Air source heat pumps: do they work? Yes they do!

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There has been a steady stream of negative press in some quarters of the press recently – so much so that I wonder who is actually pushing this agenda – then I remember that there is still a massive fossil fuel lobby.

So here is a quick summary of heat pumps and why they are the future.

Let's start with the basics; heat pumps have existed for over 100 years, that is because the most common form of heat pump is the humble refrigerator. A heat pump is simply a device that moves heat from one place to another, in the case of a fridge the heat is being removed from the fridge interior and rejected into the room, in the case of a heat pump as a home heating system the heat pump takes heat from the outside air (even air at low temperatures has heat energy in it) and amplifies this to produce heat that be used to heat your home.

So some key things to point out:

1. It is important when looking at options for home heating to break down the system into its constituent parts, these are:
    a. The heat source or boiler
    b. the heat distribution system i.e. the radiators or underfloor heating
    c. the control system i.e. timers, room thermostats and thermostatic radiator valves (TRVs)
    d. Ventilation is also an important consideration for the comfort of your home but is not covered here
2. Heat pumps generate heat energy very efficiently – they produce 3-4 times the amount of heat energy versus the electrical energy they consume. This is referred to as the Co-efficient of Performance or CoP of the heat pump. This CoP varies depending on the temperature of the output (flow) water (to the radiators or underfloor heating) and the outside air temperature. Generally the lower the flow temperature and the higher the outside air temperature the better the CoP. To give a more meaningful figure for the complete year an average seasonal CoP (SCoP) if often quoted. The range of 3-4, stated above refers to the SCoP.
3. Not only do heat pumps produce the required heat, they do so with a vastly lower CO_2 emission than a gas or oil boiler. Today some of our electricity is still generated with fossil fuels so each unit (kWh) has some carbon emission but nevertheless a heat pump produces only a fifth of the carbon emissions when compared to even the most efficient boiler. As more wind and solar power comes on stream the carbon intensity of a unit of electricity will fall further (the government's target is net zero electricity by 2035) and heat pumps will then become zero carbon.
4. In economic terms the cost of a unit of electricity is higher than the cost of a unit of gas or indeed a litre of heating oil (approx. 11 kWh of chemical energy). Recently the price of a unit of electricity has been about 3 times the cost of a unit of gas, however this ratio does vary and as gas prices fall the ratio is increasing. However gas and oil boiler are not 100% efficient – the best gas boiler is ~90% efficient and for oil the figure is closer to 85%. If your current

gas consumption is 12,000 kWh per year and you have a 90% efficient boiler then a heat pump could save you money on your energy bill (see appendix A for an example calculation).

5. With big suppliers such as Octopus and British Gas offering to fit a heat pump for a medium size home for £500 (including the £7500 Boiler upgrade Scheme grant) a heat pump could pay for itself in just a few years. The government has also stated that it will start moving some of the energy transition surcharges from electricity to gas so the relative price of electricity will fall compared to gas meaning payback could be even quicker.
6. Heat pumps are most efficient if you run them at a lower flow temperature, this is why you sometimes hear the myth that they do not work in older or poorly insulated houses or that you have to fit all new (bigger) radiators. Many heat pumps will produce heat at high flow temperatures similar to a gas boiler (~70degC) but this is not efficient and so a different approach to heating your home might be required. Incidentally if you have a high flow temperature set on your gas boiler then your boiler is also not running optimally. If your gas boiler is less than 15 years old then the chances are, that it is a condensing design which requires a lower flow temperature (closer to 60degC) to promote the condensing function that can add 10% to the gas boiler efficiency. See https://sustainabledanbury.org/blog.php Improving your boiler efficiency).
7. Slow and low: Your house losses heat through walls, roof, windows etc at a constant rate which is proportional to the temperature difference between your house and the outside. If you only have your heating on for a short time each day you will need a very powerful boiler and to run your radiators very hot to get sufficient heat into the house to maintain comfort. This can lead to large temperature variations in the internal temperature and can also lead to condensation and mould as well as premature aging of the boiler. With lower flow (and therefore radiator) temperatures your heating may need to be on for longer as the heat energy released per hour will be lower. As long as the heat supplied by the heating system matches the heat loss over the whole day the house will stay comfortable. If this sounds complex then the good news is that modern control systems take care of keeping your home comfortable. See Appendix B for more information on radiator temperatures.
8. Before you have a heat pump fitted (and also if you have a new heating system of any sort fitted) the contractor will undertake a room by room analysis of the whole house to ensure that the radiators are correctly sized and that the heat pump is adequate for the application. Most houses have oversized radiators fitted so most of the time existing radiators will be sufficient.
9. There are two types of air source heat pump; a split system or a monobloc. In the case of the monobloc the complete heat pump system is located in the external unit and the radiator fluid flows to and from the external unit. In a split system there is also an internal heat exchanger which transfer the heat energy from the heat pump's working fluid (refrigerant) to the radiator fluid. A buffer tank can also sometimes be fitted to optimise the operation of the heat pump and prevent cycling (short duration on/off operation). Smaller heat pumps tend to be monobloc whereas larger capacity heat pumps are split systems.
10. Location of external unit – these should be close to the house (to prevent excessive heat loss from the heat pump to your central heating system). The ideal location is somewhere that is out of way but that allows plenty of air flow. A big part of the external unit is a fan which ensures that there is a constant source of new air passing through the device to ensure efficient heat extraction. A south facing location (where the air might be warmer) is preferred over a colder north facing one.
11. Noise: there are two sources of noise from a heat pump; the compressor and the air fan. Modern heat pumps are very quiet and produce a low level white noise, more like a steady

