EQuilibrium™
HEALTHY HOUSING
FOR A HEALTHY ENVIRONMENT

Project Profile:
Riverdale NetZero Project—Edmonton, Alberta

This Project Profile highlights Riverdale NetZero, 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 Riverdale NetZero

Key Features

- Predicted surplus annual energy production
- Low pollutant-emitting building materials and finishes
- Building materials are regional, renewable and/or abundant
- 54 per cent reduction in potable water use: exterior drought-tolerant plants rely solely on rainwater
- A predicted 40 per cent of the house heating will be provided by passive solar gain, 28 per cent by internal sources, 21 per cent by active solar, and 11 per cent by solar photovoltaics

Project Description

Riverdale NetZero is a new semi-detached duplex on a prime inner-city site in Edmonton. Each two-storey home is approximately 234 m² (2,519 sq. ft.), including the basement. In keeping with the EQuilibrium™ Initiative, the builder–developer, Habitat Studio & Workshop Ltd., has designed and constructed these homes with the intent that they are healthy to live in, produce as much energy as they require in a year, reduce energy use to a minimum, conserve resources, have low environmental impact, and be marketable to people interested in investing in sustainable homes.

Each home's annual energy requirement is predicted to be less than the on-site annual production from renewable energy sources, which include passive and active solar heating systems and a solar photovoltaic (PV) system. The homes are highly insulated and airtight, with higher amounts of internal mass, which helps to regulate indoor temperatures and

[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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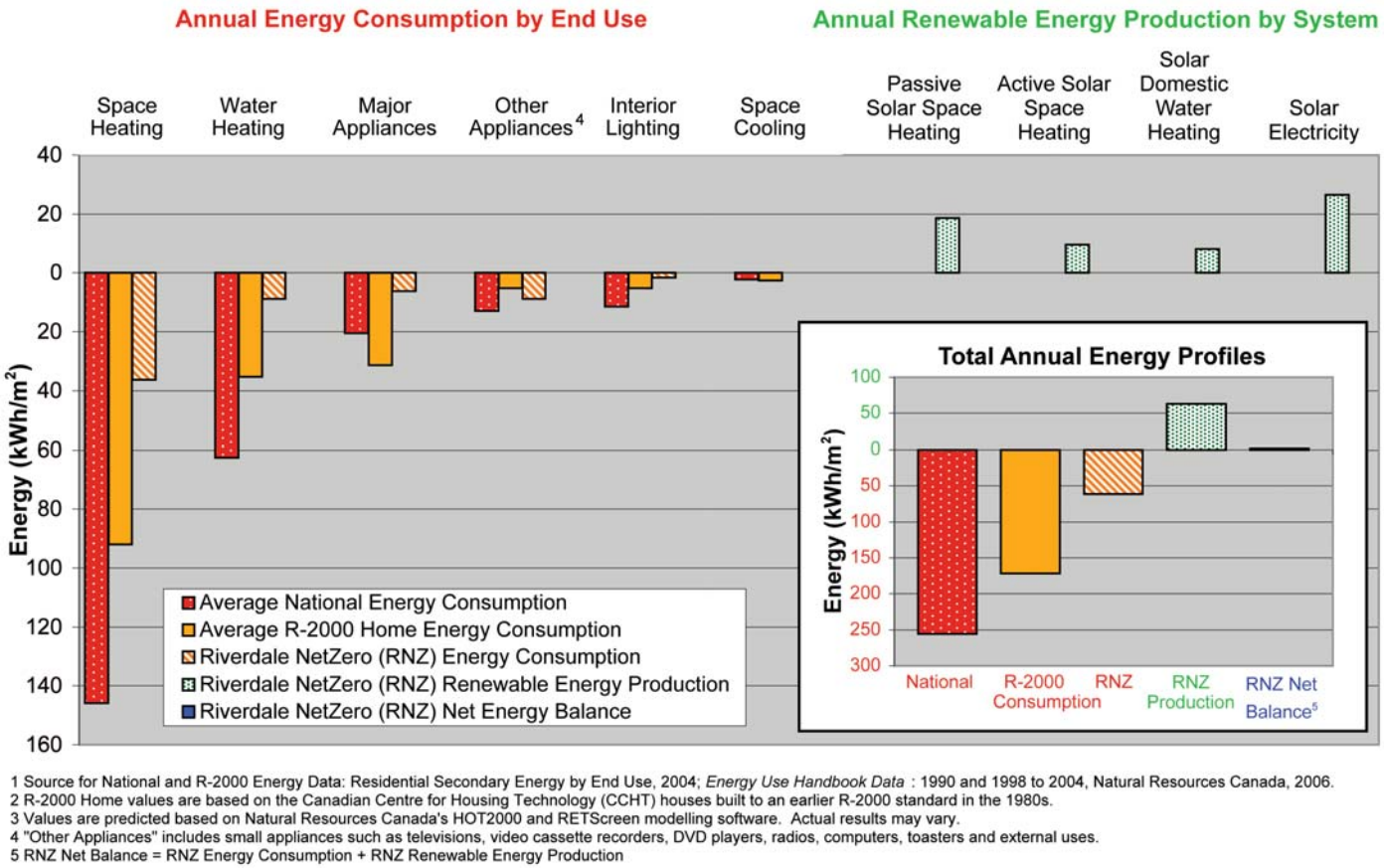


