

## Project Profile: The Green Dream Home—Kamloops, British Columbia

This Project Profile highlights The Green Dream Home, 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.<sup>1</sup>



### Key Features

- Predicted positive net annual energy production
- Passive solar heating, grid-tied photovoltaic panels, solar hot water heating system and a ground source heat pump will meet the home's annual energy requirements
- Design work was done by Thompson Rivers University (TRU) architectural and engineering technology students, and TRU trades students built the house under the supervision of skilled instructors
- Landscaping was designed by TRU horticulture students and includes drought resistant native plants and edible plants
- Has been sold to the local YMCA/ YWCA for their Dream Home Lottery fund raiser

Figure 1—Photo of The Green Dream Home Project

### Project Description

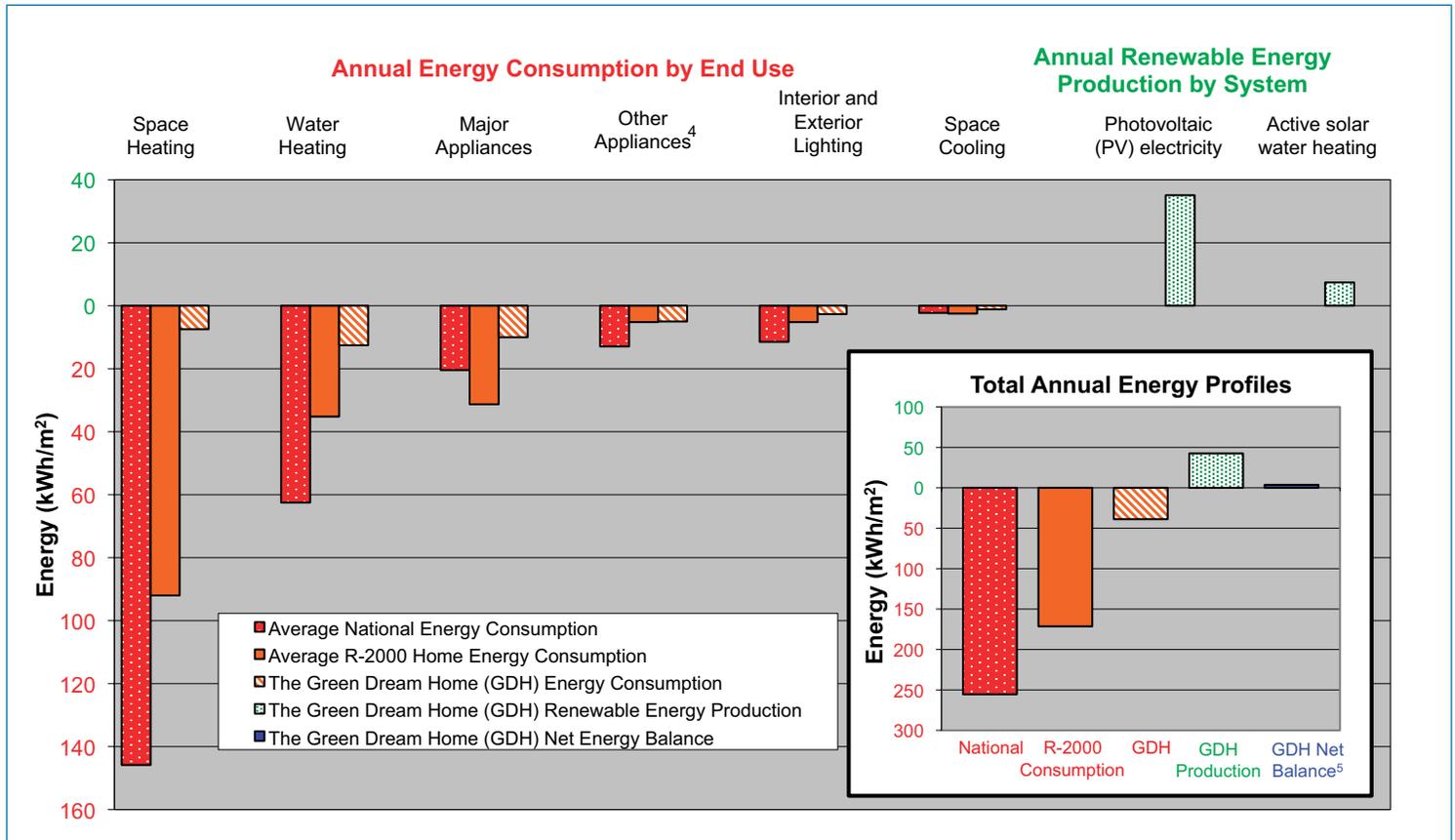
The Green Dream Home is a new, two storey detached home with a finished walk-out basement level. Located in Kamloops, British Columbia, it is a 300.7 m<sup>2</sup> (3,237 sq. ft.) house<sup>2</sup> with an attached

