

Transforming 240 Markland Drive, Etobicoke: A Blueprint for Decarbonizing Multiunit Residential Buildings

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INTRODUCTION

When the developer first laid eyes on the 1960s building (Fig. 1), the scene was far from inspiring. The building's exterior was marked by aged masonry walls, aging single-pane windows, and a failing roofing system. The mechanical systems within the building were outdated and inefficient. The lack of capital investment from the previous owner left the building aesthetically outdated and functionally deficient, presenting a challenging yet promising opportunity for revitalization.

Despite its declining state, the property held untapped potential. The developer saw beyond the immediate disrepair and envisioned a rejuvenated building that

could set a new benchmark for low-carbon multiunit residential buildings (MURBs). Adjacent to the old structure and above the existing parking garage lay a parcel of land ripe for development. This land offered the opportunity for the developer to construct a complementary new MURB. The timing for this ambitious project was ideal, allowing the integration of modern design practices, performance improvements, and aesthetic upgrades. With the support of the surrounding community, the transformation began—a project aimed at not only revitalization and development but also reducing the burden of the industry's electrification movement on local infrastructure.

WHAT IS DECARBONIZATION?

Decarbonization refers to the process of reducing or eliminating carbon dioxide emissions produced by various human activities, particularly those associated with the combustion of fossil fuels such as natural gas. Decarbonization is essential for mitigating climate change by curbing the release of greenhouse gases (GHGs), which contribute to global warming and related environmental impacts.

Decarbonization within the built environment focuses on lowering GHGs primarily through fuel switching buildings' mechanical systems from fossil fuels to electric power. The building enclosure plays a significant role, as load

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Figure 1. East elevation, preconstruction.

reduction is often required to enable this change. Deep retrofits on existing building enclosure systems are often required to improve energy efficiency and reduce overall demand and reliance on carbon-intensive fuels.

EXISTING BUILDING ENCLOSURE AND MECHANICAL SYSTEMS

Exterior Walls

The exterior walls of the building were primarily clad with white-glazed brick masonry. The construction of the wall system consists of composite masonry, where the exterior wythe of the brick masonry is bonded to the interior wythe of concrete masonry units (CMUs). The exterior brick masonry and backup CMUs rest on exposed concrete slab edges and are tied to each other by header bricks (**Fig. 2**).

The wall was insulated inboard of the concrete block masonry units with 1.75 in. (45 mm) of expanded polystyrene (EPS) insulation and finished by plaster and lathe. The effective *R*-value of the existing wall system was estimated to be about 6.4 (*RSI*-1.13).¹

Conventionally reinforced concrete shear walls extend outboard of the exterior masonry walls and form the side walls of the balconies on the east and west elevations. The balcony slabs are extensions of the floor slabs and are constructed of conventionally reinforced concrete.

The brick and concrete shear walls showed signs of age-related deterioration. The exterior face of the glazed brick had begun to spall in several locations, particularly at the upper floors of the building that have higher exposure to wind-driven rain. The suspected cause was freeze-thaw deterioration related to excessive wetting. The concrete on the shear walls had also started to spall in several locations, likely due to carbonation over years of service. Finally, the elastomeric joint sealants forming the control joints between masonry panels and around the perimeter of the window and door systems were generally cracked, crazed, and debonded from their parent substrates.

Window and Door Systems

The existing in-suite windows were aluminum framed with a single-pane glass lite with exterior single-pane storm windows, installed over four single-pane operable sash sliders. The existing swing door systems consisted of full-height inward-swinging wood door slabs with exterior aluminum storm doors (**Fig. 3**). The window performance was calculated to be U-0.76 (USI-4.3) with a solar heat gain coefficient (SHGC) of 0.67.¹



Figure 2. Exploratory opening in brick masonry.



Figure 3. Existing in-suite windows and balcony swing doors.

There were several reports of water leakage through the existing window and door systems, as well as complaints regarding tenant comfort due to air leakage/drafts. Difficult operation of the sliding windows and swing door components were also reported, as the hardware had failed due to lack of proper maintenance.

Roof System

The roof system was a protected membrane roof (PMR) system. The system was comprised of a concrete deck, four-ply asphalt and felt membrane, 1.5 in. (37.5 mm) of extruded polystyrene (XPS) insulation, and gravel ballast

(**Fig. 4**). The roof was estimated to have an overall thermal performance of approximately *R*-8 (*RSI*-1.41).¹ Active water leakage was reported into the mechanical penthouse and within several units directly below the roof.

Mechanical Systems

The building was heated by electric baseboard heaters and employed a central make-up air (MUA) unit, which did not provide fresh air during the heating months. Over half of the building's tenants had also installed portable air-conditioning units through their existing window systems for cooling.



Figure 4. Test cut within existing roofing system.



Figure 5. Exterior insulation and finish system installation on the west elevation.

DESIGN STRATEGIES AND INNOVATION

The success of the decarbonization efforts hinged upon innovative design interventions that addressed both aesthetic and performance considerations of this deep retrofit. Through strategic interventions such as wall overcladding, window and door upgrades, and roof assembly replacement, the design team optimized the building enclosure to effectively integrate advanced mechanical systems. Each design choice was carefully calibrated to optimize

building performance while minimizing environmental impact.

