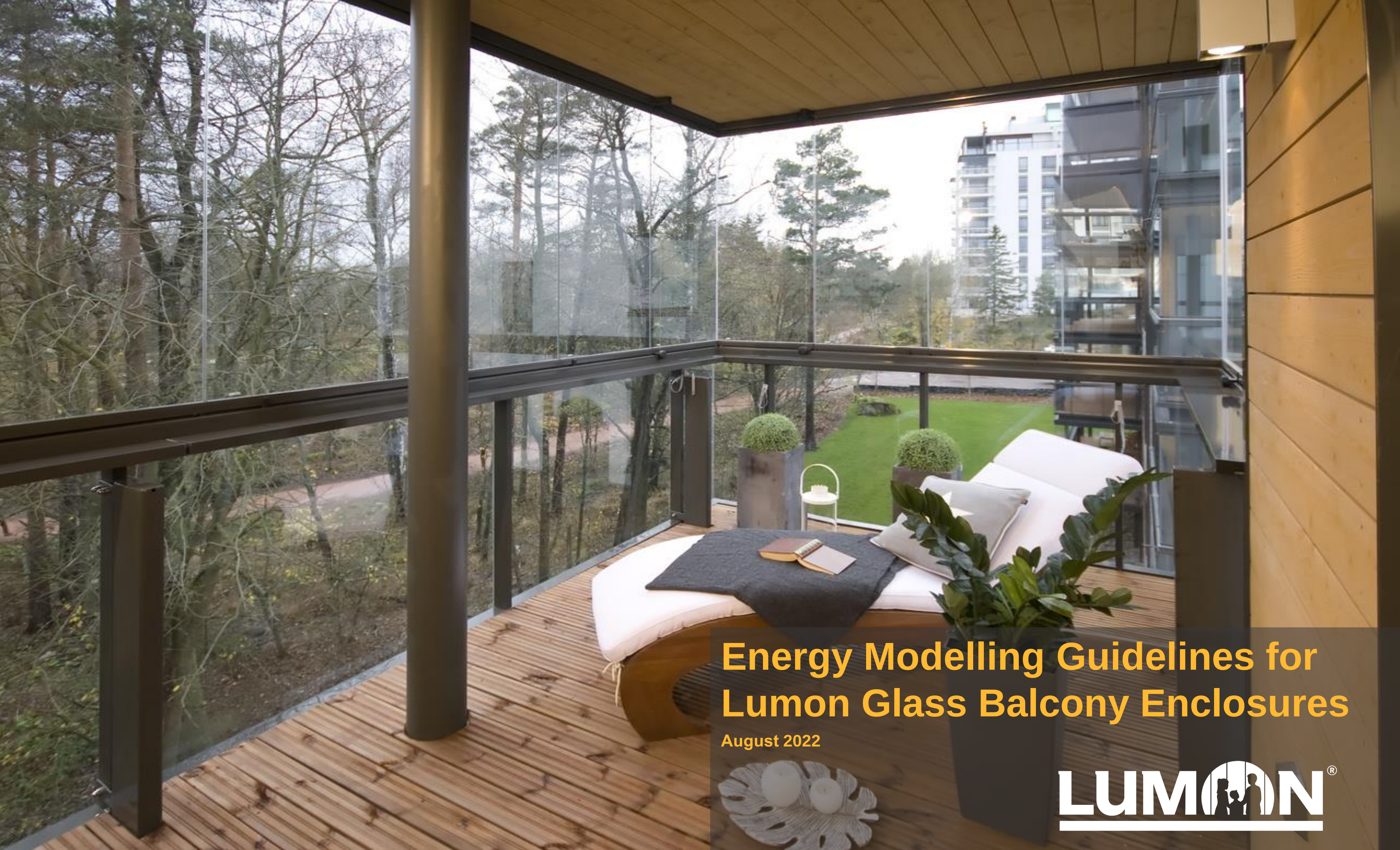
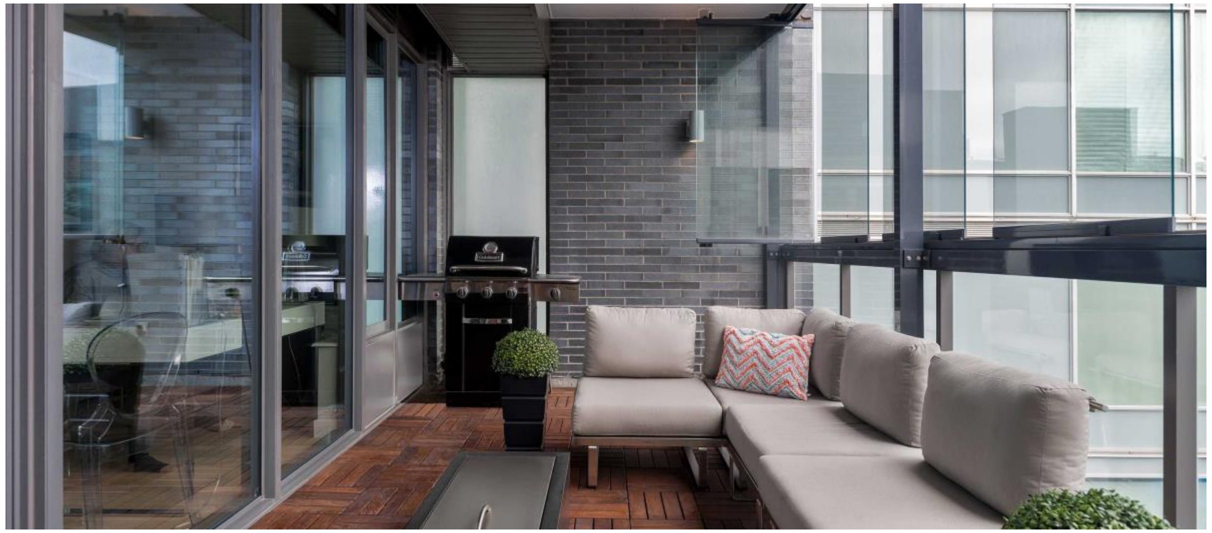


Energy Modelling Guidelines for Lumon Glass Balcony Enclosures

August 2022



An enclosed balcony provide numerous benefits, and serves as a passive buffer zone that enhances the thermal performance of the adjoining suite. This document focuses on the thermal performance of glass balcony enclosures, however, it is important to recognize that many of the additional benefits, such as enhanced comfort and habitability, may not be easily quantified.

Energy Modelling Guidelines for Lumon Glass Balcony Enclosures

Prepared on behalf of Lumon Canada by:
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DISCLAIMER

This document is intended to provide guidance to energy modelling professionals and regulatory authorities in order to assess the thermal performance benefits associated with glass balcony enclosures. All of the thermal performance modelling assessments presented herein were conducted by the author in accordance with building performance simulation best practices. Users of these guidelines remain professionally responsible for performing all of their own work and exercising due diligence in accordance with requirements prescribed by codes, standards and/or the authority having jurisdiction. Neither the author nor Lumon Canada assume any responsibility for consequential loss, errors or omissions resulting from the information contained herein.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the collegial assistance of Lumon Canada for providing technical specifications of their glass balcony enclosures, along with a number of technical studies conducted in the past for various aspects of enclosed balcony performance. Special thanks to my energy modeller colleagues who so generously volunteered their time to review and comment on these guidelines.

ABOUT THE AUTHOR

Ted Kesik is a professor of building science in the John H. Daniels Faculty of Architecture, Landscape and Design at the University of Toronto with a career focus on the integration of professional practice, research and teaching. He entered the construction industry in 1974 and has since gained extensive experience in various aspects of building enclosure design, energy modelling, quality assurance, commissioning, performance verification, and building systems integration. Professor Kesik's research and professional interests include resilience, sustainability, durability, high performance buildings, life cycle assessment and building performance simulation. His current research involves the development of design guidelines for low-carbon buildings that are resilient, sustainable and promote climate change adaptation. Professor Kesik served on the board of directors for the Canadian chapter of the International Building Performance Simulation Association (IBPSA Canada) from 2002 to 2022. In September 2019, he was inducted as an IBPSA Fellow at the International Building Performance Simulation Association's Building Simulation conference in Rome, Italy. Dr. Kesik continues to practice as a consulting engineer to leading architectural offices, forward thinking enterprises and progressive government agencies. He remains actively involved in technical organizations and is the author of numerous books, studies, reports and articles related to his areas of research and professional practice.

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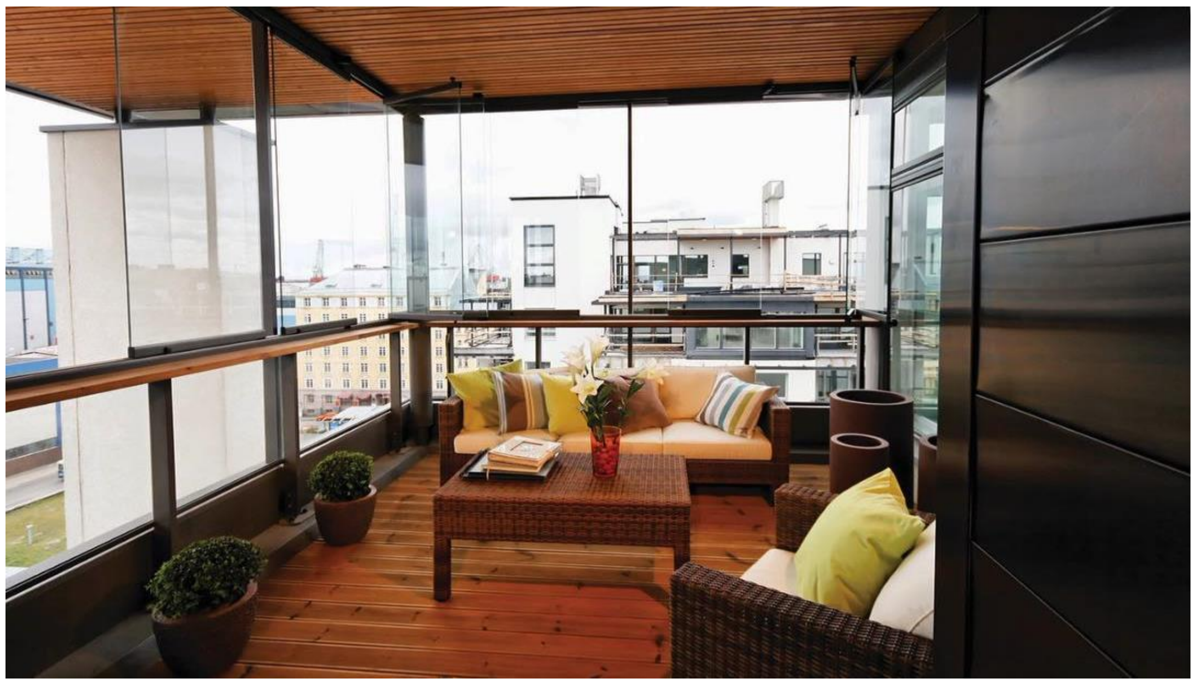


Balcony enclosures provide access to views, light and air within a safe, comfortable space and represent one of the least expensive ways to expand the size and quality of apartment suites in a way that saves energy.

Executive Summary

This technical report presents a time efficient and cost effective methodology for assessing the energy performance enhancements provided by Lumon balcony enclosures during the early stages of design. It is based on the performance requirements currently set out in Version 4, Tier 1 of the Toronto Green Standard (TGS). The energy modelling software used in the example modelling application is IESVE Version 2021.4.0.0, and it is used to assess a typical condominium suite situated in Toronto, Ontario. The energy modelling considers two cases: 1) an open balcony as typically provided on new condominium projects; and 2) an enclosed balcony featuring the Lumon glazing system. Four principal solar orientations are considered along with two window-to-wall ratios (WWRs) of 40% and 80% to capture the full range of fenestration sizing. The contribution of enclosed balconies to enhanced energy performance is compared to TGS performance targets as summarized below.