1 Source for National and R-2000 Energy Data: Residential Secondary Energy by End Use, 2004; *Energy Use Handbook Data* : 1990 and 1998 to 2004, Natural Resources Canada, 2006.
2 R-2000 Home values are based on the Canadian Centre for Housing Technology (CCHT) houses built to an earlier R-2000 standard 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, video cassette recorders, DVD players, radios, computers, toasters and external uses.
5 RNZ Net Balance = RNZ Energy Consumption + RNZ Renewable Energy Production

Figure 2—Energy Profile: Comparison of Canadian National Average,[1] R-2000 Home[2] and Predicted Riverdale NetZero (RNZ)[3] Annual Residential Energy Consumption and Production

reduce heating requirements. The homes have high-efficiency appliances. The household energy requirements are predicted to be only 24 per cent of the requirements for the average Canadian house. Surplus electricity from the PV system will be fed into the electricity grid. Electricity will be supplied by the grid to the homes when necessary, such as at night, during cloudy weather, and/or during periods of cooking and when other electrical requirements are heavy.

Each unit has a living room, dining room, kitchen and two-piece bathroom on the ground floor; three bedrooms, a study-office, and four-piece bathroom on the second floor; and family room, guest bedroom/office, three-piece bathroom, laundry and mechanical room in the basement. The single attached garages on the north side of the building partially deflect prevailing winds. The overall design of each unit maximizes the efficient use of interior space. The open-plan design has multi-function spaces to maintain a high level of amenities in a reasonably sized area. Upon completion, one unit will remain vacant for six months to a year and be used for public demonstration purposes after which it will be occupied and monitored to assess performance.

Occupant Health and Comfort

The materials selected for the home minimize indoor air pollutants, such as volatile organic compounds (VOCs) and other noxious chemicals. For example, flooring includes pre-finished, low-VOC hardwood, Marmoleum® sheet flooring and porcelain tile. All paints and finishes are water-based, low-VOC products.

The design and placement of the windows reduces the need for artificial lighting by providing natural light throughout the occupied spaces. In

order to maintain thermal comfort, a thermostatically controlled, forced-air heat distribution system distributes heat throughout the house. A heat recovery ventilator (HRV) controls indoor air humidity by venting kitchen and bathroom areas to the outdoors and distributing fresh air throughout the house via the forced-air system.

Energy Efficiency

To minimize the space-heating load, the building has an airtight, highly insulated thermal envelope. The 410 mm (16 in.) deep wall system is designed to reduce the heat loss by about 70 per cent from a typical 38 mm x 140 mm (2 in. x 6 in.) wall. The windows are exceptionally energy-efficient. The north windows are quadruple-glazed with three soft, low-e coatings and argon gas in the spaces between the glass. To optimize solar heat gain and reduce building heat loss, the south windows are triple-glazed, argon filled, with two soft low-e coatings. The east and west windows have similar characteristics to the south windows, but with a lower solar heat gain coefficient that reduces east and west passive solar heat gain in the summer. Overhangs above the south windows reduce summer heat gain.

