CTV002 Technology Overview

Refrigeration

Introducing energy saving opportunities for business

CARBON TRUST
Making business sense of climate change

Contents

Reducing energy use makes perfect business sense; it saves money, enhances corporate reputation and helps everyone in the fight against climate change.

The Carbon Trust provides simple, effective advice to help businesses take action to reduce carbon emissions, and the simplest way to do this is to use energy more efficiently.

This technical overview of refrigeration technology introduces the main energy saving opportunities for businesses and demonstrates how simple actions save energy, cut costs and increase profit margins.

Energy consumption

In some industries, most notably food & drink and chemicals, refrigeration accounts for a significant proportion of overall site energy costs. For instance, in the industrial handling of meat, poultry and fish, it often accounts for 50% of total energy costs. In ice-cream production the proportion is 70%.

Sector	Typical proportion of energy costs
Cold storage	90%
Food supermarkets	50%
Small shops with refrigerated cabinets	70% or over
Pubs and clubs	30%

In a number of commercial sectors, refrigeration also represents a significant proportion of overall energy costs, as shown in the table above.

Against these high costs, even a small reduction in refrigeration energy use can offer significant cost savings, resulting in increased profits.

> tion costs UK industry about
> onsible for discharging over
> into the atmosphere.

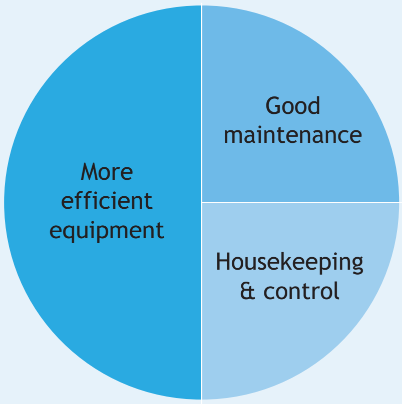
Summary of key areas

Energy saving need not be expensive. Energy savings of up to 20% can be realised in many refrigeration plant through actions that require little or no investment.

In addition, improving the efficiency and reducing the load on a refrigeration plant can improve reliability and reduce the likelihood of a breakdown.

The chart provides an indication of how most organisations can save energy and money on refrigeration.

This publication provides an understanding of the operation of refrigeration systems, identifies where savings can be realised and will enable readers to present an informed case on energy savings to key decision makers within their organisation.

