

Earthship Brighton, Stanmer Park, BN1 9PZ

www.lowcarbon.co.uk



Overview

Age/period of house:	2007
Type:	Detached bungalow
Years in residence:	1
No of rooms:	5
No of floors:	1
Floor area:	125m ²
Cost	£330,000
Wall type:	Solid wall

Key words

+ passive solar design	
+ thermal mass	+ super insulation
+ photo voltaic panels	+ wind turbine
+ solar thermal panels	+ wood pellet stove
+ rainwater harvesting	+ grey water recycling
+ reed bed	+ low impact materials
+ natural ventilation	+ sun pipes

Introduction and approach

The Earthship Brighton was designed and built by the Low Carbon Trust as a project aiming to create a model low carbon house for use as a community centre at Stanmer Organics, Stanmer Park. Earthships are off-grid self-sufficient 'green' buildings, constructed using waste car tyres and other recycled materials. They use natural systems to provide all utilities – using solar energy and rain to provide heat, power and water. They are

buildings that heat and cool themselves, harvest their own water and use plants on site to treat their sewage.

Earthships enjoy the weather, regardless of season. If it's raining they catch free water, if it's windy they generate free power and if it's sunny they are capturing free heat and electricity. Apart from using all the resources immediately around them they also employ extensive energy efficiency and water conservation measures, ensuring that the rainwater and renewable energy they harvest goes as far as possible. For more details of the project see www.lowcarbon.co.uk or the book 'Earthship: building a zero carbon future'.

Features

Energy efficiency measures

Earthship Brighton is a passive solar building which uses the sun to provide heating by a combination of solar gain, thermal mass and super insulation in the walls and ceiling. The building is orientated to face south with lots of glazing to maximise the amount of solar gain. The angle of the front glass is 22° and was calculated to allow for maximum amount of sunlight during winter months, but reflect away sunlight during the summer months when the sun is higher in the sky.

The thick walls are made from rammed car tyres and earth and store the sun's heat entering the building, which is slowly released during the night and colder days and seasons. Essentially, this means the thick walls act as a storage heater, and this effect is exactly the same as the heat you can feel emanating from a stone wall in summer on a sunny day. Behind the tyres and earth is the 'thermal wrap' or insulation blanket that separates the mass from the earth that is sheltering the building. The roof void has lots of insulation in it and is super-

insulated, that is insulated above and beyond building regulations.

The windows are high performance double-glazed units and are made by Saint Gobain. The external glazing is 29.5mm deep: 7.5 laminated safety glass, 16mm argon filled gap with Swiss spacer between the panes, 6mm Planitherm Futur N 'low e' glass. Sun pipes and skylights provide extra daylight.

Renewable energy

Earthship Brighton uses energy that flows freely and abundantly from nature for space heating as described above, but uses other technologies to supply hot water and electricity. Effectively this means that for these activities the earthship is zero carbon and there are no utility bills! There are four renewable technologies used with a combined generating capacity of 20kW: an array of photovoltaic panels and a wind turbine for electricity and solar thermal panels and a wood pellet stove for hot water.

The systems are:

Photo voltaic – 18 x 62W Unisolar solar electric panels with a peak output of 1116W. These panels were chosen because they are very durable and work well in the diffuse light of the UK.

Wind turbine – 900W Whisper wind turbine.

Solar thermal – 2 x 2m² Filsol Stamax solar thermal panels, chosen as they are very robust.

Wood pellet stove – 15kW Extraflame stove which can also be used for backup space heating in Winter.

It is estimated that the solar thermal system generates 1,636kWh of hot water a year. At the moment the output from the other systems has not been quantified.

Water

Rainwater harvesting

Earthship Brighton has no mains connection for water and harvests all the water it needs from the sky. The concept is that water is harvested, filtered and then used and 'reused' four times within the earthship water system. First rainwater is captured and then purified to a level safe to drink or wash with. Secondly the wastewater that flows from all the sinks and showers, greywater, is used to water the plants in greywater planters that clean the water. The third use is for the toilet flush and lastly as blackwater or sewage, the wastewater feeds reeds and plants to be treated back to harmless water. Whilst the water here isn't literally used four times the point is that the system reuses water as many times as it can.

The rainwater is collected, used and treated on site, and the area of the roof coupled with the average annual rainfall for Stanmer Park means that it can harvest around fifty thousand litres (50m³) of water per year. This amount is around the same that one person in

the UK on average uses every year, the average being 150 litres per person per day. With extensive water conservation measures in place this is more than enough to provide all that is needed in the community centre.

The size of the storage tanks is much larger than most domestic rainwater harvesting systems. Most rainwater systems are only designed to store 4,000 – 5,000 litres in total, as a mains water backup, if needed, can charge the tank for when the volume of water in the tank falls below 5%. In Earthship Brighton there is no mains water backup, so there are four Eco-Vat tanks, with each having a volume of 5,000 litres, which are linked in series to create a total storage capacity of 20,000 litres. This, coupled with other water conservation measures, is enough for two to three months supply based on average annual rainfall patterns for the Sussex area.

