

The Archetype Condominium

Alternative Specifications For Achieving Energy
Efficiency Performance Targets



SUSTAINABLE BUILDINGS CANADA

Final Report

December 2012

This document was prepared by Sustainable Buildings Canada for Waterfront Toronto. Any errors or omissions in this document are purely the responsibility of Sustainable Buildings Canada.

Sustainable Buildings Canada wishes to acknowledge and thank the members of the Project team:

Michelle Xuereb, Quadrangle Architects Ltd
Caesar Ruest, AutoDesk Ltd
Craig McIntyre, Provident Energy Management Inc
Brian Tysoe, MCW Consultants Ltd
Ian Stahlbrand, Internat Energy Services Canada Inc
Lyle Scott, S.A Footprint
Lisa King, The City of Toronto
Lisa Prime, Waterfront Toronto
Anna Palamarchuk, Waterfront Toronto
Michael Singleton, Sustainable Buildings Canada
Bob Bach, Energy Profiles Ltd./Sustainable Buildings Canada
Larry Brydon, Reliance Home Comfort/Sustainable Buildings Canada
Marie Crowder, Research Assistant, Sustainable Buildings Canada
Marjorie Lamb, Writer in Residence Inc.

For additional information about this document, please contact:

Michael Singleton
Sustainable Buildings Canada
33 Longboat Ave.
Toronto, ON M5A 4C9
416-752-3535, ext 1
mike-singleton@rogers.com
<http://www.sbcanada.org/>



Table of Contents

Executive Summary..... 6



1.0 The Charrette Process..... 8

1.1. Initial Meeting: Vision And Goal-Setting..... 8

 1.1.1 Stakeholders..... 8

 1.1.2 Vision Statement And Objectives 8

1.2. The Integrated Design Process And Charrette Objectives 10

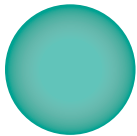
1.3. Design Charrette..... 10

 1.3.1 *Archetype Condo Presentation* 11

 1.3.2 *Preliminary Designs*..... 12

 1.3.3 *Presentation On Bim And Improving Energy Performance*..... 13

 1.3.4 *Breakout Groups* 15



2.0 Energy 16

2.1. Reference And Baseline Building 17

2.2. Cost Versus Net Energy Versus Greenhouse Gas Emissions..... 20

2.3. Net Energy Performance Improvement – 5% 21

2.4. Net Energy Performance Improvement – 15% 24

2.5. Net Energy Performance Improvement – 25% 27

2.6. Architectural Energy Performance Improvements..... 30

2.7. Conclusions From Energy Analysis 33

 2.7.1 *Building Codes And Energy Modeling:* 33

 2.7.2 *The Archetype Condominium Energy Model Results:*..... 34



3.0 Integrated Water Management..... 35

3.1. Strategies To Address Design Priorities 35

3.2. Additional Strategy Recommendations 37

3.3. Key Success Factors 37



4.0 Materials, Durability, And LEED.....	38
4.1. Durability.....	38
4.2. Flexibility	39



5.0 Further Architectural Explorations	43
5.1. Purpose.....	43
5.2. Design Considerations	43
5.2.1 Energy	43
5.2.2 Other Condo Concerns.....	43
5.3. The Site	44
5.4. Preliminary Massing	44
5.5. Explorations.....	45
5.5.1 Form.....	45
5.5.2 Orientation	46
5.5.3 Ventilation	47

6.0 Overarching Conclusion.....	49
--	-----------

Executive Summary

The “Archetype Condominium” is a design focused research project led by Sustainable Buildings Canada (SBC) with the support of a number of partners. The goal of the project is to identify ways that a condominium building might exceed the energy requirements (i.e. reduce) in the Ontario Building Code by 25% or more. This target is consistent with performance levels currently being examined and considered by Waterfront Toronto for its Minimum Green Building Requirements, and the City of Toronto as part of the Toronto Green Standard update.

A Steering Committee led by Sustainable Buildings Canada coordinated activities to develop a preliminary design for the Archetype Condominium and to evaluate methods for the project to meet environmental performance standards, with a particular focus on energy efficiency standards.

These activities included initial discussions with a selection of architects and engineers, as well as City Planning and Waterfront Toronto staff; a “Design Charrette”; follow-on research and energy modeling; and presentations at the Green Building Festival and the annual Building Industry and Land Development Association (BILD) conference to deliver the results.

While the one-day design Charrette was the pivotal activity under which a number of design scenarios were initially considered, subsequent research, further design efforts and energy modeling have fine-tuned the preliminary results that were the output of the Charrette.

The following report summarizes the results of all of these efforts. A more detailed Report specifically focusing on the Charrette deliberations is available from SBC as a reference document.

This research identified a number of critical issues regarding energy performance for condominiums given the performance targets. These issues covered both the modeling protocols and the various options and techniques that might be used to achieve greater levels of energy efficiency, including:

Building Codes and Energy Modeling:

- There is a need in the industry to establish a common metric for discussing energy as well as tools that will allow for consistent analysis methods and results. The current edition of SB-10 offers three different compliance options citing two different energy codes, which is confusing. Specifying a “percentage above code” metric increases the complexity. For the purpose of this Project SBC advised all energy modelers use the same modeling software and follow SB-10 Division 3 Option (c), which requires following ASHRAE 90.1-2010 as modified by Supplementary Standard SB-10 Division 3 Chapter 2. Ideally, this will become standard practice.
- Using energy cost as a metric to compare the performance of the proposed design and the reference building does not consistently and permanently improve the overall energy performance of a building as it is tied to current energy prices, though this is the path followed by LEED®. For projects delivered under the Enbridge Savings By Design program, SBC will not accept the annual energy cost budget method. Instead this program requires that the building be modeled to show net energy savings.
- Follow established standard operating conditions for occupancy and use as defined in the modeling rules for the applicable energy code. The overarching intent should be consistency in modeling approach to optimize comparisons for greatest accuracy.
- Consider different performance increments over code for different building types. The current process uses a weighted cross section of archetype buildings. Some building types (including condominiums) have greater challenges to improve their energy performance.

The Archetype Condominium Energy Modelling Results:

- Designs that have high window to wall ratios (greater than 40%), and solid walls with a low R-value such as spandrel panel, will be challenged to meet the more aggressive energy performance targets and will result in increased costs for mechanical systems.
- Select the best possible building envelope that the budget can afford before resorting to mechanical solutions.
- Passive heating and cooling, natural ventilation, and maximized day-lighting opportunities have the potential to lower energy use significantly.

The Archetype Condominium Environmental Performance Results

- Use the integrated design approach to ensure all potential opportunities for improving environmental performance are identified.
- Consider ways of sharing opportunities with adjacent lands and communities. Build relationships and governance/legal structures to enable truly “integrated design” solutions and share costs and/or savings.
- Guidelines/RFP requirements should be updated to support design opportunities. Tailor the language within the RFP in order to extract the best product from the builder.

- Consider including durability requirements or building envelope commissioning as a standard.
- Water treatment opportunities and conservation mechanisms need to be considered and “designed in” from the outset.
- Integrating water features with the mechanical systems represent an opportunity to share costs across a number of buildings. The Deep Lake Water Cooling project is an excellent example of this approach.
- There is a need to educate consumers about conservation and low impact development issues and to ensure they are active participants in the process.

The “Archetype Condominium” project was made possible through the funding support of Enbridge Gas Distribution and the significant efforts of the Sub-Committee, and Design and Energy Modeling Teams. SBC wishes to express our greatest appreciation and thanks to the organizations and individuals that made this project possible.

The Design Charrette was attended by approximately 30 individuals, bringing a wide range of expertise to the project. SBC wishes to also thank those involved for their support, guidance, and insights.



1.0 The Charrette Process

The SBC Charrette process involves a number of steps and activities. These are intended to set the Vision and Goal for the project and then to explore ways of achieving those goals. At the outset, it was understood that one of the goals was to achieve three levels of incremental energy performance, 5%, 15%, and 25% better than the current Ontario Building Code (OBC). The Charrette also sought to examine and consider over-arching environmental performance as a catalyst for quality design.

1.1 Initial Meeting: Vision And Goal-Setting

The initial half-day meeting was held on July 10, 2012 at the Waterfront Toronto Office in preparation for the full-day design charrette. The purpose of the session was to establish the goals for the site that would guide the more detailed investigation of building characteristics at the design charrette.

1.1.1 Stakeholders

The first step in the process was getting an understanding of the various stakeholders who would be interested in the results of this charrette and then working to define their desired outcomes:

- **Enbridge** comes at the topic as a energy utility. Their interest is in total energy savings and therefore Enbridge offers incentives through two programs: The High Performance New Construction (HPNC) program, which focuses on electricity savings and peak demand reduction delivered in partnership with local electric utilities, and the Savings By Design program which focuses on natural gas savings and features the integrated design process as delivered through the use of the design charrettes.
- **Waterfront Toronto** (WT) was the client for the design charrette. WT provided the site in the West

Donlands, which is a neighbourhood targeting LEED for Neighbourhood Developments. The site is subject to WT's Minimum Green Building Requirements (MGBR) and includes a requirement for all buildings to achieve LEED® Gold. Their objective was to re-examine their targets for their MGBR based on the new energy efficiency requirements in the Building Code.

- **The City of Toronto** was an interested participant through the process. That interest centred on exploring potentially higher energy efficiency targets that might be used under The Toronto Green Standard with respect to the new energy efficiency requirements in the Building Code.
- **Developers** From the perspective of the developer, the objective was to understand the potential impacts to cost and schedule to meet the new code regulations and other potential energy targets while also meeting the expectations of the buyer, maximizing density and profitability.

1.1.2 Vision Statement and Objectives

The initial meeting included a facilitated group discussion focusing on the aspirations, core purpose, and vision for the project. The Sustainable Buildings Canada (SBC) team developed the following Vision Statement and objectives for the charrette.

Vision Statement:

“A realistic demonstration of how to achieve the Waterfront Toronto’s Minimum Green Building Requirements Version 2 (MGBRv2) standard that addresses builders’ requirement to deliver a practical, marketable and cost effective product.”

Objectives for the Design Charrette:

1. Demonstrate energy performance levels for both the proposed Toronto Green Standard-Phase II Tier 1 & 2 energy efficiency requirements and Waterfront Toronto's Minimum Green Building Requirements Version 2.

2. Explore/demonstrate a variety of other environmental performance indicators and options, including:

- Long-term life-cycle cost (LCC) effectiveness
- LEED Platinum
- LEED durability requirement
- Energy Utilization Intensity (EUI) minimization.

Details

The following key considerations and conclusions were made:

- Standards: The benchmark reference building for the charrette was designed to the OBC 2006 MNECB compliance option (25% better than MNECB 1997)
- Design Challenges and Expertise: Plans were made to organize charrette participants into three teams -- one team to address energy, and the other two to address other elements of sustainability.
- The "energy team" would examine measures, assemblies, and technologies to achieve modeled performance improvements of approximately 5%, 15%, and 25% over the benchmark reference building. The sustainability teams would examine other elements including water conservation, storm water management, and materials selection.
- The Archetype Building should be a showpiece that can test the new standards and demonstrate methods for exceeding them. It should also represent a practical design – the analysis must reflect the actual characteristics of the building and/or market. In particular, building envelope performance will reflect current design practice.
- Costing and design implications – The charrette should describe the benefits of applying the new energy efficiency standards and assure builders and developers that these new standards can be achieved.
- Role of architecture – Show how quality architectural design can contribute to achieving better energy and overall performance.
- Performance Standards – The building could simply meet the Waterfront Toronto MGBR or it could exceed normal regulatory requirements.
 - Two sustainable performance evaluation standards are mandatory for the project:
 - Waterfront Toronto Minimum Green Building Requirements (MGBR) Version 2;
 - Toronto Green Standard (TGS) Tier 1, Version 1.
 - Possible advanced sustainable performance evaluation options included:
 - LEED-NC Version 4 – current draft, expected to be released in 2014.
 - LEED Platinum - Earlier discussions had focussed around setting a target of achieving a LEED-NC 2009 Gold ranking. The possibility of raising this to LEED Platinum was discussed at this meeting.
 - Water efficiency should meet at least the current standard.
- Incentives
 - Targeting the Toronto Green Standard Tier 2 would result in an incentive of a 20% reduction in development charges.
 - Other available incentives include the Enbridge SBD program and the HPNC program – these two programs can be stacked.
- The final report must reflect version 2 of Waterfront Toronto's MGBR and identify what is involved in achieving it.

1.2 The Integrated Design Process And Charrette Objectives

The charrette was intended to employ the Integrated Design Process (IDP) for achieving building performance. In accordance with the IDP, the project considered additional elements, beyond energy efficiency, that contributed to building sustainability. Two “sustainability teams” examined the impact of materials selection as well as design options to address water conservation and storm water management.

The Integrated Design Process, which is required by projects in the Enbridge Savings by Design (SBD) program, is a design approach focused on achieving environmentally sustainable buildings by designing for the entire building life cycle, and by increasing cooperation between the design team and other stakeholders. The approach requires a multi-disciplinary team of designers and experts that work with stakeholders throughout the design process and make use of specialized expertise when required, in order to consider a variety of design options, and select those that optimize building environmental performance while meeting all the other design objectives. Detailed modeling of energy performance and the embodied energy of materials represent two tools that can be used in the IDP process.

1.3 Design Charrette

The full-day charrette was held on August 13, 2012 at the Earth Rangers Centre in Woodbridge, Ontario. The charrette included representatives from SBC, Waterfront Toronto, Quadrangle Architects Limited and the City of Toronto. The event brought together a team of architects, engineers, modeling experts, contractors and building specialists to assist in designing the Archetype Condo.

