



Project Profile: Avalon Discovery 3—Red Deer, Alberta

This Project Profile highlights Avalon Discovery 3, 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



Key Features

- Predicted net zero annual energy consumption
- Roof-integrated photovoltaic (PV) tiles
- Highly insulated slab-on-grade foundation with in-floor radiant heat
- Low emission building materials
- 100% xeriscape landscaping with rainwater storage backup
- Garage loft provides storage space in place of basement

Figure 1—Photo of Avalon Discovery 3

Project Description

Avalon Discovery 3 is a new, one and one-half-story, 243.8 m² (2,624 sq. ft.), detached home on a residential lot in a new suburban community in Red Deer, Alberta.

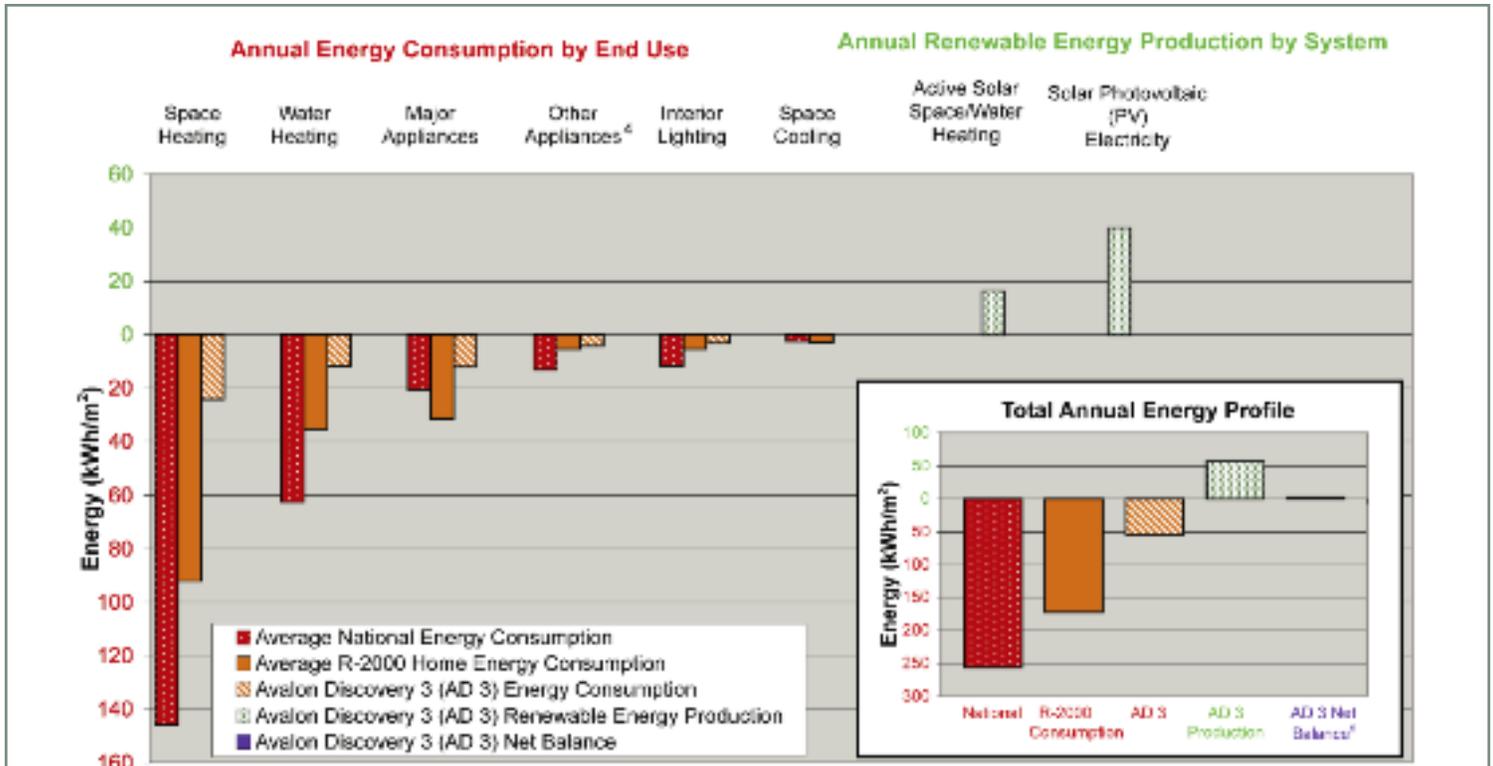
It is predicted that the home will produce approximately as much energy annually as it consumes - a net-zero

