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THE KEN SOBLE TOWER TRANSFORMATION

The Ken Soble Tower in the late 1960s and now being modernized in accordance with the Passive House EnerPHit retrofit standard.

North America's First EnerPHit Apartment Tower

By ERA Architects with Entuitive, Transsolar KlimaEngineering, JMV Consulting, Reinbold Engineering, Nemetz (S/A) & Associates.

The Ken Soble Tower Transformation is a groundbreaking project rehabilitating a post-war apartment tower in Hamilton, Ontario to the Passive House EnerPHit retrofit standard - reducing greenhouse gas emissions by 94% and laying the groundwork for the industry-wide repair and renewal projects which are urgently needed to maintain thousands of apartments across Canada.

Built in 1967, the Ken Soble Tower is the oldest high-rise multi-residential building in CityHousing Hamilton's portfolio. A local landmark with significant community value, the tower had fallen into a state of disrepair, declining occupancy and increasing costs. After considering several options including sale, rebuild, capital repair, and rehabilitation, CityHousing Hamilton opted to engage in a modernization program that would ensure long-term asset viability, and secure housing quality and indoor comfort for resident seniors while reducing the building's environmental impact.

The Passive House standard was determined to be the best means of achieving these goals, kickstarting a broader program of Passive House development for CityHousing Hamilton's portfolio at large. While organizations in the EU and Canada's West Coast have adopted Passive House as a target, CityHousing Hamilton is one of the first large organizations in eastern Canada to do so.

At 18 storeys and more than 80,000 sq.ft., the Ken Soble Tower will be one of the largest EnerPHit certified projects in the world. The rehabilitation project will modernize 146 units of affordable seniors' housing, while reinvigorating community spaces and outdoor gathering areas, allowing for aging-in-place and barrier-free living, and a changing climate. Slated for completion in 2020, the project will also provide residents with improved comfort and control of their indoor environments and with the ability to withstand extreme climate events into the future.

As one of the most complex EnerPHit projects in the region, the design of this project required the development of a number of new strategies and processes. Lessons were learned across the architectural, structural, building envelope, mechanical and electrical disciplines, which have been identified here in an effort to support the dissemination of the Passive House standard in the Ontario context.

LEAD ARCHITECT: ERA ARCHITECTS

For lead architects and retrofit specialists ERA Architects, a highly-integrated design process was required from the outset. To ensure that the holistic goals of Passive House were being met, an extremely high standard of coordination was adopted to the extent that even detailing decisions received inputs from a number of disciplines to ensure dynamic thermal comfort standards were being met. ERA hosted weekly collaborative design sessions, with all disciplines coming to the table to discuss shared impacts of their progress. Design solutions were assessed based on their ability to meet the stringent requirements of Passive House, and their familiarity and constructability in the local trade context.

This process required more work up front, but was rewarding and established strong teamwork from the start. With Passive House's relative infancy in North America, ERA was also challenged in sourcing appropriate products not readily available in Canada for high-rise applications. HVAC equipment, Passive House-certified windows, and appropriate insulation to meet the effective R38 envelope requirements were some of the primary sourcing challenges. This process revealed market gaps which will likely begin to be filled as Passive House construction becomes more standard in the Canadian market.

SYSTEMS

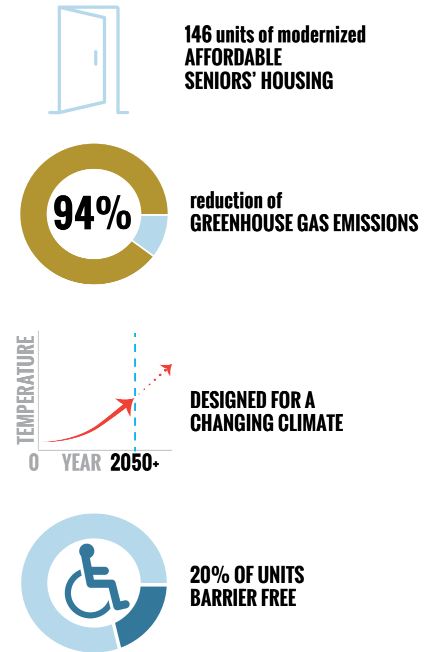
Centralized HVAC with Cooling
Riser Replacements for Most Systems
Full Building Sprinklering

ENVELOPE

R38 Overcladding
Passive House Windows
Juliette Balconies

MODERNIZATION

Accessibility Upgrades
New Community Room and Solarium
Interior Upgrades to Support Aging-in-Place
Rain Gardens and Green Gathering Spaces



Working with an existing building to meet the EnerPHit standard is different from designing a Passive House new-build. There were many advantages of working with the existing building, which included a large thermal mass, a solid structure to which to attach insulation, a simple shape, and low glazing-to-opaque wall ratio. Conversely, a disadvantage was its solar orientation not being ideal from the perspective of solar gain. Existing windows were primarily east and west facing, which was poor for both passive solar gain in winter and overheating in summer.

