EQuilibrium™
HEALTHY HOUSING
FOR A HEALTHY ENVIRONMENT

Project Profile: ÉcoTerra™—Eastman, Quebec

This Project Profile highlights ÉcoTerra™, 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—Photo of ÉcoTerra™

Key Features

- Factory-built modular construction
- Predicted net zero annual energy consumption
- Reduced CO_2 emissions
- Sustainable use of materials through recycling and waste reduction
- Off-site manufacturing to reduce environmental impact
- House oriented to maximize solar exposure
- Uniformity of air temperature and air quality throughout

Project Description

ÉcoTerra™ is a new, two-storey detached home in Eastman, Que., which is between Montréal and Sherbrooke. The 141 m² (1,517 sq. ft.) home sits on a 1.1 ha (2.7 acre) forested rural lot. The objective of the builder-developer, Les industries Ste-Anne de la Rochelle Inc. (Alouette Homes), was to design and build a grid-connected home that not only produces as much energy as it consumes in a year (a net-zero energy home), but also features a healthy indoor environment, low environmental impact, significant resource conservation, and affordability considerations.

Built using factory pre-engineered modular sections to optimize construction quality and reduce the environmental impact at the site, the home combines renewable-energy technology with energy-efficient construction techniques. The pre-fabrication approach, and technologies

[1] For more information on this initiative and the various EQuilibrium™ projects, visit the CMHC website (www.cmhc.ca) and type the search keyword "EQuilibrium".

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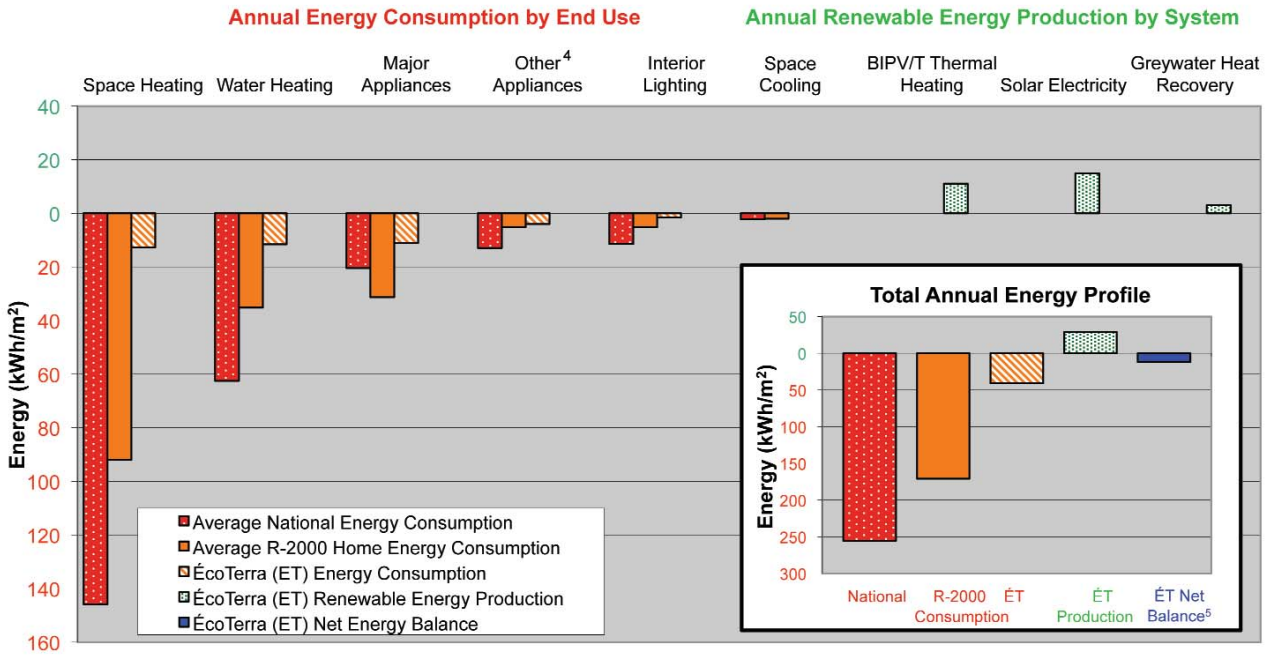
Figure 2 - Comparison of Canadian National Average[1], R-2000 Home[2] and Predicted ÉcoTerra[3] (ÉT)
Annual Residential Energy Consumption and Production



