KINDRED WORKS

Specific and Measurable Communication of the Environmental Performance of MURBs

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Executive Summary

- Energy models obtained for code compliance can also be used as a basis for statements about environmental performance.
- Current industry practices encourage the use of relative performance metrics which are opaque, difficult to compare, and difficult to verify.
- Total energy use intensity, greenhouse gas intensity, and thermal energy demand intensity are three metrics that are well suited to describing the environmental performance of pre-development projects.
- Table 2 gives examples of performance benchmarks applicable to new construction MURBs in Ontario.
- Energy models are idealized estimates of performance. Care should be taken when comparing modelled consumption to existing building benchmarks.

Introduction

As a growing number of real estate developers make net zero commitments, stakeholders will expect to see more evidence that business decisions are being informed by carbon reductions. In the case of new construction, investors, lenders, and tenants are increasingly favouring low carbon designs that minimize decarbonization transition risk, physical climate-related risks, and exposure to future energy costs. For projects intended to address these risks, it's important that environmental performance is communicated in a specific and measurable fashion. This goes a step beyond highlighting sustainable features and reporting "percent better than" metrics. Developers need to state absolute, quantitative metrics alongside relevant benchmarks.

This paper provides guidance for developers of Multi-Unit Residential Buildings (MURBs) in Ontario looking to communicate the environmental performance of pre-development projects. Recommended practices surrounding energy modeling, energy and carbon metrics, and benchmarking, are shared.

Three Step Process

The actions a developer needs to take, to be able to communicate environmental performance in a specific and measurable fashion, can be summarized in three steps.

1 ENERGY MODELING 2 METRICS SELECTION 3 BENCHMARKING

1 ENERGY MODELING

In the operation of buildings, carbon emissions come from the fossil fuels and electricity used to create comfortable living conditions and facilitate occupant activities. In order to claim a proposed building will achieve carbon emissions reductions, it's necessary to estimate how much fuel and electricity the building will use.

An energy model is a computer simulation that predicts the annual energy needs of a building. This includes energy in the form of natural gas or electricity used for heating, cooling, ventilation, lighting, elevators, and more. To make a prediction, energy models need extensive information about the proposed building, such as the climate it's located in, its shape and size, how much insulation is in the walls, and its HVAC system. Typically, this information is gathered by a certified energy modeler working with the architect, mechanical engineer, and electrical engineer.

Depending on the building type and its location, an energy model may be required by the authorities having jurisdiction regardless of the developer's sustainability goals. In Ontario, a popular way of demonstrating compliance with the Energy Efficiency Criteria (SB-10) of the Ontario Building Code (OBC), is through energy modeling. In Toronto, energy modeling is required for residential buildings more than 4 storeys as part of the Site Plan Approval (SPA) process. Regardless of whether energy modeling is performed for code compliance, municipal approvals, or voluntarily, it's a necessary step for reporting the environmental performance of a project. As will be explained in the next section, it doesn't take much effort to turn the results of a compliance energy model into metrics that speak to climate change mitigation.

2 METRICS SELECTION

Energy models produce a huge volume of data which needs to be distilled into key performance metrics. In our experience, suitable metrics are those that meet the following criteria:

1. **Relevant:** Speaks to how the building mitigates climate change, and how it adapts to physical climate-related risks.
2. **Comparable:** Enables apples-to-apples comparisons with other buildings.
3. **Verifiable:** Can be verified post-occupancy.

Three metrics which meet these criteria are total energy use intensity (TEUI), greenhouse gas intensity (GHGI), and thermal energy demand intensity (TEDI). These metrics describe the amount of energy used or carbon emitted per unit of floor area, thereby enabling comparisons between small buildings and large buildings. Further descriptions of these metrics are provided in Table 1.

Progressive jurisdictions, green building rating systems, and building codes are increasingly adopting TEUI, GHGI, and TEDI as the basis for building performance criteria. Examples of entities that reference some or all three of these metrics include: Toronto Green Standard, Canada Green Building Council Zero Carbon Building standard, and the Vancouver Building By-law.

RELATIVE METRICS

The current industry standard practice is to report environmental performance in terms of *relative metrics*. For example, a developer might claim a proposed building achieves a "30% reduction" in energy use or greenhouse gas (GHG) emissions. These types of statements raise the question: "30% relative to what?" Typically, the baseline is a reference building which is a hypothetical version of the proposed building where certain features – such as the amount of insulation in walls – have been modified to match code-prescribed values. The problem with this approach is that, for any two proposed buildings the reference buildings will be different. This makes it impossible to compare apples-to-apples, and can lead to incorrect conclusions about building performance. We recommend abandoning relative metrics in favour of *absolute metrics* such as TEDI, TEUI, and GHGI.