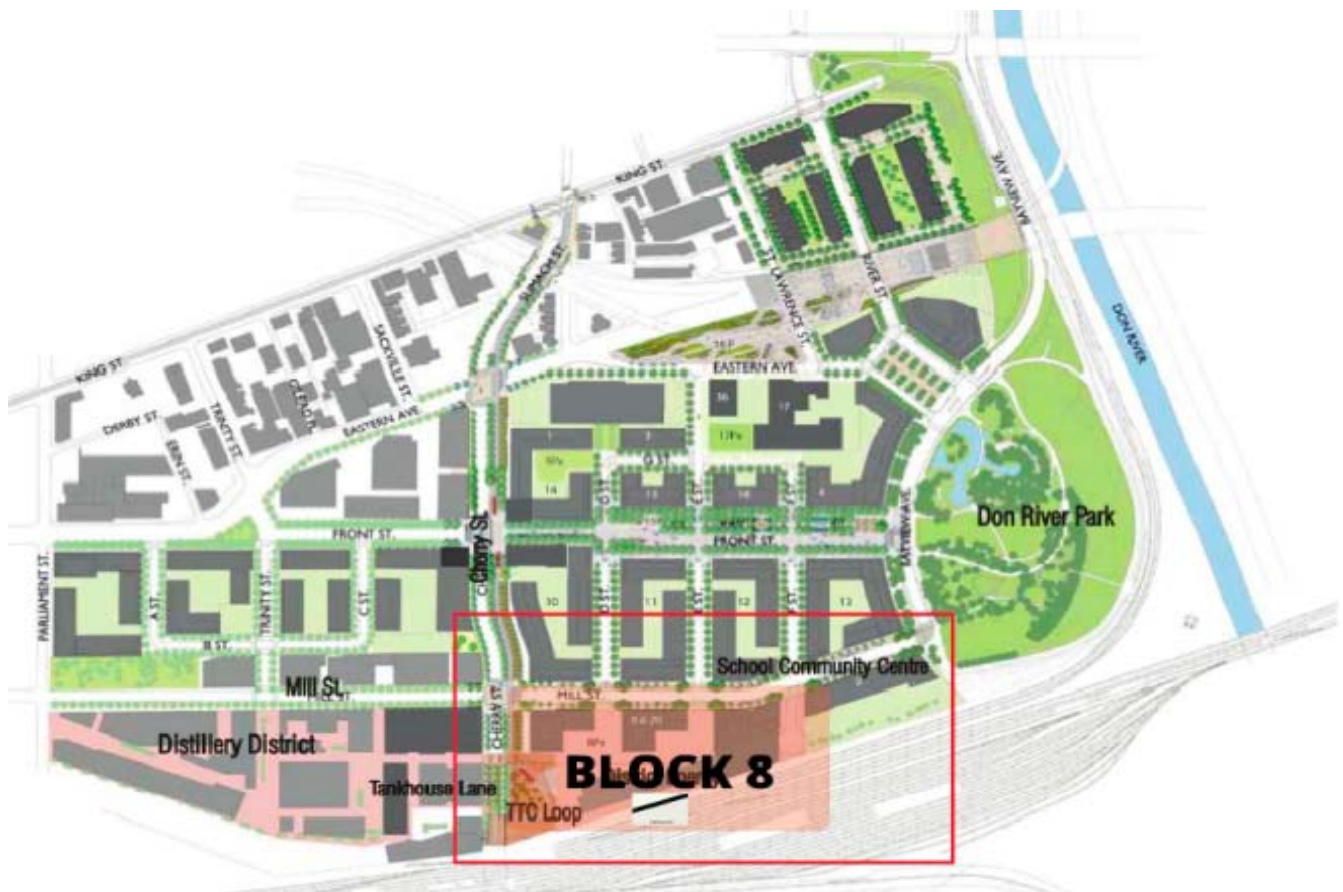
1.3.1 Archetype Condo Presentation

The Site

The site for the Archetype Condo is at the southeast corner of Mill Street and Cherry Street in Toronto. This site lies within Block 8 of Waterfront Toronto's revitalization area. The development planned for this area will function as an extension of the Distillery District with a focus on residential buildings, including 579 units, on the south side of Cherry Street. The plan for Block 8 is to construct three buildings – two 14-storey towers and one 24-storey tower with a 6-storey podium.

The site plan requires an affordable housing option and publicly accessible green space. Waterfront Toronto encourages variability in unit sizes with larger units designed for families; however, there are no specific requirements regarding unit sizes.

Figure 1.3-1: The Site

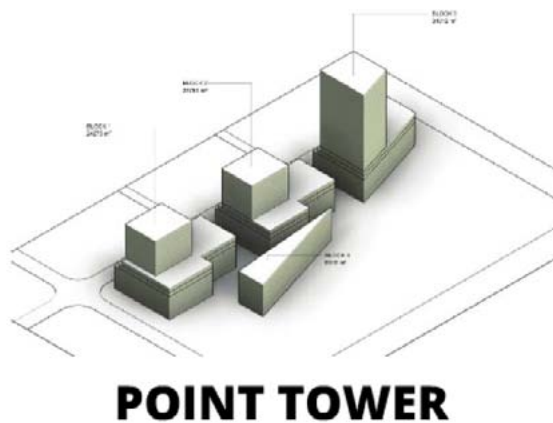


1.3.2 Preliminary Designs

Two preliminary design options were prepared by Quadrangle Architects and presented at the charrette by Michelle Xuereb. Both design options were used during the charrette in examining the effects of various modifications on building environmental performance.

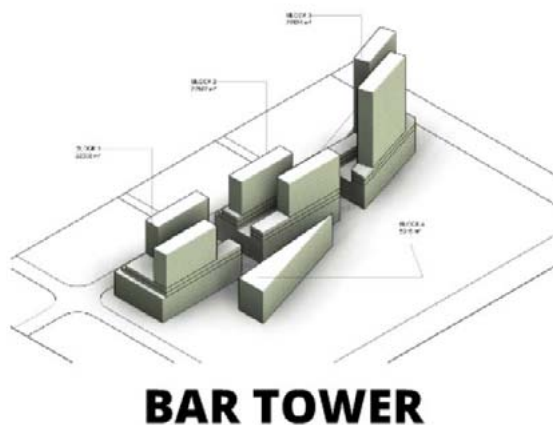
1. Point Tower: The point tower design, with a podium base, fits within the current zoning envelope for the site. The design meets all requirements for open space, maximizes saleable area, and considers access in and out of the site.

Figure 1.3-2: Point Tower



2. Bar Tower: The bar tower design consists of two bar buildings in a single loaded corridor of shallow, wide units. This design option was the result of early discussions with the energy modelers about the energy footprint of a condo building being made up of one third each for ventilation, occupant/equipment interface, and building envelope. The idea was to create a form based on maximized opportunities for passive strategies.

Figure 1.3-3: Bar Tower



1.3.3 Presentation on BIM and Improving Energy Performance

Caesar Ruest and John Janzen of Autodesk discussed building information modelling software that can model the impacts of modifications as they are considered in the design process -- i.e. to evaluate modifications on the fly. For example, the software can be used to quickly evaluate changes to target glazing, square footage, etc. The model also serves as a visual tool. For the energy modelling exercise, one of the four buildings was selected to be modelled for each option.

The objective for the energy team was to achieve EUI levels as close as possible to the values for the TGS tiers.

Potential Green Standards in Table 1.3-1 are presented as hypothetical levels and may be altered after further consideration by City staff. The target for Waterfront Toronto is a 50% energy use reduction from MNECB, based on cost.

Craig McIntyre of Provident Energy presented a table (Table 1.3-1) demonstrating the energy use intensity levels that would be required to exceed certain energy performance standards. For example, to exceed MNECB by 17%, to meet OBC 2006 standards a building would have to achieve an Energy Utilization Intensity (EUI) of 20.8 ekWh/ft²/yr.

Table 1.3-1: EUI Values for Exceeding Performance Standards

Code, Standard, or Program	Floorspace & Occupancy Type Weighted Average Performance Increment	Typical Weighted Average EUI, ekWh/ft ² /yr
MNECB	0%	25.0
Ontario Building Code		
OBC 2006 (above MNECB)	17%	20.8
OBC 2012 (above MNECB)	25%	18.8
Current Toronto Green Standard		
TGS Tier 1 (above MNECB)	25%	18.8
TGS Tier 2 (above MNECB)	35%	16.3
Potential Green Standard (2012)		
TGS Tier 1 Phase I (above OBC 2012)	5%	17.8
TGS Tier 1 Phase 2 (above OBC 2012)	15%	15.9
TGS Tier 2 Phase 1 (above OBC 2012)	15%	15.9
TGS Tier 2 Phase 2 (above OBC 2012)	25%	14.1
Waterfront Toronto Minimum Green Building Requirements		
Minimum Green Building Requirements V1	40% Less than MNECB based on Energy Cost	~ 15.0
Minimum Green Building Requirements V2	50% Less than MNECB based on Energy Cost	~ 12.5

Additional data was presented, based on ASHRAE Research Project 1365, demonstrating the relationship between insulation, thermal bridges, and effective wall R-value. The information showed that extra insulation does not always offer a significant increase in overall thermal performance. Other issues – e.g. thermal bridging – must be addressed to achieve improvements in building envelope performance. This is presented in Figure 1.3-4, taken from ASHRAE RP1365,

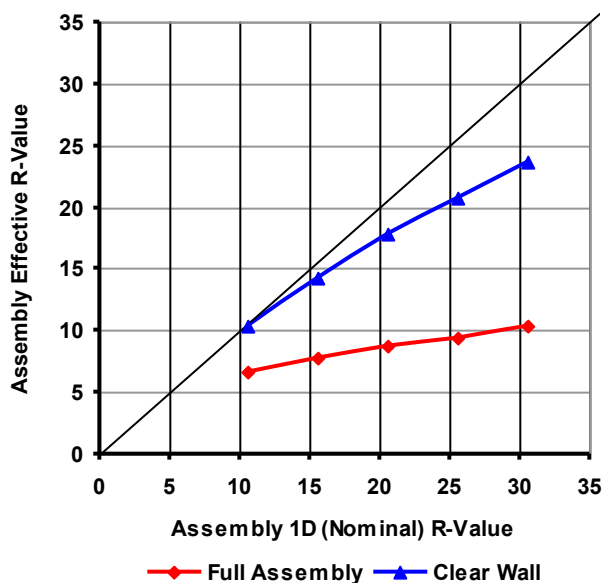


Figure 1.3-4: Impact of Additional Insulation

This diagram taken from AHRAE 1365 RP demonstrates that the impact of adding additional insulation does not result in a linear improvement to effective thermal performance of a wall assembly. In fact the additional layers of insulation have a reducing effect on the effective R-value.

Craig McIntyre also presented a column chart showing the energy intensity of recent projects modelled by his firm. The typical buildings were 30% to 40% better than MNECB. Many energy measures were utilized routinely, and buildings shown on the chart were all LEED certified up to LEED Gold.

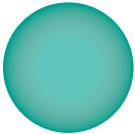
1.3.4 Breakout Groups

The charrette participants divided into three groups, with each team analyzing different aspects of the building environmental performance:



Team 1: Energy

Team 1 used the energy modeling software to evaluate strategies to achieve net energy performance improvements of 5%, 15%, and 25% relative to the OBC standards as well as to explore the impacts of various envelope improvements.



Team 2: Integrated Water Management

The team developed strategies to address soil and waste issues as well as methods to incorporate low impact development (LID) and water conservation into the site design.

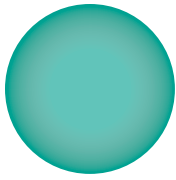


Team 3: Durability, Materials, and LEED Checklist

The team considered material options to upgrade durability and structural options for long-term adaptability of building forms. The team also evaluated the ability of the project to achieve LEED certification.

The following four chapters present the recommendations and analyses resulting from the team discussions and the follow-on research.

Note that the energy modeling that occurred as part of the Charrette represented only the preliminary steps. The Sub-committee undertook to develop more detailed scenarios as a subsequent effort. This included more specific assessments of the 5%, 15%, and 25% scenarios as well as a study of the potential net energy savings from building envelope improvements. The results of these analyses are synthesized into the Team 1 results presented in Chapter 2 below.



2.0 Energy

The energy team first established an energy model for a benchmark reference building consistent with the performance energy requirements of the Ontario Building Code. This reference building served as a basis for developing three sets of strategies that would achieve a 5%, 15% and 25% net energy reduction relative to the reference building as measured by physical units of energy used (kWh, m³) not by total energy costs for the building. Energy costs are also shown for reference. The unit energy costs used were \$0.11/kWh for electricity and \$0.25/m³ for natural gas.

Discussions at the Charrette focused on energy efficient options for glazing, the building envelope, and mechanical systems. The energy team decided on the use of the point tower design with a 70% window-to-wall ratio as the basis for assessing strategies to achieve the three levels of energy efficiency. Attendees felt that the 70% window to wall ratio was an accurate reflection of the current condominium design practice (and also noted that this feature was a market driven design, not one rooted in energy performance).

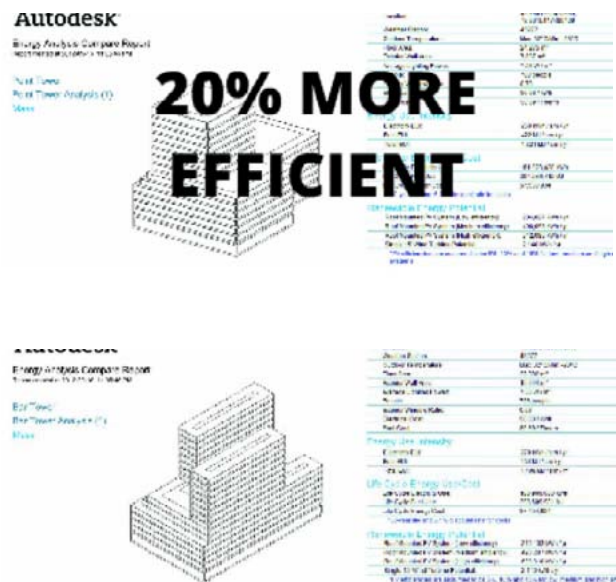
In addition to the net energy reduction targets explored, the team felt that a separate study focusing exclusively on building envelope improvements would be a worthwhile demonstration of the potential net energy savings available in an improved building envelope.

