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Air to Air Heat Pumps

Case Study	
Business Type:	414m^2 office building
Location:	Billingham
Existing space heating:	Electric radiators
Proposed system:	28kW multi-split air-to-air heat pump
Installed cost:	£24,480
Simple payback period:	4.1 years

Annual Savings	
Electricity:	33,986kWh
Cost:	£5,921
Carbon:	10.1tCO_2e

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What is an air-to-air heat pump?

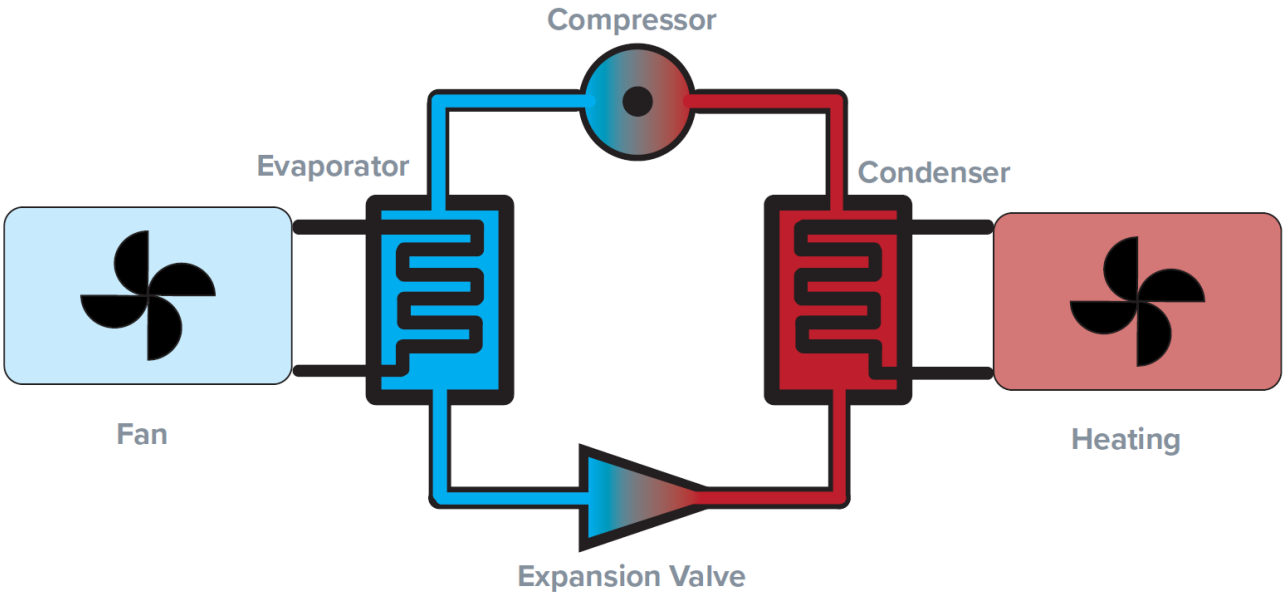
There are several different varieties of heat pumps. This factsheet describes air-to-air (AtA) heat pumps. These work by taking thermal energy from the outside air and transferring it via a refrigerant to heat the space within buildings. AtA heat pumps use refrigeration technology and are electrically powered, but do not use electricity to heat air directly. By using the energy contained in the outside air they can deliver heat very efficiently.

What are the benefits?

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 AtA 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 4. This means that they produce 4kWh heat for every kWh of electricity consumed.



Will it work when it's cold outside?

This system can work even on the coldest of days, due to the use of refrigerant fluid that has a low boiling point. An outdoor heat exchanger transfers heat from the surrounding air into the refrigerant, which subsequently evaporates into gas. The gaseous refrigerant travels to a compressor, where the pressure is greatly increased. This causes the temperature of the refrigerant to rise further. From the compressor, the warm refrigerant travels to the indoor unit and condenses, forcing it to release its heat, warming the air in the building. The cooled refrigerant passes through an expansion valve, which causes its pressure to drop and its temperature to reduce along with it. Having released all the heat it absorbed earlier, the refrigerant is then ready return to the outdoor heat exchanger and the process begins again.

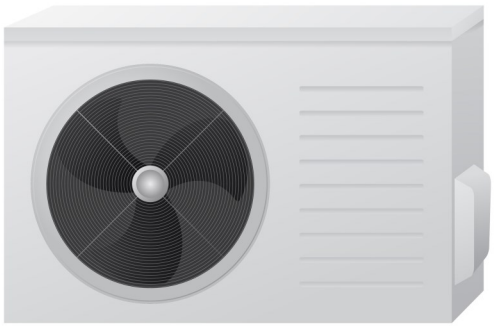
How much space is required?

AtA heat pumps do not take up a large amount of space, consisting primarily of an outside fan unit, or units depending on how many are needed to heat the building. Inside, a wall unit or ceiling cassette unit would be installed, often resembling an air conditioner or vents in the ceiling, and this would distribute the heat around the building. To determine how many heat pumps are required in your building, it is best to receive expert independent advice about it, so that a well-informed estimate can be made based on your energy usage and needs.

