Department for Business, Energy & Industrial Strategy

Energy Technology List

Heat pumps: Air to Air, Water to Air, Air to Water, Water or Brine to Water Heat Pumps

A guide to equipment eligible for ETL

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Introduction

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Introduction

The Energy Technology List (ETL) is a list created and updated monthly by the government's Department for Business, Energy and Industrial Strategy (BEIS), which provides details of energy-saving products for businesses. Since its inception, the scheme has assessed nearly 60,000 products, and now features 56 technology categories

To be listed on the ETL, heat pump **products must meet minimum efficiency criteria** to be listed on the ETL.

This leaflet illustrates the benefits of investing in heat pump equipment which qualifies for the ETL.

The ETL comprises two lists:

- **Energy Technology Criteria List**: defines the performance criteria that equipment must meet to qualify for the ETL;
- **Energy Technology Product List**: is the list of products that have been assessed as being compliant with ETL criteria.

Eligible heat pump products on the ETL can be searched at:

https://etl.beis.gov.uk/products/heat-pumps

Heat pump products may also qualify for the renewable heat incentive (RHI) which reduces the cost of the qualifying products for the buyer

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Setting the Scene

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Setting the scene: Heat Pumps

Further information
For more information see the Carbon Trust's Renewable energy sources guide (CTV010v3).

Heat Pump Definition

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 refrigeration cycle. Heat pumps are usually categorised by the heat source they use and the heat sink, which can be air, ground or water (eg air to air or brine to water). The majority of heat pump products are air source heat pumps, although the market for ground source heat pumps is growing.

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. While some heat pumps are made for heating only, many – especially those using air as the heat source – are also capable of providing comfort cooling by reversing the refrigeration 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.

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Setting the scene: Refrigerants

Refrigerants and their global warming potential (GWP)

Refrigerant gases used in heat pumps are more harmful to the environment than CO_2. But that is changing…

- The European Commission considered the environment impact of refrigerant gases to be so significant to the EU's climate goals that they introduced a phased withdrawal of many existing refrigerants from the market, known as the F-Gas regulation.
- Since the 1st January 2018 the F-Gas regulation has had a substantial impact of the market, requiring a 37% reduction in the global warming impact of refrigerant gases sold in the EU. The reduction is being met through the removal from sale of refrigerants with high GWPs such as R404A and R134a.
- The most common type of refrigerant currently used in heat pumps is R410A, though some lower GWP alternatives exist for some applications. R32 (GWP 675) is a widely advertised lower GWP refrigerant that is a viable replacement for R410A (GWP 2088) in small air-conditioning systems. Some heat pump manufacturers are already leading the market for R32 systems, although this is seen as a transitionary refrigerant due to it's medium GWP. It is expected that in the future HFO blends may replace R32 as a low GWP refrigerant in R410A systems, as is already the case for some ground source heat pumps in Scandinavia.

When choosing new refrigeration equipment select a product that uses a refrigerant with a medium or low GWP (e.g. R32, R290, R744).

- Some refrigerants have very low (e.g. R744 CO_2) or zero GWP (e.g. R290 propane)
- Choosing a product that uses a low GWP refrigerant future proofs the investment. It reduces ongoing maintenance costs as the price for high GWP refrigerants are increasing rapidly (e.g. 800% in 2017). It also avoids the need to refurbish the equipment at a later date to use a lower GWP gases as higher refrigerants gases are removed from the market.