Charrette discussions and considerations

The energy team began with a model reference building developed prior to the charrette by Autodesk and Provident Energy. The model, in Autodesk Green Building Studio, was designed to meet the requirements of the OBC 2006 MNECB path (25% better than MNECB 1997).

During the Charrette, the team used this model to evaluate the two preliminary designs developed by Quadrangle Architects: a point tower and a bar tower. Initial modeling indicated that the point tower would be more energy efficient. However, post-Charrette analysis showed that variations of the bar tower design could have lower energy use¹.

Figure 2-1: Point Tower and Bar Tower used for analyzing energy efficiency strategies



The point tower, which met the zoning requirements, was chosen as the basis for further modeling of energy efficiency strategies.

¹ Reference Chapter 5 for a detailed exploration of the bar tower architectural design. The post-charrette analysis indicated the bar tower could realize an 18% lower overall EUI, 38% better fuel EUI and a 9% improvement in electricity EUI.

2.1 Reference And Baseline Building

Craig McIntyre and Adam Barker from Provident Energy Management prepared the benchmark buildings that were used in post-charrette assessment of energy reduction strategies. The reference building followed SB-10 compliance path 2 for meeting the OBC energy efficiency requirements. This path requires exceeding ASHRAE 90.1-2010 energy efficiency standards by 5%. To comply with the ASHRAE 90.1-2010 prescriptive path, the reference building energy model was developed with a window-to-wall ratio of 40% and an effective wall R-value of 15.6.

For the analysis to reflect actual (and marketable) building characteristics, the energy team decided to base their energy efficiency strategies on a baseline building with a window-to-wall ratio of 70%² and an effective wall R-value of R-11 to reflect current typical spandrel wall construction. The models for 5% and 15% energy reduction also used this lower effective wall R-value because of the high cost of achieving an R-15.6 with spandrel construction.

While the baseline building was used as a starting point for the performance models, total net energy usage determined for the reference building had to be used to set reduction goals for these performance models. Therefore the three performance models were able to include realistic design options but faced the added challenge of offsetting the higher energy use resulting from the baseline building characteristics. This represents a critical outcome for any potential design – high window to wall ratios result in higher energy use than alternative designs which subsequently needs to be off-set by greater energy efficiency elsewhere in the building in order to meet the performance target.

Table 2.1-1 and Figure 2.1-1 provide the summary for the **reference building energy** model created by Provident Energy. Note the difference in Wall Assemblies and R-value, and Window to Wall Area between the buildings.

Table 2.1-2 and Figure 2.1-2 provide the summary for the **baseline building energy** model created by Provident Energy.

² Reduction in glazing below the 70% was used as an energy conservation measure in the 5% performance improvement model.

Table 2.1-1: Reference Building Overview

	Reference Building
Roof Assemblies and R value	IEAD; 20.8 R Value
Wall Assemblies and R Value	Steel Framed; 15.6 R Value
Window Type and U Value	Metal Framed; 0.55 Total U Value;
Window to Wall Ratio	40%
Floor, Slab Assemblies and R Value	-
Balcony Isolation and Edge	N/A
Space Heating Type and Efficiency	Central Atmospheric HW Boiler; 80% Efficient
Pumps and Drives	Constant Speed
Space Cooling Type and Efficiency	Centrifugal Chiller with Cooling Tower; COP of 6.1
Ventilation and Pressurization	Combined 100 cfm/Suite
Metering and Controls	None
Lighting Loads	6.6 W/sq.m.
Low Flow Fixtures	-
Onsite Energy Production	None
Renewable Energy	None
Net Energy Reduction	-
Energy Fuel Cost Reduction	-
GHG Reduction	-

Figure 2.1-1: Energy by End Use in Reference Building

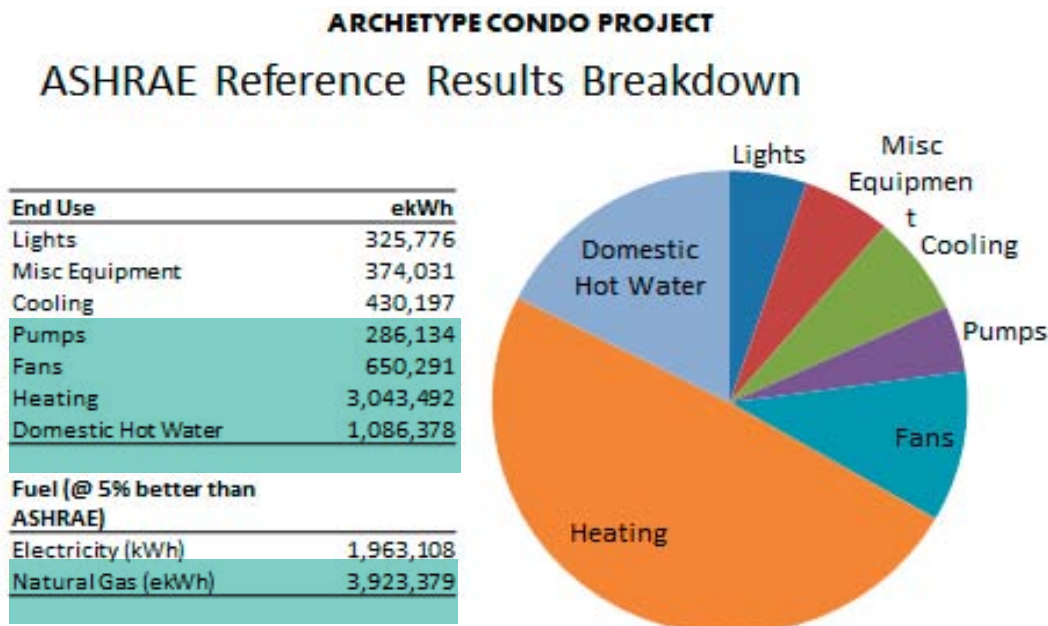
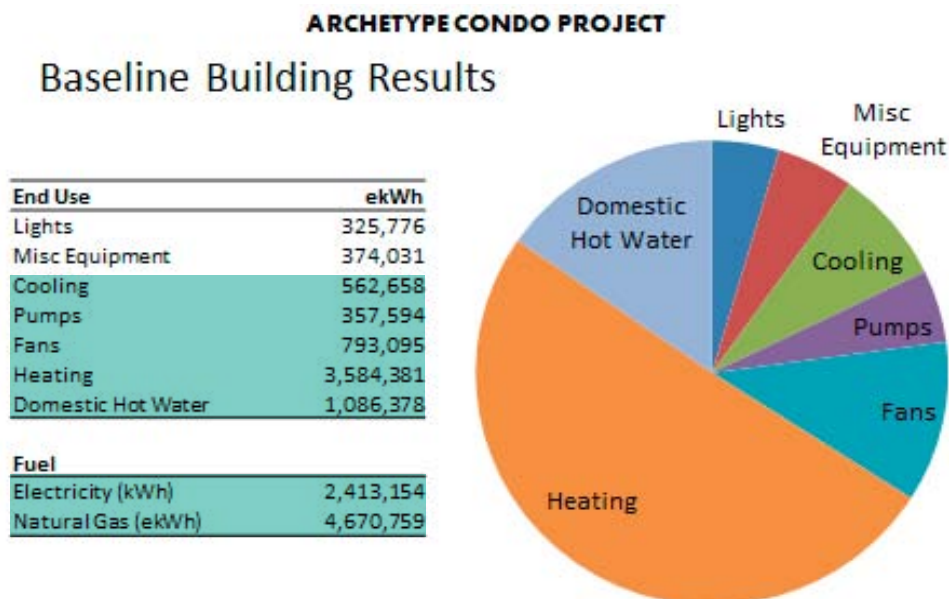


Table 2.1-2: Baseline Building Overview

	Baseline Building
Roof Assemblies and R value	IEAD; 20.8 R Value
Wall Assemblies and R Value	Spandrel Panel; 11 R Value
Window Type and U Value	Metal Framed; 0.55 Total U Value;
Window to Wall Ratio	70%
Floor, Slab Assemblies and R Value	-
Balcony Isolation and Edge	N/A
Space Heating Type and Efficiency	Central Atmospheric HW Boiler; 80% Efficient
Pumps and Drives	Constant Speed
Space Cooling Type and Efficiency	Centrifugal Chiller with Cooling Tower; COP of 6.1
Ventilation and Pressurization	Combined 100 cfm/Suite
Metering and Controls	None
Lighting Loads	6.6 W/sq.m.
Low Flow Fixtures	-
Onsite Energy Production	None
Renewable Energy	None
Net Energy Reduction	-
Energy Fuel Cost Reduction	-
GHG Reduction	-

Figure 2.1-2 Energy by End Use in Baseline Building



2.2 Cost vs Net Energy vs Greenhouse Gas Emissions

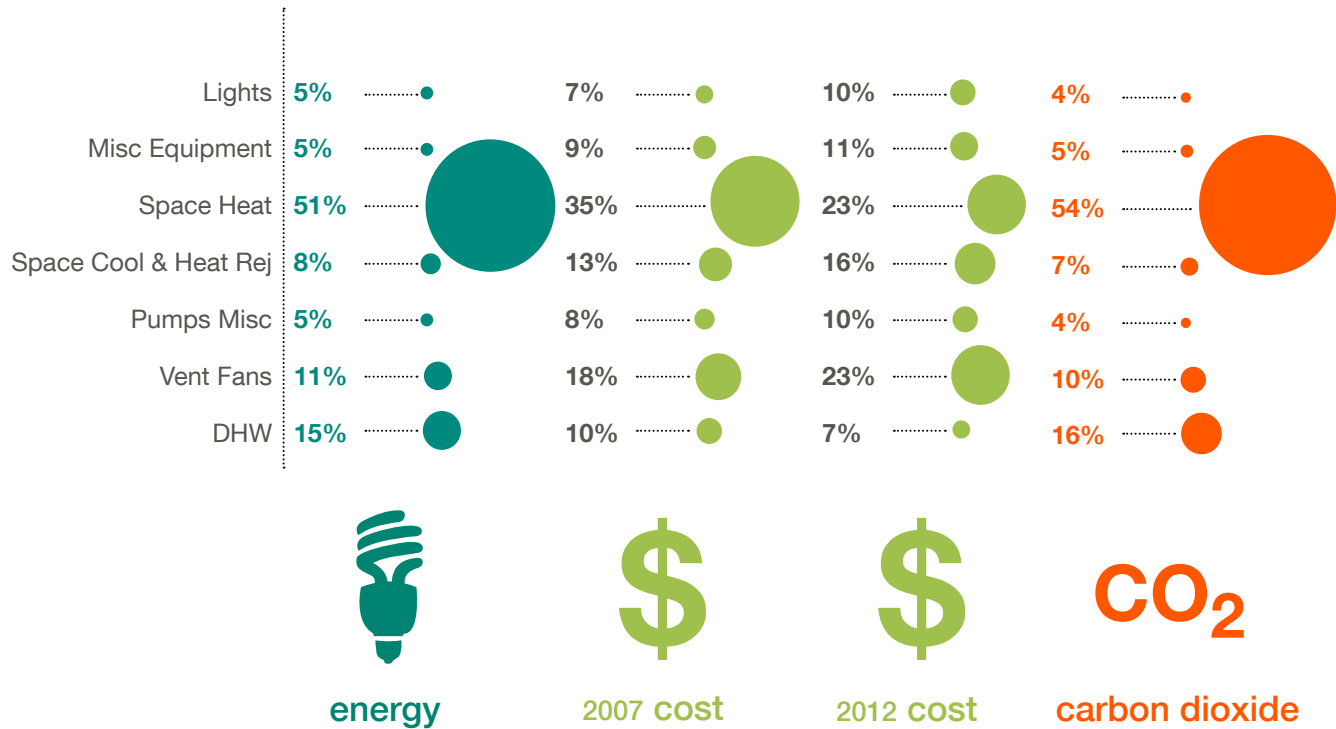
Throughout the early stages of discussion, there was much discussion about the metrics for measuring energy savings. The new OBC plus SB-10 requires that energy performance is described in terms of net energy consumption. By comparison, LEED requires that energy savings be demonstrated in terms of current utility costs. As these values are subject to change, reporting energy savings in terms of costs becomes a moving target and does not necessarily reflect true energy savings.

Figure 2.2-1 shows the effect of prioritizing the design for net energy and net energy cost would impact the energy conservation measure selected for reduction. If net energy is the metric, targeting measures which reduce space heating requirements would be a priority compared with using the 2012 energy cost metric

where targeting ventilation fans or space cooling also provide the potential for significant savings. Some would argue that lower Green House Gas (GHG) emissions should be the baseline metric since that is the path to reducing climate change impacts.

The 2012 unit energy costs used were \$0.11/kWh for electricity and \$0.25/m³ for natural gas. GHG emission reductions are based on 0.150 kg CO₂eq/kWh for electricity¹, 1.879 kg CO₂eq/m³ of natural gas.

Figure 2.2-1: Net Energy vs. Cost vs. Greenhouse Gas Metrics



¹ Source: Environment Canada. (2009) National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2007. Submission to the United Nations Framework Convention on Climate Change, Greenhouse Gas Division.

2.3 Net Energy Performance Improvement – 5%

Ian Stahlbrand, of Internat Energy Solutions, prepared the model for a 5% energy performance improvement.