Toronto Green Standard Version 4 Tier 1 Targets	
TEUI (kWh/m2.yr)	**135**
TEDI (kWh/m2.yr)	**50**
GHGI (kg CO_{2e}/m2.yr)	**15**

40% WWR Summary of Performance

The average reduction in the three key TGS performance metrics is about 15% for the 40% WWR case, where the thermal insulation and window R-values for the base case open balcony option are near the minimum level needed for compliance. The average reduction in TEDI is most significant at 31% compared to an open balcony.

Average - 40% WWR	**Open Balcony**	**Enclosed Balcony**	**Savings**
TEUI (kWh/m2.yr)	114.1	101.3	11%
TEDI (kWh/m2.yr)	41.6	28.5	31%
GHGI (kg CO_{2e}/m2.yr)	10.7	10.3	4%

80% WWR Summary of Performance

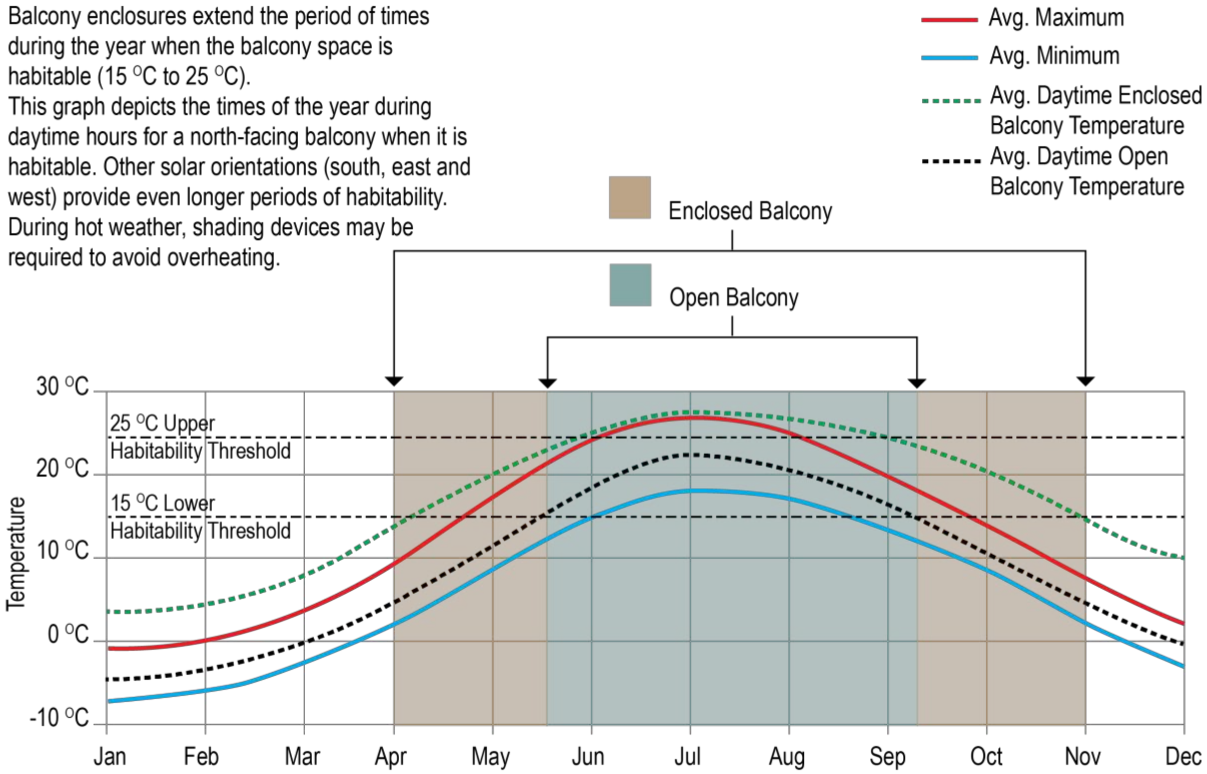
The average reduction in the three key TGS performance metrics is also about 15% for the 80% WWR case, where the thermal insulation and window R-values for the base case open balcony option are near the minimum level needed for compliance. The average reduction in TEDI is 29% compared to an open balcony.

Average - 80% WWR	**Open Balcony**	**Enclosed Balcony**	**Savings**
TEUI (kWh/m2.yr)	121.7	107.9	11%
TEDI (kWh/m2.yr)	45.9	32.4	29%
GHGI (kg CO_{2e}/m2.yr)	10.9	10.5	4%

Based on simulation results obtained by using this methodology, Lumon balcony enclosures are shown to be an effective means of complying with TGS performance targets. They represent feasible alternatives to increased levels of thermal insulation, envelope airtightness and window performance exceeding conventional practices currently applied to Toronto condominium building projects. Balcony enclosures also provide a high margin of flexibility to accommodate design changes to the enclosure without compromising compliance with TGS Version 4, Tier 1 performance targets. They are especially effective in reducing the thermal energy demand intensity for borderline building enclosures.

Background

Balconies are important in multi-unit residential buildings because they provide a connection between the indoors and outdoors without requiring direct access to an adjoining green space. But in cold climates like Canada, open balconies are often uncomfortable and unusable due to cold, wind and driving rain. Balcony enclosures provide an affordable means of achieving safe and comfortable balconies, both for new and existing apartment suites.



Average minimum and maximum monthly temperatures, Toronto, Ontario Canada

Glass enclosures moderate the balcony environment to extend habitability beyond the summer months to provide comfortable conditions during much of the spring and fall. Overheating in summer is avoided by opening the operable windows to ventilate the balcony area, while in winter the enclosed balcony acts as a buffer space that helps retain solar gains.

Balcony Enclosure Benefits

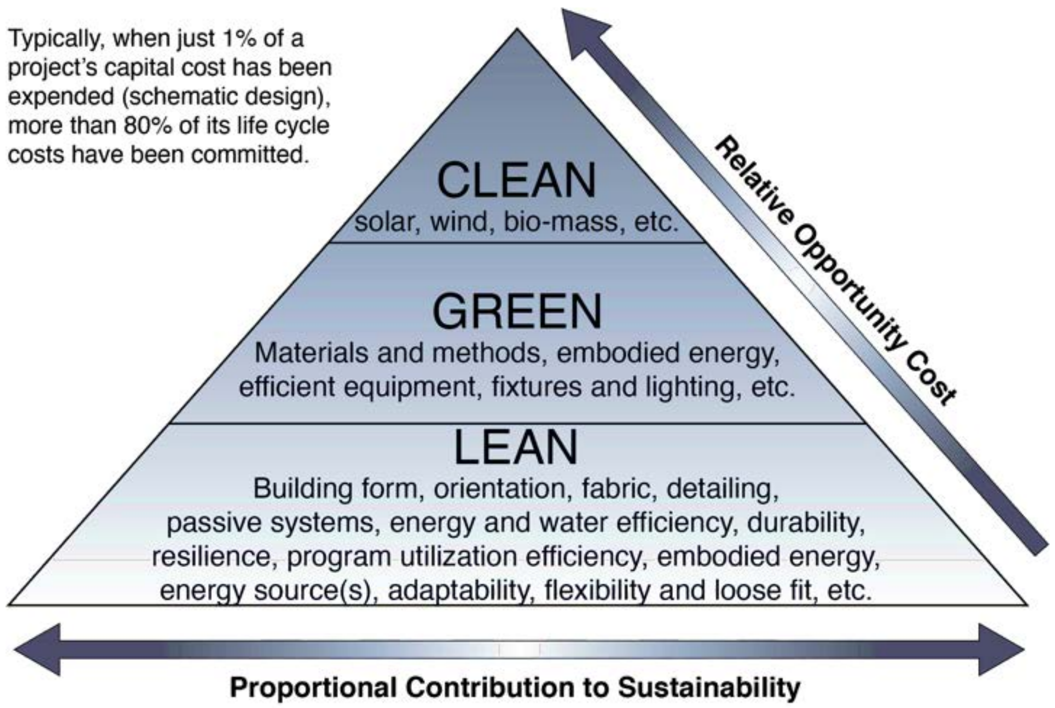
There are many benefits associated with balcony enclosures that go beyond better energy efficiency. Most importantly, balcony enclosures permit inhabitants to adjust their operable glazing so that they can choose between an open balcony and a fully enclosed balcony and anywhere in between.

- Enclosed balconies provide a buffer between inside and outside and moderate heat transfers.
- In winter, a fully enclosed balcony with the operable glazing closed provides better comfort and energy savings for the indoor space.
- In summer, partially open glazing, along with shading devices such as blinds, combine for a comfortable balcony and indoor space, saving on space cooling energy.
- Unlike open air balconies, an enclosed balcony with variably operable windows and shading devices can be fine tuned by occupants to perfectly suit their comfort preferences.
- During rainy and/or windy weather, unlike open balconies, an enclosed balcony can still be enjoyed as a moderated indoor environment.
- Unwanted noise from traffic and aircraft is largely dampened by balcony enclosures.
- Enclosed balconies provide enhanced thermal resilience and help maintain habitable indoor temperatures during power outages that coincide with cold weather events.
- Enhanced security is provided by balcony enclosures that create a safer environment for children and pets.
- Balcony enclosures protect against wind borne projectiles caused by extreme wind events.
- The durability of balconies is enhanced because balcony enclosures provide protection against the elements and exposure to natural forces that deteriorate building elements.
- Enclosed balconies reduce the risk of fire spreading from adjoining units.

An enclosed balcony can serve as a wintergarden in which hardy plants may continue to thrive while also protecting the balcony and its furnishings from the elements.

Overview

Enclosed balconies represent passive systems in buildings that can be adjusted to suit the needs of their inhabitants. They do not require any external inputs of energy to deliver performance in terms of energy efficiency and comfort. Unlike active systems, such as heating, cooling and ventilation equipment, that do not function when there is a power outage, balcony enclosures continue to deliver all of their benefits all of the time.



Balcony enclosures represent cost effective means of enhancing the sustainability of buildings because they are passive systems that do not require any energy inputs to moderate the indoor climate. They provide numerous benefits on a year-round basis and continue to function during power outages and extreme weather events.

From a sustainability perspective when taking into account the life cycle of buildings, investments in lean technologies are far more cost effective than those devoted towards green and clean technologies. The emerging building design thinking supports the view that buildings should be as passive as possible with active systems only playing a supplementary role to the minimum extent possible. Not only does this approach make buildings more energy efficient, but it also makes them more affordable in the long run while providing enhanced comfort and thermal resilience.

Thermal Resilience

Due to climate change there is now a sharp increase in the frequency and intensity of extreme weather events that can endanger inhabitants of buildings with poor thermal resilience. During extreme cold weather events accompanied by extended power outages, may residents have had to abandon their buildings because they quickly became to cold to inhabit. Balcony enclosures positively contribute towards two indicators of thermal resilience: passive habitability; and thermal autonomy.

Passive Habitability

Passive Habitability (PH) is a measure of the duration of time that an indoor space remains habitable following a prolonged power outage coinciding with an extended period of extreme weather.

Thermal Autonomy

Thermal Autonomy (TA) -is a measure of the fraction of time during a year that a building can passively maintain comfort conditions without active system energy inputs.

Balcony enclosures act as a buffer between indoors and outdoors reducing the rate of heat transfer. During cold weather, the apartment suite will require less heating energy input and in the event of a power outage, it will stay habitable much longer.

This reduction in heat transfer also increases the thermal autonomy of a building so that it represents a lesser burden on energy infrastructure since its energy demand have decreased. Downsized equipment and the capacities of energy supplies may provide significant avoided costs for a building project, but also to the energy grid's infrastructure.

In this guidelines document, the focus is on energy efficiency and how balcony enclosures can help contribute to compliance with energy code performance targets. But it is important to appreciate that a full accounting of the benefits, avoided costs and marketing benefits associated with balcony enclosures will yield a different assessment than looking at the cost effectiveness of energy savings alone.

