# R-2000 NET-ZERO ENERGY
## Pilot Case Study

## MCKERNAN HOME HABITAT STUDIO

Edmonton, Alberta

## Project DESCRIPTION

Natural Resources Canada (NRCan) spearheaded a national demonstration project to engage the residential industry in designing and building net-zero energy houses. The goal was to showcase industry leadership in realizing such an ambitious goal while delivering homes attractive to the marketplace.

NRCan established the energy performance framework that ensured consistent and transparent rating of the homes. The Pilot requirements were based on NRCan's R-2000 high performance home program, a well-established and premium housing program in Canada.

This project saw the construction of 26 net-zero energy or net-zero energy ready homes. A net-zero energy home is a house that produces as much energy as it consumes on an annual basis.

Leveraging Habitat Studio's previous experience in building net-zero energy homes (e.g. the Riverdale Home, also in Edmonton, Alberta), construction methods have been refined to achieve the best balance between energy conservation measures and mechanical system requirements. Construction of the home was completed in May 2015.



Canada

# The BUILDER: HABITAT STUDIO

**Habitat Studio is a veteran in building net-zero energy homes, with 10 built as of 2015. Their Riverdale net-zero energy home was previously featured as part of the EQuilibrium™ Sustainable Housing Demonstration Initiative with Canada Mortgage and Housing Corporation (CMHC) as a demonstration project.**

**McKernan Home: the first net-zero energy home in Canada recognized under NRCan's R-2000 Net-Zero Energy Pilot**

## Affordability

**The McKernan net-zero energy home costs $40,000 to $50,000 more than houses in the same location built to code. In Edmonton, Alberta, this is about a 10% increase over the typical market price.**

# Key FEATURES

## EnerGuide Rating

**0** GJ/Yr

**Roof:**
R-80 blown cellulose

**Main walls:**
R-24 cavity + R-17 c.i. cellulose

**Basement:**
**walls:** 2" Type 1 EPS + R-22 Batt
**under slab:** 4" Type 2 EPS

**Windows:**
low-E, argon-filled, triple pane

**HRV:**
84% efficient at 0°C and 72% at -25°C

**Airtightness:**
0.43 ACH at 50 Pa

**Space heating and cooling:**
air source heat pump, 7.83 HSPF/18 SEER + electric backup

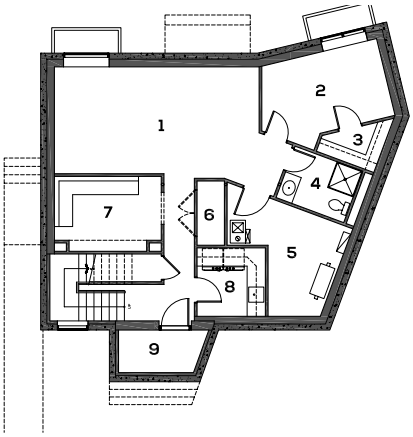
**Water heating:**
3.27 EF hybrid heat pump water heater, 42% efficient drain water heat recovery

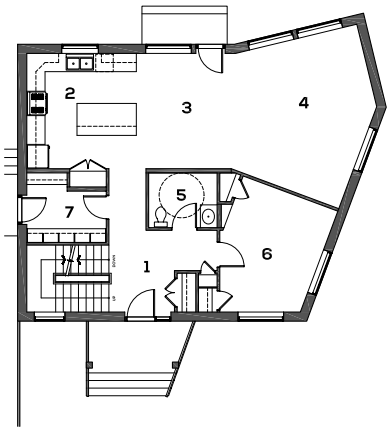
**Rated annual energy consumption:**
44.02 GJ
*This house consumes ~65% less energy than its reference house.*

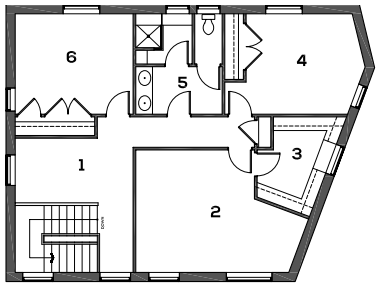
**Electricity generation:**
>10 kW solar PV system, 39 panels 275 W each, rated annual energy production: 45.02 GJ

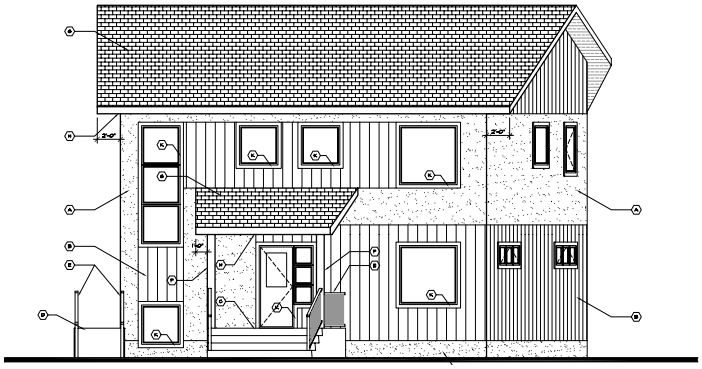
**Estimated net annual energy use:**
-1 GJ

