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Air to water heat pumps

CASE STUDY

Business Type:	100m^2 beauty salon
Location:	Newcastle-Upon-Tyne
Existing heating system:	Gas boiler
Proposed heating system:	14kW air to water heat pump
Installed cost:	£7,500
Simple payback period:	10.7 years
Lifetime:	25 years

ANNUAL SAVINGS

Electricity:	18,954 kWh
Cost:	£703
Carbon:	2.4tCO_2e (BEIS 2022)

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WHAT IS AN AIR-TO-WATER HEAT PUMP?

There are several different types of heat pumps. This factsheet describes air-to-water (AtW) heat pumps, which are sometimes called Air Source Heat Pumps (ASHP). AtW heat pumps work by transferring thermal energy from the outside air into thermal energy at a higher temperature which can be used to heat the space within buildings or to produce hot water. AtW heat pumps use refrigeration technology and are electrically powered. By using the energy contained in the outside air they can deliver heat very efficiently, even when it's very cold or below freezing outside .

WHAT ARE THE BENEFITS OF AN AIR-TO-WATER HEAT PUMP?

Heat pumps are so efficient because they move (pump) heat from outside to inside. Even when it is really cold outside, there is heat energy in the air. The refrigeration system in the heat pump increases the temperature of this outdoor air to a higher temperature so it can be used in the heating or hot water system.

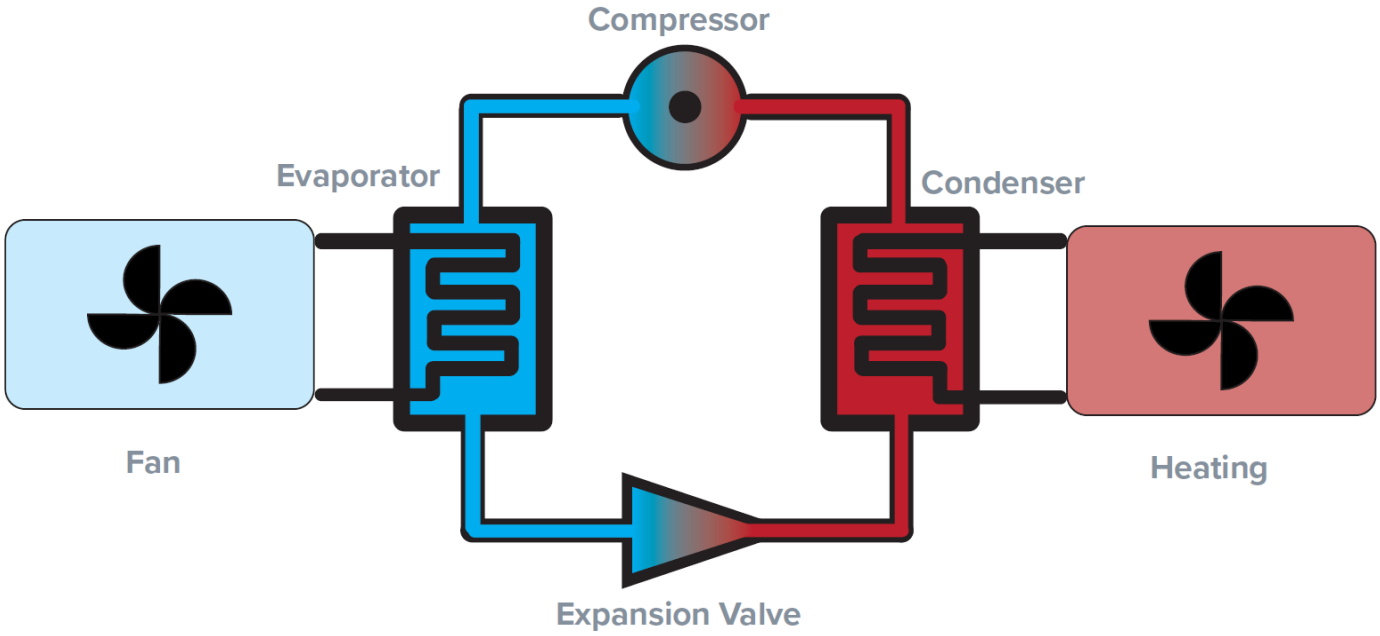
An AtW heat pump can produce several units of heat energy for each unit of electricity it consumes. This can make them cheap to run compared to some other types of heating system. Furthermore, the UK's electricity network is becoming greener as more of our power is generated by renewable energy. Therefore, the greenhouse gas emissions produced by heating using heat pumps can be a lot lower than they are from heating with gas, oil or directly with electric heaters.