Table 1 - Recommended absolute metrics

TEUI Total energy use intensity	Kilowatt-hours per square metre per year ($kWh/m^2/yr$)	All the energy used by a building in a year, normalized by floor area. This includes energy used by mechanical systems, air conditioning, lighting, appliances, electronics, etc. Buildings with lower total energy use are less expensive to operate, for owners and tenants alike, while imposing less stress on regional power grids. The lower a building's TEUI, the better.
GHGI Greenhouse gas intensity	Kilograms of carbon dioxide equivalent per square metre per year ($kgCO_2e/m^2/yr$)	The annual greenhouse gas emissions resulting from the building's total energy use, normalized by floor area. This includes emissions from the combustion of fossil fuels on site, and emissions from the production of electricity. Greenhouse gases are expressed in terms of kilograms of CO_2 equivalent (CO_2e). There are seven greenhouse gases but CO_2 is the most prevalent. For simplicity, the warming effect of all seven gases are converted to an equivalent value of carbon dioxide. GHGI is the single most important metric of a building's impact on climate change.
TEDI Thermal energy demand intensity	Kilowatt-hours per square metre per year ($kWh/m^2/yr$)	The annual energy required to heat a building, normalized by floor area. Thermal energy demand considers heat losses through the building envelope and free heat gains from occupants, lighting, appliances, electronics, and solar radiation. Buildings with lower thermal energy demand require less energy to heat and cool, helping to reduce energy consumption, provide more comfortable interior conditions, and more easily maintain livable conditions during energy scarcity or absence. The lower a building's TEDI, the better.

3 BENCHMARKING

Since current industry practices encourage reporting of environmental performance in terms of relative metrics, most tenants, lenders, and investors will not have an intuition for absolute metrics like TEUI. For this reason, it's important to establish a point of reference – or benchmark – when communicating environmental performance. For example: "The average multifamily residential building in Ontario uses 226 kWh/m^2/yr. The proposed development is predicted to use only 74 kWh/m^2/yr."

Benchmarks generally fall into one of three categories:

- **Mandatory targets:** Performance levels specified by building codes, municipal by-laws, or other legislative frameworks. These benchmarks represent the minimum level of performance for a new development.
- **Voluntary targets:** Performance levels specified by green building rating systems, funding programs, and other frameworks. These benchmarks represent high efficiency and low carbon emissions.
- **Surveys of existing buildings:** Average performance of a subset of the existing building stock (e.g., MURBs built 2010 or later). Unlike mandatory and voluntary targets, surveys originate from actual, metered consumption data.

Table 2 lists some examples of benchmarks applicable to MURBs in Ontario. Figure 1 shows the TEUIs of those benchmarks. Expectedly, voluntary targets make for ambitious benchmarks. Surveys of existing buildings make for relaxed benchmarks because they include older buildings which would not meet mandatory targets today.

BENCHMARKING AGAINST EXISTING BUILDINGS

Special care needs to be taken when comparing energy models to surveys of existing buildings. The energy consumption predicted by energy models is based on a building's performance during a typical weather year. The metered consumption from real buildings, on the other hand, can fluctuate from year to year due to warmer- or cooler- than average weather. This discrepancy can lead to exaggerated comparisons. To avoid this, we recommend sourcing weather-normalized benchmarks, like those provided by the Ontario Energy and Water Reporting and Benchmarking initiative.

Another consideration is the inevitable performance gap between energy models and reality due to imperfect modeling assumptions. One study[1] suggests that MURBs in the Greater Toronto Area use 13% more energy and produce 28% more GHGs than their energy models predicted. We recommend treating energy models as idealized estimates of performance.

