Canada's Advanced House Demonstration Project - The Most Energy Efficiency House Around

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A first in the Canadian residential building industry, the Advanced Demonstration House is a unique project intended to promote and create awareness of energy efficiency techniques to builders, designers and consumers in Canada.

This project showcases a conventional looking house with passive solar design and energy efficient features. The concept underlines the best new products and materials now, or soon to be available to the Canadian buying public, at an affordable price. But the most important feature is the fact that the construction of this house does not require specialized trades people.

The design and construction was tendered to Fram Building Group, Canada's largest super energy efficient and high-end track builder. Fram commissioned architects Gabor and Popper to design a house suitable for a suburban lot, based on an energy efficient concept originally conceived in 1985 by a Toronto engineering firm. They came up with a 250-square meter house with a two-storey south-facing sunroom, four bedrooms, three bathrooms, a two-car garage and large basement area. The builder will retain ownership of the house and sell it at the end of a twelve month demonstration period, effectively reducing the project costs to those directly associated with the demonstration, such as component testing, incremental construction cost, performance monitoring and the costs of leasing the building for one year.


Figure 1. View of house from the West

Whole House Approach
The Advanced House touches on a very important issue in low energy building practice, that is the whole house approach. Whereas in the past, attempts to reduce energy consumption rested almost solely on decreasing space heating loads, this house emphasizes total building energy efficiency, including water, which in some parts of Canada is a precious resource. In fact, the house was designed to have a predicted annual energy budget of approximately 10,500 kWh per year, or 47 per cent below that of a house of equal size, built to super energy efficient (R-2000) standards. The actual performance will be verified during a two-year monitoring programme.

Characteristics of the House

The Latest in High Performance Windows
The Advanced House incorporates a substantial amount of passive solar design. To combat winter chilling and summer overheating, the designers specified triple glazed units with clad wood frames, two low-emissivity coatings, two half-inch argon filled spacers, and swiggle butyl rubber spacers. According to FRAME, a computer simulation programme which investigates the energy performance of a window design, the average window unit to be installed rated an RSI of 1.36.

A Large, Two-Storey Sunspace

The house is built on a corner lot, favouring a south-western exposure. A two-storey sunspace is located at the back of the house on the south wall and is separated by a masonry fireplace, two sets of french doors opening on to the living room and one set of french doors opening into the kitchen. Double-glazed, low-emissivity, gas-filled glazing was chosen for the sunspace because of its good solar transmission characteristics. Passive solar gains are stored in the thermal mass of the masonry fireplace, in the concrete floor slab and the underlying backfill.

When the sun is shining, the sunspace heats ventilation air. Outdoor air is ducted to the ceiling of the sunspace and a return duct, mounted high on the house wall of the sunspace, draws in the fresh warmed air off the ceiling down to the floor slab where it passes through parallel ducts and then to an integrated mechanical system.

A temperature activated roof window will open to exhaust hot air when the temperature in the sunspace reaches above the adjustable set point.

The total passive solar contribution provides the equivalent of 6,904 kWh which is 42 per cent of the total energy use or 62 per cent of space heating according to ENERPASS, a computer simulation programme that evaluates the energy efficiency of a home.

A Unique Integrated Mechanical System (IMS)

The integrated mechanical system combines four functions: space and domestic water heating and ventilation; thermal storage and cooling; load management and monitoring; grey water heat recovery.

Developed by Toronto engineers Allen and Associates, the IMS called "The Integrator" includes a heat pump unit and a thermal storage tank. The heat pump cabinet contains a 40-gallon hot water tank with 6 kW back-up heating coil, an exhaust air fan coil and a house air fan coil. The 200-gallon ice slush, cold water storage tank contains the grey water heat exchanger.

The heart of "The Integrator" is the liquid-to-liquid heat pump which is connected to the thermal storage tank for cooling and to the hot water tank for heating.

Space heating is supplied by recirculated house air passing through the hot water fan coiled for forced air distribution. Sources of waste heat include warm exhaust air (heat from solar gain, appliances, lights, fireplace and occupants) and grey water (clothes washing, sinks, shower and baths). Cooling is accomplished by circulating cold brine from the storage tank through the cooling coil of the fan coil unit. Since energy is drawn from the storage tank, the C.O.P. of the heat pump is rated at between 2.8 to 3.0.

According to ENERPASS, the energy consumption would be 58 per cent greater if the builder opted to install three separate systems, such as an electric furnace, a 70 per cent efficient heat recovery ventilator and a central air conditioner.

Energy Efficient Lights and Appliances

An average Canadian home registers about 7,000 kWh per year on the hydro meter to power lights and appliances. By choosing energy efficient lights and appliances, designers of the Advanced House reduced by half the energy consumption to 3,500 kWh without comprising the occupant's lifestyle.

For example, incandescent lighting was replaced by compact fluorescent bulbs, high efficiency fluorescent and halogen lamps, thereby reducing by 70 to 80 per cent the amount of energy used and energy efficient appliances with very low energy ratings were chosen.

