



Department for
Business, Energy
& Industrial Strategy



Energy Technology List

Refrigeration Equipment: **Industrial**

A guide to energy efficient equipment listed on the Energy Technology List (ETL)



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Introduction

Energy Technology List

The ETL is a government register of energy saving products. When you select products from the list you are choosing from amongst the most energy efficient products in the marketplace.

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.

Businesses can also claim accelerated tax relief through the Annual Investment Allowance (AIA) for investments in plant and machinery equipment. The AIA has been temporarily increased to £1 million from January 2019.

This leaflet illustrates the benefits of investing in refrigeration energy saving 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 refrigeration products on the ETL can be searched at:

https://etl.beis.gov.uk/engetl/fox/live/ETL_PUBLIC_PRODUCT_SEARCH



Setting the scene

Further information

For more information see the Carbon Trust's [Refrigeration systems technology guide \(CTG046\)](#).

Definition

Refrigeration is the process of mechanically cooling or reducing the temperature of a space, a product or a process. There are two primary applications of industrial refrigeration equipment:

- Cooling, freezing and temperature maintenance during storage, transportation and distribution of food products
- Air conditioning systems

Other applications of industrial refrigeration can be found in chemical plant (for example, for the separation of gases), in manufacturing and construction, in ice and snow sports and in environmental test chambers. In some industries, most notably food and drink and chemicals, refrigeration accounts for a significant proportion of overall site energy costs.

Industrial refrigeration systems use large amounts of energy and typically cost 7-10 times as much to run over their lifetime as they do to buy*. Just in the Chemicals and Food and Drink manufacturing sectors, refrigeration is estimated to consume 5,240GWh/yr (over 5% of industrial electricity use)** , equating to carbon dioxide emissions of approaching two million tonnes per year.

The use of energy efficient industrial refrigeration equipment, such as that listed on the ETL, can result in significant energy savings and, therefore, reduced energy bills.

*Food and Drink Industry Refrigeration Initiative, Guide 2, Purchase of efficient refrigeration plant, IOR, July 2007

** UK Energy Consumption, BEIS and ONS, 2017



Industrial refrigeration equipment eligible for the ETL

There are eight sub-technologies within the industrial refrigeration technology category included in the ETL:

- Absorption & Other Heat Driven Cooling & Heating Equipment
- Air-cooled condensing units
- Automatic permanent refrigerant leak detection
- Refrigeration system controls
- Evaporative condensers
- Packaged chillers (tested for seasonal performance to ESEER)
- Refrigeration compressors
- Air blast coolers

ETL listed refrigeration equipment must meet defined energy efficiency levels under various load conditions. In this document, the baseline scenario below has been used to calculate the potential financial (£), energy (kWh) and carbon savings (tonnes CO₂) unless otherwise indicated:

- Refrigeration equipment operates continuously, 8,760 hours a year
- Price for electricity* 11.14p/kWh
- Carbon emissions* for electricity 0.35156 kgCO₂/kWh
- ETL listed products are within the top 25% of most efficient products in the marketplace

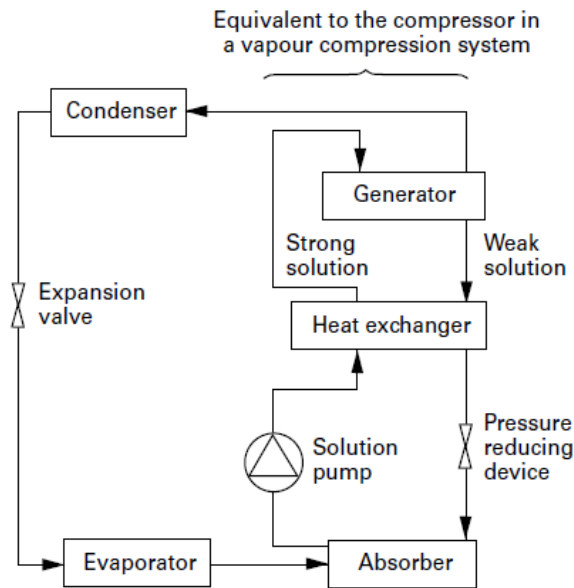
* BEIS 2017

Products eligible under the ETL: Absorption and Other Heat Driven Cooling & Heating Equipment

Absorption and Other Heat Driven Cooling & Heating Equipment

- This category only covers products installed as part of a CHP scheme that has been awarded a certificate from the CHP Quality Assurance (CHPQA) programme. The absorption chiller's useful chilling effect must be driven by heat derived from the CHP plant. The absorption plant is assessed with the CHP plant under the CHPQA programme*.
- Absorption coolers (chillers) are heat-driven (as opposed to electrically driven) machines used in industrial refrigeration to cool a process or product. They operate using an absorption refrigeration cycle. In this cycle, two fluids are used – a refrigerant in conjunction with an 'absorber' – which have a high mutual solubility.
- Figure 1 shows the absorption refrigeration cycle. The compressor of the conventional system is replaced by an absorber and generator. The refrigerant vapour from the evaporator is absorbed at low pressure and low temperature. The resulting solution is then pumped to high pressure and heated in the generator where the refrigerant is released. The remainder of the cycle is conventional.