Thermal resilience has not been incorporated into building codes and standards even though its importance is widely acknowledged. This does not prevent users of this guideline to conduct the assessment of thermal resilience in order to capture all the thermal performance benefits associated with balcony enclosures.

LUMON®

General Energy Modelling Methodology

This guidance document primarily focuses on balcony enclosures for new building projects, but the general methodology is applicable to existing buildings that are retrofit with balcony enclosures. It is assumed that users of this document are knowledgeable energy modellers familiar with conducting simulations for the purposes of code compliance. As such, these guidelines will only focus on how to model balcony enclosures as part of an energy modelling exercise for an entire building.

General Methodology

This general methodology applies to new buildings but may be easily adapted to existing buildings.

For new buildings, developers and designers are obliged to comply with energy efficiency requirements in applicable codes and standards within their jurisdiction. Typically, this requires a whole building energy model to be developed and run to ensure mandatory energy performance targets are satisfied. At this point, the addition of glass balcony enclosures may be considered in order to assess their contribution to enhanced energy performance. It is important to note that it is not necessary to assess the performance benefits of balcony enclosures by applying them to the entire building energy model. A separate energy model for a typical suite is a far more efficient way to investigate balcony enclosure performance enhancements.

In existing buildings, balcony enclosures are usually considered as a part of a comprehensive retrofit program for the building where a number of energy conservation measures are assessed for their feasibility and cost effectiveness. For such situations, a whole building energy model that incorporates all typical energy conservation measures may be developed. But the assessment of balcony enclosures only needs to be conducted for a typical suite after a package of conventional energy conservation measures has been decided, similar to what is done in new building projects. This approach can also be deployed where only balcony enclosures are being considered for an existing building where no other retrofits are contemplated, or that has had prior retrofit measures applied.

The key to economically and efficiently assessing the energy performance of balcony enclosures is to examine a typical case in a given building, and then if the indications are favourable, to extend this to a whole building energy model.

This guideline is solely intended to promote the proper energy modelling of enclosed balconies, above and beyond performance simulations used for code compliance purposes. It is aimed at providing an economical and efficient means of assessing the thermal benefits of balcony enclosures for buildings.

Step-by-Step Guide

This step-by-step guide will be followed by an example application. It is assumed that in the vast majority of cases, this methodology will be applied to multi-unit residential buildings with balconies.

1. For new buildings, establish a baseline case for a suite with an unenclosed balcony that complies with applicable energy code requirements. (Note: It is advisable to model the worst-case scenario, typically a north facing suite with the highest exposed wall area and window-to-wall ratio in the proposed building.) For existing buildings, the in-situ condition of a typical suite with an unenclosed balcony should be used as the basis of assessment.

2. For each solar orientation (e.g., north, south, east, west), energy model the typical suite with an open balcony and obtain key energy performance metrics such as energy use intensity (EUI), thermal energy demand intensity (TEDI) and greenhouse gas intensity (GHGI). Peak heating load energy demand may also be of interest if a new space heating system is being contemplated. These constitute the baseline cases.

3. Apply the proposed balcony enclosure in a subsequent energy model and run the revised energy model for each of the building face solar orientations.

4. Analyze and summarize energy performance benefits according to key metrics required by the authority having jurisdiction (e.g., Toronto Green Standard or BC Energy Step Code). Optionally, conduct a sensitivity analysis to identify potential tradeoffs between energy conservation measures that are associated with the energy performance benefits afforded by balcony enclosures.

5. If balcony enclosures are selected for the building project, then extend the typical balcony enclosure models to the entire building energy model as required. Proceed with code compliance modelling as per usual.

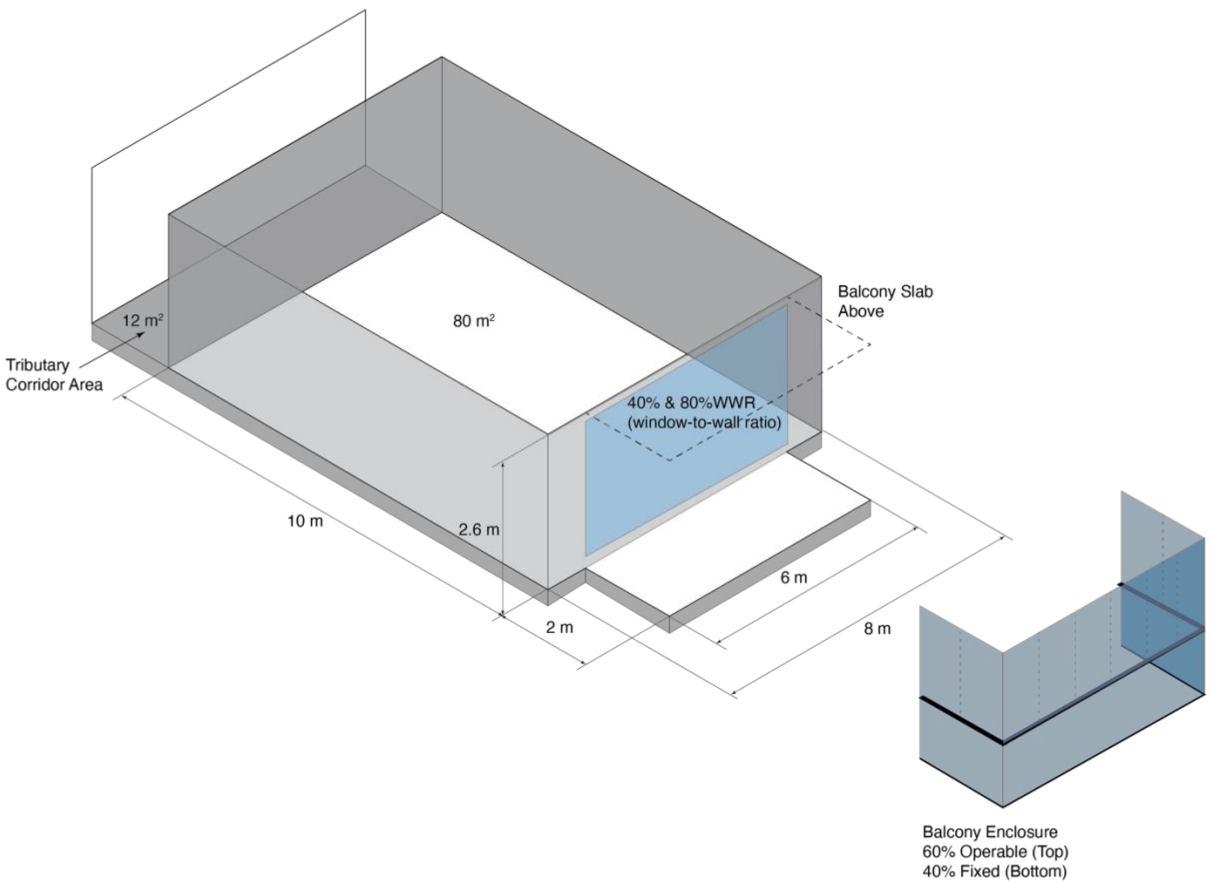
Modelling Protocols

Several critical modelling protocols are necessary to observe when applying these guidelines in practice. First, the baseline case must accurately reflect what would normally be constructed or presently exists (e.g., opaque balcony guards, etc.). For existing buildings, reasonable estimates of enclosure thermal properties and airtightness must be applied. Second, for the enclosed balcony case it must be assumed the balcony enclosure is fully shut during the heating season and fully open during the cooling season. Occupants may use the enclosures differently, but this assumption helps gauge the full potential benefits of balcony enclosures. Third, all energy modelling best practices should be observed, such as the inclusion of thermal bridging at balcony slabs.

The example that follows considers the energy performance benefits associated with a balcony enclosure in a new condominium building project.

Example Modelling Application

This example is based on typical condominium suite situated in Toronto, Ontario. The energy performance of the condominium must comply with Version 4, Tier 1 of the Toronto Green Standard (TGS). The energy modelling for this example has been conducted using IESVE Version 2021.4.0.0 whole building performance simulation software. Other approved software, such as EnergyPlus, may also be used to assess the performance of balcony enclosures. Check with the authority having jurisdiction for a list of acceptable software for compliance modelling purposes.



Schematic of example energy model for a typical condominium suite indicating suite dimensions, window-to-wall ratio for glazed façade and size of balcony. Note that the tributary corridor area assigned to the suite that must be included in the energy modelling of the suite.

This example begins with an 80 m^2 suite which has a 6 m by 2 m open balcony featuring a glass guard (not shown). Based on a typical double loaded corridor with a shared elevator lobby, the tributary area of the hallway corridor has been estimated to be 12 m^2 – thus the total conditioned floor area for energy modelling purposes is 92 m^2, however different ventilation rates and heating systems apply to each for the calculation of TEUI and TEDI.

In order to attempt to satisfy TGS v4 Tier 1 targets (EUI 135, TEDI 50, GHGI 15) for all orientations, the following data were input to the energy model for the base case suite having an open balcony: Glazing U-Value 2.1 $W/m^2.K$, SHGC 0.35; Exterior opaque wall effective RSI 0.88 (R-5); Electric boilers for the suite; Make-up air unit (MAU) for corridors uses a gas furnace; DX cooling for both suite and corridors; Outdoor air for suite is 25 L/s (50 CFM), corridor tributary area 12.5 L/s (25 CFM); air leakage is 0.25 $L/(s.m^2.fac)$ as required by TGS modelling guidelines.

For the unconditioned enclosed balcony space, Lumon provides the following properties: the U-Value of the glazing is 5.6 $W/m^2.K$; SHGC 0.78 (clear glazing). The balcony enclosure 60% operable glazing is modelled as fully open during summer (May-September) and closed for the remainder of the year. Since the balcony zone is modelled as a void without no internal gains and air conditioning, air leakage is not defined for the balcony – instead a default value for a leaky enclosure is input to the model. area, but IES assumes it quite leaky (I need to search more if we are looking for a certain value here).

Thermal bridging for the external surface of the suite must be considered for both the opaque and glazed exterior wall area, including the effect of the balcony slab, to arrive at an accurate effective thermal resistance value.

In order to fully assess the performance of the balcony enclosure, 8 cases were simulated for the four cardinal solar orientations and two window-to-wall ratios – 40% and 80%. It is important to note that since the assessment of the balcony enclosure performance is most likely to take place during the early stages of design, sufficient latitude must be afforded to the designer/developer in terms of window-to-wall ratio.

Balcony enclosures can contribute to improving the energy efficiency of the whole building in order to more easily comply with performance targets set out in energy codes.

Another issue to consider is the contribution of the balcony enclosure to the compliance of the building with energy codes. In some cases, the balcony enclosure will help a conventional building enclosure system comply with a higher performance standard such that little upgrading of standard practices is warranted. In other cases, the balcony enclosure can significantly enhance the performance of a building enclosure system that already complies with applicable energy codes. One question that arises is: should every suite individually comply with performance targets, or should only the average of the suite/balcony solar orientations comply? This remains more of a marketing issue than a building science question.

This photo depicts a Lumon balcony enclosure that matches the type used for this example modelling application. Only the operable glazing units have air spaces between each unit – the lower fixed glazing is effectively sealed and continuous.

Energy Modelling Assumptions

The energy modelling assumptions for balcony enclosures are related to the energy modelling conventions used within a particular authority having jurisdiction. Code requirements for minimum levels of energy efficiency will drive many of the assumptions used to model energy performance.

In this example, a typical condominium building located in Toronto, Ontario has been selected. Based on the current regulatory requirements this building must comply with Tier 1 of Version 4 of the Toronto Green Standard. Specifically, it must satisfy the following performance targets:

Toronto Green Standard Version 4 Tier 1 Targets

Thermal Energy Use Intensity - TEUI (kWh/m^2·yr)	135
Thermal Energy Demand Intensity - TEDI (kWh/m^2.yr)	50
Green House Gas Intensity - GHGI (kg CO_{2e}/m^2.yr)	15

Typical Condominium Suite

Based on typical characteristics for condominium buildings designed to comply with Tier 1, Version 4 of the Toronto Green Standard, the following assumptions were used in the energy modelling.