Exterior Walls

The design team evaluated several options for wall overcladding. The team ultimately chose a drained exterior insulation and finish system (EIFS) due to its numerous benefits. The EIFS is lightweight and enhances resistance to air and water leakage, significantly reducing overall energy consumption. It also improves tenant thermal comfort and reduces the risk of exterior wall condensation.

Additionally, the EIFS protects the masonry and concrete shear walls from further deterioration, thereby enhancing durability and lowering ongoing maintenance costs.

The EIFS overclad generally consists of 3 in. (75 mm) of EPS insulation covered with a reinforced cementitious base coat and a finish coat lamina. A liquid-applied air and water-resistive barrier is applied directly over the existing brick and reinforced concrete shear walls and floor slabs (**Fig. 5**).

Due to the glazed brick and painted concrete substrates, qualitative bond and quantitative mechanical fastener load testing were conducted to identify effective EIFS attachment methods. The testing revealed that the EIFS should be both mechanically fastened and adhered with ribbons of the cementitious base coat for optimal performance.

The EIFS was integrated with the new window systems, resulting in enhanced overall performance and increasing the effective *R*-value to 12.8 (*RSI*-2.25).¹

WINDOW AND DOOR SYSTEMS

The design team also evaluated several window and door systems. The team selected thermally broken aluminum-framed window and window-wall systems with double-glazed insulated glazing units (IGUs) for their many advantages over the existing window systems. The new systems meet the North American Fenestration Standard performance requirements for air and water leakage resistance, enhancing resilience and reducing overall energy consumption. Additionally, the thermally broken frames and IGUs improve tenant thermal comfort and reduce the risk of condensation on the window systems.

The window systems are generally comprised of fixed IGUs over four-sash operable windows to limit maintenance on the operable windows. The windows were installed in punched configurations and mullered to insulated swing doors at balconies.

Drained window-wall systems are used at the corridor windows on the south elevation. This approach was chosen to replicate the existing window systems that feature opaque spandrel panels bypassing the existing floor slabs.

At the ground-floor lobby and entrance vestibules, a thermally broken aluminum-framed commercial glazing system is used. This commercial system consists of fixed IGUs with thermally broken outward-swinging doors.

All glazing systems utilize sub-sill membrane flashings (**Fig. 6**) and transition membranes for critical barrier continuity to adjacent walls. These membranes are married into the adjacent air- and water-resistive barrier of the EIFS for improved air- and water-leakage resistance and to be in line with best-practice detailing.



Figure 6. New residential window systems with subsill flashings.



Figure 7. New protected membrane roof system under construction.

The IGUs consist of two panes of annealed or tempered glass (depending on safety glass requirements), separated by a warm edge spacer. A low-emissivity coating is installed on surface #2 of the IGU, and the cavity is filled with argon. These improvements lead to increased performance with a U -value of 0.4 (USI -2.27) and a reduced SHGC of 0.40.¹

Roof Systems

The design team decided to maintain a PMR system due to its numerous benefits. PMR membranes have longer service lives as they are not subjected to extreme temperature variations. Additionally, the membrane is protected from physical damage caused by weathering, foot traffic, and other factors.

Although some existing components could be salvaged, the system's composition was changed to enhance performance. The existing XPS insulation, which was bonded to the existing membrane and brittle from ultraviolet exposure, was in poor condition and could not be salvaged. A two-ply modified bitumen membrane was used over the existing reinforced concrete roof deck. A 4 in. (100 mm) layer of new XPS insulation

was installed over a polyethylene separator sheet, improving the roofing system's thermal performance (**Fig. 7**). The existing gravel ballast was salvaged and supplemented with new gravel where necessary to meet wind uplift performance requirements.

Mechanical Systems

The electric baseboard heaters are replaced with ground-source heat pumps fed by a geothermal exchange field. The rooftop MUA units are replaced with an electric heating coil, direct-expansion cooling, and a 55% efficient energy recovery ventilator.

CHALLENGES WITH IMPLEMENTATION

Navigating challenges is an inherent part of any project, but challenges can be particularly pronounced in retrofit projects, especially ones as comprehensive as the deep retrofit executed at this building.

Tenant Engagement

While the roof replacement and wall overclad projects were primarily performed from the

exterior of the building, the window and door replacements and the mechanical retrofits were being performed within the building's interior and within occupied space. This involved a high level of coordination between various trades to ensure the sequencing of the construction activities had minimal impact on the tenants and their living conditions. Throughout the planning and construction stages, several town hall meetings were organized to communicate the design intent, phasing, and scheduling, as well as to answer questions from the tenants. Active resident engagement is pivotal for the project's success.

Local Bylaws on Combustible Insulation

Recent changes to the city's bylaws regarding the use of combustible insulation in an EIFS overclad presented additional challenges for the construction team. The EPS insulation utilized in the EIFS is classified as combustible foam plastic. However, once covered by the cementitious base coat, the EPS insulation within the specified system is fire protected, passing the required tests by Underwriters' Laboratories of Canada (ULC), notably CAN/ULC-S101-07, which assesses

fire endurance tests of building construction and materials. This system is also compliant with the local *Ontario Building Code*.