The following five energy conservation measures were applied to achieve a 5% net energy reduction relative to the reference model:

ENERGY CONSERVATION MEASURES

- ECM 1 – Upgrade heating boilers to 85% efficient forced draft boilers
- ECM 2 – Upgrade chiller to a VSD centrifugal chiller
- ECM 3 – Upgrade domestic hot water boilers to high efficiency condensing boilers
- ECM 4 – Upgrade to low flow showerheads and faucets
- ECM 5 – Upgrade to higher performance window-wall assembly

1. Forced draft boilers achieve higher efficiencies than standard atmospheric boilers especially at part load .
2. A variable speed drive (VSD) chiller achieves optimal efficiency at part load, where it operates the majority of the time. This measure also includes upgrading to a VSD motor on the cooling tower fan and load reset temperature control on the condenser loop.
3. The low return water temperature for domestic hot water systems allows the condensing condition to be met year round, allowing for an efficiency of 95% or higher.
4. Reduce showerheads from 2.5gpm to 1.5gpm and faucets from 2.2gpm to 1.0gpm for hot water (and cold water) savings.
5. Window-wall systems are commercially available with an overall U-value of 0.50 Btu/h-ft²F, representing a slight improvement over the baseline system. This requires special attention to framing and thermal breaks.

Building Summary – 5% Performance Improvement

Table 2.3-1: Overview and Comparison to Reference Building for 5% Performance Improvement

	Reference Building	Proposed Building
Roof Assemblies and R value	IEAD; 20.8 R Value	IEAD; 20.8 R Value
Wall Assemblies and R Value	Steel Framed; 15.6 R Value	Steel Framed; 11.0 R Value
Window Type and U Value	Metal Framed; 0.55 Total U Value;	Metal Framed; 0.50 Total U Value
Window to Wall Ratio	40%	70%
Floor, Slab Assemblies and R Value	-	-
Balcony Isolation and Edge	N/A	N/A
Space Heating Type and Efficiency	Central Atmospheric HW Boiler; 80% Efficient	Forced Draft HW Boiler; 85% Efficient
Pumps and Drives	Constant Speed	Constant Speed
Space Cooling Type and Efficiency	Centrifugal Chiller with Cooling Tower; COP of 6.1	Centrifugal VSD Chiller with Cooling Tower; COP of 6.1
Ventilation and Pressurization	Combined 100 cfm/Suite	Combined 100 cfm/Suite
Metering and Controls	None	None
Lighting Loads	6.6 W/sq.m.	6.6 W/sq.m.
Low Flow Fixtures	-	Low Flow Showerheads 1.5 gpm. Faucets 1.0 gpm
Onsite Energy Production	None	None
Renewable Energy	None	None
Net Energy Reduction	-	314,292 kWh (5.3%)
Energy Fuel Cost Reduction	-	-\$18,373 (-5.9%)
GHG Reduction	-	66,713 kg CO ₂ e (6.6%)

Energy Use with a 5% Performance Improvement

Because the baseline building began with a window-to-wall ratio of 70% and a wall effective R-value of 11, the initial energy performance was 20.3% below the reference building model, as shown in Table 2.3-2. Upgrades to the mechanical systems, which were less expensive than envelope upgrades, were addressed before making changes to the building envelope. The window-wall assembly upgrade, ECM 5, will have the highest cost, however a fenestration upgrade was considered necessary given the high percentage of glazing in the building.

The measures with the greatest individual impact were ECM 1 (heating boiler upgrade) and ECM 5 (use of high performance glazing).

Table 2.3-2: Incremental Impacts of Environmental Conservation Measures

	Consumption			Performance Improvement	
	Electricity (kWh)	Gas (m ³)	Total (kWh)	Incremental Change (%)	Relative to Reference (%)
Baseline Building	2,413,200	451,800	7,084,800	-	-20.3
ECM 1 - Heating Boiler Efficiency	2,421,000	371,000	6,257,300	11.7	-6.3
ECM 2 - VSD chiller	2,249,900	371,000	6,086,200	2.7	-3.4
ECM 3 - DHW Boiler Efficiency	2,249,900	354,600	5,916,200	2.8	-0.5
ECM 4 - Low Flow Fixtures	2,249,900	330,500	5,667,100	4.2	3.8
ECM 5 - Glazing	2,265,800	320,000	5,574,600	1.6	5.3

Figure 2.3-1: Energy by End Use -- 5% Performance Improvement

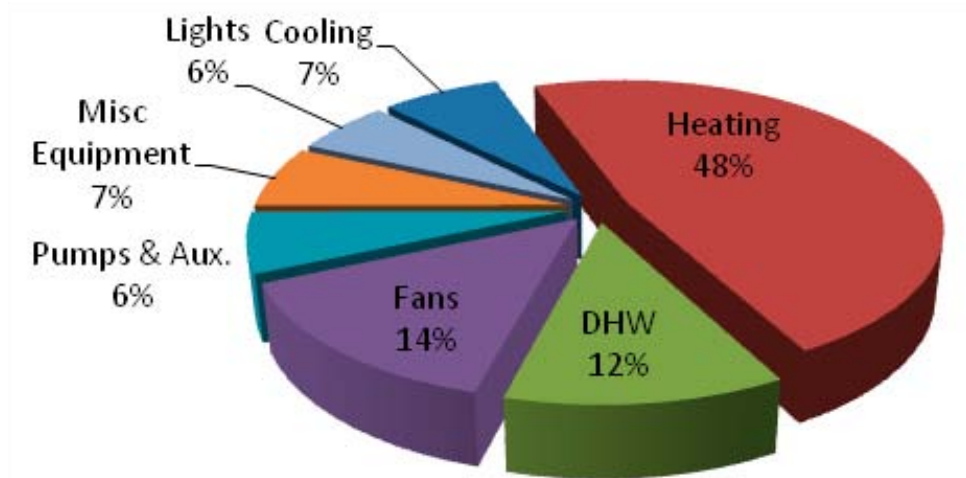


Figure 2.3-2: 5% Performance Improvement Option expressed in terms of energy savings, 2012 costs savings and carbon savings



2.4 Net Energy Performance Improvement – 15%

Brian Tysoe, of MCW Consultants Ltd, prepared the model for 15% energy performance improvement.

The following seven energy conservation measures were applied to achieve a 15% net energy reduction relative to the reference building model:

- 1.** In-Suite energy recovery captures waste heat as part of the suite ventilation system with an assumed efficiency of 40% (conservative estimate).
- 2.** 88% non-condensing boilers are approximately 10% more efficient than a standard atmospheric boiler.
- 3.** 95% efficient domestic hot water heaters bring significantly higher efficiency than standard atmospheric units.
- 4.** Low flow fixtures include efficient showerheads and aerators resulting in a 20% reduction in DHW
- 5.** VSD Cooling Tower and Load Reset Control on the cooling tower fan for reduced fan power during part-load operation; load reset control reduces the condenser water temperature set-point during part-load operation for lower cooling tower and chiller energy consumption
- 6.** VSD on the chiller compressor for lower chiller power during part-load operation)
- 7.** High-Performance Glazing with U-Value of 0.37BTU/hr-ft²-F (reduced glass conductance value to reduce skin losses through fenestration)

ENERGY CONSERVATION MEASURES

- ECM 1 – In-Suite Energy Recovery Ventilation
- ECM 2 – 88% Efficient Boiler
- ECM 3 – 95% Efficient Domestic Hot Water Heater
- ECM 4 – Low Flow Domestic Hot Water Fixtures
- ECM 5 – VSD Cooling Tower and Load Re-set Control
- ECM 6 – VSD Chiller
- ECM 7 – High-Performance Glazing with U-Value of 0.37BTU/hr-ft²-F

Building Summary – 15% Performance Improvement

Table 2.4-1: Overview and Comparison to Reference Building for 15% Performance Improvement Model

	Reference Building	Proposed Building
Roof Assemblies and R value	IEAD; 20.8 R Value	IEAD; 20.8 R Value
Wall Assemblies and R Value	Steel Framed; 15.6 R Value	Steel Framed; 11 R Value
Window Type and U Value	Metal Framed; 0.55 Total U Value	Metal Framed; 0.37 Total U Value
Window to Wall Ratio	40%	70%
Floor, Slab Assemblies and R Value	-	-
Balcony Isolation and Edge	N/A	N/A
Space Heating Type and Efficiency	Central Atmospheric HW Boiler; 80% Efficient	87% Efficient Forced Draft
Pumps and Drives	Constant Speed	Constant Speed
Space Cooling Type and Efficiency	Centrifugal Chiller with Cooling Tower; COP of 6.1	VSD Centrifugal Chiller with VSD Cooling Tower and Load Reset Control; COP of 6.1
Ventilation and Pressurization	Combined 100 cfm/Suite	In Suite ERV
Metering and Controls	None	None
Lighting Loads	6.6 W/sq.m.	6.6 W/sq.m.
Low Flow Fixtures	-	Low flow
Onsite Energy Production	None	None
Renewable Energy	None	None
Net Energy Reduction	-	922,773ekWh (15.8%)
Energy Fuel Cost Reduction	-	-\$22,683 (-7.3%)
GHG Reduction	-	184,052 kg CO2e (18.4%)

Energy Use with 15% Performance Improvement

The baseline building model had an initial energy performance of 20.4% below the reference building model because of the lower wall R-value and higher window-to-wall ratio.

ECM 1 (In-suite ERV) and 2 (boiler upgrade) resulted in the largest reductions in energy use. The glazing upgrade was also significant.

Table 2.4-2: Incremental Impacts of Environmental Conservation Measures

	Consumption			Incremental Change (%)	Performance Relative to Reference (%)
	Electricity (kWh)	Gas (m)	Total (ekWh)		
Baseline Building	2,413,244	447,192	7,041,677	-	-20.4
ECM 1	2,614,290	368,430	6,427,539	8.7%	-9.9%
ECM 2	2,620,169	298,053	5,705,020	11.2%	2.4%
ECM 3	2,620,169	288,853	5,609,795	1.7%	4.0%
ECM 4	2,620,169	273,382	5,449,670	2.9%	6.8%
ECM 5	2,486,547	273,382	5,316,048	2.5%	9.1%
ECM 6	2,423,338	273,382	5,252,839	1.2%	10.2%
ECM 7	2,487,029	235,413	4,923,558	6.3%	15.8%

Figure 2.4-1: Energy by End Use -- 15% Performance Improvement

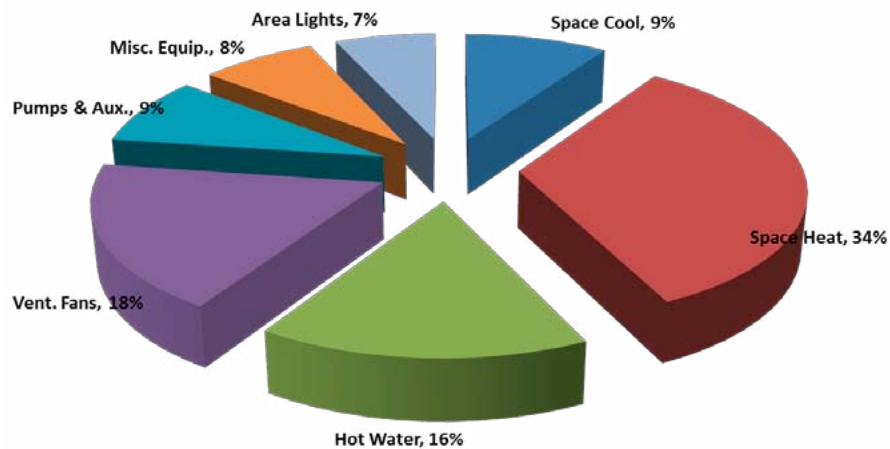


Figure 2.4-2: 15% Performance Improvement Option expressed in terms of energy savings, 2012 costs savings and carbon savings.



2.5 Net Energy Performance Improvement – 25%

Shaheen Asif and Lyle Scott, of S.A. Footprint, prepared the model for 25% energy performance improvement.

The following two energy conservation measures were applied to achieve a 25% net energy reduction relative to the reference model:

1. A geothermal vertical loop installed beneath the building consisting of a vertical ground coupled heat pump system to provide heating and cooling for the site. This system will take advantage of the balanced cooling and heating loads expected for the building. A ground source heat pump system requires boreholes to transfer the heat to and from the earth and heat pumps (located within the building) to transfer and upgrade the heat to the desired temperature. The boreholes and heat pump were sized to meet 100% of the peak cooling load requirement, which is almost equal to the peak heating load. The capital cost of ground coupled system can be reduced by using natural gas fired heating makeup air unit and/or using hybrid ground source systems in which part of the heating is supplemented by boilers and using supplemental heat rejecters (such as cooling tower, fluid cooler or cooling ponds) to reject the excess heat.

2. Ground source heat pump systems can be expensive to install if the pumping system is oversized. It is recommended that variable speed drives on the heat pump loop be installed. These will reduce associated electricity use.