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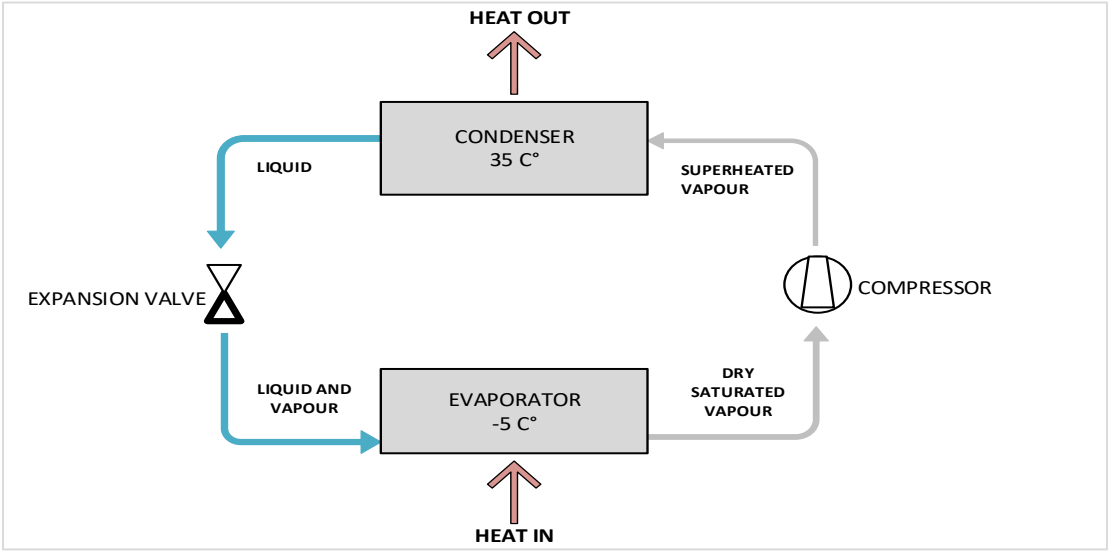
Standard Vapour Compression Heat Pump Circuit



Most heat pumps use a mechanical vapour compression cycle with the compressor driven by an electric motor. Standard vapour compression heat pumps work by alternately evaporating and condensing a refrigerant. The main components are shown in the figure above and include: an evaporator, a compressor, a condenser, an expansion valve and a refrigerant such as R410A. Standard heat pumps are able to efficiently provide water flow temperatures of up to 55°C.

Source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/565248/Heat_Pumps_Combined_Summary_report_-_FINAL.pdf

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Measuring heat pump performance

The steady state performance of a heat pump is measured by the **coefficient of performance (COP) which is the ratio of the heating capacity to the effective power input of the unit**. The COP is measured in terms of delivered electricity.

The **seasonal space heating energy efficiency (SSHEE) is a measure of performance averaged across a defined load profile, which is designed to represent real life use.** SSHEE is measured in primary energy terms allowing comparison of different technologies using different energy sources.

For gas heat pumps, Seasonal Primary Energy Ratio (SPER) is used as a performance measure. This is the ratio of the effective heating capacity to the total primary energy input (before any conversion or delivery losses, for example electricity generation losses) averaged across the heating season.

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%. Heat pumps can therefore provide an energy efficient, low carbon form of space heating. Furthermore, as the carbon intensity of the UK electricity grid decreases (with increasing uptake of renewable energy, and eliminating coal fired generation), the carbon savings from heat pumps will increase.

Updated from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/565248/Heat_Pumps_Combined_Summary_report_-_FINAL.pdf