1 Source for National and R-2000 Energy Data: Residential Secondary Energy by End Use, 2004; *Energy Use Handbook Data: 1990 and 1998 to 2004*, Natural Resources Canada, 2006.
2 R-2000 Home values are based on the Canadian Centre for Housing Technology (CCHT) houses built to an earlier R-2000 standard in the 1980s.
3 Values are predicted based on Natural Resources Canada's HOT2000 and RETScreen modelling software. Actual results may vary.
4 "Other Appliances" includes small appliances such as televisions and other consumer electronics, toasters, microwave ovens and vacuum cleaners
5 ÉT Net Energy Balance = ÉT Energy Production + ÉT Renewable Energy Consumption

Figure 2—Energy profile: Comparison of Canadian National Average,[1] R-2000 Home[2] and predicted ÉcoTerra™ (ÉT)[3] annual residential energy consumption and production

and techniques applied, have immediate applications, especially for the European export market under Super E®.[2]

The total annual energy requirement for the home is predicted to be equal to the on-site annual production from renewable energy sources: active and passive solar space and water heating, a geothermal heat pump, and photovoltaic electrical panels. The household energy requirements are predicted to be only 17% of the requirements for the average Canadian home. The homeowner will receive a credit for any surplus on-site electrical production fed into the electrical utility grid and, if required, electricity will be supplied by the grid to the house.

ÉcoTerra™ includes a living room, dining room, kitchen and two-piece bathroom with laundry on the main floor, and two bedrooms, an office, and four-piece bathroom on the second floor. The basement is unfinished.

During the first year of occupancy, the energy generation and energy and water consumption will be monitored to assess the building's performance.

Occupant Health and Comfort

Airtight construction combined with a heat recovery ventilator (HRV) system are key health features of the home.

They ensure enhanced thermal comfort, proper humidity levels, and good indoor air quality. Special attention has been given to daylighting, with the large south-facing windows and open spaces increasing light penetration on the main floor. Roof overhangs are used to prevent overheating from solar gain.

[2] The Super E® House Program is designed to help Canadian exporters deliver energy-efficient and healthy housing to other countries. For more information, go to http://www.super-e.com/html/canada/English/index-e.html. Retrieved September, 2007.

Materials selected for the home help to minimize indoor air pollutants, such as volatile organic compounds (VOCs). Many interior finishes are factory-applied to reduce on-site air pollution and increase indoor air quality.

Energy Efficiency

The well-insulated, airtight building envelope (the exterior shell) significantly reduces space heating requirements, and the house is oriented to maximize solar gain. The exterior of the basement wall is insulated with urethane foam. The utilization of energy-efficient, triple-glazed, low-e, argon-filled windows contributes to the reduction in heat loss and the large south-facing windows enable passive solar heat gain. Thermal mass materials, which store heat and moderate interior temperature fluctuations, include the concrete floor and half wall in the family room, and concrete slab and walls in the basement. Drainwater heat that would otherwise escape from the house is captured with a heat recovery exchanger, further adding to the home's energy efficiency.

Renewable Energy Production

ÉcoTerra™ utilizes a building-integrated photovoltaic system combined with a heat recovery system (BIPV/T). A 3 kW, Uni-Solar® PV array, composed of 21 PV film sheets laminated to a standing-seam metal roof, is connected to a DC/AC inverter. The inverter connects through the electricity meter to the electrical utility grid. It is estimated that it will provide 3,420 kWh of electricity annually. Electricity is used to operate all appliances, lighting, fans, compressors, and controls. Solar heat generated at the rooftop-integrated photovoltaic system is captured and then distributed in the home, assisting with space heating, domestic water heating and clothes drying. Removing this excess heat from the vicinity of the BIPV/T also improves the efficiency of the PV array.

To further reduce energy costs, a three-ton, two-stage geothermal heat pump will provide space and water heating and is expected to reduce annual electricity consumption by about 7,200 kWh in comparison with an electrically heated house.

Resource Conservation

The house is factory-built using pre-engineered modular sections that maximize efficient use of materials and reduce waste. Wood is from local sources. Moisture control strategies, including airtightness, are implemented to ensure a long life cycle for structural wood elements.

An adaptable and flexible design allows for the large upstairs space to be outfitted with movable interior walls to accommodate the occupants' changing needs without extensive renovation expense. Modifications can be made to the basement and north-facing outdoor deck to create additional living space.

Reduced Environmental Impact

A system of streams and stormwater management ponds provides erosion control. A rain barrel system will capture roof runoff, thereby attenuating the volume of runoff onto the site during rain storms and enhancing this erosion protection.

