



## Project Profile: The Laebon CHES Project—Red Deer, Alberta

This Project Profile highlights the Laebon CHES Project, 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

- Home design optimizes passive solar heating benefits
- Predicted net annual energy production
- Home includes grid-connected photovoltaic panels, a high efficiency ground-source heat pump, and a solar hot water system
- Energy efficient building envelope utilizes pre-fabricated structural insulated panels (SIPs)

Figure 1—Photo of the Laebon CHES Project

## Project Description

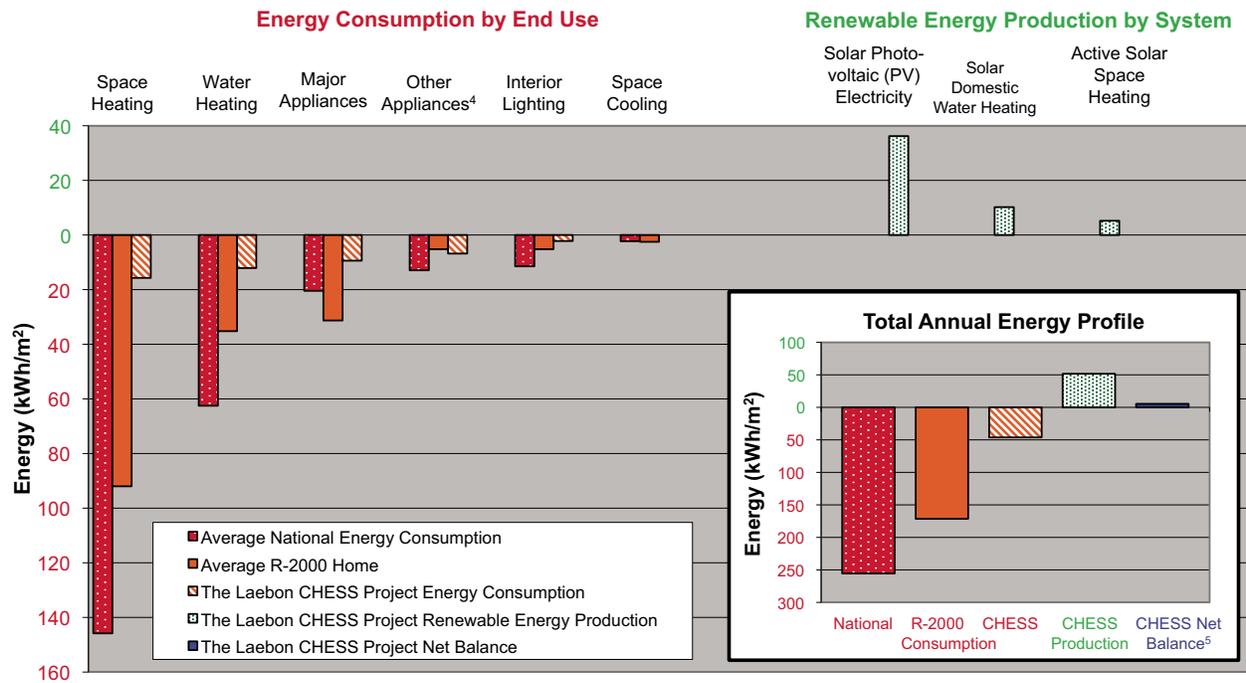
The Laebon CHES (Canadian Housing Energy Sustainable Solutions) Project is a new, single family detached home built on a residential lot in a new development in Red Deer, Alberta.

The one and one-half-storey home has a floor area of 150.6 m<sup>2</sup> (1621 sq. ft.) with an additional 72.1 m<sup>2</sup> (776 sq. ft.) in the basement.

In keeping with the EQUilibrium™ Housing Initiative, the Laebon CHES design considers the entire home as an integrated system. The design of the house addresses how the home will influence and interact with the surrounding environment, and accounts for the source of raw materials and the impacts of manufacturing. The design was also influenced by both an analysis

of the full life-cycle costs of available options, and the need to provide a healthy, comfortable indoor environment for the occupants. The home's annual energy requirement is predicted to be slightly less than the on-site annual production from renewable energy sources, which include passive and active solar heating systems and a solar

<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".



