CARBON TRUST

Heat pump equipment

A guide to equipment eligible for
Enhanced Capital Allowances

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Cover picture of Mitsubishi Heavy Industries equipment supplied by 3D Air.

Introduction

ECAs are a straightforward way for a business to improve its cash flow through accelerated tax relief. The scheme encourages businesses to invest in energy saving plant or machinery specified in the ETL to help reduce carbon emissions, which contribute to climate change.

The Energy Technology List (ETL) is a register of products that may be eligible for 100% tax relief under the Enhanced Capital Allowance (ECA) scheme for energy saving technologies[1]. The Carbon Trust manages the list and promotes the ECA scheme on behalf of government.

This leaflet gives an overview of heat pump equipment specified on the ETL and illustrates the reductions in energy bills that can be realised by investing in qualifying ETL energy saving equipment over non-qualifying equipment.

Background

The ETL comprises two lists: the Energy Technology Criteria List (ETCL) and the Energy Technology Product List (ETPL). The ETCL defines the performance criteria that equipment must meet to qualify for ECA scheme support; whereas the ETPL is the list of products that have been assessed as being compliant with ETCL criteria.

Further information

For more information on heat pumps, see **www.carbontrust.co.uk/heating** and **www.carbontrust.co.uk/airconditioning**

Setting the scene

A heat pump is a device that can transfer low temperature heat from a renewable source such as ambient air, water or the ground and raise it to a higher, more useful temperature using a refrigerant cycle. The relatively small amount of energy needed to transfer this heat is used to drive the refrigerant compressor. Typically, for every kWh of energy used to operate an electrically-driven heat pump, the resulting useful heat output is between 3kWh and 4kWh. Compared with an efficient gas boiler, the use of an electrically-driven heat pump can result in carbon savings of over 30%[2]. Heat pumps can therefore provide an energy efficient, low carbon form of space heating.

The majority of heat pumps sold in the UK have electrically-driven compressors. However, a gas engine can also be used to drive the compressor, in which case the waste heat from the exhaust gases can be collected as useful heat.

Heat pumps for non-domestic space heating consume approximately 4,000GWh a year[3]. Heat pumps are usually categorised by the heat source they use, which can be air, ground or water. The majority of heat products are air source heat pumps. The market for ground source heat pumps is currently small, but growing fast. While some machines are made for heating only, many heat pumps – especially those using air as the heat source – are also capable of providing comfort cooling by reversing the refrigerant cycle. Reversible air source heat pumps may also be called reversible air conditioners. In variable refrigerant flow (VRF) products it is possible to vary the flow of refrigerant in the unit, which enables them to vary their output to match demand.

Some VRF products can provide heating and cooling simultaneously and save energy by using heat removed from one part of a building to meet a demand for heat elsewhere.

1 Eligibility for ECAs is based on a number of factors. Visit http://etl.decc.gov.uk/etl to find out more.

2 Assuming gas boiler efficiency 90% (SEDBUK efficiency Band 'A'), heat pump COP 3.0, carbon emissions for gas 0.19 kgCO_2/kWh and for electricity 0.43 kgCO_2/kWh.

3 BNCH01 Model of UK consumption for non-domestic heating systems, Market Transformation Programme.

Benefits of purchasing ETL listed products

Developments in heat pump technology, such as advances in heat exchanger design and better capacity control, mean that efficiencies have improved significantly. However, the energy efficiency of products on the market varies widely. For example, for air source split heat pumps the coefficient of performance[4] (COP) typically ranges from 2.5 to 4.5[5]. This variation in efficiency between heat pump products means the potential for reduced running cost, energy consumption and CO_2 between different heat pumps, and heat pumps as a replacement technology, can be sizeable.

When replacing equipment, businesses are often tempted to opt for that with the lowest capital cost; however, such immediate cost savings can prove to be a false economy. Considering the life cycle cost before investing in equipment can help reduce costs and improve cash flow in the longer term.

