



Project Profile: Urban Ecology—Winnipeg, Manitoba

This Project Profile highlights Urban Ecology, one of the winning entries in the Canada Mortgage and Housing Corporation (CMHC) EQUilibrium™ Sustainable Housing Demonstration Initiative – a national initiative to design, build and demonstrate sustainable homes throughout Canada.¹



Figure 1—South façade of the Urban Ecology EQUilibrium™ Housing Project (left side unit)

Key Features

- Energy-efficient building envelope
- Passive solar heating and flat plate solar thermal collector system contribute to space and domestic hot water heating
- Grid-connected photovoltaic system
- Drain water heat recovery system to reduce domestic hot water energy requirements
- Targeted toward modest income families
- Designed using Manitoba “Visitability Guidelines” and CMHC FlexHousing™ concepts

Project Description

Urban Ecology is a new, two storey semi-detached 103.4 m² (1,113 sq. ft.) home with a full basement. It is located on an infill site in a downtown area of

Winnipeg, Manitoba. The area is currently undergoing revitalization. Urban Ecology is within convenient walking distance to a wide variety of amenities including shops, transit, parks and the downtown core.

The developer, Winnipeg Housing Rehabilitation Corporation (WHRC) is a non-profit developer and manager of affordable housing in Winnipeg. The west unit (on the left in Figure 1) is the EQUilibrium™ Housing

¹ To find out more about this initiative and the other EQUilibrium™ homes, visit the CMHC website www.cmhc.ca or www.equilibriumhousing.ca.

