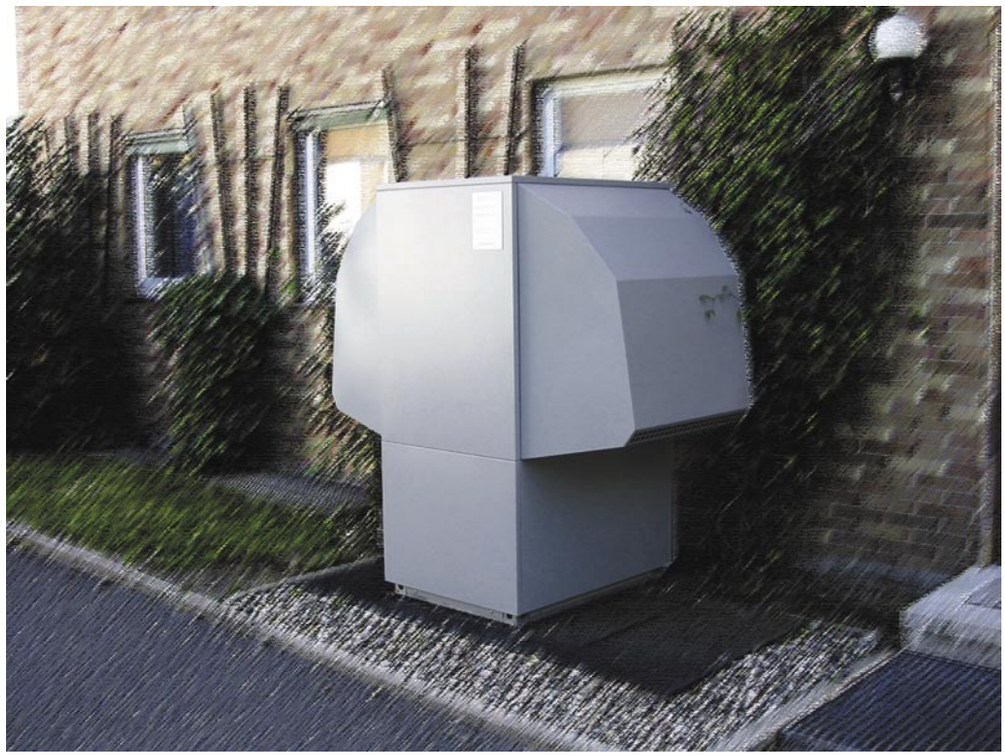
# Air source heat pumps

**Viewpoint on this technology by Prof. David Strong, Chief Executive of Inbuilt Ltd.**



Coming to a house near you! Air source heat pumps

I was involved in the development of the first generation of air source heat pumps in the late 1970s. They were an exciting new technology – a simple way to absorb heat from outside a building and use it to warm the inside, smaller and easier to install than its soil-covered cousin, the ground source heat pump.

The technology took some serious knocks in the 1980s because of reliability and technical failure to deliver on its promises, but air source heat pumps have come a long way since. There are many applications today that help contribute to the energy efficiency of our buildings, providing excellent performance and real carbon saving benefits. For example, when used for swimming pool heating in spring, summer and autumn months, a well-designed system can be very cost effective and deliver major carbon savings. Air source systems can also be very effective in recovering energy from building extract systems and from some industrial processes.

However, as awareness of their potential benefits has grown, so inevitably have the marketing promises being made. There are increasing claims that air source heat pumps provide a 'low-carbon technology' for all our space heating needs.

But there is a fundamental flaw that no one is talking about still, and it's all to do with the climate in the UK. In particular, I am concerned with the scenario when outside temperatures fall below about 5°C – that's a significant part of a typical British winter.

Most of these systems are based upon technology originally designed for air conditioning applications. Surprisingly, little objective independent information is available associated with the seasonal performance of these systems when installed in UK (and Irish) climates.

The manufacturers' literature claims coefficients of performance (COP) of 'up to 4' when used for space heating. However, what is much less clear is how efficient the technology is when seasonal factors and energy requirements for evaporator de-icing are taken into account.

Air source heat pumps have been classified by BERR as a 'renewable low-carbon technology' and three different manufacturers are listed in the BRE's Green Book as providing 'approved products'. These products are eligible for the government's Low Carbon Building Programme Grants. This is very odd given the absence of objective, reliable and independent performance data associated with the latest technology being sold and installed in the UK.

Sure, BRE has undertaken product testing in the laboratory of heat pump performance at different operating conditions. However, what is conspicuously absent is independent data regarding the actual seasonal performance of air source heat pumps. The Energy Saving Trust (EST) is planning to undertake performance trials to measure and assess seasonal performance, but the results are not yet available. This is of concern since trials undertaken in the late 1970s and early '80s found that UK climatic conditions were particularly problematic, with a significant amount of energy being wasted, associated with evaporator defrosting.

Ice build-up on the evaporator of an air source heat pump is a serious problem, with icing typically occurring whenever outdoor air temperatures fall below about 5°C (this can be as high as 7°C for some systems), with COPs in extreme conditions falling to less than 1 (i.e. worse than direct acting electric heating).

The most common method of removing the ice is for the heat pump control system to switch the unit into a reverse cycle mode. When this happens the outdoor heat exchanger (evaporator) becomes the condenser, with hot refrigerant being used to remove the ice. When operating in this mode, electricity continues to be used by the compressor and heat is removed from inside the building (i.e. the condenser temporarily becomes the evaporator).