The energy traditionally used to heat domestic water does not figure in the electricity budget because water heating is a function of the integrated mechanical system.

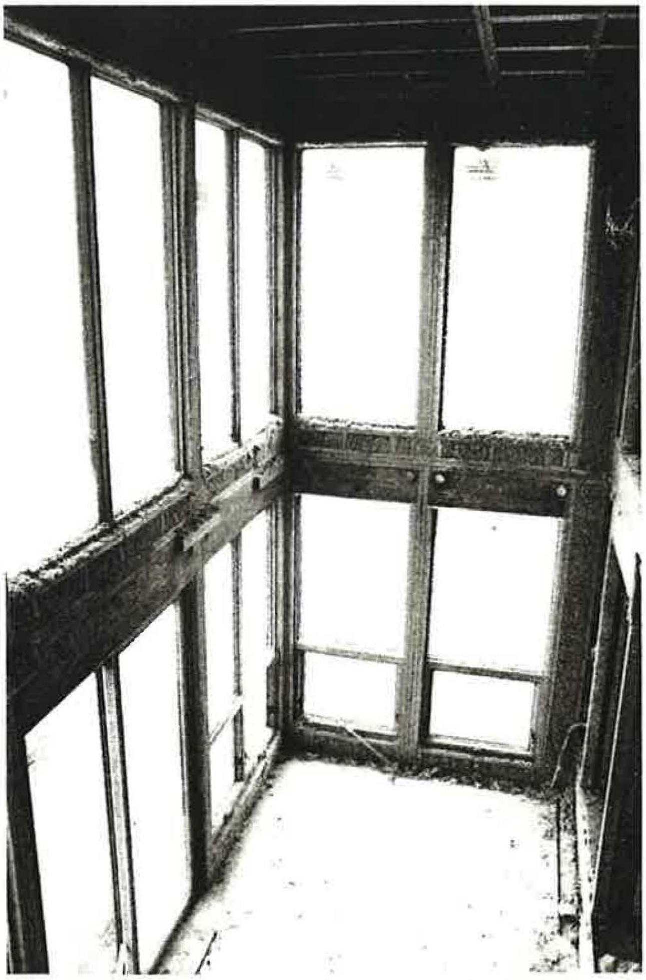

Figure 2. Sunspace interior from master bedroom

Lots and Lots of Insulation

The designers relied on ENERPASS to calculate the amount of insulation to be used: RSI 10.6 for the ceilings, RSI 7.0 for the walls and RSI 5.6 for the basement (below level) and RSI 1.2 for the basement slab.

Insulating the ceiling within the roof cavity was quite easy. As for the walls, conventional construction dictated a poured concrete foundation to support the brick veneer walls and a double-frame, exterior load-bearing system above grade. The deep wall cavities thus created were filled with wet-blown cellulose insulation, held in place with a binder. Highly compressed glass fibre insulation with an outside moisture barrier provides further insulation above grade and a drainage channel for the brick veneer.

Attention to the Indoor Environment

Air quality is an important consideration in air-tight, energy efficient houses because the potential for air leakage is almost eliminated. The Advanced House for example does not feature overhangs, cantilevers, living spaces over unheated areas and other building details that promote air leakage. In fact, the builder has sealed off vents and other penetrations and used molded thermoplastic electrical boxes with gasketted cover plates. The primary air barrier is 6 mil sealed polyethelene, installed directly behind the drywall. The exterior moisture barrier and the interior drywall provide secondary air barriers. Air tightness is targeted at 75 @ 50 pa. Ventilation air is supplied by the integrated mechanical system. The occupants can also open the windows for natural ventilation.


Figure 3. South east corner and neighbouring house

Automatic Monitoring of the Performance

A computerized energy monitoring system pulls everything together to ensure that all systems work in harmony. The Advanced House will be monitored for two years by Sciemetric Instruments of Ottawa, Ontario. The system will also activate load-shedding of the 6 kW back-up coils in the DHW tank, control the motorized roof window in the sunspace, and switch the integrated mechanical system from "winter" to "summer" modes.

With the storage capability of IMS, it is anticipated that instantaneous demands can be kept under 10 kW during peak periods, provided that the use of back-up coils is restricted.

Looking Ahead

The Advanced House is a significant project for the Canadian housing industry because it demonstrates that energy consumption can be reduced if the right equipment and technology are used and mated appropriately to form a whole system. It also proves to the Canadian public that an energy efficient house can be quite attractive and affordable.

The house will be open to the public for one year, during which all those involved in designing and building will be able to promote their accomplishments. The Ontario Ministry of Energy will have guides to provide information to visitors, and Ontario Hydro will provide displays and promotional material. Interior designers have also volunteered their services to decorate the house; with potentially thousands of visitors touring the premises, a well groomed house will surely bring the message home to builders and home owners that, at least as far as residential energy consumption is concerned, a solution to the environmental crisis is both appealing and available.

The project received financial assistance from Energy, Mines and Resources Canada, the Ontario Ministry of Energy and Ontario Hydro and was managed by the Canadian Home Builders Association (CHBA).