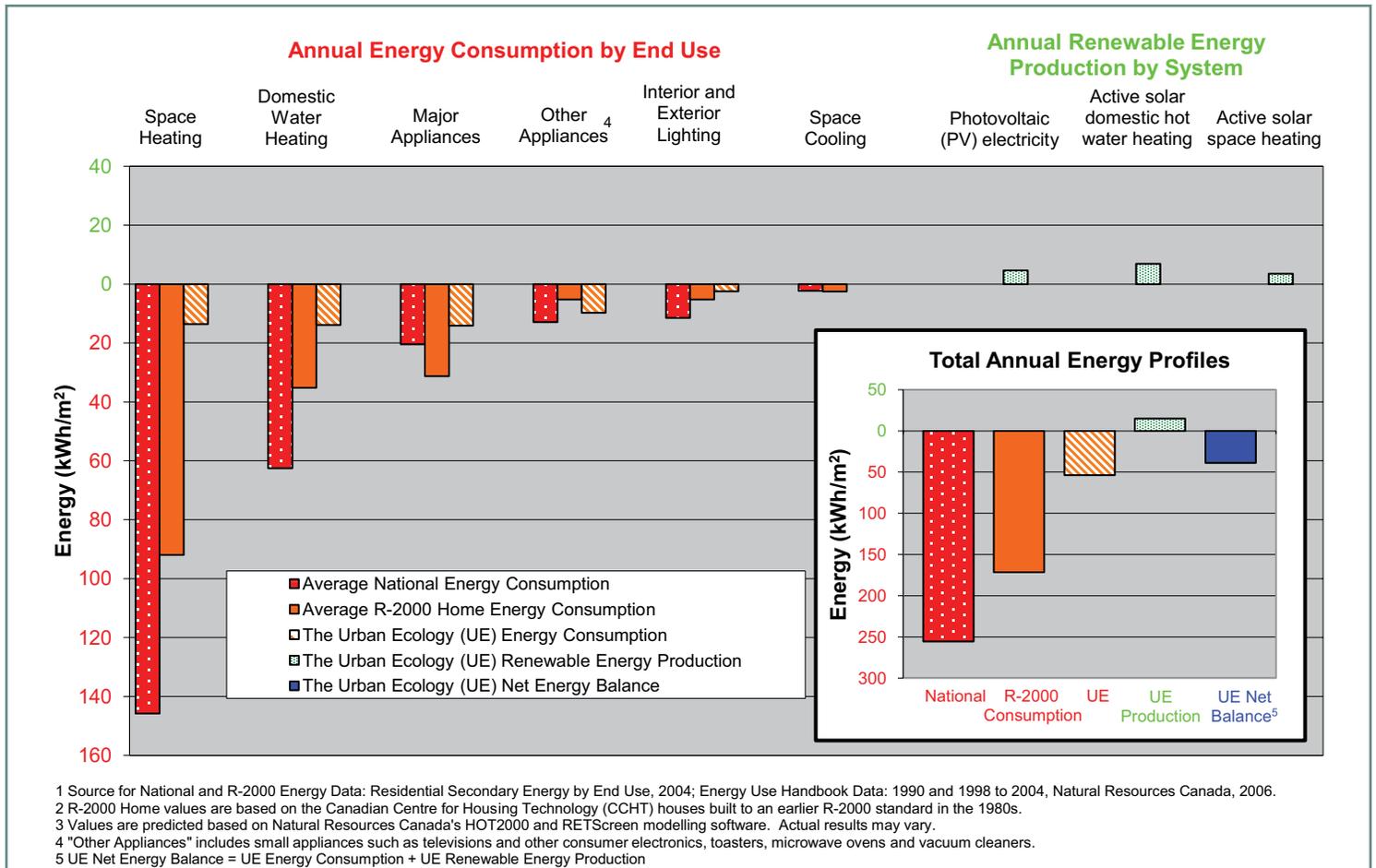


Figure 2—Energy Profile: Comparison of Canadian National Average¹, R-2000 Home², and Predicted Urban Ecology (UE)³ Annual Residential Energy Consumption and Production

Initiative demonstration home². The east unit of the duplex has been certified under Canada's R-2000 program³, as are all homes currently built by WHRC.

The main floor of Urban Ecology is an open-concept design with living room, galley kitchen, dining room, and a two piece wheelchair accessible powder room⁴. The top floor includes a

master bedroom, two other bedrooms, and a full bathroom.

The unfinished basement contains laundry facilities and the mechanical and electrical systems as well as the space to create an additional bedroom or other living space as needed.

In keeping with the EQUilibrium™ Housing Initiative, the Urban Ecology design considers the entire home as an

integrated system. This approach incorporates consideration of how the home influences and interacts with the surrounding environment, the source of raw materials and the impacts of their manufacture and transportation to the site, and factors which contribute to a healthy indoor environment. The home was designed to be of particular interest to people wanting an affordable, sustainable home.

² The EQUilibrium™ unit was registered under Manitoba Hydro's Power Smart program, exceeding the Gold level criteria. For further information on this program, see http://www.hydro.mb.ca/your_home/what_is_power_smart/energy_savings.shtml
³ For a description of Canada's R-2000 building program and associated standards, see <http://oe.nrcan.gc.ca/residential/personal/new-homes/r-2000/About-r-2000.cfm>
⁴ While the front entrance includes two steps, the back entrance is at grade, facilitating easy wheelchair access to the home.

The well insulated, air-tight building envelope, and the other energy efficiency features, are designed to reduce the household energy requirements to approximately 79% less than the energy requirements for a typical Canadian home, on a per m² (sq. ft.) of heated floor area basis. The total annual energy requirements for the home will be met, in part, by renewable

energy sources: passive solar space heating, active solar space and domestic water heating and photovoltaic (PV) electricity generation.

During the first year of occupancy, renewable energy generation, energy and water consumption, and several indoor environmental quality parameters will be monitored to assess these aspects of the home's performance.

Occupant Health and Comfort

Urban Ecology has been designed to provide a healthy indoor environment with superior air quality. An indoor air quality management plan was in effect from commencement of construction. For example, absorptive materials that were installed or stored on-site were protected from dust and moisture. The heating and ventilation system,

