ecoENERGY Efficiency for Buildings

A Grander View of the Future: A Case Study of Enermodal Engineering's New Building

The business of climate change and energy management

Increasingly, Canadian businesses are discovering that effective energy management can enhance their corporate brands, motivate their employees, increase their operational efficiencies and boost their bottom lines – all while helping conserve the environment. Just look at Enermodal Engineering and the construction of its new headquarters, called *A Grander View*.

Built in Kitchener, Ontario, the three-storey, 2150-square-metre structure is the most energy-efficient office building in Canada.[1] As such, *A Grander View* uses less than 20 percent (69 kilowatt hours per square metre [kWh/m^2]) of the energy and 9 percent of the water consumed, on average, by Canadian buildings (394 kWh/m^2). What's more, the building used 40 percent less virgin materials in its construction than the average Canadian office building and is expected to be carbon neutral by 2014.

> *"Business in Canada is stepping up when it comes to climate change. This profound environmental issue is fast becoming a critical economic issue. How Canada and its business leaders respond to this inevitable reality will help determine Canada's future prosperity."*
>
> **David McLaughlin**
> President and CEO
> National Round Table on the Environment and the Economy

Awarded top honours

Natural Resources Canada's (NRCan's) **ecoENERGY Efficiency for Buildings** program celebrates the success of a company that has risen to the challenge of creating a sustainable built environment. And NRCan is not the only organization to take note of Enermodal Engineering's accomplishments.

The Canada Green Building Council (CaGBC) bestowed on the company's building the remarkable distinction of a Platinum Leadership in Energy and Environmental Design (LEED®) certification under three separate rating systems:

[1] For more information, see "Green Buildings that Work" at www.greenbuildingsthatwork.ca/green-projects-offices.html.

Canada

A Grander View as seen from the Grand River, Kitchener, Ontario

New Construction (NC), Commercial Interiors (CI), and Existing Buildings: Operations and Maintenance (EBOM).

A Grander View was also one of Canada's two representatives at the 2011 Sustainable Building Challenge hosted by the International Initiative for a Sustainable Built Environment. The building gained entry with its high-performance envelope, innovative mechanical system and narrow footprint that enables all occupants to enjoy natural lighting.

Key features of *A Grander View*	
Building name:	*A Grander View*
Building owner:	Enermodal Engineering
Location:	Kitchener, Ontario
Building type:	Three-storey office space
Building size:	2150 m^2
Occupants:	85
Completion:	September 2009
Energy intensity:	69 kWh/m^2
Investment:	$5.5 million (land excluded)
Building cost:	$2690/$m^2$ (land excluded)
LEED®:	NC, CI and EBOM platinum achieved in 2011

Green design features

Working with Robertson Simmons architects inc. and MTE Consultant Inc., Enermodal Engineering incorporated as many sustainable design features as possible in *A Grander View* to maximize energy efficiency, reduce the impacts of construction and operations on the environment, and meet the company's corporate needs.

Site selection

To avoid contributing to urban sprawl, Enermodal Engineering set out to find an urban infill site in an established area. At the same time, the company looked for a site with sustainability features that would enable the company to manage stormwater, promote biodiversity, incorporate native plant species, create wildlife habitats and maintain a pesticide- and irrigation-free landscape.

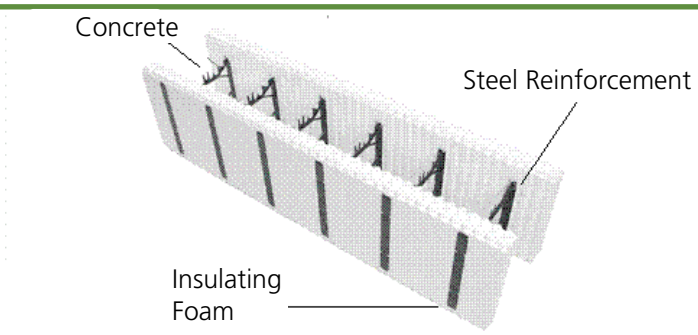
In the end, Enermodal Engineering selected a large derelict site that overlooks the Grand River. The location was ideal. It minimized environmental impacts, gave employees access to transportation routes, reduced the impacts on mature forested areas and was close to green space, which would promote employee health and well-being.