System Controls

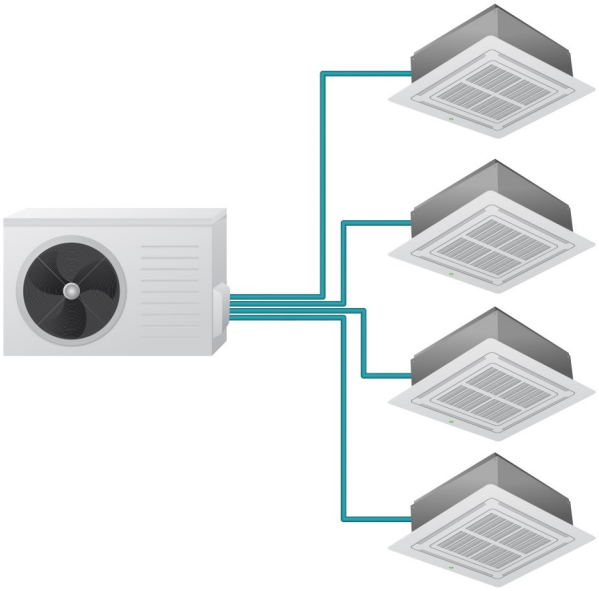
Control of the air temperature is often carried out by wall mounted room controllers, in the same way as a conventional air conditioning system. Depending on the system setup, it is possible to control one indoor unit or multiple indoor units from a single controller, meaning a high level of zoning can be achieved. With this level of control, however, there is the possibility that the air in one zone may interfere with another, so if a heat pump is reversible and in one zone is in cooling mode, this cooled air may mix with that of another zone which is in heating mode. Sensible setup of controls is therefore essential for the efficient operation of these systems.

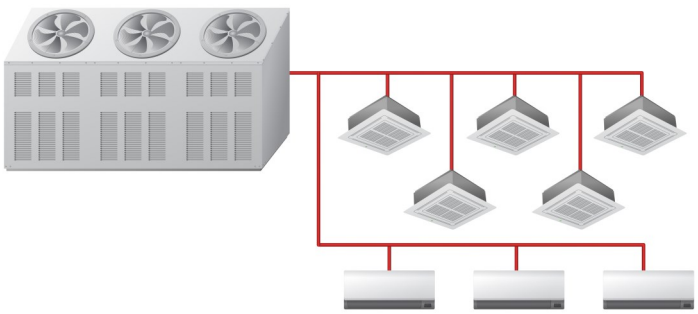
SYSTEM SETUP



The simplest system setup is a ‘split’, where one outdoor unit is connected to a single indoor unit via a pair of insulated refrigerant pipes. Indoor units can be either high up on a wall or ceiling mounted.

Next there are ‘multi-split’ systems, where a single outdoor unit feeds multiple indoor units. This is particularly useful if a number of small rooms or one large room require heating at the same time and to the same temperature, and saves space outdoors.





Larger, centralised heat pumps are also available, where a single outdoor heat exchanger is used to heat a large number of indoor units or ducted air supply. The warmed air is then distributed around a building via these ducts and enters the individual rooms via vents.

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IS MY BUILDING SUITABLE FOR AN ATA HEAT PUMP?

AtA heat pumps are well suited to open plan buildings where there are not many separate zones to heat. In buildings with lots of small rooms, it may be better to consider an alternative such as an air to water (AtW) heat pump as it could be more cost effective. You can learn more about AtW heat pumps in our dedicated factsheet on the subject.

AtA heat pumps are a good choice if you also need the ability to provide some comfort cooling on the hottest days of the summer. Most models can operate in heating or cooling mode. Of course, cooling should be used as sparingly as possible to avoid wasting energy.

COST AND PAYBACK TIMES

Installation costs vary considerably depending on how many units are required, the length of pipework and if electrical supplies need to be upgraded. However, because installation tends to be simpler, AtA heat pumps can be a cost effective alternative to more traditional forms of heating such as ducted warm air or fan convector radiators.

Running an AtA heat pump costs about one quarter of what it would cost to heat a building with conventional electric heaters. When compared with the cost of gas central heating, AtA heat pumps may be cheaper to run, but this will depend heavily on the difference between what you pay per kWh for gas and electricity .

MAINTENANCE

AtA heat pumps are generally extremely reliable, but regular maintenance is still essential. An annual service is advised to ensure:

- The refrigerant volume is correct.
- No leaks have appeared.
- That pipe lagging is in good condition.
- That the heat exchangers are clean and free of leaves, litter or other debris.

AtA heat pumps have reasonably long lifespans, with most models performing for at least 15 years. It is worth checking before purchasing a system that there is no planned phase out of the refrigerant used in the specified products, as this may make existing models unserviceable.

Further advice on maintenance and efficiency of AtA heat pumps is provided as part of a 'TM44' air conditioning survey, which is required for all non-domestic properties with over 12kW of comfort cooling installed.

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, CO_2 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; 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 CO_2itself which have found uses in industrial and large commercial heat pumps.

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