The ECA scheme provides businesses with 100% first year tax relief on their qualifying capital expenditure. This means that businesses can write off the whole cost of the equipment against taxable profits in the year of purchase. This can provide a cash flow boost and an incentive to invest in energy saving equipment which normally carries a price premium when compared to less efficient alternatives.

This leaflet illustrates the reductions in energy consumption, carbon emissions and energy bills that can be realised by investing in qualifying ETL energy saving equipment over non-qualifying equipment.

Important

Businesses purchasing equipment must check the ETPL at the time of purchase in order to verify that the named product they intend to purchase is designated as energy saving equipment. Heat pump equipment that meets the ETL eligibility criteria but is not listed on the Energy Technology Product List (ETPL) at the time of purchase is not eligible for an ECA.

Heat pump equipment eligible under the ECA scheme

There are seven sub-technologies within the heat pump technology category included in the ECA scheme:

- Air source.
  - Split and multi-split including variable refrigerant flow (VRF).
  - Gas-engine-driven split and multi-split including VRF.
  - Packaged.
  - Air to water.
- Water source (internal water loop only) – Split and multi-split including VRF.
- Ground source.
  - Brine to water (indirect closed-loop heat exchanger, buried in the ground).
- Heat pump dehumidifiers.

Using the baseline scenario below, the potential financial (£), energy (kWh) and carbon savings (tonnes CO_2) have been calculated for comparison unless otherwise indicated:

- Annual heating utilisation: 1,080 equivalent hours at full capacity.
- Annual cooling utilisation (air and water source heat pumps): 575 equivalent hours at full capacity.
- Fuel price for electricity 8.7p/kWh[6].
- Fuel price for gas 2.6p/kWh[6].
- Gas boiler efficiency 90% (SEDBUK efficiency band 'A').
- Annual savings do not degrade.

4 The coefficient of performance (COP) is the heating output of the heat pump divided by the effective power input at a specified operating condition. For example a heat pump that delivers 10kW, with an effective power input of 2.5kW, would have a COP of 4. For an electrically driven heat pump the effective power input includes the power input to operate the compressor and any power for defrosting, the power for all controls and safety devices and the fan or pumping power needed to transport the heat transfer media for the source and heat delivery inside the unit.

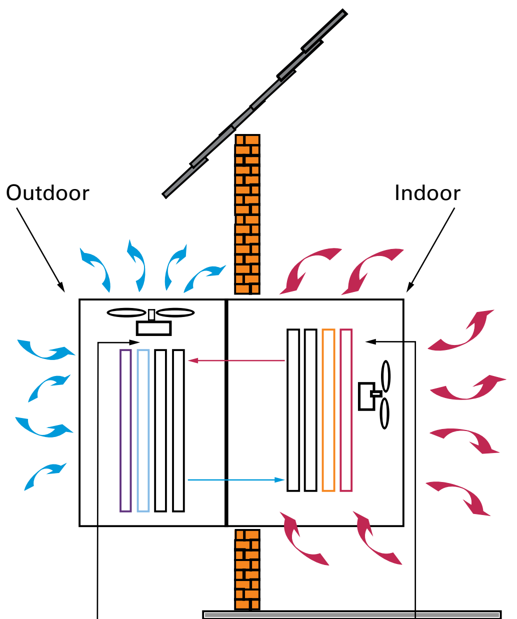
5 BNCHO2 Non-domestic heating system efficiencies, Market Transformation Programme.

6 Prices for fuels purchased by non-domestic consumers in the UK (annual average price for small consumers in 2008), Energy Statistics www.bis.gov.uk

Air source heat pumps

An air source heat pump obtains useful heat from the air itself and also the latent heat extracted from water vapour in the air. The process uses mechanical refrigeration technology to extract the heat and raise it to a useable temperature. Outdoor air is drawn through a heat exchanger where it is chilled by the refrigeration process and returned to the outdoors. The heat extracted from the chilled air is then transferred by the refrigerant and used to provide space heating via a second heat exchanger that circulates either indoor air or a fluid. The ECA scheme for air source products using ambient air (but not exhaust air) as the heat source. The heat can be supplied to either air or water.