The rainwater is drawn down by gravity from the underground water tanks to the Water Organising Module (WOM) to be treated to two standards: potable and non-potable. The two-stage filtration process reflects the fact that most of the water used in domestic and commercial buildings doesn't need to be purified to a drinking water standard. The water is then supplied to the sinks and shower.

Greywater recycling

In the earthship the first use of water is in the sinks and shower, all sinks have a hot, cold and drinking water tap. The wastewater, or greywater, that is generated flows through grease and particle filter into a rubber lined greywater planter or botanical treatment cell. This lining creates a closed area that becomes its own eco-system that adapts to the treatment of wastewater. There are various designs for grease and particle filters, but the simplest is a nylon stocking clamped over the end of the pipe, which will need changing once a month or so depending on use. A stainless steel clamp is used for all fittings in the planters.

The greywater planters are designed to recycle greywater through a variety of natural processes, such as transpiration, evaporation, oxygenation and through the rhizosphere or treatment by the bacteria that live around plants' root systems. These processes deal with the various constituent parts of greywater, by consuming the suspended solids and reducing the bacteria level, the grease and fat having already been removed by an earlier filter. It is recommended that 2.33m² of planter is needed for each plumbing fixture. Earthship Brighton has a kitchen sink, bathroom sink and a shower; this means that the minimum planter area of 7m² would be required. The two greywater planters, located in the conservatory and meeting room and linked in series, have a combined area of 12.75m², which means that 10% of the useable floor space is lost to greywater treatment.

The planters are made up of layers of up to 450mm of 20mm pea shingle, 75mm sand and 150mm of topsoil. This structure is a growing medium and stabilising environment for the plants and maximizes the opportunity for them to 'encounter' the greywater. The

level of the greywater comes up to the height of the pea shingle, effectively forming a greywater table with the sand keeping the soil from clogging up the gravel. The greywater planters are located next to the south facing windows, creating a very beneficial environment for the plants that thrive in the nutrient rich greywater and sunlight. In summer, as the plants grow, they offer increased shading from the intensity of the sun and in winter can be cut back to increase the solar gain into the earthship.

The 'recycled' water is then stored in a well at the end of the grey water system until it is pumped into the low dual flush toilet cistern. Any wastewater from the toilet, 'black-water' or sewage, is discharged from the building to a settling tank, before the liquor overflows and is treated a horizontal flow reed-bed. At the end of the reed bed the water is harmlessly returned to nature.

Materials

Earthship Brighton uses lots of low impact materials, from reclaimed wood and stone to cans and bottles. Over 20 tonnes of reclaimed and recycled building materials were used in the project, including 1,000 used car tyres, 2 tonnes of cans and bottles, 1,500 cardboard boxes, 90 reclaimed granite blocks, 4 tonnes of granite and marble offcuts, 35 reclaimed paving slabs, 150m of reclaimed floorboards, five reclaimed doors and lots of other salvaged timber.

The basic building block of the earthship walls are used car tyres. The UK throws away over 48 million of these annually and they are now banned from landfill. The technique is simple. Roll the tyre up to the site, line it with cardboard, fill it with earth and 'ram' the earth down with a sledge hammer until the tyre is fully inflated. All tyres are worked on in situation and 'pounded' a course at a time. With 1m of rammed earth behind them they create thick walls of thermal mass. Finally the tyres are rendered over with mud, adobe or cement.

Future improvements planned

Fitting compact fluorescent energy saving lights throughout. At the moment there is LED lighting in 23 fittings, with each LED light using about 1W, but they provide a very low level of light. The compact fluorescents they would be replaced with are 11W each meaning that if all the lights were on together it would use 253W, which is less than three 100W old incandescent lights!

Things that might have been done differently

- Installation of a multi-fuel wood stove instead of a wood pellet stove. Although it would be less efficient, it would enable a wider range of wood fuels to be used such as logs as wood chip from Stanmer Park.
- Use of more solar electric panels rather than a micro wind turbine, as the amount of energy harvested from the wind turbine is small. This is a common problem with micro wind turbines, as wind at ground level tends to be turbulent and disrupted as it flows around obstacles. This means that the amount of energy that can be collected tends to be low. On the other hand the photovoltaic panels at the earthship are performing well and generate a lot of power.
- Use of less concrete in the building. The use of a lower impact cement, Eco cement, was pioneered in the building and used throughout in the floor slabs, but using lime based renders could have replaced the cement render that was used on the walls.
- The level of insulation in the ceiling is around 600mm. This is excessive and studies suggest that 300mm is sufficient.

Professional contacts

Earthships – www.earthships.net

Earthwise Construction website – www.earthwiseconstruction.org

Low Carbon Trust – www.lowcarbon.co.uk

Southern Solar website – www.southernsolar.co.uk/

Materials

Rainwater system – <http://www.polypipe.com/polypipe/controller?action=PP-Residential>

Saint Gobain – www.saint-gobain.co.uk/

Sun Pipe – <http://www.monodraught.com/>

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