The off-site manufacturing of the modular sections greatly reduced the impact that typical construction would have had on the site and also reduced construction waste. The BASF Walltite® insulation/air barrier system uses a water-blown application system, thereby avoiding the use of ozone-depleting chemicals.

Water services for the home are entirely independent. Domestic water comes from a well and a EnviroSeptic™ system is used for wastewater treatment. This system allows for maximum biological activity and flexibility of septic field configuration.

Affordability

As a result of the energy-efficient features of this new house, the net annual energy consumption is predicted to be near zero. Off-site manufacturing helped the builder reduce costs. The durability of the Super E®/ R-2000[3]/ Novoclimat[4] based construction should ensure a long life cycle for the building.

[3] Developed in partnership with Canada's residential construction industry, R-2000 is an initiative of NRCan's Office of Energy Efficiency to promote the use of cost-effective energy-efficient building practices and technologies. For more information, go to http://oee.nrcan.gc.ca/residential/personal/new-homes/r-2000/About-r-2000.cfm. Retrieved June, 2007.

[4] Novoclimat is a set of technical standards developed for Quebec builders to increase energy efficiency, improve indoor air quality and provide maximum comfort in their homes. For more information, go to http://www.aee.gouv.qc.ca/habitation/novoclimat/novoclimat.jsp. Retrieved June, 2007.

