PRELIMINARY ZEBP
ENERGY MODELLING REPORT
REZONING APPLICATION

1535, 1546, 1549, 1557 GRANT STREET MULTIFAMILY

VANCOUVER, BC

FOR STUART HOWARD ARCHITECTS
405 – 375 WEST 5TH AVENUE
VANCOUVER, BC V5Y 1J6

E3 ECO GROUP INC.
BUILDING BLOCKS OF SUSTAINABILITY

JULY 06, 2018

E3 Project Number - 02556

INTRODUCTION

This report presents the inputs and results of the preliminary energy modelling conducted for the proposed multifamily development at 1535, 1546, 1549, 1557 Grant Street for use in the rezoning application submission under the City of Vancouver Green Building Policy for Rezonings, amended February 2017.

The model incorporates all design information that has been provided by the design team. The 3D building energy model has been generated following the City of Vancouver Energy Modelling Guidelines, Version 1.0 of March 2017 in addition to rules for proposed buildings as written in the NECB 2011 Part 8. Simulations were conducted using the OpenStudio graphical interface for EnergyPlus.

This report has been prepared for Stuart Howard Architects Inc. and the results presented are specific to the specified modeling methodology and shall not be used for any purpose other than the Rezoning Application for the multifamily development at 1535, 1546, 1549, 1557 Grant Street. Actual building energy use will depend on variations in variables such as climate, occupancy, controls, and maintenance.

PROJECT DESCRIPTION

The Grant Street multifamily development consists of 6 storeys of residential space use with one level of below grade parking. The building provides two-storey townhomes on the first two levels, 1 bedroom, 2 bedroom and 3 bedroom suites on the levels above, and both indoor and outdoor amenity space on the 5th floor. The residential floor area is more than 50% of the total floor area.

The preliminary building envelope incorporates modest Fenestration and Door area to Wall area Ratios (FDWR) resulting in 30.6% overall. The wall area to floor area ratio of the building is 0.56, and the window area to floor area ratio is 0.17. High performance envelope components are required to meet energy performance limits, and the current model includes triple-glazed vinyl frame windows, wood frame walls, thick insulation at roofs, and high efficiency details to minimize thermal bridging.

The proposed mechanical system for the residential suites consists of electric resistance baseboard heaters with ventilation air supplied from distributed Heat Recovery Ventilation (HRV) units in each suite. Residential suites will be passively cooled with natural ventilation and exterior shading to maintain the summer operative temperatures below the comfort threshold stipulated in the energy modelling guidelines. Electric cooktops have been modelled for the residential units. The current model uses no natural gas.

The Amenity space has been modelled with HRV, Direct Expansion (DX) cooling and electric resistance baseboards, until further information becomes available. The corridors are heated with electric resistance baseboards and ventilation air supplied to the corridors is tempered with DX cooling coil to maintain comfortable temperatures in the corridors in summer.

Domestic Hot Water (DHW) has been modelled with individual electric storage tanks in each suite.

The project needs to comply with the performance limits set by the City of Vancouver, Green Building Policy for Rezonings, amended February 2017.

The following energy efficiency strategies have been incorporated in the model to achieve the performance limits:

- Wood frame walls with efficient floor edges, all exterior walls with assembly overall effective R-value of 12.2 $ft^2.^oF.h/Btu$
- Roof assembly overall effective R-value of 37 $ft^2.^oF.h/Btu$
- High performance 3-pane vinyl fenestration with overall average R4.1 $ft^2.^oF.h/Btu$ and SHGC 0.45, along with efficient glazing transitions
- Insulation at balconies, shading features, roof parapets, wall transitions, and parkade ceiling to minimize thermal bridging and achieve efficient assembly performance with the BETBG methodology
- Distributed HRVs with 80% sensible efficiency in the suites as well as in the Amenity
- Residential suites employ passive cooling with natural ventilation and fixed exterior shading on select south and west facing windows and glass doors.
- DHW heated with individual electric resistance storage tanks in each suite.
- Low flow fixtures with 25% savings in DHW demand

PERFORMANCE LIMITS

The building performance limits from Section 5.1 of the City of Vancouver's Green Buildings Policy for Rezonings are presented in the following Table 1.