R-value of opaque wall	0.88 m^2.K/W
U-value of Glazing	2.1 W/m^2.K
Solar Heat Gain Coefficient (SHGC)	0.35
Ventilation	Suite - 25 L/s (50 CFM) Corridor - 12.5 L/s (25 CFM)
Air Leakage	0.25 L/(s.m^2.fac)
Space Heating	Suite - electric boilers Corridors – gas-fired MAUs
Space Cooling	Minimum efficiency DX cooling for both suite and corridors
Important Note: Effective U-values and R-values accounting for thermal bridging effects must be used in energy models.	

Lumon Glass Enclosure Properties

U-value of Glass	5.6 W/m^2.K
Solar Heat Gain Coefficient (SHGC)	0.77
Air Leakage Area	4 mm gap around each operable unit
Operable Units	6 units each 1.6 m height by 0.75 m width + 4 units each 1.6 m height by 1.0 m width (60% of enclosure area)
Fixed Lower Units	1 m height (40% of enclosure area)
The balcony enclosure 60% operable glazing is modelled as fully open during summer (May-September) and closed for the remainder of the year.	

Emission Factors

Targets for the greenhouse gas emissions vary from jurisdiction to jurisdiction. In this example, emission factors prescribed in the Toronto Green Standard and supplements to the Ontario Building Code were used. Check with the local authority having jurisdiction to obtain correct emission factors.

In this example, it was assumed the building facades coincided with the four cardinal solar orientations. The actual solar orientations for a particular project should be used as applicable. For the performance results summarized on the next page, energy simulations for 8 cases of unenclosed and enclosed balconies were conducted for the four cardinal solar orientations and two window-to-wall ratios – 40% and 80%. This yielded for a total of 16 cases – 8 for unenclosed balconies and 8 for enclosed balconies. The results were also averaged across the 4 solar orientations. Complete results for the simulations are available in Appendix A.

Summary of Performance Assessments

A summary of the performance results in relation to the Toronto Green Standard targets are indicated below, for both the 40% WWR and 80% WWR cases.

Toronto Green Standard Version 4 Tier 1 Targets	
TEUI (kWh/m2.yr)	**135**
TEDI (kWh/m2.yr)	**50**
GHGI (kg CO_{2e}/m2.yr)	**15**

40% WWR Summary of Performance

South - 40% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	110.6	98.5	11%
TEDI (kWh/m2.yr)	38.6	25.5	34%
GHGI (kg CO_{2e}/m2.yr)	10.6	10.2	3%

West - 40% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	115.0	102.3	11%
TEDI (kWh/m2.yr)	41.9	28.8	31%
GHGI (kg CO_{2e}/m2.yr)	10.7	10.4	4%

North - 40% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	116.0	102.6	12%
TEDI (kWh/m2.yr)	44.3	31.3	29%
GHGI (kg CO_{2e}/m2.yr)	10.8	10.4	4%

East - 40% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	114.8	101.7	11%
TEDI (kWh/m2.yr)	41.7	28.5	32%
GHGI (kg CO_{2e}/m2.yr)	10.7	10.3	4%

Average - 40% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	114.1	101.3	11%
TEDI (kWh/m2.yr)	41.6	28.5	31%
GHGI (kg CO_{2e}/m2.yr)	10.7	10.3	4%

80% WWR Summary of Performance

South - 80% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	117.3	105.8	10%
TEDI (kWh/m2.yr)	41.7	29.2	30%
GHGI (kg CO_{2e}/m2.yr)	10.8	10.5	3%

West - 80% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	123.7	109.6	11%
TEDI (kWh/m2.yr)	46.4	32.7	29%
GHGI (kg CO_{2e}/m2.yr)	11.0	10.6	4%

North - 80% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	122.8	107.8	12%
TEDI (kWh/m2.yr)	49.6	35.5	28%
GHGI (kg CO_{2e}/m2.yr)	11.0	10.5	4%

East - 80% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	123.1	108.3	12%
TEDI (kWh/m2.yr)	45.9	32.2	30%
GHGI (kg CO_{2e}/m2.yr)	11.0	10.5	4%

Average - 80% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	121.7	107.9	11%
TEDI (kWh/m2.yr)	45.9	32.4	29%
GHGI (kg CO_{2e}/m2.yr)	10.9	10.5	4%

In both the 40% and 80% WWR cases, balcony enclosures provide significant savings for the TEUI, TEDI and GHGI performance metrics. It is important to note that without balcony enclosures, the typical condominium enclosure system with unenclosed balconies would not satisfy the TGS targets in all cases, hence upgrades to the building envelope would be necessary. However, with the addition of enclosed balconies, all the targets for the entire range of window-to-wall ratios are satisfied. This example reinforces the energy efficiency design flexibility that is afforded by balcony enclosures.

Refer to Appendix A for detailed results from this energy modelling example.

Modelling of Existing Buildings

Most of the process for modelling the addition of balcony enclosures to existing buildings is the same as that employed for new buildings. However, the existing enclosure and HVAC systems must be carefully assessed in order to arrive at an accurate estimate of the performance enhancement resulting from balcony enclosures, as well as any other energy conservation measures. Normally, the base case energy model is calibrated so that it predicts the actual performance of the existing building with reasonable accuracy. This requires that the annual energy bills are analyzed and the actual weather data for the corresponding year are used in the energy model. Any additional energy conservation measures may also be included in the energy model for the retrofit cases under consideration. Usually, an optimal combination of measures is revealed in this process.

This existing multi-unit residential building has unenclosed balconies and is beginning to show signs of and aging façade. It is a candidate for a comprehensive retrofit to address updating of its appearance and performance.

As noted previously in this guideline, the energy benefits are not always the primary consideration associated with balcony enclosures. The appeal and marketability of a retrofit building can yield higher rents and lower vacancy rates. Deterioration of the balcony slabs can also be better avoided since wetting and freeze/thaw cycles are greatly minimized. However, since a number of incentives for energy conservation measures are offered in numerous jurisdictions, it is important to properly assess the full extent of energy benefits provided by balcony enclosures.

The retrofit building now features an updated façade and enclosed balconies that will improve energy efficiency, comfort and durability.

Synopsis

Building performance simulation software that is now widely available can accurately model the contribution to thermal performance improvements provided by enclosed balconies. Since most jurisdiction today require compliance with increasingly stringent performance targets in energy codes, it makes sense to incorporate the assessment of balcony enclosures at the early stages of design to optimize compliance.

For millennia, the addition of a buffer space to the outside of buildings has been recognized to provide numerous benefits and while many of these cannot be captured by building performance simulation software, these are highly valued not only by inhabitants of multi-unit residential buildings, but also by their owners and investors.

This guideline focuses on an accurate and efficient means of energy modelling for balcony enclosures only, hence issues related to cost-benefit analysis remain beyond the scope of this publication. However, it is noteworthy that if the only benefits afforded by balcony enclosures were energy savings, then they might not support a convincing business case. However, when the improvements to thermal resilience and balcony durability are viewed from a life cycle perspective, their value is more fully appreciated. Countless building projects have incorporated balcony enclosures for such good reasons.

Balcony enclosures address the weak links in highly glazed apartment buildings to balance aesthetics, comfort and occupant wellbeing with environmentally responsible performance.

Key Points

- Balcony enclosures significantly enhance the thermal performance of the adjoining suites they serve and extend the habitability of the balcony area.
- Proper energy modelling at the early stages of design can reveal the thermal benefits of balcony enclosures and their contribution to achieving energy code performance targets.
- By observing energy modelling guidelines set out in applicable energy codes and working with simplified schematics of typical suites, assessments of the potential benefits of balcony enclosures can be conducted efficiently and economically.
- The enhancement of thermal performance provided by balcony enclosures should be balanced with all their other benefits in order to arrive at a holistic assessment of their true value proposition.

Appendix A

Energy Modelling Results for Example Balcony Enclosure - Toronto ON

40% WWR – South & West

South - 40% WWR - Open Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.8379	0.226	0.6119	0	0.0009	0.0001	0.0378	0.0363	0	0	
Feb 01-28	0.0818	0.0651	0.6845	0.1854	0.4991	0	0.0025	0.0002	0.0341	0.0318	0	0	
Mar 01-31	0.0912	0.0723	0.5316	0.1468	0.3848	0	0.0031	0.0002	0.0378	0.0289	0	0	
Apr 01-30	0.0881	0.0699	0.2689	0.0692	0.1997	0	0.0043	0.0003	0.0366	0.0205	0	0	
May 01-31	0.0898	0.0719	0.0786	0.0183	0.0603	0	0.0306	0.002	0.0378	0.0138	0	0	
Jun 01-30	0.0881	0.0699	0.007	0.0008	0.0063	0	0.066	0.0042	0.0366	0.0148	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.112	0.0072	0.0378	0.0205	0	0	
Aug 01-31	0.0904	0.0721	0.0001	0.0001	0	0	0.0914	0.0058	0.0378	0.0171	0	0	
Sep 01-30	0.0881	0.0699	0.0197	0.0041	0.0156	0	0.0461	0.0029	0.0366	0.0116	0	0	
Oct 01-31	0.0898	0.0719	0.1722	0.0399	0.1322	0	0.025	0.0016	0.0378	0.0193	0	0	
Nov 01-30	0.0881	0.0699	0.3351	0.0889	0.2462	0	0.0095	0.0006	0.0366	0.0238	0	0	
Dec 01-31	0.0912	0.0723	0.7084	0.1818	0.5265	0	0.0018	0.0001	0.0378	0.0337	0	0	
Total	1.0669	0.8492	3.6439	0.9613	2.6825	3.48	0.3932	0.0251	0.4452	0.2722	0	0	10.1756
												Area	92
												TEUI	110.6043
													kWh/m^2.yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.8153
Feb 01-28	0	0.666
Mar 01-31	0	0.5169
Apr 01-30	0	0.262
May 01-31	0	0.0767
Jun 01-30	0	0.007
Jul 01-31	0	0
Aug 01-31	0	0
Sep 01-30	0	0.0193
Oct 01-31	0	0.1682
Nov 01-30	0	0.3262
Dec 01-31	0	0.6902
Total	0	3.5477
	Area	92
	TEDI	38.56195652
		kWh/m^2.yr

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	5.7343	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.97526983
	Area	92
	GHGI	10.600759
		kg CO_{2e}/m2.yr

South - 40% WWR - Enclosed Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.6034	0.226	0.3774	0	0.0036	0.0002	0.0378	0.0257	0	0	
Feb 01-28	0.0818	0.0651	0.4789	0.1854	0.2935	0	0.0064	0.0004	0.0341	0.0219	0	0	
Mar 01-31	0.0912	0.0723	0.3397	0.1468	0.1929	0	0.0093	0.0006	0.0378	0.0175	0	0	
Apr 01-30	0.0881	0.0699	0.1524	0.0692	0.0832	0	0.0166	0.0011	0.0366	0.0123	0	0	
May 01-31	0.0898	0.0719	0.033	0.0183	0.0147	0	0.0457	0.0029	0.0378	0.0107	0	0	
Jun 01-30	0.0881	0.0699	0.0008	0.0008	0	0	0.085	0.0054	0.0366	0.0153	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.1324	0.0085	0.0378	0.0213	0	0	
Aug 01-31	0.0904	0.0721	0.0001	0.0001	0	0	0.121	0.0077	0.0378	0.0205	0	0	
Sep 01-30	0.0881	0.0699	0.007	0.0041	0.0029	0	0.069	0.0044	0.0366	0.0139	0	0	
Oct 01-31	0.0898	0.0719	0.1	0.0399	0.0601	0	0.0321	0.002	0.0378	0.0138	0	0	
Nov 01-30	0.0881	0.0699	0.2175	0.0889	0.1286	0	0.0131	0.0008	0.0366	0.0159	0	0	
Dec 01-31	0.0912	0.0723	0.5062	0.1818	0.3243	0	0.0034	0.0002	0.0378	0.0235	0	0	
Total	1.0669	0.8492	2.4389	0.9613	1.4776	3.48	0.5377	0.0343	0.4452	0.2122	0	0	9.0644
												Area	92
												TEUI	98.52609
													kWh/m^2.yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.5808
Feb 01-28	0	0.4604
Mar 01-31	0	0.325
Apr 01-30	0	0.1455
May 01-31	0	0.0312
Jun 01-30	0	0.0007
Jul 01-31	0	0
Aug 01-31	0	0
Sep 01-30	0	0.0066
Oct 01-31	0	0.096
Nov 01-30	0	0.2086
Dec 01-31	0	0.488
Total	0	2.3428
	Area	92
	TEDI	25.46521739
		kWh/m^2.yr