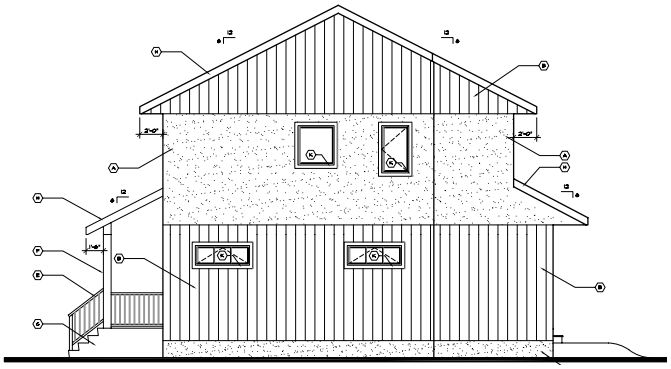
# The HOME

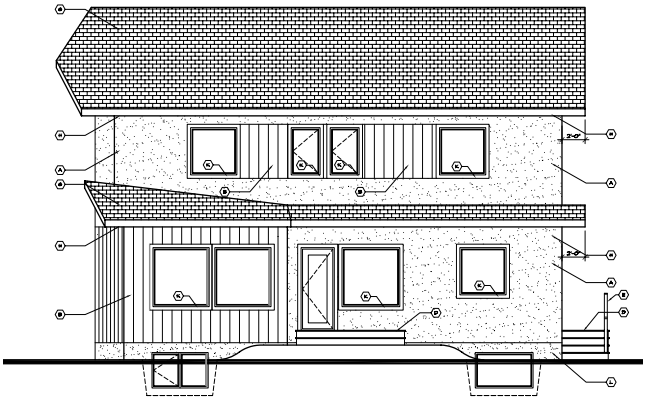


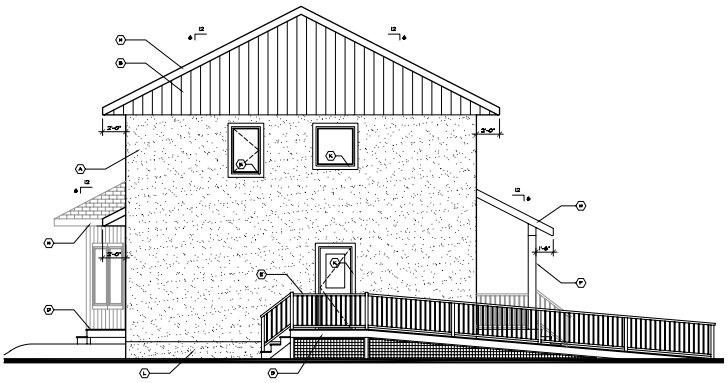









**Row 1** - *basement floor plan, main floor plan, second-floor plan*

**Row 2** - *front elevation, right elevation*

**Row 3** - *rear elevation, left elevation*

Note: Elevations may differ from the actual construction.

# Technical SUMMARY

| Habitat Studio, Edmonton, Alberta | | |
|---|---|---|
| **Site characteristics** | | |
| Location | Edmonton, Alberta | |
| Site type | Suburban, new development | |
| **Design conditions** | | |
| Occupants | 2 adults, 1 child[1] | |
| Heating degree days[2] | 5,120 | |
| **Building description** | | |
| Type: Two-storey single detached residence | | |
| Floor area (including basement) | 274.50 $m^2$ | |
| Heated volume | 762.10 $m^3$ | |
| Ceiling area | 93.14 $m^2$ | |
| Main wall area | 182.31 $m^2$ | |
| Total window area | 32.61 $m^2$ | |
| **Thermal characteristics** | **Effective** | **Nominal** |
| Roof | 14.91 RSI | R-80 blown cellulose |
| Walls: Main floor | 6.97 RSI | dense-packed cellulose R-40 |
| Basement | 1.37 RSI | 2” Type 1 EPS + R-22 Batt |
| Windows (average value) | 0.85 RSI | low-E, argon-filled, triple pane |
| Basement floor | 2.80 RSI | 4” Type 2 EPS R-16 |
| Measured airtightness level | 0.43 air changes per hour at 50 Pa | |
| **Building performance** (annual energy consumption)[3] | | |
| Space heating | 15.85 GJ | |
| Domestic water heating | 3.21 GJ | |
| Lighting, appliances and other plug loads | 22.99 GJ | |
| Mechanical ventilation | 1.55 GJ | |
| Space cooling | 0.42 GJ | |
| **Rated annual energy consumption** | **44.02 GJ** | |
| **Rated annual energy production**[4] | **45.02 GJ** | |
| **Net annual energy use** (consumption minus production) | **-1.00 GJ** | |
| | | |
| **EnerGuide rating (ERS)** | **0* GJ** | |

