Thinking about a Heat Pump?

With energy and climate change frequently in the news you may be thinking about converting from either oil or gas fired heating to a heat pump. This article aims to provide independent advice with local examples.

Background
Heat pumps use electricity to extract heat from the ground, water or, more commonly the air, with one unit of electricity producing 2 to 4 units of heat. As approximately 40%* of electricity is generated from renewable sources heat pumps are clearly a more sustainable form of heating than fossil fuels. As Air Source Heat Pumps (ASHPs) are the most common heat pumps, we consider only these in this article.

The Challenges

Capital Cost

Heat pumps vary in cost just like other household appliances, dependent on efficiency, noise levels and build quality. Capital costs are addressed in more detail later in the article.

Energy Costs

Even without the turmoil in the energy markets, running costs are extremely difficult to compare. Use will depend on the energy efficiency of the house, the size of the house, the number of occupiers, the input from solar panels and personal preferences.

The case studies below are from a variety of properties so that some energy use comparisons can be made.

It is useful to consider energy **use** as well as **costs** at any specific date as these are changing all the time. With an estimate of power used in kWh it is possible to estimate costs at a ‘spot’ date, taking account of current unit price of oil and electricity.

Comparing oil with electricity.

Electricity suppliers state your annual use in kWh, but oil is more difficult because it is not metered or measured in kWh.

The MCS $ (see background information at the end of the article for details of the organisation) adopts 8 kWh per litre of heating oil, taking account of boiler efficiency. Thus, if you use 1,500 litres of oil a year you use approximately 12,000 kWh on heating/water heating.

The MCS table below, published on 16.2.22, compares the cost of heating using a range of fuels at various prices levels.

Energy to heat property	GAS - per kW/h			OIL - per litre			LPG - per litre			ELECTRIC kWh			AIR SOURCE HEAT PUMP		
kW/h	5p	10p	15p	60p	80p	100p	60p	80p	100p	20p	25p	30p	20p	25p	30p
10000 kWh	610	1220	1830	747	996	1244	1099	1465	1831	2000	2500	3000	588	734	881
20000 kWh	1220	2440	3660	1493	1990	2489	2197	2930	3662	4000	5000	6000	1150	1439	1726
30000 kWh	1830	3660	5490	2240	2987	3733	3286	4395	5493	6000	7500	9000	1715	2143	2572
40000 kWh	2440	4880	7320	2987	3800	4978	4385	5860	7324	8000	10000	12,000	2300	2847	3417

Data extracted from MCS 031. Gas / oil typical efficiency 82%
MCs guide ASHP SCOP 3.55

Data extracted from MCS 031 - Gas/oil typical efficiency 82%, MCS guide ASHP SCoP 3.55. (see background information at the end of the article for more detail.)

As at April 2022 the Energy Saving Trust (EST) stated that the average price per kWh for gas was 7.9p, for oil 11.8p, LPG 15.5p, standard electricity 28.3p (plus 165.80 standing charge) off peak Economy 7 16.7p (plus same standing charge) **

Siting of unit

ASHPs should be sited on a southerly aspect if possible and must not be enclosed in a compound. Losses are reduced if the outside unit is adjacent to the house. ASHPs need good airflow to optimise performance. Whilst they can be landscaped out, it is essential that the exhaust cold air has room to completely dissipate. An ASHP sucking its own exhaust will become progressively less efficient. Although noise is no longer an issue for most pumps, check for your proposed model – see and hear one if possible. Appearance may well be an issue for both aesthetic and planning reasons.

Efficacy – Insulation, radiators/underfloor/solar

Heat pumps work best when operating at lower flow temperatures than fossil fuel boiler heating systems, so are well suited to properties with underfloor heating and good insulation. However, systems can be installed in older, more traditional buildings, even those with solid walls. It just requires high quality design and specification. Of course, all heating devices are more efficient if the systems are designed for low flow temperatures. In fact, a condensing boiler is a low temperature device and should be set to operate with a flow temperature of 55°C in order to optimise condensing mode operation.

To provide the same room temperature as achieved with an oil boiler it may be necessary to increase the size of radiators – typically by depth rather length or height. Some installers advise that you should wait until the system is in use rather than automatically upgrade all radiators, as it may not be necessary. Room-by-room heat loss calculations and a survey of your existing radiators should confirm what, if any, changes might be needed.

It will also be necessary to install a hot water tank if you have a combination boiler currently, unless you choose to retain the boiler for hot water only. If all fossil fuels are eventually banned, then you will need a solution for hot water that will almost certainly require a cylinder or thermal store of some sort.