This challenge was mitigated through active heating and a multi-stage cooling strategy. Likewise, the existing building had an uninsulated slab-on-grade ground floor that contributed to a significant portion of the building's heat loss. This challenge was addressed through deep perimeter insulation.

The adaptation of the German Passive House standard to a North American context resulted in a number of lessons learned. First, the PHPP modelling software was originally designed for a single-family home in a relatively mild European climate with minimal risk of overheating. To adapt this modelling to suit a multi-unit residential high-rise with colder winters and hotter summers, TRNSYS was used to run dynamic thermal simulations for both heating and cooling periods. This helped to refine the design to suit the most extreme conditions within the building and throughout the year. THERM and FLIXO were also used to understand the thermal bridges and surface temperatures to make sure the windows all met the criterion set out.

A number of technologies that are standard and affordable in Germany are not yet widely available in the Canadian market, requiring alternative approaches to achieving the targets. These included: integrated facade shade systems, high-efficiency elevators and appliances, standard thick external insulation systems, high-performance Passive House certified high-rise windows, decentralized ventilation units, and decentralized hydronic heating and cooling units.

As a result, a more North American approach was taken in the centralized ventilation, heating, cooling and hot water systems, and by incorporating heat losses from North American building components, such as code-required back-up generator block heaters, garbage chutes, and standard elevator machines.

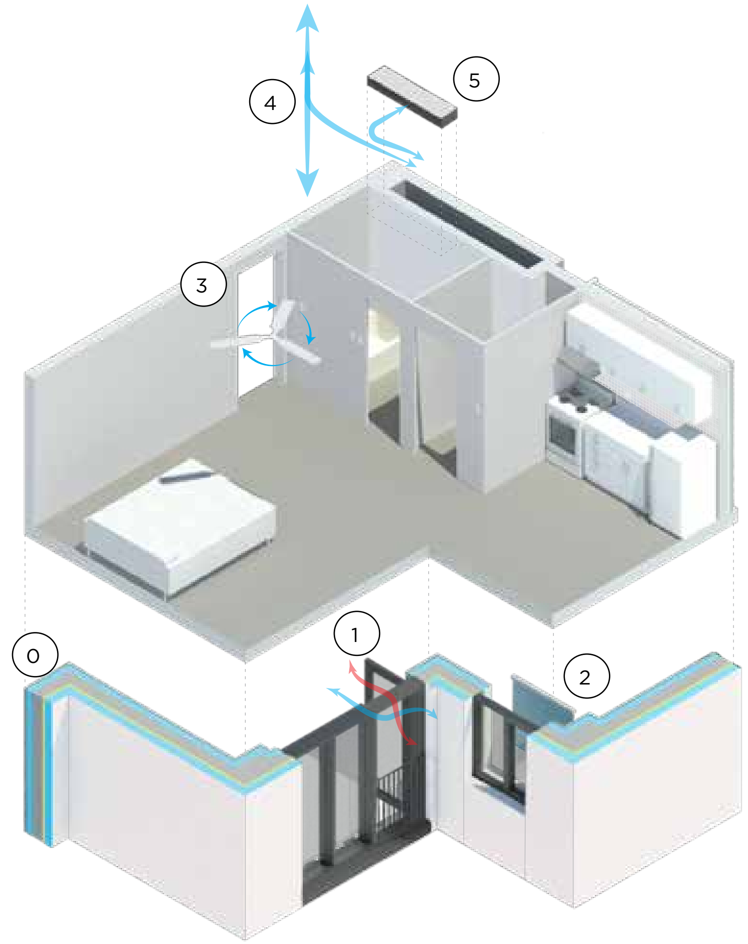
MECHANICAL ENGINEERS: REINBOLD ENGINEERING

Mechanical engineers Reinbold Engineering also played a key role in meeting the Passive House standard, designing a non-traditional mechanical system to deliver a fraction of the heat and cooling of a typical system. This demanded a creative and integrated design approach, with Reinbold undersizing the mechanical systems (relative to the existing building conditions) in response to the ultra high-performance envelope.

