JLR No.: 29308-000
Revision: 08

January 14, 2022

Prepared for:

THE CORPORATION OF THE TOWN OF CALEDON
6311 Old Church Road
Caledon, ON
L7C 1J6

Prepared by:

J.L. RICHARDS & ASSOCIATES LIMITED
107-450 Speedvale Avenue West
Guelph, ON
N1H 7Y6
Tel: 519-763-0713
Fax: 613-728-6012

Caledon Corporate Green Building Standard (2022)

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

Table of Contents

List of Tables

List of Abbreviations

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
BAS	Building automation system
BD+C	Building Design + Construction – a LEED designation
BOMA	Building Owners and Managers Association
BPS	(Ontario) Broader Public Sector – a sector that includes the province of Ontario, Ontario municipalities, Ontario school boards, post secondary institutions, health care facilities and other organizations that receive substantial funding from the Province.
CaGBC	Canada Green Building Council (also USGBC for American counterpart)
CGBS	Corporate Green Building Standard
COP	Coefficient of performance – applies to the performance of mechanical equipment such as a heat pump
EUI	Energy Use Intensity – total annual building energy consumption per unit of floor area for a building, often expressed in units of kWh/m²
EV, EVCS	Electric vehicle, Electrical vehicle charging station
GBS	Green Building Standard (a generic term for a class of standards, not any specific standard)
GHG	Greenhouse gases
GHGI	Greenhouse gas intensity - total annual building GHG emissions per unit of floor area for a building, often expressed in units of kg of CO_2e/m^2
HRV	Heat recovery ventilator
HVAC	Heating, ventilation and air-conditioning
$kgCO_2e$, tCO_2e	Units of GHG emissions that account for the different impacts of different greenhouse gases: kilogram and tonne (1,000 kg) of CO_2 equivalent, respectively
kWh, MWh	Units of energy, kilowatt-hour and megawatt-hour, respectively
LEED	Leadership in Energy and Environmental Design, an evolving series of sustainability standards published by the CaGBC, currently on version 4.1
MURB	Multi-unit residential buildings, such as apartments and rowhouses
NECB	National Energy Code for Buildings
O&M	Operations & maintenance
OBC	Ontario Building Code
POA	Plane or array (solar radiation)
PV	Photovoltaic

TEDI	Thermal energy demand intensity – A building's annual heat loss per unit of floor area, after accounting for all passive gains and losses. TEDI can also be considered as the amount of heating energy delivered to a building by the HVAC equipment. Often expressed in units of kWh/m²
ZCB	Zero carbon building – A generic term for a building with no net GHG emissions

1.0 Introduction

1.1 Purpose

The purpose of this document is to set targets and guidelines for the design and construction of new buildings and for the renovations to existing buildings. This will help to enable the Town of Caledon (the Town) to meet goals for reducing greenhouse gas (GHG) emissions, energy consumption and utility costs. The ultimate purpose of this document is to assist the Town to meet GHG emission reduction goals of net-zero by 2050, which have been adopted by Town Council.

1.2 Scope

This Standard addresses energy consumption, GHG emissions, and broader environmental performance of buildings owned and operated by the Town. This Standard also includes measures to enhance resiliency to changing weather patterns as a result of climate change.

There are three (3) key elements to the scope of this document:

1) This Standard sets firm, clearly stated goals for specific types of new buildings with respect to energy consumption and GHG emissions;
2) This Standard provides guidance on how the goals for new buildings can be applied to major additions or retrofits of existing buildings, and;
3) This Standard provides a series of prescriptive measures required for either new building development and/or renovations, where appropriate. These measures are geared to compliment broader sustainability objectives of the Town.

2.0 Background

In 2021, the Town adopted "*Resilient Caledon: Community Climate Change Action Plan*". This plan aligns the Town's efforts to mitigate the effects of climate change, aligned with the latest global science, to achieve net-zero emissions by 2050. *Resilient Caledon* includes more than 60 actions to mitigate or adapt to climate change, including Action 18, to "*Ensure Town facilities are carbon neutral and climate resilient by 2040*". Specifically, Action 18.2 requires an update of "*the Town's Corporate Green Building Standard for new municipal buildings and building renovations to achieve net-zero carbon and climate resiliency standards*." This Standard is the result of that commitment.

This Standard sets requirements for three (3) increasing levels of performance, with levels advancing every five (5) years, to align with a 'net-zero carbon' level by 2030. In very general terms, Level 1 is intended to be readily achievable now (2022), if good practices in both design and construction are employed. Level 2 is a further step that may require advance products, materials, design practice or construction practice – or some combination thereof – to achieve. Level 3 is intended to correspond to net-zero carbon building design.

This Standard has been developed for buildings of the size and type currently owned by the Town, or likely to be constructed during the next few years. The requirements of this Standard have been specifically adapted to correspond to the climate in Caledon, also considering the most likely effects of ongoing climate change.

2.1 Definitions of GHGI, EUI and TEDI

This Standard sets target values for GHGI, EUI and TEDI. All three (3) targets are based on annual values, presented as 'per square meter' of the building's floor space.

- GHGI (greenhouse gas intensity, in kg of CO_2/m^2): GHGI is a measure of the annual GHG emissions due to the energy consumption of a building. GHGI is the total annual emissions from fuels burned on site plus indirect emissions from electricity consumed on site, divided by the building's floor area. This value does not include GHG emissions from the use of refrigerants and the carbon embodied within building materials. These emissions sources are considered separately, in the prescriptive measures section of this Standard.
- EUI (energy use intensity, in kWh/m²): EUI is a measure of the total annual energy consumed by a building, divided by the building's floor area. Natural gas consumption is converted to its equivalent energy content (cubic meters to equivalent kilowatt hours). Effectively, EUI is a measure of the energy purchased for the building.
- TEDI (thermal energy density index, in kWh/m²): TEDI is a measure of the thermal energy (heat) produced by a building's heating system to maintain a comfortable indoor air temperature, by heating incoming ventilation air and replacing heat lost through the building's envelope. Cooling loads and domestic water heating are not considered in the TEDI value.

2.2 Energy and GHG Modeling of Building Types

To help determine appropriate target levels for GHGI, EUI and TEDI, energy models were developed for six (6) building archetypes, employing different design options that would impact the energy profile of the buildings. Approximate costs for these buildings were also estimated. See Section 4.0 for a summary of the model results and target GHGI, EUI and TEDI values for new buildings.

3.0 Applicability

This Standard is to apply to new buildings owned by the Town of Caledon and to renovations or additions to existing buildings, with some exceptions.

For new buildings, this Standard prescribes limits for greenhouse gas emissions (GHGI), total energy consumption (EUI) and building thermal performance (TEDI). These same limits are to be applied for major renovations or expansions.

Note that should a project show conflicts among the three (3) targets, they should be assigned a priority in this order:

1) GHGI, because of the state of the climate change emergency;
2) EUI, because this directly impacts ongoing operating costs and can be readily monitored via energy utility invoices;
3) TEDI.

3.1 New Buildings

In addition to the overall greenhouse gas and energy targets found in Table 1, all new building projects will be required to meet a common list of the prescriptive requirements outlined in Section 5.0 of this Standard.

New buildings are excluded from the requirements of this Standard if their total floor area is less than 500 m² or the total design and construction budget is less than $1,000,000. At the discretion of the Town, any new building that would be exempt from this Standard may be required to meet elements of this Standard, most commonly a customized list of the prescriptive measures listed in section 5.