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 and toasters.  
 5 CHES Net Balance = CHES Energy Consumption + CHES Renewable Energy Production

Figure 2—Comparison of Canadian National Average<sup>1</sup>, R-2000 Home<sup>2</sup>, and Predicted Laebon CHES Project Annual Residential Energy Consumption and Production<sup>3</sup>

photovoltaic (PV) system. Surplus electricity will be fed into the City of Red Deer electrical grid. The home is highly insulated, very airtight, and has high-efficiency appliances. The household energy requirements are predicted to be only 18 percent of the requirements for the average Canadian house.

The Laebon CHES home has been strategically designed to evolve with the homeowner's short- and long-term needs. The main floor area is 103 m<sup>2</sup> (1109 sq. ft.) with an open living, dining room and kitchen area, master bedroom, three-piece bathroom, and another room which could be

used as a bedroom, office, or den. The main floor includes barrier-free design features such as doors at least 864 mm (2' 10") wide, a wide front foyer, adequate space between counters in the kitchen, and a removable linen cupboard in the main bathroom to facilitate wheelchair access at the toilet. The second floor area is 47.6 m<sup>2</sup> (512 sq. ft.) with two bedrooms, a sitting area, and a three-piece bathroom. The basement, which has a nine foot ceiling, has a 72.1 m<sup>2</sup> (776 sq. ft.) developed area with a family room, bedroom, three-piece bath and laundry room. The mechanical room is also located in the basement. An unfinished attic

space above the garage could easily be developed to expand living space. 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

Good indoor air quality, thermal and acoustic comfort and the effective use of daylighting are key objectives of the Laebon CHES Project to help support occupant health and comfort.

To improve indoor air quality, materials that emit toxins or contain volatile organic compounds (VOCs) have been eliminated or minimized. In addition to low-VOC paints, and extensive use of concrete flooring, interior finishes include those made of natural products such as wood, natural linoleum and cork, all of which can be easily cleaned. The medium-density fibreboard (MDF) used for the cabinets and trim work, and the insulation products selected for the home are formaldehyde-free.

Mechanical ventilation via a heat recovery ventilator (HRV) helps maintain indoor air quality in the home by supplying fresh outdoor air to each room while exhausting stale air, odours and excess humidity. The HRV has a high efficiency particulate air (HEPA) filter which will capture more than 99% of all dust and other suspended particles entering the home, and there are both supply and exhaust vents in each room to ensure air distribution and circulation. The central vacuum system is vented to the outside to help limit dust that can become suspended in the household air during vacuuming.

Moisture management strategies include proper site grading, rain gutters and downspouts, and a layer of rigid expanded polystyrene (EPS) insulation and a foundation membrane on the outside of the basement walls. These features help water drain away from the home which in turn helps to protect the foundation from moisture related problems.

Thermal comfort is maintained with hydronic ‘in-floor’ heat, with various zones throughout the house to suit occupant needs.

Cork and leather flooring in the bedroom/study areas and natural linoleum flooring in the bathroom helps absorb internally generated noise. Entry of externally generated noise is reduced through the use of structural insulated panels (SIPs) for the exterior walls, rigorous air leakage control and quadruple pane windows. Bedrooms are placed at the back of the home, away from street noise.

Windows are placed to maximize natural light in the spaces used most during daylight hours. The east, south and west facing windows ensure that the open-concept main floor living space, which includes the kitchen, living room and dining room, has ample natural light from dawn to dusk. In addition, there are interior ‘lights’ (single panes of glass) on both sides of the enclosed stairwell to the second floor. These features allow daylight from the large windows on the south face of the home to illuminate the stairwell as well as contribute light to a second floor bedroom adjacent the stairwell.