***Figure 1** Schematic diagram of an air source heat pump in heat mode*



Air source heat pumps are available in a variety of configurations and many are reversible units, being capable of both heating and cooling. Those types that are eligible for ECAs are explained in this leaflet.

***Figure 2** Schematic diagrams of single and multi-split heat pumps in heat mode*

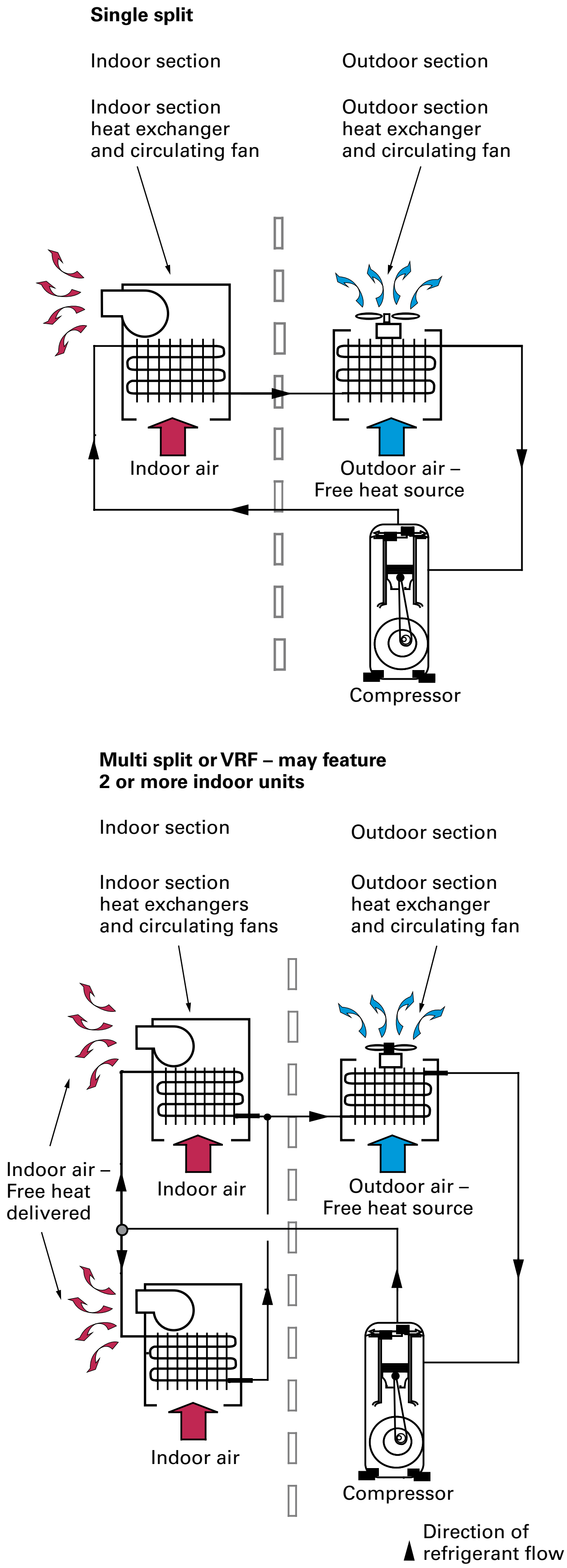
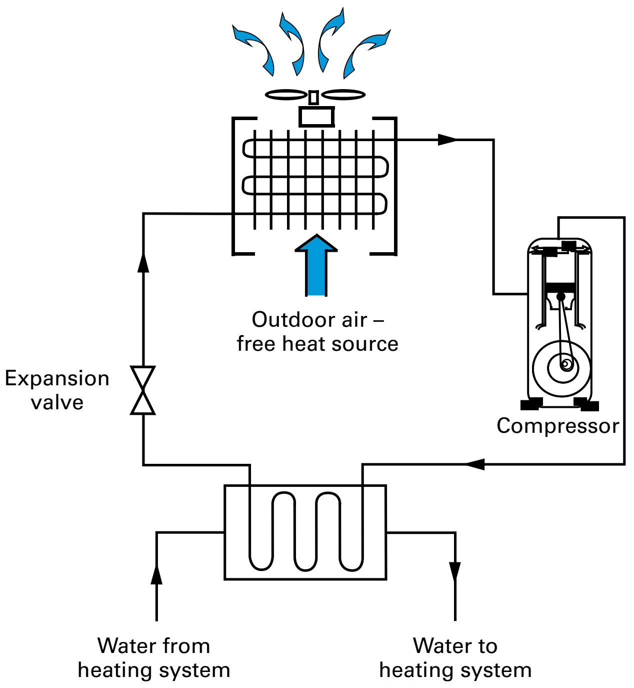