ENERGY CONSERVATION MEASURES

- ECM 1 – Market Building with Geo-Exchange System
- ECM 2 – Variable Speed Drives

Table 2.5-1: Incremental Impacts of Environmental Conservation Measures – 25% Improvement

Building Summary – 25% Performance Improvement

Table 2.5-1: Overview and Comparison to Reference Building for 25% Performance Improvement

	Reference Building	Proposed Building
Roof Assemblies and R value	IEAD; 20.8 R Value	IEAD; 20.8 R Value
Wall Assemblies and R Value	Steel Framed; 15.6 R Value	Steel Framed; 15.6 R Value
Window Type and U Value	Metal Framed; 0.55 Total U Value;	Metal Framed; 0.55 Total U Value;
Window to Wall Ratio	40%	70%
Floor, Slab Assemblies and R Value	-	-
Balcony Isolation and Edge	N/A	N/A
Space Heating Type and Efficiency	Central Atmospheric HW Boiler; 80% Efficient	Vertical Ground Loop HX; Heating COP : 3.9
Pumps and Drives	Constant Speed	Variable Speed
Space Cooling Type and Efficiency	Centrifugal Chiller with Cooling Tower; COP of 6.1	Vertical Ground Loop HX; Cooling EER : 18.1
Ventilation and Pressurization	Combined 100 cfm/Suite	Combined 100 cfm/Suite
Metering and Controls	None	None
Lighting Loads	6.6 W/sq.m.	6.6 W/sq.m.
Onsite Energy Production	None	None
Renewable Energy	None	None
Net Energy Reduction	-	42.8%
Energy Fuel Cost Reduction	-	11.9%
GHG Reduction	-	48.9%

Table 2.5-2 Energy by End Use with 25% Performance Improvement

	Consumption			Incremental Change (%)	Performance Relative to Reference (%)
	Electricity (kWh)	Gas (m ³)	Total (ekWh)		
Baseline	2,413,244	447,192	7,041,677	-	-20%
	2,333,300	102,144	3,402,748	51.6%	42.2%
ECM 2	2,294,500	102,144	3,363,948	1.1%	42.8%

Figure 2.5-1: Energy by End Use - 25% Performance Improvement

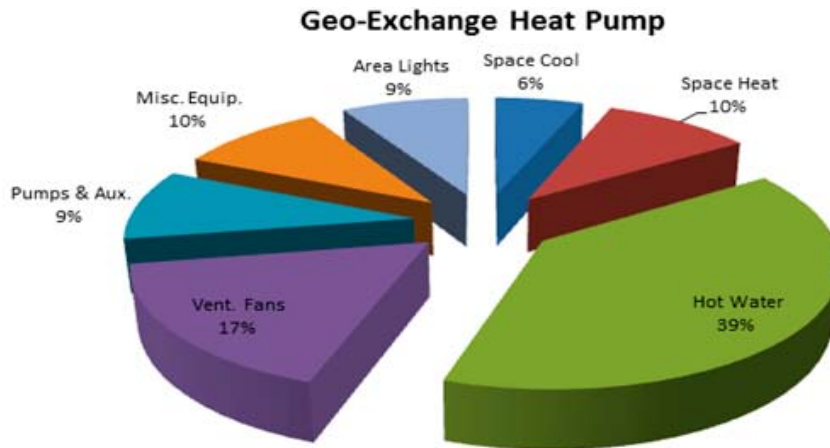


Figure 2.5-2: 25% Performance Improvement Option expressed in terms of energy savings, 2012 costs savings and carbon savings.



2.6 Architectural Energy Performance Improvements

Michelle Xuereb of Quadrangle Architects Limited worked with **Craig McIntyre** and **Adam Barker** from Provident Energy Management to prepare typical realistic wall assemblies that could be applied to the baseline building.

The baseline building assumed a window to wall ratio of 70%, a total window U-value of 0.55 and an effective R value of 11 for the spandrel glazing to reflect typical condo design in the Greater Toronto Area.

The window to wall ratio (WWR) was studied starting at the baseline of 70% and then dropping in increments of 5% down to a minimum of 40%. This minimum is specified in SB-10 Division 3, in both MNECB and ASHRAE 90.1-2010 as the highest WWR permitted if the prescriptive path is followed, and is therefore the highest WWR permitted for the reference building when following the performance path.

In addition to this, two building envelope energy conservation measures were applied to get an understanding of the cumulative net energy reduction impact relative to the baseline building model:

- 1.** Increase U-value of window assembly to 0.35 including the specification of a low E coating on surface two and warm edge spacers.
- 2.** Upgrade the opaque components from spandrel panel to a precast or brick rain screen assembly with an effective R-value of R-17. The assembly consists of brick, a 25mm air space, 25mm of extruded polystyrene on an air barrier, 13mm exterior sheathing supported by 152mm steel studs filled with mineral batt insulation, a vapour barrier and gypsum board.

Reducing the percentage of glazing has a huge potential for energy savings. While 40% may not be a realistic glazing ratio for this building typology, selecting a value less than 70% could be a cost effective solution for achieving significant net energy improvements. Looking at the bar chart in Figure 2.6-1, it is apparent that combining a reduced percentage of glazing with glazing upgrades and the opaque assemblies is a reasonable strategy for meeting the requirements of SB10 + 5%.

When considering energy improvements, it is most logical to consider providing the best possible building envelope that meets the budget of the project prior to upgrading mechanical systems.

ENERGY CONSERVATION MEASURES

- UPGRADE 1 – Window U-value of 0.35
- UPGRADE 2 – Window U-value of 0.35 + brick/precast for opaque assemblies (effective r-17)

Building Summary – Net Performance Improvement

Table 2.6-1: Overview and Comparison to Reference Building for Envelope Upgrades

	Reference Building	Proposed Building
Roof Assemblies and R value	IEAD; 20.8 R Value	IEAD; 20.8 R Value
Wall Assemblies and R Value	Steel Framed; 15.6 R Value	Steel Framed; 11 R Value OR 17 R Value
Window Type and U Value	Metal Framed; 0.55 Total U Value	Metal Framed; 0.37 OR 0.55 Total U Value
Window to Wall Ratio	40%	40% to 70%
Floor, Slab Assemblies and R Value	-	-
Balcony Isolation and Edge	N/A	N/A
Space Heating Type and Efficiency	Central Atmospheric HW Boiler; 80% Efficient	Central Atmospheric HW Boiler; 80% Efficient
Pumps and Drives	Constant Speed	Constant Speed
Space Cooling Type and Efficiency	Centrifugal Chiller with Cooling Tower; COP of 6.1	Centrifugal Chiller with Cooling Tower; COP of 6.1
Ventilation and Pressurization	Combined 100 cfm/Suite	Combined 100 cfm/Suite
Metering and Controls	None	None
Lighting Loads	6.6 W/sq.m.	6.6 W/sq.m.
Low Flow Fixtures	-	-
Onsite Energy Production	None	None
Renewable Energy	None	None
Net Energy Reduction	-	varies
Energy Fuel Cost Reduction	-	varies
GHG Reduction	-	varies

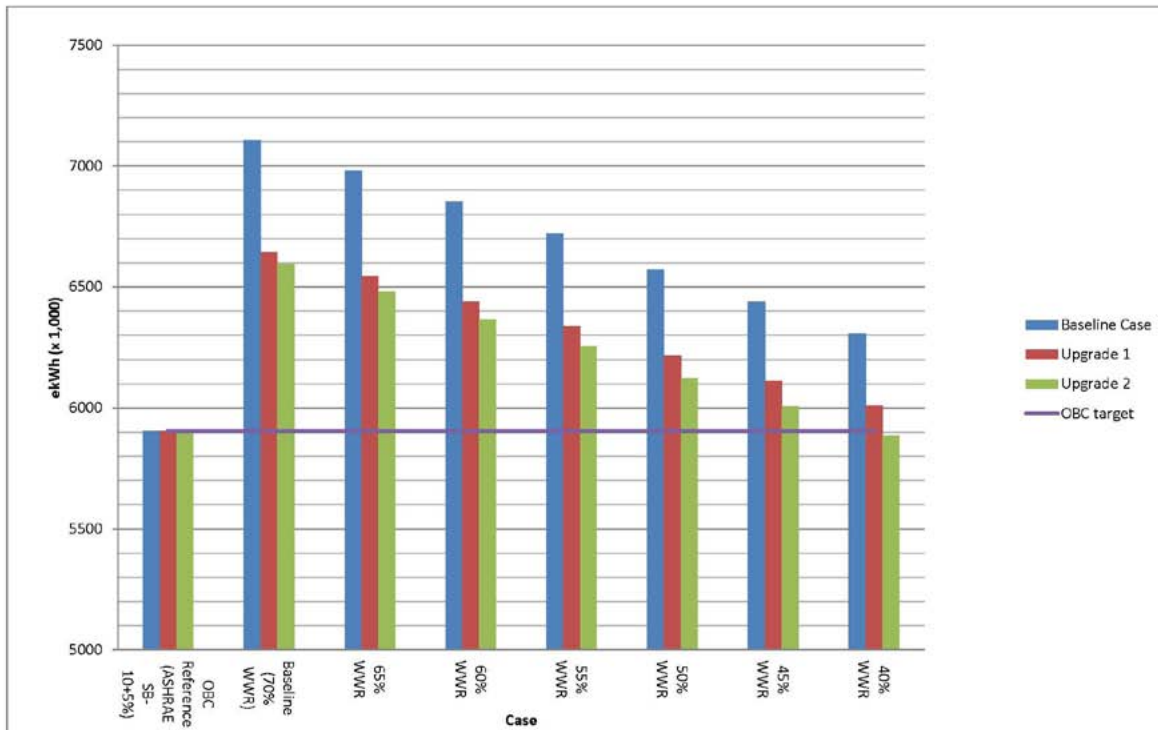
Table 2.6-2: Incremental Impacts of Envelope Upgrades

Baseline Case: 'Realistic' R-11 Spandrel; ASHRAE 2010 Roof; ASHRAE 2010 Window U-value (0.55)					
	Consumption			Incremental Change	Relative Performance (%)
	Elec (kWh)	Gas (m3)	Total (kWh)		
OBC (ASHRAE SB-10+5%)	1963154	371970	5906035	-	0
Baseline (70% WWR)	2413253	442825	7107198	-	-20.34%
65% WWR	2360208	435997	6981779	1.76%	-18.21%
60% WWR	2306341	428908	6852769	1.85%	-16.03%
55% WWR	2249403	421825	6720748	1.93%	-13.79%
50% WWR	2183273	414047	6572174	2.21%	-11.28%
45% WWR	2126055	406969	6439931	2.01%	-9.04%
40% WWR	2069616	399956	6309145	2.03%	-6.83%

Upgrade 1: 'Realistic' R-11 Spandrel; ASHRAE 2010 Roof; Upgraded Window U-value (0.35)					
	Consumption			Incremental Change	Relative Performance (%)
	Elec (kWh)	Gas (m3)	Total (kWh)		
OBC (ASHRAE SB-10+5%)	1963154	371970	5906035	-	0
Baseline (70% WWR)	2509662	390075	6644457	-	-12.50%
65% WWR	2447836	386428	6543970	1.51%	-10.80%
60% WWR	2384266	382569	6439502	1.60%	-9.03%
55% WWR	2320558	378861	6336486	1.60%	-7.29%
50% WWR	2245731	374603	6216520	1.89%	-5.26%
45% WWR	2178713	371008	6111401	1.69%	-3.48%
40% WWR	2113139	367472	6008345	1.69%	-1.73%

Upgrade 2: R-17 Brick/Precast Panel Wall; ASHRAE 2010 Roof; Upgraded Window U-value (0.35)					
	Consumption			Incremental Change	Relative Performance (%)
	Elec (kWh)	Gas (m3)	Total (kWh)		
OBC (ASHRAE SB-10+5%)	1963154	371970	5906035	-	0
Baseline (70% WWR)	2511229	385317	6595586	-	-11.68%
65% WWR	2447769	380536	6481452	1.73%	-9.74%
60% WWR	2383374	375808	6366942	1.77%	-7.80%
55% WWR	2319460	371358	6255858	1.74%	-5.92%
50% WWR	2243827	366025	6123692	2.11%	-3.69%
45% WWR	2174204	361481	6005898	1.92%	-1.69%
40% WWR	2099612	357050	5884342	2.02%	0.37%

Figure 2.6-1: Overview and Baseline Comparison for Envelope Upgrades



2.7 Conclusions From Energy Analysis

This research identified a number of critical issues regarding energy performance for condominiums given the various performance targets. These include:

2.7.1 Building Codes and Energy Modeling:

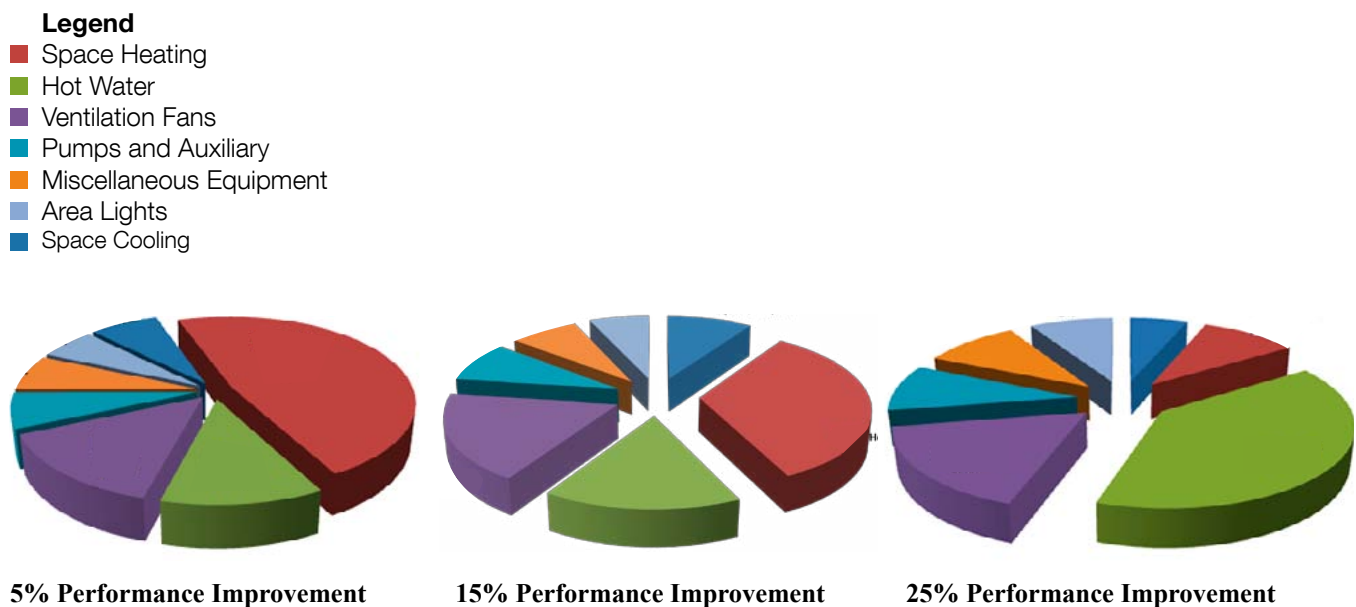
- There is a need in the industry to establish a common metric for discussing energy as well as tools that will allow for consistent analysis methods and results. The current edition of SB-10 offers three different compliance options citing two different energy codes, which is confusing. Specifying a “percentage above code” metric increases the complexity. For the purpose of this Project SBC advised all energy modelers use the same modeling software and follow SB-10 Division 3 Option (c) which requires following ASHRAE 90.1-2010 energy efficiency standards as modified by SB-10 Division 3 Chapter 2. Ideally, this will become standard practice.