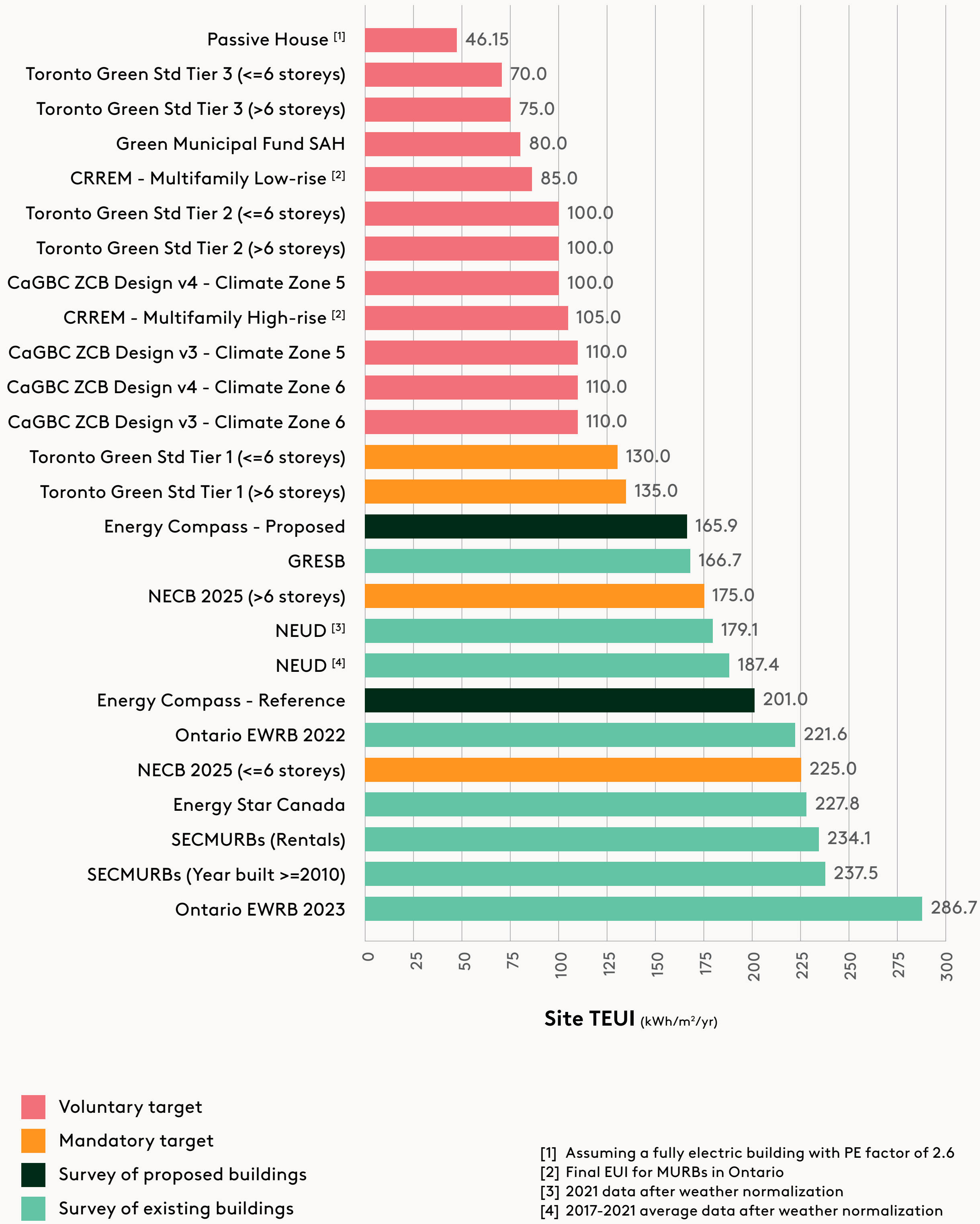
[1] EQ Building Performance; Urban Equation. (2019). Sidewalk Labs Toronto Multi-Unit Residential Buildings Study: Energy Use and the Performance Gap. Sidewalk Labs.

Table 2 – Performance benchmarks relevant to MURBs in Ontario

Benchmark	Categories	Smallest Geographic Scope	Total Energy Use Intensity (TEUI)	Greenhouse Gas Intensity (GHGI)	Thermal Energy Demand Intensity (TEDI)	Site or Source Energy
Passive House	Voluntary target	Canada [2]	X		X	Both [2]
CcGBC ZCB - Design	Voluntary target	Canada	X		X	Site
National Energy Code for building 2025	Mandatory target [3]	Canada	X [4]			Site
Toronto Green Standard	Voluntary or mandatory target [5]	Toronto	X	X	X	Site
Energy Star Canada	Survey of existing buildings	Canada	X			Both
NRCan National Energy Use Database (NEUD)	Survey of existing buildings	Ontario	X	X [6]		Site
GRESB 2023 Results	Survey of existing buildings	Americas	X	X		Site
Ontario Energy and Water Reporting and Benchmarking	Survey of existing buildings	Ontario	X [7]	X		Both
Survey of Energy Consumption of Multi-Unit Residential Buildings (SECMURBs)	Survey of existing buildings	Aggregate of eight Canadian municipalities	X			Site
CRREM North America	Voluntary target	Ontario	X	X		Site
Green Municipal Fund Sustainable Affordable Housing	Voluntary target [8]	Canada	X			Site
Energy Compass	Survey of proposed buildings	Ontario	X			Site

