NET ZERO EXISTING BUILDINGS RETROFITTING MURBs & OFFICES

WORKSHOP REPORT
June 10, 2022

Hosted by:
Sustainable Buildings Canada
The University of Toronto
& The City of Toronto

Acknowledgements

Land Acknowledgement

The University of Toronto ("U of T"), Sustainable Buildings Canada ("SBC"), and the City of Toronto (The City") acknowledge that we are on the traditional territory of many nations including the Mississaugas of the Credit, the Anishnabeg, the Chippewa, the Haudenosaunee, and the Wendat peoples and is now home to many diverse First Nations, Inuit, and Métis peoples. We also acknowledge that Toronto is covered by Treaty 13 signed with the Mississaugas of the Credit, and the Williams Treaties signed with multiple Mississaugas and Chippewa bands.

We acknowledge and recognize the efforts of Indigenous Peoples across Turtle Island for their climate leadership and for being active drivers of positive change. We are eternally grateful for Indigenous stewardship of these lands and waters since time immemorial.

General Acknowledgement

We wish to acknowledge the industry leaders, subject matter experts, and City of Toronto staff who participated in the workshop and offered their time and expertise to identifying barriers and potential solutions for retrofitting MURBs and offices in Toronto, and whose ideas and feedback are encapsulated in this report and consolidated barriers document. A special thanks goes to our Steering Committee members, namely Mike Singleton (SBC), Leona Savoie (Dorsay Development Corp.), Michelle Xuereb (BDP Quadrangle), John Robinson (U of T), Kim Slater (U of T), Angelina Ouyang (U of T), Laura Tozer (U of T), and Emily Smit (U of T), and our partners at the City, namely James Nolan, Stewart Dutfield, Cecilia Fernandez, Ana Maria Medina, Devon Stopps, and Joanna Kraus, who each invested a considerable amount of time and energy in designing the proceedings and facilitating the workshop. Finally, we wish to extend gratitude to Sustainable Buildings Canada for generously providing lunch to workshop participants.

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Context & Purpose

In partnership with the City of Toronto, Sustainable Buildings Canada (SBC), and Urban Climate Action Project (UCAP) researchers at the University of Toronto hosted a half day workshop on June 10, 2022, to explore barriers and solutions for retrofitting Toronto's multi-unit residential buildings (MURBs) and office towers.

Buildings are the largest source of GHG emissions in Toronto today, generating approximately 55 percent of total community-wide emissions, mainly from the burning of fossil fuels (natural gas) for heating and hot water. For context, Table 1 and Inset 1 speak to the enormity of the retrofit challenge.

To meet the City of Toronto's net-zero emissions target by 2040, as detailed in the City's Climate action plan, TransformTO and Net Zero Existing Buildings Strategy, the emissions from all buildings in the city will need to be cut in half from 2008 levels by 2030. Table 2 summarizes the variation in performance by building system in MURBs constructed circa 1990 and speaks to what, when and how systems may be upgraded or replaced over the next several decades.

Since it will be the private sector that will be retrofitting most of the existing buildings, the workshop engaged a cross-section of Toronto's building industry (e.g., developers, architects, engineers, contractors) as well as members of the financial sector and policy-makers in a candid conversation about barriers, ultimately exploring possible solutions for transforming the industry and normalizing the needed behaviours to achieve the TransformTO targets (see Appendix A for list of participants). The workshop was organized into three retrofit stages – Design, Implementation and Evaluation, and attendees participated in facilitated sessions focused on each of the stages.

This stakeholder report details and synthesizes participants' comments and includes a set of recommendations or next steps that will be shared with workshop participants and the industry

Table 1. Toronto Building Count

Category	Building Count
Residential	437,267
MURB	5,947
Commercial	32,082
Public Sector	3,655
Industrial	9,983
TOTAL	**488,934**

Inset 1. Scale of the Retrofit Challenge

440,000 residential buildings/18 years (2022-40) = 24444 residential retrofits per year **(67/day)**

35,700 commercial buildings/18 years (2022-40) 1983 commercial retrofits per year **(5.4/day)**

9983 industrial buildings/18 years (2022-40) 555 industrial retrofits per year **(1.5/day)**

at large, as well as an international audience and members of the University Climate Coalition (UC3) and the Urban Climate Action Network (UCAN) in support of international collaboration to achieve net-zero targets.