Figure 1: Absorption refrigeration cycle



*<https://www.gov.uk/guidance/combined-heat-power-quality-assurance-programme>

Products eligible under the ETL:

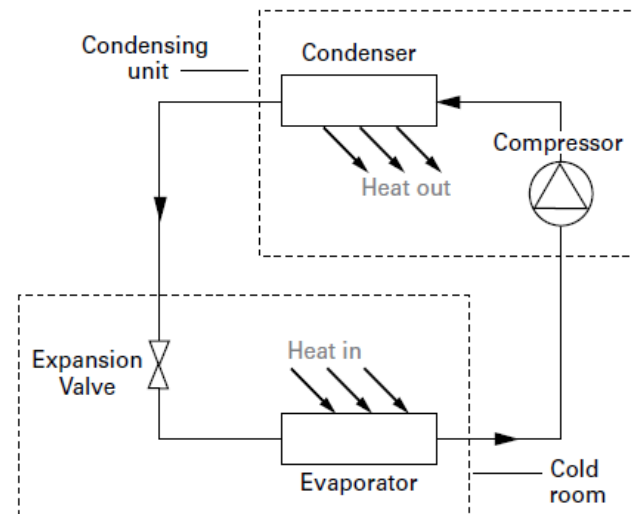
Air-cooled condensing units

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Air-cooled condensing units

- An air-cooled condensing unit consists of a compressor and an air-cooled condenser combined with various ancillary components, such as a liquid receiver, shut off valves, filter dryer, sight glass and controls.
- The unit is factory assembled and wired as a complete unit. It provides a convenient method for 'powering' a cold room or other cooling equipment that has an evaporator with expansion valve control. Refrigerant vapour from the evaporator is compressed and condensed to a high pressure liquid for return to the evaporator via the expansion valve. This process is shown in Figure 2.
- Medium and low temperature condensing units are widely used for frozen and chilled food storage. Evaporating temperatures are typically -35°C for frozen products and -10°C for chilled products.
- High temperature units are used in air conditioning applications.

Figure 2: Simple refrigeration circuit showing condensing unit linked by two pipes to a typical cooling load





Products eligible under the ETL: Air-cooled condensing units



Air-cooled condensing units

- The energy efficiency of an air-cooled condensing unit is dependent on refrigerant and operating conditions and is expressed as a Coefficient of Performance (COP) and/or SEPR (Seasonal Energy Performance Ratio). To be listed on the ETL, products must meet a minimum COP or SEPR performance threshold dependent on capacity and evaporating temperature. Products which are subject to the EU Ecodesign and Energy Labelling regulations must also meet SEPR thresholds set out under those regulations.
- Note that the COP quoted for ETL listed products is measured at the specified UK rating points shown in the ETL criteria.
- Efficiency can be enhanced by liquid sub-cooling within the unit. This can be achieved by using either additional dedicated coils in the condenser or two-stage or economised cycles.

By selecting an ETL listed air-cooled condensing unit rather than a non-compliant unit (25% less efficient), the potential annual savings are calculated as:

- £560
- 5,000 kWh
- 1.8 tonnes CO₂

With a typical additional capital cost of £300 and lifetime energy and AIA benefits of around £5,700 at today's prices, the financial benefit of choosing an ETL listed product is over 19 times the additional cost. Furthermore with a potential AIA of approximately £280 in year 1 plus additional energy savings, the extra capital cost is recovered within 1 year of purchase.

*11kW continuous load at -20°C with the condensing unit running approximately 20h/day. Average capital costs for ETL and non-ETL compliant units are £1,500 and £1,200 respectively.



