A Local Eco House Renovation

This series of articles follows the renovation of a local non-listed 1850s house to be close to carbon 'zero'

PART 3: GROUND SOURCE HEAT PUMP: USING THE ENERGY UNDER OUR FEET

A major decision for Debbie and Mike's renovation was to decide how to heat their home. As with all the decisions, sustainability was a key criterion. There are totally sustainable boilers which use only wood fuel, or 'nearly' sustainable heat pump options which use stored energy in the air, ground or water. They are deemed 'nearly' sustainable because some electricity is used to harvest the energy. As D&M had opted to generate their own green electricity, the heat pump was a good option.

The heat pump principle is well-known in its smaller form, the refrigerator in our home. The big difference between a heat pump and a fridge is scale. As the fridge works, energy is removed from the food inside the fridge and ejected at the back of the appliance as heat. In a heat pump, this is reversed. Heat energy is taken from outside the home and this warmth is 'ejected' into the house heating system. The outside heat source is chosen from what is available to harvest. The very best heat source is a large lake or river, but few of us can boast one of those in our back garden! Next is the earth beneath us and lastly, the air. Water and earth are the best options as heat pumps using these sources are more efficient (less electricity is used to harvest the stored energy).

So how does a ground source heat pump harvest the energy in the ground?

At one to two metres below the surface, the temperature varies between 14 °C in summer and 5 °C in winter. Large-bore plastic pipes are run in trenches at least a meter below the surface. These trenches can take up a lot of space. For a well insulated house, 2 to 3 times the floor area of the house is needed for the ground collector. For example, a 100 m^2 home will need between 200 - 300 m^2 of collector; two 150 m loops of pipe. To save space the pipes can be run in coils or 'slinkies'. The collection of energy is not quite as efficient as in a simple loop of pipe.

The alternative is to drill boreholes 60 to 100 m deep. This is great for places where space is at a premium, but it is more expensive to install. Both options use the same collection method: Water/antifreeze mix, or brine, is pumped through pipes in the earth. The brine picks up energy from the ground and this energy is then used by the heat pump to heat water in the house heating system. The great part is that for every unit of electricity used to run the heat pump, the ground donates another three units of free green heat energy. The eco-house heat pump uses 2.4 kW of electricity to deliver over 10 kW of home heating.

Heat pumps work best when running at much lower temperatures than boilers (say 40 °C for a heat pump compared with 80 °C for a conventional boiler). For this reason insulation in the house must be to a high standard before considering a heat pump as your main source of space heating.

House radiators will need to be about 30% bigger when run off a heat pump compared to an oil, gas or wood burning boiler to compensate for this lower temperature.

The eco-house opted for under-floor heating (as shown above). This method of heating warms the body from the toes up, so we feel warmer, and the thermostat can be lowered 1-2 degrees for the same comfort level.

Heat pumps can also be used to heat domestic hot water. However, the maximum temperature they can manage is about 55 °C. In most systems, an immersion heater will be needed to top-up the water temperature to over 60 °C once a week, to prevent the growth of legionella.

The eco-house took another route: Rather than having a conventional hot water tank for showers, taps etc., a thermal store was fitted. A thermal store is a big, very well lagged tank (pic 3) that contains a corrosion inhibitor liquid. It is heated by the heat pump. To get hot water from the taps, this liquid is circulated through a device which instantly heats the cold mains water to hot water temperatures, using the energy in the thermal store.

The beauty is that no potable hot water is ever stored; so no legionella!

Cooler liquid at the bottom of the thermal store is circulated through the under-floor heating pipes to keep the house toasty-warm.

Some points to consider when choosing a heat pump:

- **Basics** Badly insulated homes will not be efficient to heat, insulate first
- **Initial cost** Air-source is cheaper than ground-source
- **Efficiency** Ground-source is better than air-source
- **Noise** Both noisier than a conventional boiler; air-source must be outside, so consider neighbours too
- **Ground Collector** Do not scrimp on this, too much is better than too little
- Do not have underground joints, nightmare to fix leaks

Next time: Solar Thermal Energy; taking a sun shower