Highly energy-efficient appliances (for example, refrigerator, clothes washer, HRV) and compact fluorescent and LED lighting further reduce electricity loads.

Renewable Energy Production

The two units use solar energy sources to reduce purchased energy costs. The building's east-west orientation optimizes solar exposure. South-facing windows, representing 10 per cent of the above grade floor area, provide a predicted 40 per cent of the annual space heat from passive solar gain.

A water-based, drainback, active solar thermal heating system is the main heat source for both space and water heating. Each unit's 7-collector, 22 m^2 (234 sq. ft.) solar thermal array is mounted at an optimal wintertime angle (for Edmonton) of 90 degrees. Heat from the solar collectors is first stored in a 300 litre (66 U.K. gal.) domestic water heating tank, and the remainder in a 17,000 L (3,800 U.K. gal.) space heating tank. Heated water is circulated from the large storage tank to a fan coil for distribution to the house via the forced-air heat distribution system. This heat transfer is supplemented by a very small heat pump that draws more heat from the tank, which in turn makes the solar collectors more efficient in the winter. The heat pump is also connected to a small loop of piping under the garage and around the foundation to provide small amounts of cooling in the summer should it be needed. Electric resistance heaters provide backup space and water heating.

Each unit has a 28-module, 5.6 kW grid-connected PV system that is predicted to generate 6,200 kWh of electricity annually, thereby supplying more than the household electrical energy requirements. Connection to the electrical grid provides electricity "exchange" and back-up when household needs exceed supply from the PV system.

Resource Conservation

Sustainable, regional materials are used extensively in the building. The decorative exterior window trim is made from salvaged, clear cedar bevel siding. The glulam beams in the living room are recycled from a liquor store. The hardwood flooring is recycled from a school gymnasium. Other flooring is Marmoleum, cork and sustainably manufactured tile. The building envelope is constructed primarily of locally grown spruce. Most of the insulation is made of recycled newspaper.

For maximum durability, additional reinforcing steel has been used in the foundation. The concrete in the basement walls and the porch uses a 50 per cent fly ash mix. This reduces the very high amount of greenhouse gases associated with the production of cement powder.

The exterior finishes are chosen for durability. Cedar shingles encourage rapid drying, while the stucco acts as a rainscreen to prevent wind-driven rain from penetrating the walls. The junctions of exterior finishes were detailed to minimize water penetration and to accommodate repairs and eventual replacement of single components without damage to other exterior finishes.

Material efficiency is incorporated in the design of the house through "Optimum Value Engineering"[2] details that reduce the amount of lumber used and allow more room for insulation. The exterior walls use only 6.5 percent more wood fibre than a standard 38 x 140 mm (2 x 6 in.) at 400 mm (16 in.) on centre wall despite being 270 mm (10") thicker. Drywall scraps are re-used as thermal mass by placing them inside interior partitions. The wood waste generated during construction was offered to others.

Water is conserved by using fixtures with very low water requirements, minimizing lawn surface, and utilizing native and drought resistant plants. Stored rain water, collected from the roof, will be used for watering the lawns and plants.