[1] Legislative frameworks, rating systems, and surveys are frequently updated. The reader is responsible for confirming this information is current.
[2] When Canada-specific Primary Energy factor is applied
[3] Mandatory if the applicable compliance path is selected
[4] Based on proposed changes under review
[5] Tier 1 is mandatory, higher Tiers are voluntary
[6] If Ontario-specific GHG emissions factors are applied by user
[7] Weather normalized TEUI is available
[8] Within the SAH program itself, the EUI criteria is mandatory for new builds.

Figure 1 – TEUI benchmarks for MURBs in Ontario



[1] Assuming a fully electric building with PE factor of 2.6
[2] Final EUI for MURBs in Ontario
[3] 2021 data after weather normalization
[4] 2017-2021 average data after weather normalization

Independent of the decision to compare against ambitious or relaxed benchmarks, users need to be careful to select benchmarks that make sense for the proposed building.

Key considerations are:

- **Typology:** Some building types are inherently more energy intensive due to their function and the activities they host. For this reason, the building type of the benchmark should reasonably match that of the proposed building. For example, a target meant for a data centre would not make a good target for an apartment building.
- **Climate Zone:** Some benchmarks are specific to certain climate zones. In Canada, climate zones are typically defined by the number of heating degree days (HDDs) in a year. Locations that are colder for longer experience more HDDs. Buildings in colder locations are typically assessed against more relaxed targets to compensate for the greater amount of heating energy required. Proposed developments should be compared to benchmarks intended for their climate zone.
- **Geographic Location:** The location of a building also determines where its electricity is sourced from. Some energy sources are more carbon intensive than others, meaning they emit more GHGs to produce the same amount of electricity. For example, coal power plants emit 760 grams of CO_2 equivalent per kilowatt-hour, while nuclear power plants produce zero direct emissions[2]. The overall carbon intensity of a region's electricity grid is a product of the various energy sources contributing to it. Targets with GHGI limits, such as those in the Toronto Green Standard, are normally based on the carbon intensity of a particular electricity grid. It may be unreasonable to apply these GHGI limits to developments outside of the intended region.
- **Treatment of On-site Renewable Energy:** Some targets allow renewable energy generated on-site (e.g. from rooftop solar panels) to be deducted from the total energy use and/or greenhouse gas emissions. In this case, the metrics are often referred to as "net TEUI" and "net GHGI". The Toronto Green Standard and CRREM are examples of targets that allow this deduction. To avoid misleading audiences about the base efficiency of a building, it is good practice to note when metrics include the benefit of on-site renewable energy.
- **Site vs. Source Energy:** In Canada, most benchmarks are expressed in terms of site energy, which is what gets reported on utility bills. Some benchmarks also consider source energy, which includes the losses associated with converting raw fuels into heat or electricity, and the losses from delivering that heat or electricity to the building. The ratio of source to site energy varies from location to location. Energy models can output results in terms of source energy if required.
- **Floor Area Measurement:** TEUI, GHGI and TEDI are normalized by floor area. Many benchmarks are based on a specific measurement standard for floor area. Notably, Passive House uses treated floor area (TFA), which varies significantly from other common measurements. We recommend confirming the floor area definition of benchmarks and applying corrections to ensure the energy model metrics are aligned.

[2] Schlömer S., T. Bruckner, L. Fulton, E. Hertwich, A. McKinnon, D. Perczyk, J. Roy, R. Schaeffer, R. Sims, P. Smith, and R. Wiser, 2014: Annex III: Technology-specific cost and performance parameters. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Closing

With an energy model, absolute metrics, and benchmarks in hand, a developer has all the ingredients they need to make specific and measurable statements about the environmental performance of their proposed development. The value of these statements and the rigorous process behind it is twofold. Firstly, it assures stakeholders that the sustainability ambitions of a project are motivated and effective. Secondly, it holds developers and building operators accountable to ensure the stated performance is met in operations. Said differently, specific and measurable statements bring ambitious projects to the forefront, and lead to real carbon reductions in the buildings sector.