Our ASHP installation, system operation and costs

Introduction

The gas fired boiler for our central heating system was reaching its end of life. We therefore decided to reduce our carbon footprint by replacing it with an air source heat pump (ASHP) which is run on electricity. It utilises the existing radiator pipework system (so moves energy from outside air to the central heating water system); air to air systems are also available (like a reverse air conditioner) that run in parallel with an existing boiler but these do not qualify for the same grants.

ASHP central heating systems like mine need an upfront investment as the total cost may be £10,000 to £15,000 but this can be reduced by government grants and, over the subsequent 7 years, additional cash can be reclaimed through the RHI, so amounting to 75% of the total cost.

You will need an up to date Energy Performance Certificate (EPC) for your house and a full assessment of your old system, house insulation, room sizes and hence ASHP system requirements.

Installation may take a week, depending on the house size and complexity. Radiators may need to be changed. We had a hot water supply but no central heating for the week, so needed electric heating plus the open fire to keep warm, as it was December.

Electricity is more expensive than gas but I had also installed a solar system combined with batteries. This enables me to store off peak cheap electricity at night to reduce the overall running costs that should then become comparable with gas.

Installation

We had arranged for our new ASHP system to be installed in early December 2020. They started on a Tuesday by draining down the radiators and domestic water pipes so that the old hot water tank could be replaced by a new one.

As the new 200 litre tank has an immersion heater, our hot water supply was available that day again, but we had to heat the house with a fan heater plus our open fire. Maybe mid-December, mid-pandemic was not the best time as we could not go next door for a warm up! But we did not want to wait for another winter to pass, so hopefully we will be glad that we pressed ahead.

The new domestic water supply, hot and cold, is under pressure so our showers were double the flow rate, which really improved the shower experience. There is a balancing valve that ensures the hot and cold water is of equal pressure and we could turn the pressure down to a suitable setting to give a good, but not excessive, flow rate. Previously a 2 minute shower had used 10 litres of water, now it was 20.

Days two and three were spent fitting a huge number of new pipes both in the airing cupboard and the loft. A buffer tank was placed in the loft and the old header water tank and pipework removed.



By Friday four of the six new radiators required were fitted, the control system was in place and holes had been drilled through the loft wall to allow connection to the ASHP that was to be placed on a plinth outdoors on Monday. All radiators in the house (except bathrooms) were fitted with thermostatic control valves.

On Monday the pipework for the radiators was pressure tested and no leaks were found. The ASHP was connected to the loft pipes and covered in ducting. All pipes are insulated.

The 8.5 kWh Mitsubishi ASHP is quite large (approximately 1m x 1m x 0.5m) but tucked away out of view and very quiet.

Electrics were connected too, the app downloaded and the site registered by the installer's head office.

The old boiler was removed leaving a large hole in the wall that I will get bricked up.

The final day was a Tuesday again when they flushed out the pipe system to remove old debris that might clog up the ASHP.

Operating the system

It was all programmed into the FTC5 controller by the installer and set running. It all worked and the house soon warmed up.

We tried the Octopus Agile electricity tariff initially as I had time to change the charge settings daily. However, I then moved to Octopus 'Go' off peak to charge the 12.6 kWh batteries. This is only 5p/kWh between 0030 and 0430 and the batteries then power the house into the morning (depending on outside temperature/heating demand). The solar then helps power the house with grid as required. In the sunnier half of the year, overnight grid to charge the batteries will not be needed as our solar will be adequate once the heating is off.

Hot water

In winter, the hot water tank is heated every night at 0030 for 1 ½ hours. This should easily last us 24 hours but, if we have guests staying, we can boost it midday. Every 15 days the system does a Legionella Protection heating to a higher temperature automatically. This setting can also be adjusted, if needs be. In summer we will use our solar panels to heat the water at midday.

Heating

Winter

It is best to run an ASHP system all day and night (or almost). When it is heating the hot water it cannot also heat the radiators. The radiators are warm to touch but not as hot as with a gas fired system, hence they operate for longer periods to provide the required heat into the house. Using the batteries, we can maximise the cheap rates of off peak prices.

The batteries are charged up overnight with off peak from 0030 and start releasing energy at 0430. During battery charging at night the ASHP uses grid energy (low price remember!) to heat the hot water and the radiators, if required (we have a cooler overnight setting for sleeping, warming up after 0530).

Depending on the amount of solar energy generated during the day from the panels, the battery charge can last until breakfast and then be supplemented by the solar. When the battery falls to 10% remaining, the house uses grid again and the cycle restarts.

Summer

When we are generating plenty of solar power and the heating requirement has fallen, we will set the system to 'self use' mode. The batteries will store energy from the solar panels for use overnight. Excess daytime energy will be used to charge the electric car and, after that, exported to provide some income.

Initial data on electricity use compared with gas for heating, with estimated cost comparisons

The whole heating setup, including radiators, cost about £15,000 including VAT. Six of our 13 radiators were changed (£2,200 of the total cost) to ensure the heat was adequately transferred to each room. Although the Green Homes Grant was not received (due to their inefficient processing), we should receive 75% of our outlay back through the RHI payment scheme over the next 7 years and make energy savings to repay the rest.

Gas boiler

This table shows how much gas was used per day depending on the temperature outside for the three weeks prior to the ASHP installation in early December 2020. Our gas tariff was 2.56p/kWh including VAT (plus the daily charge, not included here) so the daily variable cost can be calculated.