3.2 Renovations

This Standard applies to most building renovations, dependent on their size, complexity and the features that are being renovated. For renovations, the Town Project Manager, in consultation with Energy and Environment, will select a custom list of the prescriptive requirements that will apply, based on the nature of the renovations and the building's pre-existing state. The overall GHGI, EUI and TEDI targets listed in section 4 do not directly apply to renovations but may serve as a guide. For all renovations, the Town's project manager is to consider energy and emissions performance of the building expansion, for example, to ensure waste heat capture from an ice rink is considered

Unless otherwise noted by the Town, renovations are excluded from the requirements of this Standard if:

1) the total design and construction budget is less than $250,000;
2) or the total area affected by the building is less than 500 m²;
3) or when there are firm plans to dispose of the building within five (5) years of the completion of the renovation.

If a renovation project is excluded from the Standard, it will be important for the project team to meet with the Energy and Environment Division to determine whether any broader GHG reduction and sustainability considerations should be embedded into a project scope (i.e. if a boiler is being replaced, determine what additional studies or alternatives can be used).

3.3 CGBS Reviews and Updates

The threshold values for GHGI, EUI and TEDI within this Standard have been set with the general expectation that Level 1 should be met when the Standard is first issued, with Levels 2 (2025) and 3 (2030) appropriate for widespread use approximately five (5) and ten (10) years later, respectively. While any higher Level may be selected for any specific building at any time, it is recommended that this Standard undergo a general review prior to Levels 2 and 3 coming into effect. The review should ensure that the Standard continues to reflect the most relevant technologies, design and construction practices, management practices and financial implications.

4.0 CGBS Requirements

Table 1 outlines the GHGI, EUI and TEDI targets for six (6) specific types of new buildings.

Table 1 - GHGI, EUI and TEDI Targets for New Buildings

Building Type		Level 1	Level 2	Level 3
Work Yard				
GHGI Target	($kgCO_2/m^2$)	15	10	1
EUI Target	(kWh/m^2)	120	80	50
TEDI Target	(kWh/m^2)	60	35	35
Fire Hall				
GHGI Target	($kgCO_2/m^2$)	20	10	1
EUI Target	(kWh/m^2)	150	85	45
TEDI Target	(kWh/m^2)	75	30	30
Community Centre				
GHGI Target	($kgCO_2/m^2$)	15	10	2
EUI Target	(kWh/m^2)	165	105	75
TEDI Target	(kWh/m^2)	35	15	15
Administrative Centre				
GHGI Target	($kgCO_2/m^2$)	10	5	1
EUI Target	(kWh/m^2)	90	70	45
TEDI Target	(kWh/m^2)	30	15	15
Ice Rink				
GHGI Target	($kgCO_2/m^2$)	15	15	6
EUI Target	(kWh/m^2)	250	240	200
TEDI Target	(kWh/m^2)	45	40	40
Swimming Pool (1)				
GHGI Target	($kgCO_2/m^2$)	340		85
EUI Target	(kWh/m^2)	2,500		1,100
TEDI Target	(kWh/m^2)	1,400		1,400

(1) In common with industry practice, but unlike the other five building types, the area (i.e. m^2 value) for the swimming pool is not total floor area, but the surface area of the swimming pool. It is recommended that the pool be combined with the building archetype that best reflects the rest of the building use (i.e. community centre), using the methodology outlined in 4.1. Also, there is no Level 2 for pools. Improvements beyond Level 1 may not be feasible until closer to 2030 or on a site-specific basis (e.g. using heat recovered from an adjacent ice rink).

It should be noted that the target values in this Standard do not include energy used external to the building, except for moderate outdoor lighting (e.g. signage, façade, walkway, parking lot, etc.). Thus, if there are any substantial loads exterior to the building but with energy provided through the building's infrastructure, these must be accounted for separately. This could include such things as EV charging, lighting for sports fields or heated outdoor buildings. In such cases, separate sub-metering of these loads is recommended.

4.1 Target Guidance for Mixed Use Buildings

When a mixed-use building is being constructed with more than one building archetype, GHGI, EUI and TEDI values can be determined simply by using an average of the target values for the constituent building types, weighted by their respective floor areas within the overall building. An estimated cost premium can be achieved in a similar way.

4.2 Compliance and Verification

Compliance requirements for this Standard are provided in Section 6.0 In general, during the design and construction phases, compliance requires the submission of an energy and GHG performance model of the building, to be updated as appropriate with each major submission (e.g. 30%, 60%, 90% design). This model is to be reviewed by an independent third party, one that has been accepted by the Town.

5.0 Prescriptive Measures

5.1 Introduction

Prescriptive measures are specific green measures associated with a building or its property, that are to be used in one of two ways:

1) For new buildings or major renovations where the whole-building GHGI, EUI and TEDI limits of the preceding section apply, prescriptive measures listed in Sections 5.2 and 5.3 are mandatory. Those listed in Sections 5.4 are required only if specifically requested by the Town.
2) As outlined in section 3.2, less extensive renovation building projects where the whole-building GHGI, EUI and TEDI limits of the preceding section do not apply, the Town project manager, with the Energy and Environment Division, will select the prescriptive measures that are to apply to the project. Measures may be selected from any of Sections 5.2, 5.3 and 5.4, depending on the nature and extent of the planned renovations.

Prescriptive measures have up to three Levels, where each Level increases in aggressiveness. For new construction projects with an overall assigned Level, the corresponding Levels are to apply, unless specifically noted otherwise. For example, a building designed to Level 2 is to meet Level 2 for all prescriptive measures included in the project. For renovation projects lacking an overall assigned Level, the Level for each prescriptive measure included in the project shall be assigned by the Town.

Each prescriptive measure includes:

- A brief indication of the requirements for each of the three (3) levels;
- An indication of which building types the measure generally applies to;
- High level guidance on the anticipated capital cost premiums (compared to common practice), by Level, when applicable;
- A discussion of the measure, and;
- Minimum contractor submission requirements during the design, construction and commissioning process.

Cost premiums are provided in terms of parameters that are more likely to be known in the earliest stages of project development (e.g., total floor area, lot size, number of building occupants). As some of these measures become more common, the price premiums may drop as experience is gained or more suppliers offer quality products.

The cost guidance information included in this Standard is presented as a cost premium above what was common practice when this Standard was published. The costing data was derived from multiple sources including published reports on various technologies, public records of

specific projects and unpublished cost estimates or actual costs from specific projects with which the development team was familiar. This latter category – pricing from specific projects worked on by the development team – was the source most heavily relied upon.

For clarity, the units of cost guidance are listed following, along with brief commentary. All but six (6) are based on a $/m² figure, with the measured area most commonly being gross floor area of the building, but for some measures it may be the area of the parking lot, or landscaped area, or window area, as applicable to the specific measure.

Metric	Applicable Measure	Description
$/m²	5.2.2, 5.2.4, 5.2.5, 5.2.8, 5.3.4, 5.3.8, 5.4.1, 5.4.5, 5.4.6	Cost per total interior floor space of building, including all floors but excluding basement area.
$/building	5.2.3, 5.3.7	Cost per building. The cost of these measures does not change appreciably with building size.
$/occupant	5.2.1, 5.2.6	"Occupant" here means the maximum number of occupants the building is designed for. These costs (water consumption and ventilation) depend on the maximum number of people to be served. As the number of occupants per m² of floor space varies widely across the six building types, there is no consistent conversion to $/m².
$/unit	5.3.2, 5.3.3	"Unit" refers to the number of EV chargers (5.3.2) or bicycle rack spaces (5.3.3).
$/m² window	5.2.7, 5.4.4	Cost per total window space. If any exterior wall cladding is a glass material, this area must also be included for 5.2.7.
$/m² parking lot	5.3.1	Outdoor lighting cost guidance is based on total outdoor area to be lit, which is commonly approximated by the parking lot size (although it should also include walkways and other lit areas, if substantial).
$/m² lot	5.3.5	Cost per total area of the property lot (or the developed area, if the property is large and includes significant natural area).
$m² landscaped	5.3.6	Cost per total landscaped area.
$/m² wall	5.4.2, 5.4.3	Cost per total exterior wall area, either above grade (5.4.2) or below grade (5.4.3).
$/m² roof	5.5.1	Cost per total roof area, including multiple levels if any, but excluding ground floor add-ons such as roofed entryways or patios.

