ 1,388,900	-3.9%	$ (52,500)
HVAC																	
13	Residential Corridor OA - 40 CFM per Suite	8,265,739	9,719,021	17,984,760	72	85	157	4.2%	55.2	19.0	5.6%	$1,074,500	$ 232,100	11.4	$ 1,306,600	2.2%	$ 29,800
14	Residential Corridor OA - 30 CFM per Suite	8,202,902	9,719,607	17,922,509	72	85	157	4.5%	55.2	19.0	5.7%	$1,066,400	$ 232,100	11.4	$ 1,298,500	2.8%	$ 37,900
15	ERV 75% Efficient	8,372,743	10,384,291	18,757,034	73	91	164	0.1%	60.4	20.1	0.1%	$1,088,500	$ 248,000	11.7	$ 1,336,500	0.0%	$ (100)
16	ERV 85% Efficient	8,376,114	10,369,900	18,746,014	73	91	164	0.1%	60.3	20.1	0.2%	$1,088,900	$ 247,600	11.7	$ 1,336,500	0.0%	$ (100)
17	Mag Chiller	8,342,102	10,399,209	18,741,311	73	91	164	0.2%	60.5	20.1	0.1%	$1,084,500	$ 248,300	11.7	$ 1,332,800	0.3%	$ 3,600
18	Central Plant	8,284,274	10,216,529	16,366,090	72	89	162	1.4%	60.5	19.8	1.6%	$1,077,000	$ 243,900	11.6	$ 1,320,900	1.2%	$ 15,500
18	WSHP	11,927,428	5,702,022	17,629,450	104	50	154	6.1%	60.7	14.3	29.2%	$1,550,600	$ 136,200	14.8	$ 1,686,800	-26.2%	$ (350,400)
19	GSHP	9,568,757	2,800,586	12,369,343	84	24	108	34.1%	13.6	8.6	57.2%	$1,243,900	$ 66,900	11.5	$ 1,310,800	1.9%	$ 25,600
LIGHTING																	
20	Lighting power reduction	7,972,304	10,490,592	18,462,896	70	92	162	1.6%	61.3	20.1	0.1%	$1,036,400	$ 250,500	11.3	$ 1,286,900	3.7%	$ 49,500
RENEWABLES									0.0								
21	Solar Domestic Water heater	8,370,281	10,263,866	18,634,147	73	73	146	10.8%	0.0	19.9	1.1%	$1,088,100	$ 245,100	11.7	$ 1,333,200	0.2%	$ 3,200
22	SolarWalls	8,370,281	10,322,285	18,692,567	73	90	164	0.4%	0.0	20.0	0.6%	$1,088,100	$ 246,500	11.7	$ 1,334,600	0.1%	$ 1,800
23	SolarPV	5,187,963	10,399,209	15,587,171	45	91	136	17.0%	0.0	18.8	6.9%	$ 674,400	$ 248,300	8.1	$ 922,700	31.0%	$ 413,700
TGS Targets									0.0								
24	TIER 1 (10+13+20)	7,879,894	9,616,090	17,495,985	69	84	153	6.8%	56.6	18.7	7.2%	$1,024,400	$ 229,600	11.0	$ 1,254,000	6.2%	$ 82,400
25	TIER 2 (9+10+12+14+20)	8,529,220	7,122,304	15,651,524	75	62	137	16.6%	56.1	15.0	25.4%	$1,108,800	$ 170,100	11.2	$ 1,278,900	4.3%	$ 57,500
26	TIER 3 (1+3+5+8+9+10+12+14+19+20+22)	9,070,399	96,190	9,166,589	79	1	80	51.2%	12.6	4.1	79.6%	$1,179,200	$ 2,300	10.3	$ 1,181,500	11.6%	$ 154,900
27	TIER 4 (1+3+5+8+9+10+12+14+19+20+23)	5,888,080	96,190	5,984,270	52	1	52	68.1%	12.6	2.7	86.5%	$ 765,500	$ 2,300	6.7	$ 767,800	42.5%	$ 568,600

ENERGY RESILIENCE

Standard practice for multi-unit residential buildings is to provide backup power systems that cover all life safety requirements and base buildings loads such as pressurization fans, boilers, sump pumps and domestic hot water systems. Diesel generators are more common than natural gas generators since natural gas generators cost approximately double and are larger than their diesel counterparts.

Additionally natural gas generators above 350kW have difficulty meeting the 15-second maximum time allowance for life safety equipment to come back on. Multiple or twin generators could address this concern. The benefits of natural gas generators are lower NOX emissions as well as a constantly available fuel supply that does not have to be manually delivered.