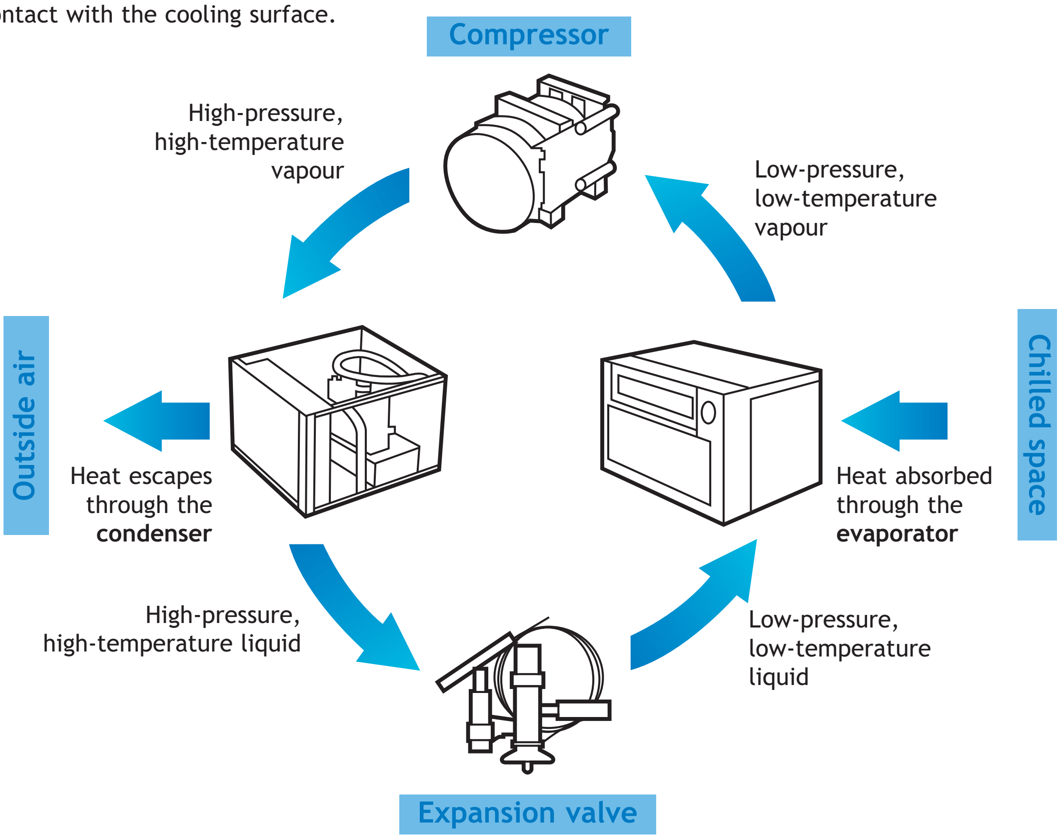


Technology overview

There are many different types of refrigeration system to suit the wide range of cooling needs in commerce and industry.

A number of systems cool the air that surrounds products being stored. The products eventually reach and are maintained at the same temperature as the cooled air. Such systems range from stand-alone cabinets for displaying chilled food to large, cold storage rooms for the bulk storage of frozen goods. In other applications such as process cooling of liquids, the product is cooled directly, that is the product is in direct contact with the cooling surface.

While applications and systems vary, the most common means of providing the refrigeration effect is the vapour-compression cycle.



How does a refrigeration system work?

The vapour-compression cycle is a closed-loop system wherein a refrigerant (or coolant) is used to extract heat from a product, thus cooling it. The extracted heat is then discharged to another area.

Heat is absorbed from the chilled space into a liquid (the refrigerant) by the **evaporator**. This heat turns the refrigerant into a low-pressure gas that flows away from the evaporator to the **compressor** where it is pressurised.

In the **condenser**, the gas gives up its stored heat (releasing it to the outside air) and condenses back to a liquid. It then flows through an **expansion** valve where pressure is released cooling the liquid and the sequence then begins all over again. The compressor also pumps liquid and gas around the system. Usually the condenser, expansion valve and compressor are outside the refrigerated space.

In small refrigeration applications such as stand-alone chilled display cabinets, fridges and freezers, all the components are commonly integrated into the housing of the unit. In larger systems, these components are often located in a central plant room or enclosure remote from the evaporator and cooled space.

Cold storerooms

For cold storerooms the compressors and condensers are often located outside the building in plant rooms or enclosures. Adequate ventilation is necessary to enable heat to dissipate.

Efficient operation of cold storerooms is covered on page 8.

Stand-alone units

In stand-alone fridges, freezers or display cabinets, the compressor and condenser are located at the rear of the cabinet. The condenser is usually a large panel (possibly finned) with a small pipe coiled back and forth across its area. This provides a large surface area for heat rejection to ambient air.

The evaporator is usually located inside the cooled volume, or just under the internal walls. It may not be visible without dismantling the cabinet.

For more information about running stand-alone units efficiently go to page 6.

Stand-alone fridges, freezers and refrigerated display cabinets

Stand-alone refrigerated units are in widespread use due to their flexibility, comparative low purchase cost and ease of installation. However, such units often operate inefficiently and waste energy. A few simple actions can significantly improve efficiency and reduce costs.

Control the temperature

Ensure that the temperature setting is not too low. Overcooling wastes energy and does not improve the preservation of product.

In order to maintain food hygiene, refrigerated food must be stored at the appropriate temperature. The table on the following page shows the temperature ranges for different types of display case and applications.*

Check seals on doors

Faulty or improperly fitting seals allow cool air to escape from the refrigerated space and warm air to enter in its place. This makes the refrigeration system work harder and wastes energy with no benefit.

Where the seals are faulty, a suitably qualified service technician should replace them.

> If you set the refrigeration temperature 1°C too low, you could increase running costs by 2% to 4%.

Control lighting

Lights add heat to the cooled space, causing the refrigeration system to work harder.

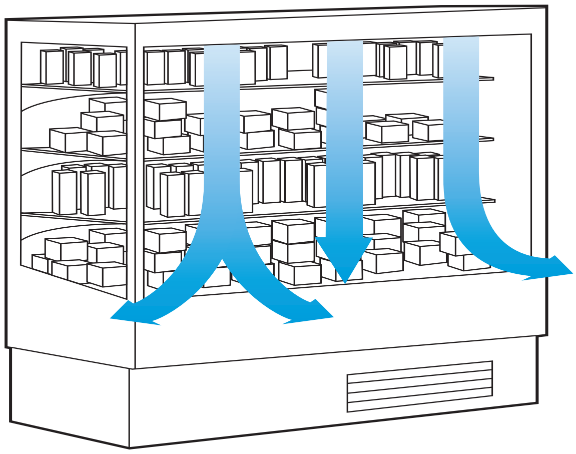
Ensure that internal lights in refrigerated spaces are switched off when not in use or outside of trading hours. This will save the energy consumed by the light itself as well as energy used to remove the excess heat.