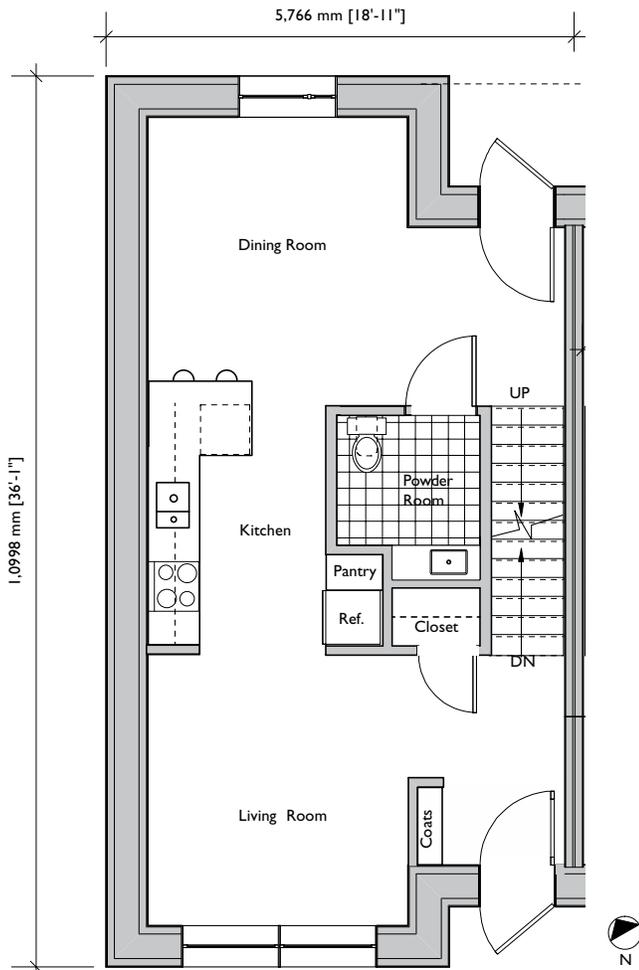


Figure 3—Main floor plan of the Urban Ecology EQUilibrium™ Housing unit

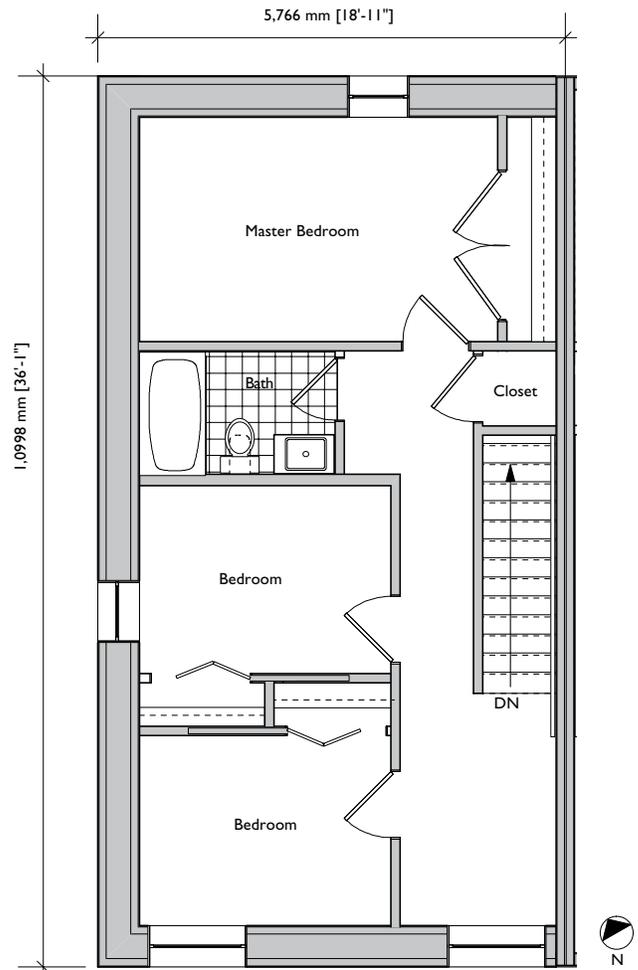


Figure 4—Second floor plan of Urban Ecology EQUilibrium™ Housing unit

including ducts, was thoroughly cleaned prior to occupancy. Indoor air quality for the occupants was enhanced with the use of finishing materials that contained zero to low levels of volatile organic compounds (VOCs). These materials included: hardwood floors sealed with a product made from a natural plant resin, formaldehyde free carpets and millwork, linoleum⁵ flooring, plywood cabinet boxes with reduced VOCs and paints containing zero VOCs in both the colorant and base. The use of synthetic materials was minimized and, where sealing or gluing was required, water based substances with low levels of VOCs were used.

Two heat recovery ventilators (HRVs) were installed in series. The HRVs ensure a continuous, balanced exchange of stale air generated in the home with fresh air from outside. The fresh air is filtered to remove particulates, and the series configuration increases the efficiency with which the system recovers heat from the air being expelled from the home and transfers it to the incoming air. Operable windows provide further ventilation opportunities as well as cross ventilation to help cool the home during summer months; no mechanical air conditioning system was installed.

A trellis on the south west face of the house provides partial shade to help keep the house cool during summer months while allowing passive solar gain during the winter months.

