MITSUBISHI ELECTRIC
AIR CONDITIONING SYSTEMS

Information Guide

The Application of Heat Pump Boilers

CPD CERTIFIED
Construction CPD Certification Service

Issue Eighteen

The Application of Heat Pump Boilers

Information Guide

This is an independent guide produced by Mitsubishi Electric to enhance the knowledge of its customers and provide a view of the key issues facing our industry today. The guide accompanies a series of seminars, all of which are CPD accredited. The changing face of construction in the 21st Century demands that designers, specifiers and suppliers work as teams to create better buildings - for occupants and the environment. Mitsubishi Electric aims to be a part of this by encouraging employees and customers to work together to increase their knowledge of the latest technology, legislation and markets.

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Heat pump boilers - heating the future

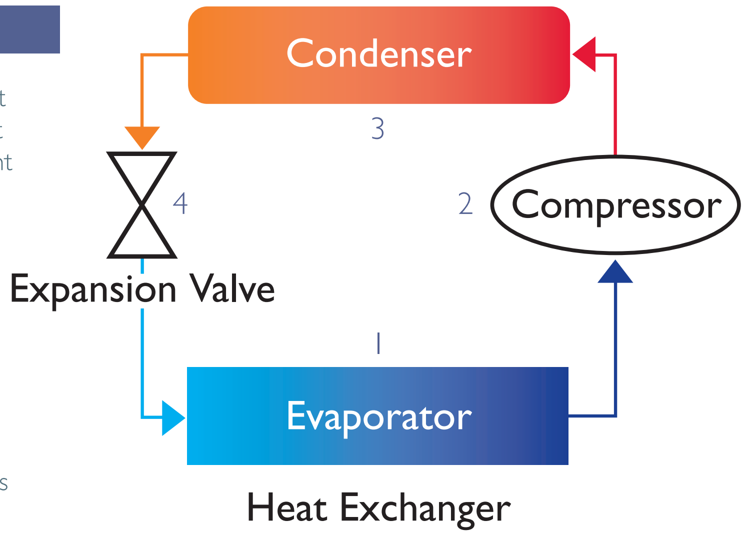
A heat pump boiler works by transferring heat energy from one place to another. The technology inside the heat pump is similar to that found in any domestic refrigerator which uses the vapour compression cycle.

The main components in a heat pump are the compressor, the expansion device and two heat exchangers (an evaporator and a condenser).

The diagram below shows how the system works to use **'free' energy** to create heat for space and water heating.

How a heat pump works

1. Refrigerant in the evaporator is colder than the heat source. This causes the heat to move from the heat source (in this case the outside air) to the refrigerant which then evaporates.
2. This vapour moves to the compressor and reaches a higher temperature and pressure.
3. The hot vapour now enters the condenser and rejects heat as it condenses.
4. The refrigerant then moves to the expansion valve; drops in temperature and pressure; and then returns to the evaporator.



Heat pumps can use two main types of heat source - the earth or air. Ground source heat pumps are connected to a pipe laid horizontally or vertically in to the earth and rely on the fact that at a certain depth, the temperature of the earth remains at a steady 12°C to 14°C. Air source heat pumps use heat energy from outside air, although they do not require 'warmth' and can operate at temperatures as low as -20°C.

The key benefit of heat pump boilers is their very high efficiency levels. With conventional boilers, 1kW of input energy provides less than 1kW of output energy, or heat. However, with an air source heat pump boiler 1kW of input energy is converted on average to 3.6kW of energy or heat. If the heat pump is powered by electricity from renewable sources such as wind, biomass solar or tidal, then it has the potential to be a zero carbon heating system.