Products eligible under the ETL:

Automatic permanent refrigerant leak detection



Automatic permanent refrigerant leak detection

- Automated permanent refrigerant leak detection systems are products designed to continuously monitor the atmosphere in the vicinity of refrigeration equipment and, in the event of detection of refrigerant, raise an alarm. This improves the energy efficiency of the refrigeration system and reduces carbon emissions and other greenhouse gases. The majority of industrial refrigeration systems currently use either an HCFC or HFC refrigerant. Some systems use ammonia; however, ammonia detection devices are currently outside the scope of the ETL.
- Leaking systems can contribute twice to climate change: firstly through the direct emission of refrigerants with a global warming effect; and secondly refrigerant leakage may lead to a reduction in the efficiency of refrigeration equipment leading to higher electricity consumption and therefore carbon emissions.
- A respected publication suggested that average refrigerant leakage rates are around 20% of total charge per year, and that typically a leaking system experiences an 11% reduction in efficiency*. Automatic permanent leak detection systems are usually multi-point or single point sensing devices. Automatic leak detection systems eligible for the ETL must be able to continuously and permanently monitor the refrigeration system for refrigerant leakage by detecting the presence of one or more specified refrigerants. They must also raise an audible alarm when the level of refrigerant in the atmosphere exceeds a specified level.

* Gartshore J. Energy Efficiency and Leakage Reduction. Refrigeration: Optimising refrigeration systems for building services engineers. CIBSE 2008



Products eligible under the ETL:

Refrigeration system controls



Refrigeration system controls

Refrigeration system controllers vary enormously in function and complexity. The simplest control is a thermostat which simply controls the temperature of the cooled space. More complex refrigeration systems, such as those with multiple compressors, ideally require more sophisticated control. When used in the right way, these controls can significantly reduce the amount of energy a refrigeration system uses. The ETL currently includes:

- System management units or packages consisting of one or more control units or modules that are designed to optimise an entire refrigeration system, including the operation of refrigeration compressor(s), evaporator(s) and condenser(s).
- 'Add-on' controllers that are designed to be used in conjunction with a specific system management unit or package, and enable the operation of additional refrigeration compressors, evaporators and condensers to be optimised.



© Parasense

The potential annual savings achieved as a result of selecting ETL listed refrigeration system controls, at an industrial site running 8 evaporators and one cold room are calculated as:

- £2,900
- 26,200 kWh
- 9.2 tonnes CO₂

With a typical additional capital cost of £3,600 and additional lifetime energy and AIA benefits of around £31,000 at today's prices, the financial benefit of choosing an ETL listed product is over 8 times the additional cost. Furthermore with a potential AIA of approximately £6,400 in year 1 plus additional energy savings, the extra capital cost is recovered within 1 year of purchase.

* Assume controls lead to 10% saving for a system using 262MWh/yr

Products eligible under the ETL: Evaporative condensers

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Evaporative condensers

- Condensers are used in a refrigeration system to liquefy the refrigerant gas discharged by the compressor. Most condensers used are air-cooled, i.e. ambient air is used to remove the heat from the condensing refrigerant.
- In an evaporative condenser, the gas to be condensed flows through a coil which is continually wetted on the outside by recirculated water. Air is drawn over the coil, evaporating some of the water.
- This improves the rate at which heat is rejected from the refrigerant gas, allowing it to condense at a lower temperature relative to the air temperature.

