Black Bank Hill

Energy efficiency from the foundation up

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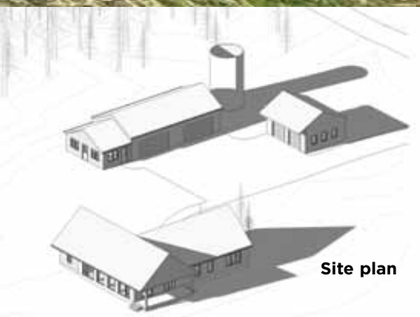


Site plan

The house at Black Bank Hill is situated in Ontario's Niagara Escarpment region on a high plateau overlooking the surrounding landscape. The owners – a retired couple who aim to live off the land – wanted a house that is energy efficient, comfortable, low maintenance, modest in size, and with a connection to place and the surrounding agricultural landscape.

➔ BY CHRISTINE LOLLEY

Building section

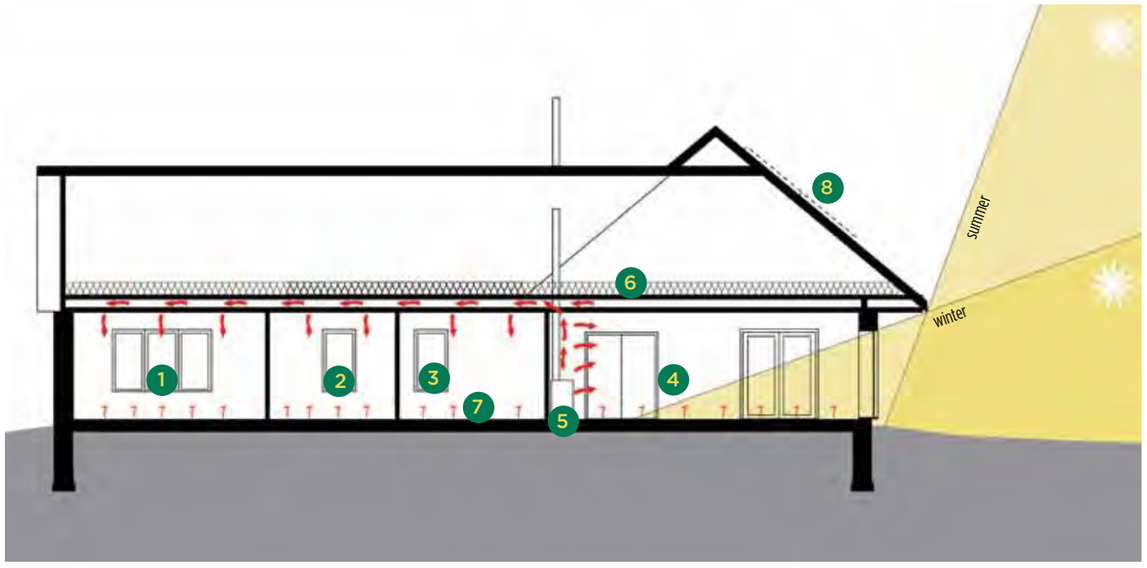
1 Master bedroom
2 B athroom
3 Bedroom
4 Great room
5 Wood stove
6 Ceiling plenum to circulate heat from stove
7 Electric in-slab heating cables
8 Future solar panels

There are a number of green home design highlights in this project, most notably our use of insulated concrete forms [ICFs] in the exterior walls made of 100% recycled cement-bonded wood fibre. They come in varying thicknesses and have a rigid mineral wool insulation insert. The decision to use this product was made very early on in the design process, and the shape and size of the walls were designed to make use of the full blocks with no need for cutting or re-shaping.

The house, seen here from the northeast corner, is situated on a large hill overlooking the Niagara Escarpment [1].

Floor plan N

1 Mud room
2 Stair to root cellar
3 Closet
4 Powder room
5 Mechanical
6 Kitchen
7 Pantry
8 Great room
9 Bedroom
10 Bathroom
11 Master bedroom
12 Study
13 Bedroom
14 Laundry room



WALL CONSTRUCTION

We designed the wall section using the thickest 14" blocks with the highest base R-value of 28, then augmented that insulation value to R-38 by incorporating a 1-1/2" layer of closed cell polyurethane to the outside of the blocks.

The full wall system we developed makes use of 2x4 wood stand-offs with bolts cast into the wall, around which is sprayed the foam insulation. 1x4 straps are then attached to the wood stand-offs, and the exterior siding is installed to the strapping, thereby creating an air space behind. On the inside, the drywall is screwed directly into the blocks. The rest of the house is insulated with R-30 under the slab and R-60 in the roof.