Figure 3 *Schematic diagram of air to water heat pump*



Installing an ETL air to water heat pump (heating capacity 12kW) at a capital cost of £12,800 and an annual running cost of £290, rather than a non-specified product with a capital cost of £12,000 and an annual running cost of £340, the potential annual savings are calculated as:

- £50.
- 600kWh.
- 0.2 tonnes CO_2.

By providing space heating from an ETL air to water heat pump (heating capacity 12kW) with an annual running cost of £290, rather than a gas boiler with an annual running cost of £375, the potential annual savings are calculated as:

- £85.
- 11,080 kWh.
- 1.3 tonnes CO_2.

Water source heat pumps

Water source heat pumps, as the term implies, obtain and relinquish heat from a water source. For the purpose of products listed in the ETPL, this means a circulated water loop within a building.

Frequently installed as a means of balancing heat load demand, they are an integrated heat/cool solution to mixed mode operation in large commercial buildings and offices. Where several heat pumps are connected to the same water loop, excess heat removed by the heat pumps in cooling mode is rejected to the water loop. It is then available as a source of heating for the heat pumps elsewhere on the loop operating in heating mode.

The water loop is equipped with a source of make up heat and a method of rejecting excess waste heat to cover conditions when the demands for heating and cooling are not balanced. These are usually a small boiler and an externally mounted dry cooler or an evaporative condenser, but can also be an air-to-water or ground-to-water heat pump.

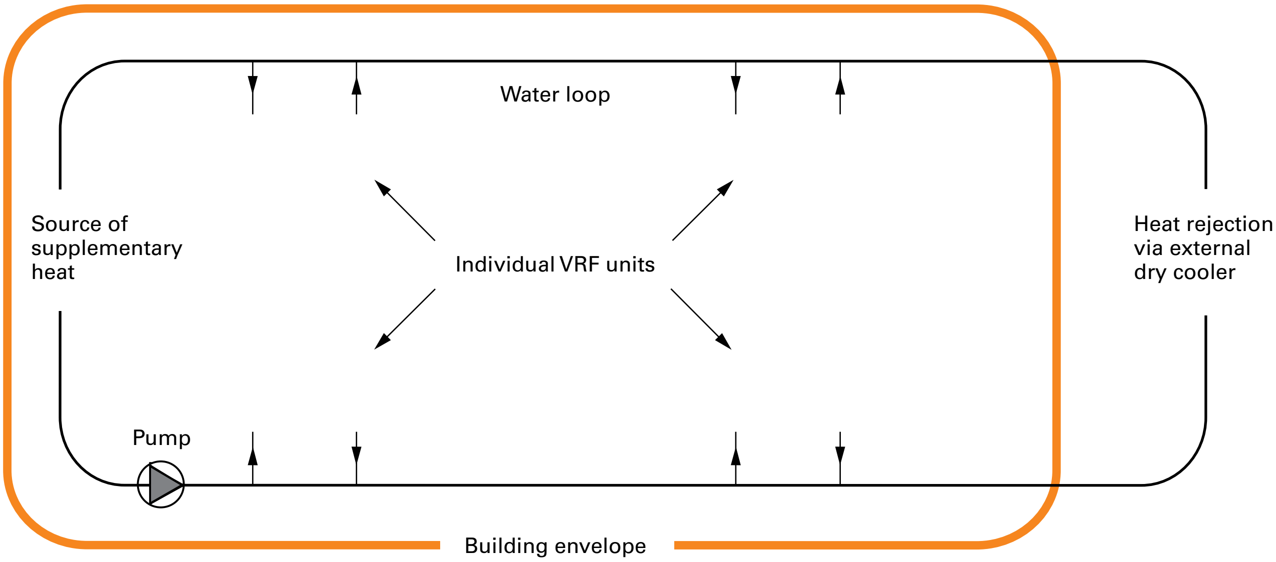
These heat pumps are free to modulate between heating and cooling, and exploit the tendency of some types of commercial premises to spend a high proportion of their operating time in a state of near equilibrium. This is where heat is emitted from internal cooling processes at approximately the same rate that heat is required for heating elsewhere in the building. In this way the water loop can exploit a source of what would otherwise be waste heat.