Timing
The change from oil to ASHP is likely to take some time – surveys, availability of fitters, engineers, grant application, possible plumbing changes (increase radiator sizes, install hot water tanks etc). This means that you will need to plan and prepare while your boiler is still working, not when it or the oil tank fails. Most boiler replacements are "distress purchases", so best not to get into that situation.

Capital Costs

Heat pumps vary in cost just like other household appliances; dependant on efficiency, noise levels and build quality. Even the cheapest are currently more expensive than the equivalent traditional boiler, particularly if it is necessary to improve insulation, upgrade radiators and install a hot water tank. However, against the higher capital cost it is important to consider the life expectancy, servicing costs (see later section) and energy costs. A new ASHP **system** also includes a great deal of value in new pumps, valves, cylinder, etc., all of which will be more efficient than your old ones and which all come with new warranties. At the point where just the ASHP itself needs replacing, the cost is much closer to a boiler replacement.

Quotes may range widely. I received two ASHP quotes for a three bedroom house in Owlesbury in May 2022, one at £9,300 and the other £18,300. The latter was based on a detailed (albeit paper-based) heat loss estimate which took account of the 'E' level EPC rating, solid walls etc. Two points here: 1) you need to make sure that the property is properly assessed for pump sizing and 2) even a poorly rated property can be fitted with an ASHP, but at a higher cost.

Grant Available - The Boiler Upgrade Scheme (BUS) replaced the Renewable Heat Incentive on 1st April 2022. Installers have to register for a BUS account in order to be able to offer the grant. The installer applies for a voucher which is redeemed on completion of the installation to pay them the £5,000.

The scheme is limited to approximately 30,000 properties per year, but government is confident that this number will be sufficient, certainly to match demand in year one. If demand is high, then quarterly caps may be imposed on the issue of vouchers.

You can check on https://www.ofgem.gov.uk/environmental-and-social-schemes/boiler-upgrade-scheme-bus
and
https://www.ofgem.gov.uk/environmental-and-social-schemes/boiler-upgrade-scheme-bus/property-owners for full eligibility. For a start the property must have a valid Energy Performance Certificate with no outstanding recommendations for loft or cavity wall insulation – unless you have an insulation exemption. This is given where the insulation requirements are unattainable in view of the construction of the building, location in Conservation Area, Listed status etc. Full details are set out here, (complete with inaccuracies!) https://www.ofgem.gov.uk/publications/evidence-insulation-exemption

The Heat Pump Federation advises that if you have solid walls you do not need to insulate these or apply for an insulation exemption.

Lifetime costs – maintenance and lifespan.

Life expectancy will vary by manufacturer and the standard of maintenance, but some will operate for twenty years or more, according to the Centre for Sustainable Energy. Annual servicing is likely to be required by the manufacturer to maintain the warranty and as a condition of the Boiler Upgrade Scheme. Typical costs are around £150 pa and are likely to include:

1. Keep the area around the pump housing free from debris and vegetation. For peak efficiency, there must be free air movement around the unit.
2. Clear moss and leaves from the air filters and fan blades.
3. Inspect the air filters' condition, and clean or replace them when necessary.
4. Assess the condition of fans, compressors, and all electrical connections.
5. Check for refrigerant leaks.
6. Ensure the compressor pump starts correctly, and checks for excessive compressor starts.
7. Assess the run times for the pumps.

Programme for possible conversion to an ASHP

Obtain an Energy Performance Certificate (EPC) (typical cost £50 to £80 but make sure the assessor knows what they are doing, particularly if you have a period property) and review need for insulation upgrade or independent Retrofit plan (these can be organised by WINACC*** for £500 - £600 or £250 for Council Tax bands A-D)
Heat Loss Report and emitter (radiator) survey (could be by an independent engineer or by quoting installers)
Upgrade insulation, draught proofing, double glazing
Obtain quotes from MCS registered installers and check that they will obtain the Boiler Upgrade Scheme voucher.

Case Studies

It is very difficult to compare 'apples with apples' as each house has its own characteristics and technology, but here are some local case studies:

<u>Sam Dyson (Hambledon PC)</u>

Full case study to follow – but experience to date is that the property has an EPC 'E' Rating and it has been difficult to get a proper EPC. Rejected twice for the grant but the ASHP itself works well.