garage on a residential lot in the Sun Rivers development. This golf course community development resides on Kamloops (Tk'emlups) Indian Band (KIB) reserve land, across the South Thompson River from the Kamloops downtown core. The builder team

is a consortium of the Canadian Home Builders' Association Central Interior (CHBA CI) and Thompson Rivers University (TRU). Student

<sup>1</sup> For more information on this initiative and the various Equilibrium™ Housing projects, visit the CMHC website ([www.cmhc.ca](http://www.cmhc.ca)) and type the search keyword "Equilibrium".

<sup>2</sup> These floor area values and others in the text include the exterior walls, and the stairway is counted on each floor. The heated floor areas for the main, second and basement floor levels are 96.4 m<sup>2</sup> (1,037 sq. ft.), 55.1 m<sup>2</sup> (593 sq. ft.) and 96.4 m<sup>2</sup> (1,037 sq. ft.) respectively, totalling 247.9 m<sup>2</sup> (2,668 sq. ft.).



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 GDH Net Energy Balance = GDH Energy Consumption + GDH Renewable Energy Production

Figure 2—Comparison of Canadian National Average<sup>1</sup>, R-2000 Home<sup>2</sup>, and predicted Green Dream Home<sup>3</sup> (GDH) Annual Residential Energy Consumption and Production

involvement included the building and site landscaping design, and classroom and job site work by construction trades students (e.g. carpenter, plumber, and electrical apprentices), under the close supervision of journeymen and experienced instructors. This TRU and CHBA CI project helps to address the need for training a new generation of highly skilled Canadian tradespeople. This approach to training will help ensure participating workers have a solid theoretical and practical knowledge of

both their craft and the manner in which their skills can be correctly applied to build the next generation of sustainable housing in Canada.

The Green Dream Home features an exterior design intended to blend with the architecturally controlled style of the neighbourhood. The south sloping site allows for large windows to capture the view and solar energy, and for outside access to both the main and lower floors. The 117 m<sup>2</sup> (1,258 sq. ft.) main floor includes an open-concept living room, dining room and kitchen, den or

bedroom, bathroom with sink, toilet and bathtub with shower, and laundry with drying closet. The master bedroom, bathroom with sink, toilet and large 'European' shower, walk-in closet and small loft area are on the 66.9 m<sup>2</sup> (720 sq. ft.) second floor. The 117 m<sup>2</sup> (1,258 sq. ft.) basement walk-out floor contains a recreation room, bedroom with walk-in closet, bathroom with sink, toilet and bathtub with shower, mechanical and electrical room, storage, and a wet bar. An unfinished attic space above the garage

is accessible for use as storage space and could be developed to expand living space. The home can be adapted to accommodate a family, empty-nesters, or a home office, thereby attracting a wide range of prospective buyers.

In keeping with the EQUilibrium™ Housing Initiative, The Green Dream Home design considers the entire home as an integrated system. The design addresses how the home will influence and interact with the surrounding environment, and accounts for the source of raw materials and the environmental impacts of their manufacturing and transportation.

The total annual energy requirement for the home is predicted to be a little less than the on-site annual production from renewable energy sources: passive solar space heating, active solar water heating and photovoltaic (PV) electrical generation. In addition, a ground source heat pump (GSHP) and drain water heat recovery (DWHR) device reduce energy requirements for space conditioning (heating and cooling) and hot water. The home benefits from its excellent solar access and optimal solar orientation. Insulated concrete forms (ICFs) were used to construct the well insulated, air-tight building envelope which, with the other energy efficiency features, are predicted to reduce the household energy requirements, on a per m<sup>2</sup> (sq. ft.) heated floor area basis, to 15% of the energy requirements for a typical Canadian home.

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

## Occupant Health and Comfort

The Green Dream Home has been designed to provide a healthy indoor environment with superior air and water quality, natural lighting in all regularly occupied rooms, and elements to ensure a quiet home. 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, and the HVAC (heating, ventilation and air conditioning) system, including ducts, was sealed during construction. Indoor air quality for the occupants was further optimized with the use of mechanically fastened natural materials (e.g. wood, stone, steel and glass). The use of synthetic materials was minimized, and where painting, sealing or gluing was required water based substances with low levels of volatile organic compounds (VOCs) were used. The hard surface floorings (cork, tile and polished concrete), are easy to clean and maintain and have low or no pollutant emissions.

