

Energy-efficient and environmentally responsible office building

Summary

As Canada's first C-2000 office building, Green on the Grand was designed to be energy-efficient and environmentally responsible. Computer simulations and detailed calculations compared the energy consumption of Green on the Grand with that of a similar office building built to contemporary energy-efficiency standards (ASHRAE 90.1).

Specifically, the building requires only 40% of the operating energy and 28% of the water use of a conventional building designed to these standards. Essentially, no CFCs or HCFCs were used to produce any of the building materials or operate any of the equipment. The building is being monitored during 1996 and 1997 to determine actual energy performance.

Highlights

- 60% reduction in operating energy
- 72% less water use
- No use of CFCs or HCFCs

Storm water retention pond at 'Green on the Grand'.



The Principle

Green on the Grand was designed by an integrated design team to meet or exceed all the requirements of the C-2000 programme. The C-2000 programme is an advanced commercial buildings programme applying to the total building performance concept. C-2000 encourages industry to build or renovate buildings that feature improved energy efficiency, minimal adverse environmental impacts, exceptional indoor air quality, and high levels of functional performance that can be maintained over the life of the buildings.

The design of Green on the Grand incorporates a number of interesting technologies and materials.

The Building

Green on the Grand is a two-storey, 2,190 m² office building built in Kitchener, Ontario, alongside the Grand River. The building layout is two offset rectangles with the building lot being long in the north-south direction.

Heating and cooling

Space heating and cooling is provided through water-based radiators located in each tenant area. Conventional finned radiators could not meet the building cooling load, so a new radiant system has been used: ceiling panels. Sized to meet the peak cooling load, radiant panels cover 30% of the ceiling area.

The radiators carry hot water in the winter and cold water in the



Green on the Grand: Canada's first C-2000 office building.

summer. The water is both heated and cooled by the same efficient appliance: a natural-gas-fired absorption chiller.

The boiler operates at 85% efficiency. Because the chiller uses natural gas and not electricity to supply building cooling, the low cost of natural gas makes up for the low efficiency of the chiller (coefficient of performance (COP) 0.95 versus COP 2.5 for an electrical air conditioner).

Instead of using cooling towers to reject heat to the outside, which consume large quantities of water and fan energy and require toxic water treatments, Green on the Grand utilises a man-made pond located at the front of the building. This not only solves a mechanical problem but also adds the beauty of water movement to the landscaping. The pond is approximately 20 m x 10 m and is an average of 0.9 m deep.

Heat recovery and ventilation

The ventilation system, independent of the heating and cooling system, supplies outdoor air to all the offices. The main component of the ventilation system is an air-handling unit which contains two heat exchangers, two fans, and a heating/cooling coil. The system is energy efficient, cost effective, and provides superior indoor air quality.

Waste management

Green on the Grand has a comprehensive waste management plan that applies the principles of reduce, re-use, and recycle to both building construction and operation.

Construction waste was minimised through the use of factory-built components such as engineered wood products; these eliminate the need for on-site cutting and waste

generation. Many waste materials were re-used on the construction site. A variety of construction materials were sent to public and private recycling centres. These strategies combined to reduce the waste generated during construction by over 70% when compared to conventional construction practices.

Each tenant is responsible for implementing a programme of in-office recycling of paper, metal, cardboard, and glass. Separate bins are provided for each of these materials.

Building envelope

Green on the Grand uses engineered wood products instead of concrete or steel for its structural support system. These wood products, made from wood strands and glue, are extremely strong, are dimensionally stable, and their glues do not contain urea formaldehyde, an indoor air contaminant. Unlike concrete or steel, which are used in structural support systems for conventional buildings, these wood products do not embody large amounts of energy, are made from renewable resources, and are easy to insulate.

The exterior walls of Green on the Grand are of wooden, double-stud construction. Double-stud walls are energy efficient for two reasons:

- there is plenty of room for insulation;
- thermal bridging is minimised because wood is less conductive than steel.

Green on the Grand windows exemplify three key features:

low heat loss, high daylight transmission, and low solar heat gain. The windows are triple-glazed with two low-emittance coatings, two argon gas-fills and two silicone edge-spacers; the total U-value is under 1.0 W/m²C.

The main entrance doors are perhaps the most energy-efficient commercial door system in the world. These newly designed doors can accommodate a triple-glazed unit, have a 12.5 mm thermal break and an air-tight seal. The door glazing system is similar to that in the windows.

These features are not available in doors from North America, especially the wide thermal break. The doors were therefore imported from Europe by Kawneer Company Canada Ltd.

Lighting

Commercial buildings consume large amounts of electricity during operation, and much of this electricity is used for lighting office space. One objective of the Green on

the Grand project is to demonstrate that offices can be attractively and effectively lit while using only 50% of the electricity that is typically required for offices. The following strategies are employed to meet this objective: daylight, energy-efficient light fixtures, and task lighting. As a result, the lighting system consumes only 9.3 W/m².

Economics

Total construction costs for Green on the Grand, including land, leasehold improvements, and design fees, are CAD 1,100/m². The operating costs for Green on the Grand will be 58% below that of similar buildings. The building is expected to have an annual utility bill (gas, electricity, water and sewerage) of only CAD 8,400, or CAD 3.85/m² of floor area, 42% that of a conventional building. Annual energy cost and savings of the Green on the Grand versus a conventional building built to ASHRAE 90.1 are listed in Table 1. The simple payback on this investment is seven years.

Table 1: Annual energy cost.

Component	ASHRAE 90.1	Green on the Grand	% Savings
Space heating	CAD 2,715	CAD 1,106	59
Water heating	CAD 133	CAD 86	35
Cooling	CAD 1,874	CAD 864	54
Lighting	CAD 6,533	CAD 1,979	70
Receptacles	CAD 3,855	CAD 2,796	27
Pumps and fans	CAD 2,099	CAD 856	59
Total cost	CAD 17,209	CAD 7,687	55



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* IEA: International Energy Agency
OECD: Organisation for Economic
Co-operation and Development

IEA

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This is achieved, in part, through a programme of energy technology and R&D collaboration currently within the framework of 39 Implementing Agreements, containing a total of over 70 separate collaboration projects.

The Scheme

CADDET functions as the IEA Centre for Analysis and Dissemination of Demonstrated Energy Technologies. Currently, the Energy Efficiency programme is active in 15 member countries.

This project can now be repeated in CADDET Energy Efficiency member countries. Parties interested in adopting this process can contact their National Team or CADDET Energy Efficiency.

Demonstrations are a vital link between R&D or pilot studies and the end-use market. Projects are published as a CADDET Energy Efficiency 'Demo' or 'Result' respectively, for on-going and finalised projects.

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