Information Guide

Domestic Air Source Heat Pumps

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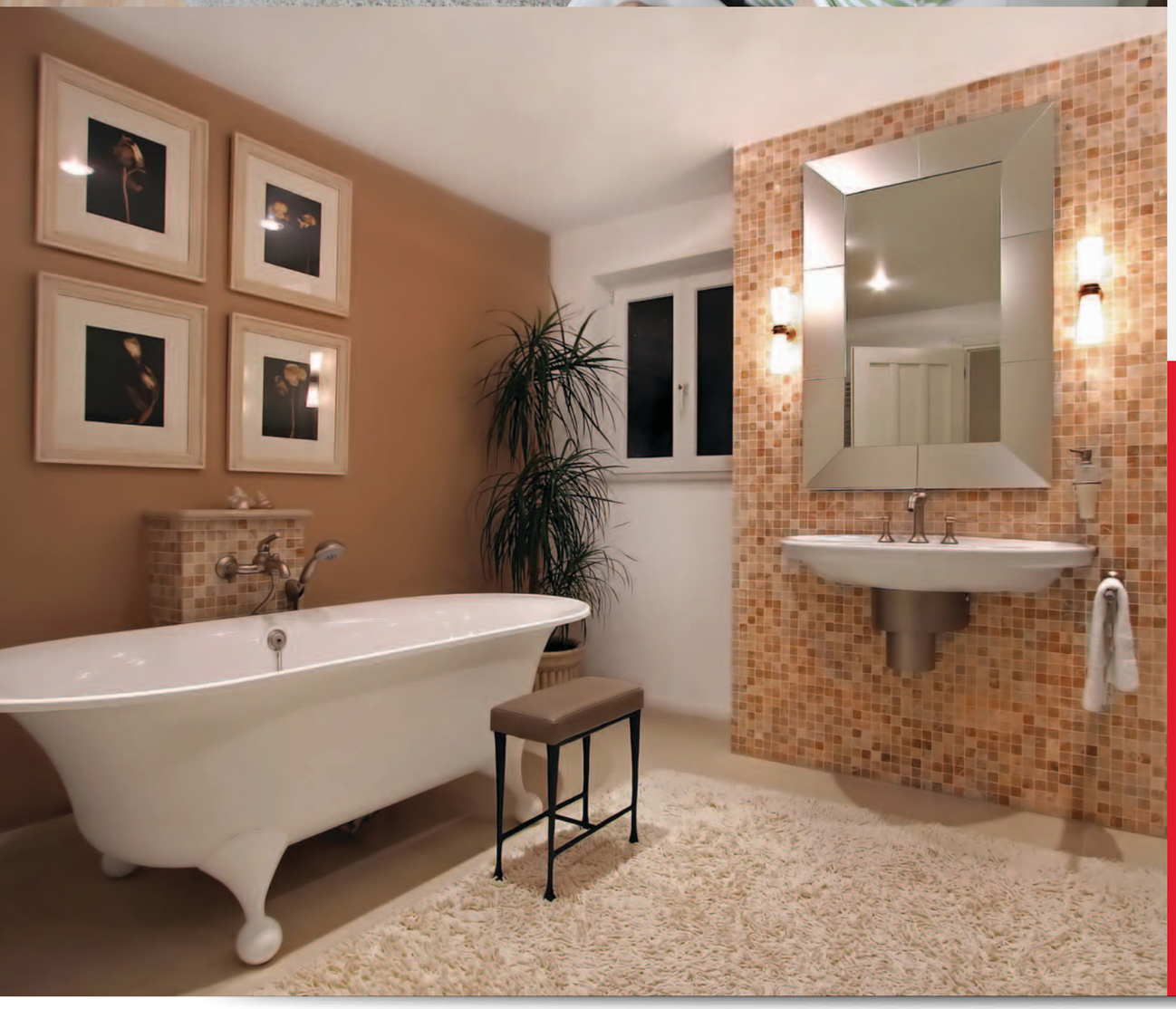

Domestic Air Source Heat Pumps

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.

Providing heating and hot water for homes is a key issue for today's housing specifiers and builders, both in the public and private sectors. With fuel costs rising, homeowners are increasingly conscious of the costs of gas, electricity or oil.