Table 1 Performance Limits

City of Vancouver Performance Limits Residential Low-Rise <7 storeys and Retail Not connected to city recognized low-carbon energy source		
TEDI limit	15	$kWh/m^2.year$
TEUI limit	100	$kWh/m^2.year$
GHGI limit	5	$kgCO_{2e}/m^2.year$
Modelled Floor Area	2,982	m^2

The Modelled Floor Area (MFA) excludes only the parking area, and includes all storage and service rooms, stairwells, and unconditioned enclosed areas. The MFA is greater than the total floor area cited on the architectural drawings, which only includes above grade areas. The above grade MFA is within 5% of the areas cited on the architectural drawings.

Without mechanical cooling, an additional performance requirement is applied through the energy modelling guidelines. Summer thermal comfort is gauged by hourly operative temperatures, and the energy modelling guidelines stipulate the following monthly temperature thresholds which may not be exceeded for more than 200 hours per year in any passively cooled zone.

Table 2 City of Vancouver Energy Modelling Guidelines Acceptability Limits for Passive Cooling

Acceptability Limits for Naturally Conditioned Spaces	
Month	80% Acceptability Limit Operative Temperature
April	N/A
May	25.0 °C
June	26.0 °C
July	26.6 °C
August	26.6 °C
September	25.6 °C
October	N/A

The simulation hourly results for operative temperature were reviewed for each zone and passive cooling measures were adjusted until the results met the compliance criteria.

SUMMARY OF KEY INPUTS AND ASSUMPTIONS

The inputs and results presented in this report are based on design information provided by the design team, yet still require many assumptions. Building energy simulations were conducted using OpenStudio 2.2.0 / Energy Plus.

The 3D building geometry was created in the OpenStudio Sketch-up plug in and based on the architectural drawings dated May 23rd, 2018.

The following Figure 1 and Figure 2 present the 3D building energy model. The windows and shading were applied to the 3D model to match the architectural drawings. Balconies and shading features rendered in purple were included in the architectural drawings. Additional shading features were added to select south and west facing windows as required to meet the passive cooling performance requirements, rendered in blue.

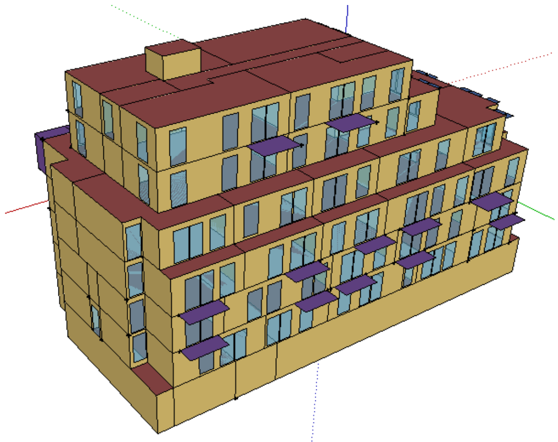

Figure 1 Finnish Canadian model, northeast view

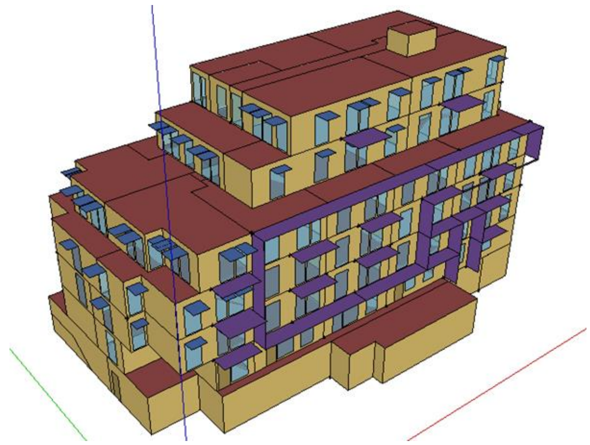

Figure 2 Finnish Canadian model, southwest view

The current model FDWR, as rendered in the images above, is 30.6% FDWR overall. This input can be easily adjusted to run parametric analysis and review the respective impact of this, and other key inputs.

