Important considerations in selecting a domestic air-source heat pump

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The majority of the following factors that are considered relevant when buying an air-source heat pump (ASHP) were posted by Tony James, on March 31st 2011, on a blog on the website www.housingenergyadvisor.com. They make very good sense for anyone considering the installation of an ASHP in either a new build or existing property. They are presented slightly annotated, along with additional notes regarding getting the most from an under-floor heating system, as commonly specified alongside ASHP technology.

Refrigerant

First, always ensure that the heat pump you are buying is a purpose-built heating solution, and not an air conditioning unit reversed. With a little homework, it is not hard to ascertain which companies manufacture air conditioning units and have seen a niche in the heat pump market. These products can often be identified by the refrigerant that they use for the heat transfer. Most air conditioning units run on R410A. This is a high-pressure refrigerant and as such is only capable of working within certain temperature ranges. However, when a heat pump is tested according to EN14511, they are tested when the outside air is 7°C and the heated water coming from the heat pump is only 35 °C. Under such conditions, most air systems using R410A perform relatively well and the Coefficient of Performance (CoP) will look quite good. However, what companies marketing these products are reluctant to tell you is how they perform when the outside air gets to 0 °C or below.

Once the air into a heat pump using R410a starts to drop in temperature the actual performance of the heat pump drops too. Consequently, you could have a 14 kW heat pump installed in your property which is only delivering 7 kW when the outside air is at –3 °C. (This information came directly from a manufacturer of well-established products.) Additionally, as the R410a is a high-pressure refrigerant, the compressor and condenser within the unit cannot provide the high temperatures that the property requires to supply the heating and domestic hot water just when the heating is required the most. Thus, overall, what you will find with a budget air-source heat pump is that when the outside air is below 0 °C the heat pump is perhaps delivering a flow temperature of around 35 to 45 °C and this water then needs to be boosted with a flow boiler. These flow boilers can be anything from 3–15 kW, thus costing at least 36p to £1.80 per hour to run in order to supplement what is meant to be an energy-saving heat pump.

Therefore, when choosing a heat pump it is advisable to purchase one from a company which manufactures heating solutions, often those which manufacture in Scandinavia and are using refrigerants such as R407c, R404a or even R134a. These refrigerants operate at a lower pressure and thus cope better when the outside air is cold. Do not be afraid to question your installer about the refrigerant used in the products they supply, and ask them about the performance of the unit when the outside air is below 0 °C.

Hot water production

Hot water production is clearly an important consideration when purchasing a heat pump. Most people who purchase a heat pump do so in order to both heat their homes and to provide hot water for baths and showers. It is well documented on many websites that heat pumps perform well whilst producing low temperatures for heating systems such as under-

floor heating. Thus, the most difficult part of a heat pump's role is to produce domestic hot water at temperatures in excess of 50 °C, which most people feel they need in their hot water tanks. Thus, extra care should be taken to ensure that a heat pump can provide the temperatures required without using the electric back-up heater as a boost (except of course for legionella cleansing). Many of the quality air-source heat pumps on the market are capable of providing hot water in excess of 50 °C when the outside air is as cold as –16 °C, and some even when the outside air is –20 °C, without the use of an electric flow boiler to top-up the temperatures.

Recharge times are also important. There is are major differences between the recharge times on domestic hot water. This will vary even with the same manufacturer, depending on the size of the heat pump you require. A larger heat pump will produce hot water quicker than a smaller system will. Thus, you may be surprised to find that some budget heat pumps can take up to two hours to recharge a tank of domestic hot water. This can be quite bad if your house is heated with radiators, as when a heat pump is heating your hot water it cannot provide heating to your radiators at the same time. The effect of this is two-fold. First, you are often waiting a long time for your hot water tank to recharge after someone has used it for a bath or shower. Second, whilst the heat pump is recharging your hot water tank, your home is cooling down. Thus, when the heat pump changes function and starts to heat your home again, the heat demand is high, and the heat pump requires the support of a flow boiler. Again, this can be very costly and defeats the object of energy-saving heat pumps. So when choosing a heat pump, try to find one that can produce hot water in 20 to 30 minutes without the backup of an immersion heater.