A heat recovery ventilator (HRV) was installed as part of the HVAC system to provide continuous and affordable indoor-outdoor air exchange. Operable

windows and tilting French doors in regularly occupied rooms provide further ventilation opportunities. In addition, a waterfall feature is installed in the main living space. This device is integrated with the home automation system; if the humidity in the home varies from the set optimal level, the waterfall will be turned on or off to assist the home to return to the optimal humidity level.

Soil gas infiltration (e.g. methane, radon, and water vapour) is minimized with the use of sub-slab polyethylene and proper treatment around slab and below-grade foundation wall penetrations such as floor drains and water pipes.

Water is delivered to the site through a two-main municipal system, operated by Corix Utilities, the supplier of all utilities to the Sun Rivers development. One main delivers filtered and treated potable water. The second main delivers water from the South Thompson River for outdoor irrigation.

The large windows on the south face of the house, combined with the strategic placement of windows on the east on all floors and on the west on the second floor, will ensure that occupants will enjoy good daylighting for much of the day.

Noise management strategies include the use of ICFs, triple glazed windows, carefully sealed exterior assemblies and quiet kitchen and laundry appliances.

## Energy Efficiency

The Green Dream Home employs a two-stage strategy to achieve a predicted small net annual energy production. The first strategy involved the design and construction of a home that is very energy efficient.

All exterior walls, including the foundation (but with the exception of the garage), utilize ICF construction with 200 mm (8") of concrete, 66 mm (2 5/8") of expanded polystyrene on each side, and an additional 134 mm (5 3/8") of expanded polystyrene on the outside face, providing an RSI value of 7.7 (R-44). One hundred twenty-seven mm (5") of extruded polystyrene insulation RSI 3.5 (R-20) was installed below the basement slab. The attic contains 75 mm (3") of blown-in urethane foam and 400 mm (16") of blown-in cellulose insulation, providing RSI 10.7 (R-60). The vinyl frame, argon filled, low-emissivity triple-glazed windows and polyurethane insulated fibreglass exterior doors also contribute to an energy-efficient building envelope. The monolithic nature of the ICF, and special attention to proper sealing of building envelope penetrations (e.g. window and door openings, pipe penetrations), provides superior

airtightness; 0.68 air-changes per hour at 50 Pa was achieved during the blower door test.

Energy efficiency considerations also played a key role in the selection of mechanical systems, appliances, and lighting fixtures. The HRV contains two electronically commutated motors (ECM) to save electricity. The GSHP is used to support space heating and cooling through a balanced system of supply and return air ductwork. It employs a two stage compressor technology and an ECM fan motor to reduce energy consumption. The system includes an electric booster element to provide additional heat in the event that it is required to meet any peak heating requirements. Appliances were selected using the NRCAN EnerGuide Appliance Directory 2007<sup>3</sup>, and lighting energy requirements are substantially reduced with the use of compact fluorescent and LED lighting.

A drain water heat recovery (DWHR) device recovers heat from drain water that otherwise would be lost to the sewer system and transfers this heat to incoming cold water destined for the thermal storage tank, discussed below.

## Renewable Energy Production

The second strategy is to install renewable energy systems, i.e. the photovoltaic panels and associated systems, and a solar hot water heating system. These systems are predicted to have sufficient combined capacity to meet the home's reduced energy requirements on an annual basis.

Optimal solar potential is achieved by orienting the building to face due south with the north portion of the lower floor buried in the hillside.

The use of renewable energy will reduce the cost of energy purchases. A 6.8 kW, 47 m<sup>2</sup> (493 sq. ft.) array of 36 190 watt PV modules has been mounted on the south facing roof at 45° to the horizontal. The roof-top array is predicted to generate approximately 8,520 kWh per year. In addition, a 1.5 kW, 9 m<sup>2</sup> (104 sq. ft.) array of 8 190 watt bifacial<sup>4</sup> PV modules has been mounted vertically as part of the railing on the south facing balcony. The balcony PV array is predicted to generate 1,420 kWh per year. This yields a total predicted annual PV production of 9,940 kWh. The electrical system is grid-intertied to Corix Utilities through three grid-dependent inverters, allowing

<sup>3</sup> For further information, and to order copies of the directory, see [www.oee.nrcan.gc.ca](http://www.oee.nrcan.gc.ca) and search under "EnerGuide Appliance Directory 2007"

<sup>4</sup> Conventional PV modules utilize solar energy falling on just one side (i.e. the 'front') of the module. Bifacial modules can utilize solar energy falling on both sides of the module, thus increasing efficiency.

excess energy to be delivered to the grid when available and for the home to import power from the grid when required. The agreement with Corix Utilities to collect energy from the PV arrays and allow the homeowner to draw energy from the grid will be the first net metering agreement of this kind at Sun Rivers.

