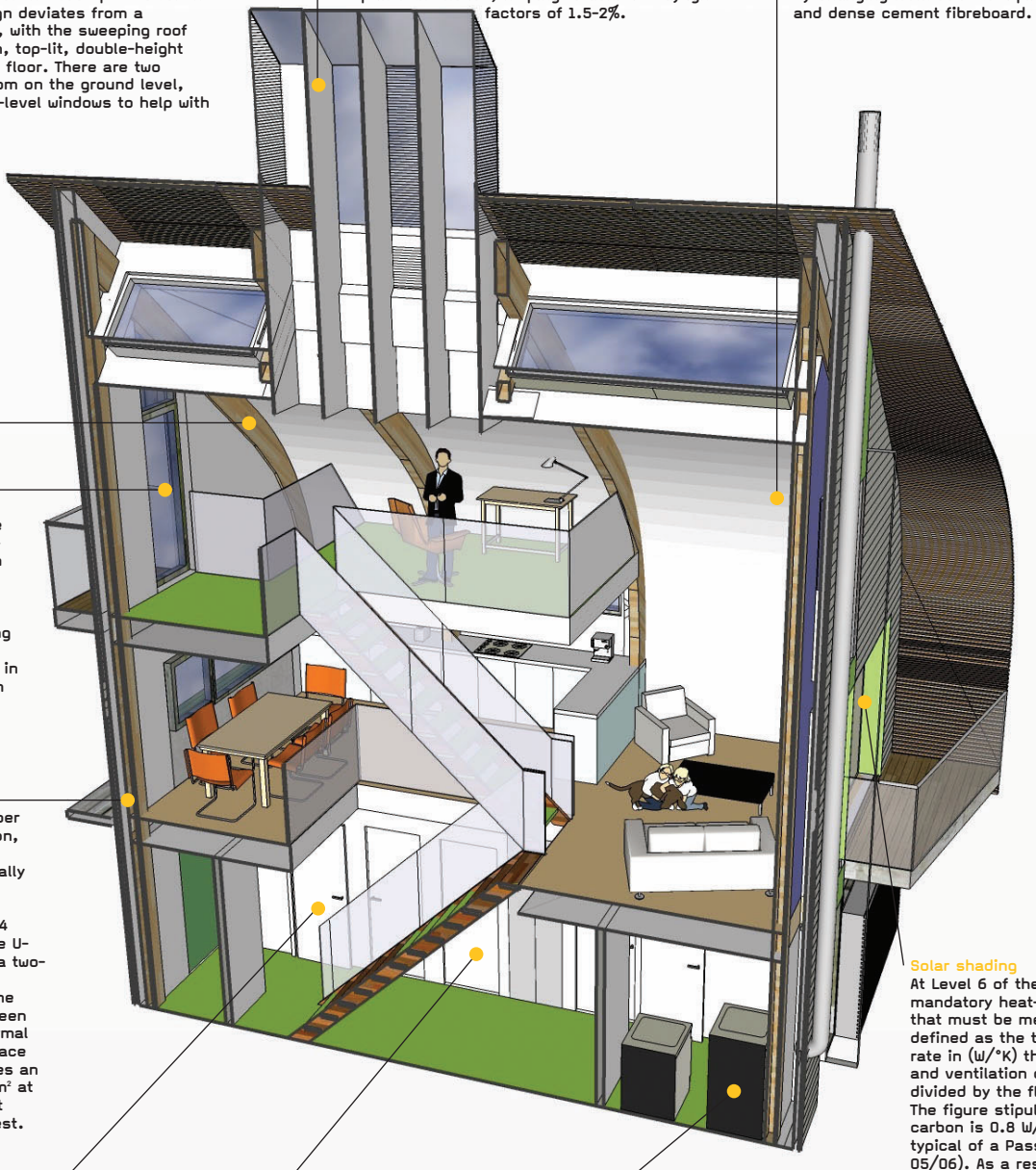
Structure
The structure of the house is a simple barn-like form, derived from a 40° roof accommodating a 46 m^2 PV array that has the potential to generate 4.7 kW of electricity and, it is estimated, will deliver about 3,600 kWh/year. That is enough to supply the electrical load for the lighting, pumps and fans and the estimated load from the appliances, as well as offsetting the 45 $kgCO_2/y$ associated with the production and delivery of the wood pellets for the space heating.The design deviates from a traditional house layout, with the sweeping roof enveloping an open plan, top-lit, double-height living space on the first floor. There are two bedrooms and a bathroom on the ground level, which make use of high-level windows to help with privacy.

Windcatcher
Located on the roof, above the central void over the staircase, is the windcatcher. When the louvres are opened, this single-glazed, chimney-like structure provides passive cooling and ventilation by harnessing prevailing winds and forcing them down into the house to disperse hot air. It also provides the ground-floor sleeping accommodation with secure night-time ventilation, as well as bringing daylight deep into the house, helping to achieve daylight factors of 1.5-2%.

Thermal mass
Some thermal mass has been introduced into the design to limit summer overheating and address future climate change. This takes the form of phase change material plasterboard for the ceilings – microscopic capsules embedded in the plasterboard absorb room heat by changing from solid to liquid – and dense cement fibreboard.



Glazing
N Tech Passive windows are used throughout the house. These are triple-glazed sealed units with low-emissivity coated glass and argon-filled cavities. They give an overall U-value (including the frames) of just 0.7 W/m^2K, a 54% reduction in heat loss compared with European Union recommendations.

Insulation
The building uses a timber portal frame construction, with walls and roof incorporating a structurally insulated panel system, Kingspan Off-Site's TEK Building System. The 284 mm-thick panels provide U-values of 0.11 $W/m^2/K$, a two-thirds improvement on current building regs. The building envelope has been designed to reduce thermal bridging to 4.5% of surface area. The house achieves an airtightness of 1 $m^3/h/m^2$ at 50 Pa, although it didn't reach this on its first test.

Solar shading
At Level 6 of the code there is a mandatory heat-loss parameter that must be met. This is defined as the total heat loss rate in ($W/°K$) through the fabric and ventilation of the building, divided by the floor area (m^2). The figure stipulated for zero carbon is 0.8 $W/°Km^2$, which is typical of a Passiv Haus (see *BSj* 05/06). As a result the ratio of glazing to wall is 18%, compared with 25-30% for a traditional house. Shading to the west elevation is provided by retractable shutters.

Mechanical ventilation with heat recovery
Background ventilation is provided by an electrically driven whole-house ventilation system. This has a specific fan power of 0.92 W/l/s (compared with a more typical 2 W/l/s) and provides 90% heat recovery.

Water
Water use has been reduced by installing a low water shower (8 litres/min), and taps, a dual-flush toilet (4/2 litres), a 160-litre bath, A++ labelled white goods and grey-water recycling for WC flushing. There is rainwater harvesting for the washing machine and irrigation.

Heating
The space-heating requirements for the house can be met by a 2 kW boiler. Finding an automatic wood pellet boiler small enough was a challenge. Instead, a 10 kW unit has been used. It is calculated that the wood pellet store will need refilling three times a year and the ash emptying once a year when the unit is serviced. The load on the boiler is partly reduced by a 4 m^2 solar thermal array, which is calculated to provide 2,940 kWh/y of solar thermal energy. This will provide about 65% of the hot water load. The estimated running cost of the wood pellet boiler is about £30/year.