Temperature °C	0	4	8	12
kWh gas used/day	162	140	105	58
Cost per day	£4.15	£3.58	£2.69	£1.48

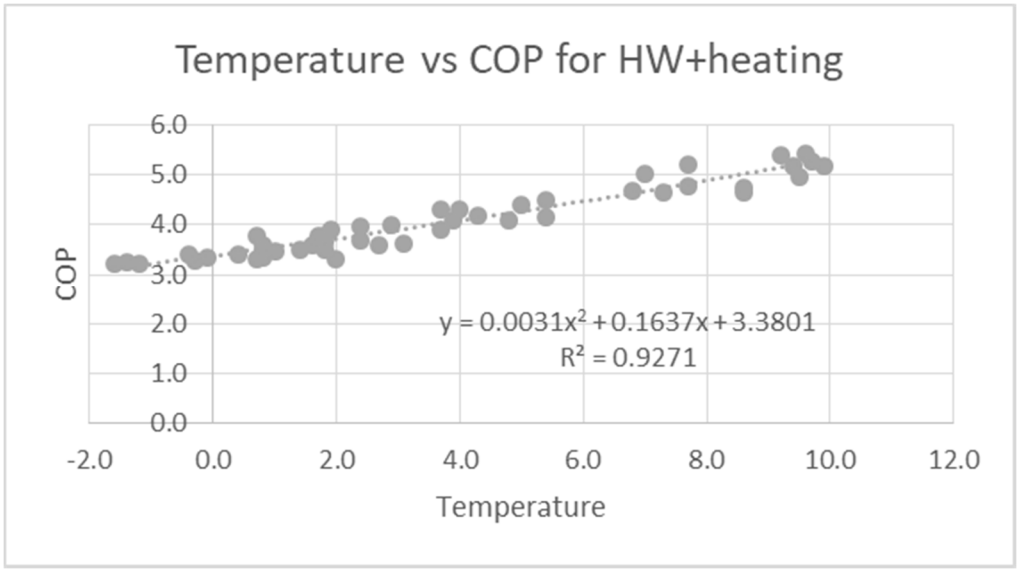
Electricity and the ASHP

I am collecting data every day on the electricity used and the heat produced by the ASHP (50 days so far to early February). The heat produced is estimated by the system using flow rates and changes in flow temperature, hence energy transfer. Data shown (see tables and graphs below) are for both heating and hot water together, to be comparable with the gas system. Heating the hot water tank is using about 1.5 kWh electricity a night to cope with our usage of two showers and daytime washing up, etc (probably less than 100 litres).

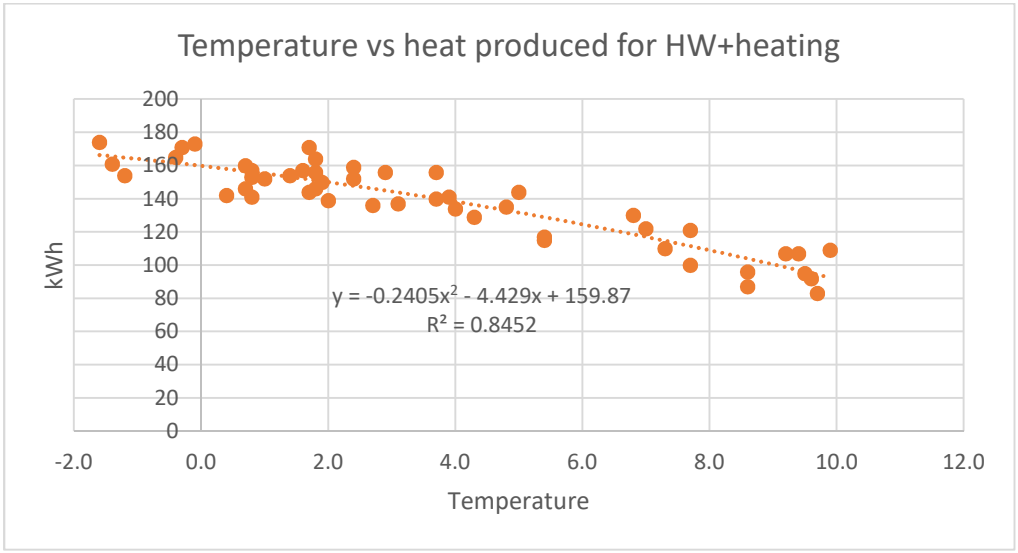
Installers of ASHP systems often quote a coefficient of performance (COP) of 3. This means that for every unit of electricity used by the ASHP, 3 units of energy are delivered into the house. The COP does vary with the temperature difference between the inside and outside temperatures as it is harder for the ASHP to extract energy from colder air. My system has given a COP better than 3, especially at milder temperatures, with an average of 3.5 over winter.

The average temperature between mid December and early February has been 4°C. To achieve parity with cheap gas prices (at the moment in the pandemic recession) I need to have electricity at an average price of 10.2p/kWh. I hope to manage this by using the ability to store off peak electricity in the batteries. Data will be recorded throughout 2021 to give a full breakdown of costs.

Temperature °C	0	4	8	12
kWh heat produced	160	138	109	72
kWh electricity used	47	35	22	10
COP	3.4	4.1	4.9	5.8



We have warmed the house up to similar, comfortable temperatures using the ASHP as with gas.



Electricity consumed at various temperatures.