Providing that there is a demand in the building, excess heat from one room may be removed by local cooling. The heat is then rejected into the water loop and may be used by another heat pump elsewhere in the building that requires heat.

This is a cost-effective way of transferring useful heat and is an alternative to rejecting the heat outside the building, as would be the case with a conventional cooling unit.

Only split water to air VRF units are included on the ETL.

***Figure 4** Schematic diagram of water source VRF heat pumps using an internal water loop as a heat source*



Split water source VRF units

A water source VRF unit is an alternative to many small packaged water source units throughout the building. In addition, larger capacity main VRF units may be grouped together with all the other equipment and installed in a central plant room.

Heating and cooling is provided to the space by split indoor units connected to the VRF units with refrigerant lines and electrical controls, in the same way as a conventional air-to-air heat pump. The indoor units are available in a variety of configurations and capacity sizes, selected to suit the building design requirements.

The temperature of the water circulated within the loop is kept within predetermined limits.

Fuel savings from installing an ETL listed water source VRF heat pump compared to a typical non-specified product are typically 7% to 10%[7].

Ground source heat pumps

The ground is a reliable and predictable source of stored solar energy. Below a depth of about 6m the ground temperature remains almost constant throughout the year, staying between 10ºC and 14ºC, depending on the location and the local geology. Providing that the heat added to the ground is balanced so that it is not extracted faster than it can be replenished, the ground is a reliable and sustainable heat sink.

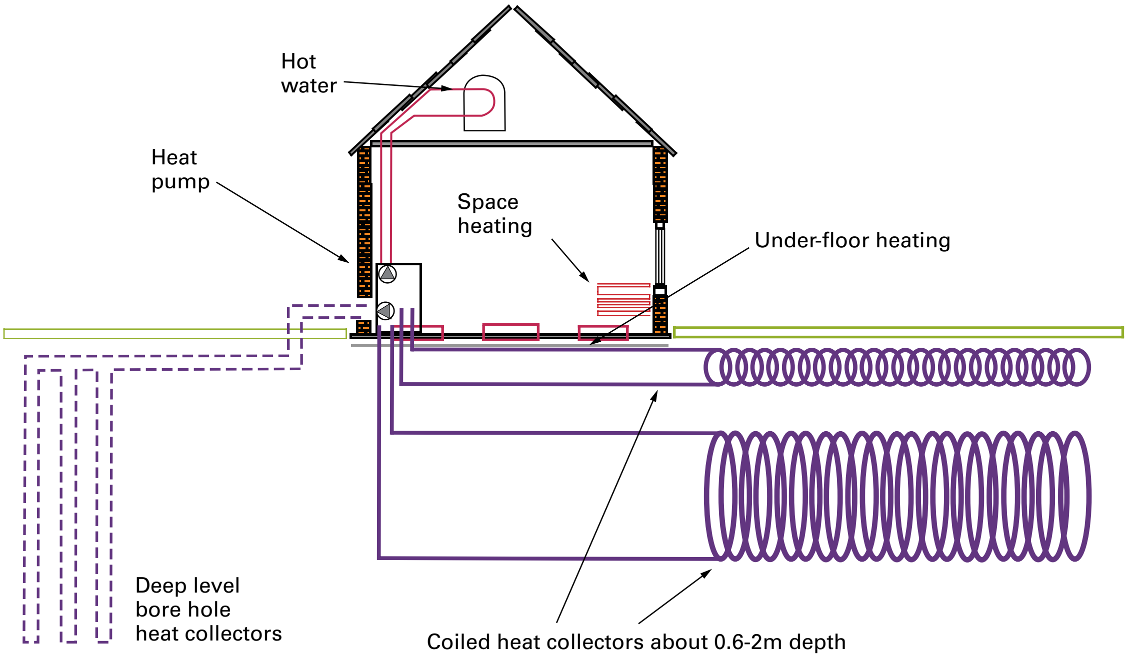
Ground source heat pumps circulate a water/anti-freeze mixture through a closed loop of pipes. These are buried either horizontally in a shallow trench at a depth of between 0.6m and 2.0m, or vertically in one or more boreholes between 15m and 180m in depth. The size and configuration of the collectors are dependent on the heat load, the type of the ground and how much is available for use.