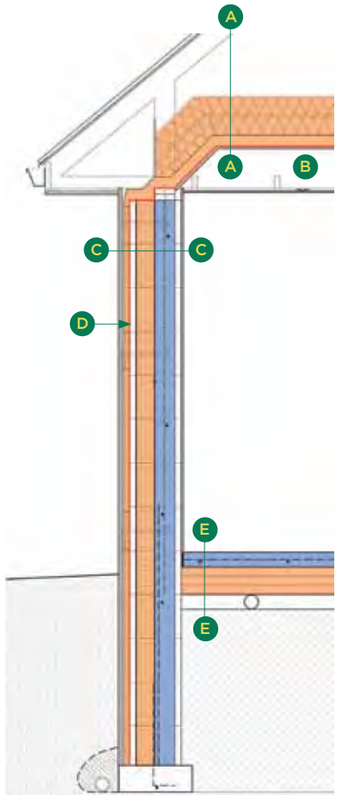
With the small exception of the 1/2" diameter metal bolts used to attach the wood stand-offs, the insulation in the Black Bank Hill wall section is consistent across the whole wall surface, creating a continuous air barrier. With traditional stick frame construction, the wood studs act as a conductor rather than an insulator, seriously reducing the effective R-value of the wall. Moreover, the blocks run all the way from the footings through to the roof trusses, eliminating the need for traditional foundation wall insulation.

INSTALLING SERVICES

As the home has no basement, we developed a unique solution to accommodate plumbing, electrical and other services in the ceiling. We combined a raised roof-truss with a drop ceiling to create a plenum space through which to run services.

Typically, roof insulation and vapour barrier are installed directly over the ceiling, which creates air leakage problems when punching holes through for lights, plumbing stacks and smoke detectors. In Black Bank Hill, however, the insulation is above the plenum space, so it is continuous and has only two penetrations: one for the wood stove chimney, one for the plumbing stack.

In complement to the highly efficient building envelope, an Energy Recovery Ventilator [ERV] provides ventilation. At 96% efficiency, it captures the heat and moisture of the exhaust air and maintains the freshness of the incoming air, providing warm and moist fresh air to the house with very little heating input required.



Wall construction

A ROOF ASSEMBLY
- Engineered roof trusses and 1/2" gypsum board on bottom chord, plastered
- 3" sprayed-polyurethane foam insulation on back of gypsum board [R20]
- 12" blown-in cellulose insulation [R40]
- 1/2" plywood sheathing on top chord, roof underlay, sheet steel roofing

B CEILING PLENUM
- Plenum space for lights, plumbing, and ducting for ERV and wood stove heat circulation system

C WALL ASSEMBLY
- 1/2" gypsum board screwed to 14" Durisol block with mineral wool insulation insert [R28]
- 2x4 strapping with 1/2" diameter anchor bolts cast into the concrete core
- 1-1/2" spray-applied polyurethane foam insulation [R10]
- 1x4 strapping and wood siding

D AIR BARRIER
- Continuous air barrier from roof to footing

E FLOOR ASSEMBLY
- Concrete slab on grade, polished, 10M Rebar grid at 24" spacing
- Electric in-floor heating cables
- 3 x 2-1/2" expanded polystyrene insulation boards, lapped and sealed [EPS] [R30]
- 4" stone on undisturbed non-organic soil

The Great Room has large south facing windows to capture solar heat gain [2]. The polished concrete floor slab helps to keep the house cool in the summer months. The high-performance windows and doors, with energy-efficient and durable fiberglass frames, were provided by Fibertec Windows and Doors [3]. The main door leads into a Mud Room that acts as an airlock to keep cold northernly winds from entering the house [4]. The steep south facing steel roof is the ideal spot for future solar panels. The R-60 roof was achieved with Climatizer Plus loose-fill fibrous insulation manufactured from selected paper stock that is chemically treated with non-toxic additives for fire resistance and retardation. [5].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The superior insulation and air tightness, along with the ERV, create very little need for mechanical heating and no need for cooling. What little heating is needed is provided in three ways:

➔**Passive solar design:** Three large, south-facing windows in the home's Great Room allow passive solar heat gain directly from the low-angle winter sun. The deep roof overhang inversely blocks the heat from the high-angle hot summer sun. The block walls and concrete floor slab help to store the sun's heat and release it slowly and evenly over time to maintain a consistent temperature throughout the day and night.

➔**Wood stove:** With the house situated on a wood lot, the owners were very keen to have a wood stove provide much of their heat. The stove's heat is distributed through ducts in the ceiling plenum by a manual-switch fan that draws hot air from the ceiling space above the wood stove and pushes it to the bedrooms in the cooler end of the house.

➔**Electric in-floor heating:** With such low heating needs, the payback on the capital cost of the mechanical equipment became the driving force of our decision-making process. Our clients opted for an electrical in-floor heating system that uses electric cables embedded into the floor slab with individual thermostat controls in each room. The total cost for this system, installed, was a fraction of what a hydronic in-floor heating system would cost. Although the operating costs associated with electric heat tend to be high, the system in this home is used rarely, that it proved to be the most cost-effective choice overall.

The Black Bank Hill house received an EnerGuide rating of 86, making it one of the most energy efficient homes in the country. Since completion in March 2011, the home's electricity use has averaged 30 kWh per day, amounting to about $100 per month [plus applicable taxes, delivery and debt retirement charges].

While a typical Canadian home consumes the same daily average, that figure does not include natural gas consumption for heating or hot water. The owners of Black Bank Hill have no gas bills so overall their home uses 65% less energy than a typical Canadian home! ❖

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Project credits

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