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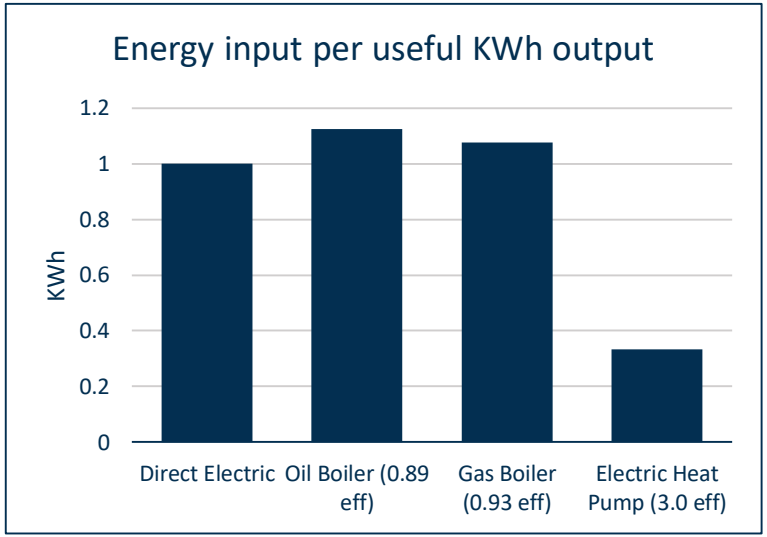
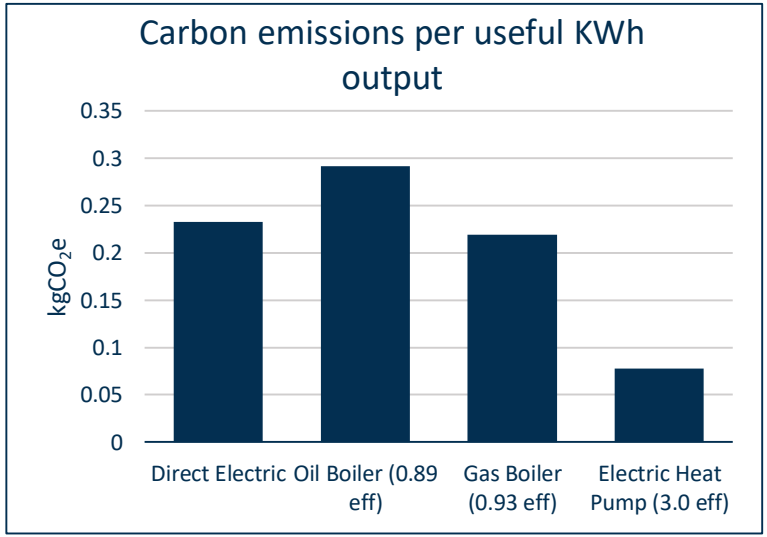
Example Performance





These graphs show a comparison between heat pumps and conventional heating technologies.
Energy savings are typically 60% to 70% compared to gas heating with carbon emissions savings of over 70% compared to oil boilers.
The carbon savings are increasing as the electricity grid becomes less carbon intensive.
Costs savings vary in relation to the difference between electricity and fuel prices (as well as the heat pump efficiency)

Source: ETL research 2021

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Common applications for different types of heat pumps

Heat pumps can provide space heating (or heating and cooling) to a wide range of commercial and industrial buildings. For heating, the **lower the required output temperature, the more efficiently a heat pump can operate**, so this heating technology is most suitable for air-based heating or low temperature water-based heating systems. Specially designed high temperature heat pumps have been developed for applications that need higher output temperatures.

The main air to air heat pump products are single and multi split and packaged rooftop or indoor heat pumps. They are used to provide space heating and cooling to a wide range of commercial buildings, often with VRF, and are also able to provide heat recovery. **VRF systems require no ductwork so free up internal space compared with warm air handling systems.**

Air to water single and multi split heat pumps are used predominantly in small retail, hospitality and offices and replace gas condensing boilers. Products can provide additional functions including sanitary hot water, hydronic heating and air curtains. Packaged products are used for larger retail and leisure premises with rooftops used where internal space is limited.

For small heating systems, a heat pump is an alternative to a conventional gas boiler heating system. For larger systems, a heat pump system is generally an alternative to a combination of a gas boiler and a chiller and fan coil units, or renewable heating such as a biomass boiler.

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Benefits of Purchasing ETL-listed Products

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Benefits of purchasing ETL-listed products

When replacing equipment, businesses are often tempted to opt for equipment with the lowest capital cost. However, such immediate cost savings may prove to be a false economy. Considering higher energy efficient products, means that life cycle costs are reduced, improving cash flow in the longer term.

In addition to the long-term financial savings, upgrading or replacing equipment with high efficiency products on the ETL provide greenhouse gas (GHG) emissions savings through the reduced demand for energy thereby improving your environmental performance.

Developments in heat pump technology, such as advances in heat exchanger design, better capacity control and use of EC fans, mean that efficiencies have improved significantly. However, the energy efficiency of products on the market varies widely.

For example, for air to water heat pumps to be listed on the ETL, the Seasonal Space Heating Energy Efficiency (SSHEE) at 52^{o}C output must be equal to or above 125% for large units (>45 KW) and 130% for units smaller than 45 KW. Low-temperature units, producing water temperatures at the outlet of less than 52^{o}C need to have a SSHEE value equal to or above 155%.