energy home. It is connected to the City of Red Deer electrical utility grid.

In keeping with the CMHC EQUilibrium™ Housing Initiative, the Discovery 3 design, by the builder Avalon Master Builder, includes strategies that reduce the impact of home construction and occupancy on both the environment and occupants. These

strategies include improved indoor air quality, renewable energy systems, locally sourced materials and energy-efficient construction techniques. Additional features include a rainwater harvesting system for landscape irrigation.

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



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 1990s.
 3 Values are predicted based on Natural Resources Canada's HDT2000 and NETScreen 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 AD 3 Net Balance = AD 3 Energy Consumption - AD 3 Renewable Energy Production

Figure 2—Energy profile: Comparison of Canadian National Average,¹ R-2000 Home² and Predicted Avalon Discovery 3 (AD 3)³ annual Residential Energy Consumption and Production

Slab-on-grade construction is employed with the Emercor™ structural insulated panel (SIP) system forming the exterior walls. The well insulated, airtight building envelope (exterior building surface), and other energy efficiency features will significantly reduce the household energy requirements, which are expected to be about 23 per cent of the energy requirements for the average Canadian home.

The ground floor includes a living room, dining room, kitchen, den, three-piece bathroom, and master bedroom with three-piece ensuite bathroom. It incorporates some

barrier-free design features and has been designed for easy conversion to barrier-free living. The second-floor includes two bedrooms, a loft area, and a three-piece bathroom.

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

A number of strategies improve indoor air quality in the home. The slab-on-grade construction and grading at the building perimeter ensure that moisture is

deflected away from the building and eliminates the potential for mold growth associated with basements. The mudroom and sun porch provide buffer zones that can help to limit contaminants entering the house. The interior finishes chosen (for example paint, adhesives, wood and ceramic flooring, grout) reduce indoor air contaminants by keeping the volatile organic compounds (VOC) of construction materials and finishes to a minimum.

Natural cross-ventilation is provided by the strategic placement of operable windows to capture prevailing winds,

ensuring fresh air for every room in the house. A heat recovery ventilator (HRV) provides fresh air throughout the house, and exhausts air from bathrooms and the kitchen area. The HRV system intake and exhaust were carefully positioned to avoid cross-contamination.

To ensure adequate daylighting throughout the home, the design includes windows aligned with stairs and hallways, helping to bring sunlight deep into the house.

Energy Efficiency

A variety of design elements significantly reduce the Avalon Discovery 3 heating requirements compared to a typical home. The house is positioned on a southwest corner lot and oriented with an east-west axis, ensuring good solar exposure. The north aspect is sheltered by the adjacent residential building.

Passive solar design includes a high-performance building envelope and interior thermal mass (the concrete slab-on-grade), both of which help ensure minimal interior temperature fluctuations. The thermal mass absorbs excess daytime solar heating and releases this stored heat at night. Appropriately designed overhangs help reduce summer solar gains through the south- and west-facing windows. Heat-mirror glazing helps retain radiant heat in the colder months. All these factors also improve thermal comfort for the occupants.

The exterior walls are a double thickness of pre-fabricated Emercor™ SIPs.

These panels have a polyurethane core and foam-sealed joints, providing very well insulated, air-tight exterior walls that are also air and vapour barriers. Additional energy efficiency features include a fully insulated ground floor slab, raised heel trusses to accommodate higher levels of spray-in insulation in ceiling cavities, and advanced windows coupled with R3-insulated shutters.