The distribution and sizing of the backup systems will need to consider Ministry of Environment and Climate Change requirements for NOX emissions. Typically, the generators must be located at higher levels such as a penthouse to satisfy the emissions requirements.

Preliminary estimate for diesel and natural gas generators for each residential tower is shown below:

	Generator Size (Kw)	Diesel Generator ($)	Natural Gas ($)
East Development	860	$ 429,636	$ 859,272
West Development	1615	$ 806,182	$ 1,612,364

There would be benefits to reliability if the back-up power systems were shared between the two development.

APPENDIX A: ENERGY MODELLING ASSUMPTIONS

Envelope	Proposed Building Design	Reference Building Design	Source
Exterior Walls	**Exterior Wall Construction** Description TBD R-17 ECM2 : R-20 ECM3: R-25	**ASHRAE 90.1.2013 SB10 CZ5** Effective: R-20	Different levels of performance will be assessed with an intention to optimize the design.
Exterior Wall - Non Residential	Exterior Wall Construction Curtain Wall - Unitized Double Glazed Low E Insulated Unit R-4.8 ECM1 : R-9.7	ASHRAE 90.1.2013 SB10 CZ5 Effective: R-20	
Balcony Slab- East Development	R-1.5 ECM1 : R-2.8	ASHRAE 90.1.2013 SB10 CZ5 Effective: R-20	
Exterior Roof	Roof Construction Rigid Insulation, XPS Insulation R-30 ECM1: R-40 ECM2: R-50	ASHRAE 90.1.2013 SB10 CZ5 Effective: R-34.5	
Wall,Below Grade	Wall,Below Grade Effective: R-15	ASHRAE 90.1.2013 SB10 CZ5 Effective: R-15	Same as Ashrae 90.1 2013 SB10
Floor Above Parking	R-20	ASHRAE 90.1.2013 SB10 CZ5 Effective: R-20	Same as Ashrae 90.1 2013 SB10
Glazing System	Overall U = 0.35, SHGC 0.4 ECM1: U-0.3, SHGC-0.4 ECM2: U-0.25, SHGC-0.32 ECM3: U-0.16, SHGC-0.25 WWR: 40%	ASHRAE 90.1.2013 SB10 CZ5 Effective: U-0.38, SHGC-0.4 WWR: 40.0%	Double glazing & Triple glazing with different framing systems can achieve the levels of performance. The impact on energy, energy cost as well as thermal and visual comfort will be assessed.

Lighting	Proposed Building Design	Reference Building Design	Source
Amenity - Event Space	**As per Ashrae 90.1-2013 SB10** Lighting Power Density: 1.07 W/ft² **ECM : 30% Better than Ashrae 90.1-2013 SB10** Lighting Power Density: 0.75 W/ft²	**ASHRAE 90.1.2013 SB10** Lighting Power Density: 1.07 W/ft²	
Atrium - first 13 m in height	**As per Ashrae 90.1-2013 SB10** Lighting Power Density: 0.71 W/ft² **30% Better than Ashrae 90.1-2013 SB10** Lighting Power Density: 0.5W/ft²	**ASHRAE 90.1.2013 SB10** Lighting Power Density: 0.71 W/ft²	
Corridor	**As per Ashrae 90.1-2013 SB10** Lighting Power Density: 0.66 W/ft² **30% Better than Ashrae 90.1-2013 SB10** Lighting Power Density: 0.46 W/ft²	**ASHRAE 90.1.2013 SB10** Lighting Power Density: 0.66 W/ft²	
Dwelling Unit - General (NECB-2015)	**As per Ashrae 90.1-2013 SB10** Lighting Power Density: 0.465 W/ft²	**ASHRAE 90.1.2013 SB10** Lighting Power Density: 0.465 W/ft²	
Electric / Mechanical	**As per Ashrae 90.1-2013 SB10** Lighting Power Density: 0.43 W/ft² **30% Better than Ashrae 90.1-2013 SB10** Lighting Power Density: 0.30 W/ft²	**ASHRAE 90.1.2013 SB10** Lighting Power Density: 0.43 W/ft^2	
Lobby - for elevator	**As per Ashrae 90.1-2013 SB10** Lighting Power Density: 0.68 W/ft² **30% Better than Ashrae 90.1-2013 SB10** Lighting Power Density: 0.48 W/ft²	**ASHRAE 90.1.2013 SB10** Lighting Power Density: 0.68 W/ft^2	
Lobby	**As per Ashrae 90.1-2013 SB10** Lighting Power Density: 1.0 W/ft² **30% Better than Ashrae 90.1-2013 SB10** Lighting Power Density: 0.70W/ft²	**ASHRAE 90.1.2013 SB10** Lighting Power Density: 1.0 W/ft^2	The lighting power density as per SB10/Ashrae 90.1-2013 requirements are assumed as baseline.
Locker room	**As per Ashrae 90.1-2013 SB10** Lighting Power Density: 0.48 W/ft² **30% Better than Ashrae 90.1-2013 SB10** Lighting Power Density: 0.34 W/ft²	**ASHRAE 90.1.2013 SB10** Lighting Power Density: 0.48 W/ft^2	
Office Enclosed	**As per Ashrae 90.1-2013 SB10** Lighting Power Density: 0.93 W/ft² **30% Better than Ashrae 90.1-2013 SB10** Lighting Power Density: 0.65 W/ft²	**ASHRAE 90.1.2013 SB10** Lighting Power Density: 0.93 W/ft^2	
Parking garage – garage area	**As per Ashrae 90.1-2013 SB10** Lighting Power Density: 0.14 W/ft² **30% Better than Ashrae 90.1-2013 SB10** Lighting Power Density: 0.29 W/ft²	**ASHRAE 90.1.2013 SB10** Lighting Power Density: 0.14 W/ft^2	
Retail - sales area	**As per Ashrae 90.1-2013 SB10** Lighting Power Density: 1.22 W/ft² **30% Better than Ashrae 90.1-2013 SB10** Lighting Power Density: 0.85 W/ft²	**ASHRAE 90.1.2013 SB10** Lighting Power Density: 1.22 W/ft^2	
Stairwells	**As per Ashrae 90.1-2013 SB10** Lighting Power Density: 0.58 W/ft² **30% Better than Ashrae 90.1-2013 SB10** Lighting Power Density: 0.41 W/ft²	**ASHRAE 90.1.2013 SB10** Lighting Power Density: 0.58 W/ft^2	
Storage	**As per Ashrae 90.1-2013 SB10** Lighting Power Density: 0.63 W/ft² **30% Better than Ashrae 90.1-2013 SB10** Lighting Power Density: 0.44 W/ft²	**ASHRAE 90.1.2013 SB10** Lighting Power Density: 0.63 W/ft^2	