5.2 Prescriptive Measures: Direct Building Elements, Mandatory in New Builds

5.2.1 Domestic Water Consumption

Intent: To reduce the amount of potable water consumed at the facility.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
0.16 m³/year	0.12 m³/year	0.08 m³/year						
Cost Guidance: Approximately 0, 200 and 700 $/occupant, for Levels 1, 2 and 3, based on the peak number of occupants for which the building is designed. Cost guidance considers the premium for low flow fixtures and automated controls.								

Description

Units of target values are m³ of Town-supplied potable water consumed indoors annually, per peak occupant. The target values can also be expressed as 0.44, 0.33 and 0.22 L/day per occupant. This measure does not distinguish between hot and cold water usage; both are included.

As office buildings are consistently consumers of very low levels of domestic water, it is suggested that all Administrative Centres be assigned the Level 3 target.

Exemption

- This measure does not apply to swimming pools or ice rinks, because both consume large quantities of water for their operation.
- The Level values exclude outdoor water consumption.

Submission Requirements

- Contractor shall include estimated water consumption values at 60% and 90% design submissions.
- Certificate per Section 6.4 at completion of construction.

5.2.2 Heat Pump Readiness

Intent: To ensure that hydronic heating delivery units (radiators, air handlers, piping, etc.) installed are compatible with the lower temperature water produced by heat pumps, thus avoiding costs to replace such equipment should the building later be converted to heat pumps.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
60°C	60°C	60°C						
Cost Guidance: Approximately 20 $/m², for all three Levels, based on the total floor area of the building. Cost guidance considers the added cost radiators and coils (in air handlers) that can operate with lower temperature water, replacing units designed only for higher temperatures. Pipe sizing is assumed to remain unchained, as the magnitude of temperature drop across devices is similar in both designs. Cost guidance does not consider any changes to the building's electrical service to provide power to heat pumps, on the assumption that the electricity draw to meet the wintertime peak heating load will often be similar to the draw to meet the summertime peak cooling load, which is assumed to already be electric.								

Description

Heat pump readiness means that all heat delivery units (radiators, air handlers, etc.) in the building, along with associated piping, must be capable of delivering the peak heating load to all areas of the building using water temperatures that can be readily achieved by heat pumps, which is assumed to be 60°C. In addition, the electrical service of the building should be sized such that it can power a heat pump-based heating system.

Any building designs that incorporate space heating by heat pumps that are capable of producing water at higher temperatures than 60°C are exempt from this provision, as they may be equipped with components compatible with the selected heat pump(s).

Submission Requirements

- Contractor shall include in 60% and 90% design submissions, including shop drawings or other technical specifications for radiators, air handler coils and similar devices.
- Certificate per Section 6.4 at completion of construction.

5.2.3 BAS and Submetering

Intent: To ensure that all new buildings are equipped with sensors and controls to monitor key energy performance metrics and ensure occupant comfort.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
Space heating; Space cooling; DHW	Level 1 plus; indoor lighting; outdoor lighting; indoor water consumption [m³]; outdoor water consumption [m³]	Level 2 plus; Any electric loads >5% of electricity consumption						
Cost Guidance: Approximately $6,000, $14,000 and $20,000 per building, for Levels 1, 2 and 3. Cost guidance is based on the cost for additional sensors and BAS programming, assuming that the building is already to be equipped with a BAS.								

Description

Parameters listed are to have their energy consumption measured and recorded, by the BAS, unless a metric other than energy is noted (e.g. water consumption in cubic meters).

Submission Requirements

- Contractor shall include in 60% and 90% design submissions, with provision of electricity and thermal submeters clearly indicated on electrical and mechanical diagrams and shop drawings or other technical specifications for any required meters.
- Contractor shall confirm that BAS has been programmed to record and retain daily (or more frequent) summed values for a minimum of 400 days.
- Certificate per Section 6.4 at completion of construction.

5.2.4 Building Commissioning

Intent: To ensure that new buildings are properly commissioned, ensuring performance conforms to design once the building is operational.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
Commissioning shall be completed, and the process should be compliant with the following ASHRAE Standard and Guidelines, or more recent versions as they are updated: • Standard 202-2018 "Commissioning Process for Buildings and Systems" • Guideline 0-2019 "Total Building Commissioning Process" • Guideline 1.1-2007 "HVAC &R Technical Requirements for the Commissioning Process" Commissioning includes, at minimum: whole building air leakage test; thermography to confirm that thermal bridging is limited; confirming of fresh air ventilation rates; HVAC system operation and set points; third-party roof testing with manufacturer sign-off; lighting controls; lighting levels and water system testing.								
Cost Guidance: Approximately 10, 12 and 14 $/m², for Levels 1, 2 and 3, based on the total floor area of the building. Commissioning costs can vary substantially depending on the provider and the complexity of the building.								

Description

Commissioning of a building ensures that the initial performance of its various components and subsystems is in accordance with the design, and that the various components and subsystems work together harmoniously. The higher cost guidance for Levels 2 and 3 reflect the expectation of more complex systems, not a change in the purpose or depth of commissioning. More specifically, systems such as ground-source heap pumps, wood pellet boilers and advance energy recovery ventilators are expected to become more common at advanced design Levels, as are HVAC systems with multiple heating or cooling sources. Both more complex pieces of equipment and more possible operational states will increase commissioning costs.

Note that individual equipment and subsystems are expected to continue being tested by their installers, per common practice, prior to commencement of building commissioning.

Building Expansions and Renovations

In some cases, for building expansions and renovations, undertaking full building air leakage testing can be cost prohibitive due to the need to properly seal off the existing building from the expansion. In these instances, a more qualitative assessment of air leakage through a thermographic scan of the building envelope is acceptable. This scan will also highlight anomalies including, but not limited to insulation gaps, and thermal energy loss.

Submission Requirements

- Contractor will demonstrate that a Commissioning Agent has been retained no later than the date of the 30% design submission. [*Note that, particularly in less complex projects, the Contractor may propose to use their own internal staff as the Commissioning Agent. The Town retains the right to accept this, or to require that a third-party Commissioning Agent be employed. The Town also retains the right to directly contract with a third-party Commissioning Agent, at their sole discretion. For all major new builds, a third-party Commissioning Agent is preferred*.]
- 60% design submission is to include a Commissioning Plan
- Commissioning Agent is to submit a Commissioning Report directly to the Town project manager within ten (10) working days of completion of commissioning.
- A Current Facilities Requirements and Operations and Maintenance Plan, including a System Operation Manual within thirty (30) days of Substantial Completion.
- Certificate per Section 6.4 at completion of construction.

5.2.5 Refrigerants (Ozone Depleting Properties and Global Warming Potential)

Intent: To ensure the use of refrigerants which are less damaging when released to the atmosphere, by having low potential to damage the ozone layer and act as a greenhouse gas.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
Report ODP and GWP	ODP<0.02; GWP<750	ODP<0.02; GWP<150						
Cost Guidance: Approximately 0, 2 and 4 $/m², for Levels 1, 2 and 3, based on the total floor area of the building. The cost guidance considers space cooling systems. Cost premiums for ice rinks would be greater. Cost guidance for refrigerants with GWP<150 is uncertain.								

Description

Ozone depleting potential (ODP) and global warming potential (GWP) are metrics associated with refrigerants, applicable when they leak or are otherwise released to the atmosphere. ODP is a measure of how much damage a gas can cause to the ozone layer, compared to CFC-11; CFC-11 is defined as having an OPD equal to 1. GWP is a measure of the ability of the gas to trap heat in the atmosphere, compared to Carbon Dioxide (CO_2); CO_2 is defined as having a GWP equal to 1.