While initial ground-work costs are higher than for air-source heat pumps of an equivalent capacity, capacity losses through periodic defrost and through reduction of ambient temperatures are avoided.

Only ground source heat pumps designed to deliver heat to water based heating systems are eligible for the ETPL.

[7] Assuming ETL listed product has COP 3.7, EER 3.3 ; non listed product COP3.4, EER 3.1.

Figure 5 *Schematic diagram of a typical ground source heat pump in heat mode showing types of ground heat collectors*



Brine to water

Brine-to-water heat pumps offer a choice of heat transfer in the building. They are used for sanitary water, indirect transfer though radiators or fan coils, or for underfloor heating. As the flow temperature for each of these may differ, some units may need to be optimised for one or more of these methods.

Brine-to-water heat pumps are typically self-contained units that may be installed either internally or externally according to the type of unit selected. Two independent sealed secondary circuits circulate low-temperature brine through the ground and hot water through the internal circuits respectively.

Brine-to-water heat pumps can provide heating and cooling as well as heating. They can also be used to heat domestic hot water, though additional heating may be required to boost the water temperature to comply with current regulations.

Energy savings from installing an ETL listed brine-to-water heat pump compared to a typical non-specified product are typically 10% to 18%[8].

Providing space heating using an ETL listed brine-to-water heat pump instead of a gas boiler could reduce carbon emissions by over 50%.

Installing an ETL brine-to-water heat pump (heating capacity 12kW) at a capital cost of £17,100 and an annual running cost of £260, rather than a non specified product with a capital cost of £16,000 and an annual running cost of £315, the potential annual savings are calculated as:

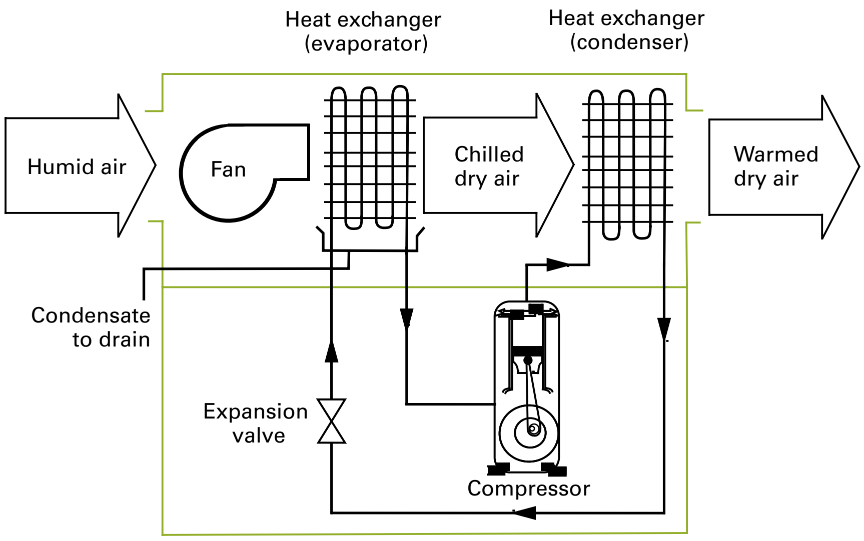
- £55.
- 585kWh.
- 0.3 tonnes CO_2.