By sharing the results of this workshop with our partners in local government, our intention is to inform policy and prompt sound decision-making based on industry needs and experience. By bringing industry professionals together, we also hope to expand and strengthen networks for the sharing of best practices and uptake of retrofit solutions for MURBs and offices. Finally, by sharing the results of this workshop more broadly (e.g., across the University Climate Coalition Network of 23 North American research institutions and the Urban Climate Action Network), we seek to mobilize knowledge in support scaling up of low carbon solutions.

Table 2. Summary of system level details for MURBs constructed circa 1990

Example Summary of Appendix Information (Cluster 12 - MURB circa 1990, 5,000 - 20,000 m²)					
Energy System Group	**Calibrated Parameter**	**Range of effective performance**		**Examplar System**	**Typical Service Life (years)**
		Q1	**Q3**		
Enclosure	Window to Wall Ratio	60%	25% building	Generally punched windows with some curtain-wall	—
	Window R-value	1.1	1.7	Double glazed, air-filled IGU with aluminum frames	25-35
	Wall R-value	2.3	9.7	1-2" of board insulation or batt insulation to interior	25-50
	Roof R-value	4.5	9.7	1-2" of mostly continuous, rigid insulation	25-30
Ventilation Systems	Ventilation Heat Recovery	38%	60%	Central pressurized cooridors with suit-level exhaust. No heat recovery assumed in base case.	15-20
Heat/ Cool Systems	Delivery system	See discussion		4-pipe fan-coil system with constant volume pumps and fans	20-30**
	Cooling COP	2	2	Central centrifugal or scroll chiller with cooling towers on roof	20-30
	Heating COP	0.70	0.93	Central, standard efficiency gas-tired boiler	20-30
User-driven Energy Use	DHW flow rates & appliances	See discussion		Typically upgraded fixtures & appliances, but to older standards	10-15
	Plugs & Lighting	15 W/m²		Some facilities have undergone lighting upgrades***	10-20

* *Heat recovery is not very common in MURBs that fit into Cluster 12, however, it is common to turn off ventilation systems, mimicking the effects of heat recovery.*

** *Active equipment (e.g. fans and pumps) losts 15-20 years, but ductwork and pipes can last 40-60 years*

*** *See discussion in the next section (i.e. 2.3) about occupant-driven energy and its importance to achieving cost-effective emissions reductions.*

Source: City of Toronto, Net Zero Existing Buildings Strategy, Final Report, Mar 2021, Table 1.

Summary of Barriers

In the lead up to the workshop, UCAP researchers scanned academic and grey literatures to produce a consolidated list of known retrofit barriers (See Appendix B), which was validated by members of SBC. By way of a pre-workshop survey, workshop participants reviewed the list of known barriers and identified their top three for both MURBS and Offices (in bold) as shown below:

MURBs	Office Towers
• Long investment payback • Poor understanding of the real business case • Disruption to tenants • Lack of confidence in new technologies/equipment providers • Lack of building owners' knowledge • Permits. • Skills shortage • Lack of building code for retrofits • Access to adequate financing • Timing and prioritization of DER investments • Fragmented market/Handoff Issue • Structural • Multi-stakeholder issue • Bylaws • Toronto's building grid	• Business cases are not well understood by decision-makers / owners • Competition for capital funds and expectation for ROI / payback • The capital and life cycle costs of a building are not easily tied together. • Impact on building tenants • Low cost/mispricing of energy • Executive Buy-in. • Technology supply chain issues. • Common leasing arrangements/terms. • Performance gap, mistrust, or lack of understanding of performance measures • Keeping rent competitive. • Lack of national standards/regulations. • High implementation and transaction costs.

Workshop Insights

Main Takeaways & Recurring Themes

Note that these are presented under major topic areas as identified at the workshop. There is occasional duplication, indicating that some barriers apply to more than one topic area. Please see Appendix for detailed list.

Framing the discussion, is the staggering scale at which retrofits need to take place. Over half (55%) of Toronto's GHG emissions come from buildings, and to meet the net-zero by 2040 target, nearly every building in the city needs to be retrofit. "Modelling shows that 29% of building emissions can be attributed to multi-unit residential buildings, 31% to single family homes, 17% to large commercial and institutional buildings, and 23% to smaller commercial and industrial buildings" (City of Toronto, 2021, p. 7).