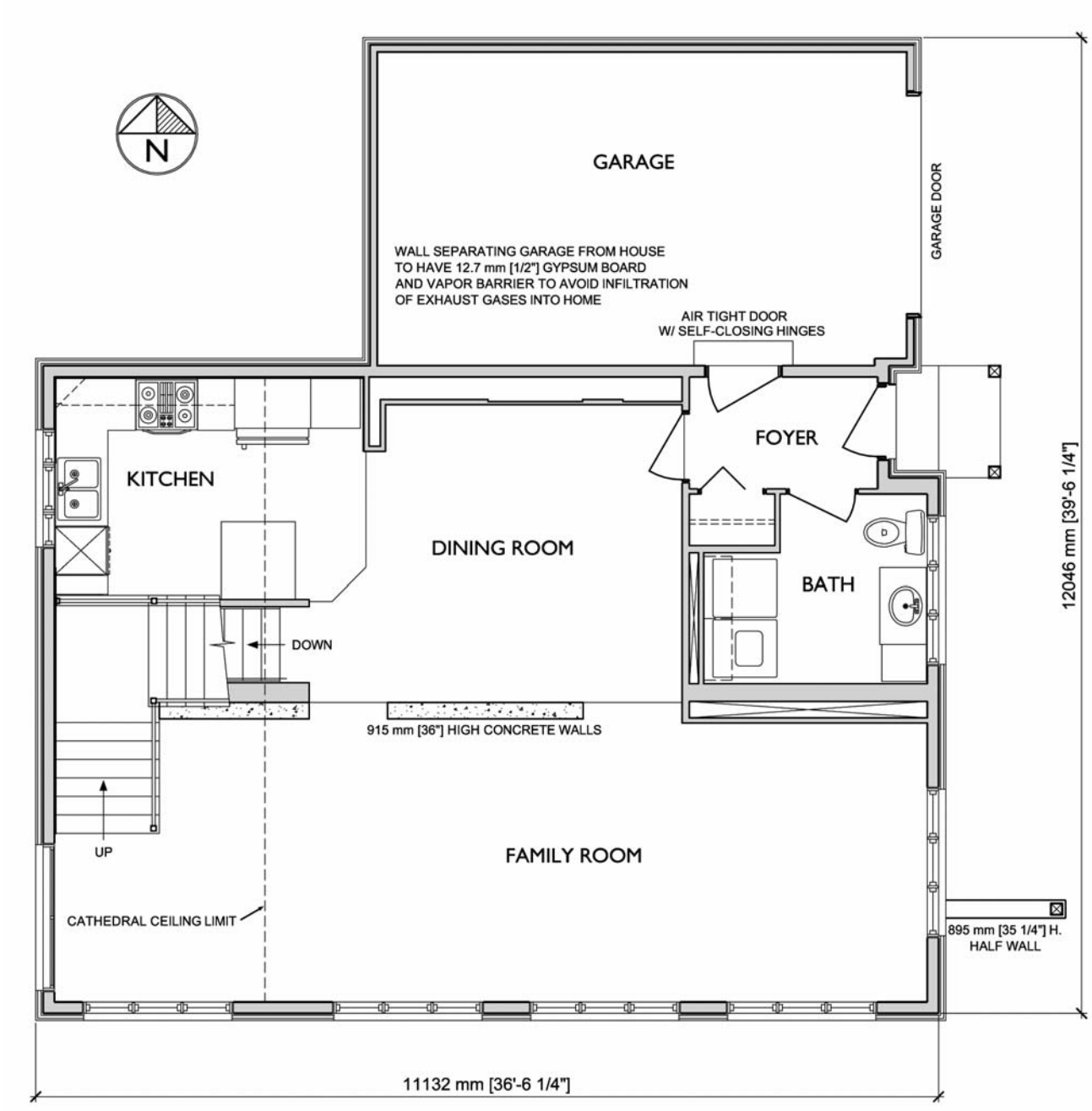


Figure 3—First floor plan of ÉcoTerra™

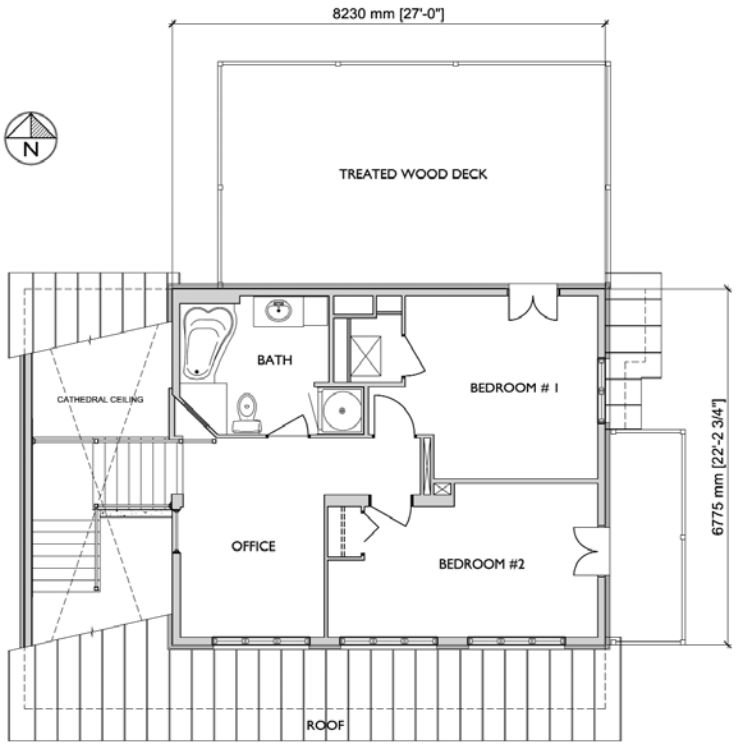


Figure 4—Second floor plan of ÉcoTerra™

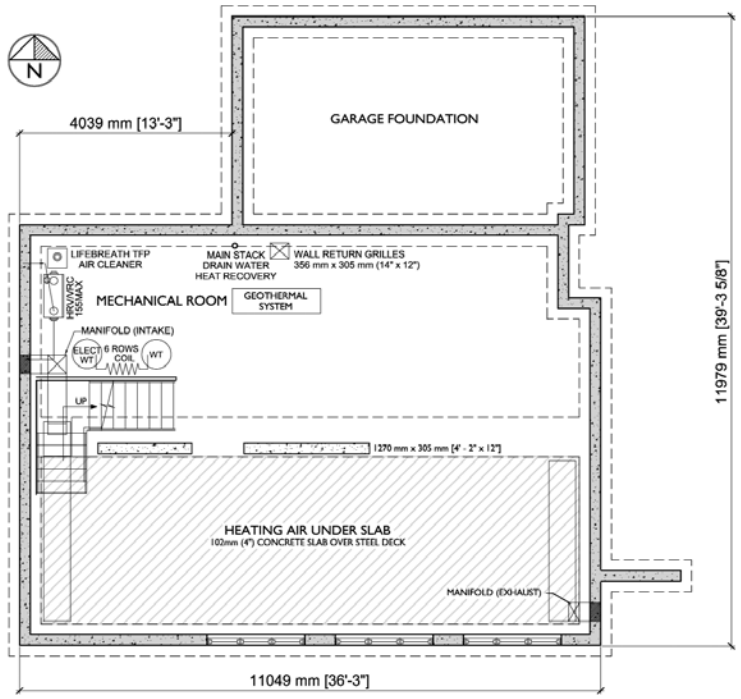


Figure 5—Basement floor plan of ÉcoTerra™

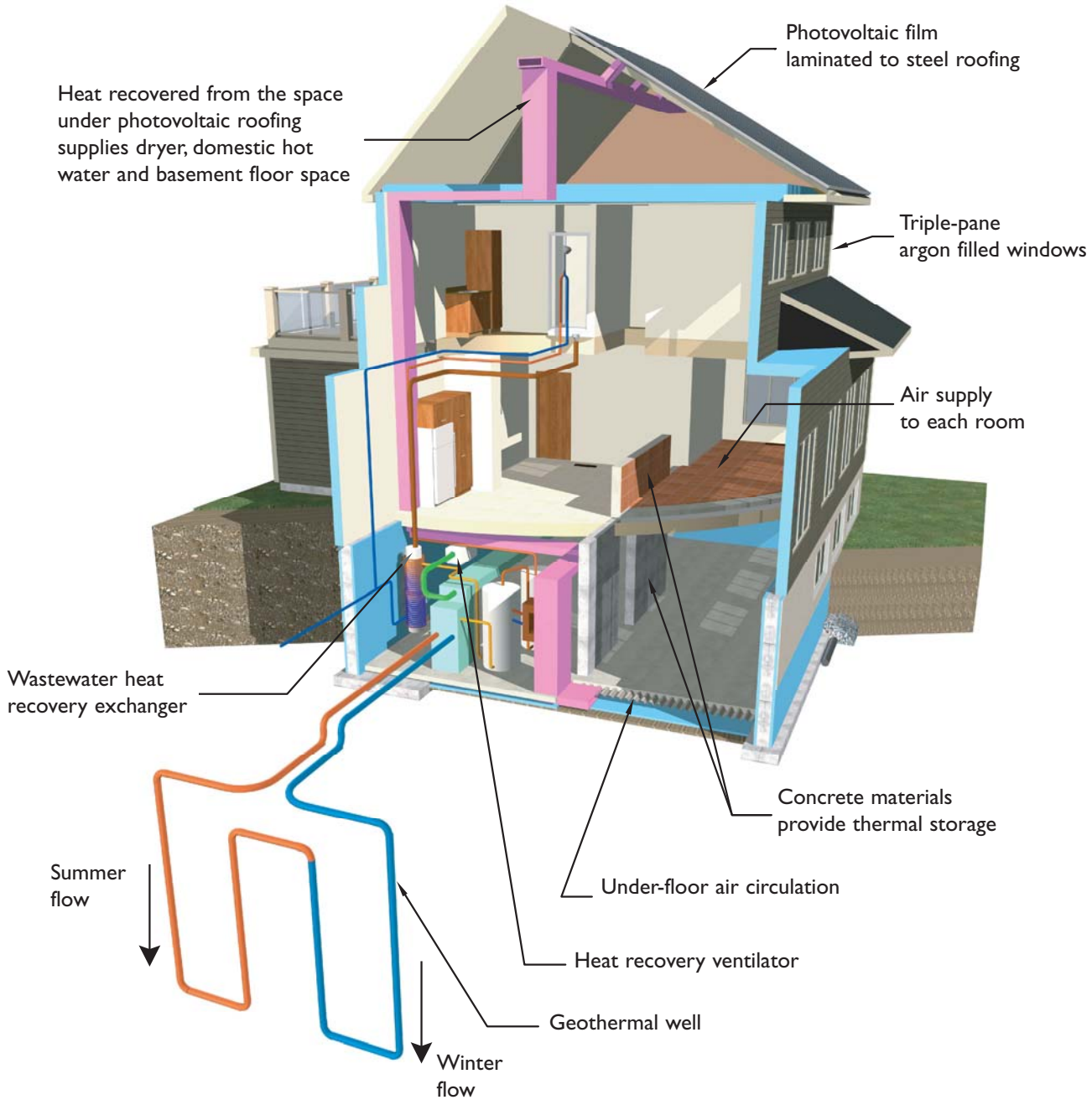


Figure 6—Cross-section of ÉcoTerra™, showing space and water heating technology

Technical Summary: ÉcoTerra™—Eastman, Quebec

Predicted Energy Consumption (by heated floor area)

Total annual energy use:	40.84 kWh/m²
Space heating:	10.02 kWh/m²
Domestic water heating:	11.54 kWh/m²
Appliances/lighting:	16.60 kWh/m²
Mechanical ventilation:	2.68 kWh/m²