Envelope:

To achieve the TEDI and TEUI targets will require a high-performance envelope. The values listed below were applied in the preliminary model, and refer to the overall effective assembly performance accounting for thermal bridging as per the Building Envelope Thermal Bridging Guide (BETBG). These are not prescriptive requirements, rather they represent preliminary targets derived by the energy model to achieve the required energy performance.

Table 3 Preliminary Envelope Performance Targets

Envelope Inputs	U-Factor with film, $W/m^2.^oC$	R-value, overall effective, $ft^2.^oF.h/Btu$
Residential Wall Overall	0.464	R12.2 Clear field assembly wood stud 16" o/c with R24 cavity insulation and R4 continuous
Roof Overall	0.153	R37 Clear field assembly R50 insulation entirely above deck
High Performance Vinyl Fenestration with 3-pane Glass	1.40 SHGC 0.45	4.1 SHGC 0.45
Exposed Floors	0.162	R35

Floor to Parking Garage	0.280	R20

The BETBG calculation assumes efficient linear transmittances at floor edges, balconies, shading features, roof parapet, vinyl glazing transitions for windows, and insulation at the parkade ceiling.

This envelope combination meets the energy performance limits in the current model, however various other combinations would also be feasible. As the design progresses the model will be used to sensitize the inputs and derive thermal performance targets that meet all the project objectives.

As the design gains detail, the target values and BETBG will be used to identify features that present the greatest opportunity to minimize thermal bridging and maintain the overall assembly thermal performance. As part of the integrated design process, the relative impact of envelope design options can be reviewed and compared using parametric analysis.

Ventilation: ASHRAE 62.1-2001/CoV Energy Modelling Guidelines

Ventilation air flow rates assumed in the model are presented in Table 4.

To anticipate the minimum flow rate of high efficiency in suite HRVs, the minimum flow to each suite was fixed to 23.6 L/s (50 CFM). This input results in ventilation flows higher than the minimum requirement; which is the greatest of 0.35 ACH or 7.1 L/s per person.

Infiltration: CoV Energy Modelling Guidelines

Flow rate m^3/s= 0.00024 m^3/s per m^2 exterior envelope area x 0.224 x hourly wind speed, m/s

Weather File: Vancouver CWEC

Internal Conditions: CoV Energy Modelling Guidelines/NECB 2011

Internal heat gains and process loads were input following the City of Vancouver Energy Modelling Guidelines.

Profiles for space temperature set points, fan on/off schedules, occupancy, lighting, and receptacle loads were assigned as per the City of Vancouver Modelling guidelines, with reference to NECB 2011 and the BC Hydro New Construction Program Energy Modelling Guideline as appropriate. The inputs are summarized in the following Table 4.

Table 4 Summary of Internal Heat Gains and Loads

Space Type	Occ. Density, m^2/ person	Recep./ Plug Loads, W/m^2	LPD input, W/m^2	Annual Lighting, Hours/ year	Service Hot Water	62.1-2001 Outdoor Air
Residential Suites	NBr+1	5.0	5.0	2044 (NECB G)	0.0016 L/s-person	0.35 ACH*
Residential Corridors			7.1	8760		0.25 L/s-m^2
Elec/Mech Room		1.0	13.4	1000		0.25 L/s-m^2
Residential Stair			7.4	4820		
Storage			6.8	1910		0.25 L/s-m^2
Amenity	5.0	1.0	13.2	3370		1.0 L/s-m^2
Parking Garage			2.0	8760		7.5 L/s-m^2
Elevators		3 kW/ elevator		3869		

** Residential suite ventilation flow rates exceed the code requirement with 23.6 L/s (50 CFM) per suite in anticipation of minimum flow rate for individual HRV units.*

Low flow fixtures have been incorporated in the model assuming they can provide service water heating demand savings of 25%.

