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Delivering, unlocking & advancing the low-carbon economy

Refrigeration systems

CASE STUDY

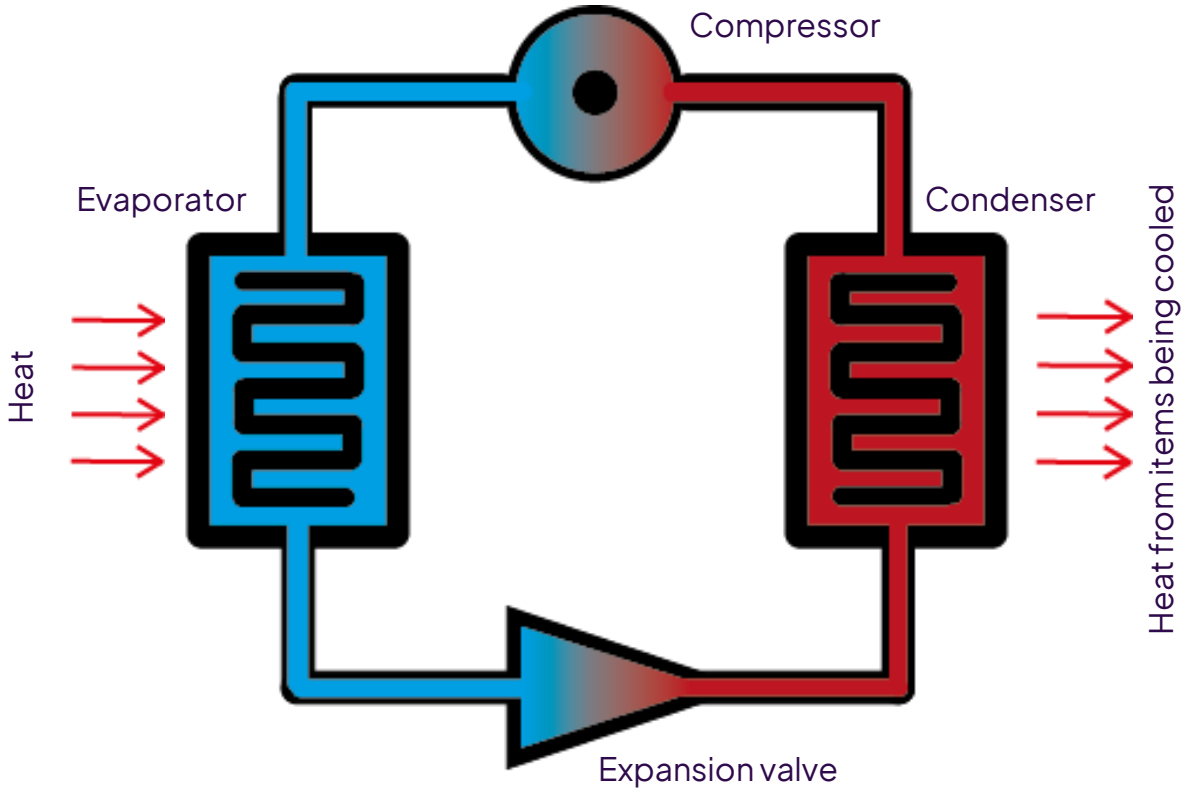
Business Type:	Brewery
Location:	Stockton-On-Tees
Current system:	5 in-line glycol chillers
Proposed system:	Single, larger, higher efficiency chiller
Installed cost:	£6,500
Simple payback period:	2.4 years
Lifetime:	15 years

ANNUAL SAVINGS

Electricity:	17,904kWh
Cost:	£2,661
Carbon:	5.3 tCO_2e (BEIS 2022)

REFRIGERATION

Refrigeration is a mechanical process by which heat is removed from one location, and moved elsewhere. This can be done in a variety of ways, but this factsheet focuses on vapour compression refrigeration systems, which make use of refrigerants to move the heat. They are used primarily in domestic and commercial situations to prolong product life and reduce spoilage. In commercial situations, refrigeration can be responsible for a significant proportion of the energy usage of a site and in some cases, well over 50% of the total. There are a number of ways to improve refrigeration energy efficiency which are often overlooked despite the potential for achieving large savings.



A refrigerator consists of four main parts: the evaporator, the compressor, the condenser, and the expansion valve. Refrigerant passes through these parts, transferring heat from the items being cooled and expelling it.

Evaporator: The liquid refrigerant in the evaporator is vapourised by the heat from the items being refrigerated.

Compressor: Raises the pressure and temperature of the refrigerant gas.

Condenser: The hot gas gives up its heat, which is released by the condenser to the surroundings.

Expansion valve: The refrigerant is allowed to expand, turning it back to cool liquid, which is then returned to the evaporator for the cycle to repeat.

DISPLAY CABINETS

Refrigerated display cabinets come in a variety of shapes and sizes and there are significant variations in their energy performance. Improvements can usually be brought about by changing the way that the cabinets are used. Hardware upgrades can bring about further improvements.

OPERATIONAL MANAGEMENT

Stocking: Overstocking restricts airflow which will make the equipment work harder and consume more energy. Ensure air vents are clear for good air flow.

Out of hours: Ensure lighting and anti-condensation heaters are switched off at night. Night covers should be used and kept in good repair. If the equipment is open fronted and doesn't have night covers, consider having some made and retrofitted.

HARDWARE UPGRADES

Controls: Automation of some maintenance cycles can lead to better energy performance and a suitable refrigeration technician could advise on available options for your business. Defrost setting should be matched to your cooling load and use temperature cut-off. Anti-sweat heaters can be automatically switched off when not required.