The front entry to the house is a buffer between indoor and outdoor temperatures, with the doors opening into an airlock area.

Renewable Energy Production

Passive and active solar heating systems are integral to the design. The solar thermal space heating system is integrated with both the solar domestic hot water and hydronic in-floor heating systems. It includes five pairs of Zen Thermic™ flat-panel solar collectors mounted vertically on the south facade of the home, and two 450 L (two 100 U.K. gal.) hot water storage tanks. The designers predict that this system will generate 46 per cent of the home's annual space and domestic hot water heating requirements. The backup electric boiler and electric baseboard heaters on the second floor will provide supplementary heat when needed.

A 8.3 kW Solarsave® photovoltaic (PV) array, comprised of two hundred forty four 34 W roofing tiles, is connected to the electrical grid, and provides electricity for the mechanical system (pumps, fans, baseboard heaters, electric boiler), ventilation and appliance loads. When PV electrical production is insufficient to meet the home's needs, electricity will be purchased from a green power utility.

Resource Conservation

Reclaimed and recycled construction materials were used where possible. All efforts were made to use locally extracted, harvested, and / or manufactured materials to reduce the embodied energy associated with transportation. Fly ash concrete (which requires less energy during manufacture than conventional concrete while utilizing waste generated from coal-fired generating stations) was used in the slab-on-grade assembly.

Materials were also chosen for their non-toxic properties, such as unfinished concrete floors, prefinished, solid wood flooring with no- or low-VOC finish, and ceramic tile with no- or low- VOC adhesives and grout. Paint and stains are VOC-free.

A double air barrier, along with minimal envelope penetrations, helps to preserve the building envelope and extend the building's life.

The overall design provided opportunities for material efficiency. A smaller footprint with a simple form and no basement uses less building material than a larger, more complex design. The main floor concrete slab (under the bamboo finish flooring) provides thermal mass. The second floor provides opportunities for development, using the materials saved by not incorporating a basement in the design. Optimum Value Engineering² was utilized for the interior walls and ceiling to further reduce material consumption and waste.

Low-flow plumbing fixtures and water efficient appliances conserve potable water. A rainwater harvesting system coupled with the use of treated greywater from the sinks supplies water for the toilet and exterior watering. The landscape employs xeriscaping, replacing conventional lawn with native perennials to greatly reduce watering requirements and fertilizer and pesticide use. The rainwater and greywater drip irrigation system reuses water and recycles nutrients into the landscape. Wood waste mulch retains soil moisture and reduces weeds.

The interior design incorporates the ability to reconfigure the house as occupant requirements change. For example, the ground floor den can be used as a bedroom or home office. All amenities are located on the ground floor and are designed for barrier-free living.

Reduced Environmental Impact

The Avalon Discovery 3 reduces its environmental impact in additional ways. A variety of nearby municipal services, including public transportation, reduce the need for private vehicle use. A target of 95 per cent construction waste reduction was achieved through activities such as waste wood mulching on-site, drywall recycling, composting of excess paint and Avalon's Take Back Policy for all trades and suppliers. An integrated recycling centre coupled with a composter will make participating in waste reduction easy for the occupants.

Affordability

As a result of the energy-efficient features of this new house, the annual energy consumption is predicted to be near zero, resulting in much lower utility costs. Avalon Discovery 3 features, such as the highly insulated and durable building envelope, the ability to economically reconfigure the house as occupant requirements change and the use of materials which contribute to good indoor air quality are being sought by more and more prospective homeowners.

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.