## Energy Efficiency

The first step to reduce the Laebon CHES Projects’ energy requirements was to create a highly-efficient building envelope. Pre-fabricated structural insulated panels (SIPs), with a

polyurethane foam core, provide an energy-efficient insulation/vapour barrier/air barrier exterior wall building system. The basement floor and the ceiling are also well insulated. Careful attention to building envelope construction details improves air tightness, which further reduces heat loss.

Passive solar energy is provided to the home through various design features. Proper design and placement of the quadruple-pane fibreglass windows, overhangs and shading devices, which are suited to the site orientation and climate, allow for solar gain or protection from the sun as needed. Once solar heat enters the home, it is stored in the thermal mass of the concrete floors and a rock wall. The heat stored in the thermal mass can help moderate indoor temperature fluctuations and when released reduce heating requirements.

Significant energy savings are expected through the selection of lighting and appliances. The Laebon CHES home features compact fluorescent lights, motion detectors and vacancy sensors which can reduce the lighting load. Similarly, the Energy Star® appliances can reduce the estimated electrical consumption of the appliances.

## Renewable Energy Production

In addition to energy efficiency measures, Laebon CHES utilizes solar hot water panels, a ground-source heat pump, and a photovoltaic (PV) system to meet its energy needs.

Ten solar thermal panels are the primary energy source for both space heating and domestic hot water. The heat captured by the panels is stored first in a 545 L (120 imp gal.) domestic hot water tank. Once the hot water needs are met, any excess heat is transferred into 2 - 1,454 l (320 imp. gal.) water storage tanks. These tanks provide the heat to the radiant in-slab floor heating system. A 3-ton ground source heat pump with 3 – 61 m (200 ft.) deep ground loops is used to provide supplementary heat for both the space heating and domestic hot water needs. It can also be used to move excess heat from the house to the ground if cooling is required during summer.

Laebon CHES has a 6.73 kW photovoltaic array consisting of 36 modules, which are predicted to generate 6,600 kWh of electricity annually. If the production exceeds household needs, the excess is supplied to the City of Red Deer electrical grid.

## Resource Conservation

The efficient use of durable, renewable and recycled materials as well as water conservation were important considerations in the selection of materials and products used in the home.

Lumber in the home is Forest Stewardship Council (FSC)<sup>2</sup> certified. The cork used in the flooring can be reharvested every decade or so from the tree that provides it. The natural linoleum used on the bathroom floors, is also made from renewable materials. The inclusion of recycled content in the drywall, insulation and finish materials was factored into the selection process. Reclaimed wood is used for the media centre and the decorative wood shelving.

The house was designed to include durable materials and building assemblies to minimize maintenance, reduce future repairs or replacement and extend the life of the building. The polyurethane manufactured ‘stone’, stucco, 30-year asphalt shingles and decking material were selected for exterior finishes for ease of maintenance, longevity and aesthetic qualities. Inside the home, materials such as the concrete floors and countertops, were selected, in part, because they are highly durable.

Resource efficiency in the Laebon CHES home is further achieved through the use of the SIP panel walls, engineered floor joists, laminated veneer lumber beams, finger joint studs and manufactured trusses – all of which

use less raw material than typical wood frame methods, allow for longer spans and can be manufactured from smaller trees. OptimumValue Engineering (OVE) practices, such as framing interior walls at 600 mm (24”), the use of two-stud corners and elimination of headers at non-load bearing walls also reduced the amount of lumber used in the home.

Water is conserved in the Laebon CHES home primarily through the selection of water-efficient plumbing fixtures. High-performance low-flow showerheads, dual-flush toilets and a horizontal axis clothes washer and energy-efficient dishwasher will reduce the amount of potable water required. Plumbing has been roughed-in for a grey-water recycle system that at some future time will allow the waste water from the showers to be used for flushing the toilets. Outdoors, the landscape design is based on xeriscaping principles, incorporating native and low water-use plants that thrive in the central Alberta climate. Plants with similar watering needs are grouped together. The use of grass has been reduced, and a rain barrel captures water for irrigation.