Martyn Kille (Hambledon)

"We live in a thatched house with a 950 sq ft ground floor area and slightly smaller first floor. Our electricity supply is Economy 7 and present annual consumption is 6800Kwh (Day 4300/Night 2500Kwh). I'm afraid I don't have pre Heat Pump figures for electricity.

We also have an oil fired kitchen range which we have kept (and provides some heat in the kitchen October to April) which uses about 750litres/year. Pre Heat Pump the central heating oil fired boiler and kitchen range together were using 1200litres/year. We also relied on an open log fire to supplement the heating.

We have been very happy with the heating system since the Heat Pump was installed and stopped having open fires. The controls are easy to manage and the heating can be adjusted easily."

(Also has solar panels but they make very little difference to heat pump cost – they produce 2,500 kWh pa.)

Tony Coates (Hambledon)

A 2.5 bedroom terraced house built in 1991 with an ASHP, 10 PV solar panels and supplementary electric heating. The house has an immersion water heater which is occasionally supplemented by energy from the solar panels. Mains electricity used 5,486 kWh pa and the solar panels produced 2,065 Kwh pa.

Meon Valley Resident – name withheld from article only

- "Cavity Wall Insulation – In summary we have had no problems with the cavity wall insulation and seen on average a 21% reduction in gas usage.
- Heat Pump Grant – The Government is currently offering a £5K grant towards the installation of a heat pump. In order to qualify for this grant all the 'basic' house insulation needs to be in place. For us this means cavity wall and roof insulation. Cavity wall insulation is complete and I am currently putting more insulation into the roof (requirement is for a minimum of 30cm). Once the insulation is complete we need to pay ~£100 to get an updated Energy Performance Certificate that we then pass to the company installing the heat pump who apply for the grant on our behalf.
- Air Source Heat Pump (ASHP) – We are planning to switch to an Air Source Heat Pump in September. The first step in the process was that the company we chose to do the installation came and did a full-house survey to evaluate heat loss in each room. A comprehensive report was produced showing where the existing radiators would be sufficient (the new system will run at a lower temperature) and where larger and/or additional radiators would be required. The report also recommended changing our hot water tank to a larger, better-insulated tank, and changing over to a pressurised heating system (which will do away with the need for a water tank in the loft).

In terms of costs, the £5K Government grant covers the cost of most of the goods (the Air Source Heat Pump, the fitting & pipework and the new hot water tank); we'll have to cover the cost of the new radiators plus all the installation costs from our own funds.

Before the recent energy price hikes, the running costs of the ASHP system were anticipated to be about the same as our existing gas boiler system. As electricity prices have risen less than gas prices, the running costs of the ASHP system should now be cheaper than a gas boiler (but will still be more expensive than before the price hikes)."

John Russell – Soberton (post war detached property)

"Our house has five bedrooms and has a gross internal floor area of approximately 3,214 SQFT/298.5 SQM. When we bought it in 2010 it had an Energy Efficiency Rating of D at 60. After a number of insulation and draught excluding measures completed a decade before the heat pump it is rated D at 65. Although the EPC says that it has the potential to be 79 (C), the additional measures would be highly disruptive and/or very uneconomic. Our EPC states "The average energy efficiency rating for a dwelling in England and Wales is band D". Therefore, our house even now is no better insulated than the average house.
We had a heat pump fitted in early January 2020. At the time, the heating and water heating electricity usage of the heat pump was estimated at 28,134kWh.

- We cook using electricity, which, along with all other electricity uses, such as refrigeration, is not included in this estimate. In 2019 I calculated the annual usage at 17,950kWh.
- The house is generally occupied by two people and we do not heat rooms we do not use.
- We have had solar PV since 2010, which provides most of our day time electricity for four months, apart from when cooking coincides with other uses.

It is not easy to calculate our usage as two of our electricity providers failed and we had a smart meter fitted in January, so that the prior readings do not correspond to the current readings.

Electricity use since the installation of the smart meter has been:

2022	**£**	**kWh**
January	227	1080
February	263	1241
March	180	839
April	170	553
May	73	210
Total	913	3923

The May figures have been extrapolated from the reading for the first nine days. The increase in the tariff to 28.46p/kWh and higher daily charge of 43.39p can be seen from a casual glance at the numbers. EDF estimated our annual charge would rise from £2,820.53 to £3,919.26 without specifying kWh usage.

I calculated that the total cost of the heat pump was £14,116, but the net cost after the RHI payments of £7,363 was £6,753. The RHI payments have since changed.