The current design incorporates electric cooktops included in the total in-suite plug load as per the City of Vancouver Energy Modelling Guidelines.

Sub-metering of space heating energy use at the suite level is recognized in the City of Vancouver Energy Modelling Guidelines as a measure to conserve energy. The current set of results assume that sub-metering will be provided and, as per the guideline, the simulation results for space heating energy use have not been adjusted.

Mechanical Systems:

The proposed mechanical system for the residential suites has been modeled as electric resistance baseboard heaters with ventilation air supplied at each suite with distributed Heat Recovery Ventilation (HRV) units. HRV units assume a minimum flow rate of 23.6 L/s (50 CFM). Outdoor air bypass at the HRV units has been modelled to maintain passive cooling conditions. Residential suites will be passively cooled with natural ventilation and exterior shading to maintain the summer operative temperatures below the comfort threshold stipulated in the energy modelling guidelines.

The Amenity space has been modelled with HRV, DX cooling and electric resistance baseboards, until further information becomes available. The corridors are heated with electric resistance baseboards and ventilation air supplied to the corridors is tempered with DX cooling coil to maintain comfortable temperatures in the corridors in summer.

Domestic Hot Water (DHW) will be heated with electric resistance storage tanks in each suite. Low flow fixtures and appliances have also been assumed to reduce demand by 25%.

Stairwells and grade level service spaces such as storage rooms were modeled as semi-heated with electric resistance baseboard heating to maintain a minimum temperature of 10°C.

Fans have been modelled at the HRV, corridor ventilation, parking exhaust, and service room exhaust.

The following preliminary assumptions have been made for the mechanical system inputs, until further information is available.

Direct Expansion cooling	=	3.2 COP
Electric Resistance DHW heating	=	98% Et
Electric resistance baseboards	=	100%
General-Purpose Exhaust	=	0.6 W/(L/s)
Outdoor Air HRV (Supply + Exhaust)	=	1.6 W/(L/s)
Parkade Ventilation Fans	=	1.6 W/(L/s)
HRV efficiency	=	80% sensible recovery

Passive Cooling:

Passive cooling for the residential suites incorporates fixed, exterior overhangs which were shown in the architectural drawings. Additional shading features were added in the model at selected south and west facing windows as required to maintain the passive cooling comfort thresholds. Simple natural ventilation by occupant control is also included in the model, triggered by a temperature based algorithm and assuming 0.75 m^2 of opening area at the wall of most perimeter zone, with slightly higher areas in corner zones. The hourly simulation results show that none of the passively cooled spaces exceed the operative temperature threshold for more than 200 hours per year.

Passive cooling is also affected by the HRV units and outdoor air bypass is recommended during summer, when the outdoor air temperature is favourable to maintain comfort in the suites.

SUMMARY OF RESULTS

The following Table 5 presents the simulation results by energy end use as required by the Zero Energy Building Program (ZEBP) Energy Checklist.

Table 5 Simulation Results by End Use

1535, 1545, 1549, 1557 Grant Street Rezoning Application Energy Modelling Results						
	Energy, kWh/year	Fuel Type	Em. Factor	Emissions (kgCO2e)	TEUI, kWh/ m^2.year	GHGI, kgCO2e/ m^2.year
Interior Lighting	53,309	Electricity	0.011	586	17.9	0.20
Exterior Lighting	12,650	Electricity	0.011	139	4.2	0.05
Heating (El)	44,345	Electricity	0.011	488	14.9	0.16
Cooling	650	Electricity	0.011	7	0.2	0.00
Pumps		Electricity	0.011	-	-	-
Fans	21,003	Electricity	0.011	231	7.0	0.08
Domestic Hot Water (El)	68,573	Electricity	0.011	754	23.0	0.25
Plug Loads (includes cooking)	59,031	Electricity	0.011	649	19.8	0.22
Process Loads	14,942	Electricity	0.011	164	5.0	0.06