PROPSED HVAC	Description	Performance	Source
MAU (Separate for East & West Tower) serving Suites & Common spaces	**100% Outside Air Variable Volume Air Handling Unit** Hydronic Heating and Cooling Outdoor Air: ASHRAE 62.1-2010 100% Outdoor air for economizer mode Supply & Exhaust fans with Variable speed drives Fan Power: 0.0008 kW/cfm		Preliminary Assumption
Fan coil Units serving Suites,Amenities & Retail	**Vertical 4 Pipe Fan Coil with in Suite ERV** Hydronic Heating and Cooling Fan Power: 0.0003 kW/cfm Constant Volume Fan, Ventilation Provided in accordance with ASHRAE 62.1-2010 -System Efficiency = 1.0 | Delivery effectiveness = 0.8 1 bedroom 50 cfm | 2 bedroom 75 cfm | 3 bedroom 100 cfm	ERV Performance Energy Recovery: 65% Sensible, 40% latent effectiveness Fan Coil Performance Fans: Multiple speed settings, with ECM motors - High speed kW/cfm: 0.0002 - Low Speed kW/cfm: 0.0001 Exhaust Fans: - Washroom: 50 Watts - Kitchen Hood: 75 Watts - Dryer: 75 Watts	Preliminary Assumption
Unit Heaters serving Vestibules & Stairs	**Unit Heaters** Hydronic Heating 0.0003 kW/CFM		Preliminary Assumption
Parking Garage System	No heating provided. Exhaust fans controlled by CO sensors	Parking Exhaust fans schedule: 4 hrs/day Exhaust Fan Efficiency: 0.0001 kW/cfm	Preliminary Assumption
Cooling Plant	**Water-Cooler Centrifugal Chillers** Chilled Water Temperature Resets with O/A Constant Volume Primary Pumps Variable-Flow Distrbution Pumps	Electric Hermetic Centrifugal Chiller COP 6.2, variable speed compressors Setpoints (supply/return): 44F/54F Pumps: head = 100' w.g., imp eff = 75%, motor eff. = 92% + VFDs	Preliminary Assumption
Boiler Plant	**Condensing Natural Gas Boilers** Hot Water Temperature Resets with O/A Constant Volume Primary Pumps Variable-Flow Distrbution Pumps	Natural gas condensing boilers, 92.5% thermal efficiency Setpoints (supply/return): 130/100F Pumps: head = 100' w.g., imp eff = 75%, motor eff. = 92% + VFDs	Preliminary Assumption
Cooling Tower	**Dual cell induced draft Cooling Towers** VFD on Fans Constant Volume Pumps		Preliminary Assumption
DHW	**Proposed Building Design**	**Reference Building Design**	**Source**
DHW	**Demand** Lavatories Public: 1.9 LPM Showerheads: 5.7 LPM Kitchen Sink: 7.6 LPM West Development: 54.36 GPM, ECM:48 GPM East Development: 30.72 GPM, ECM:27 GPM **High Efficiency Domestic hot water** Natural Gas Fired: 92%	**Demand** Lavatories Public: 1.9 LPM Showerheads: 7.6 LPM Kitchen Sink: 7.6 LPM **SB-10+Ashrae 2013 Prescriptive** Efficiency Domestic hot water Natural Gas Fired: 90%	Lower water flow rates will be assessed.