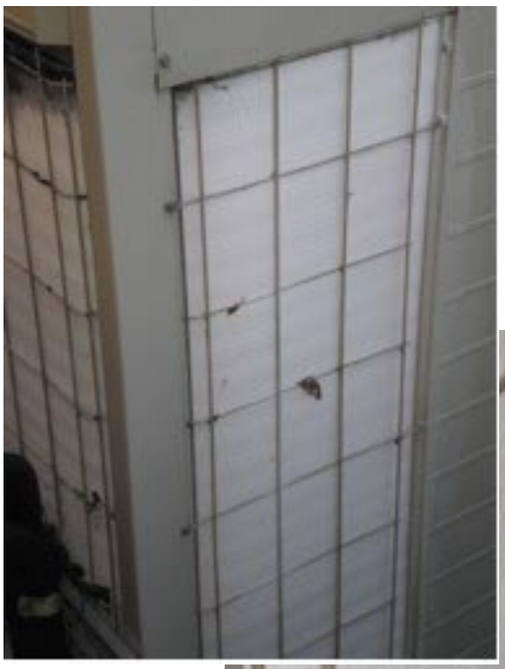
Alternatively, some systems use hot-gas bypass or direct acting electric elements to undertake defrosting. My point is, whatever type of de-icing system is used, the energy requirements to remove the ice can have a dramatic effect in reducing the seasonal performance.

The amount of energy needed to undertake evaporator defrosting is of fundamental importance in terms of economic performance. There are also three other major issues associated with air source systems:

1. Noise (from the fan and compressor) can be very problematic in domestic/urban locations.

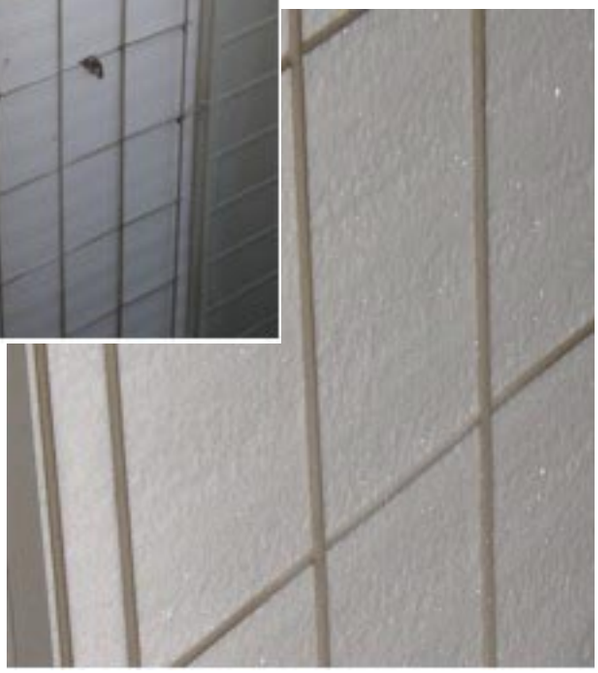
2. There are questions whether a system would continue to operate after a heavy snowfall. Snow can completely block the airflow around an air source heat pump, preventing system operation unless it's manually removed – clearly this is likely to be unacceptable to many householders (particularly the elderly or infirm).

3. And finally, the heat output from an air-source heat pump reduces dramatically as outdoor air temperatures fall. So just when you need the most heating, the system can have difficulty meeting the space heating demand! To get around this problem most manufactures include some form of additional heating system, either in the form of a direct acting electric flow boiler or a bivalent system which includes a gas or oil fired boiler (with all the attendant additional costs and complexity!)



Left: Frost build-up on air source

Below: Close up of evaporator fins heat pump evaporator showing airflow blocked by ice



These issues were major problems with the first generation 1970/80s heat pumps. They were never satisfactorily resolved by manufacturers then, and despite major improvements in compressors, heat exchangers and controls (including the incorporation of inverter/variable speed drive systems), there are major concerns that the problems will still exist with the latest technology.

It's also worrying that air source heat pumps, which are specified ostensibly as a 'renewable' low carbon form of providing space heating, can also be used to provide cooling in the summer.

This might be great news for electricity companies (in terms of providing a useful additional summer load), but an entirely perverse outcome from a sustainability perspective.

This Trojan Horse aspect of air source heat pumps is, of course, never mentioned in the context of the technology's green credentials – it is, however, mentioned as a sub-text by some of the manufacturers as an extra 'benefit'.

What is desperately needed is independent monitoring of external air source heat pumps in a number of geographical locations to ensure that systems which were originally designed and tested to primarily provide air conditioning in hot climates, are capable of operating efficiently in our cold, wet and humid climate.

Our climate hasn't changed much since the first generation air source heat pumps were marketed in the 1970s. Nor have the basic laws of physics and thermodynamics.

De-icing, noise, operation in heavy snow conditions and reduced heat output at low outdoor air temperatures were major problems then, and despite recent improvements in technology, they are likely to remain problems now.

The jury is out regarding the appropriateness of external air source heat pumps in our climate. What we desperately need is objective data, before embracing and advocating these systems as a 'renewable low-carbon technology'.

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