TRCA Satellite Office Building & Visitor's Centre

Ryerson University
Office Building (OB)

Fig: TRCA Satellite Office Building & Visitor's Centre

Project Summary

Located at the site of Kortright Centre for Conservation in Ontario, the Living City Campus is Canada's largest environmental and renewable energy education and demonstration Centre. At its heart is the TRCA office building, showcasing sustainable technologies, solutions, and ideas for the world to witness. The site is a natural oasis with pristine woodlands, falling under the Greenbelt of Natural Heritage System. The vision behind the project is to design a building that can be disassembled and reconstructed, eliminating waste at its end of life so none of its parts will end up in the landfills. The building also generates own energy and water demands and use passive strategies as far as possible for heating and cooling while taking occupational and environmental wellbeing into account. Thus, by designing such an office building through energy efficient construction and innovation the building will not only set a precedent for future edge of city net zero buildings, but it itself will become a force for good. All while helping with the Solar Decathlon goal to educate the public about replicable energy efficient design through its user interactive programs.

Design Strategy

The Integrated Design Process (IDP) was employed to take advantage of collaboration between different disciplines, considering the advantages and trade-offs between energy performance, user comfort, and costs from an early stage. Before renewables, the design has an EUI of 20 kBtu/ft^2 (62kWh/m^2), TEDI of 4.4 kBtu/ft^2 (14 kWh/m^2), GHGI of 0.5 lbCO_2e/ft^2 (2.2 kgCO_2/m^2) To achieve this, the design team determined optimal building orientation, siting, massing, and started energy modelling at early stage to develop a baseline design. A high-performance airtight modular envelope with continuous control layers integrated with hybrid mass timber and CarbonCure precast concrete panels is implemented to allow for deconstruction and reassembly. This minimizes the embodied carbon and implements biophilia. The feasibility of no HVAC system was assessed, but due to the harsh Canadian climate with hot/humid summer and cold winter months, and the requirement under OBC for ventilation systems, the design team decided on a DOAS+VRF system. This design includes solar photovoltaics (PV) on the roof, the car parking, and on the south, east, and west facades to supply energy to the building and any surplus to the surrounding architype homes. Rainwater is collected from the rooftop for non-potable water use. Living machine with a constructed wetland are used for water purification for building and educate the user about its process. The office spaces are designed considering human health and well-being which utilizes natural ventilation through a 3-story green wall, circadian lighting, low-VOC, and carbon materials (adhering to LBC requirements for IAQ).

Project Data

- **Location:** Woodbridge, Vaughan, Ontario
- **Climate zone:** ASHRE 6A
- **Lot size:** 325 hectares (Kortright Centre)
- **Building Size**: 4 stories; 3,870 m^2; 41,660ft^2
- **Occupancy:** 150 ppl; 21.9m^2/ppl; 282ft^2/pl
- **EUI (before renewables):** 62 kWh/m^2/yr ; 20 kBtu/ft^2/yr
- **Estimated average utility cost:** Target is $0,
- **Construction cost:** 10,436,930 USD 251 USD/sq.ft (316 CAD/sq.ft).
- **Certifications:** TGS Tier-4 (EUI, TEDI, GHGI); LBC (can be achieved)

Technical Specifications

- **Wall, floor, and roof R-values:** Roof: 45 ft2°F·h/Btu; Walls: 47 ft2°F·h/Btu; Ground floor: 46.5 ft2°F·h/Btu
- **Window U-values (overall system):** Triple pane wood framed windows: 7 ft2°F·h/Btu; Triple pane thermally broken fiberglass curtain wall system: 7.8 ft2°F·h/Btu
- **HVAC specifications: DOAS + VRF** (ERV, ASHPs for heating, DX refrigerant coils for cooling)
- **Other technologies:** Green wall – air filtration, constructed wetlands, rainwater harvesting, living Machine.
- **Lighting:** LED circadian ambient and task lighting
- **Renewable systems:** 124 rooftop solar panels, 400 carport modules; and PV on exterior shading; Annual production: 356 MWh.