To meet this enormous challenge, workshop participants identified barriers and solutions, which we've categorized here as internal (to the retrofit sector) and external (regulatory, financial, cultural). Regarding the former, there is a need to overcome the fragmentation and lack of understanding within the retrofit sector; a product of the multiple building types, applicable technologies, and diverse responsibilities and interests involved. Accordingly, workshop participants identified a need for greater coordination and knowledge sharing, as well as improved information flow and data availability, between building owners, developers, property managers, condo boards, building operators, and occupants, as well as more broadly in and across the building industry, local government, and neighbourhoods /communities.

Participants identified many opportunities for improving knowledge sharing between diverse actors ultimately increasing the sense of buy-in and responsibility for undertaking retrofits, as well as illuminating the need for support throughout the process. These included: retrofit roadmaps; user guides; feasibility studies; technical / costing guidance (e.g., re: construction cost, the cost for renovation and retrofits, standalone project) covering major (and typical) retrofit technologies and applications; advanced diagnostics for pre-retrofit work and detailed site inspections (to de-risk retrofit process); use of integrated project delivery; access to clean, relatable data and improved reporting requirements. The creation of a central organizer / searchable data base and

mapping application (like the 2030 District mandate, but for the entire city, containing the location, size, primary use, state of repair etc. of all buildings) was another idea for improving data availability across the retrofit sector.

Another internal barrier to overcome pertains to the handoff issue (e.g., the passing of the retrofit equipment from contractor to building owner following commissioning), underscoring the need for integrated project design and delivery to ensure the initial retrofit design is not diminished through value engineering. There is also a need to focus on building envelope ("envelope first solutions"), as mechanical upgrades alone will not suffice, and on embodied carbon (in the early stage/planning phases); solutions which both promise substantial emissions reduction.

The final internal barrier that drove discussion is the significant skills gap in workforce capacity, which necessitates large-scale education and training efforts to enable the capability of retrofits professional to implement at scale.

A key external barrier pertains to grid integration and a need to consider Scope 2 (indirect) emissions from electricity and steam generation. Related solutions will require collaboration and actions by actors outside of the retrofit sector, including Enbridge, Toronto Hydro, and Enwave, and support for possible district energy solutions. Likewise, greater coordination and collaboration with other municipalities

Likewise, there are substantial regulatory barriers imposed by provincial (e.g., building code) and municipal authorities that need to be addressed. Locally, there is a need for the City of Toronto to better enforce current Toronto Green Standard (TGS) and to further incentivize retrofits (e.g., through PACE and MLI Select programs), although incentives – even large ones may not be enough. Furthermore, the City should ensure that the buildings it owns and operates (including TCHC) rapidly undertake retrofits consistent with the TransformTO and Existing Buildings Net Zero Strategy targets. Adherence to the best practices of design, implementation, and M&V would serve as a model to other owners/operators and would be further supported if the results were made broadly available. Demonstrating best practices is vital for shifting organizational culture, and inspiring greater commitment and champions within other organizations. Efforts to influence "C-Suite" executives should be explored.

Solutions by Retrofit Phase

For brevity, we clustered the retrofit steps into three broad phases, as shown in the table below. In breakout groups, workshop participants identified possible solutions for each phase. As summarized above (see "workshop insights") the identified solutions largely pertain to improving coordination between actors in the retrofit sector, particularly at hand-off points, and between municipalities (for standardization of expectations and policies), as well as opportunities for increased/improved knowledge sharing, tools, financing, and skills development in the trades. Workshop participants also called for greater collaboration with energy sector actors and organizational change. Areas in need of greater attention (e.g., embodied carbon) were also illuminated.

Stages	EARLY STAGE 1 Design	MID STAGE 2 Implementation	LATE STAGE 3 Evaluation
Phases	• Planning/legal • Retrofit project design/ pre-retrofit survey • Energy auditing, feasibility study and performance assessment • Hand-off	• Identification of retrofit options • Site implementation • Commissioning • Hand-off	• Validation and verification (post-measurement and verification, post-occupancy survey, building operations, and maintenance) • Longer-term occupancy (Inhabitant engagement and behavior, continuous optimization processes).
Solutions	• Attention to embodied carbon • Buy-in from occupants/tenant engagement in the planning process - vision, target, roadmap • Framework and energy literacy (capital planning and lifetime maintenance)	• Holistic planning including Integrated design, and project delivery; align stakeholders; bring contractors on early in the process • Diagnostic technologies that generated feasibility studies – use consistent approaches and reporting templates	• Building info/scores platform • Coordinate with other municipalities to have common standards and requirements • Funding from the City for supporting the enhancement of tools, data sharing, a library of