This measure applies to refrigerants used in space cooling systems, and other built-in systems (e.g., includes chillers for ice pads, but excludes plug-in, self-contained equipment).

Note that HCFC and Halon refrigerants are no longer permitted in new installations in Ontario.

Submission Requirements

- Contractor shall include refrigerant specification for main and any auxiliary cooling systems, including ODP and GWP values in 60% and 90% design submissions.
- Certificate per Section 6.4 at completion of construction.

5.2.6 Ventilation Air Heat Recovery

Intent: To recover sensible and latent heat from ventilation exhaust, to reduce overall building energy consumption.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
ERV at >80% efficiency; 80% of ventilation air	ERV at >80% efficiency; 100% of ventilation air	ERV at >92% efficiency; 100% of ventilation air						
Cost Guidance: Approximately 0, 200 and 300 $/maximum occupants, for Levels 1, 2 and 3, based on the peak number of occupants. The cost guidance is based on the cost of the HRV/ERV equipment, installed; it does not include the cost of installing a centralized duct system to distribute and collect ventilation air from/to common locations, if such do not already exist.								

Description

All intake and exhaust of ventilation air is to be routed through an energy recovery ventilator (ERV, recovers both sensible and latent heat) with a nameplate efficiency rating exceeding the noted requirement. For Level 1, 80% of the building's intake and exhaust of ventilation air must pass through an ERV with a nameplate efficiency of at least 80%. For Levels 2 and 3, 100% of ventilation must pass through an ERV with a nameplate rating of at least 80% and 92%, respectively.

Exhaust from range hoods may be excluded from ventilation passing through ERV's. Also, ERV's are only to be used for ventilation of fully conditioned spaces. Ventilation of other spaces, such as parking garages or unconditioned storage areas, should not pass through ERV's. For areas that are conditioned but do not require humidity regulation, HRVs may be considered.

Submission Requirements

- Contractor shall include in 30%, 60% and 90% design submissions, including shop drawings or other technical specifications in 60% submission.
- Certificate per Section 6.4 at completion of construction.

5.2.7 Bird Friendly Development

Intent: To protect local bird populations by reducing building collisions.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
Fritted glass in 85% of glass below 12 m height	Fritted glass in 100% of glass below 12 m height	Level 2 plus <30% glazing ratio						
Cost Guidance: Approximately 40, 45 and 45 $/m², for Levels 1, 2 and 3, based on the total glass area of the building. The cost guidance is based on the added cost of fritted (or otherwise marked) glass.								

Description

Marks on glass shall be high contrast and spaced no more than 5 cm apart vertically and 10 cm horizontally, and each mark shall be at least 5 mm in diameter (or similar, if not circular). Marks shall be on the outside surface of the outermost glass pane. Other types of “bird friendly” glass may be used, if they have been demonstrated to be effective.

In locations where neighbouring trees, when mature, may exceed 12 m in height (including trees on an adjacent hill), the fritted glass must extend to the anticipated height of the trees, when mature.

There can be several other elements to bird-friendly building design and site design; these are not explicitly required by this Standard but are encouraged, such as the City of Toronto’s Bird-Friendly Guidelines.

Submission Requirements

- Contractor shall include in 60% and 90% design submissions, including shop drawings or other technical specifications.
- Certificate per section 6.4 at completion of construction.

5.2.8 Indoor Lighting

Intent: To reduce electricity consumption in the buildings indoor lighting systems.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
125 lm/W		150 lm/W						
Cost Guidance: Approximately 9, 9 and 15 $/m², for Levels 1, 2 and 3, based on the total floor area of the building. Cost guidance is based on large ceiling fixtures such as commonly used in office buildings. Other (specialty or more decorative) fixture styles do have higher base costs, and the cost premium for increased lighting efficacy (efficiency) also is currently somewhat greater than the cost premiums listed above. (It is also noteworthy that decorative or specialty lighting is typically selected for relatively small percentages of the total floor area in buildings.)								

Description

The weighted average indoor lighting efficacy shall meet or exceed the levels indicated for each Level, based on the nameplate efficacy when new. The average efficacy shall be weighted both by floor area and design lighting levels (lux).

Lighting levels within buildings should meet, but not exceed, current values recommended by the Illuminating Engineering Society (IES) in their design guide applicable to the type of building and space (e.g. IES RP-10-20, Recommended Practice: Lighting Common Applications).

Automated controls shall be employed to turn off or dim indoor lights during periods outside of normal operating hours (e.g. overnight), or specific areas/rooms that are unoccupied, even during normal operating hours.

Submission Requirements

- Contractor shall submit a lighting layout for approval within the 60% design submission (and in subsequent submissions, if material changes are made).

- Contractor shall include in 60% and 90% design submissions, including shop drawings or other technical specifications, and a calculation of the average efficacy of all indoor lighting, weighted by both floor area and light levels.
- Certificate per section 6.4 at completion of construction.

5.2.9 Embodied Carbon

Intent: To encourage use of materials with reduced associated Scope 3 emissions involved in their production.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
Report embodied carbon in these bulk materials: concrete, steel, masonry, wallboard, glass, thermal insulation, wood	Level 1 plus achieve an embodied carbon value below 350 $kgCO_2e$ per m^2 of floor area	Level 1 plus achieve an embodied carbon value below 100 $kgCO_2e$ per m^2 of floor area						
Cost Guidance: Approximately 2, 20 and 50 $/m², for Levels 1, 2 and 3, based on the total floor area of the building.								

Description

For ease of compliance, embodied carbon content of specific bulk materials only is required; it is anticipated that, collectively, these materials will account for more than 90% of the carbon embodied in the building. Level 1 requires only reporting; no threshold value is set.

Wood products may be accounted as negative embodied carbon, when appropriate.

While this Standard does not define precisely how the embodied carbon must be calculated, helpful guidance on the topic can be found in the following publications, among others.

- Zero Carbon Building Standard Version 2
- LCA Practice Guide - Carbon Leadership Forum
- Embodied Carbon in Ontario: Policy Primer for Ontario

Submission Requirements

- Contractor shall include calculation of embodied carbon in kilograms of carbon dioxide equivalent (CO_2e) in 90% design submissions, including the LCA software that was used to make the calculation, the components of the building that are included in the calculation, shop drawings or other technical specifications of key materials.
- Certificate per Section 6.4 at completion of construction.

5.2.10 On-Site Renewables – Rooftop Photovoltaics

Intent: To promote the production of GHG-free electricity from a renewable source and offset the operating costs of a building.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
120 W/m²	160 W/m²	200 W/m²						
Cost Guidance: Approximately 300, 400 and 550 $/m², or 2.50, 2.50 and 2.75 $/W, for Levels 1, 2 and 3, based on the building's footprint (i.e. total floor area divided by number of floors). Cost is based on cost to design and install a rooftop PV system, plus modest allowances for changes to the building electrical infrastructure and roof arrangement.								

Description

The Level threshold minimum values are stated in rated DC watts per square meter of total building roof area. This value may be increased by increasing the percentage of roof area covered with PV modules, decreasing the spacing between modules, or increasing the efficiency of the modules. Target values are suitable for flat roofs and most pitched roofs. For example, the Level 1 value of 120 W/m² of roof area could be accomplished with 20% efficient PV modules (readily available in 2022) covering 60% of the available roof space. Level 3 would require either module efficiencies well above 20%, or a mounting configuration that would allow almost complete coverage of the entire roof, with minimal gaps between modules (or some combination).

Currently PV power systems in Ontario require permission from the Local Distribution Company (LDC). LDC's may refuse in some locations (historically, this is uncommon), or may limit the capacity of PV systems. At the time this Standard was prepared, it was common for LDC's to limit the PV system capacity to no larger than the amount of electricity that the building would consume in one (1) year. As long as this restriction is in place, some buildings may have capacity limits imposed that are lower than the stated Level targets, especially for single-story buildings with limited electrical loads. In this situation, the rooftop PV system size and capacity should be limited to the electricity consumption of the building and the cost guidance $/W will be most applicable.