Total Electricity	274,503	Electricity	0.011	3,020	92.1	1.01
Total Natural Gas	-	Natural Gas	0.185	-	-	-
Total	274,503			3,020	92.1	1.01

Assume: 0% Electricity Generated On-Site, 0% Purchased Renewable Electricity, 0% Purchased Renewable Natural Gas

Total Annual Heat Demand - for TEDI	44,345
Total Annual Cooling Demand - for info	2,389

	TEDI	TEUI	GHGI
Modelled Whole Building Performance	14.9	92.1	1.0

Corridor pressurization adjustment	No	Not applicable
Sub-metering of energy for space heating	Yes	No Adjustments

Energy performance limits:	TEDI	TEUI	GHGI
Residential Low-Rise <7 storeys	15.0	100.0	5.0
Adjusted Whole Building Performance	14.9	92.1	1.0

The results show that the model meets the energy performance limits for this project at 14.9 kWh/m^2.year TEDI, 92.1 kWh/m^2.year TEUI, and 1.0 kgCO2e/m^2.year GHGI.

The TEDI is greatly influenced in the model by the HRV efficiency, opaque envelope performance, glass type, and glass to wall area ratio. Passive cooling features, such as exterior shading, can increase the TEDI.

The results showed that the domestic hot water heating energy use forms the largest component of the TEUI, followed by the plug loads, interior lighting, space heating, HVAC fans, process loads, exterior lighting, cooling and finally the DHW circulation pumps.

The GHGI results follow the same trend as the TEUI results because there is only electrical energy use in this model.

This preliminary model is based on rudimentary information and numerous assumptions. The following measures could be considered in future iterations to help maintain the performance limits as the design develops.

The HVAC fan power assumptions were set as per the fan power limitations from NECB 2011 and fan power use could be reduced with efficient fan selections and/or demand controlled ventilation.

Electrical energy use for lighting could be reduced with LED lighting and occupancy/vacancy sensor controls as allowed by NECB 2011.

CONCLUSIONS

The simulation results presented in this report are based on rudimentary design information and the model includes many assumptions. As the design gains detail, the model inputs will be adjusted and the simulation results will be subject to change. Additional energy efficiency measures may be required to maintain the building performance within the CoV limits as the design gains detail.

Based on the current simulation inputs and results, the following conclusions have been derived:

- High-performance envelope and fenestration assemblies will be required to maintain the TEDI below the CoV limit values. The preliminary model was used to set performance targets, and the model can be used to investigate various design options through parametric analysis to achieve the building energy performance targets effectively.
- The proposed electric heating for the residential space and ventilation air tempering helps the design maintain a respectively low GHGI.
- Heat recovery ventilation will play a key role in maintaining the TEDI targets below the CoV limits. Outdoor air bypass is recommended to maintain passive cooling comfort thresholds.
- Without mechanical cooling, the residential suites will require passive cooling measures to maintain the ASHRAE 55 comfort thresholds as described in the Energy Modelling Guidelines. The current model incorporates natural ventilation and fixed exterior shading. As the design develops these and other passive cooling measures can be reviewed and compared using the model.
- Unoccupied conditioned spaces, such as stairs, storage, mechanical and electrical rooms have been simulated with electric baseboards and 10^{o}C heating set-points. Heating output in such spaces should be limited to provide such conditions, otherwise additional measures may be required to maintain the TEDI results below the CoV limits.
- Sub-metering heating energy for individual suites provides savings in the CoV modelling methodology. If sub-metering were not applied in this project the TEUI results would increase by 2.2 kWh/m^2.year.

CLOSURE

We trust the enclosed provides helpful information for the design team to be used as part of the integrated design process and rezoning application submission. If any additional information is required, please do not hesitate to contact E3 Eco Group.

Report Prepared by:

Sonja Lotimer, BSc,

Energy Modeller

Report Reviewed by:

Kauê Queiroz

Project Manager