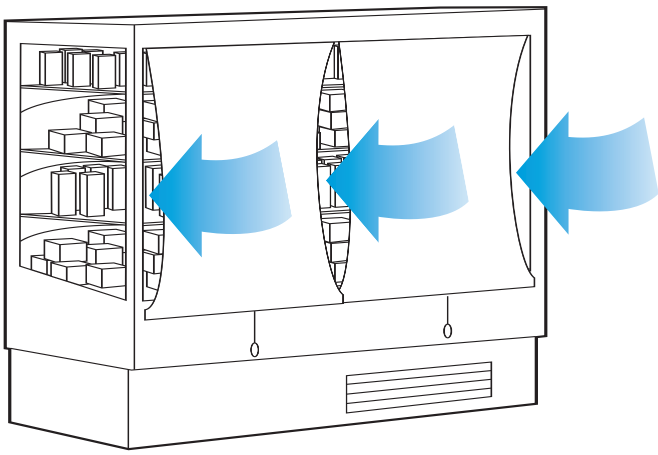
Where lights are controlled by the opening and shutting of the refrigerator door, ensure that the switch operates properly.

Don’t overfill

Overfilling the appliance will reduce the cold airflow around the products, reducing the performance and efficiency of the refrigeration system.

In open fronted display cabinets, do not load product in front of the air curtain as this will force cooled air out of the unit and require greater refrigeration effort. Cold air spilling out of the refrigerated display cabinet may also reduce comfort levels for your customers and require additional energy use from your space heating system.





Locate the unit to minimise heat gains

The warmer the air around the refrigerated equipment, the harder it has to work. Avoid installing the equipment near sources of direct heat such as radiators, hot cooking equipment and direct sunlight.

Ensure that the condenser has ample ventilation so that the rejected heat can be dissipated easily.

Install night blinds

Night blinds are an effective means of retaining cooled air in open-fronted display cabinets when retail premises are closed.

Make sure that night blinds are well installed, fit properly and are in good condition, as the heat gains caused by badly fitting night blinds can be significant. The gap between the edge of the night blind and the cabinet should be no more than 20mm.

Temperature code	Product temperature	Suitable for
L1	Below -15°C/-18°C**	Ice cream and frozen foods
L2	Below -12°C/-18°C**	Frozen foods
M0	Between -1°C & +4°C	Poultry and meat
M1	Between -1°C & +5°C	Meat and dairy products
M2	Between -1°C & +7°C	Processed meat and dairy products
H1	Between +1°C & +10°C	Produce and canned and bottled drinks
H2	Between -1°C & +10°C	Canned and bottled drinks

* The products in the table are only a guide. Refer to the Food Safety (Temperature Control) Regulations 1995 or your food supplier for more specific information relating to your food storage requirements.
** The maximum temperatures shown are those allowed after defrost.

Cooled storerooms

For organisations that operate cooled storerooms for bulk storage of frozen or chilled products, energy for refrigeration can represent a significant cost, often in excess of 50% of the total energy bill.

Good housekeeping measures in cooled storerooms do not require special skills or training and can realise a substantial reduction in running costs.

Don’t overcool

Many cooled storerooms are held at lower temperatures than required due to worries about equipment failure.

Operators believe that the lower temperature will provide a few hours grace to get a contractor to repair any failed components before the perishable goods exceed their storage temperature.

In reality, overcooling a storeroom increases the probability of equipment failure by increasing the duty on the refrigeration plant.

Always ensure that the temperature setting satisfies the requirements for safe storage of food. See page 7 for further information.