1. Occupant assumptions based on EnerGuide Rating System Version 15.
2. Heating degree days data from the National Building Code.
3. Building performance is modelled using HOT2000 version 11.2.
4. The rated annual energy production accounts for the contribution of eligible energy-producing systems. This house uses only solar photovoltaics as its energy-producing system for electricity generation.

*This house has been designed to produce more energy than it consumes on an annual basis.

# R-2000 standard pick list

## Indoor Air Quality

### IAQ 002 Millwork, cabinetry and countertops

All millwork, including trim, casements, baseboards, wainscoting and built-in cabinets, shall have low content of volatile organic compounds (VOC) as determined through ECOLOGO or GREENGUARD certification. Cabinets and vanities shall be made either from solid wood or manufactured wood products. If made from manufactured wood products, products shall meet either of the following criteria:

- Products must be made from urea formaldehyde-free fibre board or particleboard that meets the E-1 European standard or the HUD Standard, 24 CFR Part 3280.308.
- Products must have all exposed surfaces sealed with a low-VOC sealer as determined through Green Seal, ECOLOGO or GREENGUARD certification.

### IAQ 003 Flooring

*Carpeting and carpet cushion*

Except as noted, carpeting and carpet cushion used together in the house shall meet either of the following criteria:

- The carpet shall be labeled under the Canadian Carpet Institute's Green Label Plus Program, and the carpet cushion shall be labeled under the Carpet and Rug Institute's Green Label Plus Program.
- A non-Green Label carpet and/or non-Green Label Plus carpet cushion shall cover no more than 10 percent of the interior floor area including the basement floor area. Where carpeting is used in the basement, the basement slab shall be insulated with a minimum R-10, be heated, or have no direct contact between the carpet and concrete floor.

*Solid surfaces*

All solid flooring, such as bamboo, cork, laminate, resilient (sheet) stone, tile and wood, shall have low-VOC content as determined through ECOLOGO or GREENGUARD certification. Wood flooring shall be from a sustainable source, as determined through a third party under the Programme for the Endorsement of Forest Certification (PEFC) International or the Forest Stewardship Council (FSC).

*Note: Vinyl flooring shall not be used.*

*Underlayment*

All particleboard-flooring underlayment shall meet either of the following criteria:

- E-1 European standard or the ANSI A208.1-1993 Table B standard
- have all surfaces sealed with a sealer with a low-VOC content as determined through ECOLOGO or GREENGUARD certification or be pre-finished

*Flooring adhesives*

All flooring adhesives shall all have low-VOC content as determined through Green Seal, ECOLOGO or GREENGUARD certification.

### IAQ 004 Insulation

Rigid insulation materials and cellulose loose fill insulations shall have low-VOC content as determined through ECOLOGO or GREENGUARD Certification. Rigid insulation materials include extruded polystyrene insulation, polysisocyanurate insulations with or without reflective facers, expanded polystyrene rigid insulations and spray foam insulations. Fibrous insulations (e.g. batt and blanket type, loose fill or semi-rigid boards [fiberglass and mineral wool]) shall be formaldehyde-free, as determined through ECOLOGO or GREENGUARD certification.

## Energy Efficiency

### EE001 Energy-efficient appliances

An ENERGY STAR® certified clothes washer, dishwasher and refrigerator shall be included with the sale of the house.

### EE004 Reduced energy consumption of the house

Predicted energy consumption is at least 15% less than the R-2000 whole house energy target, as provided in Clause 5.1.2 of the R-2000 standard.

### EE005 Solar ready

The house shall be constructed in accordance with NRCan's *Solar Ready Guidelines for Solar Domestic Hot Water and Photovoltaic Systems*.

## Environmental Stewardship

### ES003 On-site construction waste management

Provide dedicated on-site bins for salvaging wood, cardboard, metal and scrap as part of a written, corporate, on-site construction waste management plan.

*NOTE: This requirement can also be met by third-party off-site waste diversion.*

### ES004 On-site construction waste management

Re-use construction waste on- or off-site, for example, by using land-clearing waste as mulch and/or grinding appropriate wood scrap.

**ES007** Use of wood from sustainably managed forests

Use wood building products originating from sustainably managed forests certified by a third party under the Programme for the Endorsement of Forest Certification (PEFC) International or the Forest Stewardship Council (FSC) for all main structural components.