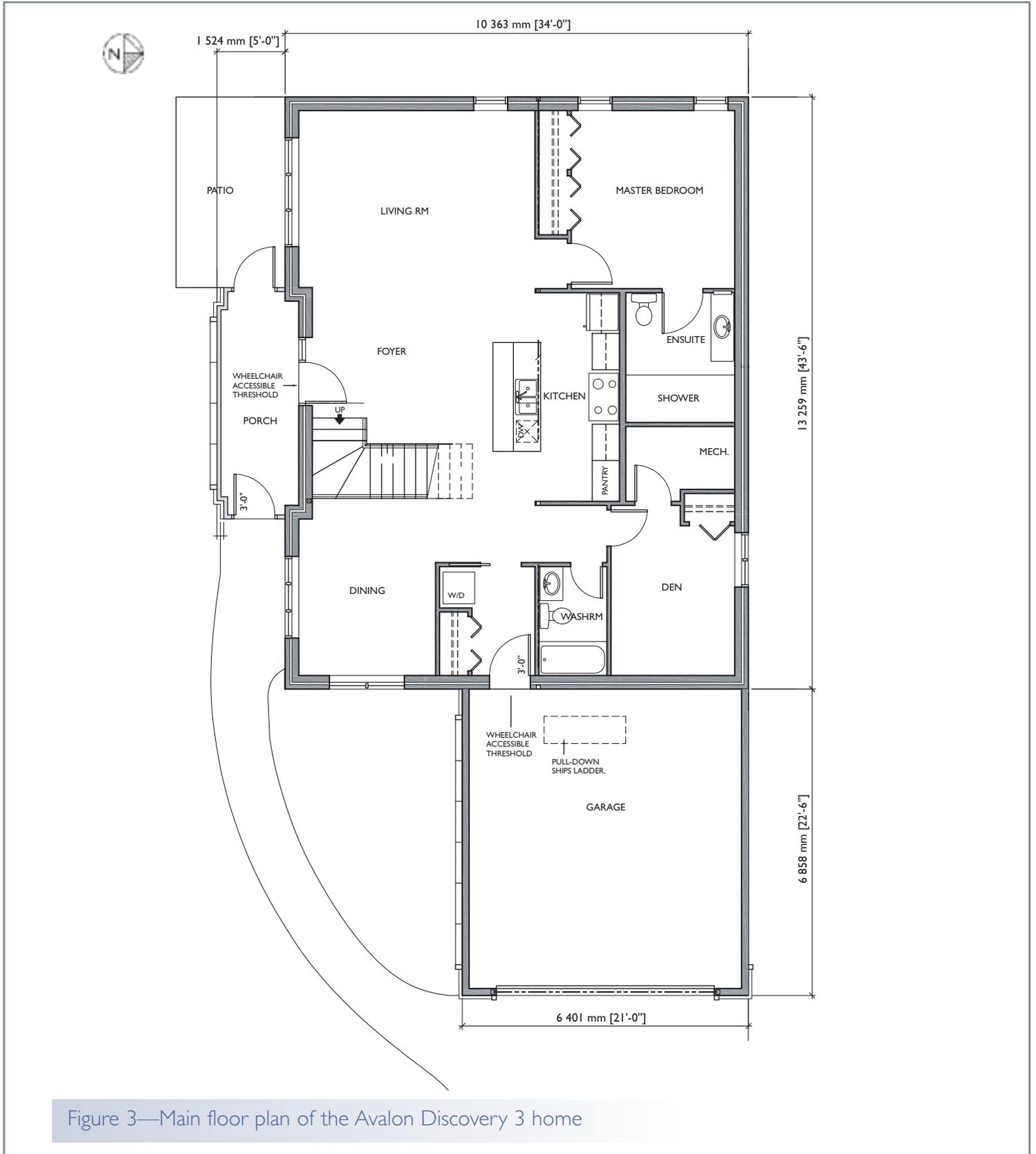


Figure 3—Main floor plan of the Avalon Discovery 3 home

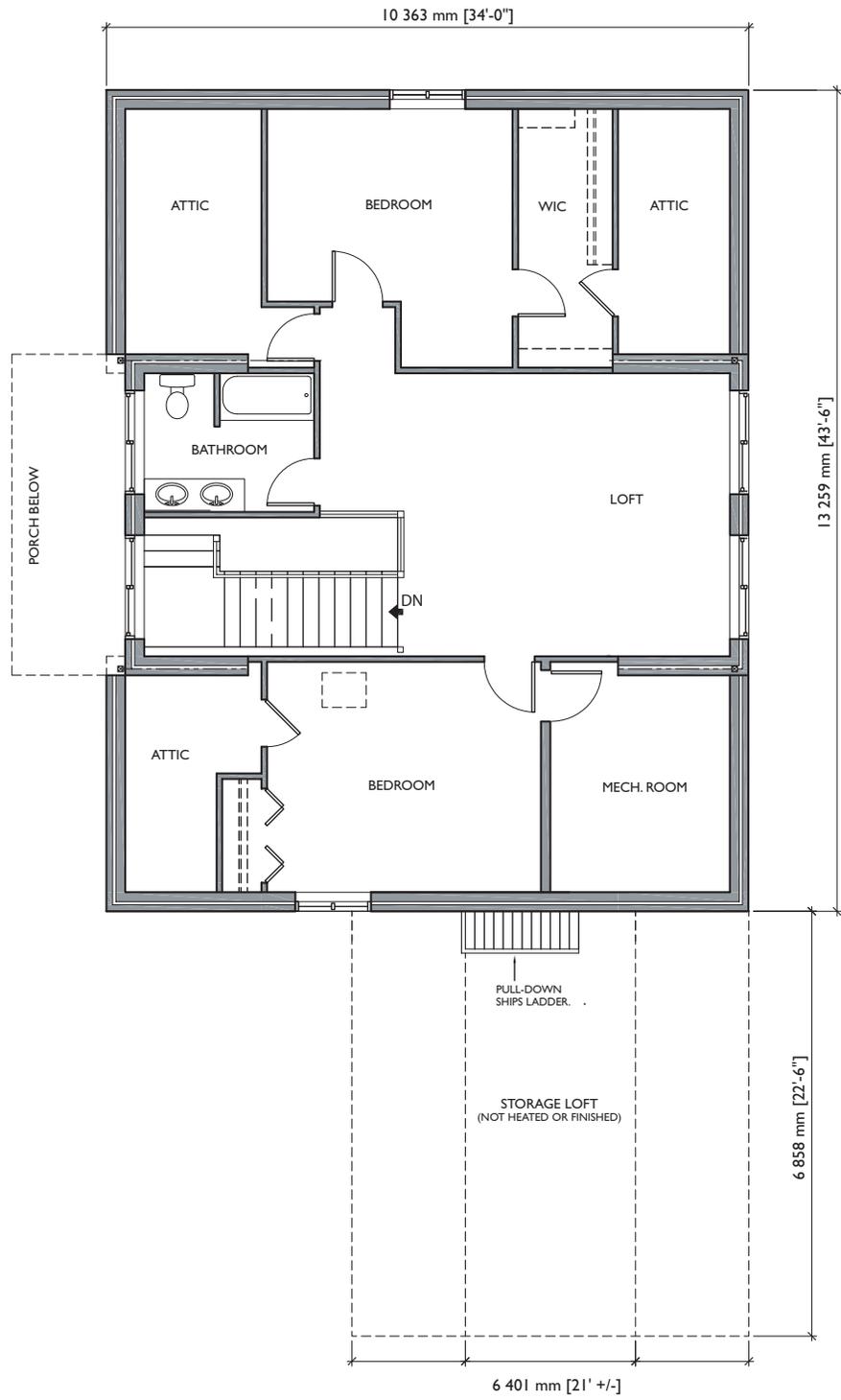


Figure 4—Second floor plan of the Avalon Discovery 3 home

Technical Summary: Avalon Discovery 3 Project—Red Deer, Alberta

Predicted Annual Energy Consumption (by heated floor area)		Building Description	
Total annual energy use:	54.56 kWh/m ²	Type:	New, single detached 1½ story on slab
Space heating:	23.93 kWh/m ²	Floor space:	243.8 m ² 2, 624 ft. ²
Domestic water heating:	11.63 kWh/m ²	Building axis:	East-West
Appliances/lighting:	14.51 kWh/m ²	Building footprint:	185.9 m ² 2,004 ft. ²
Mechanical ventilation:	4.49 kWh/m ²	Heated volume:	451.9 m ³ 15,960 ft. ³
Predicted Annual Energy Production (by heated floor area)		Heated floor area:	240.4 m ² 2,592 ft. ²
Total annual energy production:	56.06 kWh/m ²	Ceiling area:	132.5 m ² 1,429 ft. ²
Solar electricity:	39.87 kWh/m ²	External wall area:	182.3 m ² 1,966 ft. ²
Solar domestic water heating:	16.19 kWh/m ²	Window area total:	20.47 m ² 220.7 ft. ²
Predicted Annual Energy Balance: +1.49 kWh/m²		South:	7.31 m ² 78.8 ft. ²
EnerGuide for Houses* (EGH*) Rating¹ 101		North:	4.13 m ² 44.5 ft. ²