Building envelope

Up to 34 percent of the energy a building consumes is lost by thermal transmittance and air leakage through its envelope. No wonder, then, that an airtight building envelope is one of the most important elements in achieving a high-performance building. Signficantly, blower door tests conducted at *A Grander View* indicate an airtightness rating of less than 1 air change per hour (ACH) at 50 pascals (Pa), well under the average rating of between 5 and 10 ACH @ 50 Pa given to Canadian office buildings.

Features that contribute to the efficiency of *A Grander View*'s building envelope include the following:

- insulated concrete forms (R-value of 25) used for the building's walls
- triple-glazed, low-emissivity, argon-filled, fibreglass windows
- insulation-lined window openings that prevent thermal bridging between them and the thick, concrete walls
- hollow-core slab floors that provide thermal mass to control diurnal heating and cooling requirements



Insulating concrete form

A Grander View's energy data

- Total annual energy consumption: 129 528 kWh
- Total on-site renewable generation: 7378 kWh
- Lighting power density 7.4 W/m^2
- Air tightness ratio: less than 1 ACH @ 50 Pa

Energy

The superior energy performance of *A Grander View* is attributable in no small part to the building's simple mechanical system, which uses on-the-market equipment in a well-conceived design that gives occupants full control over heating and cooling.

Typically, small office buildings are heated by boilers and cooled by rooftop air-conditioning units. These two systems work independently and often at the same time, because some zones are heated while others are cooled. *A Grander View*'s mechanical design is more efficient because the building's heating and cooling is achieved with one integrated system that uses several innovative heating and cooling measures, including the following:

- *Variable refrigerant-flow heat-pump system:* The building is divided into 60 zones that each have a heating-and-cooling fan coil connected to one of three rooftop heat pumps. With one assigned to each floor, these heat pumps are connected by a loop of tubing that circulates refrigerant to small fan coils throughout the building by using variable flow compressors that can work at low speeds. This multi-split system enables occupants to control the temperature and humidity of individual workspaces. It is also an improvement over most conventional heating and cooling systems that do not work as well under part loads.
- *Natural ventilation and earth tubes:* The mechanical ventilation system is independent of the heating and cooling system and takes advantage of natural ventilation when temperatures permit. Before outdoor air enters the building, it travels through a series of concrete earth tubes that temper it, using the ambient temperature of the earth. As a result, less energy is needed to bring the air to the desired indoor temperature.
- *Heat recovery:* During winter, heat and moisture recovered from exhaust air are transferred to incoming air through energy-recovery ventilation units. The reverse occurs in summer. Depending on the season, the pre-heated or pre-cooled air is then delivered to building occupants.

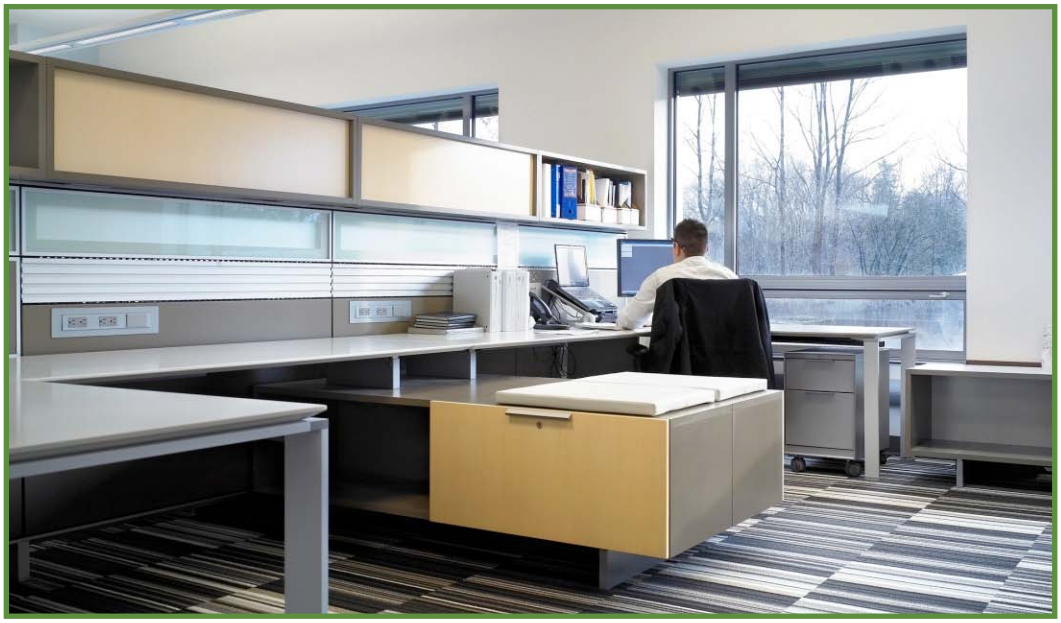
  Server rooms that house computer equipment typically generate a significant amount of heat. At *A Grander View*, this heat is reused through an air-to-water heat-pump system to meet the building's entire domestic demand for hot water.