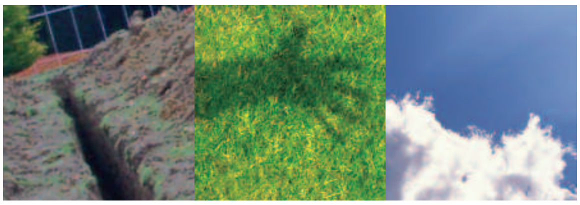
Heat pump technology is not new, but it is currently seeing a growth in interest from developers particularly in the domestic market. One reason for this is that today's heat pumps have seen a number of advances which make them a much more cost-effective option. For example, the latest air source heat pumps use inverter driven compressors.

The inverter regulates the system, so that heat output modulates to match the exact capacity required. This means that the heat pump boiler only consumes the exact amount of energy required at any given time, therefore achieving very high efficiency levels.

Another advance with modern air source heat pump boilers is reduced noise. Since part of the system is positioned outside, it is important for residential applications that noise is minimised.

Older heat pump technology had operating levels around 52 to 55dBA. Today, this has been reduced to between 39 and 49dBA.

Heat pump technology has now improved to the point where they are a viable alternative to 'traditional' gas boilers in homes. However, the key drivers for their growth in popularity with developers and home owners are legislation and increased consumer interest in reducing the carbon footprint of the average UK home.



Growing popularity

Although heat pump technology is not new, it is a relatively new development for the UK domestic market. However, heat pumps are already used widely and successfully across the rest of Europe, with around **250,000** heat pumps installed in domestic applications in 2006 across the continent.

Due to the technology's high energy efficiency, heat pumps have won Government support. The French Government supports their use with a 40% tax incentive and in 2007 50,000 domestic heat pumps were installed.

Similarly, the Swedish Government is a strong supporter of these systems both for environmental reasons and because the country has very small natural oil or gas reserves. In 2006, sales of heat pumps for domestic applications rose to 80,000 units.

In the UK, modern heat pumps are certainly growing in popularity - particularly air sourced systems, which are easier to install for homes without the space for a ground-source system and are also more straightforward to install in older properties.

Improved heat pump technology means that the systems are now more energy efficient than ever before, quieter and easier to install and maintain. But the main driver behind increased use of heat pumps is legislation aimed at reducing energy use in our homes.

The potential CO_2 savings from cutting domestic energy use are enormous, according to UK Government figures. If all the new residential properties built between now and 2016 (amounting to around 200,000 a year) used heat pumps instead of gas boilers, over 720,000 tonnes of CO_2 emissions per year could be saved. If heat pumps were to be used when replacing just 10% of all the replacement gas boilers sold for existing properties each year, then the combined savings could reach over 2 million tonnes of CO_2 by 2016.

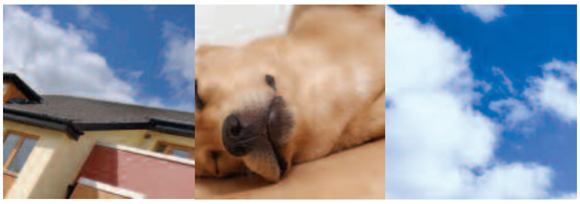
Because homes are such a potential source for energy savings, the Government is introducing tighter rules on energy performance of dwellings. For example, the Code for Sustainable Homes, introduced in 2006, is part of a growing body of legislation aimed at making homes more energy efficient and sustainable.

The Code uses a rating system of one to six stars to show the overall energy and sustainability performance of a house, with six stars representing 'Zero Carbon'. By using an air source heat pump boiler along with good insulation, Code level 3 CO_2 emissions can be achieved - which is much higher than the vast majority of today's new-build homes.

Heat pump boilers are also being made more attractive to developers since they now qualify for (ECA) Enhanced Capital Allowances. Heat pumps are also recognised as 'renewable' energy by local authorities requiring a certain level of sustainability on new developments before planning permission is granted. Also for consumers looking to install air source heat pump boilers, grants are available from many local authorities.