In the 2015 UK product requirements, medium and high temperature heat pumps (≥52^{o}C at outlet) were required to have a SSHEE value of 100%. This shows a 30% variation (improvement) in just over 5 years.

This variation in efficiency between heat pump products means the potential for reduced running cost, energy consumption and CO_2 between different heat pumps can be sizeable and selecting inferior or older products could result in underperformance and a longer payback time.

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Heat Pump Equipment Eligible Under the ETL

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Heat pump equipment eligible under the ETL

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

Air source heat pumps

- Split and multi-split including variable refrigerant flow (VRF)
- Gas engine-driven split and multi-split including VRF
- Packaged
- Heat pumps for domestic hot water heating
- Air to water

Water to air heat pumps (internal water loop only)

- Split and multi-split including variable refrigerant flow (VRF)

Water or Brine to Water Heat Pumps

- Brine to water (indirect closed-loop heat exchanger, buried in the ground)

Heat pump dehumidifiers

Heat pump driven air curtains

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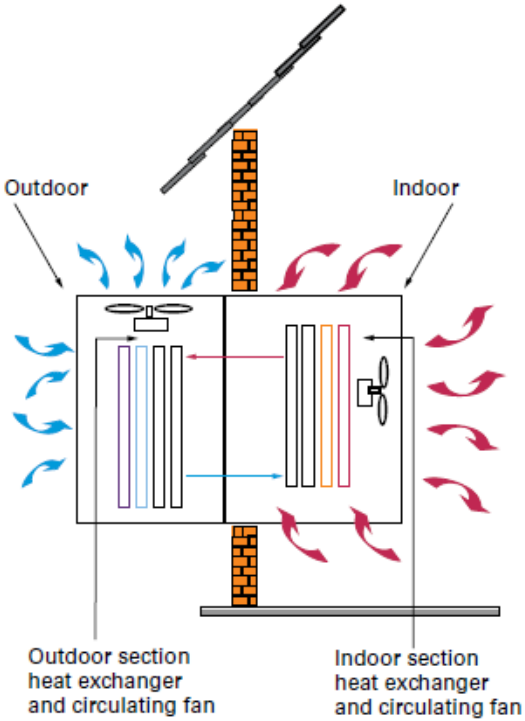
Products eligible under the ETL:
Air to Air heat pumps 1/2

Air source heat pumps

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 indoor air. The ETL includes air source products using ambient air (but not exhaust air) as the heat source. **The heat can be supplied to either air or water.**

Air to air heat pumps are available in a variety of configurations and many are reversible units, being capable of both heating and cooling. Figure 1 shows an air source heat pump in heating mode.

Single (one indoor unit) and multi-split (multiple indoor units) heat pumps are used predominantly in small retail and offices and replace gas condensing boilers. VRF have been used mainly in large commercial offices and hotels however the capacity range now extends down to under 12 kW so they can also be used for large residential and light commercial applications.



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Products eligible under the ETL:
Air to Air heat pumps 2/2

