LOW-CO_2 HEATING

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Introduction

I have been asked more than usual recently " what heating system should I install in my new home?" There' s a degree of confusion, particularly given the UK government' s strange definitions of a " zero carbon home" On this, see my article last month and Sibylle and Brian Rushbridge' s article the previous month.

The Problem

One English district council now states in its planning policy: " ground source heat pumps are a zero carbon technology" . This is not correct. As I show below, with today' s technology, ground source heat pumps have similar CO_2 emissions to condensing boilers.

Electric Heat Pumps

Electric heat pumps do not use " free renewable energy" , still less geothermal energy - an example of geothermal energy is the hot water which bubbles up to the surface in cities such as Bath. What they do is utilise electricity, which is high-grade energy, generated in a power station at 30-40% efficiency, to pump heat from a low ambient temperature up to a higher, more useful temperature.

An analogy is a domestic refrigerator. Its motor consumes electricity to pump heat from a low temperature; i.e., inside the refrigerator, to a higher temperature; i.e., the kitchen. The cold surface inside the fridge is the evaporator; the warm coil on the back of the fridge is the condenser.

If a ground source heat pump is used to heat a house, its evaporator would be buried in the garden and its condenser would be located inside the house and heat the water needed for space and water heating. A device to heat a house needs larger evaporators and condensers than a device to cool a domestic fridge but the principles are unchanged.

A heat pump can pump up more than one unit of low-grade heat to a useful temperature, using one unit of electricity, and the ratio of heat output/electricity input is called the coefficient of performance (COP). Some manufacturers claim COPs of 4.0 or more, although I know two ground source heat pumps which have been monitored in the last decade and have had measured COPs of 2.4.

Costings

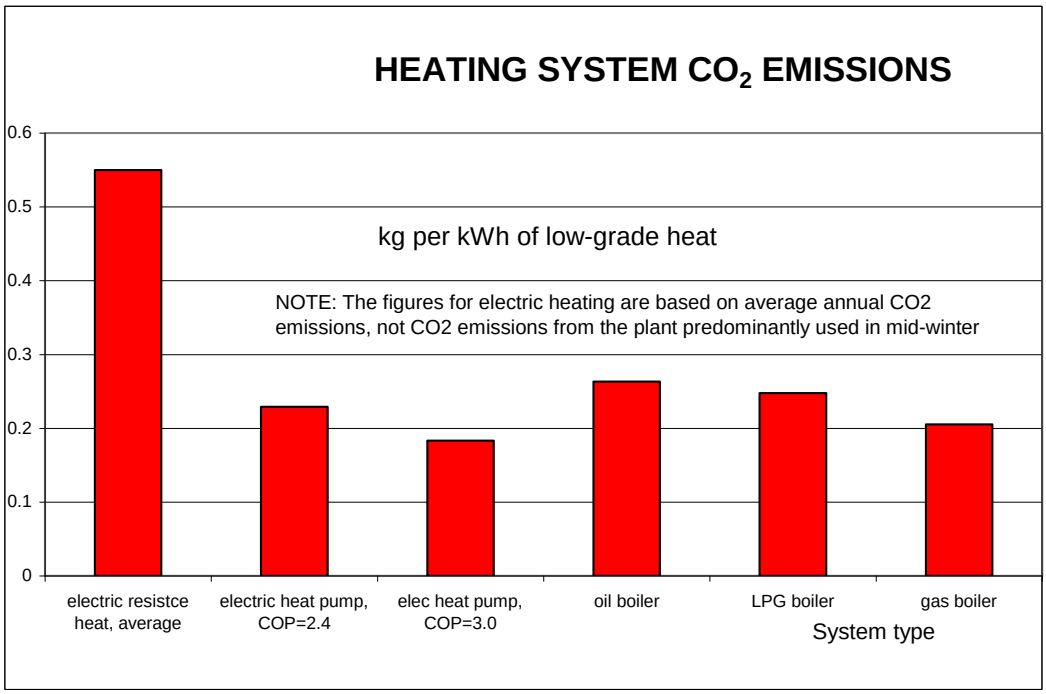
Costs can be reduced if you do some of the work yourself to bury the evaporator coil under the garden, but you are unlikely to obtain a heat pump quote matching the installed cost of an A-rated condensing LPG, oil or gas boiler; i.e., roughly £2,000. The heat pump will cost several £1,000 more.

CO_2 Emissions

Figure 1 shows greenhouse gas emissions in kilograms of CO_2 per kilowatt-hour of low-grade heat for five different heating systems:

1. electric resistance heating;
2. electric heat pumps, with a COP of either 2.4 or 3.0.
3. gas, LPG and oil condensing boilers.

Figure 1. Relative CO_2 Emissions from Different Heating Systems.



Owing to the inefficiency of electricity generation, electric resistance heating has the highest CO_2 emissions. The heat pump with a COP of 3.0 emits slightly less CO_2 than a boiler. The heat pump with a COP of 2.4, as measured, emits more CO_2 than a gas boiler and almost as much as LPG or oil boilers. (And if the money saved by fitting oil or LPG instead of a heat pump was spent instead on insulation and airtightness, the resulting house might have lower CO_2 emissions than the house with the heat pump - yet both houses would have cost the same to build.)

Also, the power stations which are used to supply electric space heating, in winter, include a lot of coal-fired plants, which produce more CO_2 than gas or nuclear plants. Altogether, on CO_2 grounds, there' s definitely not a lot to separate present-day heat pumps from condensing boilers - except cost.

Recommendations

Barring exceptional circumstances, I regard a COP of less than 3.0 as likely at the present time. It will be poorer if you have an energy-efficient house, which has a higher ratio of water heating to space heating energy. Heat pumps produce hot water at a lower COP, because the heat has to be pumped up to a higher temperature than it does for underfloor heating or for oversized radiators.

It is likely that you could spend the cost difference between a boiler and a heat pump on better insulation and airtightness and thereby save more CO_2 than if you had put your money into the heat pump. You should assess this carefully.

In my experience, once you have exhausted the potential for insulation, airtightness, passive solar and daylighting, the first renewable to consider at that stage is probably active solar, which can supply more than 50% of your water heating. However, this use of active solar would accompany a condensing boiler, not a heat pump.

Do not be influenced by UK grant aid for particular technologies. It is arguably better to miss out on a few grants and do the right thing. There are many worthwhile technologies for which the UK provides no support: *inter alia*, passive solar, daylighting, very high insulation and extremely high draughtproofing standards.

These four technologies are better recognised in Germany and Austria; anyone in Germany who builds a certified Passive House can obtain a 30 year fixed rate mortgage at an interest rate of 3.4%/year. I suggest that Germany has its priorities right and we don' t.