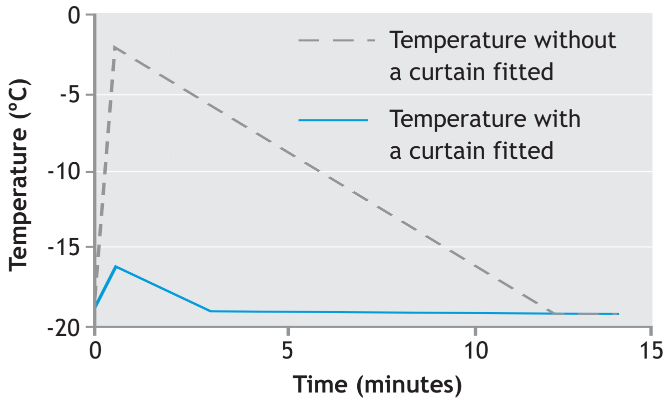
Minimise the air change rate

Air changes in cooled storerooms can account for up to 30% of the total heat load, as cool air escapes and warm air enters. This can be minimised by ensuring that doors remain closed as much as possible. Consider fitting self-closing doors if possible.

Ice build-up on storeroom floors and walls is a good indication that a high level of air change is taking place.

When a door is used regularly, install a strip curtain to prevent cool air escaping from the storeroom. Ensure that the curtains are well fitted and stay in good condition. Replace damaged strips as required.

Identify any other places where warm air could infiltrate the chilled spaces and fix them. Look out for damage or gaps to walls (especially seams between panels), and ports for conveyors and pipes, etc.



fact:

One PVC strip curtain manufacturer monitored the temperature of a small freezer store with and without a curtain. Every time the door opened the air temperature in the cooled space increased from -19°C to -2°C without the curtain, but only to -16°C with a curtain in place. The time taken to reduce the store temperature back to -19°C was 12 minutes without the strips and 3 minutes with.

Optimise the performance of the evaporator

Over time, ice will form on evaporators that operate below 0°C. As ice builds up, the evaporating temperature drops causing the refrigeration system to work harder.

> Check your door seals. A faulty door seal could increase power consumption by 11%.

The capacity of the refrigeration system could also drop due to a build-up of ice. As a result, the storeroom may not get down to the required temperature. Regular defrosting to prevent ice formation on the evaporator is essential to maintain optimum performance and efficiency levels.

Evaporators are usually fitted with automatic defrost systems to prevent the build-up of ice. Check the defrost system to ensure that it is functioning correctly. Remember that defrost systems add to the heat load in the storeroom so they should be run just sufficiently to control the build-up of ice.

Investigate the installation of a defrost-on-demand system which initiates defrost when needed rather than by timer.

Make sure that products are not stacked under or in front of the evaporator as this will impede airflow around the storeroom, resulting in an increase in temperature and, consequently, the refrigeration system consuming more power than necessary.

Reduce the heat load

Heat gains from ancillary equipment in the storeroom should be minimised. The heat from evaporator fans can contribute up to 15% of the refrigeration load and even the lighting can account for a further 10% of the load because of the heat it generates.

Talk with a refrigeration contractor to investigate replacing existing fan motors with lower power units.

Where evaporators have two or more fans, all fans need not be kept running all the time. To ensure even temperature distribution throughout the storeroom, some fans must run continuously. However with a relatively simple modification to the control circuit, fans can be switched on and off in relation to the refrigeration requirements of the storeroom.

Check the lighting in the storeroom and ensure that it is switched off when not required and that energy efficient lamps are used which contribute less to the heat load. Many conventional types of lighting equipment cannot be switched on at low temperatures.

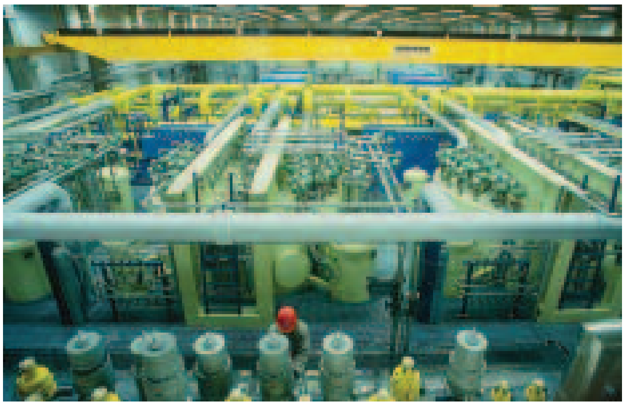
Consider additional items that give off heat in the cooled storeroom such as other motors (say, for conveyors), fork-lift trucks and charging devices. Remember that people give off heat. Ensure that they wear adequate thermal clothing for their own comfort and safety as well as reducing energy costs.

> Overcooling does not provide any extra benefit for the product, increases the likelihood of equipment failure and wastes energy.

Refrigeration plant

Cost savings of 50% or more could be achieved by ensuring that the refrigeration plant is well operated and maintained. Also, improved reliability will reduce the chance of unplanned stoppages or business interruption.