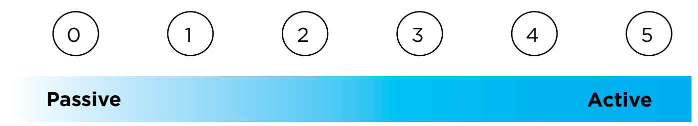
Designed in Europe, the Passive House standard can at times be at odds with Ontario's humid climate and local building code. Most of Europe does not experience the humidity of the east coast of North America - peak wet-bulb temperatures are typically under 24°C in Europe, but 30°C or higher in Ontario - and therefore the standard does not necessarily take into account the negative health and comfort impacts of humidity. While the Passive House standard relies on ventilation without additional cooling systems, the design team identified a high risk of overheating due to high relative humidity in the regional climate zone. As such, a centralized air conditioning system was integrated into the design, with resulting impacts on the Passive House energy budget.

Meeting the Passive House standard requires that areas of heat loss are reduced or eliminated entirely. This created challenges in meeting local building code requirements for both the HVAC and plumbing systems. In both cases, ventilation was the concern.

For instance, the waste water venting on the plumbing system is considered by the Passive House standard to be a vertical thermal bridge through the building.



DYNAMIC THERMAL COMFORT THROUGH COOLING



0. R38 Effective Envelope
1. Glazing with a low Solar Heat Gain Coefficient
2. Low emissivity interior shades
3. Ceiling fans to circulate air within units
4. Lightly tempered air delivered through a centralized ventilation system
5. Decentralized cooling 'boost' through a Variable Air Volume Unit activated by in-suite controls

Passive House high-rise buildings can be prone to overheating, in humid climate zones, and particularly in shoulder seasons. The design team was tasked with mitigating overheating risk, which can be a cause of death in vulnerable populations. To avoid overheating in the units without installing external operable shading, a five-stage cooling strategy was designed. It included:

- Glazing with a low Solar Heat Gain Coefficient (SHGC);
- Low emissivity interior shades;
- Ceiling fans to circulate air within units;
- Lightly tempered air delivered through a centralized ventilation system
- Decentralized cooling 'boost' through a Variable Air Volume Unit activated by in-suite controls.

Detailed dynamic simulations for both present day and future 2050 Toronto climate zones were used to inform the design, securing resilience to temperatures which are projected to rise significantly over the next 30 years.

BUILDING ENVELOPE ENGINEERS (ENTUITIVE)

As building envelope engineers, Entuitive had a critical role in the design of the project. A key contributor to overall energy performance, the building envelope renewal had two goals: improve thermal resistance (R-38 effective) to the level required by EnerPHIT, and ensure airtightness to allow for the significant downscaling of mechanical systems.

The retrofit addresses several challenges posed by the existing 1960s structure, including thermal bridges and composite masonry walls with limited interior insulation and vapour control layers. The proposed cladding upgrade also had to minimize intervention to the existing masonry for thermal and structural reasons. Additionally, to limit combustibility and embodied carbon concerns, a mineral wool-based insulation system was selected. The resulting cladding design includes a 150mm thick mineral wool EIFS system, not widely used in the local market, complete with an integrated drainage layer and new fluid-applied air barrier membrane.

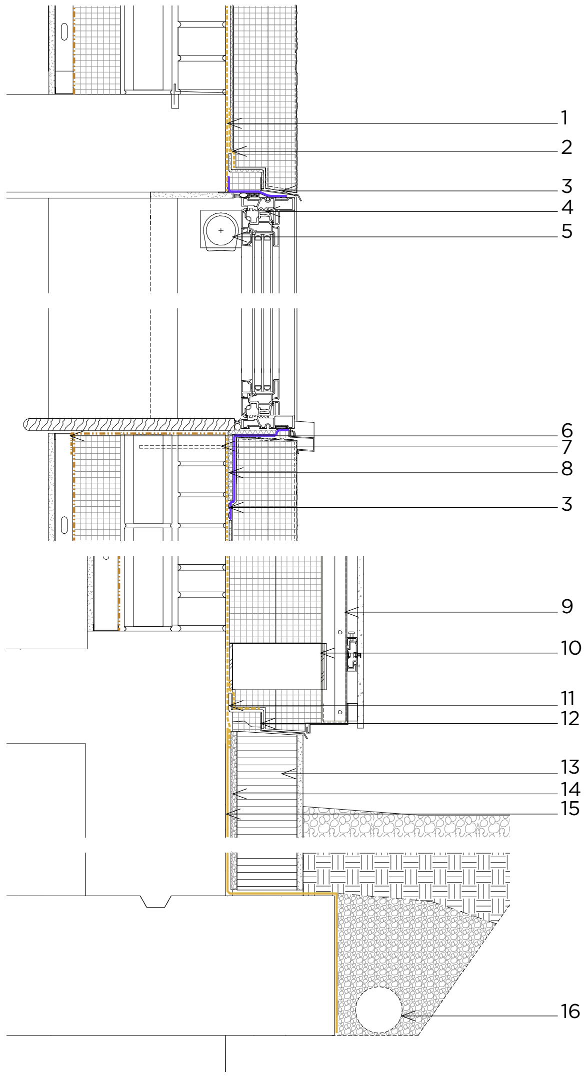
In terms of air tightness, to meet the strict air leakage criteria (targeting 0.6 ACH at 50Pa), a multi-phased approach to field testing was implemented. This included the required Whole Building Air Leakage test, supplemented by targeted mockups and "guarded" floor-by-floor testing to provide assurance as construction progresses. An appointed "air boss" will also be responsible for managing and limiting breaches through the air barrier system during construction.