Predicted Energy Production (by heated floor area)

Total annual energy production:	27.96 kWh/m²
Solar electricity:	13.85 kWh/m²
BIPV/T thermal heating:	11.07 kWh/m²
Greywater heat recovery:	3.04 kWh/m²
Predicted Annual Energy Balance:	**-12.88 kWh/m²**

EnerGuide for Houses* (EGH*) Rating[1] 98

Natural Resources Canada's EnerGuide For Houses (EGH) Rating is a standard measure of a conventional home's energy performance, and can range from 0 to 100.[1] A modified rating, termed the EGH* Rating, was developed specifically for the EQuilibrium™ initiative and is presented here. The EGH* Rating allows reductions in electricity and hot water loads and accounts fot the contribution of renewable energy systems in EQuilibrium™ houses, thereby more accurately reflecting the home's potential energy performance.

Site Characteristics

Location:		Eastman, Que.
Site type:		Rural, new development
Site area:	1.1 ha	2.7 acres
Elevation:	274 m	2,028 ft.
Latitude:		45°29' N
Longitude:		72°32' E

Average Outdoor Temperatures

January:	-10.4 °C	13.3 °F
April:	4.6 °C	40.3 °F
July:	19.4 °C	66.9 °F
October:	7.1 °C	44.8 °F

Building Design Temperatures[2]

January:	-28 °C	-18.4 °F
July:	29 °C	84.2 °F
Heating Degree Days (base 18°C [64°F]):	5,242	[9,436]
Cooling Degree Days (base 18°C [64°F]):	101	[182]

Climate

Average daily horizontal solar irradiation:		3.5 kWh/m²
Average daily vertical solar irradiation:		3.0 kWh/m²
Clearness index:		0.48 Kt
Average annual precipitation:	876 mm	34 in.
Average annual wind speed:	9.4 km/h	5.8 mph

Building Description

Type: New, single-detached two-bedroom with home office

Floor space (without basement):	141 m²	1,517 ft.²
Building axis:		East-West
Building footprint:	82.5 m²	888 ft.²
Heated volume:	671 m³	23,710 ft.³
Heated floor area:	234 m²	2,519 ft.²
Ceiling area:	87 m²	937 ft.²
External wall area:	220 m²	2,365 ft.²
Window area total:	33.4 m²	360 ft.²
South:	20.9 m²	225 ft.²
North:	0.65 m²	7 ft.²
West:	5.2 m²	56 ft.²
East:	6.7 m²	72 ft.²
South glazing-to-floor ratio:		9.1%

Thermal Characteristics

Roof:

Vaulted ceiling:	RSI 9.2	(R-52)
Flat ceiling:	RSI 10.9	(R-62)
Walls:	RSI 6.6	(R-38)
Windows:	RSI 0.7	(R-4.0)
Basement floor:	RSI 1.3	(R-7.5)

Airtightness Achieved: 0.88 ACH @ 50 Pa

Electricity

A 3 kW, grid- connected Uni-Solar® PV array, composed of 21 PV film sheets laminated to a standing-seam metal roof. Predicted to generate 3420 kWh of electricity per year.

Space Heating

Passive solar internal gains, ground source geothermal heat pump, integrated heat recovery from behind solar PV array, back-up grid electricity.

Ventilation

50 L/s heat recovery ventilator (HRV) with recirculation air control in the defrost cycle.

Water Heating

Geothermal heat pump combined with heat recovery from behind solar PV array, back-up grid electricity.

Water Consumption (estimated 4 person consumption)

Potable water use

1,340 L/day	294 U.K. gal/day
489,100 L/year	107,650 U.K. gal/year

Water re-use (greywater use)

0 L/day	0 U.K. gal/day
0 L/year	0 U.K. gal/year

[1] For further information on EGH Ratings, see www.nrcan.ca and search under "EGH Rating"

[2] Building design temperatures are based on historic temperature data and are used when designing a building and its heating and cooling systems for a particular geographic area.

The technologies used in this project carry long manufacturers' warranties, are relatively maintenance-free and can be easily applied to a wide range of house designs in the marketplace.

Project Team

Builder-developer: Les Maisons Alouette Homes (Les Industries Ste-Anne de la Rochelle Inc.)

Primary contact: Bradley Berneche
brad.berneche@alouettehomes.com

For more information about this project and other EQuilibrium™ housing projects, visit the CMHC website at www.cmhc.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 eventually 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™ 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.cmhc.ca

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