- Using energy cost as a metric to compare the performance of the proposed design and the reference building does not consistently and permanently improve the overall energy performance of a building as it is tied to current energy costs, though this is the path followed by LEED®. For projects delivered under the Enbridge Savings By Design program, SBC will not accept the annual energy cost budget method. Instead this program requires that the building be modeled to show net energy savings.
- Follow established standard operating conditions for occupancy and use as defined in the modeling rules for the applicable energy code. The overarching intent should be consistency in modeling approach to optimize comparisons for greatest accuracy.
- Consider different performance increments over code for different building types. The current process uses a weighted cross section of archetype buildings. Some building types (including condominiums) have greater challenges to improve their energy performance.

2.7.2 The Archetype Condominium Energy Model Results:

- Designs that have high window to wall ratios (greater than 40%) and solid walls with a low R-value such as spandrel panel will be challenged to meet the more aggressive energy performance targets and will result in increased costs for mechanical systems.
- Select the best possible building envelope that the budget can afford before resorting to mechanical solutions.
- Passive heating and cooling, natural ventilation, and maximizing day-lighting opportunities have the potential to lower energy use significantly.
- Achieving a 5% reduction in energy use can be achieved through the application of relatively inexpensive and readily available technologies and minor design changes. Specific design changes and technologies include:
 - Higher efficiency window-wall assemblies
 - Heating boiler upgrade to higher efficiency units.
 - Chiller upgraded to a variable speed drive (VSD).
 - Domestic hot water boiler upgrade to condensing type
 - Low flow water fixture
- Achieving a 15% reduction in energy use requires the use of more advanced technologies delivering greater energy efficiency. These technologies are also readily available but do represent higher costs, however no other major design changes are required. Specific design changes and technologies include:
 - High performance glazing, with U-value of 0.37 BTU/hr-ft²-F or lower.
 - In-suite energy recovery ventilation.
 - 88% high efficiency non-condensing boiler for space heating.
 - 95% efficient condensing domestic hot water heating.
 - Low flow domestic hot water heating.
 - VSD chiller and load re-set control.
- Achieving a 25% reduction in energy use requires a significant reduction in space heating and cooling energy use such as could be achieved through the use of a geothermal heat pump system. With no major design changes to the building envelope or other systems, this represents a significant capital investment and relatively a long payback period. However, the use of a geothermal heat pump system results in an energy efficiency improvement that surpasses the target. Specific design changes and technologies include:
 - Geothermal heat pump system
 - Variable Speed Drives

Figure 2.7-2: Energy by End Use Comparison





3.0 Integrated Water Management

At the design charrette, Team 2 examined strategies for addressing water, soil, and waste as well as ways to incorporate low impact development into the site.

Four design principles were established:

- Minimize builder risk
- Integrate Low Impact Development (LID) into design process, and provide guidance on the use of proven LID approaches
- Reward integrated solutions that “optimize the relationship between systems”

3.1 Strategies To Address Design Priorities

Three design priorities were identified, and strategies to address these priorities defined:

1. “Treatment train” Opportunities for Storm Water Management³

The treatment train is an approach to storm water management that focuses first on source control, then conveyance control and finally on end-of-pipe solutions.

- Green roof: add “low phosphorus” specification to green roof requirement
 - Specifications should be amended to require low-phosphorus roofs. Recommended changes include requiring different plant material and specifying media that retains large phosphorus loads⁴.

³ Waterfront Toronto requires the site to deal with the first 5 mm of any rainfall event before releasing water to offsite storm water systems.

⁴ Example product: SorbitiveMEDIA made by Imbrium is an oxide-coated, high surface area reactive engineered media that sorbs and retains large phosphorus loads; must be replaced every 7 years

- Parkland area, integrated with permeable paver surfaces
 - Set a minimum requirement for vegetative surfaces (i.e. min. density; min. areas)
- Courtyard integration - Raise courtyard to retain water
- Divert water to bioswales
- Encourage multiple treatments
 - Support treatment train effect by using right-of-way features
- Link with LEED credits

2. Water Conservation Strategies

Establish a goal to reduce potable water use by 40%.

- Rain-water for irrigation
 - Consider rainwater for toilet flushing
- Low flow shower heads, toilets, shower only units
- Concept of water banking: strategy for collecting/drawing on non-municipal water to meet conservation targets
- Water metering for individual units (Waterfront Toronto requirement)

Must implement rainwater harvesting to receive required 4 LEED points

DESIGN PRIORITY AREAS

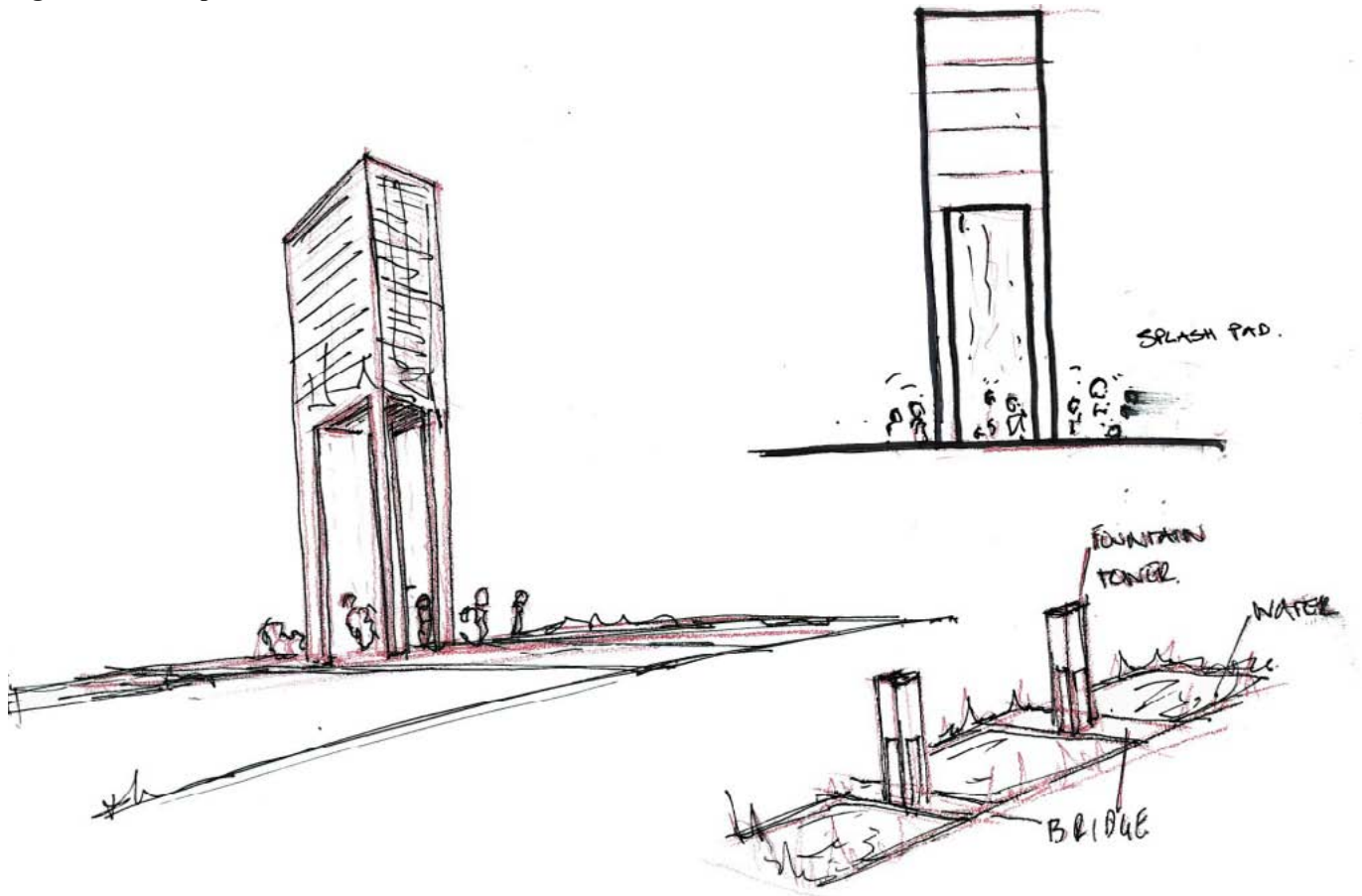
- “Treatment train” opportunities for storm water control
- Water Conservation
- Integrating water features & mechanical system

3. Integrating Water Management & Mechanical System

Integration focuses on using water from the building site.

- Cooling tower integration
 - Traditional cooling tower would be integrated with a water feature to reject heat from the space cooling system.
 - This assumes the cooling systems a cooling tower.
- Collect/evaporate rainwater for irrigation
- Could collect building grey water, but would require enhanced treatment⁵
- Could use storm water management strategy to fulfil the public art (Artscape) requirement
 - i.e. Use a fountain with cascading water⁶

Figure 3.1-1: Proposed Water Feature



⁵ Grey water must be treated if it is publicly accessible. Rainwater does not have to be treated.

⁶ Water would have to be treated to potable standards.

3.2 Additional Strategy Recommendations

The team offered the following recommendations for the site:

- Drain water heat recovery (DWHR) could be installed into the plumbing and drainage system to reduce water-heating energy.
- A passive solar aspirating air collector could be located on the building exterior to preheat ventilation air.
- Thermal mass within the structure itself can be combined with passive solar collection to heat the building into the evening.
- Earth cooling tubes can be used to pre-cool and/or pre-heat the ventilation air.
- A geothermal exchange system could use the lake as a heat sink to reduce heating and cooling costs. There is an opportunity to create energy for large developments in the area.

3.3 Key Success Factors

The following steps were recommended to address the design priorities and incorporate sustainability principles into the development of the site.

1. RFP Process

Guidelines/RFP requirements should be updated to support design opportunities. Tailor the language within the RFP in order to extract the best product from the builder.

2. Sharing Wins

Look outside the site into the adjacent parklands, communities. Build relationships and governance/legal structures to enable truly “integrated design” solutions and share costs and/or savings (i.e. crossing site lines, enabling developer-occupant funded service materials). There is a need to build an integrated “water budget” to better understand opportunities for shared costs and/or savings.

3. Market Readiness

There is a need to educate consumers about conservation/LID issues
There are liability/cost issues with regards to ownership.

4. No One Size Fits All

Respect different technical requirements/styles between residential and commercial developers.



4.0 Materials, Durability, and LEED

Members of Team 3 considered material options to upgrade durability and structural options to achieve long-term adaptability of the building form.

4.1 Durability

Design and install building systems that match the intended service life of the building. Those components that do not match the intended service life should be designed so that they can be easily accessed for repair or replacement. A clear maintenance plan must be provided to ensure that ongoing maintenance will be required for these systems to meet the performance criteria.

The current standard design for the envelope is window/wall system. The R-value is relatively poor and issues of water penetration and mould growth are potential risks. Insulated glazing units have a service life of approximately 25 years. Window/wall systems are not easily retrofitted. This has the potential to be an ongoing issue within the building stock currently being designed and built within Greater Toronto Area.

Systems that would support both durability and energy efficiency in condo design include:

- Rain screen wall and windows systems i.e. masonry or pre-cast walls with punched windows which are easier to repair/retrofit;
- Fibreglass windows in lieu of aluminum (where permitted) to minimize thermal bridging;
- A proper drainage system to extend the life span of materials by minimizing ongoing damage from water penetration;
- Mandatory building envelope commissioning or field review;
- Inverted roof systems to protect the membrane while also supporting rainwater capture and cool roofs;
- Modular tray green roof system to protect the membrane, reduce solar heat gain and allow simple removal for repairs to membrane.

Waterfront Toronto could consider including compliance with the LEED Canada durability credit or require mandatory building envelope commissioning (part of LEED Version 4.0) within their revised version of The Minimum Green Building Requirements

Improving durability for all components of the building envelope, including masonry, cladding, and glazing systems has the potential to improve the life span of a building and therefore the reputation of a developer. At the charrette, the proposed forms were examined in terms of flexibility, durability, and adaptability.

The following diagrams illustrate some of the suggested design modifications:

- Diagram **A**: To provide the greatest flexibility for current and future building use, a point tower under 15 stories could be designed on a column system with shear walls only at the core.
- Diagram **B**: Connecting the two bar buildings with an elevated walkway that could function as a stiffening element would increase lateral stability as well as centralizing circulation. Alternate shear walls between suites could also be removed to allow horizontal expansion of suites.
- Diagram **C**: The bar buildings has greater outside surface area which leads to higher heat loss. It also provides better opportunities for cross ventilation, the potential for pre-heating air in a conditioned sun room, and opportunities for natural daylight. The corridor wall could be super insulated with limited fenestration.