Active solar domestic hot water heating is provided using two roof-mounted evacuated tube collectors. This system is predicted to produce approximately 2,100 kWh of heat energy, providing about 52% of the domestic water energy needs for the home. This 5.8 m<sup>2</sup> (62.1 sq. ft.) system provides heat to a 300 l (66 U.K. gal.) primary thermal storage tank. Pre-heated hot water leaving the primary tank enters a 150 l (33 U.K. gal) secondary tank where, when required, temperatures can be boosted using an electric heating element. A tempering mixing valve at the output of the secondary tank ensures domestic hot water is at a safe temperature for use in the home.

## Resource Conservation

The Green Dream Home design incorporates conservation attributes such as building durability, efficient use of materials, water conservation, and adaptability and flexibility.

Sustainable materials include regional “pine beetle killed” framing materials from forests within a 100 km radius of the site, and cork flooring and bamboo cabinets. Fly ash, a ‘waste’ product from coal-fired generating stations, was used to reduce the amount of cement in the concrete by 25%, thereby reducing the very high amount of energy use and greenhouse gas emissions associated with the production of cement powder. Building durability is enhanced with the use of well drained and insulated concrete walls that are highly resistant to water damage and other hazards such as fire. Stucco, stone veneer siding and 50 year rated recycled rubber tire roofing shingles also contribute to durability. Material use is reduced by factors such as the use of ICFs (no formwork is required) and minimal interior partition walls.

Kamloops is a relatively dry area of Canada, and the Sun Rivers lots have separately metered potable and irrigation water supplies. Hence there is both a conservation and economic rationale for conserving water. The use of low flow fixtures, dual flush toilets, and appliances with low water consumption will decrease the use of potable water. The automatic irrigation sprinklers at Sun Rivers are connected to rain sensors and allow night time watering, when watering is most effective.

In terms of flexibility and adaptability, The Green Dream Home has been designed using CMHC FlexHousing™ concepts<sup>5</sup>. Features include one wheelchair accessible bedroom and bathroom on the main floor, access to both the basement and main floors from the outside, and provision for future adaptations such as incorporating a suite (allowed at Sun Rivers), utilization of the unfinished space adjacent to the second floor, possible expansion of the building to the east, and increased levels of accessibility.

## Reduced Environmental Impact

In addition to the features outlined above, other development philosophies as well as design and construction technologies and techniques will reduce The Green Dream Home’s environmental impact.

During construction the builder prepared a gravelled area for staging to minimize erosion and keep dirt off the street. A comprehensive waste management strategy, including separate on-site recycling bins for wood, gypsum (drywall), and metal waste, was in place during construction. Excess Styrofoam from the ICF blocks was collected and returned to the plant. The home includes recycling bins and garden composting facilities.

<sup>5</sup> For further information, see [www.cmhc.gc.ca](http://www.cmhc.gc.ca) and search under FlexHousing™

While arid, the Kamloops area is subject to significant rainfall events. Site grading and landscaping are designed to capture all water falling on the lot. The driveway pavers allow water falling on the driveway to infiltrate into the soil below. Water from roof eaves trough leaders is directed toward a catch basin installed at the low point of the site under the south patio. The catch basin empties into the development's storm water management system as required. The site landscaping incorporates a combination of drought resistant decorative planting with edible and ethnobotanical<sup>6</sup> landscaping aimed at reducing the ecological footprint of the occupants. Trees have been carefully placed to avoid shading the PV panels while providing desirable shade to the house.

In addition to the reductions in greenhouse gas (GHG) emissions due to the use of energy efficiency and renewable energy features, and the reductions in indoor pollutant emissions with the use of natural and low VOC building materials, the absence of combustion appliances (e.g. gas or wood fireplaces) in the home will further reduce air pollution emissions.

The Green Dream home is part of a clustered development where homes are grouped together surrounded by green spaces (public spaces and golf courses). The Kamloops downtown core is within a short driving distance, cycle or walk. An extension of public transit to the development is pending, as is a multi-unit complex that will include retail shops and services.