Air source heat pumps

Split and multi-split including VRF

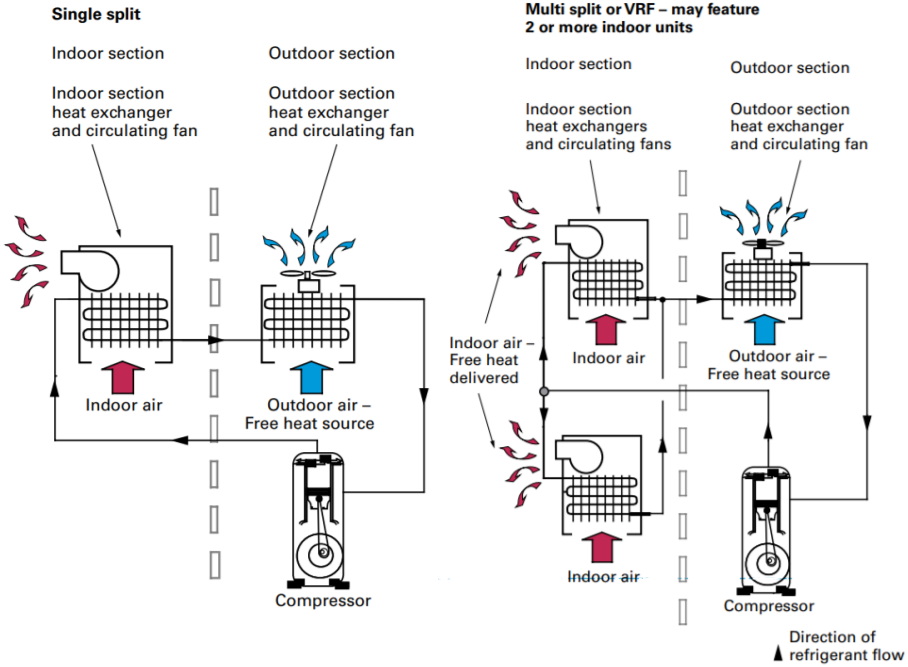
'Split' type heat pumps have separate heat collection and rejection units for each space known as 'outdoor' and 'indoor' units. The 'outdoor' and 'indoor' units are specifically designed to be connected together during installation by refrigerant pipework to form a single functional system. VRF heat pumps are systems specifically designed to automatically adjust the flow of refrigerant to each 'indoor' unit so that the heat delivered is matched to its demand. In particular, one of the 'indoor' units of a VRF system could be an air curtain.

Gas engine-driven split and multi-split including VRF

Air to air gas engine driven (GED) split and multi-split heat pumps use a gas-fired internal combustion engine to drive the compressor rather than electrical energy.

Packaged heat pumps

'Packaged' type heat pumps are single factory assembled units that incorporate all the elements of the refrigeration system and air distribution mechanisms for space heating. Packaged products are used for larger retail and leisure with rooftops used where internal space is limited.



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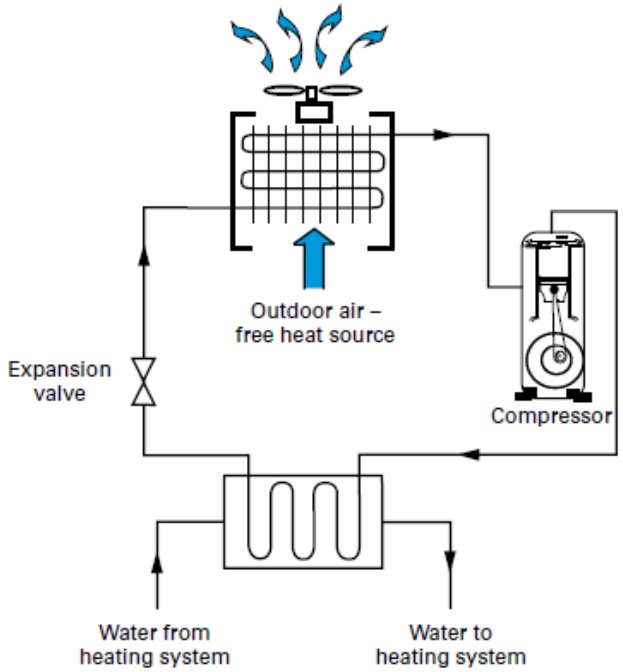
Products eligible under the ETL:
Air to Water heat pumps 1/2

Air to water heat pumps

Air to water heat pumps
Air to water heat pumps are products that are specifically designed to transfer heat from the air outside a building to a water-based heating system, by means of a reverse refrigeration cycle. They may also be used to provide domestic hot water for sanitary purposes as well as for heating. They are mainly used to provide domestic space heating but can also provide space heating (or space heating and cooling) to a wide range of commercial buildings.