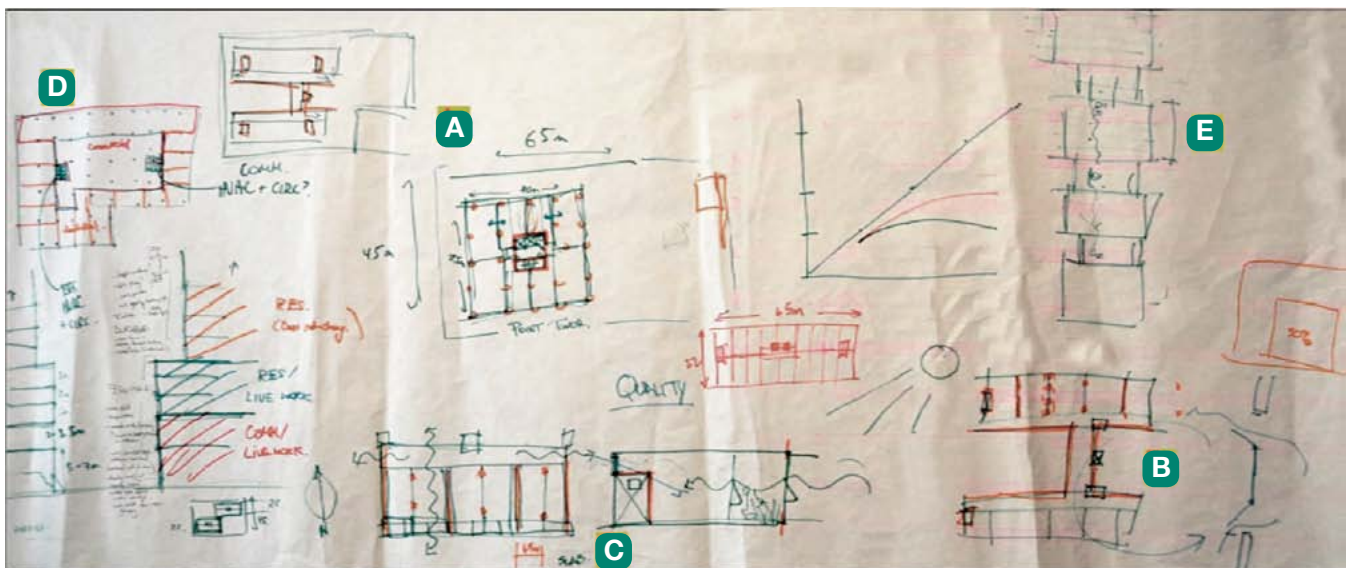
- Diagram **D**: The podium should be laid out primarily for commercial use, and the towers for residential. A bar building would likely permit modifications to the structural layout that could help maximize the potential for variable suite size or adding light office space for home business.
- Diagram **E**: The current practice in Toronto is to place mechanical penthouses on the roof due to the height allowances included in the zoning by-law for this purpose. This leads to unquestioned assumptions within the mechanical design and limits design opportunities for other rooftop uses. The idea of zoning services within the tower was discussed. Mechanical systems could be reduced **in size to** serve a group of floors, shortening runs and losses in transmission. Grey-water from the upper floors could be collected and reused for the floors directly below them using gravity.

4.2 Flexibility

The structure of a building is designed for a much higher service life than other components of the building. The ideal design anticipates possible future changes to a building and allows for flexibility. Waterfront Toronto is investigating revising their MGBR measure for long-term flexibility to include structural design, which minimizes or eliminates shear walls outside of the building core (stairs, elevators and mechanical shafts).

Currently the Toronto market favours small residential units. Beyond the building core, typical current condo unit design consists of shear walls which also function as demising walls between suites, limiting opportunities for horizontal expansion. WT noted that the intention behind the flexibility measure is to allow condo units with less than three bedrooms to be converted or combined with other suites without requiring structural modifications.

Figure 4.1-1: Sketches from Design Charrette



Structural Flexibility

The group discussed removing shear walls. It was noted that this leads to lateral load issues, which must then be addressed in another manner. In shorter buildings, the stair and elevator cores resist the entire lateral load. For taller buildings, it may be necessary to provide additional lateral resistance. The height at which a building requires additional lateral resistance depends on the form of the building, and the layout of the stair and elevator cores.

A point tower, having a square, “closed tube” central core can achieve 30 to 40 storeys without additional lateral resistance. By contrast, a bar type building in which all stair and elevator cores are aligned with the long axis may only be able to achieve less than 10 storeys without additional lateral resistance.

The additional lateral resistance could be provided in a number of different ways. The first option would be to provide shear walls at every second demising wall, rather than at every demising wall. This would allow the simple combination of two units to suit a future unit expansion.

A second option would be to provide shear walls with punched openings. These openings could be in-filled with a steel-stud or masonry panel to suit present design; and the infill panels could be easily removed to suit a future unit expansion.

A third option would be to provide beams and columns, connected together into moment frames. Such a system would provide the maximum opportunity for future flexibility, as they are entirely shear wall free, aside from the core elements. However, it should be noted that they are more expensive to build than shear wall buildings. They require greater structural floor depth than a slab-on-shear wall system, which results in greater ceiling depths, greater floor-to-floor heights, and increased cladding costs.

Change of Use

A study by the Cascadia Chapter of the Green Building Council (The Greenest Building: Quantifying the Environmental Value of Building Reuse) was cited which examines potential reductions to climate change from the retrofit and reuse of existing buildings. Using life cycle analysis, the study examined changes of use in terms of their carbon impacts. In most cases the retrofit and reuse in combination with increased energy efficiency measures made more sense than building new.

There is an associated cost of ensuring that a building is adaptable, particularly when discussing change of use. For example, a space designed to accommodate both industrial and residential space could lead to issues with respect to toxicity and ventilation rates.

The building could be divided for future use design compatibility:

- Podium – live, work, office (the proportions of the podium would support this)
- Ground level– live work
- Tower – live and office

The group concluded that the Flexibility measure should remain performance based rather than prescriptive.

Parking

Parking is one of the most costly components of condo design. Adding additional parking levels can have serious implications to a project’s pro-forma. If parking levels can be minimized, these costs could be applied to other components of the building design. Recently within the City, projects with excellent access to transit are being built with lower parking ratios (as low as 0.4 parking spaces per unit). Developers have also noted that demand for parking has gone down in developments within the downtown core.

This site has a very high water table, making parking levels increasingly costly to construct and will eventually have excellent access to light rail transit. This may allow parking ratios for the site to be quite low.

Affordability of Larger Units

Waterfront Toronto is encouraging family units within its unit mix ratios to persuade a wider mix of occupants.

It was noted that affordability is an issue with larger suites since purchasers pay a premium per square foot for suites above 1100 ft² making it potentially unaffordable. Condo maintenance fees can also make the move to a condo impractical, particularly for families.

Amenities can also play an important role in flexibility by providing services to residents that make living in the condo appropriate over time, e.g. affordable grocery stores help support daily living. In most condo buildings, amenity spaces are generally sized to the areas required by the City since increasing amenity space results in a decrease in saleable area (suites). How can the developers benefit by providing higher quality/more flexible amenity spaces that have long-term community benefits?

Maximizing Passive Strategies – Heating, Ventilation and Orientation

Buildings that rely too heavily on mechanical systems are at a disadvantage when exploring ideas of long term adaptability. Maximizing opportunities for passive heating, cooling and ventilation makes a building more resilient and adaptable to climate change and fluctuations in energy supply and cost. By making a building more resilient to these factors, it is inherently more flexible over time.

In typical condo design, buildings are oriented with the long axis in the north south orientation since it is difficult to market north facing windows. Passive design strategies would mean rotating the building 90 degrees with the long facades facing north and south to provide maximum opportunity for access to controllable daylight and heat.

The bar tower is a single loaded corridor which is oriented with the long dimension on the east west axis. The intent behind this design was to explore opportunities to maximize passive opportunities within the design. It was noted that by adding a circulation element to connect these corridors, the connecting element would work to centralize the building cores as well as increasing structural stiffness.

Though the design increases exposure to heat loss, the intent would be to minimize glazing on all faces but the south face and to super-insulate all non-suite walls and minimize glazing on these faces. Operable windows would be provided on both long faces to promote cross-ventilation within the suites.

South facing conditioned sunrooms are proposed in lieu of balconies to minimize thermal bridging as well as to provide opportunities to preheat air and access daylight. The intent would be to provide operable windows both to the exterior and between the sunroom and the suite.

The suites would be fitted with sunshades and ERVs for times when natural ventilation is not possible. The opportunity for all suites to face south where the sun angle is most controllable was also explored.

Zoning the building - Durability

If the mechanical/ electrical room can be built in the middle of the tower, it could improve efficiency and possibly house the building rainwater retrieval system.

Zoning the building and adding a mechanical room with solid wall midsection would stiffen the building and improve structural efficiency.

The cooling tower typically goes on the roof of the building. If the heavier systems are placed in parking level areas, this reduces parking space. Cisterns for rainwater harvesting are placed at the bottom. Zoning for energy or water usage may provide savings. Planning documents make assumptions about structural elements and restrictions in code and bylaws often limit design.

Windows

Operable windows create air infiltration issues, as well as durability issues. Insulated glazing units typically have a service life of 25 years.

Masonry or pre-cast with punched window provides adaptability over time since windows can be replaced and maintained on a unit-by-unit basis. Punched windows also provide options for moment frames around windows, minimizing shear walls and providing horizontal flexibility.

Glazing issues included the following:

- Centre of glass U-value does not fully describe the thermal performance of a window assembly – it must also include frame and spacer effects.
- Reduce window to wall ratio to less than 50%. Closer to 40% would be ideal. Less glazing area provides better energy performance.
- Use a number of smaller windows to reduce overall fenestration area, or reserve oversized glazing units for specific rooms.
- Less fenestration can be offset by more reflective finishes on ceiling to draw natural light deeper into the suite.
- A higher solar heat gain coefficient for fenestration results in improved passive gains.
- Punched windows have a lower frame to glass ratio and permit the use of frame materials having lower heat conductivity.
- Punched openings allow for easier replacement in future and are typically much less expensive than window wall. However, building envelope costs may go up depending on the selected cladding.
- Aluminum, thermally broken frames are more expensive than fiberglass and have a higher rate of heat loss. They must be used where combustible construction is not allowed.
- Focus on reducing thermal bridging. It is possible to improve the energy performance of a balcony if it is enclosed.

- Construct light wells for daylighting where possible.
- A curtain wall system also has durability issues over the long term and the cost to replace it is very expensive.
- Key durability issues include water vapour, airflow, and water penetration.

It was noted that if passive measures such as operable windows are provided to tenants, is important to educate tenants about how to take use these.

Building envelope commissioning

Mandatory building envelope commissioning or mandatory field review should be implemented. Statute limitations and cost issues could interfere with requiring this. LEED 2012 will require envelope commissioning. At the time of commissioning, the waterfront development may be using LEED 2012.

Because things get covered up as construction proceeds, it is necessary to do third party envelope reviews an average of once or twice per week and to include testing and reporting. With all of the durability issues currently in the press surrounding condo design, insurance companies may see the value in requiring this process. Costs would be roughly \$50,000 to \$60,000.

Window to wall ratio

Use the aesthetics of the Distillery District up to a certain height – favour materials that exist and the ratios that exist. Using that as a model up to a certain height could be done. This may be too prescriptive in terms of design. Aesthetic should not be constrained, and we do not want to force people to use specific materials.

- Window to wall ratio maximum is 40% if following the prescriptive path of the energy code.
- Effective and efficient window design is based on rhythm and grid.



5.0 Further Architectural Explorations

Both before and after the charrette, the architectural team led by Michelle Xuereb of Quadrangle Architects Limited continued to explore opportunities for potential energy savings inherent in architectural design. This section describes the process for the development of the two design options using energy savings as a catalyst. It should be noted here that the intent was to ensure that a similar density was achieved in both design options, and it was acknowledged that the floorplate efficiency of the bar tower layout would be lower than the point tower due to the increased circulation..

5.1 Purpose

The point in time at which decision makers (developers, designers, and planners) have the greatest opportunity to impact the energy usage of a building is at the concept design stage. A building's massing and orientation will impact its energy usage for as long as the building is standing and in use. Finding ways to increase the dialogue around massing and orientation in a way that promotes good decision making is key to improving long term energy performance.

There is a growing suite of tools at our disposal for testing the energy impacts of a building at the earliest design stages. Part of the exercise before, during, and after the charrette was to explore ways in which these tools could be used from schematic design through to compliance energy modeling, enabling good design decisions that consider energy impacts throughout the process.

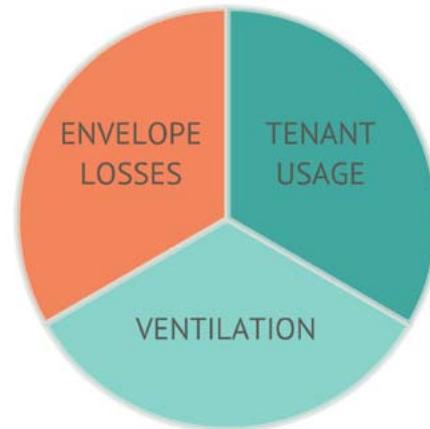
5.2 Design Considerations

5.2.1 Energy

The energy usage within a typical condo can be broken down into thirds:

- Envelope losses
- Tenant usage
- Ventilation

Figure 5.2-1: Energy Usage within a Typical Condo

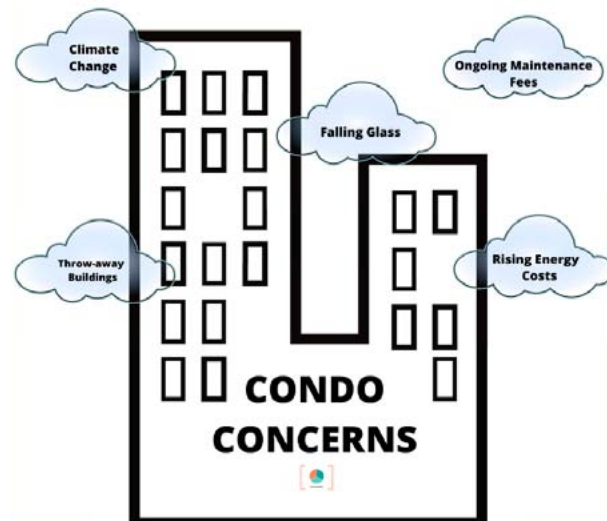


The design must consider all of these elements when setting out the massing and orientation of the building.