Some buildings, by their location, size or nature, may not be suitable hosts for rooftop PV systems. Any exemption from the requirement for a rooftop PV system will require clear and convincing reasons from the Contractor, which must then be formally accepted by the Town's Project Manager.

Submission Requirements

- Contractor shall include in 30%, 60% and 90% design submissions, all applicable documentation to facilitate the design, installation, operation and maintenance of the PV system (shop drawings or other technical specifications, maintenance manuals, etc.).
- Contractor shall contact the LDC (Hydro One Networks, Inc. or HONI), informing them of the intent to install photovoltaics, prior to the 30% design submission, and shall include evidence of such contact in the design submission. Contractor shall submit, in a timely manner, any and all documents required by HONI to gain their approval.
- Design submissions to include a detailed estimate of expected annual electricity production.
- Provide, within five (5) working days of submission, a copy of the application for a Connection Impact Assessment, if required by local utility.
- Report receiving local utility's permission to connect and operate within five (5) working days of receiving permission.
- Certificate per Section 6.4 at completion of construction.

5.3 Prescriptive Measures: Exterior and Site Design Elements, Mandatory in New Builds

5.3.1 Outdoor lighting

Intent: To reduce electricity consumption in the buildings outdoor lighting systems.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
140 lm/W		160 lm/W						
Cost Guidance: Approximately 2.20, 2.20 and 2.80 $/m², for Levels 1, 2 and 3, based on the total lighted outdoor area (e.g. parking lot area).								

Description

The weighted average outdoor lighting efficacy shall meet or exceed the levels indicated for each level, based on the nameplate efficacy when new. The average efficacy shall be weighted both by floor area and design lighting levels (lux).

Outdoor lighting levels should meet, but not exceed, current values recommended by the Illuminating Engineering Society (IES) in their design guide applicable to the type of outdoor space (e.g. IES RP-8-18, Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting).

All outdoor light fixtures shall have a U0 Uplight rating as per the BUG rating system (Backlight, Uplight, and Glare).

In addition, outdoor areas are not to be lit continuously at constant levels from dusk to dawn; the average lighting intensity of outdoor areas shall be reduced by at least 50% from at least 1:00 a.m. to 6:00 a.m., except in locations where security concerns are paramount.

Partial or complete exemptions from this measure may be granted by the Town if the operational requirements of the building would otherwise be impaired (e.g. overnight dimming of some outdoor lighting may not be acceptable at firehalls).

Submission Requirements

- Contractor shall submit a lighting layout for approval within the 60% design submission (and in subsequent submissions, if material changes are made).
- Contractor shall include in 60% and 90% design submissions, including shop drawings or other technical specifications, and a calculation of the average efficacy of all outdoor lighting, weighted by both illuminated area and light levels. Include schedule of timed changes to lighting levels.
- Certificate per Section 6.4 at completion of construction.

5.3.2 Electric Vehicle Infrastructure

Intent: To reduce community and corporate GHG emissions by promoting the use of electric vehicles.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
Charging ports for 5% of parking spaces	Charging ports for 10% of parking spaces	Charging ports for 15% of parking spaces						
Cost Guidance: Approximately $7,500 per charging port and for Levels 1, 2 and 3. Cost guidance is based on Level 2 chargers, each with two charging ports at $15,000 per 2-port charger. Higher capacity Level 3 chargers may cost $50,000-$80,000 per charging port; single, 2-port Level 3 chargers are expected to be used only for Town fleet vehicles, and thus will be strategically placed at facilities throughout the Town to meet the needs of the Town's mobile workforce. Adding EV chargers to existing facilities is highly encouraged, however budget considerations for increasing electrical capacity to buildings cannot be generalized within this measure. It is therefore recommended that any need for increasing electrical capacity to support EV charging be identified on a site per site basis, along with associated costs.								

Description

"Charging ports" refers to the complete installation of EV chargers, such that all cars in the specified number of parking spaces may be plugged into chargers simultaneously. Note that charging stations and strategies for sharing multiple cars per station are evolving. To accommodate future developments, this Standard does not require that every car can receive a specific minimum charge rate simultaneously, nor does it explicitly define the capacity of the infrastructure that must be installed. The infrastructure and/or charging ports installed must be capable of providing fully functioning EV charging with equipment available at the time of construction. All EV chargers must be data network compatible and provide both CCS and CHAdeMo connectors.

The parking spaces attributed to the EV charging spaces must also be painted, with signage installed to signify that the parking space is for EV vehicles only that are being charged. This will be aligned with the existing charging spaces throughout the Town, and the Town's EV Charging Station Policy.

In addition to parking lot chargers, the Town may require charging infrastructure for fleet vehicles based at specific buildings, particularly work yards and fire halls. This infrastructure may be designed to support L3 chargers. Any such requirements related to fleet vehicles are to be requested by the Town for specific buildings.

Submission Requirements

- Contractor to include number of current and future EVSE spaces and indicate locations on Site Plan submission.
- Contractor shall include in 60% and 90% design submissions, including shop drawings or other technical specifications.
- Certificate per Section 6.4 at completion of construction.

5.3.3 Bicycle Infrastructure

Intent: To support active transportation and reduce community reliance on vehicles.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
8 spaces minimum; charging for 2 electric bikes	12 spaces minimum; charging for 2 electric bikes	16 spaces minimum; charging for 4 electric bikes						
Cost Guidance: Approximately $2,500, $3,000 and $3,500 $/building for Levels 1, 2 and 3. This cost guidance is based on outdoor bicycle racks; bicycle sheds or indoor parking will have higher costs. The cost of a bicycle repair kit and electrical outlet(s) for charging electric bikes is included. The cost of a shower is not included in the cost guidance, as it is assumed that all of the building types would already include at least one shower. For further guidance, the cost of adding additional bike rack spaces only is estimated at approximately $125 per space.								

Description

Each site is to provide bicycle parking for the minimum amount of spaces as indicated. In addition, each site is to provide at least one (1) on-site shower, a bike repair station and electric outlets to accommodate the simultaneous charging of at least two (2) electric bikes (four (4) for Level 3).

Submission Requirements

- Contractor to include bicycle parking locations and quantity on Site Plan submission.
- Contractor shall include in 60% and 90% design submissions, including shop drawings or other technical specifications.
- Certificate per Section 6.4 at completion of construction.

5.3.4 Reduced Heat Vulnerability

Intent: To reduce solar heat gain in the building specifically, and the urban heat island effect.

NOTE: *This measure should only be specified on buildings where rooftop solar (see 5.5.1) is determined to not be feasible, as rooftop solar is preferred over reducing heat vulnerability.*

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
SRI >82 (low slope); SRI>39 (steep slope)								

Cost Guidance: Approximately 2.50 $/m², for all three Levels, based on the building's roof area. The cost premium is based on using white thermoplastic polyolefin (TPO) for a membrane roof, rather than lower cost black membrane. For inverted (ballasted) roofs or sloped roofs, the cost premium is expected to be minimal, as light-coloured materials (e.g. ballast, shingles) are approximately the same cost as corresponding dark-coloured materials.

Description

The uppermost material (e.g., shingles, ballast, membrane) of a roof must have a Solar Reflectance Index (SRI) at or greater than the target values listed. Low slope includes roofs from flat to 20° slope; steep slope roofs have slopes greater than 20°.

"Green roofs" covered with plants also meet this requirement.

"Blue roofs" that retain water on the roof meet this requirement, only if the design is able to retain at least 1 cm of water for at least 80% of the days from June 1 through August 31, in a year of typical weather.

Submission Requirements

- Contractor shall include in 60% and 90% design submissions, including shop drawings or other technical specifications.
- Certificate per Section 6.4 at completion of construction.