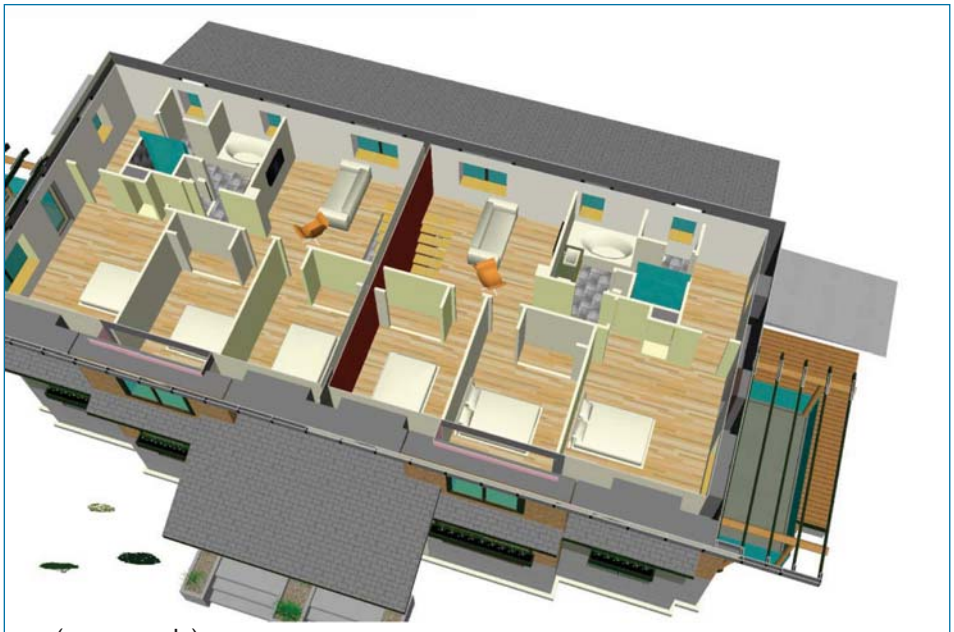
Reduced Environmental Impact

The goal of low environmental impact guided the building siting and design, construction practices, and selection of building materials and equipment. The duplex is on an urban site previously occupied by one home, thereby doubling the site density and making use of existing infrastructure. The location is a 15- minute walk to downtown Edmonton and is well-served by public transit, reducing the environmental impact and costs associated with transportation.

During construction, cardboard, polyethylene and metal waste were collected, separated and recycled accordingly. Framing crews travelled by bio-diesel powered minivan and bicycle. Electrical energy consumed during construction was "green" power purchased from an electricity retailer.

Affordability

One key target of an EQuilibrium™ home is greatly reduced utility costs. Ultra water-efficient appliances also reduce water consumption costs. The results of extensive energy performance modelling using HOT2000™, RETScreen® and HeatVision were used to select the energy efficiency and solar energy measures from a number of options, in order to rigorously control additional equipment and construction costs.



(not to scale)

Figure 3—Cutaway view of the second floor of the semi-detached units

[2] Optimum Value Engineering (OVE) refers to framing techniques that reduce the amount of lumber used to build a home while maintaining structural integrity. OVE techniques result in lower material and labour costs and improved energy performance.

