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48 Grenoble Energy Strategy

For

Tenblock

Project Location

48 Grenoble., Toronto, Ontario

Footprint Project Number

21729-001

Date

2022-03-18

Prepared by

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Executive Summary

PROPOSED DEVELOPMENT

The proposed development is comprised of:

- Residential GFA: 731,312 sf (67,941 sm)
- Parking Total GCA: 235,999 sf (21,925 sm) 4 Floors
- Total number of residential units: 993
- Total number of Floors: 43 in East Tower, 41 in West Tower, 6 in Podium

ENERGY CONSERVATION DESIGN FEATURES

The design assumptions were determined from information available and with the intent of meeting the energy requirement of Toronto Green Standard (TGS) V3 Tier 1as a minimum Code requirement and with the goal to strive for a higher level of energy performance. The detailed energy model inputs can be found in Appendix A. The following **E**nergy **C**onservation **M**easures (ECMs) are incorporated in this proposed building design:

- Opaque envelope performance with overall R-9 effective (including thermal bridging) for walls and R-40 roofs, Glazing performance: U-0.33 and 0.34 SHGC;
- 45%-50% Window to Wall Ratio (WWR);
- Corridor Ventilation 30 CFM/Suite
- In suite ventilation energy recovery provided for dwelling units - 76% effective;
- Low flow lavatories, showerheads and faucets;
- High efficiency condensing boilers;
- High efficiency chillers, with variable speed compressors; and
- Variable speed control on all fans and pumps.

ENERGY PERFORMANCE

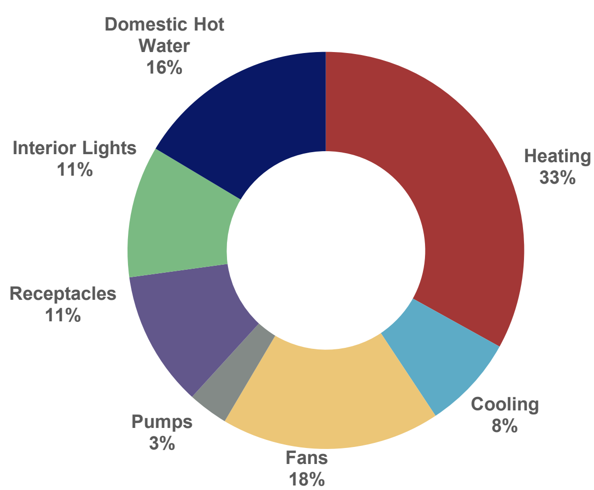
The energy use intensity (EUI) of the proposed design is 157.8 ekWh/sm, meeting (TGS) V3 Tier 1 targets for total EUI, TEDI and GHG emissions.

- TEUI (ekWh/sm): 157.8
- TEDI (ekWh/sm): 40.5
- GHGI (kgCO2e/sm): 17.7
- Emissions determined from SB-10 2017 Table 1.1.2.2
- Using current average prices: Electricity \$0.16/kWh and Natural Gas = \$0.26/m^3

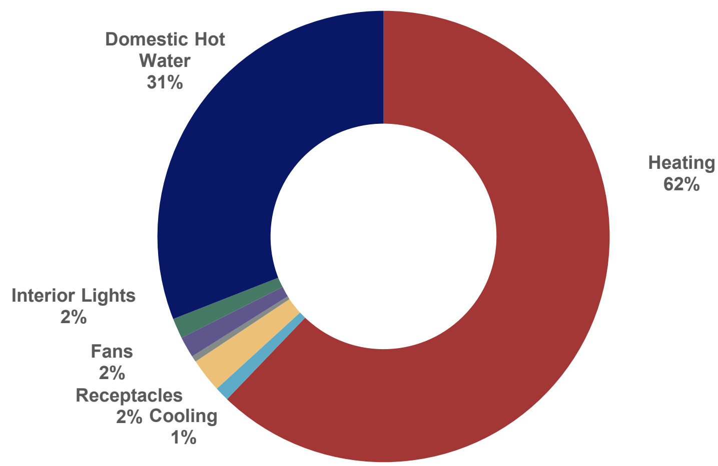
Results Summary

Design Case	Description	TEUI (kWh/m²)	TEDI (kWh/m²)	GHGI (kg eCO2/m²)	Energy Savings	Cost Savings	GHG Savings
Baseline Design	As per Input Summary	185.0	54.4	21.3	-	-	
Proposed Tier 1	As per ECM Summary	157.8	40.5	17.7	15%	12%	17%
Proposed Tier 2	As per ECM Summary	124.4	25.6	13.5	33%	28%	37%
Proposed Tier 3	As per ECM Summary	91.7	12.6	8.3	50%	37%	61%
Proposed Tier 4	As per ECM Summary	73.2	14.9	5.8	57%	27%	70%

