Project Summary

During the 1960s, the city of Toronto, Ontario underwent an immense construction boom that transformed its international standing. However, with the resulting tall towers, transmission signals became blocked, trapped within the confines of the city’s new skyline. To remedy this, Canadian National Railway erected the CN Tower, which was capable of broadcasting transmission signals over and above the new towers of Toronto. However, the structure, completed in 1975, was more than just a transmission tower – it was a symbol of the city, and an embodiment of Canadian innovation.

It was during this same year that a six-unit row house named Tinbury Place was completed. Although not as monumental as the CN Tower, Tinbury Place, in its own way, was and remains just as important, providing a home to six different families. However, this row house is part of Toronto’s residential building stock which today represents a significant proportion of the city’s greenhouse gas emissions. These aging structures rely upon dated, combustion-based mechanical systems to condition leaky, ineffectively insulated spaces. Given the Earth’s global warming, Toronto must once again innovate, now to create a retrofit strategy that meets its net zero emissions goal by 2050 while sheltering families from the changing climate and maintaining their comfort and health at an affordable price within the city’s growing housing costs. Five decades after the CN Tower’s completion, the city’s spirit of innovation lives on, embodied by Solar Row.

Design Strategy

Solar Row represents a net zero energy and operational carbon retrofit strategy that is scalable, improves occupant comfort and whose applicability extends well beyond the realm of Tinbury Place. Our team’s design includes an affordable, minimally disruptive overclad retrofit that serves as a template for all attached housing retrofits to be undertaken across the region at a rapid pace. This template pulls together a range of tried and tested components that are readily available in the market today. Solar Row is an innovative and scalable retrofit approach that bridges the gap between healthy, comfortable, environmentally friendly living with high-performance and cost-effective solutions.

Project Data

- Location: Toronto, Ontario, Canada
- Climate Zone: 6 (IECC) | 5A Cool, Humid (NECB)
- Lot Size: 0.40 acres (1620 m²)
- Building Size: 11,670 ft² (1084 m²) | 6 identical units; 2 stories + basement
- Total Occupancy: 24 or 486 ft²/person (45.2 m²/person)
- Retrofit Budget: US $51.08/ft² (US $549.82/m²)
- EUI (Existing): 54.5 kBtu/ft² (171.5 kWh/m²)
- EUI (Retrofit w/o PV): 18.22 kBtu/ft² (57.48 kWh/m²)
- Utility Costs: US $34.22/month/unit
- Carbon Emissions: 0 tons CO₂e/ft²/year
- R-Values (Effective):
  - Walls (A.G.): R-38 (6.69 m²·K/W)
  - Walls (B.G.): R-42 (7.40 m²·K/W)
  - Roof: R-62 (10.92 m²·K/W)
  - Slab: R-20 (3.52 m²·K/W)
  - Windows: R-8 (1.35 m²·K/W)
- Airtightness: 0.80 ACH @ 50Pa
- Enthalpy Recovery: 86% SRE
- HVAC: ASHP tied to ERV
- DHW: Air to Water Heat Pump
- On-Site PV: 69,180 kWh/year (total)
Project Highlights

**Architecture:** For the proposed retrofit, the original wood-framed structure is preserved, and an over-clad insulated panel system is installed for its high thermal resistance and ease of installation. Coupled with a rooftop photovoltaic (PV) system, this approach provides an affordable, constructable, and scalable net zero energy strategy that also modernizes the dated façade of the half century old building.

**Engineering:** To minimize occupant disruptions and provide a scalable net zero energy solution to this Toronto archetype, our team is taking a replicable engineering approach to integrate passive design elements into the existing building stock. High-efficiency electrical mechanical systems powered by a rooftop PV system will meet the reduced energy loads. Coupled with water reduction measures which reduce water consumption by 54%, all engineering systems are carefully designed to balance energy and environmental performance with costs, reliability, and durability.

**Market Analysis:** The Greater Toronto Area housing market is faced with various pressures, including population growth, finite housing stock, and rising real estate and utility costs. Solar Row is a retrofit strategy that entails a budget of US $51.08/ft$^2$ which is less than a third of the average Canadian retrofit. This means Solar Row provides an affordable and high-performance renovation strategy that can service the over 100,000 single-family row housing units present throughout the city.

**Durability & Resilience:** The Solar Row approach utilizes an over-cladding system that will withstand the variable and changing climatic conditions of region. The design also minimizes the demand of active systems to provide interior comfort all while improving the functions of the existing fifty-year-old structure. Moreover, rainwater harvesting into underground cisterns reduces the usage of fresh water for toilet flushing and irrigation while providing an emergency source of water.

**Embodied Environmental Impact:** To retrofit sustainably, the project maximizes the reuse of existing structure components and, where possible, the use of local, low-carbon materials to mitigate the embodied carbon of the building. New materials are selected in a manner promoting responsible resource use. Every choice made in this undertaking, from production to transport to installation to disposal, considers the subsequent carbon impacts, the results of which are presented in a cradle to grave lifecycle assessment (LCA).

**Integrated Performance:** The Solar Row retrofit was approached with the House-As-A-System mindset which recognizes the inherent relationship between the various functions and features of the building. In conjunction with an integrated design process that begins from the pre-design stage between different disciplines, architectural and engineering elements work together to achieve optimal performance while minimizing impacts on costs and time.

**Occupant Experience:** Improvements to the occupants’ lives through the high-performance retrofit extends beyond comfort and indoor environmental quality to the promotion of healthy living and continued financial and energy security. The Solar Row strategy also focuses on optimization of occupant lifestyle through condensed construction cycles, high-efficiency appliances, thoughtful design solutions, and integration with the existing surrounding community.

**Comfort & Environmental Quality:** Occupant comfort is achieved through an improved thermal barrier, mitigation of drafts, and user-friendly home automation strategies to control ventilation, relative humidity, lighting, and temperatures. Significant reduction of air infiltration not only improves the energy efficiency of the home, but also keeps unwanted moisture, dust, allergens, pollutants, and other airborne particulates to the exterior environment while also mitigating the infiltration of noise and odours to the interior environment.

**Energy Performance:** This retrofit project attains net zero energy status with an on-site solar photovoltaic system that utilizes the east and west-facing roofs. This 61.8 kW system generates 69,180 kWh annually, supplying enough electricity to exceed the post-retrofit demand of 18.22 kBtu/ft$^2$/year (57.48 kWh/m$^2$/year) energy use intensity. All surplus energy generated by Solar Row is sent back into the provincial energy grid, thus aiding to pay back the retrofit’s upfront costs.