Soil gas (e.g. methane, radon) and water vapour infiltration into the home is minimized with the use of sub-slab polyethylene and proper air sealing around penetrations of the slab and below-grade foundation wall, such as floor drains and water pipes. If radon levels are found to be an issue, a sub-slab system can be retrofitted by the homeowner⁶.

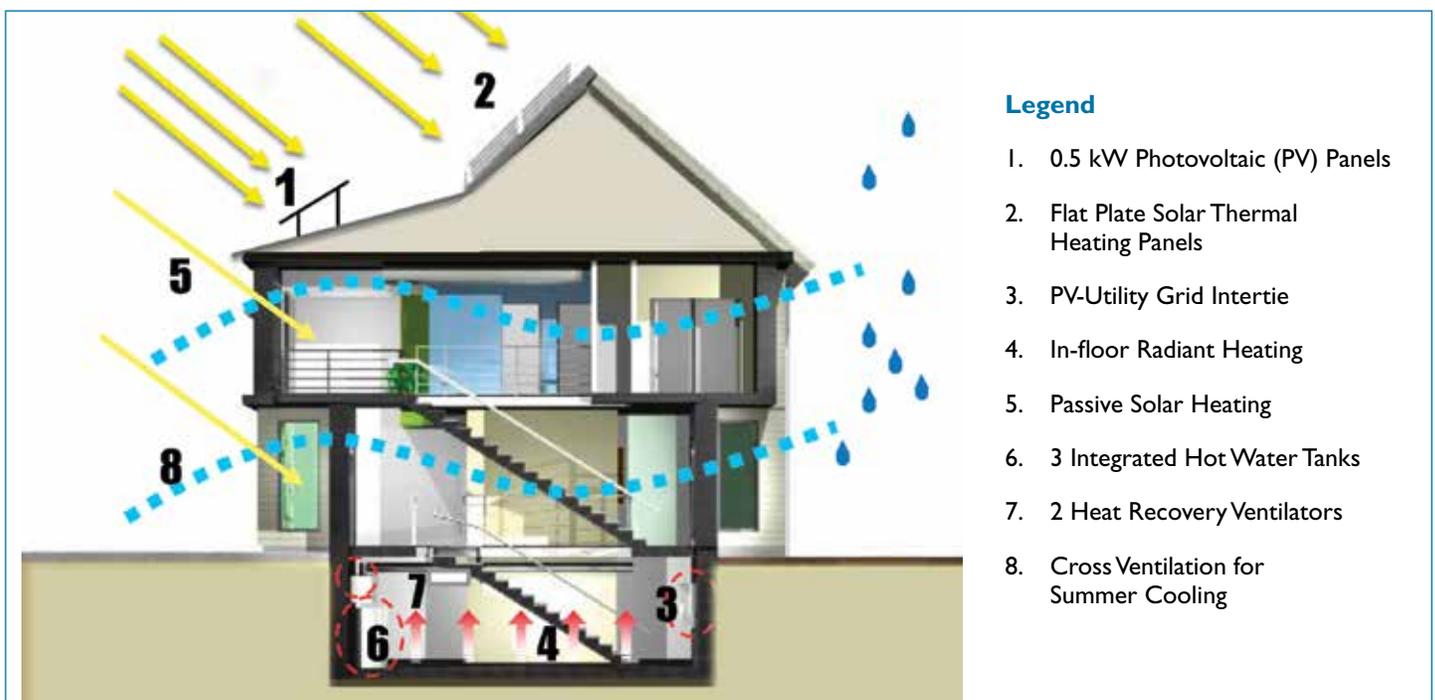


Figure 5—Building mechanical systems in the Urban Ecology EQUilibrium™ Housing Project

⁵ Linoleum is manufactured using linseed oil (from the flax plant), pine tree rosin, wood flour, limestone and natural pigments, which are layered onto a jute backing.

⁶ Radon in homes, and remediation techniques, are discussed in the CMHC publication Radon: A Guide for Canadian Homeowner, which can be downloaded at <http://www.cmhc-schl.gc.ca/odpub/pdf/61945.pdf>

The large windows on the southern façade of the house, combined with the open concept design for the active living area, help ensure that occupants will enjoy good daylighting in rooms typically occupied for much of the day.

Design elements also help ensure a quiet home. The use of insulated concrete forms for the foundation, a double stud wall for the main and second floor exterior wall assembly, triple and quadruple glazed windows and carefully sealed exterior assemblies limit infiltration of outdoor noise. Noise transfer through the party wall between the units is reduced using an insulated (and 1 hour fire resistant rated) double 38x89 mm (2x4) wall assembly that yielded an STC⁷ rating of 57. In addition, quiet kitchen and laundry appliances help reduce noise generated inside the house.