<sup>2</sup> Under FSC Certification, forests are certified against a strict set of environmental and social standards. For further information on the Forest Stewardship Council, see <http://www.fsc.org>

## Reduced Environmental Impact

Several technologies and techniques have been employed to reduce the initial and long-term environmental impact of the home. For example, an emphasis was placed on selecting materials with reduced embodied energy<sup>3</sup>, meeting the Built Green™ requirements for Alberta<sup>4</sup>, and considering the manufacturing processes of materials used.

One of the ways the Laebon CHES team reduced embodied energy of the house was by selecting products that were manufactured locally, thereby decreasing the transportation related energy consumption. For example, the insulation, cabinets, reclaimed wood and concrete countertops are all manufactured in central Alberta.

The SIP panels and polyurethane manufactured ‘stone’ exterior façade were made in Calgary. Reclaimed wood was purchased for interior trim work.

As much as possible, products were selected that would have minimal site waste during construction and that could be reused or recycled at the end of the home’s life. The SIPs panels are one example. This minimized the amount of waste sent to the land fill.

The team looked for suppliers who demonstrated environmentally-responsible operations and management practices and offered sustainable products and services. Factors considered by the team when selecting suppliers and materials included the presence or absence of harmful chemicals or ozone depleting substances.

## Affordability

In the Laebon CHES home, several strategies have been implemented to provide cost savings over the long term. Products throughout the home were selected for durability and ease of maintenance thereby reducing the cost of having them repaired or replaced. The highly-efficient building envelope is expected to result in immediate and long-term savings on monthly energy costs. Effective lighting strategies, appliance selection and reductions in water use can also reduce costs. The Laebon CHES project also has the ability to easily expand and adapt with the changing needs of the home owners. This can save on the costs associated with moving or extensive renovations (e.g. for increasing wheelchair access) that might otherwise be required due to aging, illness or other changing life circumstances.

<sup>3</sup> Embodied energy includes the amount of energy used in the extraction of raw materials, the manufacture of the product and the transporting of product to where it is used.

<sup>4</sup> Built Green™ is an industry driven, volunteer program to promote building practices that reduce the impact of buildings on the environment. The Laebon CHES home achieves the highest Built Green™ achievement level, Platinum. For further information see: <http://www.builtgreencanada.ca/>