The Government is also setting tough targets for the reduction of carbon dioxide and energy use from the UK's domestic housing stock. This has been done through Part L of the Building Regulations, and also the Code for Sustainable Homes which covers new dwellings.

With these drivers in mind, heat pumps are becoming an increasingly popular choice for providing heating and hot water to new and existing dwellings.

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1. Heat Pumps:
a solution for today's challenges

Providing heating and hot water for homes is a key issue for today's housing specifiers and builders, both in the public and private sectors. With fuel costs rising, homeowners are increasingly conscious of the costs of gas, electricity or oil. As these prices rise, more homes are pushed into fuel poverty. This means that more than 10% of the household income is spent on fuel.

According to Department of Energy and Climate Change (DECC) figures, in 2010, domestic energy consumption was 32% of the UK's total energy consumption[1]. Most of that energy (61%) was used for domestic space heating with water heating accounting for 18%.

The Government is also setting tough targets for the reduction of carbon dioxide and energy use from the UK's domestic housing stock. This has been done through Part L of the Building Regulations, and also the Code for Sustainable Homes which covers new dwellings. Part L introduced the Standard Assessment Procedure (SAP) for new homes to demonstrate compliance with Part L. The SAP now includes Annex Q (also known as SAPQ) which updated the legislation to allow for the enhanced performance of products used in domestic buildings. SAPQ covers a number of technologies such as mechanical ventilation, flue gas heat recovery and heat pumps.

The Code encourages the design of well-insulated homes, and rewards 'points' for the use of renewable and low-carbon technologies.

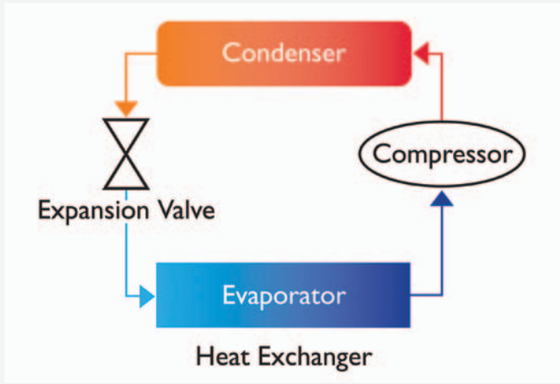
A further incentive for the move away from fossil-fuel heating systems is the Government's Renewable Heat Incentive. The scheme is currently in its first phase, with its official launch at the end of September 2011. It offers Premium Payments for eligible households that will help reduce the capital cost of switching to low carbon heating. The second phase will begin in Autumn 2012 and will expand to offer incentives for more households.

Finding technologies that can provide reliable heating and hot water at reasonable cost, while reducing the impact on the environment is therefore an important goal for Government, housebuilders, local authorities and householders themselves.

With these drivers in mind, it is not surprising to find that heat pumps are an increasingly popular choice for providing heating and hot water to new and existing dwellings. The technology has been established for many years, offering reliable and predictable performance. Furthermore, occupiers find heat pumps are an easy-to-use technology, with low-maintenance performance.

A heat pump is a device which moves heat from one area to another. This means that it is possible to move heat energy from a lower temperature environment (such as the ground or the air) to a higher temperature environment (for example, inside a building). In practice, this means that heat can be extracted from the ground or air and moved into a building, for example by attaching the heat pump to an underfloor heating system or radiators.

Heat pumps work by circulating a refrigerant around a compression/expansion cycle, as shown in the diagram below. The technology inside a heat pump is therefore



similar to that found in any domestic refrigerator using the vapour compression cycle.

A heat pump system uses 'free' energy to create heat for space heating and water heating. The 'heat source' is usually either the external air, the ground or nearby water supply, all of which have absorbed energy from the sun. These give the names to air-source, ground-source or water-source heat pump systems.

The final destination for the heat extracted from the source is also used to describe a heat pump. Air to air systems for example extract heat from ambient air and introduce this heat to an occupied space via fan coils. Air to water systems extract heat from ambient air and heat water for direct use or for space heating via correctly-sized heat emitters.