	• Shared/public database of case studies that include technical and costing • Incentive and support for feasibility studies - make PACE-LIC program widely available. Support and enhance financing programs such as MLI Select • Trades - Education and support for trades and training; knowledge and decision-making tools for trades, integrated project delivery • Enforcement of TGS standards • ERVs - contracts for future delivery of solutions • Address grid decarbonization uncertainty Enable prioritization of envelope (lowest payback, safest option) – e.g., Passive Haus • Professional training requirements to undertake the preliminary assessments – need a large pool of experienced professionals • Require an energy management plan for each building	• Mandatory code/regulatory framework (require buildings to have a net-zero transition plan) plus incentives • Financing alternatives and Regulatory incentives - e.g., property tax discount • Focus on MURBs as one of the predominant building forms with very high potential – then translate to other typologies • Clear communication of energy modelling approaches, requirements, and process. Establish appropriate modelling protocols. • Normalize testing (i.e., building performance) throughout the implementation - mock-ups • Education for the board of directors, property managers on net-zero retrofits • Finance - tie retrofit to rent/condo fees (incentive) and assist owners in accessing federal incentives – act as a clearing house for incentives • List of typical retrofit options with solid explanation of the technical details and the expected costs – links to providers	sample user guides, tools, posters for different buildings • Education for building owners/property managers/residents on deep energy retrofits • Need knowledge sharing -> repeatable processes -> shared failures, exact costs specific heat pumps, the standard format for easy access. • MV quarterly to ensure performance - required reporting • Better collaboration between design, construction, and operation to ensure performance - i.e. – integrated project delivery • Simplify process - info, data availability and accessibility • Build capacity for operation and improve hand-over knowledge transfer • Develop building specific M&V tools • Ensure each M&V report includes an assessment of lessons learned from the project team

Recommendations for the City

Much of the motivation for undertaking this workshop was to develop a set of recommendations specifically for the City of Toronto – recognizing the roles, responsibilities, and limitations of the City's mandate. Given that perspective, the Steering Committee has synthesized the discussion down to a series of realistic recommendations. While not prioritized, these include:

- Identify who is responsible for the solutions identified here and convene small working groups to advance next steps.
- Extend existing Retrofit Roadmaps to include specific direction on how to undertake a deep energy retrofit from concept through feasibility study, implementation, and post project evaluation. These should include technology specific archetypes citing expected savings, cost, and return on investment (ROI).
- Support and subsidize the development of diagnostic tools used as part of the upfront planning and ensure that these are widely available to the industry.
- Support and subsidize the development of energy modelling tools, protocols and metrics used as part of the upfront planning and ensure that these are widely available to the industry.
- Implement a PACE/LIC financing program for commercial buildings.
- Support and amplify the roll-out or existing federal programs including the MLI Select program. Assist owners in accessing those programs or fund the development of a clearing house for that purpose.
- Collect project results and act as a clearing house for the dissemination of the results – establish consistent reporting metrics as part of that effort.
- Develop deep energy retrofit educational materials suitable for different audiences including condominium boards, building owners etc.
- Ensure that all City-owned and operated buildings develop energy management and deep energy retrofit plans that identify how they will meet the Transform TO targets and establish a plan to undertake the required retrofits.
- Establish a working group or similar that includes Toronto Hydro, Enbridge Gas and Enwave to identify and prioritize mitigation strategies related to Scope 2 emissions from electricity generation and steam production. Consider expansion of district systems as appropriate and consistent with the TransformTO targets.