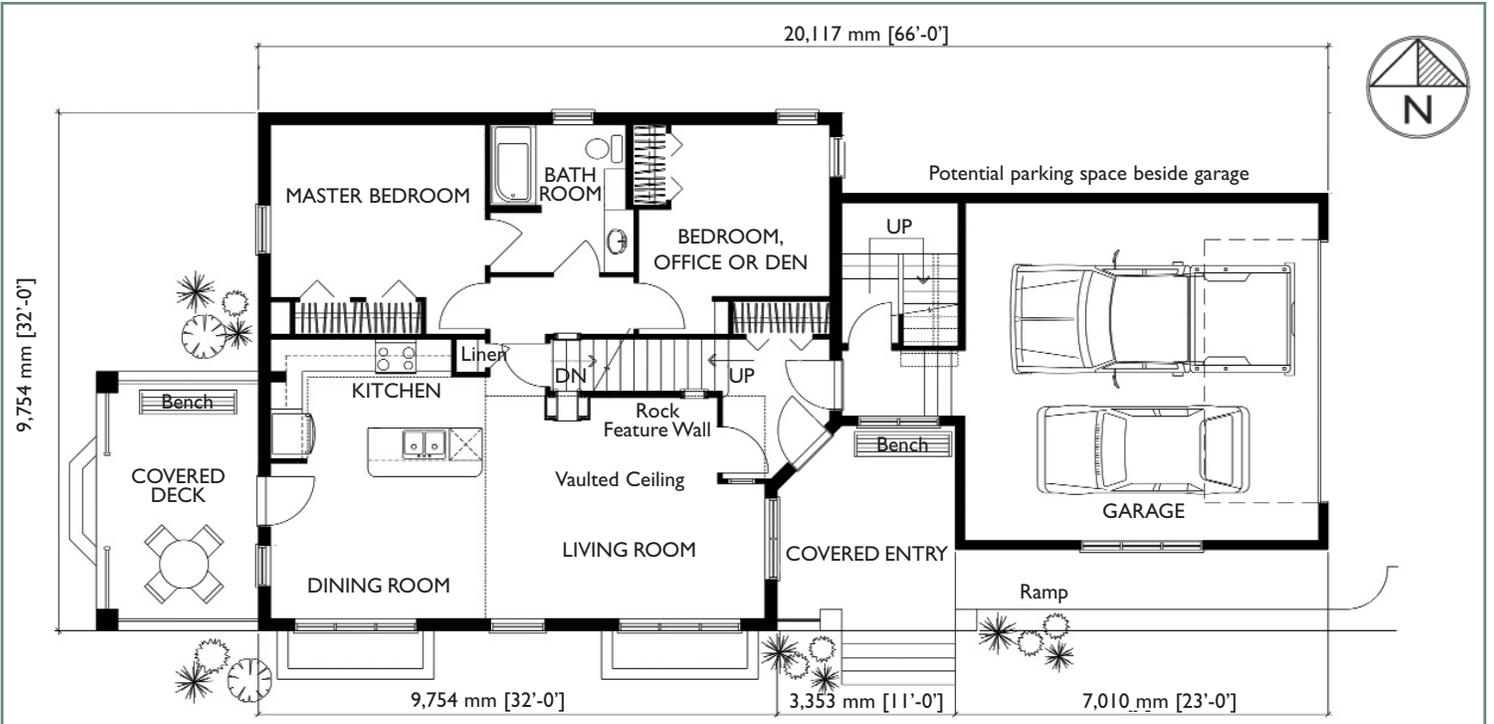


Figure 3—Main floor plan of the Laebon CHES Project

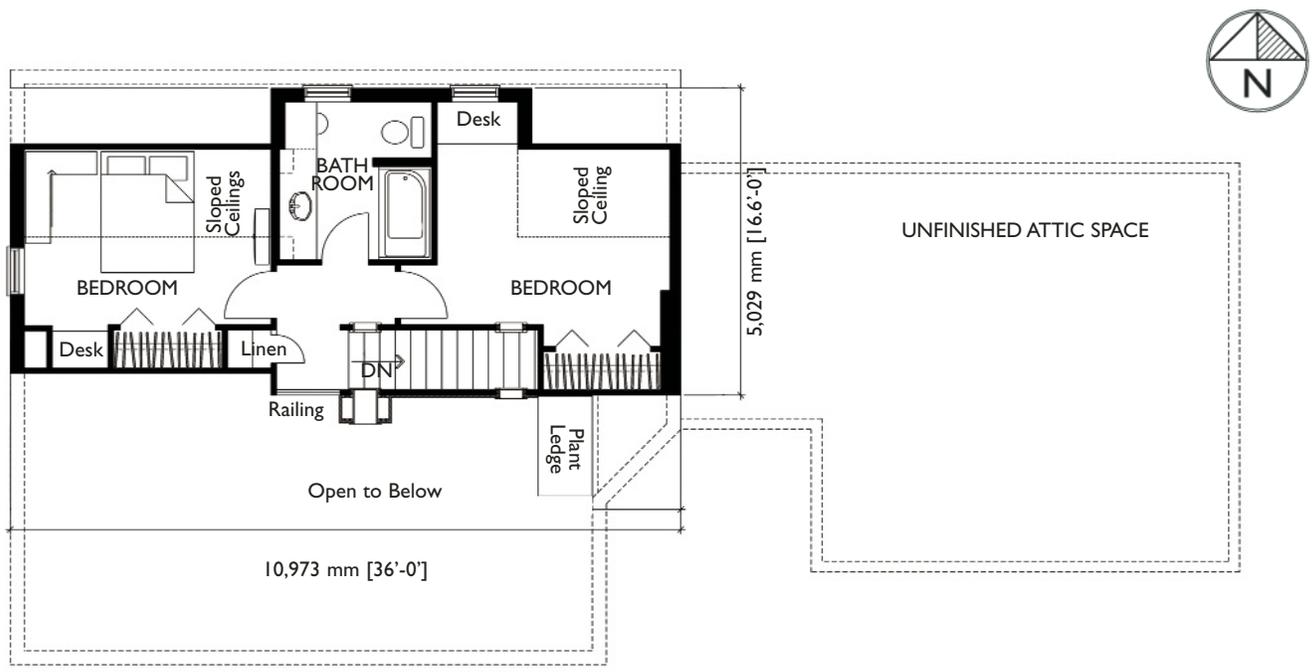


Figure 4—Second floor plan of the Laebon CHES Project

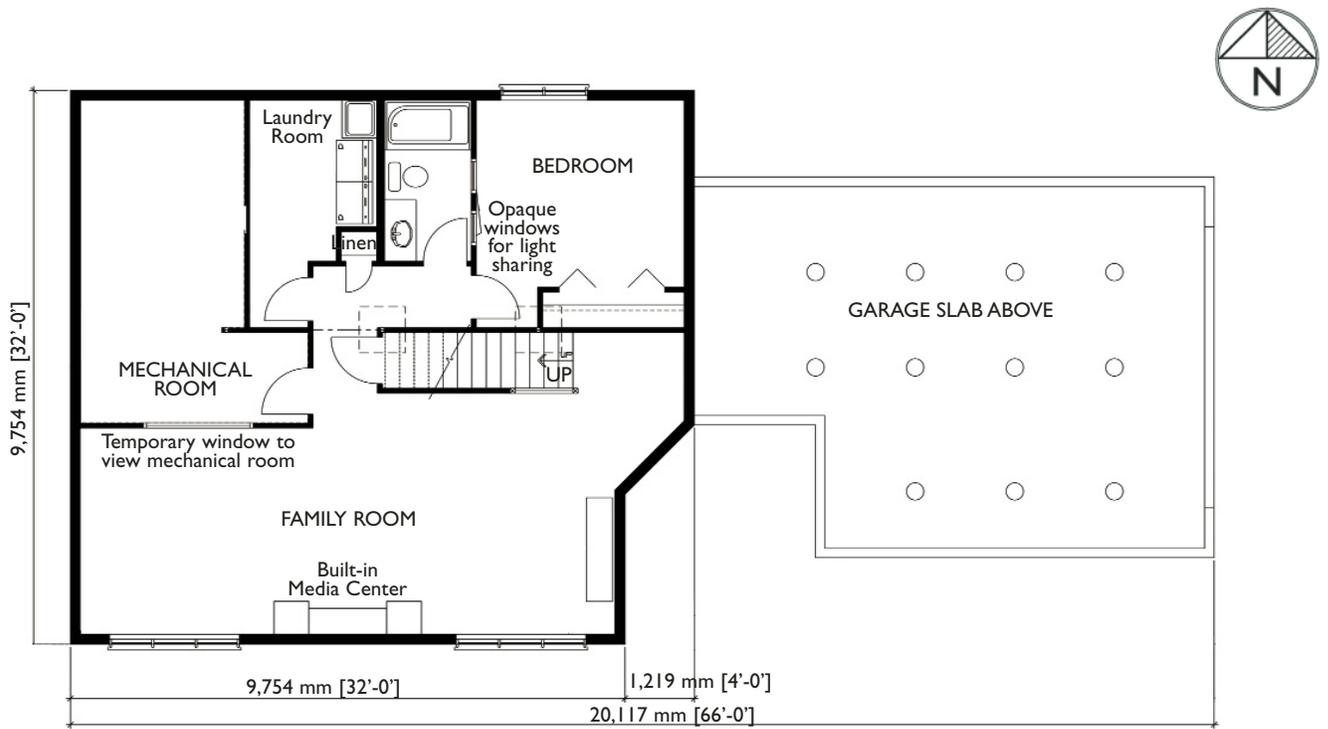


Figure 5—Basement floor plan of the Laebon CHES Project

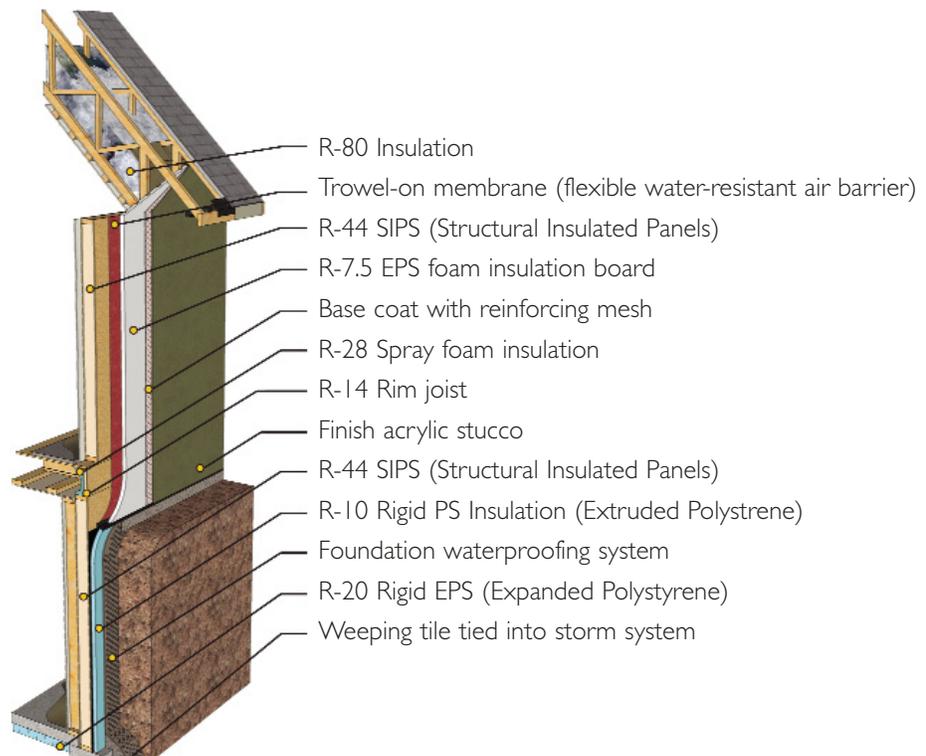


Figure 6—The Laebon CHES Project Building Envelope

## Technical Summary: Laebon CHES Project, Red Deer, Alberta

Building Description			Predicted Annual Energy Consumption	
Type: New 1 1/2 storey detached with finished basement			Space heating	15.7 kWh/m <sup>2</sup>
Floor area (including basement):	229 m <sup>2</sup>	2470 ft <sup>2</sup>	Domestic water heating	12.1 kWh/m <sup>2</sup>
Solar Orientation	South		Appliances/lighting	16.0 kWh/m <sup>2</sup>
Building footprint	103 m <sup>2</sup>	1109 ft <sup>2</sup>	Mechanical ventilation	2.4 kWh/m <sup>2</sup>
Heated volume	740.8 m <sup>3</sup>	26,162 ft <sup>3</sup>	<b>Total predicted consumption</b>	<b>46.2 kWh/m<sup>2</sup></b>
Heated floor area	229 m <sup>2</sup>	2470 ft <sup>2</sup>	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)	
Ceiling area	101.0 m <sup>2</sup>	1087 ft <sup>2</sup>	Predicted Annual On-site Renewable Energy Production	