## Affordability

As a result of the energy-efficient features of this new house, a small net annual energy production is predicted. Utility costs are therefore predicted to be less than would otherwise be the case. In the current economic climate of uncertain energy prices, this is seen by the team to be a very marketable attribute.

In addition, the design elements which contribute to durability are expected to result in reduced maintenance costs. FlexHousing™ concepts, which appeal to the growing 50+ demographic seeking affordable yet flexible housing options, will help decrease costs associated with future renovations.

Finally, the many features that have been provided to enhance occupant health and comfort are expected to be sought by more and more prospective home owners.

<sup>6</sup> Ethnobotany is the scientific study of the relationships that exist between people and plants, including the study of plants used by the First Nations peoples of Canada.

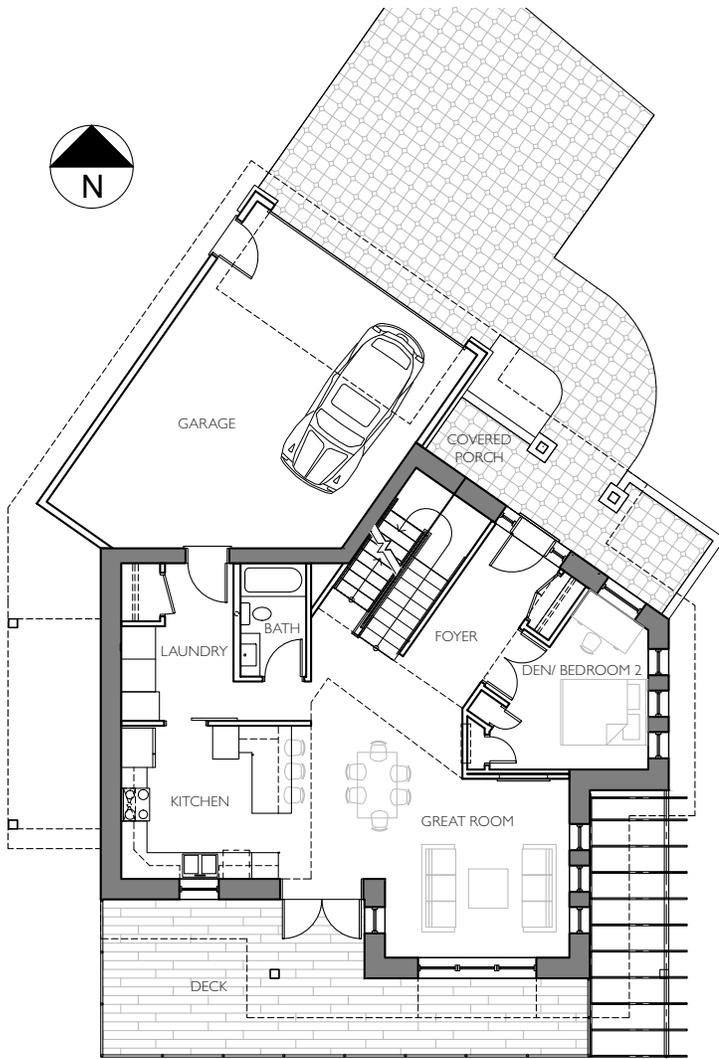


Figure 3—Main floor plan of The Green Dream Home

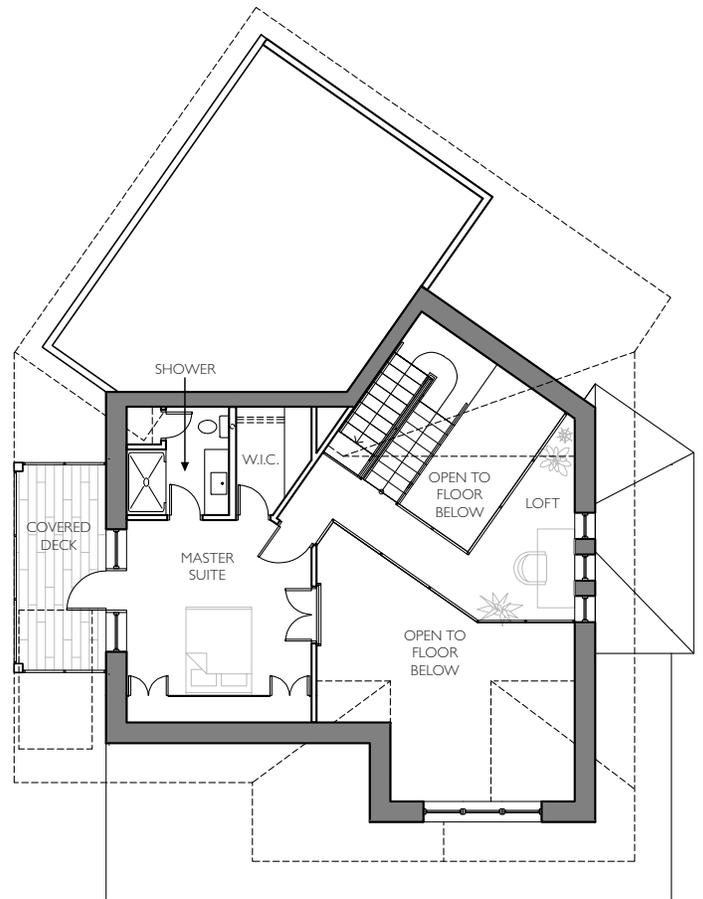


Figure 4—Second floor plan of The Green Dream Home Project

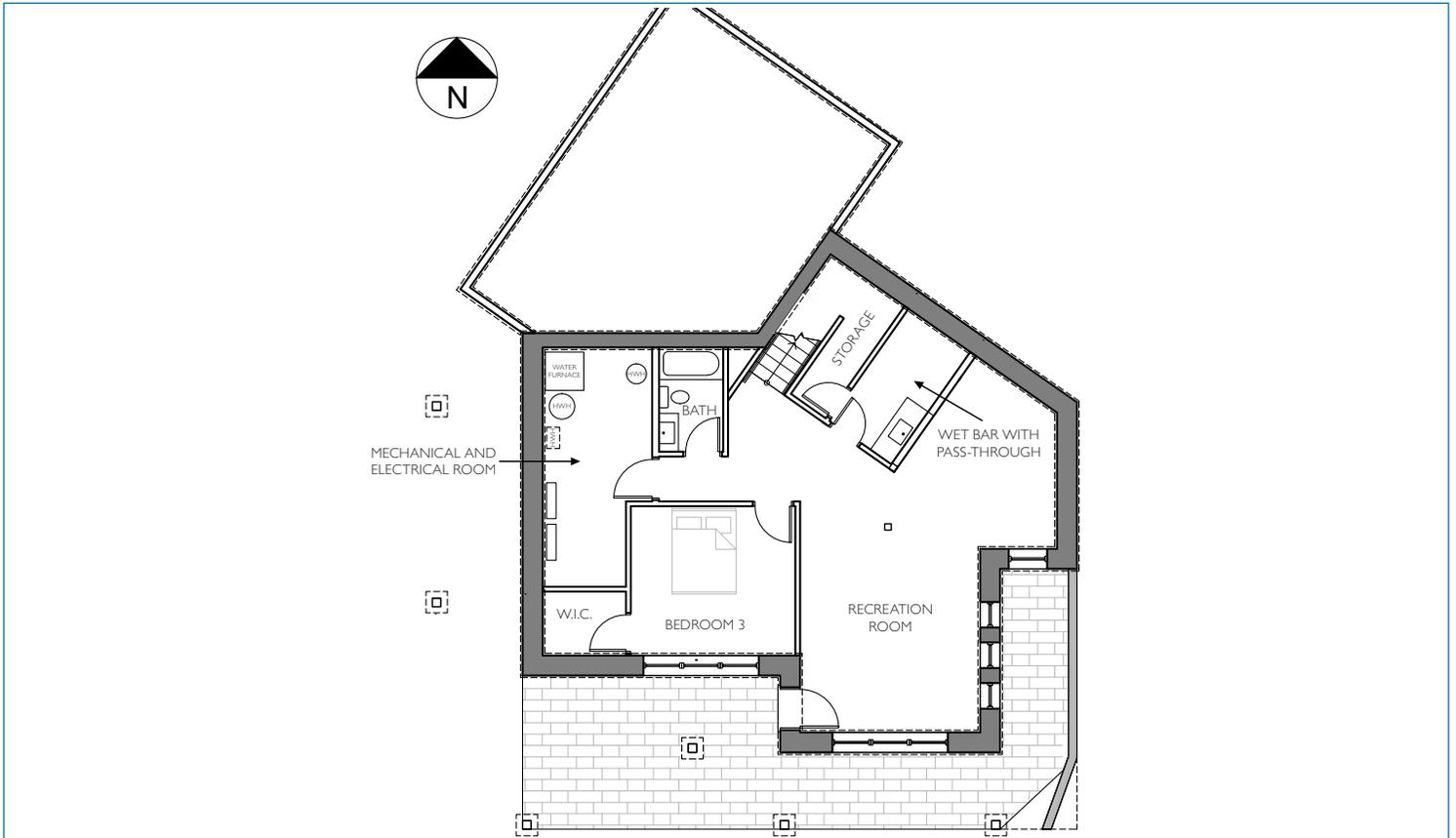


Figure 5—Basement walk out floor plan of The Green Dream Home

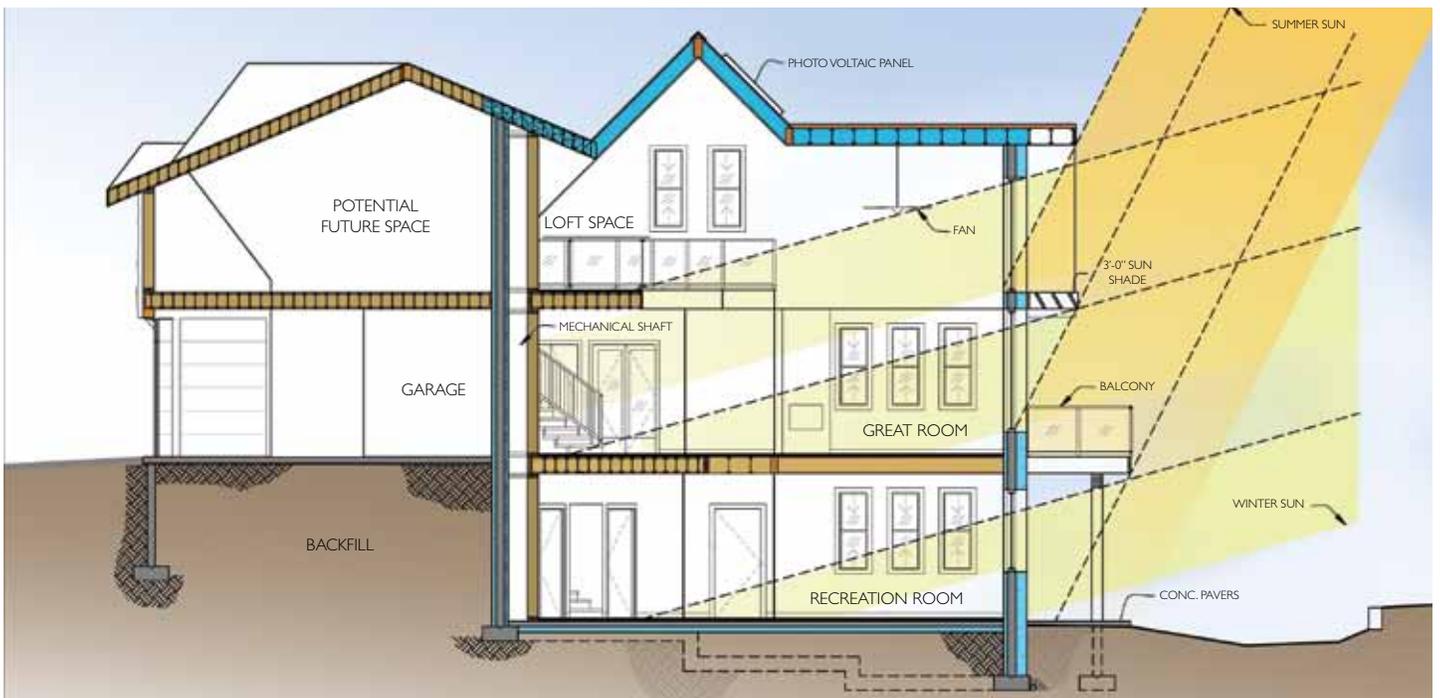


Figure 6—Cross-section of The Green Dream Home showing direct sunlight penetration in summer and winter

