Innovative Design:
Net-Zero Energy Buildings

[1] The first Now House retrofit in Toronto used a solar thermal system for heat and hot water and grid-tied solar photovoltaic panels to produce electricity. With Ontario's FIT solar rebates, the home achieves a net-zero energy cost and net income of approximately $1100 annually. Photo by: Heidi Nelson.

How would the built environment be impacted if every project could satisfy its energy needs within its own boundaries? This is the ambitious challenge that designers in the GTA are answering, using innovative approaches to create buildings and communities that use only the clean, renewable resources provided by nature.

A net-zero energy building [NZEB] can be simply defined: it generates all the energy required to meet its own needs using renewable energy technologies.

While the definition is simple, designing to achieve net zero is a challenge that requires an innovative approach – the building must be ultra efficient, treating energy as a precious commodity. Renewable energy installations like solar panels or wind turbines are integrated to generate the energy needed to supply the building. A connection to the central grid may be used to meet peak loads or share excess energy as long as the energy generated is equal or greater to the amount consumed – hence the term 'net-zero'.

In Toronto, the Now House project, led by Lorraine Gauthier, has demonstrated that existing single family dwellings can pursue net-zero energy. This vintage post-war house was retrofitted with new low-e windows, added insulation and energy saving systems like heat recovery for ventilation and grey water. Solar panels added to the roof generate hot water and electricity, allowing the house to come within a tiny fraction of net-zero energy [and win several awards along the way].

There is potential for a tremendous impact as new and existing buildings in the GTA pursue this ambitious energy standard. Renewable energy added as part of net-zero projects can displace other sources of electricity and eliminate unwanted by products associated with coal, gas and nuclear power.

Designing for Net-Zero Energy

- **Integrated Design Process:** Use a collaborative process to set targets, evaluate innovative approaches and integrate the results of whole building energy modeling.
- **Local site and climate:** Information like wind patterns and solar shading are essential to understanding the potential for energy generation and passive design strategies. Compare the site solar potential with program and operational requirements to guide the design and future decisions.
- **Design for ultra low energy use:** Employ passive strategies such as natural ventilation and solar shading with design measures such as highly insulated envelope and highest efficiency systems. Most NZEBs have an annual Energy Use Intensity below 80 ekWh/m².
- **Renewable energy systems:** Use the most appropriate surfaces to install photovoltaic panels or hot water collectors to capture solar energy.

[2] The 5-1/2" inches of spray foam insulation applied to the exterior walls, attic and roof helped reduce gas use by 79% measured against pre-retrofit usage. Photo by: Heidi Nelson.

A decentralized power grid will waste less energy through transmission losses and is more resilient to demand shortages.

Southern Ontario is a prime candidate for this type of development as the provincial FIT program allows participants to generate increased revenue from their renewable energy investments.

In Toronto and elsewhere, emergent thought is moving increasingly to sustainable communities rather than individual buildings. While density is an essential ingredient to low-carbon living, a net-zero building approach may run into limitations in an urban environment – how could we power a thirty-plus story apartment building with limited area roof mounted solar panels? Integrating large scale renewable energy generation and achieving net-zero at the community level may prove to be the right solution. In this scheme individual buildings will play a slightly different role, sharing heat and electricity with neighbours along with other resources such as clean water and food production.

Renewable energy technologies and ultra-efficient buildings will remain at the forefront of our industry as climate change and energy policy continue to push into the mainstream. Whether at the community scale or as an individual building, net-zero energy is a challenge that designers in the GTA will continue to answer.

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[3] Now House before the retrofit. Now House chose to retrofit a 60 year old post WWII bungalow because of the potential for replication on thousands of similar bungalows across Canada. Photo by: Gonzalo Cardenas.

[4] Now House after the near zero energy retrofit. The pre-retrofit EnerGuide rating was 68; post-retrofit is 89, and with the inclusion of solar is rated at EGH 93.7. Photo by: Harry Mahler.

[5] The Now House Windsor 5 project tested five different approaches to energy reduction, which led to the retrofit of 95 similar homes in this community and demonstrated the economies of scale of a multi-residential retrofit. Photo by: Steve Harjula.

[6] Before a mid-construction open house, Now House was branded to help visitors locate it more easily among the 250 similar bungalows in the Topham Park, Toronto community. Photo by: Harry Mahler.