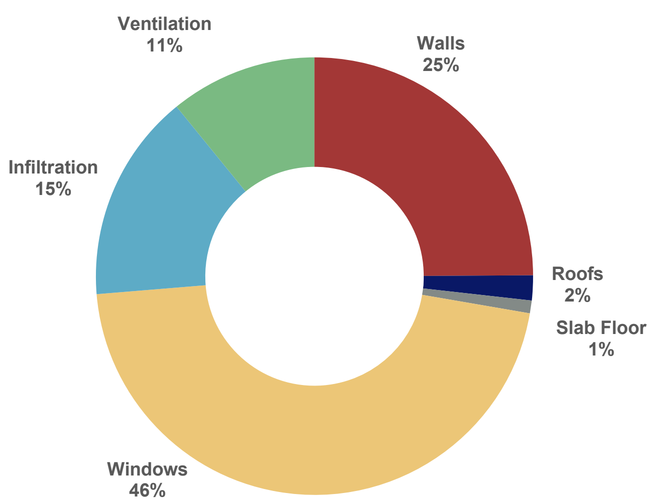
Refer to Appendix C for a detailed list of all ECMs considered.



Annual energy consumption by end-use



Greenhouse Gas Emissions by end-use



Thermal energy demand intensity by component

Base Building Design Description

MASSING & ORIENTATION

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

The calculated window-to-wall ratio (WWR) for the Building based on the preliminary design information is approximately 50% in the current design.

DAYLIGHTING

The proposed building's form and function promote daylighting mainly for residential units, as all units have exterior glazed exposure.

48 Grenoble

THERMAL PERFORMANCE

Thermal performance values are based on preliminary envelope assembly information provided by the architect.

- Exterior wall performance R-9 which includes spandrel panel with back pan insulation and interior insulation between the stud.
- Roof: R40
- Roof/Soffit/Parking Garage plenum: R-20
- Glazing System U value is 0.33 Btu/h sf °F. Overall U value is estimated based on typical curtain wall sizes.

LIGHTING

The baseline lighting targets are set equal to 15% better than the 2017 Ontario Building Code SB-10 requirements. LED lighting fixtures are required in the proposed design to achieve these lighting power density targets.

APPLIANCES

All in-suite appliances have been set to ENERGY STAR® minimum requirements.

HEATING AND COOLING

Central boilers and chillers will serve the proposed development. The following list summarizes the baseline mechanical design. Detailed model inputs and performances can be found in Appendix A.

- Central Heating and cooling are provided by condensing water loop connected to high efficiency natural gas hot water heaters and fluid coolers.

VENTILATION

Dwelling unit ventilation is provided by in suite energy recovery ventilators, whereas lobby and amenity ventilation as well as corridor pressurization is provided by a hydronic make up air unit.

Amenity and corridor ventilation accounts for over 30% of the total proposed design ventilation. Measures to reduce the corridor ventilation load are explored in Appendix B.

The ventilation is provided by MUAs connected to fan coil systems, the proposed model is assumed to have energy recovery wheel with 65% effectiveness.

DOMESTIC HOT WATER

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

Energy Conservation Measures

Energy conservation measures were determined by first examining where the proposed building design loads could be reduced. Many load reduction measures have been incorporated into the proposed design: good envelope performance, ventilation energy recovery in residential suites, and low flow plumbing fixtures. The following items provide the most opportunity for further load reduction:

- Glazing
- Domestic Hot Water
- Corridor Ventilation
- Building Air Tightness
- Mechanical System Type

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 40% 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

Three glazing performance measures were analyzed:

- Lower SHGC;
- Lower U value (triple glazing down to .15 U value for Tier 4);
- Lower U-value combined with a lower solar heat gain coefficient (SHGC);

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 panes (i.e. triple glazed) or increasing the thermal break of aluminum frames.

DOMESTIC HOT WATER

Lower Flow Fixtures

1.8 Litre per minute (LPM) lavatories and 3.8 LPM kitchen sinks should have negligible incremental capital costs and will reduce the domestic hot water load by 17%.

Drain Water Heat Recovery

Utilizing drain water 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%. Incremental costs are estimated at $500/dwelling unit.

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.**Electric Domestic Water Heaters**

Electric domestic water heaters were analyzed as an alternative to **N**atural **G**as (NG) heaters as a measure to achieve greenhouse gas emissions required by Tier 4.

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 on 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.

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 to the ground in the summer months. The soil remains at a relatively constant temperatures and essentially serves as a highly efficient heat rejection medium.