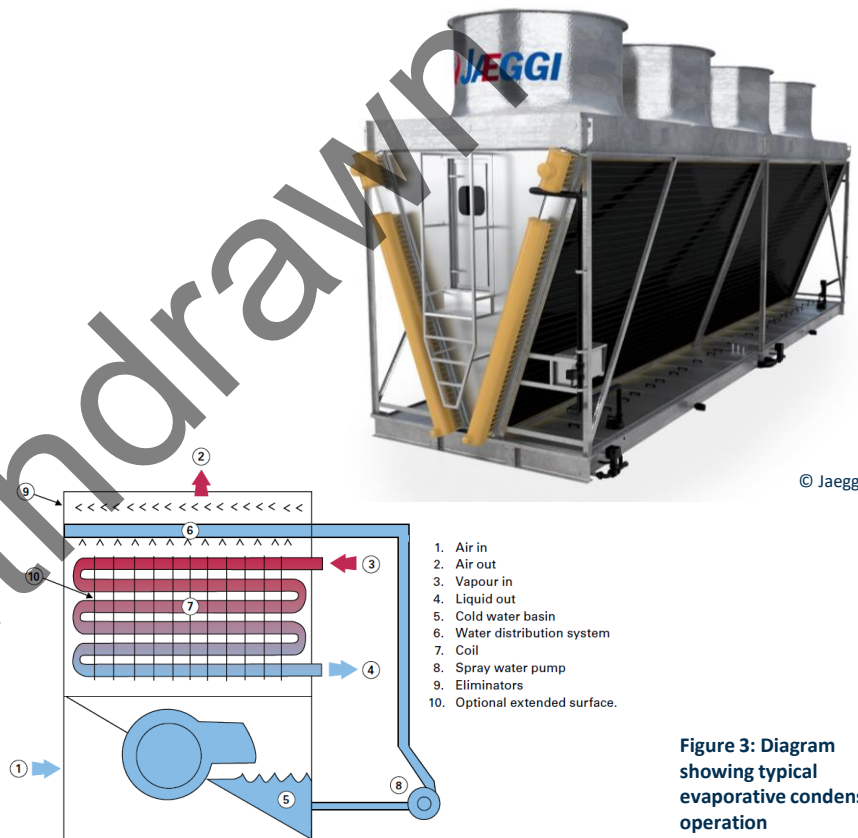


Figure 3: Diagram showing typical evaporative condenser operation



Products eligible under the ETL: Evaporative condensers



Evaporative condensers

An evaporative condenser has two advantages over an air-cooled type:

- The evaporation of water is more effective at removing heat than dry air.
- The heat is rejected against the wet bulb ambient temperature rather than the dry bulb. The wet bulb temperature is up to 8°C lower than the dry bulb in hot weather.

This means that evaporative condensers allow refrigeration systems to operate with lower head pressures and higher efficiencies than can be achieved using air-cooled condensers or water-cooled condensers.

Evaporative condensers must be kept clean and the fans and water pumps must be operational to ensure optimum performance. In addition, the water must be treated to prevent legionella formation.

Only condensers with axial fans are included on the ETL. Hybrid products which switch to dry operation when a switch point is reached, may also be eligible.

By installing an ETL listed evaporative condenser in place of an existing air-cooled condenser on a system with 700kW heat rejection, the potential annual savings are calculated as:

- £10,900
- 98,000 kWh
- 34.4 tonnes CO₂

With a typical cost of £37,000 and lifetime energy and AIA benefits of around £116,000 at today's prices, the financial benefit of replacing an air cooled condenser with an ETL listed evaporative condenser is over 3 times the purchase cost. Furthermore with an AIA of approximately £7,000 in year 1 plus additional energy savings, the capital cost is recovered within 4 years of purchase.

* Assuming design conditions of 1000kW heat rejection, 32°C dry bulb and 21°C wet bulb.



Products eligible under the ETL:

Packaged chillers

Packaged chillers

Packaged chillers are factory assembled refrigeration units that are designed to cool liquid using a self contained, electrically-driven mechanical vapour compression system. A packaged chiller includes the refrigeration compressor(s), controls and the evaporator in the packaged unit. The condenser may be built-in or remote. Some packaged chillers may also include a hydronic unit comprising a chilled water buffer tank and a chilled water circulation pump.

The ETL covers four categories of products:

- Air-cooled packaged chillers that provide cooling only
- Air-cooled, reverse cycle, packaged chillers that provide both heating and cooling.
- Water-cooled packaged chillers that provide cooling only.
- Water-cooled, reverse cycle, packaged chillers that provide both heating and cooling.

By selecting an ETL listed 400kW air cooled packaged chiller, rather than a non-compliant unit, the potential annual savings are calculated as:

- £4,600
- 41,800 kWh
- 14.7 tonnes CO₂

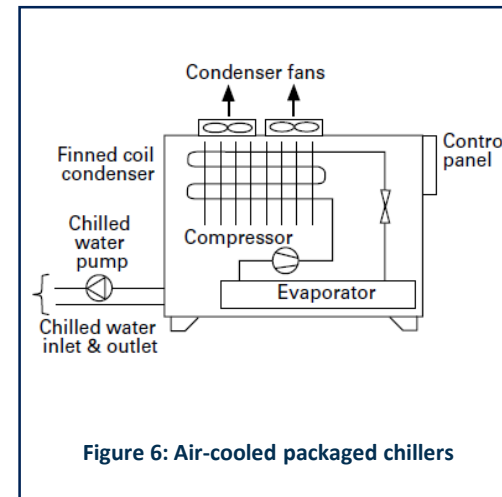
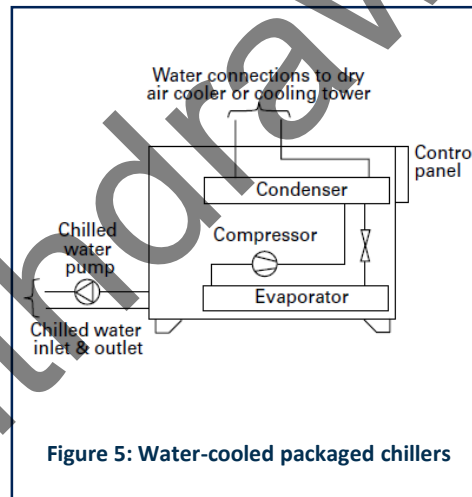
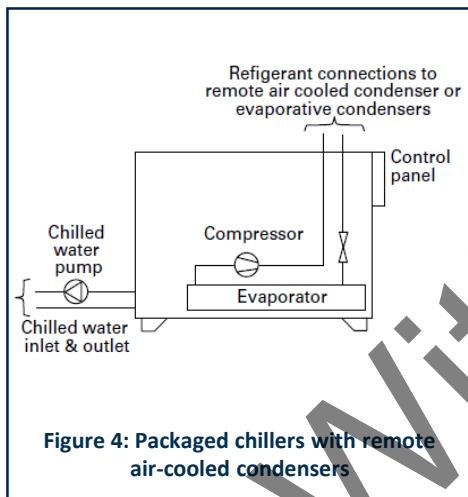
With a typical additional capital cost of £10,000 and lifetime energy and AIA benefits of around £50,000 at today's prices, the financial benefit of choosing an ETL listed product is over 5 times the additional cost. Furthermore with a potential AIA of approximately £11,000 in year 1 plus additional energy savings, the extra capital cost is recovered within 1 years of purchase.