- *Automated natural cooling:* The cooling system uses outdoor air to cool the building naturally. An automated louver and fan at the top of the atrium exhaust hot air, while nearby windows can be opened to bring in cool air. The louver and fan are controlled by sensors that monitor indoor and outdoor conditions to ensure the cooling devices operate only when needed.
- *Heating, ventilating and air-conditioning (HVAC) sensors and controls:* Occupancy sensors in each zone of the building ensure that *A Grander View*'s heating and cooling system conditions space only in occupied rooms. At the same time, carbon dioxide sensors, which are linked to the ventilation system and are on walls in each room, adjust the ventilation rate based on the number of people in a given space.

- *Photovoltaic solar panels:* A 5.5-peak-kW photovoltaic array enables sunlight to be converted directly into electricity. As such, the array harnesses renewable, emissions-free solar energy that is directed back to the grid through the Ontario Power Authority's Feed-in Tariff Program.
- *Daylight maximization:* Recognizing that lighting is one of the largest consumers of energy in a typical office, Enermodal Engineering adopted three key design features that enable *A Grander View* to use daylight as its principle source of light for the benefit of all employees:
  - a 12-metre-wide footprint that enables most interior spaces to benefit from windows on at least one external wall
  - a large skylight that provides natural light to the central atrium, stairs and corridors
  - interior glass walls that allow light to pass through and brighten spaces

Enermodal Engineering further cut demand for lighting by increasing the lighting efficiency of the building with low-wattage fixtures, such as compact fluorescent pendant lamps and premium efficiency T-8 lamps and ballasts. Daylighting sensors automatically dim lights when there is sufficient natural light, and occupancy sensors turn off the lights in unoccupied areas. With these lighting features, *A Grander View* is expected to have a lighting power density of only 7.4 watts per square metre, 33 percent below the energy savings required by ASHRAE 90.1-2004, Energy Standard for Buildings Except Low-Rise Residential Buildings.

Recycled, salvaged and locally sourced building materials: The building was constructed with materials made primarily from recycled content, including paint (100 percent), gypsum board (95 percent), carpet tile (80 percent), ceiling tile (80 percent) and structural steel (74 percent). Some of the construction materials were salvaged from demolished buildings, including stone from a church and beech flooring from a Toronto building. And 40 percent of the building's materials came from local sources to minimize greenhouse gas (GHG) emissions associated with transportation.



A Grander View open-concept work spaces.
Shai Gil/Enermodal Engineering Limited

A Grander Flow by Deanna Marsh.
Shai Gil/Enermodal Engineering Limited

Other features implemented at *A Grander View* that contribute to the building's environmental sustainability include the following:

- low-flow water fixtures
- a cistern to collect rainwater for use in toilets
- recovery of condensate from the building's heat pumps
- landscaping that provides habitats for native species and requires no irrigation
- an east-west building orientation
- recessed windows and automated external shades that manage solar heat gain, low angles of the sun and glare
- the use of non-toxic materials with low levels of volatile organic compounds
- construction procedures that improved indoor air quality

Key success factors

A collaborative approach

Historically, engineers, architects, owners and other stakeholders, and construction teams have operated separately to deliver individual portions of building designs. According to Stephen Carpenter, President of Enermodal Engineering, however, this piecemeal approach does not work when there is a desire to do more than just put up bricks and mortar. To erect high-performance buildings, clients and professionals must work together.