Energy Efficiency

Urban Ecology employs a two-stage strategy to achieve a predicted near net zero annual energy consumption. The first strategy was to design and construct a home that is very energy efficient, dramatically reducing energy requirements. This involved consideration of solar orientation, appropriate shading devices to help manage heat and light penetration, increased building envelope insulation and airtightness, energy efficient windows and doors, energy efficient

mechanical systems, appliances, and lighting, and heat recovery on waste water and ventilation.

The site constraints are such that the front façade of the building faces about 26 degrees to the west of due south, hence the potential for passive solar “gain” is reduced somewhat in comparison to the front façade facing due south. Regardless, the majority of the windows are located on the front façade to optimize the available solar gain potential. The foundation walls utilize insulated concrete form (ICF) construction. The ICFs provided 70 mm (2 ¾”) of Type 2 expanded polystyrene (EPS) insulation on the outside face of the 200 mm (8”) thick concrete core and 200 mm (8”) of Type 2 EPS on the inside, providing an RSI value of 8.2 (R-46). The main and second floor exterior walls are 406 mm (16”) deep double stud wall construction. These walls are filled with formaldehyde-free sprayed-in fibreglass insulation with 25% recycled content and a US Environmental Protection Agency (EPA) registered mold and mildew inhibitor, yielding a thermal insulation layer of RSI 11.4 (R-65). Blown-in loose fill fibreglass was installed in the attic, yielding RSI 14 (R-80); 60 cm (24”) raised heel trusses were used to accommodate this depth of insulation at the intersection of the roof with the exterior walls. The fibreglass frame, argon filled, low-emissivity, triple glazed (on the

southern façade) and quadruple-glazed windows (on the other façades) and polyurethane foam core insulated fibreglass exterior doors also contribute to an energy-efficient building envelope. The post-drywall airtightness value was 0.82 air-changes per hour at 50 Pa.

Energy efficiency considerations also played a key role in the selection of mechanical systems, appliances, and lighting fixtures. Both the HRV’s and the air handling unit which distributes air throughout the house contain energy-efficient brushless DC motors. Appliances were selected using the NRCAN EnerGuide Appliance Directory 2007⁸. Lighting energy requirements are substantially reduced with the use of compact fluorescent lights (CFLs). Simple, cost effective track lighting systems were installed throughout the house. Each track was initially installed with a fixture head that accommodates a 9 watt CFL, which is equivalent to a 40 watt incandescent bulb. Additional fixture heads (or heads with a higher wattage bulb) can be added to the system to provide additional light if required. This system provides low energy consumption lighting solutions; the homeowner can adjust the light levels as well as direct light on various task areas, as required. The system will also facilitate the future use of more energy efficient light emitting diode (LED) lighting technology.

⁷ STC (Sound Transmission Class) is a rating of how well a building partition attenuates airborne sound; the larger the number the better the attenuation. A rating of 57 is considered good airborne sound attenuation in this context.

⁸ The Directory has subsequently been updated. For further information, and to order copies of the directory, see www.oee.nrcan.gc.ca and search under “EnerGuide Appliance Directory 2011”

Another feature of the home which contributes to energy conservation is the phantom load switch. A standard light switch was installed to control power going to electrical outlets in the living room where the home's media equipment (e.g. TV, DVD player, stereo system) is located. When the media equipment is not in use, but still consuming stand-by power, the homeowner can turn off the switch thereby saving the power that would otherwise be consumed.

A drain water heat recovery (DWHR) device has been installed; this device captures heat from drain water that would otherwise be lost to the sewer system and transfers this heat to cold water destined for the solar thermal storage tanks, discussed below. The DWHR unit is predicted to reduce the domestic hot water energy requirements by 12%.

Renewable Energy Production

The second strategy employed to reduce energy demand from the utility was to install renewable energy systems, i.e. the solar photovoltaic (PV) system and a solar hot water heating system used for both space heating and domestic water heating. These systems are predicted to have sufficient combined capacity to reduce the home's annual purchased energy requirements by 2,225 kWh.