*ESEER and capital costs of ETL and non-ETL listed units are 4.2 and 3.44, and £58,000 and £48,000 respectively.

*The chiller serves a 400kW process cooling load operates for 2000 hours per year.

Products eligible under the ETL: Packaged chillers

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Products eligible under the ETL: Refrigeration compressors



Refrigeration compressors

The compressor in a refrigeration system compresses the refrigerant gas from the low pressure of the evaporator to a higher pressure so that it can condense in the condenser, thus rejecting heat to ambient air or water.

The ETL covers the following types of refrigeration compressors:

- High temperature with HFC or HC refrigerant.
- Medium temperature with HFC or HC refrigerant.
- Low temperature with HFC or HC refrigerant.
- Medium temperature transcritical/subcritical with R744 refrigerant.
- Low temperature transcritical/subcritical with R744 refrigerant.
- Low temperature subcritical cascade with R744 refrigerant.

The compressor and motors are housed either in a hermetic enclosure which is welded tight, or in a semi hermetic enclosure which has gasketed removable covers.

By installing an ETL listed compressor with a 40kW capacity operating for 7,300 hours per year instead of a 15% less efficient, non-ETL listed one, the potential annual savings are calculated as:

- £1,100
- 9,900 kWh
- 3.5 tonnes CO₂

With a typical additional capital cost of £800 and lifetime energy and AIA benefits of over £11,000 at today's prices, the financial benefit of choosing an ETL listed product is over 14 times the additional cost. Furthermore with a potential AIA of approximately £900 in year 1 plus additional energy savings, the extra capital cost is recovered within 1 year of purchase.

Capital cost of ETL compliant unit is £4,800



Products eligible under the ETL:

Air blast coolers



Air blast coolers

- Air blast coolers are products that are specifically designed to cool water or process liquid by means of a heat exchanger, over which air is forced by a fan(s), prior to transfer to a refrigeration system. Air blast coolers include 'ambient air pre-coolers' and 'dry adiabatic coolers', commonly known as 'free coolers' and 'hybrid coolers'. General air blast coolers comprise a heat exchanger and cooling fan and are used to cool water and other process liquids. Packaged air blast free coolers can be used to pre-cool liquids prior to their transfer into the refrigeration system, reducing the refrigeration load. Adiabatic or hybrid products use the additional cooling effect of evaporating water.
- The ETL encourages the purchase of air blast coolers that either turn off the cooling fan when the ambient air temperature is high, and/or feature variable speed fan(s) with appropriate controller to modulate the cooling fan speed according to cooling demand. Air blast coolers that are sold as an integrated part of a mechanical chiller are covered by the 'Packaged Chillers' sub-technology of the ETL.

By choosing an ETL listed air blast cooler with a cooling capacity of 250kW and typical capital cost of £20,400, the potential annual savings compared with a non-listed product are calculated as:

- £290
- 2,600kWh
- 900 kgCO₂

With a typical additional capital cost of £3,400 and lifetime energy and AIA benefits of over £4,200 at today's prices, the financial benefit of choosing an ETL listed product is over 1 times the additional cost. Furthermore with a potential AIA of approximately £3,900 in year 1 plus additional energy savings, the extra capital cost is recovered within 9 years of purchase.

* Assume operating 6,000 hrs/yr with EER of 100 for ETL unit (which is 25% better than non ETL unit)



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; email ETLQuestions@carbontrust.com

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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