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	4.6231	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.94193383
	Area	92
	GHGI	10.2384112
		kg CO_{2e}/m2.yr

West - 40% WWR - Open Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.9363	0.226	0.7103	0	0	0	0.0378	0.0395	0	0	
Feb 01-28	0.0818	0.0651	0.7497	0.1854	0.5642	0	0.0006	0	0.0341	0.0334	0	0	
Mar 01-31	0.0912	0.0723	0.5499	0.1468	0.4031	0	0.0029	0.0002	0.0378	0.0278	0	0	
Apr 01-30	0.0881	0.0699	0.2568	0.0692	0.1876	0	0.0089	0.0006	0.0366	0.019	0	0	
May 01-31	0.0898	0.0719	0.0678	0.0183	0.0495	0	0.0444	0.0028	0.0378	0.0156	0	0	
Jun 01-30	0.0881	0.0699	0.0035	0.0008	0.0027	0	0.087	0.0056	0.0366	0.0175	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.1383	0.0088	0.0378	0.0246	0	0	
Aug 01-31	0.0904	0.0721	0.0001	0.0001	0	0	0.1166	0.0074	0.0378	0.0212	0	0	
Sep 01-30	0.0881	0.0699	0.0229	0.0041	0.0188	0	0.0492	0.0031	0.0366	0.0125	0	0	
Oct 01-31	0.0898	0.0719	0.1915	0.0399	0.1516	0	0.0138	0.0009	0.0378	0.0195	0	0	
Nov 01-30	0.0881	0.0699	0.3888	0.0889	0.3	0	0.0006	0	0.0366	0.0258	0	0	
Dec 01-31	0.0912	0.0723	0.7838	0.1818	0.6019	0	0	0	0.0378	0.0361	0	0	
Total	1.0669	0.8492	3.951	0.9613	2.9896	3.48	0.4623	0.0295	0.4452	0.2924	0	0	10.5764
												Area	92
												TEUI	114.9609
													kWh/m^2.yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.9137
Feb 01-28	0	0.7311
Mar 01-31	0	0.5352
Apr 01-30	0	0.2499
May 01-31	0	0.066
Jun 01-30	0	0.0034
Jul 01-31	0	0
Aug 01-31	0	0
Sep 01-30	0	0.0225
Oct 01-31	0	0.1875
Nov 01-30	0	0.3799
Dec 01-31	0	0.7656
Total	0	3.8548
	Area	92
	TEDI	41.9
		kWh/m^2.yr

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	6.1351	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.98729383
	Area	92
	GHGI	10.7314547
		kg CO_{2e}/m2.yr

West - 40% WWR - Enclosed Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.6899	0.226	0.4639	0	0.0001	0	0.0378	0.0303	0	0	
Feb 01-28	0.0818	0.0651	0.5397	0.1854	0.3542	0	0.0012	0.0001	0.0341	0.0244	0	0	
Mar 01-31	0.0912	0.0723	0.3771	0.1468	0.2303	0	0.0061	0.0004	0.0378	0.0196	0	0	
Apr 01-30	0.0881	0.0699	0.1602	0.0692	0.091	0	0.0165	0.0011	0.0366	0.0144	0	0	
May 01-31	0.0898	0.0719	0.0318	0.0183	0.0135	0	0.0556	0.0035	0.0378	0.0132	0	0	
Jun 01-30	0.0881	0.0699	0.0008	0.0008	0	0	0.1019	0.0065	0.0366	0.0196	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.1471	0.0094	0.0378	0.0252	0	0	
Aug 01-31	0.0904	0.0721	0.0001	0.0001	0	0	0.131	0.0084	0.0378	0.024	0	0	
Sep 01-30	0.0881	0.0699	0.0088	0.0041	0.0047	0	0.0639	0.0041	0.0366	0.0143	0	0	
Oct 01-31	0.0898	0.0719	0.114	0.0399	0.0741	0	0.0179	0.0011	0.0378	0.0139	0	0	
Nov 01-30	0.0881	0.0699	0.2572	0.0889	0.1683	0	0.0022	0.0001	0.0366	0.0182	0	0	
Dec 01-31	0.0912	0.0723	0.5683	0.1818	0.3864	0	0	0	0.0378	0.0278	0	0	
Total	1.0669	0.8492	2.7477	0.9613	1.7864	3.48	0.5434	0.0347	0.4452	0.2448	0	0	9.4119
												Area	92
												TEUI	102.3033
													kWh/m^2.yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.6673
Feb 01-28	0	0.5211
Mar 01-31	0	0.3624
Apr 01-30	0	0.1533
May 01-31	0	0.03
Jun 01-30	0	0.0007
Jul 01-31	0	0
Aug 01-31	0	0
Sep 01-30	0	0.0084
Oct 01-31	0	0.11
Nov 01-30	0	0.2483
Dec 01-31	0	0.5501
Total	0	2.6516
	Area	92
	TEDI	28.82173913
		kWh/m^2.yr

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	4.9706	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.95235883
	Area	92
	GHGI	10.3517264
		kg CO_{2e}/m2.yr

40% WWR – North & East

North - 40% WWR - Open Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.9638	0.226	0.7378	0	0	0	0.0378	0.0403	0	0	
Feb 01-28	0.0818	0.0651	0.7882	0.1854	0.6028	0	0	0	0.0341	0.0346	0	0	
Mar 01-31	0.0912	0.0723	0.6069	0.1468	0.4601	0	0.0003	0	0.0378	0.0316	0	0	
Apr 01-30	0.0881	0.0699	0.2827	0.0692	0.2135	0	0.0038	0.0002	0.0366	0.0213	0	0	
May 01-31	0.0898	0.0719	0.0769	0.0183	0.0586	0	0.0291	0.0019	0.0378	0.0134	0	0	
Jun 01-30	0.0881	0.0699	0.0056	0.0008	0.0049	0	0.0669	0.0043	0.0366	0.015	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.1124	0.0072	0.0378	0.0208	0	0	
Aug 01-31	0.0904	0.0721	0.0008	0.0001	0.0007	0	0.0894	0.0057	0.0378	0.0172	0	0	
Sep 01-30	0.0881	0.0699	0.0256	0.0041	0.0215	0	0.0347	0.0022	0.0366	0.0103	0	0	
Oct 01-31	0.0898	0.0719	0.2032	0.0399	0.1633	0	0.0075	0.0005	0.0378	0.0202	0	0	
Nov 01-30	0.0881	0.0699	0.4159	0.0889	0.327	0	0.0001	0	0.0366	0.0284	0	0	
Dec 01-31	0.0912	0.0723	0.8057	0.1818	0.6239	0	0	0	0.0378	0.0366	0	0	
Total	1.0669	0.8492	4.1754	0.9613	3.2141	3.48	0.3443	0.022	0.4452	0.2897	0	0	10.6727
												Area	92
												TEUI	116.0076
													kWh/m².yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.9412
Feb 01-28	0	0.7697
Mar 01-31	0	0.5922
Apr 01-30	0	0.2758
May 01-31	0	0.0751
Jun 01-30	0	0.0056
Jul 01-31	0	0
Aug 01-31	0	0.0008
Sep 01-30	0	0.0252
Oct 01-31	0	0.1992
Nov 01-30	0	0.407
Dec 01-31	0	0.7876
Total	0	4.0793
	Area	92
	TEDI	44.34021739
		kWh/m².yr

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	6.2314	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.99018283
	Area	92
	GHGI	10.7628568
		kg CO_{2e}/m2.yr

North - 40% WWR - Enclosed Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.7223	0.226	0.4963	0	0	0	0.0378	0.0279	0	0	
Feb 01-28	0.0818	0.0651	0.5824	0.1854	0.3969	0	0.0001	0	0.0341	0.024	0	0	
Mar 01-31	0.0912	0.0723	0.4328	0.1468	0.286	0	0.0004	0	0.0378	0.0205	0	0	
Apr 01-30	0.0881	0.0699	0.183	0.0692	0.1137	0	0.0045	0.0003	0.0366	0.0125	0	0	
May 01-31	0.0898	0.0719	0.0325	0.0183	0.0142	0	0.033	0.0021	0.0378	0.0082	0	0	
Jun 01-30	0.0881	0.0699	0.0008	0.0008	0	0	0.0797	0.0051	0.0366	0.0147	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.123	0.0079	0.0378	0.0197	0	0	
Aug 01-31	0.0904	0.0721	0.0001	0.0001	0	0	0.0987	0.0063	0.0378	0.0169	0	0	
Sep 01-30	0.0881	0.0699	0.0109	0.0041	0.0068	0	0.0408	0.0026	0.0366	0.009	0	0	
Oct 01-31	0.0898	0.0719	0.1273	0.0399	0.0873	0	0.0085	0.0005	0.0378	0.0122	0	0	
Nov 01-30	0.0881	0.0699	0.2858	0.0889	0.1969	0	0.0004	0	0.0366	0.0188	0	0	
Dec 01-31	0.0912	0.0723	0.5946	0.1818	0.4128	0	0	0	0.0378	0.0254	0	0	
Total	1.0669	0.8492	2.9723	0.9613	2.011	3.48	0.3891	0.0248	0.4452	0.2096	0	0	9.4371
												Area	92
												TEUI	102.5772
													kWh/m².yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.6997
Feb 01-28	0	0.5638
Mar 01-31	0	0.4182
Apr 01-30	0	0.176
May 01-31	0	0.0307
Jun 01-30	0	0.0007
Jul 01-31	0	0
Aug 01-31	0	0
Sep 01-30	0	0.0105
Oct 01-31	0	0.1233
Nov 01-30	0	0.2769
Dec 01-31	0	0.5764
Total	0	2.8762
	Area	92
	TEDI	31.26304348
		kWh/m².yr

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	4.9958	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.95311483
	Area	92
	GHGI	10.3599438
		kg CO_{2e}/m2.yr