5.3.5 Stormwater Management

Intent: To build community resiliency through onsite management of stormwater using best management practices to reduce flooding.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
- Retain 100% of the 90th percentile rainfall event for Caledon; - 80% TSS removal.		- Retain 100% of the 90th percentile rainfall event for Caledon; - 90% TSS removal.						
Cost Guidance: Approximately 4 and 10 $/m², for Levels 1 and 2, and 3, based on the lot size (or area affected by the project, if much smaller than the lot size). Cost guidance assumes that stormwater is being retained in surface structures (e.g. building roof, parking lot surface, dry pond). If the site requires substantial retrofits to achieve the criteria, such as in an underground tank or other structure, cost premiums may be substantially greater. Cost guidance is based on a generally flat, "green field" site, not a change to an existing stormwater management system. Cost premium can vary substantially, depending on space constraints. Cost premium for increasing TSS removal from 80% to 90% in Level 3 is uncertain.								

Description

This criteria applies to municipal buildings that do not have stormwater that is designed and managed as part of a larger subdivision plan. For buildings that have defined stormwater management as determined through an area-wide plan, they should continue to be in compliance with that approved plan.

While details of and options for stormwater management can be complex, the three (3) basic requirements for stormwater management in Ontario are (1) to retain small and moderate rainfalls onsite, (2) to temporarily detain larger precipitation events on site, releasing the stormwater slowly, to mitigate flooding and erosion impacts, and (3) to manage the quality of stormwater leaving the property by removing total suspended solids (TSS).

As of January 2022, Ontario regulations require that stormwater from rainfall events up to and inclusive of the 90th percentile (which, for Caledon, is currently estimated to be 27 mm) be retained onsite. All Levels comply with this requirement. All levels also require that, for larger rainfall events, where a portion of the stormwater leaves the site, stormwater leaving the site have 80% (Levels 1 and 2) or 90% (Level 3) of TSS removed. All Levels in this standard also call for parking lot salt management:

- **Water Quantity Control:** Common design practice for controlling the quantity of stormwater generated from impervious areas is to detain (i.e. temporarily store precipitation) and control the rate of outflow from a site, and to retain (i.e. permanently manage with no outflow) precipitation onsite. This is done with the intent of managing flooding and erosion impacts of the receiving natural system and maintain the water balance on site. Detention of runoff can be achieved through practices like roof top storage detaining precipitation on the surface (until it evaporates) and restricting the rate at which stormwater from very large rainfalls drains, so that it takes several hours to drain. The 90th percentile rainfall amount (i.e. 27 mm) is currently the maximum level of a rainfall event

that is to be retained onsite; larger events are expected to have excess water flow from the site in a controlled manner.

- **Water Quality Control:** Removal of TSS can be achieved through infiltration and filtration of stormwater. As such, a portion of the water quality control criteria can be met by achieving water quantity control criteria. Filtration of stormwater can be met through manufactured treatment devices like oil and grit separators, or through the use of Low Impact Development (LID) practices like bioswales which are vegetated surface swales.
- **Parking Lot Salt Management:** Chlorides from road de-icing agents, is a chemical of concern that is significantly impacting the environment. To help improve lot level stormwater quality, all new parking lots associated with new buildings shall implement the "Parking Lot Design Guidelines to Promote Salt Reduction" by Lake Simcoe Region Conservation Authority.

Applicable only to work yards, a pollution prevention plan, including spill response (both incidental and ongoing), must be developed and implemented.

Submission Requirements

- Contractor shall provide a stormwater management report including rainfall data and volume calculations.
- Contractor to include SWM measures on Site Plan submission (existing area wide or specific to the site, as applicable).
- Contractor shall include in 30%, 60% and 90% design submissions, including shop drawings or other technical specifications in 60% submission.
- Certificate per Section 6.4 at completion of construction.

Resources

- Design of Practices: CVC/TRCA LID Guide (most current addition); Low Impact Development Treatment Trail Tool Low Impact Development Treatment Train Tool - STEP Water (sustainabletechnologies.ca).
- Parking Lot Guidelines to Promote Salt Reduction: Parking Lot Design Guidelines (lsrca.on.ca).

5.3.6 Biodiversity

Intent: To promote biodiversity, decrease outdoor water consumption, and avoid invasive species.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
20% native, drought tolerant; 25% pollinator friendly; tree planting as described below.	30% native, drought tolerant; 25% pollinator friendly; tree planting as described below.	50% native, drought tolerant; 25% pollinator friendly; tree planting as described below.						
Cost Guidance: Approximately 4, 6 and 9 $/m², for Levels 1, 2 and 3, based on the size of the total area to be landscaped.								

Description

The native, drought tolerant and pollinator friendly percentages refer to a percentage of the landscaped area on the building site and may overlap. That is, areas planted with plants that are both pollinator friendly and drought tolerant may count toward both targets. All native plants should be sourced from colder climate zones. Priority shall be given to plants native to Ontario, but plants native to other areas of Canada will also be acceptable.

Tree planting must be incorporated into both softscape and hardscape with a minimum soil volume of 16 m^3, 30 m^3, and 45 m^3 for small, medium and large-sized trees, respectively. Shade trees are required, approximately 6 - 8 m apart along all street frontages and open space frontages and 8 - 10 m apart along public walkways.

In addition, Caledon's Comprehensive Town-Wide Design Guidelines document should be followed, specifically that a minimum portion of the overall street and visitor parking areas should have grassed areas, and that these areas shall have vegetated trees or shrubs, and that any islands with trees shall have a minimum width of 3 m.

Submission Requirements

- Contractor to include landscaped locations, identifying drought tolerant and pollinator friendly areas on Site Plan submission.
- Contractor shall provide details of drought tolerant and pollinator friendly vegetation in 90% design submission, including a listing of all plant varieties selected for the site. A maintenance plan for the various plants is also to be included in the 90% submission.
- Certificate per Section 6.4 at completion of construction.

5.3.7 Education

Intent: To educate the community and facility users on the important efforts the Town is undertaking to address climate change

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
Fixed signage								
Cost Guidance: Approximately $1,500 per building, for Levels 1, 2 and 3.								

Description

This consists of fixed signage in one or more prominent places, describing the green features of the building. Where a substantial outdoor element is included in a design (e.g. pollinator friendly landscaping, advanced stormwater management), topical signage at the outdoor location should be included.

Submission Requirements

- Permanent signage design is submitted for review at least four (4) weeks prior to fabrication.
- If live or dynamic displays are intended, suitable sensors, wiring and display devices are to be included in the electrical drawings in the 60% and 90% submissions.

5.3.8 Construction Waste Management

Intent: To divert waste construction materials and demolition materials from landfills to re-use or recycling facilities.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
75% of 3 waste streams	90% of 3 waste streams	90% of 5 waste streams						
Cost Guidance: Approximately 2, 4 and 8 $/m², for Levels 1, 2 and 3, based on the total floor area of the building. Cost guidance is based on waste generated during construction, excluding any waste from demolition that may precede the construction. Cost guidance is based on added cost to collect and re-cycle materials, versus tipping fees for unsorted materials. Cost premium excludes costs for levels of material recycling that are already common practice in the construction industry.								

Description

A waste stream is defined by a common construction waste material, and may include concrete, metal, drywall, plastic, wood, or glass. The designated percentage, by weight, of the material type must be separated at the construction site and sent to a facility where it is prepared for re-use or recycled.

Submission Requirements

- Contractor to develop and submit a compliant Construction and Demolition Waste Management Plan prior to site mobilization.
- Contractor to provide regular reports on construction waste diverted to recycling facilities, and on total construction waste amounts, not less than quarterly during construction period.
- Certificate per Section 6.4 at completion of construction, including declaration of final quantities of construction waste materials.