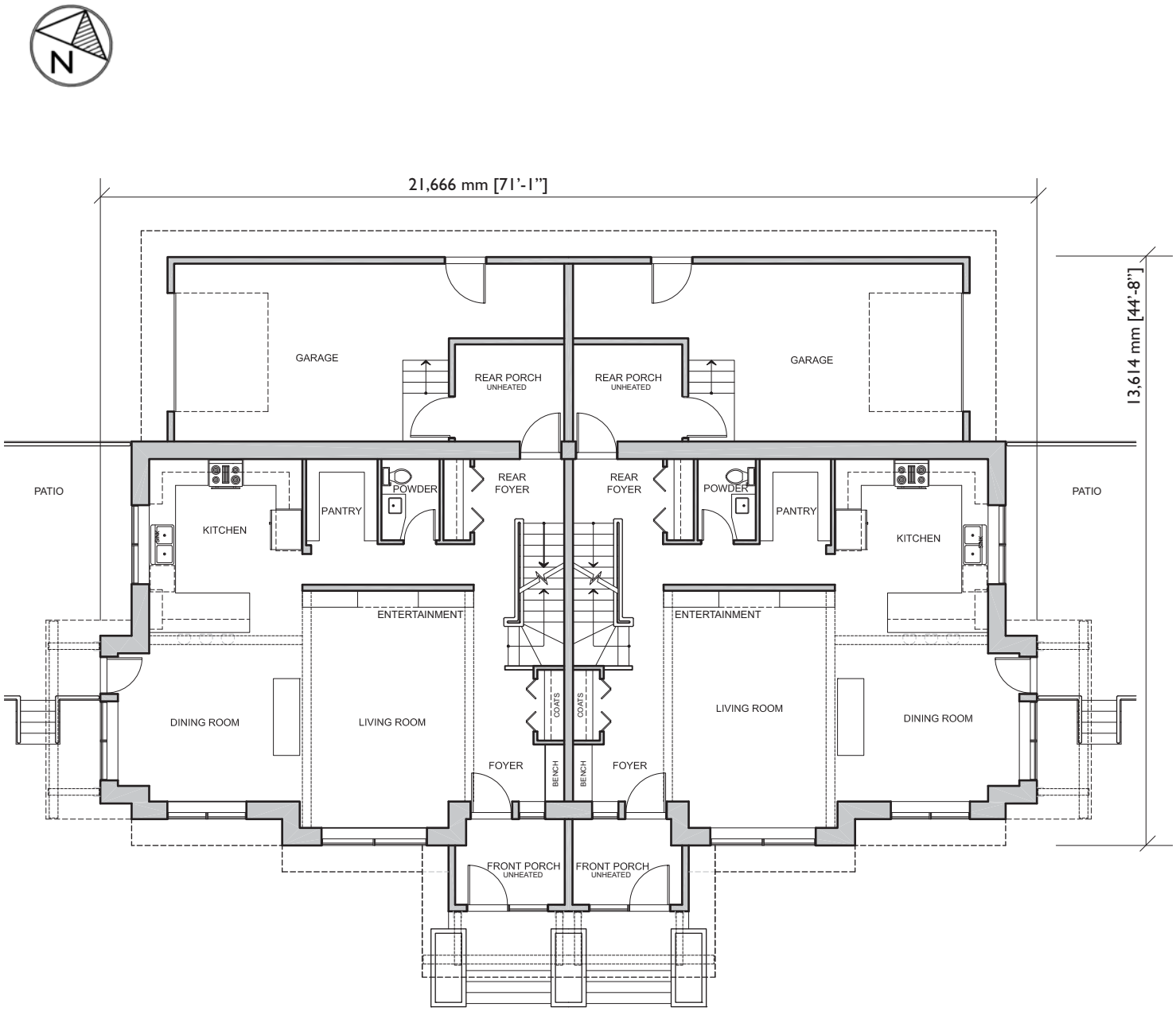


Figure 4—Main floor plan of the Riverdale NetZero project

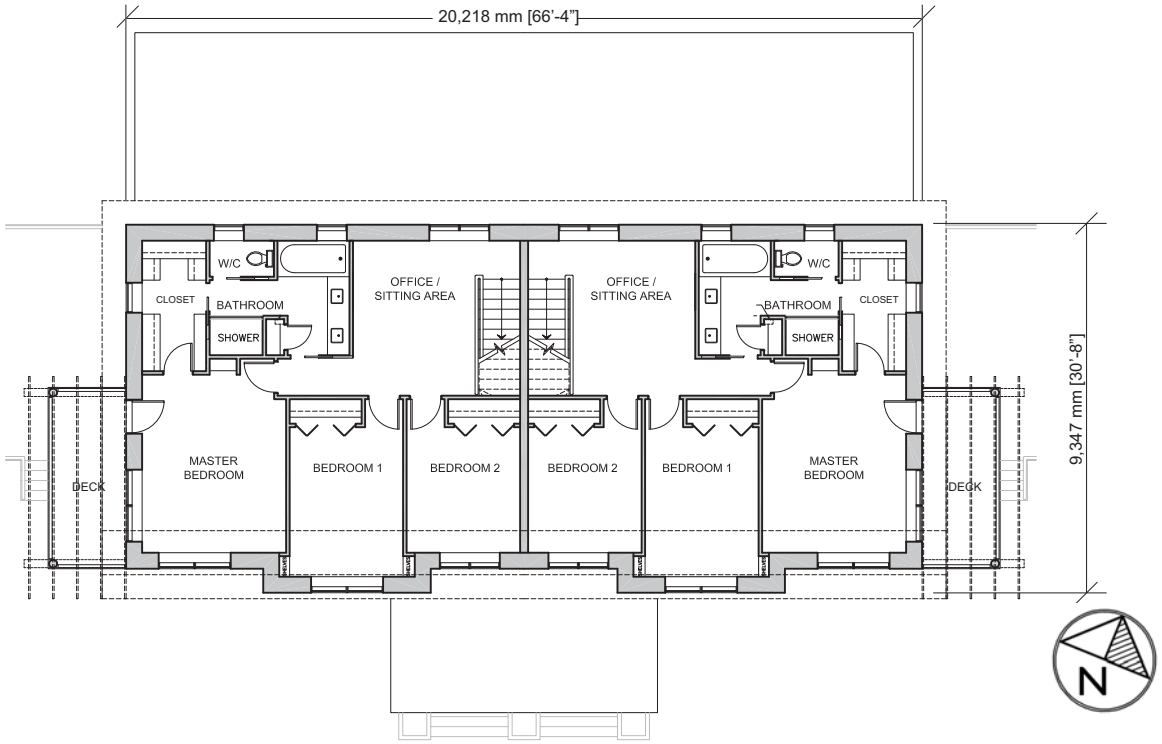


Figure 5—Second floor plan of the Riverdale NetZero project