East- 40% WWR - Open Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.9364	0.226	0.7104	0	0	0	0.0378	0.0405	0	0	
Feb 01-28	0.0818	0.0651	0.7514	0.1854	0.5659	0	0.0001	0	0.0341	0.0348	0	0	
Mar 01-31	0.0912	0.0723	0.5568	0.1468	0.41	0	0.0008	0	0.0378	0.0314	0	0	
Apr 01-30	0.0881	0.0699	0.2377	0.0692	0.1685	0	0.0087	0.0006	0.0366	0.0192	0	0	
May 01-31	0.0898	0.0719	0.0578	0.0183	0.0395	0	0.0439	0.0028	0.0378	0.0163	0	0	
Jun 01-30	0.0881	0.0699	0.0041	0.0008	0.0033	0	0.0822	0.0052	0.0366	0.0178	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.1335	0.0085	0.0378	0.0241	0	0	
Aug 01-31	0.0904	0.0721	0.0001	0.0001	0	0	0.1115	0.0071	0.0378	0.0208	0	0	
Sep 01-30	0.0881	0.0699	0.0183	0.0041	0.0142	0	0.0509	0.0032	0.0366	0.0141	0	0	
Oct 01-31	0.0898	0.0719	0.1838	0.0399	0.1438	0	0.0151	0.001	0.0378	0.0218	0	0	
Nov 01-30	0.0881	0.0699	0.3945	0.0889	0.3056	0	0.0003	0	0.0366	0.0299	0	0	
Dec 01-31	0.0912	0.0723	0.7917	0.1818	0.6098	0	0	0	0.0378	0.0377	0	0	
Total	1.0669	0.8492	3.9324	0.9613	2.9711	3.48	0.4468	0.0285	0.4452	0.3084	0	0	10.5574
												Area	92
												TEUI	114.7543
													kWh/m².yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.9138
Feb 01-28	0	0.7328
Mar 01-31	0	0.5422
Apr 01-30	0	0.2308
May 01-31	0	0.056
Jun 01-30	0	0.004
Jul 01-31	0	0
Aug 01-31	0	0
Sep 01-30	0	0.0179
Oct 01-31	0	0.1798
Nov 01-30	0	0.3856
Dec 01-31	0	0.7735
Total	0	3.8363
	Area	92
	TEDI	41.69891304
		kWh/m².yr

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	6.1161	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.98672383
	Area	92
	GHGI	10.725259
		kg CO_{2e}/m2.yr

East- 40% WWR -Enclosed Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.6885	0.226	0.4625	0	0.0001	0	0.0378	0.0315	0	0	
Feb 01-28	0.0818	0.0651	0.5354	0.1854	0.35	0	0.0002	0	0.0341	0.0275	0	0	
Mar 01-31	0.0912	0.0723	0.3747	0.1468	0.2279	0	0.0037	0.0002	0.0378	0.0229	0	0	
Apr 01-30	0.0881	0.0699	0.1501	0.0692	0.0809	0	0.0194	0.0012	0.0366	0.0153	0	0	
May 01-31	0.0898	0.0719	0.0268	0.0183	0.0085	0	0.0524	0.0033	0.0378	0.0132	0	0	
Jun 01-30	0.0881	0.0699	0.0008	0.0008	0	0	0.0909	0.0058	0.0366	0.0179	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.1407	0.009	0.0378	0.0242	0	0	
Aug 01-31	0.0904	0.0721	0.0001	0.0001	0	0	0.1209	0.0077	0.0378	0.0217	0	0	
Sep 01-30	0.0881	0.0699	0.0075	0.0041	0.0034	0	0.0606	0.0039	0.0366	0.0144	0	0	
Oct 01-31	0.0898	0.0719	0.1074	0.0399	0.0675	0	0.018	0.0012	0.0378	0.0147	0	0	
Nov 01-30	0.0881	0.0699	0.254	0.0889	0.1652	0	0.0009	0.0001	0.0366	0.0227	0	0	
Dec 01-31	0.0912	0.0723	0.5745	0.1818	0.3927	0	0	0	0.0378	0.0297	0	0	
Total	1.0669	0.8492	2.7198	0.9613	1.7585	3.48	0.5078	0.0324	0.4452	0.2556	0	0	9.3569
												Area	92
												TEUI	101.7054
													kWh/m².yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.6659
Feb 01-28	0	0.5169
Mar 01-31	0	0.36
Apr 01-30	0	0.1432
May 01-31	0	0.025
Jun 01-30	0	0.0007
Jul 01-31	0	0
Aug 01-31	0	0
Sep 01-30	0	0.0071
Oct 01-31	0	0.1034
Nov 01-30	0	0.2451
Dec 01-31	0	0.5563
Total	0	2.6237
	Area	92
	TEDI	28.51847826
		kWh/m².yr

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	4.9156	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.95070883
	Area	92
	GHGI	10.3337916
		kg CO_{2e}/m2.yr

PERFORMANCE SUMMARY

South - 40% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	110.6	98.5	11%
TEDI (kWh/m2.yr)	38.6	25.5	34%
GHGI (kg CO_{2e}/m2.yr)	10.6	10.2	3%

West - 40% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	115.0	102.3	11%
TEDI (kWh/m2.yr)	41.9	28.8	31%
GHGI (kg CO_{2e}/m2.yr)	10.7	10.4	4%

North - 40% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	116.0	102.6	12%
TEDI (kWh/m2.yr)	44.3	31.3	29%
GHGI (kg CO_{2e}/m2.yr)	10.8	10.4	4%

East - 40% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	114.8	101.7	11%
TEDI (kWh/m2.yr)	41.7	28.5	32%
GHGI (kg CO_{2e}/m2.yr)	10.7	10.3	4%

Average - 40% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	114.1	101.3	11%
TEDI (kWh/m2.yr)	41.6	28.5	31%
GHGI (kg CO_{2e}/m2.yr)	10.7	10.3	4%

Toronto Green Standard Version 4 Tier 1 Targets	
TEUI (kWh/m2.yr)	**135**
TEDI (kWh/m2.yr)	**50**
GHGI (kg CO_{2e}/m2.yr)	**15**

80% WWR – South & West

South - 40% WWR - Open Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.8379	0.226	0.6119	0	0.0009	0.0001	0.0378	0.0363	0	0	
Feb 01-28	0.0818	0.0651	0.6845	0.1854	0.4991	0	0.0025	0.0002	0.0341	0.0318	0	0	
Mar 01-31	0.0912	0.0723	0.5316	0.1468	0.3848	0	0.0031	0.0002	0.0378	0.0289	0	0	
Apr 01-30	0.0881	0.0699	0.2689	0.0692	0.1997	0	0.0043	0.0003	0.0366	0.0205	0	0	
May 01-31	0.0898	0.0719	0.0786	0.0183	0.0603	0	0.0306	0.002	0.0378	0.0138	0	0	
Jun 01-30	0.0881	0.0699	0.007	0.0008	0.0063	0	0.066	0.0042	0.0366	0.0148	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.112	0.0072	0.0378	0.0205	0	0	
Aug 01-31	0.0904	0.0721	0.0001	0.0001	0	0	0.0914	0.0058	0.0378	0.0171	0	0	
Sep 01-30	0.0881	0.0699	0.0197	0.0041	0.0156	0	0.0461	0.0029	0.0366	0.0116	0	0	
Oct 01-31	0.0898	0.0719	0.1722	0.0399	0.1322	0	0.025	0.0016	0.0378	0.0193	0	0	
Nov 01-30	0.0881	0.0699	0.3351	0.0889	0.2462	0	0.0095	0.0006	0.0366	0.0238	0	0	
Dec 01-31	0.0912	0.0723	0.7084	0.1818	0.5265	0	0.0018	0.0001	0.0378	0.0337	0	0	
Total	1.0669	0.8492	3.6439	0.9613	2.6825	3.48	0.3932	0.0251	0.4452	0.2722	0	0	10.1756
												Area	92
												TEUI	110.6043
													kWh/m².yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.8153
Feb 01-28	0	0.666
Mar 01-31	0	0.5169
Apr 01-30	0	0.262
May 01-31	0	0.0767
Jun 01-30	0	0.007
Jul 01-31	0	0
Aug 01-31	0	0
Sep 01-30	0	0.0193
Oct 01-31	0	0.1682
Nov 01-30	0	0.3262
Dec 01-31	0	0.6902
Total	0	3.5477
	Area	92
	TEDI	38.56195652
	kWh/m².yr	

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	5.7343	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.97526983
Area		92
GHGI		10.600759
		kg CO_{2e}/m2.yr

South - 40% WWR - Enclosed Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.6034	0.226	0.3774	0	0.0036	0.0002	0.0378	0.0257	0	0	
Feb 01-28	0.0818	0.0651	0.4789	0.1854	0.2935	0	0.0064	0.0004	0.0341	0.0219	0	0	
Mar 01-31	0.0912	0.0723	0.3397	0.1468	0.1929	0	0.0093	0.0006	0.0378	0.0175	0	0	
Apr 01-30	0.0881	0.0699	0.1524	0.0692	0.0832	0	0.0166	0.0011	0.0366	0.0123	0	0	
May 01-31	0.0898	0.0719	0.033	0.0183	0.0147	0	0.0457	0.0029	0.0378	0.0107	0	0	
Jun 01-30	0.0881	0.0699	0.0008	0.0008	0	0	0.085	0.0054	0.0366	0.0153	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.1324	0.0085	0.0378	0.0213	0	0	
Aug 01-31	0.0904	0.0721	0.0001	0.0001	0	0	0.121	0.0077	0.0378	0.0205	0	0	
Sep 01-30	0.0881	0.0699	0.007	0.0041	0.0029	0	0.069	0.0044	0.0366	0.0139	0	0	
Oct 01-31	0.0898	0.0719	0.1	0.0399	0.0601	0	0.0321	0.002	0.0378	0.0138	0	0	
Nov 01-30	0.0881	0.0699	0.2175	0.0889	0.1286	0	0.0131	0.0008	0.0366	0.0159	0	0	
Dec 01-31	0.0912	0.0723	0.5062	0.1818	0.3243	0	0.0034	0.0002	0.0378	0.0235	0	0	
Total	1.0669	0.8492	2.4389	0.9613	1.4776	3.48	0.5377	0.0343	0.4452	0.2122	0	0	9.0644
												Area	92
												TEUI	98.52609
													kWh/m².yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.5808
Feb 01-28	0	0.4604
Mar 01-31	0	0.325
Apr 01-30	0	0.1455
May 01-31	0	0.0312
Jun 01-30	0	0.0007
Jul 01-31	0	0
Aug 01-31	0	0
Sep 01-30	0	0.0066
Oct 01-31	0	0.096
Nov 01-30	0	0.2086
Dec 01-31	0	0.488
Total	0	2.3428
	Area	92
	TEDI	25.46521739
	kWh/m².yr	

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	4.6231	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.94193383
Area		92
GHGI		10.2384112
		kg CO_{2e}/m2.yr

West - 40% WWR - Open Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.9363	0.226	0.7103	0	0	0	0.0378	0.0395	0	0	
Feb 01-28	0.0818	0.0651	0.7497	0.1854	0.5642	0	0.0006	0	0.0341	0.0334	0	0	
Mar 01-31	0.0912	0.0723	0.5499	0.1468	0.4031	0	0.0029	0.0002	0.0378	0.0278	0	0	
Apr 01-30	0.0881	0.0699	0.2568	0.0692	0.1876	0	0.0089	0.0006	0.0366	0.019	0	0	
May 01-31	0.0898	0.0719	0.0678	0.0183	0.0495	0	0.0444	0.0028	0.0378	0.0156	0	0	
Jun 01-30	0.0881	0.0699	0.0035	0.0008	0.0027	0	0.087	0.0056	0.0366	0.0175	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.1383	0.0088	0.0378	0.0246	0	0	
Aug 01-31	0.0904	0.0721	0.0001	0.0001	0	0	0.1166	0.0074	0.0378	0.0212	0	0	
Sep 01-30	0.0881	0.0699	0.0229	0.0041	0.0188	0	0.0492	0.0031	0.0366	0.0125	0	0	
Oct 01-31	0.0898	0.0719	0.1915	0.0399	0.1516	0	0.0138	0.0009	0.0378	0.0195	0	0	
Nov 01-30	0.0881	0.0699	0.3888	0.0889	0.3	0	0.0006	0	0.0366	0.0258	0	0	
Dec 01-31	0.0912	0.0723	0.7838	0.1818	0.6019	0	0	0	0.0378	0.0361	0	0	
Total	1.0669	0.8492	3.951	0.9613	2.9896	3.48	0.4623	0.0295	0.4452	0.2924	0	0	10.5764
												Area	92
												TEUI	114.9609
													kWh/m².yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.9137
Feb 01-28	0	0.7311
Mar 01-31	0	0.5352
Apr 01-30	0	0.2499
May 01-31	0	0.066
Jun 01-30	0	0.0034
Jul 01-31	0	0
Aug 01-31	0	0
Sep 01-30	0	0.0225
Oct 01-31	0	0.1875
Nov 01-30	0	0.3799
Dec 01-31	0	0.7656
Total	0	3.8548
	Area	92
	TEDI	41.9
	kWh/m².yr	