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 extend the construction schedule.

Integrating geothermal into the building is typically done in two ways. The heat can be transferred with a water-to-water heat pump (centralized system) or multiple water-to-air heat pumps (distributed system). Multi-unit residential buildings utilize distributed heat pump systems as typically the mechanical designs are already distributed systems i.e. fan coils.

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 ~0.16/kWh, whereas the average natural gas costs is 0.26/m^3). Therefore energy cost savings will be far less significant than energy savings when compared to a natural gas heated reference building.

The incremental geothermal system capital costs and discrepancy in utility costs due to switching from natural gas to electric heating make it imperative that the base building heating and cooling loads are reduced 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.

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

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 synchronization, the efficiency and feasibility of a CHP is reduced. Increasing the carbon emission associated with CHP design for this application will significantly reduces the chance to meet TGS V3 targets and therefore not recommended for this project.

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. Considering this project limitation, it is more beneficial to integrate other solar strategies such as solar domestic hot water.

RECOMMENDATIONS

A complete SPA application has been submitted for this project before May 1st, 2022; thus, TGS V3 Tier 1 is minimum energy target for this project. With high performance envelope, optimized window to wall ratio, thermally broken balconies and an energy efficient mechanical system, this project will meet TGS V3 Tier1 requirements for the thermal demand, energy and carbon intensities.

Results Summary Energy Conservation Measures

Please refer to Appendix B to review the ECM table.

TORONTO GREEN STANDARD TIER 1

- Window to wall ratio (WWR) 50%
- Wall R-Value R 9 (without balcony slab)
  - (spandrel with semi-rigid insulation in the cavity and 38mm back-pan insulation)
- Wall R-Value R 4.2 (with balcony slab)
  - (spandrel with semi-rigid insulation in the cavity and 38mm back-pan insulation)
- Window U-Value - 0.33 Btu/h sf °F
- Corridor Ventilation 30 CFM/Suite
- Decreased **L**ighting **P**ower **D**ensity (LPD) by 30% from SB-10 levels
- ERV 65% effective

TORONTO GREEN STANDARD TIER 2

Tier 1 Plus

- Wall R-Value R 15
- Windows U-value - 0.3 (Triple pane) Btu/h sf °F
- Windows SHGC: 0.35
- Corridor Ventilation 15 CFM/Suite
- ERV 75% effective (best product currently available)
- Reduced **I**nfiltration by 25%
- Low flow water fixtures: 1.8 LPM lavatories and 3.8 LPM kitchen sinks

TORONTO GREEN STANDARD TIER 3

Tier 2 Plus

- WWR 35%
- Wall R-Value R 20 (Eliminate balconies)
- Windows Average U Value - 0.25 BTU/(hrFf^2)
- Corridor Ventilation 10 CFM/Suite
- Reduced Infiltration by 50%
- Reduced LPD by 50%
- Reduced plug load by 10%
- Drain water heat recovery
- Solar domestic hot water heaters
- Increased Boiler performance to 97% from 95%
- ERV 90% effective

TORONTO GREEN STANDARD TIER 4

Tier 3 Plus

- WWR 30%
- Roof R-Value R 40
- Windows Average U Value - 0.15 BTU/(hrFf^2), SHGC – 0.2
- Corridor Ventilation 0.06 (cfm/sf), recirculation range hoods, condensing dryers
- Reduced Infiltration by 75%
- Reduced plug load by 20%
- Ground Source Heat Pumps Cooling EER 17
- Electric Domestic Hot Water Boilers

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 are.

Additionally natural gas generators above 350 kW 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 NO_X emissions as well as a constantly available fuel supply that does not have to be delivered.

The distribution and sizing of the backup systems will need to consider Ministry of Environment and Climate Change requirements for NO_X emissions. Typically, the generators must be located at higher levels such as a penthouse to satisfy the emissions requirements. A typical design for this development would locate a single generator at the top of the building.

Appendix A: Energy Modelling Assumptions

MODEL SUMMARY

Project Title	**48 Grenoble**
Date	**03/18/2022**
Location	**Toronto**
Software	**eQuest 3.65 7175 DOE 2.3**
Weather File	**CAN_ON_TORONTO-CITY-CENTRE_6158359_CWEC2020.BIN**

BUILDING SUMMARY

Project Size	**1,071,870 sf (Total GCA), 731,045 sf (Total GFA)**
Total Number of Residential Units	**993**

OPAQUE ENVELOPE

	Design	
	Description	**Performance**
Overall Wall	Window wall/Precast Panel combined including thermal bridging components	R-4.2
Roof/Exposed Floor	TBD	R-30/ R-20