Project Highlights

The following summarizes the strategies to meet expectations of each of the contest design goals:

Architecture: The architectural design intent of this project presents a minimal impact approach in relation to the surrounding site through a modular design. The east-west elongated form of the building is elevated on screw pile foundations, creating gentle impact, and sitting lightly on the land. The central staircase is linear in form which emphasizes the narrow rectangular building itself. The skylight above the central staircase along with the transparent openings on the exterior skin of the building, maximizes natural light internally.

Engineering: Our team designed this building to be highly insulated, air-tight, with a modular panelized envelope with continuous control layers. Hybrid mass timber and concrete structure allow for easy deconstruction and reconstruction and employs circular economy strategies. South facing windows with light shelves for improved lighting on the interior and PV integrated static shading on the exterior, west facing operable double skin façade with integrated green wall for passive cooling, natural ventilation, and fresh air are implemented. The HVAC system designed for the proposed building is a DOAS+VRF, while water is heated by heat pump water heater.

Market Analysis: The net zero design of the TRCA building will facilitate high occupational comfort and wellbeing while maintaining low operational cost and low embodied carbon. The consumer centric design will not only attract clients but, also help the governing body to retain high-performing employees due to their job satisfaction in the building. The cost estimation of the project is about 10,436,930 USD including all the energy efficient strategies and biophilic components. This gives an amount of 251 USD/sq.ft (316 CAD/sq.ft).

Durability and Resilience: Passive strategies such as natural daylighting and ventilation as well as renewable strategies like solar panels and rainwater harvesting on the roof top are ways to increase the building's resilience. Having these measures means the building is self-sustaining in energy and water use and is not dependent on the city's electrical grid and water supply. The site is in a possible future flood plain, the building is elevated about 0.5m from the ground on screw pile foundations to tackle that.

Embodied Environmental Impact: The use of mass timber in the structure with GLT columns, beams, TCC floors, and natural low-carbon materials in the envelope reduce the "embodied carbon" in building while sequestering carbon when combined with sustainable and local timber production and building demolition practices. OneClick LCA analysis was done and the embodied carbon benchmark for the TRCA Building was measured to be 142 kg CO_2e/m^2 which is Cradle to Grave Level B.

Integrated Performance: Architecture and engineering of the building is integrated with one another in relative to the climate and building envelope. The east-west oriented building design also consists of continuous triple glazing windows as well as operable windows placed strategically in the vision zones, flooding the interior areas with natural light, and helping in cross-ventilation. The installation of the solar panels was optimized to ensure technical feasibility with the electrical system and energy efficiency performance. Design considerations based on the WELL and LBC standard were done and achieving these certifications can be possible.

Occupant Experience: Biophilic component like the green wall in the west double skin façade will not only filter the incoming air but is also reduces stress, improves cognitive function, enhances mood, productivity, and creativity. Manually operable windows and blinds, movable acoustic panels, task lighting control, allows users to operate according to their needs and to enhance satisfaction. Open layout for the workstations can lead to collaboration and interaction between colleagues.

Comfort and Environmental Quality: Efficient sensor control are installed throughout the building to ensure the building's acoustical control, thermal comfort, and indoor air quality are met. They monitor the building situation, in turn providing the provision to adjust building systems. Efficient daylighting, ventilation, products with low VOCs, utilizing vegetation are strategies to ensure occupant comfort and environmental quality.

Energy Performance: To achieve our energy target of $65kWh/m^2/yr$ before renewables, strategies maximizing natural daylighting and ventilation are employed. Additionally, high performing building envelope, LED lighting, triple-panel windows, light shelves, and exterior shading will be added to increase energy efficiency further. Once optimization of the energy efficiency is tackled, solar panels in various locations will be tested and added into the system to ensure the building reaches zero energy status. Energy modelling and IDP approach helped in adhering to zero carbon principles and evaluate building's performance from the very beginning.