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. 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 for the contribution of renewable energy systems in EQUilibrium™ houses, thereby more accurately reflecting the home's potential energy performance.		West:	4.73 m ² 51.0 ft. ²
Site Characteristics		East:	4.30 m ² 46.4 ft. ²
Location:	Red Deer, Alberta	Ratio of south glazing area to floor area:	3%
Site type:	Urban, new development	Thermal Characteristics	
Site area:	500 m ² 5,227 ft. ²	Roof:	RSI 15.3 R-87
Elevation:	850 m 2789 ft.	Walls:	RSI 12.29 R-70
Latitude:	52.2 N	Windows:	RSI 0.85 R-4.8
Longitude:	113.8 W	Basement slab:	RSI 10.6 R-60
Average Outdoor Temperatures		Airtightness Target:	0.5 ACH @ 50 Pa
January:	-13.5 °C 7.7 °F	Electricity	
April:	3.7 °C 38.7 °F	Two hundred forty-four 34 W roofing tile 8.3 kW Solarsave® grid-interconnected solar photovoltaic (PV) system.	
July:	15.8 °C 60.4 °F	Space Heating	
October:	4.6 °C 40.3 °F	Passive solar and six 30 tube flat panel solar collectors providing heat to hydronic radiant floor. Backed up by electric boiler supplied by photovoltaic/grid-intertie. Includes 2- 450 L (2 - 100 U.K. gal.) insulated storage tanks and integration with domestic water heating.	
Building Design Temperatures²		Ventilation	
January:	-35°C -31.0 °F	60 L/s low volume high efficiency heat recovery ventilator (HRV) coupled with natural ventilation through operable windows.	
July:	28 °C 82.4 °F	Water Heating	
Heating Degree Days (base 18°C [64°F]):	5,550 [9,990]	Passive solar and six 30 tube flat panel solar collectors integrated with domestic space heating and backed up by electric boiler supplied by photovoltaic/grid-intertie.	
Cooling Degree Days (base 18°C [64°F]):	39.8 [72]	Water Consumption (estimated 4 person consumption)	
Climate		Potable water use	
Average daily horizontal solar irradiation:	3.7 kWh/m ²	124 L/day	27 U.K. gal/day
Average daily vertical solar irradiation:	4.1 kWh/m ²	45,077 L/year	9,921 U.K. gal/year
Average annual precipitation:	487 mm 19 in.	Water reuse (greywater use)	
Average annual wind speed:	4.0 km/h 2.5 mph	112 L/day	25 U.K. gal/day
		40,953 L/year	9,018 U.K. gal/year

¹ For further information, 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.

Project Team

Primary contact: Ryan Scott
ryan@avalonmasterbuilder.com

Builder: Avalon Master Builder

Developer: Melcor Developments Ltd.

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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