Defrost cycle

The UK climate is not often the best for an air-source heat pump. Although the air is often warmer in the UK than in Scandinavia, the UK suffers from damp air. When this damp air is passed over metal that is perhaps at –5 °C when the outside air is 0 °C, ice very quickly forms on the evaporator. This ice restricts the airflow entering the evaporator and reduces the efficiency of the heat pump. Defrosting the heat pump can use a substantial amount of energy, and many pumps use the heat from the radiators or buffer tank to perform the defrost cycle. A good air-source heat pump should have a large surface area for collecting the heat energy, with wide fins allowing a good airflow over the evaporator. Additionally, do not be afraid to ask your installer how often the defrost cycle comes into effect. Try to avoid those that are on timers, or those that start on demand and run for a set length of time. On average, these air-source heat pumps can consume around 1,000 kWh of extra energy a year, which could cost at least £120 a year more than those with a demand-only defrost cycle and no pre-set timed defrost cycle.

Coefficient of Performance vs. Seasonal Performance Factor

When buying a heat pump ignore the CoP. As mentioned before, the UK has regulations that calibrate the performance of a heat pump when the outside air is 7 °C and the flow temperature is 35 °C. Most heat pumps perform really well at these temperatures, but what you really need to know is how the heat pump is going to perform over the year (the Seasonal Performance Factor – SPF). Many factors will affect the seasonal performance of a heat pump. For example, we could put a high quality air-source heat pump with a good CoP of 4.6 into a property with single glazing, radiators, and poor insulation and get an SPF of 2.5. However, if we then install the same heat pump into a new build with under-floor heating we could get an SPF of 4.2. Thus, the characteristics of the building and the heating system will clearly affect the actual performance of the heat pump.

A good heat pump installer of a high quality product will be able to provide you with a demonstration of how the heat pump should perform over the year and give you an indication

of the running costs. Although this demonstration will never be 100% accurate, as the installer won't know how many baths you will take or how often you will open your doors and windows, it will provide you with a good indication of performance. The Energy Saving Trust did an evaluation of heat pumps and found that performance varied substantially from one product to another. Thus, do not be afraid to ask your installer about the SPF of *your* proposed heat pump installation.

Balancing under-floor heating

If using an under-floor (u-f) heating system for heat delivery from an ASHP, it is important to ensure that the flow rate of the u-f system is balanced. Balancing is a vital part of the commissioning process, but unfortunately not all homeowners are familiar with it and the process is also often overlooked by installers. If a property's u-f system is not properly balanced it will operate on a uniform flow rate, meaning that all rooms will receive the same level of output regardless of size and orientation, so some rooms will be over-heated and others will be under-heated.

Installers can manually balance each room, but this will only result in the optimum flow rate and heating output for that specific time of year. Any subsequent seasonal changes will still have to be carried out by an installer – at extra cost to the homeowner and additional job time for the installer.

It is therefore recommended that 'auto-balancing' controls to the manifold are also specified as part of any installation of u-f systems. This replaces the need for manual balancing. Auto-balancing technology calculates the actual energy needs of the individual rooms over the heating season and adapts to those needs, balancing the system through the changing seasons and the property's changing use patterns. In turn, this gives more even floor temperatures and faster system reactions with lower energy consumption.

Research by Uponor Ltd., a company that supplies a version of this technology, suggests that an auto-balanced system is 12% more efficient than an unbalanced or manifold balanced system.

Installer requirements

Finally, ensure that you use an experienced installer. A heat pump is simply a method of transferring heat from one location to another. This uses a temperamental refrigerant cycle, electronics and hydraulics. Consequently, your heat pump installer has to have knowledge of all these factors to understand how your system will work and ensure the system is perfect for your needs.

An example of this is the temperature differentials around the refrigerant cycle (called the Delta T's). Should these Delta T's be wrong by 2 °C on the refrigeration system, the heat pump can use around 1,000 kWh per year more than it should, costing you at least £120 a year more to run. This can be quite scary when you think that the Delta T's are controlled by simple circulation pumps. Thus, it is really worth ensuring that your installer has the required knowledge and qualifications to ensure that your heat pump, and the heating distribution system it is using, are performing perfectly. That way, with a high quality heat-pump system designed specifically for your building and installed correctly, you can save a substantial amount of money. In addition to that, you will have the peace of mind that no matter what the weather conditions are, you will always have a warm home, a small energy bill, and loads of hot water.

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