External wall area	151.1 m <sup>2</sup>	1626 ft <sup>2</sup>	Solar (photovoltaic) electricity	36.2 kWh/m <sup>2</sup>
Window area total	22.7 m <sup>2</sup>	244.4 ft <sup>2</sup>	Solar domestic water heating	10.2 kWh/m <sup>2</sup>
South	12.46 m <sup>2</sup>	134.2 ft <sup>2</sup>	Active solar space heating	5.2 kWh/m <sup>2</sup>
North	4.02 m <sup>2</sup>	43.3 ft <sup>2</sup>	<b>Total predicted production</b>	<b>51.6 kWh/m<sup>2</sup></b>
West	3.44 m <sup>2</sup>	37 ft <sup>2</sup>	Note: All values are based on heated floor area.	
East	2.79 m <sup>2</sup>	30 ft <sup>2</sup>	Predicted Annual Energy Balance <b>+5.4 kWh/m<sup>2</sup></b>	
Ratio of south glazing area to floor area:	5.5%		EnerGuide for Houses <sup>1</sup> (EGH*) Rating <b>101</b>	
Thermal Characteristics			Space Heating Information	
Roof	RSI 14.1	R-80	Space heating requirements for the Laebon CHES Project will be met as follows (predicted values):	
Walls	First and second floor RSI 9.2	R-52	Passive solar gain	23%
	Basement RSI 9.5	R-54	Internal gains <sup>2</sup>	29%
Windows	RSI 1.80	R-7.8	Active solar thermal heating system supplying a radiant in-floor heating system	16%
Basement floor	RSI 3.5	R-20	Three-ton ground source heat pump (effective seasonal COP 2.5) <sup>3</sup> for supplemental space heating	33%