Although most changes and repairs to refrigeration plant will require the assistance of a suitably qualified refrigeration maintenance contractor, it is important to be able to identify problems as they arise so that appropriate help can be sought at an early stage.



Nick Wall/Science Photo Library

Repairs and optimising the operation of your refrigeration plant will save you money. A suitably qualified technician should carry out most actions.

Keep condensers clean and cool

Condensers are used to reject waste heat from refrigerant. When they are blocked or fouled, the condensing temperature increases resulting in greater required refrigeration.

For air-cooled condensers, ensure that there is an ample flow of ambient air over the heat exchanger surfaces. Grilles should be free of debris or blockages and there should be no dirt, fouling or corrosion to the heat exchanger itself. Remove any objects (such as stacked boxes) that might reduce free air movement from around the condenser. Consider shading condensers from direct sunlight if required.

Ventilate the plant room

A compressor in a poorly ventilated plant room will run hotter than necessary, which will reduce reliability and performance. Provide adequate ventilation by making sure that cool air can enter the plant room and warm air can be removed. If necessary, use an extractor fan controlled to switch on when the internal temperature gets too high.

Refrigerant leakage

Most large refrigeration systems have sight glasses where the refrigerant can be seen. If bubbles can be seen in the refrigerant when the system is in a stable operation, it usually indicates that there is a refrigerant leak in the system. As refrigerant levels drop, the system will operate less efficiently and may not achieve the desired cooling level.

Many common refrigerants are powerful greenhouse gases. For instance, 1kg of the refrigerant R134a has a global warming potential 1,300 times greater than that of 1kg of CO_2.

One small failure in management of refrigerant leakage could neutralise any benefit of savings in CO_2 through energy efficiency.

It is illegal to knowingly vent refrigerants. As soon as a leak becomes apparent, find and repair it before recharging the system with refrigerant.

> A 15% loss in refrigerant gas could increase power consumption by 100%.

Check the oil level

Compressor reliability may be reduced if the oil level (shown in the compressor's sight glass) is too low or too high. Check the oil level regularly and if a change is noticed, take steps to have the cause identified and corrected by a qualified service technician.

Neither oil nor refrigerant are lost from the system during normal operation. If the levels change, there is a problem. Oil may leak or be trapped somewhere in the system. Refrigerant can only be lost through leakage.

> You should be satisfied that you have a good contractor. The next section covers finding and engaging a contractor.

Noisy compressors

Listen for excessive noise coming from your compressor. This could mean that bearings are worn, resulting in reduced performance and efficiency. Worn bearings should be replaced by a refrigeration maintenance contractor.

Pipework

Vibrating pipework that is not properly supported is more likely to fracture resulting in a major refrigerant leak. Consult your refrigeration maintenance contractor to ensure that pipes are properly secured.

Insulation on pipework should be in good condition to prevent unnecessary heat gains. Replace insulation where it is damaged or missing. Waterlogged insulation will be a considerable source of heat gain and the source of the water logging should be identified and repaired.

Monitor the control settings

Refrigeration systems have several automatic control parameters and cut-outs. These are set during system commissioning, but may drift away from the ideal level over time, resulting in inefficient or needless operation of the system.

Check your system settings periodically to ensure that they remain at optimum levels.

Maintenance

Regular maintenance will save money by ensuring the refrigeration plant operates efficiently and will reduce the risk of business interruption through breakdowns.

Simple actions

Keeping your refrigeration system in good condition requires both inspection and maintenance.

Inspect

- Look out for scaling and ice build-up on the evaporator fins. This will hinder heat extraction
- Listen for excessive noise coming from compressors – it could mean worn bearings and may need to be replaced by a technician
- Check evaporators and condensers for broken vent fins which make it more difficult to transfer heat. Your refrigerator maintenance technician can replace damaged fins.

Maintain

- Ensure that bleed/drip pipes are not iced up. On metal pipes gentle heat can be applied to defrost. Check that any integral defrosting element is working correctly
- Excessive ice build-up on evaporators means poor heat exchange. A stiff brush will remove light ice build-up, but never chip at the ice – it could damage blades. Heavy ice needs removing by following the manufacturer's guidelines for defrosting the equipment
- Have compressor units serviced and lubricated regularly.

> Take time to do simple jobs and have units serviced regularly. For repairs always use a qualified refrigeration contractor.