GLAZING

	Design	
	Description	**Performance**
U-value (effective)	Preliminary Design Information	0.33
SHGC		0.34
Window-to-Wall Ratio		50%

INTERIOR LIGHTING

	Design	
	Description/Controls	LPD (W/sf)
Amenity & Lobby	Targets per SB-10 2017	0.9
Corridor		0.56
Dwelling Unit		0.46
Locker		0.39
Mechanical / Electrical		0.36
Parking Garage		0.12
Stairs		0.58
Office		0.79
Conference / meeting / multi-purpose		0.82
Storage		0.53

ELECTRICAL

	Design	
Load	Description	Power or Power Density
Amenity & Lobby	ASHRAE default per space type	0.09 W/sf
Dwelling Unit	Energy Star® appliances	0.46 W/sf
Miscellaneous Fans and Pumps	Preliminary estimate Total power de rated for varying schedules	32.8 kW
Elevator		45.4 kW

WATER-SIDE

	Design Description Performance
Hot Water	Natural gas condensing boilers, 92.5% thermal efficiency Setpoints (supply/return): 130 / 100 °F Pump Power: 19 w/gpm (includes primary and secondary)
Chilled Water	Variable speed centrifugal chillers, 0.58 kw/ton Setpoints (supply/return): 42 / 57 °F Pump Power: 19 w/gpm (includes primary and secondary)
Condenser	Induced draft cooling towers, efficiencies per ASHRAE 90.1-2013 + VFDs Setpoints (supply/return): 84/ 96 °F Pump Power: 22 w/gpm (includes primary and secondary)
Domestic Hot Water	Natural gas condensing water heaters, 95% thermal efficiency Supply Temperature: 140F Modelled Peak Lavs 3.8 LPM | Showers 5.7 LPM | Kitchen sink 5.7 LPM Residential: 85.4 gpm

AIR-SIDE HVAC

	Design Description Performance
MUAs - Residential Corridors, main lobby and amenities	DOAS Supplying tempered ventilation air at 30 cfm per suite to corridors and lobbies Supply Fan W/cfm: 0.9 with Variable Speed Fan Hydronic Heating & Cooling Coils
MUAs -Fancoil and ERVs Condo	Ventilation Provided in accordance with ASHRAE 62.1-2010 directly to suite via ERV 1 bedroom 50 cfm | 2 bedroom 75 cfm | 3 bedroom 100 cfm ERV Performance Energy Recovery: 65% Sensible, 60% latent effectiveness Fans: ECM motors, 0.6 W/cfm Fan Coil Performance Fans: Two Speed with ECM motors Constant speed W/cfm: 0.3 Exhaust Fans:

	Washroom: 30 Watts Kitchen Hood: 50 Watts Dryer: 50 Watts Amenity Spaces: ERV Performance Energy Recovery: 65% Sensible, 60% latent effectiveness Fans: ECM motors, 0.6 W/cfm Fan Coil Performance Fans: Two Speed with ECM motors Constant speed W/cfm: 0.3
Heating Only Spaces Hot Water Force Flow Heaters	Fan Coil Performance Fans: Constant volume, with ECM motors W/cfm: 0.15 65 °F Heating Setpoint

Appendix B: Energy Conservation Measures Summary

ARCHITECTURAL

Reduce Window-to-Wall Ratio

- Window to wall ratio 45%-50% (Tier1), 40% (Tier2) and 30% (Tier3 and 4);
- No incremental cost;
- Recommend utilizing this overall window to wall ratio;

Low-e Performance

- Assumed high performance double glazing, center of glass SHGC = 0.27;
- 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 = 0.3 – 0.2 and 0.14;
- 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;
- Incremental cost are quite substantial, however lower U-values are required to meet the TGS Tier 3 and 4 targets;

Increased Wall Performance

- Increasing to overall R-10 can be achieved by increasing insulation between studs and also back pan insulation with thermally broken balconies or without balconies; Recommended for this project.
- Increasing to overall R-15 can be achieved by eliminating the spandrels, and increasing performance in architect details of the envelope
- Increasing to overall R-20 can be achieved by removing the balconies which results in significant reduction in thermal bridging, and improving solid wall construction

DOMESTIC HOT WATER

Lower Flow Fixtures

- 1.8 LPM lavatory & 3.8 LPM sink, reduces domestic hot water loads by ~11%;
- Negligible incremental cost;
- Recommend using lower flow fixtures;

Domestic Water Drain Recovery

- 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;
- Not recommended in this application;

Solar Domestic Water Heater

- 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 ventilation to 20 CFM per suite down to 0.06 CFM per suite to achieve TGS Tier 2 and 3 targets;
- Further reduction to achieve .06 CFM/sf 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