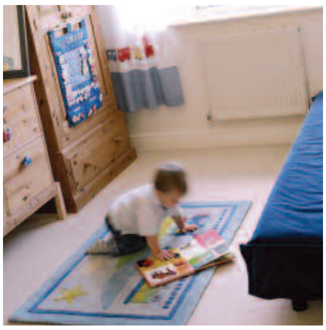
One important aspect of heat pump boilers is that they require installation by trained installers, since the system must be installed and correctly set up in order to achieve efficient performance. The Building Research Establishment has recently set up its Microgeneration Certification Scheme (MCS) which has established standards for manufacturers and installers of domestic heat pumps.

The aim of the scheme is to ensure that homeowners can select an installer from an approved list. Product and installer training, usually carried out by manufacturers, will feed into the MCS which will continue to be updated.



Heat pumps in action

Today's highly efficient inverter driven heat pumps are an increasingly popular choice for both private housebuilders and local authorities. There are a number of working examples which demonstrate the real benefits that heat pumps can bring to the environment as well as householders.



Mitsubishi Electric has installed its Ecodan heat pump boiler in a four-bedroom home near Luton. The aim was to create a test project where energy consumption and system performance can be tracked over the long-term and also to examine the impact of retrofitting an air source heat pump boiler into an existing home. Before installation, the Ecodan system was independently tested by BRE and potential savings of around 30% in carbon emissions compared with a gas fired boiler were predicted.

The Luton house has a total area of $177m^2$, with double glazed windows, loft insulation and cavity wall insulation. The previous heating system had been an 80% efficient gas boiler providing 23.2kW of heat from an input of 29kW. Existing radiators had a flow temperature of 70°C with a total output of 13.4kW. Hot water demand was 140 litres per day.

The design team confirmed that heat pump boiler technology could be suitable for this property and installed the Ecodan system to provide space heating and hot water.

Tracking energy use for the first three months after installation (September, October and November 2007) shows that carbon reduction has been greater than tests predicted, at an average of 45%. Also the system provides the householders with a saving of 35% in running costs over a gas fired boiler.

During the trial, external temperatures varied widely, showing that the heat pump boiler can cope well with the UK's fluctuating temperatures.

As consumers become more aware of their need to reduce energy use and be more concerned with their personal 'carbon footprints' use of heat pump boilers is becoming a more acceptable choice for homes. At Shrewton in Wiltshire the executive development of Highfield Orchard has eight newly built homes using heat pump technology for water and space heating.

An individual Ecodan unit is fitted on the outside of the eight executive, 3 and 4 bedroom new homes, which all feature underfloor heating. The system was designed for loads between 5.2kW and 8.3kW. Shrewton was a new site off the gas grid and the developer considered a number of alternative sources for space and water heating. These included ground source which was ruled out on the basis of cost; and oil which raised concerns over the capital costs of tanks and also future prices.

Ease of installation and maintenance were key reasons for the specification of this technology. Unlike other sustainable heating systems, the homeowner would notice very little difference between it and 'traditional' gas fired central heating. This is an important factor when introducing the technology to the domestic market. The developer of the homes at Shrewton used the heat pump technology as a marketing feature, offering low running costs to the end user.

Whatever type of heat pump boiler is used, the quality of system design, installation and commissioning is all-important in ensuring efficient performance. Training courses are available and qualified plumbers who complete a course can easily install the system which features a standard two-pipe flow and return, as well as a single-phase electrical connection.

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Further information

Code for Sustainable Homes: Mitsubishi Electric has produced a Guide on the Code, so please ask your representative for a copy.

Heat pumps: The Heat Pump Association (HPA) offers information on its website at **www.heatpumps.org.uk** The Energy Saving Trust also has some good background information: **www.energysavingtrust.org**. The Carbon Trust also covers this area: **www.carbontrust.co.uk**

For information on UK housing and government plans see **www.communities.gov.uk**

The Microgeneration Certification Scheme can be found at **www.redbooklive.com.** Click on 'Environment and buildings' and follow the link to Microgeneration.

If you missed the CPD seminar on **The Application of Heat Pump Boilers**, you can call your Mitsubishi Electric Regional sales office to arrange an in-house presentation of this information.

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Issue 18 Version 1 (January 2008)

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