Choose a high-calibre contractor and make sure that the contract selected provides appropriate cover

Refrigerator system suppliers should be able to recommend a good refrigeration service technician. Professional bodies such as the Institute of Refrigeration or the British Refrigeration Association may also be able to help. In appointing a contractor, the following points should be considered:

- Are the contractors familiar with your particular type of refrigeration plant?
- Are the contractors located locally and how quickly can they respond to call-outs?
- How will they provide support when their regular technician is unavailable?
- Do they have standard service and maintenance procedures that are relevant to the plant? This will help in the comparison of quotes and tenders for a maintenance contract and will provide a reference against which future performance and delivery can be measured
- Are the technicians suitably trained in handling refrigerants effectively and safely? Suitable qualifications include the Construction Industry Training Board (CITB) Refrigerants Handling Assessment or City and Guilds 2078
- Do they operate under quality and environmental management systems? Are these accredited to ISO 9000 and ISO 14000 respectively?
- Do they have appropriate health and safety policies and safe systems of work for dealing with refrigeration equipment and materials?
- Are they adequately insured?

Your contractor can help you with all these issues, or call the Carbon Trust Helpline on 0800 085 2005.

Which type of contract?

The contract selected will determine the level of service that is received. Contracts range from inspection maintenance, which provides a fixed number (usually one) of maintenance visits each year, to comprehensive, which covers scheduled maintenance visits as well as the cost of any further maintenance or repairs.

Remember that the contract should be designed around each refrigeration plant and must cover the system requirements as laid down by the manufacturer or supplier.

> All refrigeration systems will benefit from regular maintenance, whatever size they are.

Maintenance schedules

The maintenance schedule will be determined by the size and complexity of the refrigeration plant. As a minimum you should check that the schedule covers the following points:

- Compressor oil levels, suction and discharge temperatures and pressures
- Accuracy of gauges
- Condenser fan and pump condition, fouling or blockages and condition of safety equipment such as fan guards
- Refrigerant levels in the receiver
- Evaporator refrigerant levels (via the sight glass) as well as operation of the defrost system. Condition of fans, blockages and fouling as well as safety equipment should be covered as per the condenser (above)
- Operation of all safety controls
- Resetting of control parameters to the optimum set point
- Suction superheat to ensure that the expansion valves operate properly
- Checks for undue noise and vibration, and condition of insulation.

If you are unclear about anything, you should ask your maintenance contractor for clarification.

Monitoring

Monitoring is used to detect trends in the performance of the refrigeration system, expose developing problems and prompt timely intervention. It helps to maintain efficient operation and prevent unwanted interruptions to business through refrigeration failure.

The amount and frequency of monitoring should be in line with the size and complexity of the system. However, all businesses can benefit from keeping track of the energy used by their refrigeration system.

Pressures and temperatures

Suction and discharge pressures should both be logged. Smaller systems may not have pressure gauges installed, however, it is a small price to have them installed and the information provided could save a lot of money. Ambient temperature and the temperature inside the cooled space should also be recorded.

A drop in suction pressure is indicative of a problem such as refrigerant leakage.

Discharge pressure increasing while ambient temperature remains constant could indicate a blocked condenser. However, it is normal for discharge pressure to rise if the ambient temperature rises.

Monitoring the temperature inside the cooled space will reveal if overcooling is occurring or could indicate that the cooling capacity of the refrigeration system has been reduced.

How often?

For smaller systems, keeping a weekly or preferably daily log sheet of key data should be appropriate.

For larger systems, it would be worth recording data more frequently, say, once per shift. Computerised monitoring with automatic fault alarms may be justified where a refrigeration fault could lead to significant stock losses, production problems or energy wastage. Such systems can be installed and operated in-house or remotely by a contractor.

A refrigeration specialist will be able to determine the most appropriate level and frequency of monitoring for the system.

> Keeping a log of key operational parameters on refrigeration plant will assist a refrigeration maintenance technician to diagnose any problems as they occur.

CASE STUDY

Camerons Brewery Ltd

Based in Hartlepool with a staff of 100, Camerons Brewery Ltd produces a variety of beers, including Kronenbourg 1664, Harp Irish and Scorpion lagers as well as Camerons Strongarm Bitter, Trophy ales, Castle Eden, Nimmos and Butterknowle ales and various seasonal specials. The company is capable of brewing up to 500,000 barrels per year, but is currently only using 50 per cent of this capacity.

Energy bills were costing Camerons over £220,000 per year, and monitoring showed that much of this was due to the high cost associated with chilling.