Passive House-certified windows suitable for high-rise buildings are not widely available in the North American market. An Alternative Solution was submitted to the local building authority to permit the use of fibreglass-framed windows, typically prohibited in non-combustible, high-rise applications. The successful submission, which references the upcoming changes to the National Building Code, will allow their use in this application for one of the first times in Ontario. The existing concrete balconies will also be removed to improve thermal continuity, replaced with Juliette balconies, featuring similar fibreglass-framed doors.

PASSIVE HOUSE CONSULTANTS: TRANSSOLAR KLIMAENGINEERING AND JMV CONSULTING

Collaborating with all disciplines, Passive House consultants Transsolar KlimaEngineering and JMV Consulting were essential in ensuring that all designs would meet Passive House standards. Key challenges included preventing overheating, sourcing insulation material, working with the existing building and adapting local design practices to Passive House design methodology, modelling and technology.

Achieving the EnerPHit certification required the combined knowledge and collaboration of the entire design team. This meant finding new building envelope and mechanical solutions, and designing unique specifications around installation quality and air tightness. Time was spent ensuring that products were readily available in Ontario that would meet the stringent targets.



Wall construction detail

1. AWB flashing
2. Polyurethane Z-girt
3. Silicone transition strip
4. Fiberglass window
5. Roller shade
6. Vapour barrier
7. Helical tie
8. Fiberglass angle
9. Galvanized steel girt
10. Fibreglass cladding clips
11. AWB flashing
12. Polyurethane thermal break Z-girt
13. Concrete board-faced
14. Drainage plane
15. Fluid-applied bituminous waterproofing
16. Weeping tile

To mitigate the impact of this loss, an Alternative Solution to the local building code was developed which included a positive air attenuator, an air admittance valve and a bladder of air at the bottom of the building. Typically, air admittance valves are only permitted when it is not possible to vent through the roof.

ELECTRICAL ENGINEERS: NEMETZ (S/A) & ASSOCIATES LTD.

For electrical engineers Nemetz SA & Associates, the primary challenges were tied with both meeting Passive House standards and working within the constraints of an existing building.

An example of a small but consequential Passive House challenge was that local regulations require that emergency generators have a continuously running block heater installed to allow the generator to start up within 15 seconds of a power failure. The intended block heater alone initially took up 7% of the overall project's primary energy budget. However, increased insulation at the generator room and other modifications to the envelope mitigated this issue.

In a scenario not uncommon in retrofits, it was a challenge to work with the existing electrical service and transformer. Like most older apartment towers, the Ken Soble tower did not previously have a cooling system or sophisticated HVAC system, so the introduction of these new systems required the capacity of the transformer to be closely monitored.

Though the electrical engineer's design is less affected by Passive House considerations than other disciplines, Nemetz was called upon to collaborate closely with mechanical engineers Reinbold in ensuring the electrical requirements of Passive House certified HVAC equipment could be integrated into the design within the constraints of the existing building's capacity.

SCALING LARGE PASSIVE HOUSE PROJECTS IN ONTARIO

Since the Ontario Passive House market is still in its nascency, the approach and considerations required for large-scale projects are still relatively unfamiliar within the architecture and engineering fields. The challenges and considerations described here attempt to share lessons learned with others in the field to narrow this gap.

However, there are a host of other market gaps that will also need to be filled in order to scale large Passive House projects in Ontario. Trades training within the construction industry will be particularly crucial: by familiarizing the construction industry with the unique requirements of Passive House buildings on site, it will be possible to execute projects successfully in an increasingly affordable, efficient, and low-risk manner. In part, this will require the 'demystification' of the standard, which is deliberately low-tech and largely relies on standard construction methods.

New capacity is already being built through early adopters and sophisticated constructors, and in parallel, increasingly stringent local performance requirements which are driving others to follow suit. And indeed, a number of high-performance Ontario retrofits are already gathering the critical mass needed to catalyze this industry growth, paving the way for the widespread renewal of our aging housing supply -- and in so doing, securing a healthy, resilient future for thousands of Canadians.

ERA Architects is a Toronto-based architectural practice specializing in the retrofit of existing buildings. http://www.eraarch.ca
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