By providing space heating from an ETL listed ground source heat pump (heating capacity 12kW) with an annual running cost of £2,460, rather than a gas boiler with an annual running cost of £375, the potential annual savings are calculated as:

- £115.
- 11,385 kWh.
- 1.4 tonnes CO_2.

8 Assuming ETL listed product has COP 4.3; non-listed product has COP 3.6.

Figure 6 Schematic diagram of a packaged heat pump dehumidifiercollectors



Heat pump dehumidifiers

A heat pump dehumidifier removes water vapour from moist air using refrigeration technology. They can be used to improve personal comfort, to protect building fabric and stored goods, and to dry industrial products. Moist air from the space is drawn through a heat exchanger where it is chilled by the refrigeration process. This causes the water vapour to condense and the resulting condensate is drained away. The sensible heat extracted from the air and the latent heat of condensation of the water is then transferred by the refrigerant and used to reheat the air via a second heat exchanger before the dry, warmed air is returned to the space. Any excess heat not required to heat the space can be used for other purposes such as water heating.

Products can consist of a single package or two or more factory-built sub-assemblies designed to be connected during installation.

Only heat pump dehumidifiers designed for permanent installation within the building (i.e. not portable units) and which have a dehumidification capacity greater than 0.625 litres/hour are eligible for inclusion on the ETPL. Fuel savings from an ETPL heat pump dehumidifier compared to a typical non-specified product are around 10%[9]. Where heat pump dehumidifiers are used to replace alternative technologies for providing dehumidification such as ventilation and heating, savings can be considerably greater.

Information for purchasers

For further information about the ECA scheme, the Energy Technology List (ETL) and other Technology Information Leaflets in the series please visit **www.carbontrust.co.uk/eca**, contact the Carbon Trust on 0800 085 2005 or email customercentre@carbontrust.co.uk

[9] Assuming the ETL heat pump dehumidifier has a dehumidification efficiency ratio (DER) of 1.80 litres/kWh compared to a DER of 1.62 litres/kWh for the non-specified product. The DER is the ratio of the dehumidification capacity to the effective power input of the dehumidifier measured over a defined interval of time.

Go online to get more

The Carbon Trust provides a range of tools, services and information to help you implement energy and carbon saving measures, no matter what your level of experience.

Carbon Footprint Calculator

Our online calculator will help you calculate your organisation's carbon emissions.
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The Carbon Trust offers a variety of events and workshops ranging from introductions to our services, to technical energy efficiency training, most of which are free. **www.carbontrust.co.uk/events**

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We have a library of free publications detailing energy saving techniques for a range of sectors and technologies
www.carbontrust.co.uk/publications

Need further help?

Call our Customer Centre on 0800 085 2005
Our Customer Centre provides free advice on what your organisation can do to save energy and save money. Our team handles questions ranging from straightforward requests for information, to in-depth technical queries about particular technologies.

* Subject to terms and conditions.

The Carbon Trust is a not-for-profit company with the mission to accelerate the move to a low carbon economy. We provide specialist support to business and the public sector to help cut carbon emissions, save energy and commercialise low carbon technologies. By stimulating low carbon action we contribute to key UK goals of lower carbon emissions, the development of low carbon businesses, increased energy security and associated jobs.

We help to cut carbon emissions now by:

- providing specialist advice and finance to help organisations cut carbon
- setting standards for carbon reduction.

We reduce potential future carbon emissions by:

- opening markets for low carbon technologies
- leading industry collaborations to commercialise technologies
- investing in early-stage low carbon companies.

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