They are most suitable for use with underfloor heating, fan coils or low temperature radiators as the efficiency reduces as the output temperature increases. The maximum output temperature for some products is about 52°C but many products can now go up to 65°C and can also be used to provide sanitary hot water. Some commercial products, particularly ones using CO_2 as the refrigerant, just provide sanitary hot water. Potential other uses include waste heat recovery and industrial process heating



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Products eligible under the ETL:
Air to Water heat pumps 2/2

Installing an ETL compliant air-to-water heat pump with a capacity of 12kW instead of direct replacement of an electric heating boiler of 32 KW, could lead to potential annual savings of:

- £2,658
- 21 MWh
- 4.9 tonnes CO_2

With a typical capital cost of £16,000 installed for the heat pumps (compared with £2,500 for a replacement electric boiler) and assuming a 10 year lifetime, the energy saving benefits could be around £18,743 at today's prices. It would only take 2.6 years to recover the extra capital cost for the heat pump. Further savings and a faster payback may be possible by claiming the Renewable Heat Incentive, local grants, or signing up to time of use tariffs.

Compared to direct electric heating, energy and carbon emission savings will both be typically over 62%.

An ETL listed heat pump must meet defined energy efficiency levels under various load conditions. In this case study, the baseline scenario below has been used to calculate the potential financial (£), energy (kWh) and carbon savings (tonnes CO_2) unless otherwise indicated:

- Annual heating utilisation: 1,080 equivalent hours at full capacity.
- Price for electricity 12.66p/kWh
- Carbon emissions for electricity 0.233 $kgCO_2$/kWh
- Electric boiler efficiency is 100%
- ETL listed products are presumed to be in the top 25% of energy efficient products available in the marketplace.
- For Air to Water Heat Pumps this translates into a Seasonal Coefficient of Performance of 3.33
- The annual increase in electricity cost is assumed to be equal to the discount factor (inflation) applied to the capital cost

Energy cost and emissions data from BEIS 2020

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Products eligible under the ETL:
Water to Air heat pumps 1/2

Water to air 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 ETL, this means a circulating water loop within a building. Frequently installed as a means of balancing heat load demand, water to air heat pumps are an integrated heating/cooling solution to mixed mode operation in large commercial buildings and offices. Whilst air-to-air VRF systems are used in similar applications to provide heating and cooling, for larger buildings water source heat pumps can provide a more suitable and cost effective solution. 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. Water loop systems are free to modulate between heating and cooling, and exploit the tendency of some commercial premises to spend a high proportion of their operating time in a state of near equilibrium. Heat is emitted from internal cooling processes at approximately the same rate that heat is required for heating elsewhere in the building. The water loop effectively transfers what would otherwise be waste heat to part of the building where it can be used. Excess heat from one room may be removed by local cooling by a heat pump unit. The heat is rejected into the water loop and may be used by another heat pump in another part of 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, multi-split and VRF units are included on the ETL.

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Products eligible under the ETL:
Water to Air heat pumps 2/2

Water to air heat pumps

Split water source VRF units

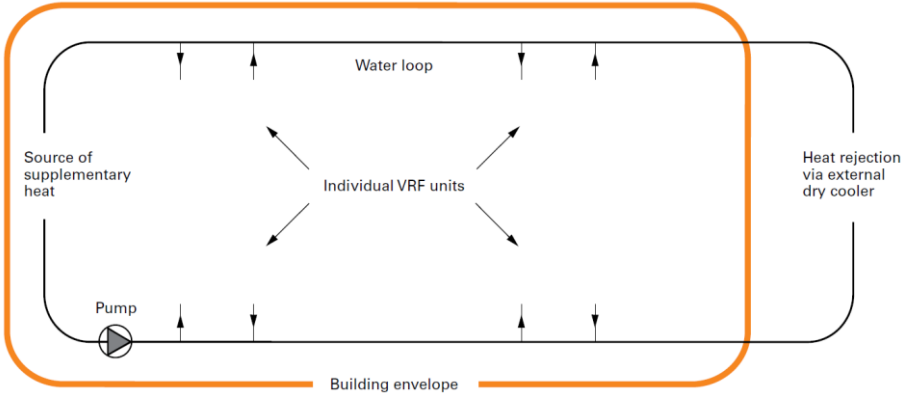
A water source VRF unit is an alternative to many small packaged water source units throughout the building. The VRF units are connected to the internal water loop.

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. They are used to provide space heating or cooling to commercial buildings. VRF are suitable for large buildings with simultaneous demands for heating and cooling .