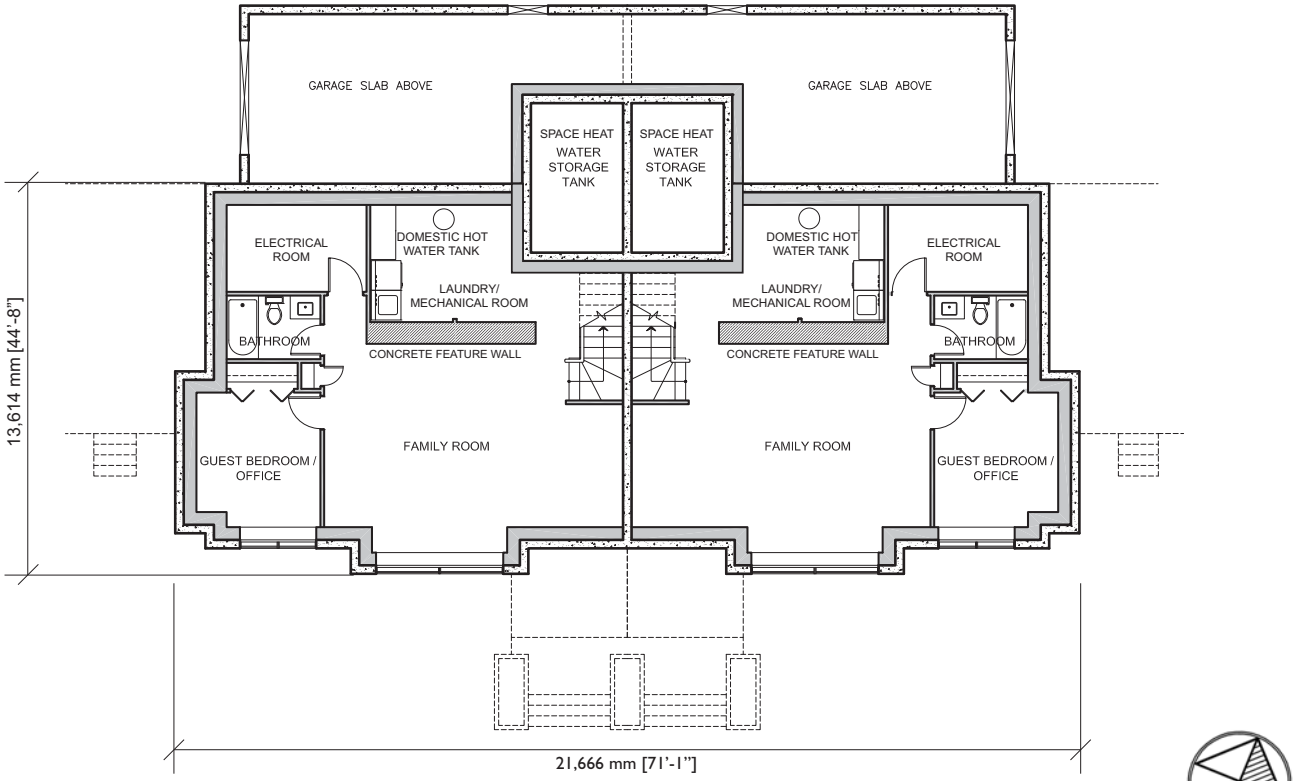


Figure 6—Basement plan of the Riverdale NetZero project

Technical Summary: Riverdale NetZero Project—Edmonton, Alberta[1]