Despite meeting these standards, the bylaw mandated the building owners to implement a temporary fire safety plan (FSP), incorporating alternative fire safety measures to mitigate fire hazards during construction. The bylaw's focus was primarily on the period during which the EPS insulation remained exposed before the installation of the base coat. Securing approval for the FSP necessitated coordination with local building and fire departments, as well as the trades involved in EIFS installation. Specific requirements of the FSP included limiting the duration of EPS exposure, capping the maximum dimensions for continuous EPS installation, and instituting a 24-hour fire watch. This resulted in significant changes to the typical installation practices for EIFS, but these adjustments were well accommodated by the EIFS subcontractor.

COVID-19 Pandemic

The deep retrofit was also performed during a period of global turmoil—the COVID-19 pandemic. The design phase commenced in 2020, followed by construction in 2021. This time frame had a significant impact on construction practices, available labor, and supply-chain interruptions, to name a few. The resilience and collaboration of the design and construction teams allowed the project to adapt

to these challenges and ultimately achieve its goal of becoming a low-carbon citizen.

SUSTAINABILITY AND CLIMATE RESILIENCE

Geothermal Field

Both the existing building and the new adjacent development are/will be heated and cooled by a geothermal system incorporated into this project. The EIFS overclad and new window and roof systems significantly increased the exterior wall and roof *R*-values, decreased the mechanical heating and new cooling demands, and subsequently reduced the number of boreholes required to balance the geothermal field. The geothermal system allows full-building decarbonization through electricity use rather than relying on fossil fuels. This dramatically reduces operational carbon.

Climate Resilience

The building tenants will benefit from increased building resilience during extreme weather. In the event of power outages, the EIFS and roof insulation contribute to maintaining comfortable conditions for several days as opposed to hours.

Embodied Carbon

The EIFS overclad also dramatically reduced the embodied carbon for the overclad materials, as compared with other options that were considered. The GHG reductions on site contribute to Canada's commitments to reduce carbon emissions. The

building is now a low-carbon citizen and was zero-carbon certified by the Canadian Green Building Council in November 2023.

Electrical Demand

The deep retrofit work conducted not only lowered GHG emissions, enhanced building performance, and improved resilience, but it also reduced peak electric demand. Post-retrofit utility bills show that energy consumption and winter peak electric demand in Q1 2023 dropped by 56% (or 541,000 kWh) and 54% (or 433 kW), respectively, compared to Q1 2022. This reduction in peak electricity demand is especially important as Canada moves towards electrifying the building industry to meet the 2050 net-zero carbon target. Demand on the local grid is projected to increase drastically, and electrical infrastructure will need to keep up. The building's sustainable design demonstrates how future development projects can help reduce the burden of the industry's electrification movement on local infrastructure.

CONCLUSION

The transformation of this 1960s building is a testament to what can be achieved when vision meets innovation. From an outdated and inefficient structure, the building has been reborn as a model of sustainable design and performance (**Fig. 8**). The developer's commitment to integrating advanced technologies and sustainable practices has not



Figure 8. West elevation, post construction.

only revitalized the building, but it has also set a new standard for new developments.

This project underscores the importance of deep retrofits in achieving environmental goals and showcases the potential of existing buildings to contribute to a sustainable future. As this building stands as a beacon of what's possible, it encourages other developers, designers, and communities to embrace the challenge of transforming our built environment for the better. By embracing innovation, collaboration, and a commitment to environmental stewardship, we can continue to drive progress towards a low-carbon future for all. 

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ABOUT THE AUTHORS



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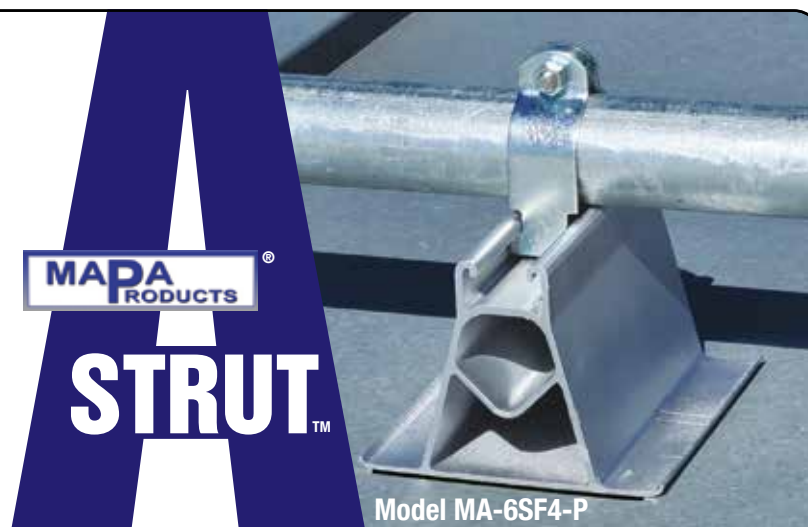
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