For coordinated projects, much of the time and energy involved in them must be invested early in the design process. The Integrated Design Process (IDP) treats the building structure, building systems and site as one interdependent system. The approach also brings together key stakeholders and design professionals to work collaboratively and interactively from the early planning stages through to building occupation. As such, the IDP enables each party to develop a clear understanding of the design goals and provides a forum in which professionals can take advantage of complementary systems and design principles to achieve multiple aims.

The IDP does not involve any radical new elements. Instead, it integrates proven approaches into a systematic total process that governs design throughout its life cycle – from pre-design to post-occupancy. The result is a highly efficient design that reduces long-term operating and maintenance costs and incurs minimal, and sometimes zero, incremental capital costs.

Energy modelling

To simulate its proposed design, Enermodal Engineering used NRCan's EE4[2] energy modelling software. Recognized by Canada Mortgage and Housing Corporation and

[2] EE4 is being replaced by CanQUEST, a new building energy use analysis tool, based on the U.S. Department of Energy's eQUEST®.

the CaGBC's LEED® Canada program, EE4 gives companies the flexibility to model many building types and functions. It also compares automatically the energy-consumption results with those of an equivalent reference building designed in accordance with the *Model National Energy Code of Canada for Buildings* (MNECB) 1997.

Enermodal Engineering's computer model of *A Grander View* predicted the building would use less than 20 percent of the energy consumed by a building constructed to meet the MNECB 1997. The NRCan Validation of New Building Designs Service later confirmed that the actual energy performance of *A Grander View* is consistent with Enermodal Engineering's estimate.

"As a consulting firm that works only on sustainable buildings, demonstrating that we have a green workplace is increasingly important to current and potential employees and our clients."

Stephen Carpenter
President
Enermodal Engineering

Commissioning

Commissioning is one of the most cost-effective ways to reduce operating costs and improve the energy efficiency of – and occupant comfort in – commercial buildings. Ongoing commissioning, along with measurement and verification, ensures that a building's mechanical systems continue to function well, with all of the individual components working and communicating with one another properly. Without commissioning, significant inefficiencies and improper installations can go unchecked.

For *A Grander View*, early commissioning helped the general contractor to ensure that the tradespeople installed the mechanical system properly. In initial design meetings, the commissioning authority also helped streamline and improve on proposed ideas. In fact, on the authority's recommendation, the design team removed a planned perimeter-heating system and incorporated an air-to-water heat pump that reclaims heat from a server room to heat domestic water.

The savings that Enermodal Engineering realized from these measures alone illustrate the value of involving commissioning agents in the design phase. Enermodal Engineering estimates that through commissioning, it could reduce energy consumption by 20 percent, with energy use now closely tracking that of the calibrated energy model.

Corporate culture: practise what you preach

Enermodal Engineering recognizes that employees who are committed to a company's stated environmental goals and understand the role of each team member can contribute significantly to the achievement of sustainability objectives. Enermodal Engineering's *Employee Sustainability Committee* comprises volunteers from every division. The committee meets monthly and proposes corporate green initiatives to management. These initiatives have included employee-lifestyle incentives that extend beyond the workplace, such as free rain barrels, compost bins and low-flow shower heads and up to $3,000 toward the purchase of a hybrid vehicle.

The company also has several corporate programs and policies that help support its overall sustainability goals, including the following:

"Businesses succeed when they innovate and when they adapt to new market opportunities. The scale of new technologies, practices, services, products and innovations that will be required to address climate change is large. The business of addressing climate change and the rapid shift to a low-carbon economy that lies ahead has the potential to drive forward the next chapter of technological innovation."