5.2.2 Other Condo Concerns

Other issues that were raised throughout the charrette were issues surrounding the current market, peripheral to code compliance, but significant to buyers.

Figure 5.2-2: Condo Concerns



These issues amounted to the creation of additional strategies to guide decision-making:

Figure 5.2-3 Additional Design Objectives for Condo Design



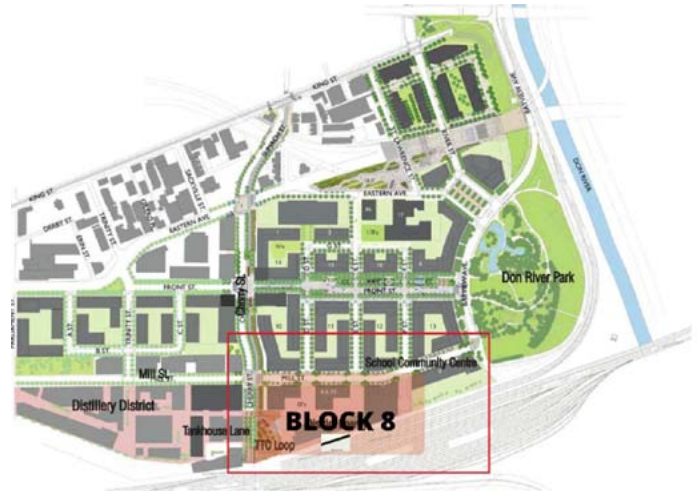
Combining the goal of maximizing net energy savings and the strategies to address other condo concerns, the team determined that the architectural design needed to maximize opportunities for passive design strategies. This could be done through both form and orientation.

5.3 The Site

- Block 8 is in the West Donlands directly south of the Panam residential village, currently under construction. This will bring several hundred new LEED® Gold certified units into the market, with the potential to shift buyers' focus more clearly onto environmental issues;
- The site is a continuation of the distillery district and has large open space zoned centrally to make this visual and physical pedestrian connection;
- The current zoning calls for podium bases which address the street and three point towers;
- The site is subject to a 30 meter railway setback directly to the south maximizing protected solar opportunities;

- In early discussions with Waterfront Toronto, it was determined that for the sake of the exercise, some deviations from the zoning envelope would be allowable in order to broaden the exploration of passive strategies.

Figure 5.3-1 The Site

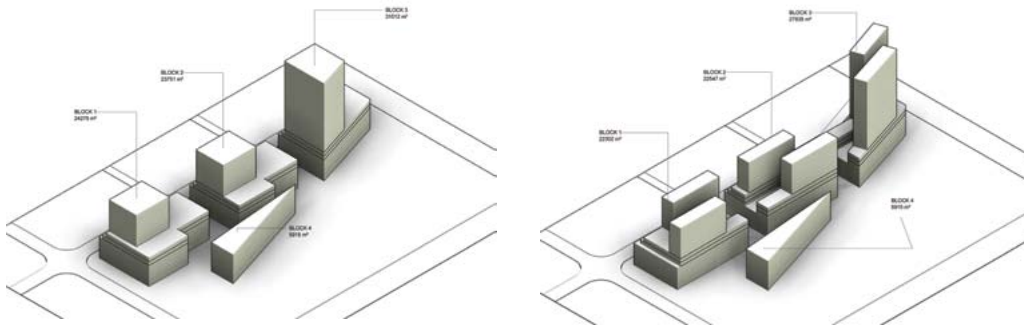


5.4 Preliminary Massing

Two massing models were created:

- The Point Tower Option is an as-of-right option which meets the zoning as laid out in the block plan. It is made up of standard 750 square meter point towers on podiums;
- The Bar Tower Option looks at whether the density of the site could be matched with a narrow floor plate. This option is a single loaded corridor that offers opportunities for controlled solar access, cross ventilation and reduced glazing.

Figure 5.4-1 Schematic Design Models - Point Tower and Bar Tower



In an “apples to apples” simulation within Green Building Studio, the first run showed that the bar tower option was 20% less efficient than the point tower. This made sense since both were modelled with 70% glazing and the bar tower has a larger area which resulted in a larger heat loss. The energy group then moved away from this option for the sake of the discussion within the charrette.

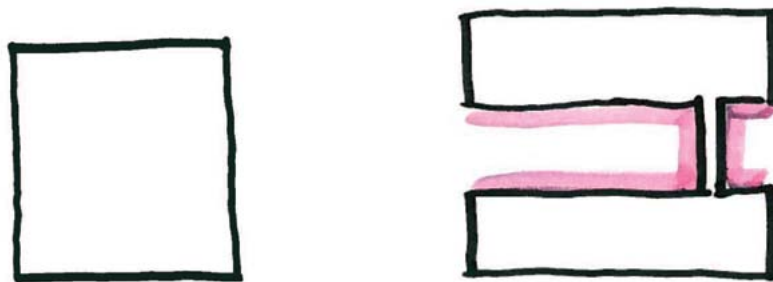
Seeing more opportunities for passive strategies as well as ways to address issues of durability, adaptability and flexibility discussed within the charrette, the bar tower design was further tweaked. The intent was to optimize the form and then compare it to the “as of right” point tower design with 70% glazing.

5.5 Explorations

5.5.1 Form

The main difference between the Point Tower's square design and the Bar Tower's double rectangular floor plate is the additional building envelope that is exposed to the elements and therefore subject to thermal gains and losses. This explains why the preliminary energy model showed a 20% benefit compared to the compact tower form.

Figure 5.5-1 Form, The Square versus The Narrow Bar

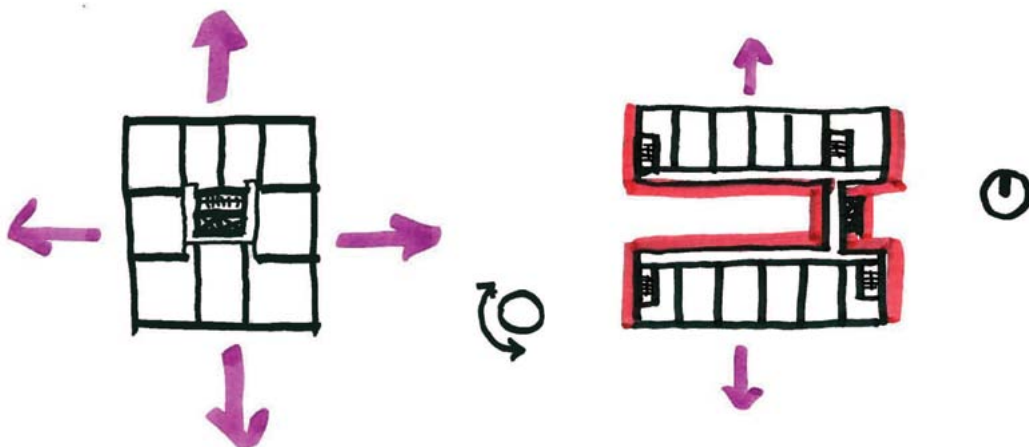


5.5.2 Orientation

To maximize opportunities for controlling daylighting and solar heat gains, glazing should be focused on the North or South faces.

Comparing the Point Tower's square plan to the Bar Tower's rectangular floor plate, the discussion focuses again on exposed building face. Layering on the suite layouts it is evident that in the square plan, each suite faces one or two directions. In this layout, the result is large expanses of glazing on all faces regardless of cardinal directions. The building could be turned in any direction and it would have the same impact since there is no hierarchy.

Figure 5.5-2 Orientation, The Square versus The Narrow Bar



Looking at the double bar tower, the units face only north or south. The intent was to minimize glazing on the east and west faces. This serves two purposes; it allows glazing to be focused on the north and south facades only where maximum solar thermal control is possible. It also allows the addition of another material of a higher R-value on the other faces. This material could be a more thermally resistant, durable rain screen system rather than window/wall, making it easier to maintain over time. Achieving an average glazing ratio around 40% glazing for the overall building is possible with this approach.

One of the issues that was raised out of this was the notion that people are not interested in north facing units, so we started looking to tweak the design by shifting.

Figure 5.5-3 Orientation, The Square versus The Shifted Bar



5.5.3 Ventilation

In this next design iteration, the team has shifted the bar towers relative to each others, allowing for the opportunity to provide entirely south facing units. Now all suites have optimum access to controllable solar heat gain and daylighting.

Figure 5.5-4 Ventilation in the Narrow Bar



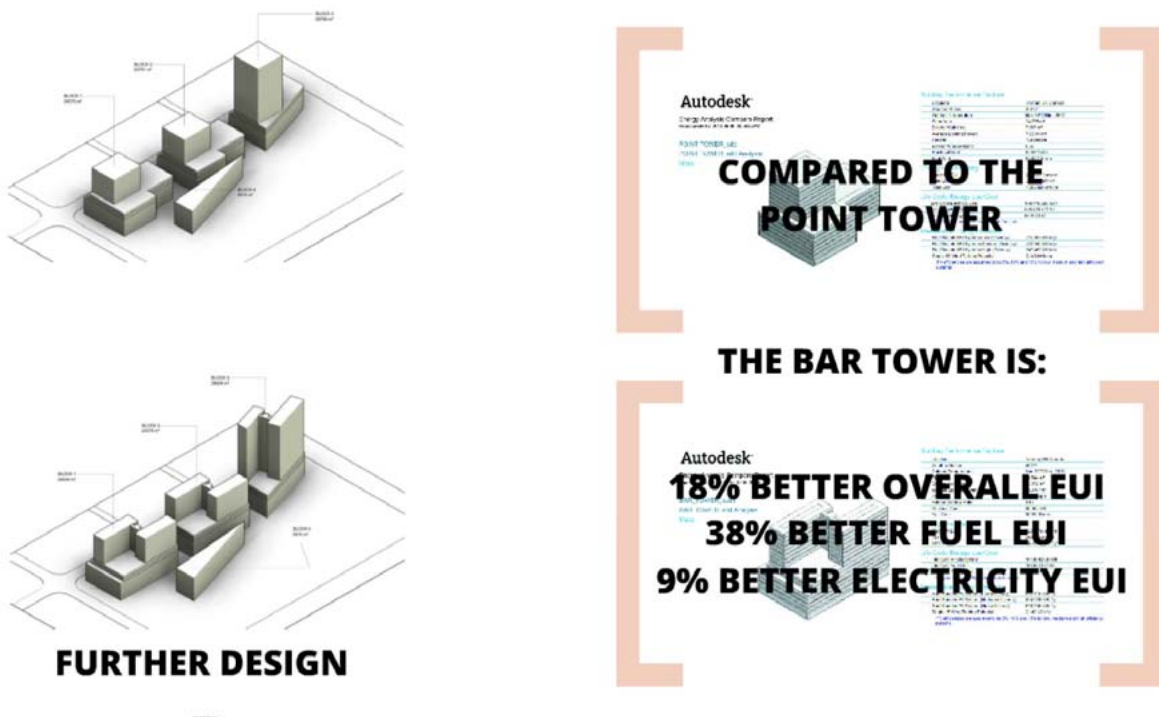
Recalling that energy usage is made up in equal thirds by envelope losses, tenant usage, and ventilation, the single loaded corridor design offers opportunities to increase reduce thermal losses through super insulation while also providing the opportunity to provide through-ventilation. Offering passive design elements to tenants provides opportunities for these buildings to be less reliant on mechanical systems making them inherently more resilient in the face of rising energy costs and rolling power outages. Engaging the tenants in an education programs that empowers them in how to maximize their success with these systems is also encouraged.

Recalling Waterfront Toronto's desires to maximize horizontal flexibility, the team then looked at a combination of shear walls and columns for the construction.

Following these deeper discussions, the architectural team revisited the bar tower design and worked with Autodesk to provide more accurate modelling data. The model was retested using Green Building Studio software with the following upgrades to the building envelope:

- 20% glazing on the north, east and west faces,
- High R value continuous insulation on the opaque walls within the north, east, and west faces.

Figure 5.5-5 Results of Further Energy Analysis of the Point Tower compared to the Revised Bar Tower Design



Drastically different results flowed from this comparative analysis. In the energy simulation run during the charrette, the bar tower was 20% less efficient than the point tower. The post-charrette analysis indicated the bar tower could realize an

18% lower overall EUI, 38% better fuel EUI and a 9% improvement in electricity EUI. It should be noted that this improvement was made solely based on the envelope changes. No mechanical design changes were made to make up for the passive offsets.

6.0 Overarching Conclusion

The process of energy efficient and green design should be collaborative, involving a range of experts and future occupants as the earliest stages of design.

With rising energy prices and condo maintenance fees, buyers are becoming savvier about issues of ongoing costs. This will drive the industry towards a culture of accountability.

We cannot isolate the discussion of energy usage in condominium design from the other real issues of adaptability, durability, and flexibility. Holistic consideration of these aspects will lead to more inspired design which supports passive solutions. This in turn will create a building stock with a longer lifecycle and communities that are more resilient to issues of climate change.

Figure 6.0-1 Making Better Buildings