The main advantage of heat pumps is that as well as offering up to 30% to 50% reductions in CO_2 emissions compared to conventional gas boilers, they can also offer high efficiency levels and may lower energy costs for users. With conventional boilers, 1kW of input energy provides less than 1kW of output energy or heat. By contrast, an air source heat pump converts 1kW of electrical energy to between 3–4kW of thermal heat energy[2]. The latest air source heat pumps use inverter driven compressors to modulate the system to match the exact capacity required along with weather compensation in central heating mode – thereby achieving very high efficiency levels.

1. Figures from the 28th July 2011 report from DECC: Energy consumption in the UK.
2. The heat pumps' actual COP will vary based upon ambient air and required water temperatures. Heat pump performance was independently tested by BRE in accordance with BSEN14511 Part 3 standard rating conditions.

The benefits of heat pumps

- Up to 30% to 50% reduction in carbon emissions
- Helps to achieve Level 3 of the Code for Sustainable Homes
- Easy to install – self-contained unit only requiring water and electric connections
- No gas supply, flues or ventilation required
- No need for groundwork or external pumps
- Single phase power supply with a low starting current
- Low running costs
- Low maintenance
- Low noise: 45dBA at 1 metre (based on a 5kW model)
- VAT reduced to 5% for domestic applications

2. Heat pumps: specifying and installing

The specification and installation of heat pumps are particularly important stages. Correct sizing and fitting are vital if the end-users are to gain the full benefits of this technology. There are some important points to bear in mind.

1. What heat pump to choose?

In order to qualify under Part L and also the Code for Sustainable Homes, the heat pump product selected should be listed under the Microgeneration Certification Scheme (MCS). The same applies to the installer selected for the project. It is also intended that the Renewable Heat Incentive will require the use of MCS accredited equipment and installers. Information can be found on www.microgenerationcertification.org

2. What size of heat pump?

Sizing is a very important issue, as it will affect the long-term comfort of occupants. It is important to consider the size of the property, the size of each room to be heated and what the likely hot water demand will be. It is highly advisable to ensure that the property is as well insulated as possible before installing heat pumps, particularly when retrofitting to existing properties. This will increase the cost-effectiveness of the installation in the long-term.

3. Outdoor units – positioning

Modern heat pumps for the domestic market are generally relatively small in size. Also modern heat pumps offer a very low noise rating of 45dBA (for a 5kW model), making them suitable even in urban neighbourhoods.

4. Indoors – do radiators have to change?

Installation of heat pumps into existing properties is now a relatively common occurrence. It is possible to purchase packaged systems, and these offer a number of benefits including simplified on-site installation and consistent electrical and plumbing layout. For an air-to-water heat pump system, existing radiators can sometimes be used, however it is important to consider the heat pump as a system. It may be necessary to change radiators to a more suitable size in order for the system to function optimally.

5. Will I need a back-up system?

Heat pumps work effectively all year round, even if the outdoor temperature drops to –15°C, so in the majority of cases there is no need for back-up boilers.

6. Consider variable flow temperatures

In the past, heat pumps were only regarded as suitable for use with underfloor heating, but advanced control systems mean that it is possible to provide optimum variable flow temperature control. Radiators can now be provided with the hot water they require.

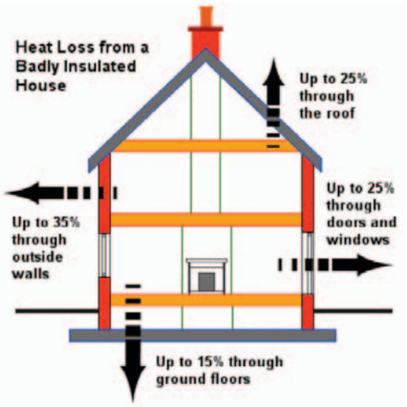
By the simple mechanism of radiator valves (TRV) the radiators are turned on and off to maintain the desired comfort level. Flow temperature is varied automatically, based on ambient temperatures. Operating at these lower flow temperatures improves energy efficiency considerably – energy savings of over 30% are achieved using a heat pump with a variable flow temperature as opposed to a fix-flow temperature. Lower temperatures also give occupants a more consistent and comfortable heat output.

3. Applying heat pumps in homes – factors for getting it right

Today's heat pumps are a flexible option for providing low-carbon and low-cost space heating and hot water in homes. The heat pump is integrated just like a conventional boiler system, with a domestic hot water cylinder supplying the shower and other hot water needs; while heating can be delivered by underfloor heating or radiators.