The CEO Climate Policy Recommendations of G8 Leaders, July 2008, page 9

- a green housekeeping program that uses cleaning products that are only EcoLogo™ certified as non-toxic
- purchasing policies that prioritize environmental considerations in all buying decisions (As result of these policies, at least half of all food purchased by Enermodal Engineering is either organically or locally produced, or both, and all coffee is fair trade.)
- waste-reduction techniques
- an annual occupant survey that collects employee responses about thermal comfort, indoor air quality, lighting levels and building cleanliness

Lessons learned

Enermodal Engineering has received numerous awards over the years, including several for *A Grander View*, such as the Tree for Life Award from the Canadian Consulting Engineer Awards. In addition, the company's headquarters earned Canada's only LEED® triple Platinum certification, joining the ranks of Enermodal Engineering's LEED® Platinum certified office in Calgary and LEED® Platinum candidate office in Toronto. With every design realized and LEED® certification obtained, the company maintains that it continues to learn. Enermodal Engineering's experience constructing *A Grander View*, for example, provided two key lessons:

We have the power to make change happen

Policies, technologies and knowledge already exist to help make buildings more sustainable and energy-efficient. In fact, carbon neutrality is possible using technology already on the market. Yet there is no single silver bullet to becoming energy-efficient. Organizations need a good design team that sees a completed building as a whole, rather than as a collection of parts. Such teams know that simple mechanical design principles, a straightforward HVAC design and proper commissioning are critical to achieving landmark energy savings.

Think outside the building

The location of a building can have unanticipated impacts on the environment. For example, a rural location – far from public transit, restaurants and highway access – results in increased emissions because employees and visitors rely largely on automobiles for transportation. For this reason, the site for *A Grander View* was chosen to minimize the environmental impacts of more than just the construction and operation of the building itself. To mitigate travel-related energy consumption and GHG emissions, Enermodal Engineering encourages employees to use public transport and carpooling through measures that include funding toward transit passes and designated parking for carpooling.

Yet Enermodal Engineering insists that organizations can do even more to minimize the impacts of an office building on the environment. Builders can orient buildings to take advantage of daylighting, plant shade trees to help cool indoor spaces and adopt landscaping plans that preserve the existing environment by managing stormwater, promoting biodiversity, using native species, creating wildlife habitats, preventing erosion

A Grander View at dusk.
Shai Gil/Enermodal Engineering Limited

and requiring neither pesticides nor irrigation. At the same time, by locating buildings in mature green spaces, builders can ensure that workplaces have a positive effect on the health and happiness of employees.

A Grander View of the future

A Grander View has proven it is possible to construct energy-efficient buildings at a reasonable cost, using available technology. Perhaps even more importantly, Enermodal Engineering has demonstrated that behavioural and organizational changes that lower demands on energy are as crucial as an energy-efficient design.

Granted, any organization can become more sustainable by implementing energy efficiency measures and operational policies. In fact, even conventional buildings can be modified to realize energy and water savings. But Enermodal Engineering has shown that to embrace the true notion of sustainability, organizations must address not only the environmental aspects but also the economic and social aspects of their built environments over the life cycle of the buildings.

In short, *A Grander View* demonstrates that high performance is achieved through the following:

- new design practices, rather than new technologies
- an integrated design process that includes early modelling and commissioning
- ongoing commissioning, measurement and verification
- the unwavering commitment of upper-level managers

Take your cue from *A Grander View*: Build your space to the highest standard

NRCan's **ecoENERGY Efficiency for Buildings** has the tools and resources you need to capitalize on the many business advantages of becoming more energy-efficient and reducing your construction, operation and maintenance costs. Take advantage of all that the program offers – including training tools and information on cost-saving technical measures – to customize a comprehensive energy-management strategy to meet the needs of your organization. You will not only boost your bottom line but will also help the Government of Canada continue to create jobs, spur economic growth and address climate change in a fair, effective and comprehensive way.

For more information

For more information on NRCan's **ecoENERGY Efficiency for Buildings**, visit oee.nrcan.gc.ca. For more information on Enermodal Engineering, visit the company's Web site at www.enermodal.com.

Natural Resources Canada's Office of Energy Efficiency
Leading Canadians to Energy Efficiency at Home, at Work and on the Road

Aussi disponible en français sous le titre :
A Grander View - une vue prenante sur l'avenir : une étude de cas sur le nouveau bâtiment d'Enermodal Engeneeering