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-eligible product are at least 25% greater.

Water source VRF heat pumps using an internal water loop as a heat source



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Products eligible under the ETL:
Water or Brine to Water Heat Pump

Water or Brine to Water Heat Pump
Water or Brine to Water Heat Pump systems are specifically designed to transfer heat from the ground or a surface water source to a water-based heating system by means of a refrigeration cycle. The liquid heat transferring medium for the heat pump may be brine or water. 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 10°C and 14°C, depending on the location and the local geology. Heat pumps using underground aquifers as the heat source are also eligible for the ETL within the Water or brine to water heat pump technology category. Pipes 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 (always required for underground aquifer source heat pumps). 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. Water or Brine to Water Heat Pumps use an electrically operated refrigeration system to transfer heat from the ground or surface water into a water-based heating system. They can be used to provide space heating in a wide range of buildings, and some products may be also able to provide cooling by reversing the refrigeration cycle within the product.

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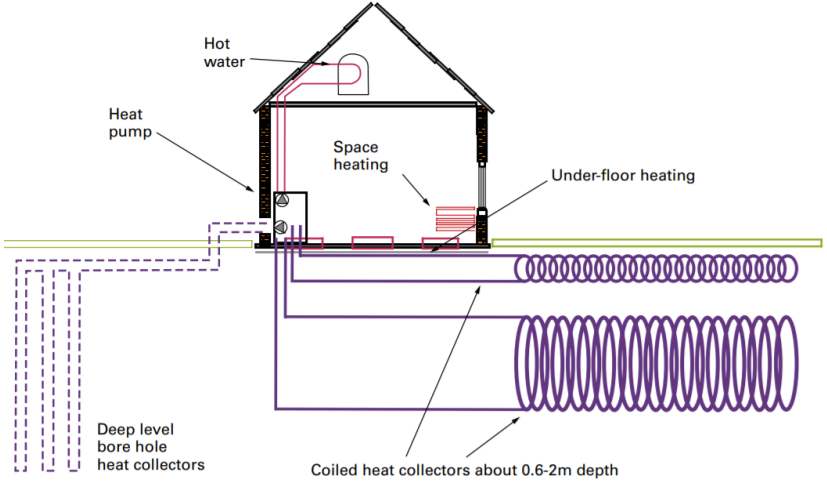
Products eligible under the ETL:
Water or Brine to Water Heat Pump

Water or Brine to Water Heat Pump

While initial ground-work costs are higher than for air source heat pumps of an equivalent capacity, capacity losses through periodic defrost are avoided and the efficiency can be much higher, especially during winter months when heating is needed most.
Only ground source heat pumps designed to deliver heat to water based heating systems are eligible for the ETPL.
Energy savings from installing an ETL listed ground source heat pump compared to a typical non-specified product are typically 10% to 18%.
Providing space heating using an ETL listed brine-to-water heat pump instead of a gas boiler could reduce carbon emissions by over 50%.

Brine to Water heat pumps
In a brine to water heat pump, the heat is collected from the ground or surface water by circulating a solution of water and anti-freeze (known as 'brine') through a buried or submerged, closed-loop, ground heat exchanger.

Water to Water heat pumps
In a water to water heat pump, the heat is collected from ground water (aquifer) or surface water by circulating the water through a direct, open-loop heat exchanger.



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Products eligible under the ETL:
Water or Brine to Water Heat Pump

Water or Brine to Water Heat Pump
Transfer medium Ground and surface water source heat pumps use either brine or water as the heat transfer medium that is circulated through the pipes. Ground source heat pumps typically circulate a water/anti-freeze mixture (brine) through a closed loop of pipes. Surface water heat pumps may use water or brine and aquifers typically use water. **Open and closed loop systems** Ground source 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 in a closed system and hot water through the internal circuits respectively. Surface water source heat pumps typically use an open loop system, where the water is extracted directly from the source and circulated through the heat pump, before being returned to the body of surface water. Alternatively, a closed loop system can be used whereby brine or water is circulated through the water source within a closed loop pipe. Using an open loop system can result in higher efficiencies, although maintenance and the impact on the water source can be higher.