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	6.1351	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.98729383
Area		92
GHGI		10.7314547
		kg CO_{2e}/m2.yr

West - 40% WWR - Enclosed Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.6899	0.226	0.4639	0	0.0001	0	0.0378	0.0303	0	0	
Feb 01-28	0.0818	0.0651	0.5397	0.1854	0.3542	0	0.0012	0.0001	0.0341	0.0244	0	0	
Mar 01-31	0.0912	0.0723	0.3771	0.1468	0.2303	0	0.0061	0.0004	0.0378	0.0196	0	0	
Apr 01-30	0.0881	0.0699	0.1602	0.0692	0.091	0	0.0165	0.0011	0.0366	0.0144	0	0	
May 01-31	0.0898	0.0719	0.0318	0.0183	0.0135	0	0.0556	0.0035	0.0378	0.0132	0	0	
Jun 01-30	0.0881	0.0699	0.0008	0.0008	0	0	0.1019	0.0065	0.0366	0.0196	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.1471	0.0094	0.0378	0.0252	0	0	
Aug 01-31	0.0904	0.0721	0.0001	0.0001	0	0	0.131	0.0084	0.0378	0.024	0	0	
Sep 01-30	0.0881	0.0699	0.0088	0.0041	0.0047	0	0.0639	0.0041	0.0366	0.0143	0	0	
Oct 01-31	0.0898	0.0719	0.114	0.0399	0.0741	0	0.0179	0.0011	0.0378	0.0139	0	0	
Nov 01-30	0.0881	0.0699	0.2572	0.0889	0.1683	0	0.0022	0.0001	0.0366	0.0182	0	0	
Dec 01-31	0.0912	0.0723	0.5683	0.1818	0.3864	0	0	0	0.0378	0.0278	0	0	
Total	1.0669	0.8492	2.7477	0.9613	1.7864	3.48	0.5434	0.0347	0.4452	0.2448	0	0	9.4119
												Area	92
												TEUI	102.3033
													kWh/m².yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.6673
Feb 01-28	0	0.5211
Mar 01-31	0	0.3624
Apr 01-30	0	0.1533
May 01-31	0	0.03
Jun 01-30	0	0.0007
Jul 01-31	0	0
Aug 01-31	0	0
Sep 01-30	0	0.0084
Oct 01-31	0	0.11
Nov 01-30	0	0.2483
Dec 01-31	0	0.5501
Total	0	2.6516
	Area	92
	TEDI	28.82173913
	kWh/m².yr	

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	4.9706	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.95235883
Area		92
GHGI		10.3517264
		kg CO_{2e}/m2.yr

80% WWR – North & East

North - 80% WWR - Open Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	1.0831	0.226	0.8571	0	0	0	0.0378	0.0469	0	0	
Feb 01-28	0.0818	0.0651	0.8776	0.1854	0.6922	0	0.0001	0	0.0341	0.0403	0	0	
Mar 01-31	0.0912	0.0723	0.6608	0.1468	0.514	0	0.0005	0	0.0378	0.0364	0	0	
Apr 01-30	0.0881	0.0699	0.2982	0.0692	0.229	0	0.006	0.0004	0.0366	0.024	0	0	
May 01-31	0.0898	0.0719	0.0814	0.0183	0.0631	0	0.0418	0.0027	0.0378	0.0169	0	0	
Jun 01-30	0.0881	0.0699	0.0054	0.0008	0.0046	0	0.0829	0.0053	0.0366	0.0183	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.1339	0.0085	0.0378	0.0247	0	0	
Aug 01-31	0.0904	0.0721	0.0011	0.0001	0.001	0	0.1059	0.0068	0.0378	0.0208	0	0	
Sep 01-30	0.0881	0.0699	0.0344	0.0041	0.0303	0	0.0451	0.0029	0.0366	0.0155	0	0	
Oct 01-31	0.0898	0.0719	0.2283	0.0399	0.1884	0	0.0107	0.0007	0.0378	0.0247	0	0	
Nov 01-30	0.0881	0.0699	0.4715	0.0889	0.3826	0	0.0002	0	0.0366	0.034	0	0	
Dec 01-31	0.0912	0.0723	0.9152	0.1818	0.7333	0	0	0	0.0378	0.0433	0	0	
Total	1.0669	0.8492	4.6569	0.9613	3.6956	3.48	0.4273	0.0273	0.4452	0.346	0	0	11.2988
												Area	92
												TEUI	122.813
													kWh/m².yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	1.0605
Feb 01-28	0	0.8591
Mar 01-31	0	0.6461
Apr 01-30	0	0.2913
May 01-31	0	0.0796
Jun 01-30	0	0.0053
Jul 01-31	0	0
Aug 01-31	0	0.0011
Sep 01-30	0	0.034
Oct 01-31	0	0.2243
Nov 01-30	0	0.4626
Dec 01-31	0	0.897
Total	0	4.5608
	Area	92
	TEDI	49.57391304
		kWh/m².yr

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	6.8575	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		1.00896583
	Area	92
	GHGI	10.9670199
		kg CO_{2e}/m2.yr

North - 80% WWR - Enclosed Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.8163	0.226	0.5903	0	0	0	0.0378	0.0331	0	0	
Feb 01-28	0.0818	0.0651	0.6541	0.1854	0.4686	0	0.0001	0	0.0341	0.0283	0	0	
Mar 01-31	0.0912	0.0723	0.479	0.1468	0.3322	0	0.0006	0	0.0378	0.0246	0	0	
Apr 01-30	0.0881	0.0699	0.1997	0.0692	0.1305	0	0.0062	0.0004	0.0366	0.0145	0	0	
May 01-31	0.0898	0.0719	0.0381	0.0183	0.0198	0	0.0426	0.0027	0.0378	0.0112	0	0	
Jun 01-30	0.0881	0.0699	0.0012	0.0008	0.0004	0	0.0905	0.0058	0.0366	0.0171	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.1365	0.0087	0.0378	0.0224	0	0	
Aug 01-31	0.0904	0.0721	0.0001	0.0001	0	0	0.1089	0.0069	0.0378	0.0192	0	0	
Sep 01-30	0.0881	0.0699	0.0141	0.0041	0.01	0	0.0459	0.0029	0.0366	0.0108	0	0	
Oct 01-31	0.0898	0.0719	0.1467	0.0399	0.1068	0	0.0099	0.0006	0.0378	0.0157	0	0	
Nov 01-30	0.0881	0.0699	0.3294	0.0889	0.2405	0	0.0004	0	0.0366	0.0235	0	0	
Dec 01-31	0.0912	0.0723	0.6795	0.1818	0.4977	0	0	0	0.0378	0.0304	0	0	
Total	1.0669	0.8492	3.3581	0.9613	2.3968	3.48	0.4415	0.0282	0.4452	0.2508	0	0	9.9199
												Area	92
												TEUI	107.825
													kWh/m².yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.7937
Feb 01-28	0	0.6355
Mar 01-31	0	0.4643
Apr 01-30	0	0.1927
May 01-31	0	0.0363
Jun 01-30	0	0.0011
Jul 01-31	0	0
Aug 01-31	0	0
Sep 01-30	0	0.0137
Oct 01-31	0	0.1427
Nov 01-30	0	0.3205
Dec 01-31	0	0.6613
Total	0	3.262
	Area	92
	TEDI	35.45652174
		kWh/m².yr

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	5.4786	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.96759883
	Area	92
	GHGI	10.5173786
		kg CO_{2e}/m2.yr

East- 80% WWR - Open Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	1.0404	0.226	0.8145	0	0	0	0.0378	0.0556	0	0	
Feb 01-28	0.0818	0.0651	0.8156	0.1854	0.6302	0	0.0009	0.0001	0.0341	0.0483	0	0	
Mar 01-31	0.0912	0.0723	0.5865	0.1468	0.4397	0	0.008	0.0005	0.0378	0.0424	0	0	
Apr 01-30	0.0881	0.0699	0.256	0.0692	0.1868	0	0.0316	0.002	0.0366	0.0313	0	0	
May 01-31	0.0898	0.0719	0.0631	0.0183	0.0447	0	0.0795	0.0051	0.0378	0.0254	0	0	
Jun 01-30	0.0881	0.0699	0.0042	0.0008	0.0035	0	0.118	0.0075	0.0366	0.0262	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.1763	0.0113	0.0378	0.0326	0	0	
Aug 01-31	0.0904	0.0721	0.0006	0.0001	0.0005	0	0.1518	0.0097	0.0378	0.0298	0	0	
Sep 01-30	0.0881	0.0699	0.0261	0.0041	0.022	0	0.0815	0.0052	0.0366	0.0233	0	0	
Oct 01-31	0.0898	0.0719	0.2026	0.0399	0.1627	0	0.0276	0.0018	0.0378	0.0323	0	0	
Nov 01-30	0.0881	0.0699	0.4344	0.0889	0.3456	0	0.0009	0.0001	0.0366	0.0421	0	0	
Dec 01-31	0.0912	0.0723	0.8935	0.1818	0.7116	0	0	0	0.0378	0.052	0	0	
Total	1.0669	0.8492	4.3231	0.9613	3.3617	3.48	0.6761	0.0432	0.4452	0.4413	0	0	11.3249
												Area	92
												TEUI	123.0967
													kWh/m².yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	1.0179
Feb 01-28	0	0.7971
Mar 01-31	0	0.5718
Apr 01-30	0	0.249
May 01-31	0	0.0612
Jun 01-30	0	0.0042
Jul 01-31	0	0
Aug 01-31	0	0.0006
Sep 01-30	0	0.0257
Oct 01-31	0	0.1986
Nov 01-30	0	0.4255
Dec 01-31	0	0.8753
Total	0	4.2269
	Area	92
	TEDI	45.94456522
		kWh/m².yr

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	6.8836	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		1.00974883
	Area	92
	GHGI	10.9755307
		kg CO_{2e}/m2.yr

East- 80% WWR -Enclosed Balcony

Date	Interior Lighting (MWh)	Other Process (MWh)	Space Heating (MWh)	Space Heating Natural Gas (MWh)	Space Heating Electricity (MWh)	Service Water Heating Natural Gas (MWh)	Space Cooling (MWh)	Heat Rejection (MWh)	Interior Central Fans (MWh)	Interior Local Fans (MWh)	Exhaust Fans (MWh)	Pumps (MWh)	
Jan 01-31	0.0898	0.0719	0.7698	0.226	0.5439	0	0.0001	0	0.0378	0.0437	0	0	
Feb 01-28	0.0818	0.0651	0.5909	0.1854	0.4055	0	0.0012	0.0001	0.0341	0.0371	0	0	
Mar 01-31	0.0912	0.0723	0.4088	0.1468	0.262	0	0.0105	0.0007	0.0378	0.0311	0	0	
Apr 01-30	0.0881	0.0699	0.1704	0.0692	0.1012	0	0.0368	0.0024	0.0366	0.0232	0	0	
May 01-31	0.0898	0.0719	0.0342	0.0183	0.0159	0	0.0789	0.005	0.0378	0.0211	0	0	
Jun 01-30	0.0881	0.0699	0.0012	0.0008	0.0004	0	0.1171	0.0075	0.0366	0.0237	0	0	
Jul 01-31	0.0906	0.0721	0	0	0	0	0.1726	0.011	0.0378	0.0309	0	0	
Aug 01-31	0.0904	0.0721	0.0001	0.0001	0	0	0.1497	0.0096	0.0378	0.0282	0	0	
Sep 01-30	0.0881	0.0699	0.0109	0.0041	0.0068	0	0.0806	0.0051	0.0366	0.0198	0	0	
Oct 01-31	0.0898	0.0719	0.126	0.0399	0.0861	0	0.027	0.0017	0.0378	0.0208	0	0	
Nov 01-30	0.0881	0.0699	0.2907	0.0889	0.2019	0	0.0018	0.0001	0.0366	0.0303	0	0	
Dec 01-31	0.0912	0.0723	0.6514	0.1818	0.4695	0	0	0	0.0378	0.0414	0	0	
Total	1.0669	0.8492	3.0544	0.9613	2.0931	3.48	0.6763	0.0432	0.4452	0.3513	0	0	9.9665
												Area	92
												TEUI	108.3315
													kWh/m².yr