References

City of Toronto (March 2021) Net Zero Existing Buildings Strategy – Final Report

Appendices

Appendix A - Attendee List

First Name	Last Name	Organization
Nick	Cheal	Multiplex
Emily	King	Entuitive
Jeremy	Orr	KingSett Capital
Paul	Carter	Entuitive
Wells	Baker	EQ Building Performance
Sarah	Gray	RDH
Natasha	Jeremic	Entuitive
Lorenzo	Daieff	Dunsky
Scott	Rouse	Energy-Efficiency
Cara	Sloat	Hammerschlag & Joffe
Anya	Barkan	Multiplex
Suneel	Gupta	First Service Residential
Maral	Ohanessian	Multiplex
Scott	Armstrong	WSP
Brandon	Law	RWDI
Joanna	Jackson	Minto
Alanna	Komisar	Mantel Development
Alex	Lukachko	RDH
Keith	Burrows	The Atmospheric Fund
Lee	Hodgkinson	Dream

First Name	Last Name	Organization
Mike	Singleton	Sustainable Buildings Canada
Leona	Savoie	Dorsay Development Corp.
Michelle	Xuereb	BDP Quadrangle
John	Robinson	University of Toronto
Kim	Slater	University of Toronto
Angelina	Ouyang	University of Toronto
Laura	Tozer	University of Toronto
Emily	Smit	University of Toronto
James	Nolan	City of Toronto
Devon	Stopps	City of Toronto
Joanna	Krauss	City of Toronto
Stewart	Dutfield	City of Toronto
Cecilia	Fernandez	City of Toronto
Ana Maria	Medina	City of Toronto

Appendix B - Consolidated Barriers

- MURBs
- Offices

Appendix C - Key Barriers & Solutions Identified by Workshop Participants

- Scale
  - The staggering scale at which retrofits need to take place

- Knowledge sharing/information flow
  - Retrofit roadmaps that recognize the vast differences between building types – commercial vs institutional vs residential etc.
  - Sample user guides / user experience of retrofits
  - The importance of ownership structure – notably as relates to condominiums and related boards
  - Property managers may not be aware of current Toronto Green Standard requirements and may not have embraced any of the Transform TO targets
  - There is a general lack of information regarding how to achieve the targets and who's responsibility they area
  - The need for buy-in and ultimate leveraging of neighbourhood, communities etc.
  - Technical and costing guidance covering major (and typical) retrofit technologies and applications
  - Need for support throughout the process and the use of integrated project delivery

- Data & Data Availability
  - Criticality of sharing knowledge about cost, reporting on construction cost, the cost for renovation and retrofits, and standalone project
  - Significant building data gap
    - The industry does not have access to use, clean relatable data
    - The retrofit sector is not well understood and is fragmented – multiple building types, applicable technologies etc.
    - Mandatory (e.g., Energy & Water Reporting & Benchmarking) vs voluntary reporting (e.g., 2030 District) and the likelihood that mandatory data will not be adequate

- Data & Mapping
  - The need for a central organizer for data collection and mapping (like the 2030 District mandate but for the entire city)

- 480,000 buildings - need for searchable data and content – e.g. – location, size, primary use, state of repair etc.,

- Handoff issue & integrated project design
  - Need to apply the integrated project delivery approach to the retrofit to ensure the initial retrofit design is not diminished through value engineering

- Diagnostics for pre-retrofit work – mitigating risk
  - Need to address the many unknowns that are only revealed with detailed site inspections – detailed inspections will narrow the cost variance
  - Building in uncertainty to the Retrofit Feasibility
  - Advanced Diagnostics will help de-risk the retrofit process
  - More detailed feasibility studies will eliminate risks and narrow the variance of cost estimation

- Grid integration
  - Possible need to consider Scope 2 (indirect) emissions from electricity and steam generation – including Enbridge, Toronto Hydro, Enwave as part of possible district energy solutions

- Skills development and workforce gaps
  - There is a significant gap in workforce capacity – need for large-scale education and training efforts. Both capability and scale.

- Building envelope
  - Focus on building envelope - Envelope first solutions – the only what to achieve the targets. Mechanical upgrades alone will not be enough.

- Regulatory - need incentives, and enforcement
  - E.g. – Toronto Green Standard (TGS) – must be backed up by

- Embodied carbon
  - Need to address embodied carbon in early-stage/planning phases

- Organizational Change
    - Leadership - requires a strong commitment and champions within the organization – particularly in the "C-Suite"
    - Ensure that City-owned and operated buildings (including TCHC) rapidly undertake retrofits consistent with the Transform TO targets. Adhere to the best practices of design, implementation, and M&V as part of that activity and make the results broadly available

- Finance
    - Requires innovative financing such as PACE and MLI Select programs-
    - Incentives – even large ones may not be enough

Appendix D - Miro Board Links

- Board 1 – note taking by Laura Tozer
- Board 2 – note taking by Kim Slater
- Board 3 – note taking by Emily Smit