The Carbon Trust recommended that Camerons Brewery stop using its existing screw refrigeration plant, which was both unreliable and uneconomical to maintain, and introduce a new chilling system. In order to cover the cost of the two new smaller and more energy efficient refrigeration plants, Camerons were granted an interest-free Carbon Trust loan. It is estimated that the new chilling system will save the company an estimated £5,500 per year on energy bills.

Image courtesy of Camerons Brewery.

Buying new equipment

From time to time it is necessary to invest in new refrigeration systems as the business or organisation changes or old equipment requires replacement.

During its lifetime, the energy costs of a new refrigeration system will be several times greater than the original purchase price. Therefore, it is worthwhile taking care to ensure that a new system meets the refrigeration needs as efficiently as possible.

Understand your refrigeration needs and minimise the load.

Investigate:

- What type of product is being cooled?
- How much of the product is being stored and for how long?
- What level of cooling is required?
- Where should the refrigeration plant be located?

Matching the new refrigeration equipment to the existing and foreseeable requirements may enable the system size to be reduced, lowering capital and energy costs.

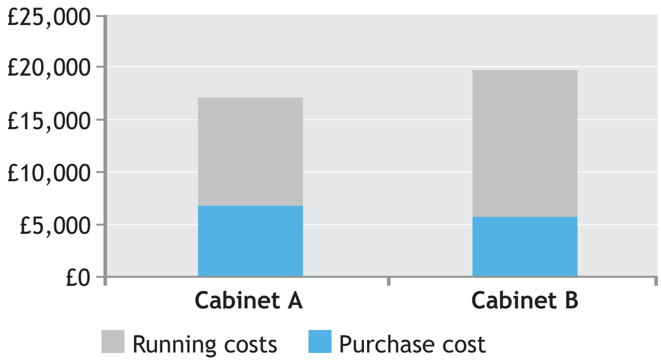
> Your refrigeration requirements may have changed over time. A like-for-like replacement of the old system may not make the best economic and operational sense.

Example

Refrigerated display cabinet A has a purchase cost of £6,800, which is £1,100 pounds more than the cost of a similar cabinet B at £5,700. Cabinet A consumes 44kWh per day, where as cabinet B consumes 55kWh. During its 10-year life, cabinet B has energy costs over £3,500* in excess of those for cabinet A.

The lifetime energy savings achieved through picking the more efficient option will repay the premium in purchase cost for cabinet A by over 3 times.

Purchase and lifetime energy costs for two similar refrigerated display cabinets



*Based on an electricity unit cost of 7p/kWh.

Consider the lifetime costs

Work out the real cost of your fridge. As well as the capital costs (the system and installation) you will need to know the total energy consumption figure, which your supplier will be able to give you. The total consumption includes the energy used by the refrigeration system's compressor, condenser fan motor, lights, fans and defrost heaters, where fitted.

First, work out the annual costs of running your fridge. Take the total consumption (for a year) and multiply it by the cost of electricity (£/kWh), usually found on your electricity bill. Then multiply this figure by the number of years you will be running the unit. This will give you the running cost for its entire lifetime. Adding this to the capital cost will give you the total life-cycle costs of the unit.

When you have worked out the total life-cycle costs for all your options, you will be able to choose a unit that saves energy and money.

Use supplier information or performance databases such as www.ukepic.co.uk to get details of the energy consumption of each system or model.

Enhanced Capital Allowances (ECAs) are available to provide businesses with tax relief on investments in energy efficient technology. Refer to the ECA Technology List to ensure that the selected system is among the most efficient. The ECA website is www.eca.gov.uk

Also, look for the CE mark and EN441. These don't necessarily indicate greater efficiency but they do show that the product meets safety and quality standards.

For larger or bespoke systems, request the most energy efficient features such as:

- Low power lights and fan motors
- Defrost on demand controls for evaporators
- Strip curtains or night blinds
- Larger condensers which can dump more waste heat.

Specify what is required

Detailed specifications result in better tender returns and the value of competing tenders can be compared reliably.

Tax incentives

Enhanced Capital Allowances (ECAs) enable businesses to buy energy efficient equipment using a 100% rate of tax allowance in the year of purchase. Businesses can claim this allowance on the investment value of energy efficient equipment, if it is on the Energy Technology List. The procedure for claiming an ECA is the same as for any capital allowance. For further information please visit www.eca.gov.uk or call the Carbon Trust on 0800 085 2005.