When thinking about applying air source heat pumps, it is important to consider the right type of system for the building. Heat loss from a building is proportional to the internal/external temperature difference. This means that the quality of insulation and air tightness will affect the heat loss of a building.

Clearly, new buildings constructed to modern standards will have better insulation and air tightness than older buildings, but ensuring good building insulation should be considered a first step in the process of delivering low carbon heating because it helps to reduce the heating required. The diagram opposite shows how external temperatures affect heat loss in a three-bedroom semi-detached home building to 2006 Building Regulations, where an internal temperature of 20°C is being maintained.



- Fabric Heat Loss
- Heat from inside the property is absorbed by the building fabric (roof, walls etc) and escapes to the colder outside air, it usually accounts for the majority of heat lost
- Ventilation Heat Loss
- Heat is lost through cold air infiltration through any non airtight elements

It can be seen that falling external temperatures lead to greater heat loss from the building. The air source heat pump should be selected based on the peak heat loss of the building. There are three main factors that determine peak heat loss:

1. **Internal temperature of the building (typically 21°C)**
2. **Design minimum outdoor temperature (typically –3°C)**
3. **The thermal efficiency of the materials used to construct the building**

Another important issue to consider is how heat is going to be delivered in the space. Radiators are a popular choice, as they are familiar to homeowners and offer a cost effective solution in terms of retrofitting an air source heat pump. There are three points to bear in mind when sizing radiators for an air source heat pump system:

1. **Water flow temperature through the radiator**
2. **The peak heat loss of the room**
3. **Space to locate the radiators**

Case study 1

Retrofit Home

A 1955 three-bedroom semi-detached home had previously been operating a back boiler which achieved 50% efficiency. This was replaced with an 8.5kW Ecodan air source heat pump from Mitsubishi Electric. The average flow temperature is 37°C and maximum flow temperature is 48°C (at –8°C outdoor temperature).

We can see from the graph opposite that the cost to the home owner for space heating and hot water was £628 for the year.

Annual space heating and hot water running costs 2010 – £628

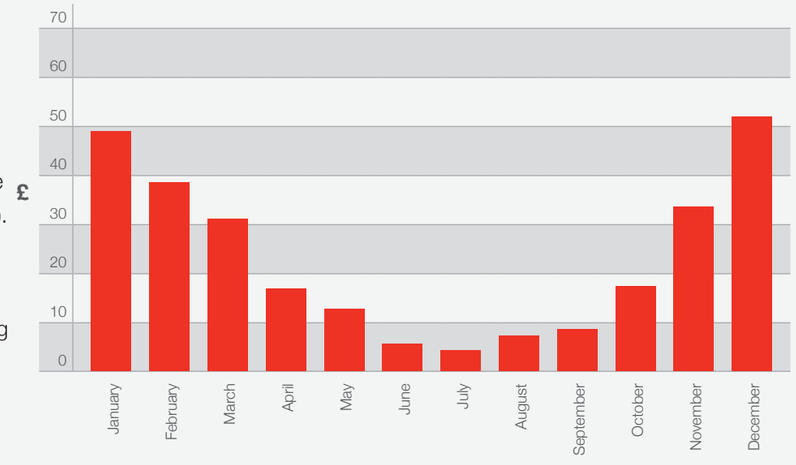
Case study 2

New-build Home

A three-bedroom semi-detached house built in 2009 was designed with the use of air source heat pumps in mind. It was occupied by a young family, with high water demand. The average flow temperature was 35°C; with maximum flow temperature at 44°C (at –8°C outdoor temperature).

Compared to similar homes using a 90% efficient condensing gas-fired boiler, this house saw a 48% CO_2 saving and a 33% saving on fuel costs against gas. This costs the householders £286 per year to run now.

Annual space heating and hot water running costs 2010 – £286



Further information

If you missed the CPD seminar on **Domestic Air Source Heat Pumps** you can call your Mitsubishi Electric Regional sales office to arrange an in-house presentation of this information.

If you would like to receive invitations to future CPD events, please email **lesmarcomms@meuk.mee.com**

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