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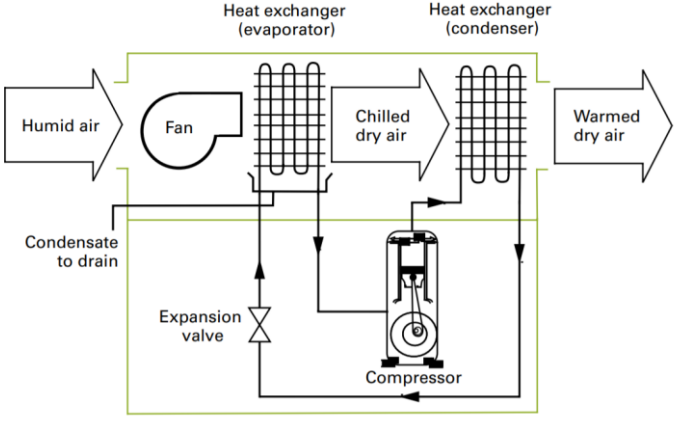
Products eligible under the ETL:
Heat pump dehumidifiers

Heat pump dehumidifiers

A heat pump dehumidifier removes water vapour from moist air using refrigeration technology.

They can be used to improve personal comfort, protect building fabric and stored goods, and dry industrial products. They are also well suited to leisure centres or hotels with swimming pools. Moist air from the space is drawn through a heat exchanger where it is chilled by the refrigeration process, 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 or equal to 0.625 litres/hour are eligible for inclusion on the ETL. Fuel savings from an ETL heat pump dehumidifier compared to a typical non-specified product are around 10%. Where heat pump dehumidifiers are used to replace alternative technologies for providing dehumidification such as ventilation and heating, savings can be considerably greater.



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Products eligible under the ETL:
Heat pump driven air curtains

Heat pump driven air curtains
Heat Pump Driven Air Curtains are products fitted above a doorway or similar opening that are specifically designed to reduce the infiltration of air from one space to another, and that is heated and/or cooled by a heat pump that transfers heat by means of a refrigeration cycle. Air curtains are used to reduce losses by disrupting the natural convection between two adjacent spaces that are at differing temperatures, thereby reducing the amount of heating or cooling needed to maintain the temperature of a space. They are typically used in commercial premises for situations where an open door is required to allow uninterrupted access or where traffic through the doorway is so high that the door is open for extended periods. Heat pump driven air curtains use a heat pump to heat or cool the air curtain expelled by the product. This reduces the need to heat the air directly with electricity or heat derived from other fuels. The ETL aims to encourage the purchase of higher efficiency split type heat pump driven air curtains, which have separate heat collection and rejection units for each space known as ‘indoor’ and ‘outdoor’ units. The ‘indoor’ and ‘outdoor’ units are specifically designed to be connected together during installation by refrigerant pipework to form a single functional unit. Within the Heat pump driven air curtains technology category, the ETL covers air curtains driven by either single-split or multi-split heat pumps.

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Further Information

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Renewable Heat Incentive (RHI)

Some heat pumps (ground source, water source and air source) are eligible for the RHI.

The RHI is a UK Government scheme which helps businesses, public sector and non-profit organisations meet the cost of installing renewable heat technologies. Payments are made over 20 years and are based on the heat output of your system.

The RHI is a current financial support mechanism to reduce the cost burden for high efficiency and renewable heating products. There are certain requirements for eligibility for the RHI, such as the heat pump units being less than 45 KW (for a single unit), and that the heat pump product is being used for both space heating and water heating, or just space heating.

For more information on the RHI, such as tariffs, qualifying technologies and guidance please follow this link to the UK Government RHI page.

For guidance on applying for the RHI, please follow this link.

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Where can I find more information?

For information about the ETL please visit: https://www.gov.uk/guidance/energy-technology-list and see our Information for Purchasers factsheet. Or contact the ETL Help Line on 0300 330 0657

For more information on the ETL:

To search for a product on the ETL please visit:
https://etl.beis.gov.uk/engetl/fox/live/ETL_PUBLIC_PRODUCT_SEARCH

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