Date	ApHVAC room units heating load (MWh)	ApHVAC heating coils load (MWh)
Jan 01-31	0	0.7472
Feb 01-28	0	0.5724
Mar 01-31	0	0.3941
Apr 01-30	0	0.1635
May 01-31	0	0.0324
Jun 01-30	0	0.0011
Jul 01-31	0	0
Aug 01-31	0	0
Sep 01-30	0	0.0105
Oct 01-31	0	0.122
Nov 01-30	0	0.2818
Dec 01-31	0	0.6332
Total	0	2.9583
	Area	92
	TEDI	32.15543478
		kWh/m².yr

	Suite Energy (MWh)	Emissions (kg/MWh)
Electricity	5.5252	0.03
Natural Gas	4.4413	0.18085714
		Emissions (kg)
		0.96899683
	Area	92
	GHGI	10.5325742
		kg CO_{2e}/m2.yr

PERFORMANCE SUMMARY

South - 80% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	117.3	105.8	10%
TEDI (kWh/m2.yr)	41.7	29.2	30%
GHGI (kg CO_{2e}/m2.yr)	10.8	10.5	3%

West - 80% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	123.7	109.6	11%
TEDI (kWh/m2.yr)	46.4	32.7	29%
GHGI (kg CO_{2e}/m2.yr)	11.0	10.6	4%

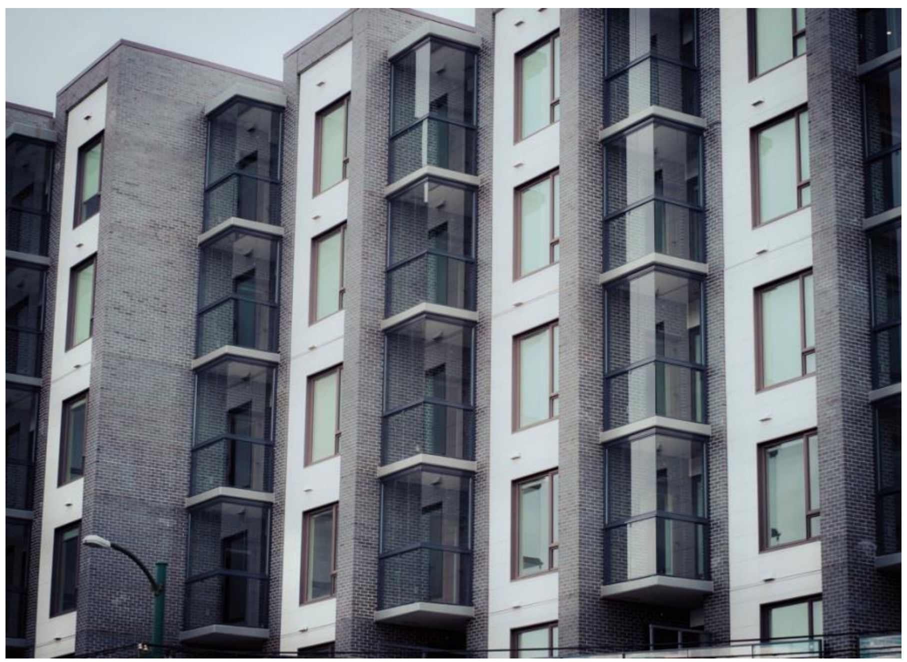
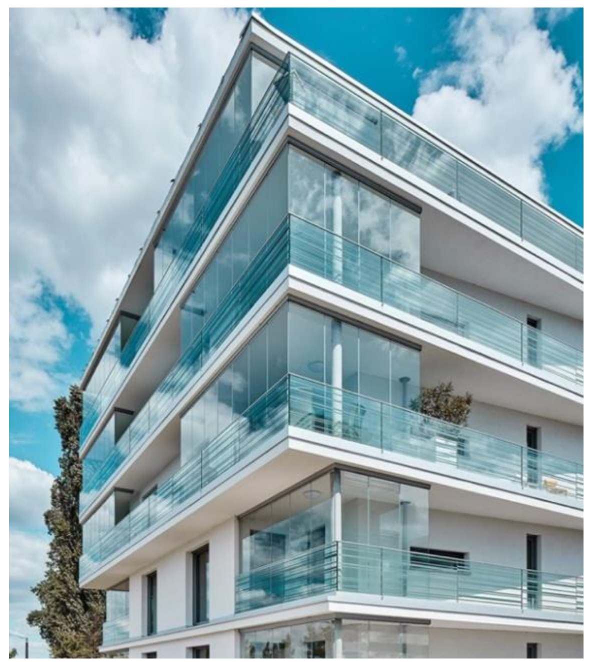
North - 80% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	122.8	107.8	12%
TEDI (kWh/m2.yr)	49.6	35.5	28%
GHGI (kg CO_{2e}/m2.yr)	11.0	10.5	4%

East - 80% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	123.1	108.3	12%
TEDI (kWh/m2.yr)	45.9	32.2	30%
GHGI (kg CO_{2e}/m2.yr)	11.0	10.5	4%

Average - 80% WWR	Open Balcony	Enclosed Balcony	Savings
TEUI (kWh/m2.yr)	121.7	107.9	11%
TEDI (kWh/m2.yr)	45.9	32.4	29%
GHGI (kg CO_{2e}/m2.yr)	10.9	10.5	4%

Toronto Green Standard Version 4 Tier 1 Targets	
TEUI (kWh/m2.yr)	**135**
TEDI (kWh/m2.yr)	**50**
GHGI (kg CO_{2e}/m2.yr)	**15**




Appendix B
Sources of Additional Information

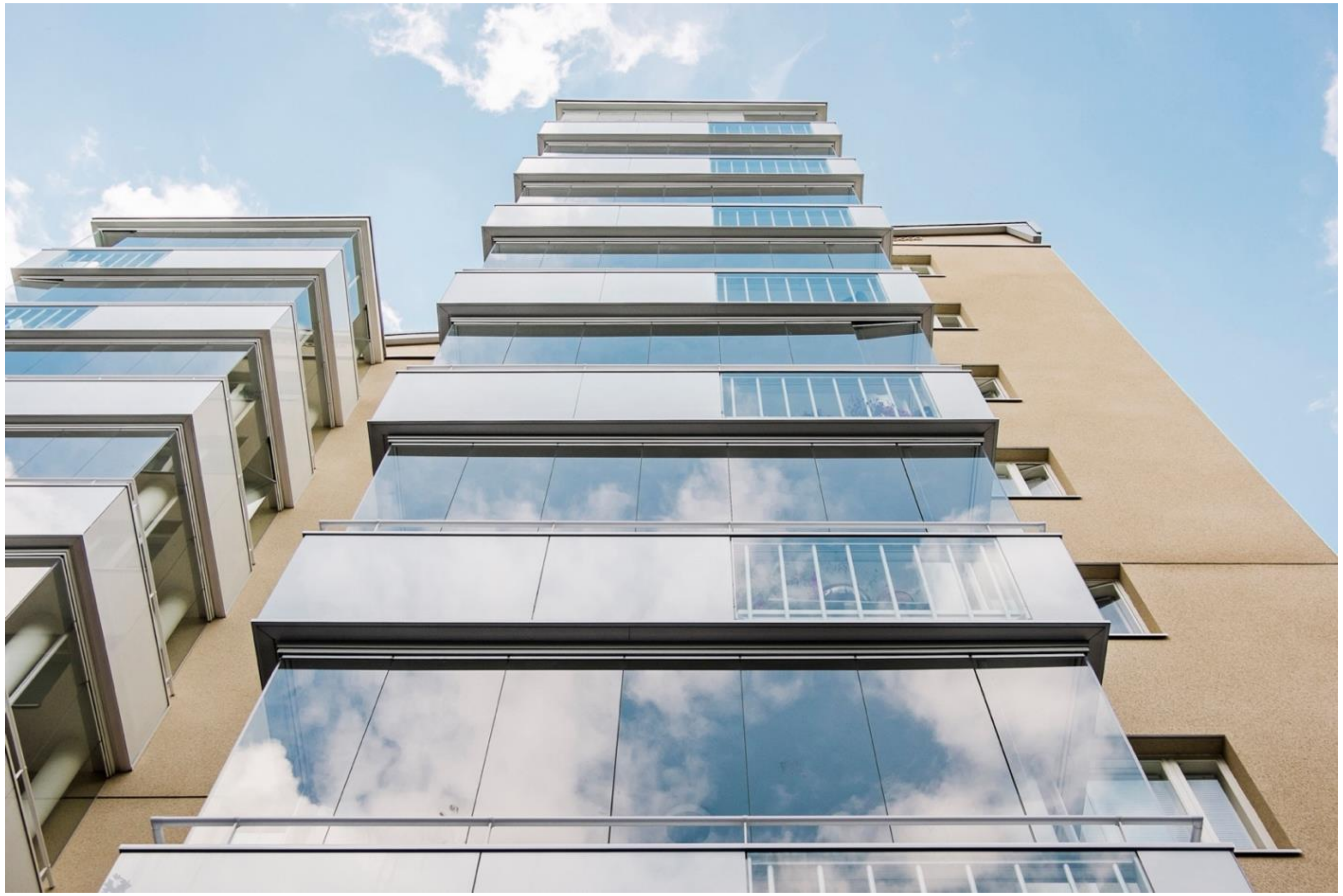
Toughened glass	6mm	8mm	10mm	12mm	Grey 6mm	Grey 8mm
Glass properties	EN 410					
Light transmission -Tv (%)	88	87	87	85	44	35
Light reflection out ρv (%)	8	8	8	8	5	5
Light reflection in ρvi (%)	8	8	8	8	5	5
Colour rendering index RD65 - Ra (%)	98	97	97	96	96	95
Energy properties	EN 410					
Solar factor -g (%)	82	80	77	74	66	57
Energy reflection ρe (%)	7	7	7	7	5	5
Direct energy transmission Te (%)	79	76	73	68	45	36
Energy absorption αe (%)	14	17	20	25	50	59
Shading coefficient - SC	0,94	0,92	0,89	0,85	0,66	0,57
UV transmission - UV %	57	52	49	46	18	12
Selectivity	1,08	1,09	1,12	1,15	0,78	0,69
Thermal properties	EN 673					
U-coeff. W/(m²K)	5,7	5,6	5,6	5,5	5,7	5,6
Other						
Noise insulation (RW (C;Ctr) EN 12758 -dB	31 (-2; -3)	32 (-2; -3)	33 (-2; -3)	34 (0; -2)	31 (-2; -3)	32 (-2; -3)

Energy Codes & Standards, Energy Modelling Guidelines

It is widely recognized the two most progressive energy codes in Canada are the BC Energy Step Code and the Toronto Green Standard. Both of these set energy performance targets for buildings and differ from all of the other national and provincial building codes in this regard. They also share an aspiration to achieve net-zero buildings in the near future recognizing this will require a number of steps in order to for the building industry to navigate a successful transformation. As such, these energy codes represent best building practices that are recommended to all design professionals regardless of lesser requirements in their jurisdiction. The resources listed below will be helpful in understanding how to properly carry out energy modelling in order to comply with these energy performance targets set out in the Toronto Green Standard.

Toronto Green Standard
https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/toronto-green-standard/

Energy Efficiency Report Submission & Modelling Guidelines for the Toronto Green Standard (TGS) Version 4
https://www.toronto.ca/wp-content/uploads/2022/04/978f-TGS-V4-EM-Guideline.pdf



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