A 525 watt, 3.5 m² (37.7 sq. ft.) array of three 175 watt PV modules is mounted on the southwest facing roof at 45° to the horizontal. This array is predicted to generate approximately 680 kWh per year. The PV micro-inverters feed the energy to the service panel where it is distributed to the home. If more energy is being generated by the PV than is required by the house, the excess is fed into the Manitoba Hydro grid. Alternately, if the PV production cannot meet the electrical requirements of Urban Ecology, electrical energy is provided to the home by the grid. Extra capacity was incorporated into the system components (e.g. inverters, wiring) to accommodate future expansion of the PV array.

Active solar domestic hot water and space heating is provided using four flat plate collectors. This 11.9 m² (128 sq. ft.) closed loop system provides heat via heat exchangers to two 454 litre (100 imp. gal.) solar thermal storage tanks, one for domestic hot water, the other for space heating. This system is predicted to produce approximately 1,030 kWh of domestic hot water heat energy per year, and 515 kWh of useable⁹ space heat per year, thereby meeting approximately 50% of the domestic hot water energy needs and 26% of the space heating energy needs for the home. A 30 watt PV module is used to power the pump that circulates

the solar heated glycol solution through the heat exchangers. When there is no sun, and therefore minimal to no solar electricity generated, the pump will not run therefore avoiding cooling of the tanks and electricity use.

The heat within the two tanks is supplied by the solar collectors and heat captured from the DWHR unit. Solar heated water from one of the tanks enters a secondary standard electric residential 150 litre (33 imp. gal.) hot water tank which is used to boost the domestic hot water temperature if required. Due to the high water temperatures that can be obtained through solar heating alone, a tempering mixing valve at the output of the electric tank helps ensure the domestic hot water is at a safe temperature for use in the home.

Solar heated water from the space heating tank is circulated through a hot water coil in the air handling unit and through the radiant floor tubing in the basement floor slab. The air handling unit distributes warm air through the duct work to all rooms in the house as needed. This ductwork is also used to distribute the fresh (intake) ventilation air from the HRVs to the rooms in the house. When additional solar heat energy is available during the winter months, the basement will be heated to as much as 25°C degrees, storing the heat energy in the thickened (14 cm [5.5"])

⁹ While the domestic hot water produced from the solar array will likely be fully utilized, the hot water produced by the array for space heating will only be utilized during the heating season.

basement floor slab. When the solar tank temperature is not hot enough for space heating, a small in-line 5 kW electric boiler boosts the water temperature to what is required.

Resource Conservation

The Urban Ecology design incorporates conservation attributes such as simple design, relatively modest footprint and size, building durability, efficient use of materials, water conservation, and building adaptability features.

The house was built as a semi-detached home on a double wide, previously vacant infill lot to maximize land use and provide additional housing opportunities. The interior living space of Urban Ecology, (excluding the 406 mm (16") thick building envelope walls and the basement space), totals 98 m² (1057 sq. ft). This modest floor area and shared party wall use less building materials and reduces the energy requirements of each home in comparison to larger, single-family residences, potentially conserving resources and energy.

Sustainable materials were used throughout Urban Ecology. The elm flooring was recovered from trees infected with Dutch elm disease destined for the landfill. The carpets are made of 37% bio based material

(corn sugars), consumed 30% less energy for production, and emitted 63% less greenhouse gas in their manufacture, than nylon carpet. Linoleum flooring, made from renewable materials, was installed in the entrances. The exterior wall fibreglass insulation is partially comprised of recycled material and the method of installation results in no material waste. Closed cell spray foam was used to seal and insulate at the rim board between floor joists and at the cantilevers to ensure consistent air tightness and reduced air leakage. The spray foam includes a bio-based material, does not off-gas VOCs, and is made from renewable resources and recycled materials. Material waste was reduced by construction techniques such as the use of ICFs; any leftover ICF material was returned to the manufacturer for re-use.

The use of low flow fixtures, dual flush toilets, appliances with low water consumption, and rainwater harvesting helps decrease potable water use.

In terms of flexibility and adaptability, Urban Ecology has been designed using CMHC FlexHousing™ concepts¹⁰, and Manitoba “Visitability” guidelines¹¹. Features include direct wheelchair access from the back yard parking area to the main floor with a no step entrance, and a wheelchair accessible two-piece bathroom on the main floor.

Reduced Environmental Impact

In addition to the features outlined above, other development philosophies as well as design and construction technologies and techniques help reduce Urban Ecology’s environmental impact. The project was built on a vacant serviced lot in an established area of downtown Winnipeg, utilizes existing infrastructure and contributing to the revitalization of the area.