## Technical Summary: The Green Dream Home, Kamloops, British Columbia

Building Description			Predicted Annual Energy Consumption	
Type: New, 2-storey with walk-out lower floor, 3 bedroom single detached residence			Space heating	7.46 kWh/m <sup>2</sup>
Floor space	284 m <sup>2</sup>	3,057 ft <sup>2</sup>	Domestic water heating	12.55 kWh/m <sup>2</sup>
Solar Orientation	due south		Appliances/lighting	14.74 kWh/m <sup>2</sup>
Building footprint including garage	166.7 m <sup>2</sup>	1,794 ft <sup>2</sup>	Mechanical ventilation	2.93 kWh/m <sup>2</sup>
Heated volume	802 m <sup>3</sup>	28,332 ft <sup>3</sup>	Space cooling	1.16 kWh/m <sup>2</sup>
Heated floor area	284 m <sup>2</sup>	3,057 ft <sup>2</sup>	<b>Total predicted consumption</b>	<b>38.84 kWh/m<sup>2</sup></b>
Ceiling area	90 m <sup>2</sup>	969 ft <sup>2</sup>	Note: All values are based on heated floor area of 284 m <sup>2</sup> . The space heating value does not include the contribution from passive solar gains and internal gains (see Space Heating Information, below)	
External wall area	372 m <sup>2</sup>	4,004 ft <sup>2</sup>	Predicted Annual On-site Renewable Energy Production	
Total window area	29.76 m <sup>2</sup>	320.4 ft <sup>2</sup>	Solar (photovoltaic) electricity	35.08 kWh/m <sup>2</sup>
South	14.75 m <sup>2</sup>	158.7 ft <sup>2</sup>	Active solar domestic water heating	7.39 kWh/m <sup>2</sup>
North	4.35 m <sup>2</sup>	46.9 ft <sup>2</sup>	<b>Total predicted production</b>	<b>42.47 kWh/m<sup>2</sup></b>
West	3.97 m <sup>2</sup>	42.8 ft <sup>2</sup>	Note: All values are based on heated floor area.	
East	6.69 m <sup>2</sup>	72.0 ft <sup>2</sup>	Predicted Annual Energy Balance + 3.63 kWh/m <sup>2</sup>	
Ratio of south glazing area to floor area:	5.0%		EnerGuide for Houses (EGH*) Rating <sup>1</sup> 101	
Thermal Characteristics			Space Heating Information	
Roof	RSI 10.57	R-60	Space heating requirements for The Green Dream Home will be met as follows (predicted values):	
Walls	main and second floors RSI 7.75	R-44	Passive solar gain	39%
	basement RSI 7.75	R-44	Internal gains <sup>2</sup>	23%
Windows	RSI 0.75 to 0.85	R-4.1 to 4.8	4-ton ground source heat pump (COP 5.1) <sup>3</sup>	
Basement floor	RSI 3.52	R-20	for back-up space and water heating	38%
Measured Airtightness Level	0.68 ACH @ 50 Pa		Domestic Hot Water Information	
Site Characteristics			Domestic hot water requirements for The Green Dream Home will be met as follows (predicted values):	
Location	Kamloops, British Columbia		Active solar thermal heating system	52%
Site type	Suburban, new development		Electric element provides back-up	
Site area	754 m <sup>2</sup>	8,116 ft <sup>2</sup>	for water heating	37%
Elevation	346 m	1,135 ft.	Drainwater heat recovery	11%
Latitude	50°42'N		Ventilation	
Longitude	120°27' W		Heat recovery ventilator (HRV) with electronically commutated motors (ECMs) and integrated with heating and cooling duct work. Ventilation rate 60 L/s, 0.33 air change per hour.	
Climate			Water Consumption (estimated 2 adult & 2 children consumption)	
Average daily horizontal solar irradiation	3.65 kWh/m <sup>2</sup>		Potable water use	998 L/day 220 U.K. gal/day
Average daily vertical solar irradiation	3.4 kWh/m <sup>2</sup>			364,270 L/yr 80,183 U.K. gal/yr
Average annual precipitation	257 mm	10 in.	Potable water reuse	n/a n/a
Average annual wind speed	19.0 km/h	11.8 mph	(greywater use)	n/a n/a
Average outdoor temperatures				
January	-0.4 °C	31.3 °F		
April	9.4 °C	48.9 °F		
July	20.8 °C	69.4 °F		
October	8.5 °C	47.3 °F		
Building design temperatures <sup>4</sup>				
January	-28 °C	-18.4 °F		
July	26.7 °C	80.1 °F		
Heating Degree Days (base 18°C [64°F])	3,650	[6,570]		
Cooling Degree Days (base 18°C [64°F])	1,174	[2,113]		

<sup>1</sup> 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.

<sup>2</sup> Internal gains include heat from occupants, lights, appliances, mechanical systems, and consumer electronic items.

<sup>3</sup> The coefficient of performance (COP) for a heat pump is the ratio of the heat delivered (output) to the electric energy used in operating the pump (input).

<sup>4</sup> 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.

## 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](http://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 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](http://www.equilibriumhousing.ca).



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Produced by CMHC

30-07-12

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