Ground Source Heat Pumps (GSHP)

- Whole building served by GSHP; heating COP = 4, cooling EER = 17;
- 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 Tier 1 and Tier 2 targets. Measure was run as an illustrative comparison for what would be required to achieve Net-Zero ready design;
- GSHP systems have better payback when coupled with reduced building demands;

Combined Heat & Power

- Cost decreases, however energy and emissions increase;
- Not recommended for this application;

Appendix C: Results Summary

Design Case	Description	TEUI (kWh/m²)	TEDI (kWh/m²)	GHGI (kg eCO2/m²)	Energy Savings	Cost Savings	GHG Savings
Base Case	As per Input Summary	185.0	54.4	21.3	-	-	-
Envelope							
01	Reduce 40% WWR	181.1	55.0	21.2	2.1%	4.0%	0.6%
02	50% WWR + 25% Infiltration Reduction	181.8	51.6	20.7	1.7%	0.5%	2.7%
03	50% WWR + 50% Infiltration Reduction	178.7	48.8	20.2	3.4%	1.1%	5.3%
04	50% WWR + 75% Infiltration Reduction	175.6	46.0	19.6	5.1%	1.6%	7.9%
05	50% WWR + R-10 Wall	172.3	44.3	19.2	6.9%	3.1%	9.8%
06	50% WWR + R-15 Wall	169.4	42.1	18.7	8.4%	3.9%	12.0%
07	50% WWR + R-20 Wall	167.8	40.8	18.5	9.3%	4.3%	13.3%
08	50% WWR + R-25 Wall	162.3	38.5	18.3	12.2%	4.8%	14.1%
09	50% WWR + R-30 Roof	184.8	54.2	21.3	0.1%	0.1%	0.2%
10	50% WWR + R-40 Roof	184.7	54.1	21.3	0.2%	0.1%	0.3%
11	50% WWR + (U=0.3, SHGC 0.32)	184.9	66.5	23.0	0.1%	10.2%	-8.0%
12	50% WWR + Triple Glazing (U 0.28, SHGC=0.31)	174.8	58.0	21.3	5.5%	12.3%	0.1%
13	50% WWR + U-0.18 + SHGC 0.30	177.0	46.4	19.8	4.3%	0.7%	7.2%
14	50% WWR + U-0.18 + SHGC 0.47	158.2	42.5	18.3	14.5%	14.6%	14.4%
Lighting and Electrical							
15	50% WWR + 30% LPD Reduction	182.6	55.7	21.4	1.3%	3.2%	-0.3%
16	50% WWR + 50% LPD Reduction	181.1	56.6	21.4	2.1%	5.4%	-0.5%
17	50% WWR + 10% Plug Load Reduction	185.0	54.4	21.3	0.02%	0.04%	-0.01%
18	50% WWR + 20% Plug Load Reduction	184.9	54.5	21.3	0.03%	0.09%	-0.01%
HVAC and DHW							
19	50% WWR + Residential Corridor 20 CFM	177.3	48.9	20.1	4.1%	2.3%	5.6%
20	50% WWR + Residential Corridor 10 CFM	169.7	43.6	18.9	8.3%	4.5%	11.3%
21	50% WWR + Unit ERV Efficiency 75%	181.6	51.1	20.7	1.9%	0.4%	3.0%
22	50% WWR + Unit ERV Efficiency 85%	178.3	48.0	20.1	3.6%	0.8%	5.8%
23	50% WWR + Unit ERV Efficiency 90%	176.7	46.4	19.8	4.5%	1.0%	7.3%
24	50% WWR + Drain Water Heat Recovery	176.3	54.4	19.7	4.7%	1.2%	7.5%
25	50% WWR + Low Flow Fixtures	182.0	54.4	20.8	1.6%	0.4%	2.6%
26	50% WWR + Solar Water Heater	176.3	54.4	19.7	4.7%	1.2%	7.5%
27	50% WWR + Residential Corridor 20 CFM	177.3	48.9	20.1	4.1%	2.3%	5.6%

Design Case	Description	TEUI (kWh/m²)	TEDI (kWh/m²)	GHGI (kg eCO2/m²)	Energy Savings	Cost Savings	GHG Savings
TGS Targets							
28	Proposed Tier 1	157.8	40.5	17.7	15%	12%	17%
29	Proposed Tier 2	124.4	25.6	13.5	33%	28%	37%
30	Proposed Tier 3	91.7	12.6	8.3	50%	37%	61%
31	Proposed Tier 4	73.5	14.9	4.9	57%	27%	70%