Targeted Airtightness Level	0.5 ACH @ 50 Pa		Domestic Hot Water Information	
Site Characteristics			Domestic hot water requirements for the Laebon CHES Project will be met as follows (predicted values):	
Location	Red Deer, Alberta		Active solar thermal heating system	84%
Site type	Suburban, new development		Supplemental electric on demand water heater	16%
Site area	473.1 m <sup>2</sup>	5,092 ft <sup>2</sup>	Ventilation	
Elevation	903.7 m	2,965 ft.	Two-speed heat recovery ventilator (HRV) with 2 ECM motors. Seasonal efficiency of 88%.	
Latitude	52°16' N		Water Consumption (estimated 4 person consumption)	
Longitude	113°50' W		Potable water use	616 L/day 135.6 U.K. gal/day
				224,840 L/yr 49,487 U.K. gal/yr
Climate			Potable water reuse (greywater use)	Not connected
Average daily horizontal solar irradiation	3.7 kWh/m <sup>2</sup>			
Average daily vertical solar irradiation	4.1 kWh/m <sup>2</sup>			
Average annual precipitation	487 mm	19 in.		
Average annual wind speed	17.0 km/h	11 mph		
Average outdoor temperatures				
January	-13 °C	8.6 °F		
April	4 °C	39.2 °F		
July	16 °C	60.8 °F		
October	5 °C	41.0 °F		
Building design temperatures <sup>4</sup>				
January	-31 °C	-23.8 °F		
July	28 °C	82.4 °F		
Heating Degree Days (base 18°C [64°F])	5,550	[9,990]		
Cooling Degree Days (base 18°C [64°F])	25	[45]		

1 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.

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

3 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).

4 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™ Housing

### **What is EQUilibrium™ Housing?**

EQUilibrium™ Housing 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](http://www.cmhc.ca)

Although this information product reflects housing experts' current knowledge, it is provided for general information purposes only. Any reliance or action taken based on the information, materials and techniques described are the responsibility of the user. The predictions for energy consumption and production of the building are based on computer modelling and current understandings of best construction practices. Actual building performance may vary. Users are advised to consult appropriate professional resources to determine what is safe and suitable in their particular case. Canada Mortgage and Housing Corporation assumes no responsibility for any consequence arising from use of the information, materials and techniques described.