Prior to construction, the builder installed a parking pad of crushed recycled concrete to provide a base for trucks entering the site; this minimized erosion and keep dirt off the street. Silt fencing was also installed around the perimeter of the site to reduce soil erosion and entry of sediment into the storm sewers during construction.

Roof runoff into storm sewers is reduced through eavestroughs leading to a rainwater barrel for landscape use and a rain garden located at the front of the house. The latter contains plants that can withstand periods of drought or periods of saturation and helps recharge ground water as well as reduce storm water runoff and erosion. Other site storm water runoff is reduced through ground infiltration. Infiltration is facilitated in part through the use of crushed limestone (on a base of the crushed recycled concrete utilized

¹⁰ For further information, see www.cmhc.gc.ca and search under FlexHousing™

¹¹ For further information, see http://www.gov.mb.ca/housing/visitable_housing.html

during construction) rather than impervious asphalt for the parking area and a permeable surface ramp (concrete slabs spaced slightly apart with spaces filled with crushed limestone) installed in the landscaping for wheelchair access. Recycled wood chips were installed on the site as a low maintenance ground cover which reduces the need for herbicides, irrigation and reliance on gas or electric powered lawn mowers.

Greenhouse gas (GHG) emissions from Urban Ecology are reduced due to the use of energy conservation and renewable energy features. In addition, the reductions in indoor emissions with the use of natural and low VOC building materials, and the reduced potential for harmful gases in the home or immediate surroundings in the absence of combustion appliances (e.g. gas furnace or domestic hot water heater, or wood fireplaces) will further reduce local air pollution emissions.

Affordability

Affordability of Urban Ecology is enhanced by the relatively small and efficiently designed home, operating cost savings related to energy conservation and efficiency features and the use of renewable energy systems. A modest, simple design with the focus on quality rather than quantity will help Urban Ecology reduce its impact on the environment, consume fewer resources, and generate less waste than the typical contemporary Canadian home.

As a result of the energy-efficiency and renewable energy features of this new house, the annual consumption of purchased energy is predicted to be substantially less than that of a conventional home. In the current economic climate of uncertain future energy prices, this is a very positive attribute, in particular for the budget conscious, modest income consumer.

In addition, the incorporation of FlexHousing™ concepts appeals to those seeking housing that can be easily modified to accommodate life's changing needs. Finally, the healthy and comfortable indoor environment, which has been integrated into the design of the home, is a feature sought by more and more prospective home owners.