Predicted Annual Energy Consumption (by heated floor area)

Total annual energy use:	61.51 kWh/m²
Space heating:	33.65 kWh/m²
Domestic water heating:	9.44 kWh/m²
Appliances/lighting:	16.39 kWh/m²
Mechanical ventilation:	2.02 kWh/m²

Predicted Annual Energy Production (by heated floor area)

Total annual energy production:	63.01 kWh/m²
Passive solar space heating:	18.68 kWh/m²
Active solar space heating:	9.57 kWh/m²
Active solar domestic water heating:	8.15 kWh/m²
Solar electricity:	26.60 kWh/m²
Predicted Annual Energy Balance:	**+1.5 kWh/m²**

EnerGuide for Houses* (EGH*) Rating 100

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[2]. 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 for the contribution of renewable energy systems in EQuilibrium™ houses, thereby more accurately reflecting the home's energy performance.

Site Characteristics

Location:	Edmonton, Alberta	
Site type:	Urban, new development	
Site area:	889 m²	9,569 ft.²
Elevation:	618 m	2,028 ft.
Latitude:	53°32'31" N	
Longitude:	113°27'53" W	

Average Outdoor Temperatures

January:	-14.2 °C	6.4 °F
April:	3.7 °C	38.7 °F
July:	16 °C	60.8 °F
October:	4.6 °C	40.3 °F

Building Design Temperatures[3]

January:	-32°C	-25.6 °F
July:	28 °C	82.4 °F
Heating Degree Days (base 18°C [64°F]):	5,589 °C	10,060 °F
Cooling Degree Days (base 18°C [64°F]):	28 °C	50 °F

Climate

Average daily horizontal solar irradiation:		3.6 kWh/m²
Average daily vertical solar irradiation:		4.0 kWh/m²
Clearness index:		55%
Average annual precipitation:	365 mm	14 in.
Average annual wind speed:	13.0 km/h	8.1 mph

Building Description

Type: Semi-detached, new 3-bedroom units with study-office areas

Floor space (with basement):	234 m²	2,519 ft.²
Building axis: East-West, facing 22° East of South		
Building footprint:	82.5 m²	888 ft.²
Heated volume:	634 m³	22,425 ft.³
Heated floor area:	234 m²	2,519 ft.²
Ceiling area:	76.7 m²	826 ft.²
External wall area:	390.2 m²	4,200 ft.²
Window area total:	29.6 m²	319 ft.²
South:	16.91 m²	182 ft.²
North:	3.34 m²	36 ft.²
West (on west unit):	9.35 m²	101 ft.²
East (on west unit):	0 m²	0 ft.²
Ratio of south west glazing area to floor area:		10%

Thermal Characteristics

Roof:	RSI 17.6	R-100
Walls:		
First and second floor	RSI 9.96	R-56
Basement	RSI 9.51	R-54
Windows:		
South	RSI 1.2	R-7.3
East & West	RSI 1.4	R-8.3
North	RSI 1.8	R-10
Basement floor:	RSI 4.2	R-24
Airtightness target:	0.5 ACH @ 50 Pa	

Electricity

28 module, 5.6 kW grid-dependent solar photovoltaic (PV) system predicted to generate 6,200 kWh of electricity per year.

Space Heating

Direct gain passive solar, plus active solar thermal feeding a hydronic fan-coil based forced-air heat distribution system integrated with room ventilation supply. Electric resistance backup heater.

Ventilation

48.2 L/s heat recovery ventilator (HRV).

Water Heating

Active solar thermal system with drain water heat recovery and electric resistance backup heater.

Water Consumption (estimated 4 person consumption)

Potable water use

330 L/day	73 U.K. gal/day
120,450 L/year	26,500 U.K. gal/year

Potable water reuse (greywater use)

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

[1] All size, area, energy use, and system capacity values are for each unit.
[2] For further information on EGH Ratings, see www.nrcan.ca and search EGH Rating
[3] 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.

Project Team

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

EQuilibrium™

What is EQuilibrium™ housing?

EQuilibrium™ is a national sustainable housing demonstration initiative, 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 affordable, premium quality 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.

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