HI TECH IN A MOUNTAIN HOM

A progressive client wanted "comfortable living with minimal environmental impact." Keith Construction and Design delivered.

Design: Keith Construction and Design, Vernon, B.C. Construction Keith Construction and Design
Solar Array: Roost Solar
FutfHaus Earth Tubes: Trevor Butler
Photography:
House: Don Weixl
LuftHaus: Trevor Butler
Solar Array: Steve Russell

After a stuttering start, the owner of this high tech, nominally Net Zero home in Vernon, B.C. he calls his "Earth Ship," found himself looking for another builder when it became obvious the first builder chosen just "wasn't getting a feel for it," the "it" being incorporating into a remotely located house up the side of a mountain the most creative, progressive ideas available today in new home construction.

Ken Dahlen, owner of Keith Dahlen Construction, on the other hand, was up for the challenge. "You've got to look at it differently. People might say, 'Well architecturally, what is it?' but you have to look beyond the architectural to the concepts of, say, creating a solar roof and building the house into a hillside."

And not incidentally, you have to be willing to work continuously with the homeowner on virtually every aspect of the technology, including the crazy ideas for which most builders have little tolerance. For instance, during the planning stage, the owner had the idea of building a reservoir uphill from the house and generating hydroelectricity through small turbines as the water flowed to the house. With untypical patience, Dahlen says, "We did a cost analysis and told him it would cost more to pump the water up to the reservoir than was worth it." The idea was scrapped.

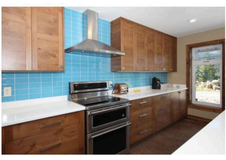
However, just about everything else you could think to build into an energy efficient home was included. The homeowner had "concepts" says Dahlen, and Dahlen worked with him to see them become reality. One of the first was to build the house right in to the mountain so the north, east and west walls were inside the mountain and only the south facing facade was exposed.

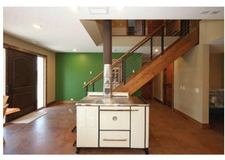
Dahlen and his engineers ran some numbers and showed that the homeowner could achieve 95 per cent of the climate smoothing effects he was looking for by burying only the back wall. The design was modified. The rest of the house is super-insulated, similar to Passive House construction. "The walls are double staggered 2 x 6 stud exterior walls with R 32, spray foamed the ceiling to R 60. The works," says Dahlen.

Heating and cooling

The heating sources start with the south facing window wall that allows massive amounts of natural light and heat. Next up in a hydronic system of in-floor heat on the first floor with the heat provided by a wood stove. With the super-insulated walls, it promises to be enough to heat the home, but there was also installed an Earth Tube system (see sidebar), a series of tubes run into the hillside that are used primarily to provide cooling in the summer but also when heating the house to reduce the gradient between the temperature of the outside air being heated and the inside air temperature desired, thus reducing the amount of energy used.

One of the innovative additions to the Tesla Power Wall lies in its advanced monitoring system. The owner can see energy production, output and efficiency in real time, all the time, anywhere there is an internet connection. So far the system is producing exactly what was expected, says Power Wall and solar array installer Steve Russell. "The winter production will drop off, but it is pretty easy to see it. And being higher up on the mountain helps the production," he says. Though the feed-in tariff is not as generous as that in Ontario, any solar energy produced but not used and pumped into the provincial grid will give the home owner credit on his energy bill.





Unfortunately, the B.C. codes have not yet caught up with the sophistication of these new forms of heat and require what it calls, "a primary source of heat" for which none of the above systems qualify. The simplest and cheapest solution to meet code was electric baseboard. "It will likely never be used," says Dahlen.

The power

The most dominant and obvious feature of the house is the solar array, which suppliers about 40.26 kW of power. The owner, being very passionate about solar, required the entire house to be designed around it. Then there is the 36-degree tilt of the due-south-facing roof, which is the most efficient angle for generating energy at the home's latitude. The steep angle also allows for snow to run off the panels easily, helping efficiency. The house was purposely designed with almost no roof obstructions: no stacks, vents, valleys or ridges to get in the way of the panels, and only one chimney. Even the installation of the panels was done in such a way that the they can be easily repaired, replaced or upgraded.

And unlike most solar installations, the power generated by the solar panels is delivered not only to the grid, but also to a Tesla Power Wall comprising two very large lithium ion batteries that put out 13.5 Kwh and powers the home in the event of a grid outage. The home is normally run first by the solar power sent to the Power Wall, then from the municipal grid. In the event of total grid failure, the Power Wall itself, fully charged and will no supplemental energy supply from the panels, could supply the energy needs for the house for about two days.

The water supply

The house also excels at water management. Toilets are low-flow and the plumbing is designed for planned installation of a greywater system that recycles water from bathtubs and showers to be used to flush toilets. Rainwater from the roof is channelled into in-ground drains which then flow into a 2,000-gallon cistern for use in irrigating gardens and landscaping. cc

Earth Tubes

This earth tube system, brand named LuftHaus in the case of this home, uses the stable temperatures underground to mitigate the fluctuations of the unstable air temperatures above ground. It is most effective in providing cooling in the summer, as the gradient between above and below ground temperatures is usually between 10° - 15°C. So, on a day where the air temperature is 30°C, the system can easily reduce the temperature to the low 20°s.

Unlike a geothermal system, the earth tubes don't need to be more than eight feet below the surface. Outside air is pulled though the underground tubes by the furnace, cooled, and then connected to the forced air system to cool the home.

In the winter, the reverse occurs, where the outside air is warmed as it is pulled into the house through the tubes and, though it is not enough to heat the house by itself, it provides warmer air for the furnace to heat thereby reducing the energy needed to bring the living spaces up to a comfortable temperature.

One of the attractions of earth tube systems is their low-tech nature. In some cases, the air is brought in to the home by convection and no mechanical help is required to circulate the air. Otherwise, the fan of an HRV unit or the furnace fan are enough. They system amounts to little more than buried tubes dropped in the ground during construction before the basement is backfilled.