5.4 Prescriptive Measures: Direct Building Elements, Not Mandatory in New Builds

5.4.1 Thermal Resistance – Roofs

Intent: To reduce unwanted thermal conduction losses and gains.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
32	40	50						
Cost Guidance: Approximately 0, 600 and 1,200 $/m², for Levels 1, 2 and 3, based on the building's footprint (i.e. total floor area divided by number of floors).								

Description

Minimum wall R-values shall meet or exceed those specified. These R-values are to be the value of the complete roof assemblies, including the detrimental effects of any thermal bridging, which should be minimized. Units are $ft^2 \cdot °F \cdot h/BTU$.

Submission Requirements

- Contractor shall include an indicative section detail of the roof, including a calculation of effective thermal resistance, in the 30% design report.
- Certificate per Section 6.4 at completion of construction.

5.4.2 Thermal Resistance – Walls, Above Grade

Intent: To reduce unwanted thermal conduction losses and gains.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
16	24	32						
Cost Guidance: Approximately 250, 750 and 1,250 $/m², for Levels 1, 2 and 3, based on the total above=grade wall area (excluding windows and doors) of the building.								

Description

Minimum wall R-values shall meet or exceed those specified. These R-values are to be the value of the complete wall assemblies, including the detrimental effects of any thermal bridging, which should be minimized. Units are $ft^2 \cdot °F \cdot h/BTU$.

Submission Requirements

- Contractor shall include an indicative section detail of an exterior wall, including a calculation of effective thermal resistance, in the 30% design report.
- Certificate per Section 6.4 at completion of construction.

5.4.3 Thermal Resistance – Walls, Below Grade

Intent: To reduce unwanted thermal conduction losses and gains.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
10	12	15						
Cost Guidance: Approximately 100, 200 and 350 $/m², for Levels 1, 2 and 3, based on the total below grade wall area, where the interior space adjacent to the wall is fully conditioned.								

Description

Minimum wall R-values shall meet or exceed those specified. These R-values are to be the value of the complete wall assemblies, including the detrimental effects of any thermal bridging, which should be minimized. Units are $ft^2 \cdot °F \cdot h/BTU$.

Submission Requirements

- Contractor shall include an indicative section detail of a below-grade wall, including a calculation of effective thermal resistance, in the 30% design report.
- Certificate per Section 6.4 at completion of construction.

5.4.4 Thermal Resistance – Windows

Intent: To reduce unwanted thermal conduction losses and gains.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
4	6	8						
Cost Guidance: Approximately 300, 500 and 800 $/m², for Levels 1, 2 and 3, based on the total window area of the building.								

Description

Minimum window R-values shall meet or exceed those specified, for all non-operable windows; for operable windows, the target values shall be decrease by 10% (i.e. 3.15, 4.5 and 6.3 for Levels 1, 2 and 3, respectively). These R-values are to be the value of the complete window assemblies, not "centre of glass" values. Units are $ft^2 \cdot °F \cdot h/BTU$.

Submission Requirements

- Contractor shall include in 30%, 60% and 90% design submissions, including shop drawings or other technical specifications in 60% submission.
- Certificate per Section 6.4 at completion of construction.

5.4.5 Air Tightness

Intent: To reduce unwanted thermal conduction losses and gains.

Level 1	Level 2	Level 3	WY	FH	CC	AC	IR	SP
1.5 L/s/m² at 75 Pa	1.3 L/s/m² at 75 Pa	1.0 L/s/m² at 75 Pa						
Cost Guidance: Approximately 0 $/m², for all three Levels, based on the total floor area of the building. The reason for the zero cost premium is that air tightness is more a factor of attention to detail and quality workmanship during construction than of design or materials. The evidence is that well trained crews can construct low leakage envelopes with minimal additional labour.								

Description

Level target values are maximum values expressed as L/s (at 75 Pa pressure difference) per square meter of the entire building envelope; that is, the sum of all wall, roof, window and door areas.

Buildings with many overhead doors may have difficulty in achieving these targets, but products that provide improved seals for overhead doors are commercially available.

Submission Requirements

- Contractor shall include design details to ensure air tightness in 90% design submissions, including shop drawings or other technical specifications in 60% submission, executed contract with air tightness testing provider, air tightness testing plan describing the

project's approach, quality assurance and quality control activities, completed air tightness testing report.
- Commission Agent to submit blower door (air tightness) test report within five (5) working days of completion of the test (included in section 5.3.4 Commissioning Agent)
- Certificate per Section 6.4 at completion of construction.

6.0 Compliance

For new construction, compliance with this standard during the design phase is assured by a combined energy and GHG model, which is submitted with all major submissions from concept design through as-built, with the as-built energy/GHG model being the final model.

6.1 Energy Modelling Requirements

During the design phase, compliance with this Standard will be based on energy modeling. This Standard does not specify acceptable and unacceptable modeling software; upon award of contract, the Contractor is to recommend the energy modeling software they intend to use and gain the acceptance of the Town prior to proceeding. The Contractor must submit an energy model that demonstrates that the GHGI, EUI and TEDI values will be achieved. The energy model is to be included with each major design submission (e.g., 30%, 60%, 90% and 100%), and the model inputs used at each submission must be in accordance with the other design documents of the submission.

Design related modelling inputs not specified in this document, shall represent, to an appropriate degree of accuracy, the design of the facility. Software limitations shall not be limited to the accuracy of the energy modelling to show compliance. Consultants are expected to overcome any software limitations with appropriate engineering calculations.

For guidance, energy modelers may refer to:

- Canadian Green Building Council's "Zero Carbon Building - Design Version 2 Energy Modelling Guidelines";
- Ontario Building Code's Supplementary Standard SB-10 "Energy Efficiency Supplement";
- National Energy Code of Canada for Buildings 2017 (NECB), particularly the room/space type as per NECB 2017 Table 8.4.3.2(2) B and the operation schedules for occupancy, lighting, receptacle equipment, heating, cooling and service water as per Note A-8.4.3.2(1).
- The occupancy and lighting schedules included in ANSI/ASHRAE/IES Standard 90.1: Energy Standard for Buildings Except Low-Rise Residential Buildings.

In all cases, more recent versions of the above documents may be used, if and when they are published. However, information and specifications from the actual building design should be used in place of recommendations included in any of these documents, in cases where specific project data is known to differ from the guidelines. Note also that the air infiltration rate to be used in the final energy model is to correspond to the measured data (see section 6.2).

As weather input to the energy modeling software, the Canadian Weather for Energy Calculations (CWEC) typical year weather file for Pearson Airport should be used.

The Emissions Factors to be used for natural gas and electricity should be referenced from the most recent "National Inventory Report: greenhouse gas sources and sinks in Canada".

To be acceptable to the Town, the Contractor must have the energy model reviewed by an independent third-party, who may be the building commissioning agent. This third party will be responsible for verifying model inputs, assumptions and outputs.

6.2 New Construction, Construction Phase

During construction, any changes to the design or construction details that, in the Town's judgement, risk compliance with the most recently submitted energy model, may trigger a request from the Town to update the energy model to demonstrate continued compliance with the GHGI, EUI and TEDI targets of this Standard.

During the commissioning work at the close of the construction phase, some tests are required to be delivered by the Commissioning Agent. These tests are to inform changes to inputs in the energy model, as appropriate. Mandatory tests are:

- Measurement of whole building air infiltration rate (blower door test);
- Thermography to detect thermal bridging;
- Measurement of fresh air ventilation rates.

The measured values from these tests are to be used as inputs to the final energy model for the building. Specifically, the measured air infiltration rate is to be used as the air infiltration rate in the energy model, the thermography results are to be used to adjust the effective R-values in the energy model and the measured fresh air ventilation rates are to be used as the ventilation rates in the energy model.

At the completion of construction, the Contractor is to submit a final energy model as part of the completion process, with the expected GHGI, EUI and TEDI values clearly indicated. These final GHGI, EUI and TEDI values are to be reviewed by the third-party modeler first mentioned in Section 4.2 of this Standard.

