GREEN OPEN HOMES B&NES

1980s Retrofit:

Ground Source Heat Pump and Solar PV systems

Overview

Floor Area:	314m^2
Age:	c.1980
Location:	Chew Stoke
Type:	2-Storey Detached
Construction:	Stone and blockwork with Cavity walls and roof insulation
Space Heat Demand:	EPC methodology 25,017kWh/yr
Water Demand:	EPC methodology 3,173kWh/yr

Key Features

- Hot Water Cylinder Upgrade
- K3 Radiators
- Smart Heating Controls
- Solar PV System
- Ground Source Heat Pump (GSHP)
- Solar PV Panels

Introduction

The overall goal of the retrofit was to reduce CO2 output. To aid the goal, Phil replaced a non-condensing oil boiler with a heat pump, reducing heating and hot water carbon emissions by about 90%. They chose to install a Ground Source Heat Pump (GSHP), which was funded by the Renewable Heat Incentive Scheme (RHI).

The property has a large electric cooker, which meant careful assessment was needed before installing a GSHP. The properly also has a set of Solar PV panels to generate energy.

Key Features

Ground source heat pump (GSHP)

Two pumps were installed one 6kW and one 9kW, which operate in tandem to provide room heating. Both pumps are required to get the system up to temperature, then generally only the 6kW is needed to keep the house warm. The 9kW pump also provides domestic hot water, up to about 63C. Running at about 4:1 efficiency the 6kW pump is drawing about 1.5kW.

Phil tries to heat the domestic hot water (DHW) in the middle of the day, so that the pump runs from the solar PV.

The pump produces hotter water for DHW than for space heating, which runs at about 40C.

A nearby field provided a good site for an underground collector array.

Solid floors meant that underfloor heating was impractical without major works and therefore radiators were chosen for the installation.

Hot Water Cylinder Upgrade

As the temperature of the hot water would be reduced, a larger hot water tank was required – increasing from 100 litres to 300 litres. This is sufficient for five people to shower provided they do so fairly quickly, without turning the water pressure to the maximum.

As the water temperature is too low to kill legionella, an immersion heater runs once each week, to raise the water temperature from 63C (the maximum the pump can provide) to 70C, which will kill all legionella.

The recovery time from cold is about 45 minutes. Phil has had 12 people in the house over Christmas, and have not run out of cold water!

K3 Radiators

Heat loss calculations were done for the whole house, and radiator sizes calculated for a range of flow

temperatures. (The lower the flow temperature, the more efficiently the heat pump will run.) We settled on 40C as a reasonable compromise. Broadly speaking, the radiators in bedrooms did not need changing, but most radiators downstairs were upgraded, typically to K3 (ie triple panel / triple convector).

Heating Controls
The heating controls were upgraded to a Honeywell Evohome system. This allows all radiators to be controlled individually from a single point. Broadly the system works well, although the control panel is a little clunky, with slightly restricted options for settings.

Phil has not fit remote control thermostatic radiator valves (TRVs) to all radiators – some use manual TRVs. The manual TRVs are used in rooms which only require constant 'background' heat. Honeywell do not recommend doing this as, allegedly, it interferes with the way the system "learns" what heating each room requires. However we have found it works well. It is generally said that heat pumps work well with underfloor heating, as they work best when providing a constant level of background heat. However, we have found that for most rooms through the winter we can keep them at a background level of warmth, and with a couple of hours notice heat them up – eg in late afternoon the temperature in the sitting room is raised by 3-4C, so that it is comfortable for the evening. We feel that this is an advantage of using radiators over underfloor heating.

Installation

The system was installed in July/August 2021. Initial surveys were carried out by Solarsence and Will Grafton of RWE consulting. Will G. is an independent consultant specialising in heat loss calculations and consequent heat generation requirements. Will offered impartial advise and very knowledgeable. Phil dug the trenches and fitted the new radiators, Solarsense, removed and replaced the boiler and water cylinder.

Cost

In terms of cost the electricity for the heat pump is greater by 3-4 times, than the price of oil however the heat pump is 3-4 times more efficient, so running costs are about the same.

Performance

Replacing the non-condensing oil boiler with a heat pump, has reduced the CO2 emissions by 90% from their former levels.

In terms of cost, the electricity for the heat pump is greater by 3-4 times, than the price of oil for the same amount of energy – however the heat pump is 3-4 times more efficient, and therefore the running costs are fairly neutral.

"We've been very pleased with the new GSHP system – it works just as well as the old oil system, and the new control system means we feel like we're not heating up rooms unnecessarily. Note however that rooms do not heat up so quickly, and a little more thought is required so that rooms can be heated in advance of them being used."

Appraisal

GSHP vs ASHP
The installation costs of the GSHP were high. Compared to an ASHP the main additional cost would be the ground works and the collector array (assuming there is somewhere suitable to install a collector array). Most of the cost was covered by the RHI, but as this is not available going forward, Phil believes GSHP could have limited interest.

Future Recommendations

Battery Storage
Phil considered combining their solar PV system with battery storage and using it to run the GSHP. In their view the cost of the battery storage system is still too high for this to be financially viable, although as battery prices fall and electricity prices rise, Phil predicts this could change. Note that many battery systems cannot deliver more than 3kW therefore may not always be able to facilitate the complete powering of the GSHP by the Solar PV and Battery system.

Contacts

Photo voltaic (PV) panels + battery

Solar Sense - https://www.solarsense-uk.com/
Will Grafton – https://www.rwgconsulting.co.uk/
Kensa - https://www.kensaheatpumps.com/