The quantity of heat delivered relative to their electricity consumption is known as their coefficient of performance (COP). COP can be defined in several different ways, and there are numerous complicated test standards which express COP at various different conditions of ambient temperature and heating demand. The COP figures quoted on manufacturers datasheets are generally only valid for laboratory conditions and cannot always be achieved because the heat pump is just one part of the overall system. As a rough guide, most properly designed systems can achieve a COP of around 3. This means that they produce 3kWh heat for every kWh of electricity consumed.

Another benefit of AtW heat pumps is that they are eligible for the Renewable Heat Incentive (RHI) which, in non-domestic buildings, currently pays 2.79p per kWh delivered. heat for 20 years from installation.

WHAT COMPONENTS DOES AN AIR-TO-WATER HEAT PUMP HAVE?

AtW heat pumps can be considered as refrigerators in reverse and have the same basic components as a refrigerator: Evaporator, Compressor, Condenser and Expansion Valve.



The evaporator is located outside and is a large, finned heat exchanger which has a fan to drive ambient air over it. The compressor consumes electricity to raise the temperature and pressure of the refrigerant gas in the system. The condenser is a heat exchanger which gives up the heat to the building or hot water system that is to be heated. There are two common types of AtW heat pumps:

1. **Split systems** – in a split system, the evaporator (with fan) is located outside the building and is connected to an indoor unit which contains the condenser, expansion valve and other controls. The outdoor and indoor units are connected via refrigerant pipework.
2. **Monobloc systems** – in a monobloc system, all of the refrigeration components are contained within one outdoor unit. The unit is supplied with electricity and produces heat in the form of hot water. With both split and monobloc AtW heat pumps there can be a hot water cylinder and/or buffer vessel located inside the property with other hydronic controls such as pumps, valves, expansion vessels and weather compensated heating controls.

IS MY BUILDING SUITABLE FOR AN AIR-TO-WATER HEAT PUMP?

Heat pumps produce heat at lower temperature than conventional heating systems such as boilers and are best used in buildings with underfloor heating. Where this is not practical, oversized radiators or fan convector radiators can be used. However, these options require the heat pump to be set to deliver heat at a higher temperature than with underfloor heating and this reduces the COP.

It's also important to use heat pumps in well insulated buildings which can be kept at a steady temperature. Draughty buildings with poor insulation lose their heat very quickly and it can be difficult to get them back up to temperature with a heat pump that operates at low flow temperatures.

It may be necessary to get planning consent for an AtW heat pump, mainly because they generate some noise from the fans of the outdoor unit but also because of the visual impact.

Where heat pumps are used to replace fossil fuel boilers, it's possible that the building's electrical supply might need to be upgraded to cope with the additional load.

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WHAT ABOUT MAINTENANCE?

Heat pumps are inherently very reliable but they do require periodic inspection and maintenance. The outdoor units have to be kept clear of leaves and other debris. As with other forms of water based heating systems, the system water pressure and quality has to be maintained through the use of corrosion inhibitors and various hydronic controls such as pressure relief valves and expansion vessels need to be checked on a routine basis.

In the normal service life of a heat pump, it should not be necessary to have the refrigerant topped up, but as with all refrigeration systems leaks can develop and repairs by a suitably qualified refrigerant engineer can be needed.

ABOUT REFRIGERANTS

Refrigerants are themselves an environmental concern as they are potent greenhouse gases. The industry classifies them according to their global warming potential (GWP), usually on a 100 year time basis. By definition, carbon dioxide has a GWP of 1. Traditionally, heat pumps have used conventional hydrofluorocarbon refrigerants (HFCs) such as R410A. These have GWPs in the region of 2,000 which are obviously a great concern if they are allowed to leak. The industry is moving towards other alternatives such as R32 which has a lower GWP of around 700 but this is still a concern. There are some natural refrigerants such as ammonia or CO2 itself which have found uses in industrial and large commercial heat pumps.

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