## Water Conservation

**WC004** Irrigation systems

Landscaping systems shall be designed to not require irrigation, be irrigated with rainwater or domestic reclaimed water (in accordance to CSA B128.1-06 Design and Installation of Non-Potable Water Systems) only, or be irrigated by the following type of system. Should potable water be required for irrigation, irrigation systems shall include a low-volume, non-spray irrigation system (drip irrigation, bubblers, drip emitters, soaker hose) and a zoned irrigation system that separates turf and bedding areas.

## Resource Management

**RM001** Use of wood-conserving technologies

The measures below shall be used substantially (80% or more) for the given application:

a) use of at least four advanced framing techniques (Optimum Value Engineering) throughout the framing of the house from existing best practices, such as:

- 2x6 framing at 600 mm (24") on centre
- spacing roof trusses up to 600 mm (24") on centre
- two-stud corners
- single top plates
- elimination of jack studs and cripples
- engineered lintels and single headers, where possible

b) Use of finger-jointed framing lumber or engineered lumber.

**RM002** Use of wood-conserving technologies

Engineered floors are used substantially (80% or more).

**RM006** Exterior cladding

Use a rain screen system (i.e. one that separates the exterior cladding from the wall sheathing and includes a drainage plane).

**RM007** Roofing

Use roof cladding for pitched roofs that have a minimum durability of 35 years and are recyclable.

**RM008** Insulation

As a minimum, the product or combination of products chosen shall be used in the entire building envelope.

*Glass fibre* (batt, blanket, loose fill or semi-rigid type): be third-party certified to meet or exceed 70% recycled content

*Cellulose:* be third-party certified to meet or exceed 80% recycled content

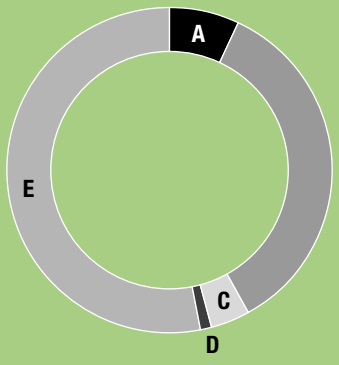
*Rock wool* (batt, blanket or semi-rigid type): be third-party certified to meet or exceed 40% recycled content

*Foam board insulation*: Extruded polystyrene insulation shall be third-party certified to meet or exceed 20% recycled content. Expanded polystyrene insulation and the EPS component in an insulated concrete form (ICF) shall be certified to meet or exceed 10% recycled content.

*Spray-on foam insulation*: be third-party certified to meet or exceed 5% recycled content

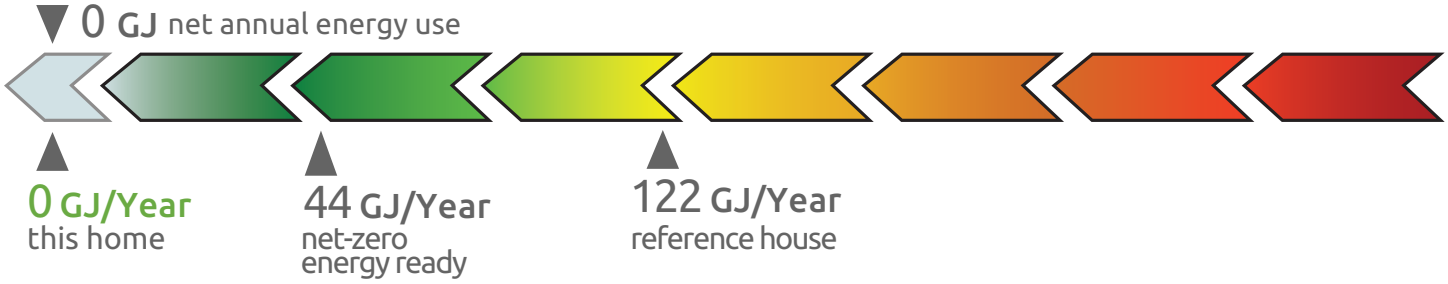
# The PERFORMANCE

## Energy consumption by usage




| | | |
|---|---|---|
| **A** | Water heating | **7%** |
| **B** | Space heating | **35%** |
| **C** | Ventilation | **4%** |
| **D** | Space cooling | **1%** |
| **E** | Base loads (appliances, lighting, etc.) | **53%** |

Home performance data provided by the occupant shows that this house can produce more energy than it consumes. Data received in 2016 shows that this home consumed about 35 GJ and produced about 39 GJ over a year, resulting in a net annual energy use of -4 GJ.






Cat. No. M134-57/5-2018E-PDF
ISBN 978-0-660-28474-3