Aerofoils: Aerofoils attach onto the end of the refrigerator shelf and help reduce cool air loss out of the front of open fronted refrigerators. They can be retrofitted onto existing models.

LED lighting: Consider replacing fluorescent and older style lighting with more energy efficient LED lights.

Cabinet Doors: Transparent front opening or sliding doors can be retrofitted onto cabinets. This are especially useful where chillers may have infrequent use.

Replacement: If refrigerated cabinets are nearing the end of their service life, the best energy efficiency gains can be made by replacing them with modern, efficient units. Thoroughly researching the lifetime energy consumption of units can lead to savings in the long term, and the ongoing running cost should be considered alongside the capital cost of new units. All chilled cabinets from March 2021 must comply with minimum efficiency thresholds under

COLD ROOMS

Chiller and freezer rooms are susceptible to heat gain through door openings as well as through the building fabric such as walls and roof. There are a number of ways to help make them as energy efficient as possible:

OPERATIONAL MANAGEMENT

Shut openings: Keeping doors closed as much as possible to reduce heat gain.

Keep evaporators clear: Ensure that evaporators are clear to allow good airflow. Don't over-cool: Ensure that the space is only cooled to the highest allowable temperature for the products inside.

Maintain doorways: Regularly check door seals and strip curtains to keep in good working order and repair as needed.

HARDWARE UPGRADES

Upgrade doors: There are several options to reduce heat gain in a cold storage space. Standard strip curtains can be replaced with insulated versions. Automatic rapid close doors reduce the time heat has to ingress.

Fan and door interlock: Door interlocks can be installed which will turn off any fans whilst the doors are open. This reduces air movement and limits the amount of cooled air blown out of the room.

Insulate: Any improvements to the chiller or freezer room's walls, roof and ceiling's thermal resistance will help reduce the energy demand.

Defrost cycle optimisation: Walk in freezers have automatic defrost systems. If these are set to defrost too regularly, a lot of energy can be wasted. A refrigeration engineer will be able to recommend the most appropriate settings for the system and make adjustments to

HOW CAN I SAVE ENERGY ON REFRIGERATION?

COMPRESSORS

The compressor is the most energy intensive part of the refrigeration system and reducing the load on it will help save energy.

Set the condensing temperature: A refrigeration technician will be able to assist in lowering the condensing temperature to be as low as possible.

Regular maintenance: Having the cooling system regularly checked and maintained will reduce the chance of refrigerant loss. Undercharged refrigerant levels can cause increased energy demand, as well as be a direct source of emissions if the low level was caused by leakage.

Speed controllers: If the load across chillers varies across the different chiller units, the time of day or the seasons, then variable speed drives (VSDs) can help reduce energy usage. They do this by modulating the work the compressor does dependent on the cooling load. VSDs can either be retrofitted into existing systems, or new compressors with them already incorporated can be installed.

CONDENSERS

The condenser is the point at which the heated refrigerant vapour is cooled, giving up its latent heat as it turns from a gas back into a liquid.

Regular cleaning: Check condensers regularly for damage, and clean dirt and debris to ensure no blockages occur. Technicians can do this during routine maintenance.

Condenser load: If the current condenser struggles to meet demand at times of heavy use, consider installing additional condensers.

Fan replacement: When replacing condensers at the end of their life, consider upgrading to units which have the most energy efficient motors, or condensers which have DC brushless fans with electronic commutation.

Location: The efficiency of the whole refrigeration system is influenced by the location of the condenser so it is important that they are placed in a well ventilated area away from other heat sources.

EVAPORATORS

Evaporators are located within the chiller or cold room. In the evaporator, low-pressure refrigerant takes on latent heat from the items being cooled. Energy efficiency can be improved by considering the following:

Maintenance: Regularly check and clean evaporators. Ice build-up may indicate a problem. Coil cleaning should be performed by a technician.

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HEAT RECOVERY

Rejected heat in a refrigeration system is usually expelled as waste and if a site also has a heating requirement this resource can sometimes be utilised. High or low grade heat can be recovered and used to preheat water or support space heating. Further information on heat recovery can be found in our Heat Recovery Factsheet.

F-GAS REGULATIONS

Most refrigerants are from a group of gases called hydrofluorocarbons (HFCs), referred to in the refrigeration industry as 'F-gases'. These have a very high global warming potential (GWP), up to 3000 times greater than carbon dioxide. As such, their use is regulated and as a business, you are required to keep records about the equipment you operate if it contains F-gases equivalent to 5 tonnes or more of carbon dioxide. You can calculate the weight of F-gas in carbon dioxide equivalent here.

You must keep records for 5 years on the quantity and type of gas in the equipment when it is installed, if it is added during maintenance, and dates and results of all mandatory leak checks. What you have done to recover and dispose of gas must also be recorded.

Regular checking of the refrigerant levels in your business is useful to ensure that the equipment is functioning correctly, and is not leaking. You are breaking the law if the right leak checks are not in place, or if you don't fix leaks. Ensuring your system is leak free prevents unnecessary greenhouse gas emissions from occurring.

Some refrigerant gases are being phased out, and some have been banned. In 2020, the use of virgin HFCs with a GWP of over 2,500 was banned, and only recovered gases can be used to top up existing refrigeration systems.

It is important for businesses to ensure equipment is compliant, and this should be considered when installing new equipment, so that it will be well maintained for years to come, and you can help futureproof your business.

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ABOUT US

Decerna provides a wide range of consultancy and development services, to ensure that the right decisions are made, to support our customers in the whole journey, from initial concept through to implementation of low carbon systems and infrastructure. Please get in touch to find out how we can help your organisation to de-carbonise.

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