breeze rather than a harsh noise such as petrol lawn mower or vehicle. All heat pumps manufacturers publish the noise or more correctly the sound pressure level of their products – this is measured at 1m (metre) distance from the unit and is stated in decibels. However it is important to note that decibels or dB is not a linear measure. A noise increase of 3bB is actually a doubling of the noise level. Also noise levels decrease by 6dB for every doubling of the distance so if the heat pump is rated as 50dB (at 1m distance) then the sound pressure level at 2m will be 44dB and at 4m will be 38dB. Sound can reflect off hard surfaces so it is also important to consider the effect of walls and fences etc. Generally regulation require the unit to be 1m away from your boundary. A recent NESTA consumer survey suggest that noise is not a problem in practice.

12. Insulation: another myth is that heat pumps only work in modern super insulated buildings. As already described heat pumps produce heat, radiators distribute the heat throughout the building and then the heat is lost through the outer surfaces. Thus the heat pump selected must match the heat loss (and there are plenty of large heat pumps on the market). The point is that better insulation is recommended whatever heating source you have. You will consume less gas or electricity to maintain comfort in your house if it is well insulated. For most houses if you have double glazing, cavity walls (ideally filled with insulation) and have a double layer of insulation in your loft then that is a good level of insulation – if you don't have these then loft insulation and cavity wall insulation are very cost effective to upgrade. A basic upgrade of loft and walls should be done whether or not you change your boiler. Grants are available and this is discussed in the Energy Advice section of the website.
13. Heat pumps offset their Carbon emissions from manufacture very quickly (about 1.5 years) and much quicker than an electric vehicle (1500kgCO2 vs 8000kgCO2 for an EV). They are also made from plentiful materials such as iron, aluminium, steel and some copper.
14. If you are looking to significantly reduce your carbon footprint then fitting a heat pump is one of the easiest and most cost effective actions you can take.
15. Finally a word on hydrogen. There has been considerable press on using hydrogen as an alternative for Natural gas. However this is unlikely to ever be practical as to produce clean green hydrogen and then burn this in a boiler is very inefficient. See Appendix C.

Appendix A

If your current gas consumption is 12,000 kWh per year and you have a 90% efficient boiler, your actual heat demand is 12,000x90%=10,800kWh. If you had a heat pump with with a SCOP of 4 then you would consume 10,800÷4=2,700kWh of electricity. At the current gas (7p per kWh) and electricity prices (28p per kWh) a heat pump with a SCOP of 4 would save you £184 off your bills per year (this includes the £100 per year gas standing charge you would no longer need).

Appendix B

The temperature of your radiators is the average of the flow and return temperature, if you have a flow temperature of 60deg on your gas boiler this will typically be setup to return at 40degC (this is often referred to as a 20deg delta or difference) and therefore your radiators will have an average temperature of 50degC. With a heat pump the flow and return temperature difference is lower (5degC) and therefore a flow temperature of 52.5decC (return 47.5degC) will give the same average temperature of 50degC as with the gas boiler set to 60degC.

If you are concerned about your radiator heat output with a heat pump you could operate your boiler at a lower flow temperature to mimic a heat pump. I did this last year and operated for the entire winter with a 55degC flow temperature which is an average radiator temperature of 45degC (which is would be very efficient for a heat pump). I maintained an internal temperature of 19.5degC without any problem.

Appendix C

Using hydrogen in a boiler: To produce green hydrogen from green electricity by electrolysis results in a 68% efficiency i.e. 1kWh of electricity produces 0.68kWh of Hydrogen. If this is burnt in a boiler of 90% efficiency then this would produce 0.61kWh of heat energy. If you use the same 1kWh of electricity you can produce 4 kWh of heat (SCoP of 4) that is 6.5 times the amount of heat for the same unit of electricity with a heat pump.