Technical Summary: Urban Ecology—Winnipeg, Manitoba¹

Building Description			Predicted Annual Energy Consumption	
Type: New, 2-storey with unfinished basement, 3 bedroom semi-detached residence			Space heating	13.6 kWh/m ²
Floor space (not including basement) 103.4 m ² 1,113 ft ²			Domestic water heating	13.9 kWh/m ²
Solar orientation southwest			Appliances/lighting	24.3 kWh/m ²
Building footprint 54.8 m ² 590 ft ²			Mechanical ventilation	2.0 kWh/m ²
Heated volume 396 m ³ 13,985 ft ³			Space cooling	0.0 kWh/m ²
Heated floor area 148.6 m ² 1,599 ft ²			Total predicted consumption	53.8 kWh/m²
Ceiling area 53.9 m ² 589 ft ²			Note: All values are based on heated floor area. The space heating value does not include the contribution from passive solar gains and internal gains (see Space Heating Information, below)	
External wall area (gross) ² 107.7 m ² 1,159 ft ²			Predicted Annual On-site Renewable Energy Production	
External wall area (net) ³ 90.6 m ² 975 ft ²			Solar (photovoltaic) electricity	4.6 kWh/m ²
Total window area 13.1 m ² 140.8 ft ²			Active solar domestic water heating	6.9 kWh/m ²
South 9.33 m ² 100.4 ft ²			Active solar space heating	3.5 kWh/m ²
West 1.05 m ² 11.3 ft ²			Total predicted production	15.0 kWh/m²
North 2.72 m ² 29.3 ft ²			Note: All values are based on heated floor area.	
East 0 m ² 0 ft ²			Predicted Annual Energy Balance	
Ratio of south glazing area to floor area: 8.0%			-38.8 kWh/m²	
Thermal Characteristics			EnerGuide for Houses ⁴ (EGH*) Rating	
Roof RSI 14.1 R-80			95.1	
Walls			Space Heating Information	
Main and Second floors RSI 11.5 R-65			Space heating requirements for Urban Ecology will be met as follows (predicted values):	
Basement RSI 8.2 R-46			Passive solar gain	38%
Windows RSI 1.04 to 1.78 R-5.9 to 10.1			Internal gains ⁵	41%
Basement floor slab RSI 3.5 R-20			Active solar thermal system	7%
Measured Airtightness Level 0.82 ACH @ 50 Pa			Electric back-up hot water heater	14%
Site Characteristics			Domestic Hot Water Information	
Location Winnipeg, Manitoba			Domestic hot water requirements for Urban Ecology will be met as follows (predicted values):	
Site type Urban, infill			Active solar thermal system	49%
Site area 610 m ² 6,566 ft ²			Electric back-up hot water heater	39%
Elevation 235 m 771 ft.			Drain water heat recovery	12%
Latitude 49°54' N			Ventilation	
Longitude 97°09' W			Two heat recovery ventilator (HRV) units with brushless DC motors. Connected in series, and integrated with space heating duct work. Individual efficiency 79%, combined efficiency 95%. Design ventilation rate 60 L/s, 0.33 air change per hour.	
Climate			Water Consumption (estimated 2 adult and 2 children consumption)	
Average daily horizontal solar irradiation 3.7 kWh/m ²			Potable water	360 L/day 79.2 U.K. gal/day
Average daily vertical solar irradiation 3.6 kWh/m ²				131,480 L/yr 28,938 U.K. gal/yr
Average annual precipitation 514 mm 20 in.				
Average annual wind speed 16.9 km/h 10.5 mph				
Average outdoor temperatures				
January -18.3 °C -0.9 °F				
April 3.8 °C 38.8 °F				
July 19.8 °C 67.6 °F				
October 5.7 °C 42.3 °F				
Building design temperatures ⁶				
January -33 °C -27.4 °F				
July 30 °C 86.0 °F				
Heating Degree Days (base 18°C [64°F]) 5,670 [10,620]				
Cooling Degree Days (base 18°C [64°F]) 186 [334]				

¹ All area, volume, predicted energy production and use, and system capacity values are for the Equilibrium™ unit.

² Includes common wall and above grade foundation wall.

³ Includes above grade foundation wall but does not include common wall.

⁴ Natural Resources Canada's EnerGuide for Houses (EGH) Rating is a standard measure of a home's energy performance, and can range from 0 to 100. The rating is based, in part, on the assumed energy consumption of appliances, assumed hot water draws, and other electricity usages in conventional homes. The EGH* Rating allows reductions in electricity and hot water loads in Equilibrium™ homes, thereby more accurately reflecting the home's potential energy performance.

⁵ Internal gains include heat from occupants, lights, appliances, mechanical systems, and consumer electronic items.

⁶ Building design temperatures are based on historic temperature data for a particular area and are used when designing a building and its heating and cooling systems for that area.

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For more information about this and
other EQUilibrium™ homes, visit the
CMHC website at www.cmhc.ca or
www.equilibriumhousing.ca.

EQUilibrium™ Sustainable Housing Demonstration Initiative

What is EQUilibrium™ Housing?

EQUilibrium™ is a national sustainable housing demonstration initiative, created and led by Canada Mortgage and Housing Corporation (CMHC), that brings the private and public sectors together to develop homes and communities that address occupant health and comfort, energy efficiency, renewable energy production, resource conservation, reduced environmental impact and affordability.

CMHC's EQUilibrium™ Housing initiative offers builders and developers across the country a powerful new approach to establish a reputation for building premium quality sustainable homes that will meet the needs of Canadians now and well into the future.

EQUilibrium™ Housing combines a wide range of technologies, strategies, products and techniques designed to reduce a home's environmental impact to an absolute minimum. At the same time, EQUilibrium™ Housing also features commercially available, on-site renewable energy systems to provide clean energy to help reduce annual consumption and costs.

The ultimate goal is a highly energy-efficient, low-environmental-impact house that provides healthy indoor living for its occupants and produces as much energy as it consumes on a yearly basis. As part of the initiative, all EQUilibrium™ Housing projects will be open to the public for a minimum time period of six months and then monitored for performance with occupants for at least one year.

For more information on this project and on the CMHC EQUilibrium™ Sustainable Housing Demonstration Initiative, visit www.equilibriumhousing.ca.



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