Our system has one pump outside of the house and one inside. This allows that system to produce water of 70°C for the heating and the hot water runs at 60°C. No new radiators were necessary and cost seems to be the only restraint on how warm we want the house to be on the coldest days."

(John points out that although the mains electricity use is reduced by his solar PV this does not greatly reduce heating costs as most solar energy is provided when the heating is off)

Catriona Cockburn - Petersfield (Set up Petersfieldcan.org, an environmental group)

"We have a 5 bed house (2 adults with and 3 children) EPC B. Yes I agree about the altruism with ASHP's but we have been pleasantly surprised by our bills. We have not seen the escalation in our bills like others have. We had an air source heat pump fitted in February and came off gas on 2.2.22. We do have 4KWp Solar PV (not so sunny in February) 2 x 2 KWh batteries and an EV. We use Good Energy (one of the Greenest but not cheapest). Our estimated annual electricity consumption is £7,099 kWh pa.

7th Feb. 2022 - 27th Feb. 2022 649.0 kWh

28th Feb. 2022 - 5th April 2022 1041.0 kWh

6th April 2022 - 30th April 2022 512.0 kWh

1st May 2022 - 22nd May 2022 310.0 kWh

23rd May 2022 – 19th June 2022 432 kWh

See also the Energy Saving Trust Case Studies**.** The Energy Saving Trust states that it is an independent organisation – working to address the climate emergency.

The DBEIS* has also just released these case studies from the Heat Pump Demonstrator Programme. https://es.catapult.org.uk/case-study/electrification-of-heat-case-studies-on-heat-pump-experiences/

The government has also launched this checker website:

https://www.heat-pump-check.service.gov.uk/

Summary

Even with the £5,000 Boiler Upgrade Scheme an ASHP is likely to cost more to buy than merely replacing an oil boiler but over the lifespan of the pump capital and repair costs are likely to be lower. Even older properties with poor EPC ratings can be fitted with pumps but start by improving the energy efficiency of your property and at least obtain an EPC.

Background Information/Bibliography

*Department for Business, Energy & Industrial Strategy 31.3.22

** energysavingtrust.org.uk/about-us/our-data - uses Ofgem's price cap for gas and electricity prices.

The Energy Saving Trust (EST) states that is an independent organisation – working to address the climate emergency.

*** WINACC Winchester Action for Climate Change

$ The Microgeneration Certification Scheme (MCS) is a standards organisation; their website states:

"We create and maintain standards that allows for the certification of products, installers and their installations. Associated with these standards is the certification scheme, run on behalf of MCS by Certification Bodies who hold UKAS accreditation to ISO 17065.

MCS certifies low-carbon products and installations used to produce electricity and heat from renewable sources.

MCS is a mark of quality. Membership of MCS demonstrates adherence to these recognised industry standards; highlighting quality, competency and compliance."

MCS has published an updated version of MCS 031 – the Heat Pump System Performance Estimate template. 16th February 2022.

Due to the Domestic Renewable Heat Incentive (DRHI) coming to an end on 31 March 2022 and with the volatility in energy prices, MCS identified a need to update MCS 031.

MCS 031 v3 removes any anomalies from the previous template and no longer provides financial information or DRHI data.

The template now enables installers to estimate the amount of electricity that might be consumed for a heat pump to deliver a given amount of heat.

Please note, installers can still use the template to convert figures to estimated running costs. However, they should follow any guidance or requirements stipulated by their consumer code.

The changes were agreed in conjunction with the MCS Heat Pump Working Group.

SCoP definition : SCoP is the seasonal Coefficient of Performance

MCS Seasonal Coefficient of Performance (SCoP) is derived from the EU ErP labelling requirements, and is a theoretical indication of the anticipated efficiency of a heat pump over a whole year using standard (i.e. not local) climate data for 3 locations in Europe. It is used to compare the relative performance of heat pumps under fixed conditions and indicates the units of total heat energy generated (output) for each unit of electricity consumed (input). As a guide, a heat pump with a MCS SCoP of 3 indicates that 3 kWh of heat energy would be generated for every 1 kWh of electrical energy it consumes over a 'standard' annual cycle.

A more realistic evaluation of performance comes from the SPF, or Seasonal Performance Factor. This is a measured ratio between heat (and hot water) generated by the heat pump and the electricity used to run it. Under the Domestic Renewable Heat Incentive and now under the MCS Standard, all heat pump systems have to include an electricity sub-meter, so that the homeowner can see exactly how much electricity the heat pump system has consumed.

Colour-coded ASHPs