APPENDIX B: ENERGY CONSERVATION MEASURES SUMMARY

ARCHITECTURAL

Reduce Window to wall ratio 40%

- No incremental cost
- Recommend utilizing this overall window to wall ratio to meet Tier3 requirement for residential towers.

Low-e Performance

- Double glazed system with argon space and analysis for surface 2 and 5 low-e coating.
- Same frame performance, substantial thermal breaks with insulating spacers
- Reduced the cooling load substantially; however the reduced solar heat gain increased space heating loads and resulted in an increased total energy use
- Other methods of solar control incorporated into the base design, therefore not recommended in this application.

Triple Glazed

- Assumed U values = 0.16
- Same frame performance, substantial thermal breaks with insulating spacers
- Reduced heating load substantially
- Recommend combining improved U-value with improved SHGC for more balances savings.
- Current design already specifying triple glazing for majority of the facade, however further reduction in U-values are required to meet the TGS Tier 4 targets.

Increased Wall Performance

- Increasing wall R can be achieved by adding insulation between studs and reducing thermal bridging element with different wall types.

RENEWABLES

Lower Flow Fixtures

- 1.9 LPM lavatory , reduces domestic hot water loads by 15%
- Negligible incremental cost
- Recommend using lower flow fixtures

Domestic Water Drain Recovery-Residential

- Savings estimated using a recovery effectiveness of 30%
- $500/dwelling unit
- Low flow fixtures conflict with this strategy, as separating the plumbing makes it more difficult to achieve proper waste flushing

Solar Domestic Water Heater-Residential

- For each residential tower solar wall area of 500 m2 was considered on south facade as part of the energy conservation measure.

Solar Wall-Residential

- Backup system and thermal storage will be required
- Assumed 30% annual load not met by solar
- This measure was run using the lower flow fixtures to reduce initial system sizing and costs
- Cost estimated at $500/square meter of collector
- System loads and sizing would need to be calculated during detailed design
- Space restraints might not allow for backup and storage equipment or the solar collectors

VENTILATION

Corridor Ventilation

- Reducing the corridor 50 CFM per suite down to 30 CFM per suite to achieve TGS Tier 2 and 3 targets
- Further reduction to achieve 0.3 L/s.m2 outdoor air is required to achieve Tier 4 TEDI number. In this situation, no direct exhaust from the suites are acceptable and recirculation range hoods and condensing dryers would be required.

CENTRAL HEATING & COOLING PLANT

Geo-exchange

- Heat pump chiller providing simultaneous heating and cooling
- Geothermal field heat sink shall consist of a vertical borehole distribution of heat exchange piping positioned under the building
- Incremental costs do not account for soft costs such as design, or project specific limitations such as the ground loop being below the parking garage
- Not recommended for this application. Measure was run as an illustrative comparison for what would be required to achieve energy performance higher than Tier2 and approaching Net-Zero ready design
- Ground Source Heat pumps systems have better payback when coupled with reduced building demands;

TORONTO GREEN STANDARD TARGETS

Proposed TGS V3 –Tier 1

- Window wall ratio 40% -Current design
- Overall Wall R-Value R 15
- Overall Glazing U-Value - 0.35
- Low flow plumbing fixtures; Lavs 1.9 LPM

Proposed TGS V3 –Tier 2

- Tier 1 Plus
  - Reduced Infiltration by 30%
  - Corridor Ventilation 30 CFM/Suite
  - Heat pump domestic hot water heater
  - Reduced lighting power density by 30%.

High Performance - TGS V3 –Tier 3

- Tier 2 Plus
  - Triple glazing
  - Balacony slab thermal break
  - Overall R 25 wall
  - Roof R50
  - Geo-exchange system
  - ERV 85% Efficient (best product currently available)

Approaching Net Zero - TGS V3 –Tier 4

- Tier 3 Plus
  - Solar PV