6.3 New Construction, Operating Phase

Once a building is completed and operating, the Town will record energy consumption and, at least once per year, calculate the GHGI and EUI values of the building, by summarizing utility invoices and applying appropriate GHG emission factors for electricity and natural gas. In some cases, data from utility invoices may be supplemented by measurements of the building's BAS system.

Any significant deviations from the modeled values are to be investigated. Investigation can take any form deemed appropriate by the Town, but should include:

- A comparison of the past year's weather vs. weather included in the energy model, and;
- A review of the usage of the building during the past year, to determine if it is in accordance with the expected usage.

TEDI values are not subject to verification during operation.

6.4 Compliance with Prescriptive Measures

As the prescriptive measures cover a range of individual topics, methods of ensuring compliance may vary among them. However, the compliance process for each measure should include the following:

1) Within the concept design submission, each applicable prescriptive measure should be clearly addressed, with an affirmation that the target Level will be met or exceeded.
2) Within the 100% design submission, a signed certification that the final design complies with each of the applicable prescriptive measures, with individual descriptions of how compliance was verified.
3) Within the substantial completion documents, a signed certification that the constructed building complies with each of the applicable prescriptive measures, with individual descriptions of how compliance was verified. Where compliance was verified by or supported by a field test (e.g., thermography, air infiltration rate test), complete test reports must be submitted. Certificates may be signed by any of the Designer, General Contractor or Building Commissioning Agent, as is most applicable for individual Prescriptive Measures. (Thus, multiple certificates are acceptable.)

For guidance on verification of compliance for each prescriptive measure, see the individual measures in Section 5.0 of this Standard.

7.0 Financial Guidelines

The following three (3) tables provide cost estimates for new buildings, of the design and construction costs, annual utility costs, and return on investment (IRR) over a 40-year period, corresponding to the three levels. In addition, costing information for Level 3 designs are provided with and without a PV array sized to produce 100% of the energy consumed annually, thus net-zero energy. As there are multiple design paths to meet the GHGI, EUI and TEDI requirements, the values in these three tables are provided for guidance purposes only; actual costs will differ for every design.

In all cases, the reference cost is a building designed to meet the Ontario Building Code 2017 (OBC), equipped with a heating system based on a natural gas boiler. For the purposes of calculating utility costs, the cost of carbon included in the electricity and natural gas pricing was assumed to be $170/tonne, which is the price planned for the year 2030, and assumed to be a reasonable, yet conservative, approximation of the average cost of carbon during a building's lifetime.

The Level 3 designs are presented both without and with rooftop (or ground mount) PV sufficient to generate all required electricity, the annual utility costs for those facilities with PV is zero; thus, a reduction of 100%. Note that Level 3 work yards, firehalls, community centres and administrative centres are expected to have sufficient roof space to accommodate enough PV to achieve net zero (assuming they do not exceed 3 floors in height). Ice rinks and swimming pools are likely to require more PV than can be accommodated on their own roofs; roofs of adjacent buildings, PV parking lot canopies or conventional ground mount systems in open areas are potential locations for additional PV for these buildings types. Of these alternate locations, parking lot canopies are likely to cost more than rooftop or conventional ground mount PV, but such additional costs were not factored into the values in the following tables.

Table 2 - Estimated Capital Cost Premium

Building Type	Level 1	Level 2	Level 3	Level 3 + PV
Work Yard	4%	5%	8%	10%
Fire Hall	5%	6%	9%	11%

Building Type	Level 1	Level 2	Level 3	Level 3 + PV
Community Centre	3%	1%	6%	8%
Administrative Centre	2%	1%	3%	5%
Ice Rink	4%	5%	14%	19%
Swimming Pool	0%		1%	3%

Table 3 - Estimated Annual Utility Cost Premium (Savings)

Building Type	Level 1	Level 2	Level 3	Level 3 + PV
Work Yard	(-22%)	(-44%)	(-51%)	(-100%)
Fire Hall	(-28%)	(-52%)	(-63%)	(-100%)
Community Centre	(-14%)	(-47%)	(-50%)	(-100%)
Administrative Centre	(-21%)	(-39%)	(-47%)	(-100%)
Ice Rink	(-19%)	(-22%)	(-29%)	(-100%)
Swimming Pool	(-33%)		(-47%)	(-100%)

Table 4 - Estimated 40-Year Return on Investment (IRR)

Building Type	Level 1	Level 2	Level 3	Level 3 + PV
Work Yard	1.2%	3.3%	1.5%	4.0%
Fire Hall	2.5%	4.4%	3.4%	5.2%
Community Centre	2.5%	23.6%	6.3%	8.8%
Administrative Centre	3.2%	20.6%	6.3%	6.9%
Ice Rink	0.6%	2.6%	(-0.9%)	-0.4%
Swimming Pool	---		32.3%	15.7%

8.0 References

Green building general information

Architecture 2030. 2018. "Zero Code." Santa Fe, NM.

BC Energy Step Code. 2019. "Design Guide." British Columbia.

BC Energy Stepcode. 2019. "BC Energy STep Code Costing Study Analysis." British Columbia.
Canada Green Building Council. 2020. "Zero Carbon Building Design Standard Versin 2." Ottawa, ON.

Canada Green Building Council. 2020. "Zero Carbon Building Performance Standard Version 2." Ottawa, ON.

Canada Green Building Council. 2017. "Zero Carbon Building Standard." Ottawa, ON.

City of Mississauga. 2019. "Coproate Green Building Standard for New COnstruction and Major Renovations Building Projects." Toronto, ON.

Credit Valley Conservation & Toronto Regional Conservation Authority. 2010. "Low Impact Development Stormwater Management Planning." Toronto, ON.

Passive House Institute. 2015. "Criteria for the Passive House, EnerPHit and PHI Low ENergy Buildign Standard." Darmstadt, Germany.

Pembina Institute. 2020. "Carbon Metrics in Codes and Alignment with Energy Disclosure Tools." Ottawa, ON.

Resilient Caledon. 2021. "Community Climate Change Action Plan." Caledon, ON.

U.S. Green Building Council . 2019. "LEED v4 for Building Design and Construction." USA.

ZEBx. 2021. "Construction Cost Analysis of High-performance Multi-unit Residential Buildings in British Columbia." British Columbia.

Green building costing information

Altus Group. 2018. "2018 Canadian Cost Guide." Ontario.

Altus Group. 2021. "2021 Canadian COST Guide." Ontario.

J.L. Richards & Associates Limited. 2021. "Caledon Corporate Green Building Standard Update: Energy, Emissions and Financial Analysis Report." Ottawa, ON.

The City of Toronto. 2017. "Zero Emissions Buildings Framework." Toronto, ON.

BEST MANAGED COMPANIES CANADA Platinum member

www.jlrichards.ca

Ottawa

864 Lady Ellen Place
Ottawa ON Canada
K1Z 5M2
Tel: 613 728-3571

ottawa@jlrichards.ca

Kingston

203-863 Princess Street
Kingston ON Canada
K7L 5N4
Tel: 613 544-1424

kingston@jlrichards.ca

Sudbury

314 Countryside Drive
Sudbury ON Canada
P3E 6G2
Tel: 705 522-8174

sudbury@jlrichards.ca

Timmins

834 Mountjoy Street S
Timmins ON Canada
P4N 7C5
Tel: 705 360-1899

timmins@jlrichards.ca

North Bay

501-555 Oak Street E
North Bay ON Canada
P1B 8L3
Tel: 705 495-7597

northbay@jlrichards.ca

Hawkesbury

326 Bertha Street
Hawkesbury ON Canada
K6A 2A8
Tel: 613 632-0287

hawkesbury@jlrichards.ca

Guelph

107-450 Speedvale Ave. West
Guelph ON Canada
N1H 7Y6
Tel: 519 763-0713

guelph@jlrichards.ca

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS