Greening energy use in a 1922 rural cottage in Yorkshire

Prof Nick Cowern Oct 8 · 5 min read

A few years ago I moved to a small cottage tucked into a south-facing slope of the North York Moors. The house had solid walls, single glazed windows, a coal fireplace, a reeky old oil tank and boiler, and of course no connection to the gas network. Just plenty of sunlight, trees and fresh air… and the building constraints of a conservation area in a UK National Park.

As an academic interested in and concerned by climate change I wanted to end my dependence on fossil fuels, and to do so as cheaply as possible. The coal fireplace went pretty quickly, replaced by a wood burning stove, an intention to use only sustainable, well-seasoned, locally-sourced wood, and a firm decision to minimize use of that oil-fired boiler!

To reduce energy use — the house's Energy Performance Certificate had a rock-bottom performance level of G — I installed secondary glazing to the largest windows, fixed the obvious draughts, checked the loft insulation, looked at solid-wall insulation and thought 'no thanks', and got on with life.

Then, during my second summer at the house, the oil boiler failed, permanently. I went rapidly into learning mode, searching the web for alternatives. What came up repeatedly was the idea of installing an air-source heat pump and upgrading thermal insulation, but on the subject of heat pumps opinion was divided, many saying that they were too expensive and liable to fail. Then I met an installer — a real enthusiast — who changed my thinking. His experience and belief were that heat pumps were the future, and that that future had arrived. Costs were falling, reliability had become acceptable: we'd reached the point where heat pump tech was mature and could be trusted. So, I looked into the subject carefully.

As a scientist I knew that, even though we feel cold in freezing weather, there is actually still a rich resource of heat in that cold air. Remarkably, as heat is related to absolute temperature, the heat content of air at 0°C is *only about 8% less than at room temperature*. Of course, out in the open air at 0°C your body is about 37°C warmer than the air, and that difference can pull heat rapidly out of your skin. But a heat pump doesn't have that problem. Operating on exactly the same principle as a fridge, an air source heat pump pulls heat from the air into a pre-chilled refrigerant fluid, then uses electricity to compress that fluid and pipe its absorbed heat, via warm air or water, into the home. The pressure on the refrigerant fluid is then released, chilling it ready for another heat pump cycle. This approach typically converts about 1 energy unit of electricity into 3–4 energy units of heat — a huge improvement on simple electrical heating, which gives only one unit of heat.

In the UK, most heat pumps are air-to-water devices, meaning that they take heat from air but use water to carry away the produced heat. This is a convenient way to supply heat to radiators or underfloor heating. As my house already had radiators I chose economically to stick with this arrangement, simply buying three high-output radiators, binning three of the smaller existing ones, and relocating some of the rest in the manner, David Attenborough might say, of a chain of Hermit Crabs upgrading their homes. The existing hot-water tank stayed, contrary to advice to install a larger one, and up to now has proved adequate for a household of two. On advice I installed a 12-kW rated heat pump — meaning that the heat output could be as high as 12 kW, though the electricity used to pump that heat would typically be about 4 kW. This turned out to be slightly more than I needed, as even during the coldest weather the system only calls on about 3 kW of electricity. Normal winter use in my house (when the wood stove has not been lit) is about 1–2 kW, making this system arguably cheaper to run than any other form of heating.

The heat pump installation took about four weeks of my installer's 'elapsed' time as he went about ruminating, calling the manufacturer occasionally, sharing coffee and kindly resolving the problems of other clients whose installations had been less successful than his. While this was happening I had the bulky external oil tank removed, revealing a pleasant area of back yard where none had existed before, and I summoned up the grit to take on solid-wall insulation. As my cottage is small, and in a conservation area, the insulation had to be internal and the usual method — building a 10 cm thermal barrier — would have taken up too much room space. Instead, I took my installer's advice again and put in a rather remarkable material called 'Sempatap', a dense latex foam backed with fine grade fibreglass which can be put up like wallpaper. It is 10mm thick, so has almost no impact on room size, but is able to cut heat losses through a solid wall by up to 30%. It is warm to the touch, and breathable. It is not an easy job to do but I knew a professional decorator willing to take on a challenge, and after some tribulations (the material supplied had a fault and needed to be scrapped and replaced at the manufacturer's expense) the result was perfect. After hanging the Sempatap the walls were cross lined (two layers of lining paper, one hung horizontally, the other vertically) and painted, and have kept the house warm and dry ever since.

Since then there have been more improvements, mainly to extend secondary glazing to all the house windows, and I will top up the loft insulation to 400 mm and insulate the floors. But for me it's the wall insulation and the heat pump that have made the main difference in terms of comfort, running costs, and satisfaction.

One last thing. In an electrically heated house, electricity tariffs take on a new significance. For many the best available tariff in future will be one that responds to the availability of plentiful cheap wind and solar energy by reducing its price accordingly. In the UK, one innovative, fast-growing energy supplier has pioneered this model by pegging its tariff to a small multiple of the wholesale electricity price that generators charge to supply the grid. That means that, when renewable energy is plentiful, the tariff drops and can even go negative, as happened several times this summer. You simply look up the expected prices over the next 24 hours, decide your electricity use according to price and need, and take the rewards. A couple of years ago I signed up for this tariff (called 'Octopus Agile') and have been paying much lower electricity bills ever since (an average of 8p per unit). I can heartily recommend it if most of your consumption is outside the peak evening period. With a heat pump, it almost certainly will be.