RETROFITTING A CITY SCHOOL

Our Lady of Perpetual Help, Toronto, Canada

Project Summary

Solar Decathlon
U.S. Department of Energy
Elementary School Division

reGeneration
Ryerson University

Project Description

PROJECT SUMMARY

Our Lady of Perpetual Help Catholic School (OLPH) is a two-story elementary school in Toronto, Canada. Built nearly 100 years ago, the school's dated structure and operations have been failing to serve an adequate environment for its occupants. Further, the existing capacity of the school no longer meets the demands of a growing student population in the city.

Beyond incorporating energy-efficient building systems, the retrofit of OLPH also accommodates the need for additional learning and gathering spaces as well as fulfils a responsibility to provide an ecologically restorative and resource-efficient environment for future generations. It serves as an example for renewing treasured schools in Toronto. This aligns with the city's climate action plan to achieve net-zero emissions by 2050, as well as the Toronto Catholic District School Board's (TCDSB) plan for pursuing energy-efficient infrastructure projects as a designated 'net-zero energy' school board. As such, design strategies in this project emphasize supporting the comfort, health, safety, and learning experience of its students while inspiring environmentally regenerative solutions in building design.

DESIGN STRATEGY

This project aims to minimize energy use and carbon emissions while maintaining function, architectural aesthetics, and student enjoyment of space. As a retrofit, the project in itself minimizes embodied and operational carbon by extending the service life of existing infrastructure. An energy- and resource-efficient design is then incorporated with minimizing use and implementing high-performing energy systems and on-site renewable energy generation. Some specific strategies include renewable and high-performing material choices, daylight harvesting and shading, natural ventilation, energy-efficient appliances, solar photovoltaics (PV), geothermal energy generation, water recycling, and the incorporation of learning stations for children.

TARGET MARKET

Design solutions in this project are directly addressed to the students, educators, and community members of the University-Rosedale ward who have an active involvement in developing a sustainable neighbourhood. The TCDSB is identified as a target partner in capital development. With TCDSB being a newly designated 'net-zero energy' school board in 2016, project goals align with energy-efficient strategies outlined in the board-wide Energy Conservation and Demand Management Plan (ECMP). The project also aims to appeal to the board's Long-Term Program and Accommodation Plan (LTAPP) to create much needed capacity in the areas of the city experiencing enrolment growth. In addition, the project considers constructability, ease of installation, and material availability to consider the likelihood of adoption by stakeholders in the construction industry.

PROJECT INFORMATION

ASHRAE climate zone	5A
Property size	95433 sqft
Existing floor area	36150 sqft
Retrofit total floor area	41075 sqft
Stories	2
Design occupancy	400 students, 40 staff
Estimated Construction Cost	$102 USD/sqft ($129 CAD/sqft)

TECHNICAL SPECIFICATIONS

Annual heating demand	240.6 MBTU
Annual cooling demand	40.8 MBTU
Peak heating load	221.8 BTU/hr
Peak cooling load	112.6 BTU/hr
R roof	R-42 to R-52
R walls	R-38 to R-41
R slab	R-17 to R-37
R windows	R-4.5 to R-5
Site EUI	23.2 kBTU/sqft
Net solar PV generation	269177 kWh annually

Project Highlights

Architecture: Architectural design focuses on solving existing performance issues of the building, while supporting energy efficiency strategies and preserving the history of the school. In the proposed redesign, a central skylit atrium brings daylight in and improves transparency within the existing structure. The new extension of the school on the south side creates a new gym and multipurpose area inspired by biophilic design strategies.

Engineering: Energy consumption is reduced by minimizing heat transfer across the envelope and incorporating energy-efficient HVAC systems. Thermal performance of the existing envelope is improved by internal insulation of the brick façade and the new extension is insulated externally to achieve R-values close to Passive House standards. Water resource use is minimized with on-site water recycling systems. Radiant flooring provides heating and fan-coil units in select zones provide strategic mechanical cooling, both sourced by a geothermal heat pump. Mixed ventilation is provided by both a dedicated outdoor air system and natural ventilation.

Energy Performance: As a result of implementing the energy reduction strategies introduced in the *Architecture* and *Engineering* sections, OLPH's energy use intensity has been reduced to 23.2 kBTU/sqft. Lighting and plug load reduction strategies also contribute to this. On-site solar photovoltaic (PV) generation results in net-positive energy consumption, netting 269177 kWh generated annually.

Comfort and Environmental Quality: Occupant health and well-being, occupants, thermal comfort, air quality, acoustic conditions, and lighting of indoor spaces are integrated in building design to achieve adequate ventilation and occupant comfort standards. The project entails removal of existing toxic materials, acoustic design within floor assemblies, and adequate daylight illuminance levels to suit the varying lighting needs of school spaces.

Durability and Resilience: Building resilience against future weather patterns are considered with improved envelope thermal performance and HVAC system upgrades. A vapour open wall assembly is designed to minimize the risk of freeze-thaw deterioration in masonry. In addition, evacuation and recovery plans including an emergency drinking water reserve is implemented in the event of disruption from municipal sources.

Embodied Environmental Impact: Being a retrofit, the repurposing of the building is the first step in reducing embodied carbon. Further, low-embodied carbon materials including mass timber and stone wool insulation are selected in building design. The use of dowel-laminated timber (DLT) panels in the new extension also reduces embodied carbon associated with adhesives or nails in panels. A cradle-to-grave lifecycle analysis estimates 86.84 lb CO_2e/sqft of the project's carbon emissions, which places the project in Class C for educational buildings in North America.

Integrated Performance: All disciplines including planning and architecture, civil engineering, envelope design, mechanical engineering, and environmental management were involved in project decision making to implement passive and active design strategies, which together achieve net-zero energy and net-zero carbon design.

Market Analysis: The retrofit of OLPH proposes a solution for renewing city schools with energy- and resource-efficient design while anticipating additional spaces for a growing population. With an estimated project cost of $4.2 million USD, the retrofit is lower cost than that of a new build school of the same type. Considering the energy reduction targets of the Toronto Catholic District School Board (TCDSB) along with City of Toronto goals to achieve net-zero by 2050, this project aligns with community and project ownership goals. Project adoption by the construction industry is also considered with majority local material sources, and preassembled components where possible to minimize construction time. Beyond energy-efficient design, the project also appeals to intended occupants with a renewed learning environment for future generations.

Occupant Experience: Occupant enjoyment of space is promoted through user and learning experiences. Safe and inclusive design, biophilic design, a reflection on school history, learning stations installed throughout the school, and community engagement opportunities aim to enhance the quality of life for students, staff, and community members.