Energy Efficiency Loans

The Carbon Trust can provide an energy efficiency loan to SMEs in England and Wales of up to £100,000* and for all businesses in Northern Ireland of up to £200,000 for investment in energy saving projects such as the upgrading or replacement of lighting, boilers or insulation. The loans are interest-free, unsecured, repayable over a term of up to four years and with no arrangement fees. In Scotland, the Scottish Executive offers a similar scheme called 'Loan Action Scotland'.

*Subject to terms and conditions and local funding.

Regulation

The operation and maintenance of refrigeration systems are subject to legislation covering health, safety and environmental issues. Some major aspects of regulation are described briefly below.

The sale and use of chlorofluorocarbons (CFCs) is banned. The use of hydro chlorofluorocarbons (HCFCs) in new plants is banned, and their use for maintenance of existing plants will be phased out by 2010.

Fluorinated gases (HFCs) will come under control from 2006 as a means of reducing global warming by reducing refrigerant leakage. These new regulations will require scheduled inspections of plant using HFCs by suitably accredited technicians, with larger plants requiring more frequent inspection and the installation of automated leak detection equipment.

Under the Health and Safety at Work Act, 1974, due care should be taken to ensure that individuals are protected from the risks associated with refrigeration systems (e.g. providing guards for moving machinery or excessively hot or cold surfaces and having suitable controls for handling hazardous substances such as ammonia).

The UK Pressure Systems and Transportable Gas Containers Regulations, 1989, apply to all refrigerant systems with a compressor motor of over 25kW. These regulations place a duty on the user to ensure that the system is operated safely. The user must appoint a competent person to draw up a written scheme for examination of the plant and regularly inspect the plant using that scheme.

Water-cooled systems must be protected from legionella contamination and so appropriate water treatment is required. Such systems must also be registered with the local authority.

This section is correct at time of writing and does not provide a comprehensive review of regulations covering the operation of refrigeration systems. Regulations may be subject to update, and from time to time, new regulations may be introduced.

To become familiar with all the relevant legislation relating to refrigeration systems, up-to-date documentation and guidance notes can be obtained from HMSO or regulator websites. Alternatively, speak to a refrigeration contractor, consultant and/or insurer for help.

Glossary

Air curtain	A steady stream of air (generated by a fan) that acts as a barrier to separate environments at different temperatures, without blocking the movement of people or objects. Air curtains are used in open-fronted refrigerated display cabinets to retain chilled air within the cabinet's volume while still allowing ready access to the stored products.
Ambient temperature	The temperature of the outside air.
Ancillary load	Load created by secondary equipment. In the case of refrigeration, this may be the additional heat created by lighting or evaporator fan motors in refrigerated space.
Automated leak detection	System that continually monitors for the presence of air-borne refrigerant gases and generates an alarm when excessive levels are detected, indicating leakage of refrigerants from the refrigeration system.
CFC	Chlorofluorocarbon. This is a type of refrigerant consisting of chlorine, fluorine and carbon. CFCs are no longer produced.
Compressor	A machine which raises the pressure of a gas, such as a refrigerant vapour. This will usually raise the temperature and energy level of the gas.
Condenser	A heat exchanger in which a gas, such as a refrigerant vapour cools and then condenses to liquid form.
Defrost-on-demand control	A control system that automatically initiates a defrost sequence when an appropriate amount of ice has built up on the evaporator surface.
Discharge	The high pressure exit from a compressor.
Evaporator	A heat exchanger in which a liquid refrigerant absorbs energy from its surroundings and vaporises, producing a cooling effect.
Expansion valve	A valve through which liquid refrigerant passes and reduces in pressure and temperature.
Halocarbons	A family of primary refrigerants based on hydrocarbon molecules in which some or all of the hydrogen has been replaced by either fluorine or chlorine. Halocarbons include CFCs, HCFCs and HFCs.
Heat exchanger	A device for transferring heat between two physically separate streams.
HCFC	Hydrochlorofluorocarbon. A primary refrigerant of the halocarbon family.
Receiver	A vessel used to store a fluid (liquid or gas) usually at pressure. In a refrigeration system, the most common are high-pressure receivers, located after the condenser. Some systems also utilise a low-pressure receiver located before the compressor suction.
Refrigerant	The working fluid of the refrigeration system which absorbs heat in the evaporator and rejects it in the condenser.
Refrigerant leakage	Most types of refrigeration system are prone to some degree of refrigerant leakage. This can cause a loss of cooling performance, excessive energy consumption and damage to the environment.
Suction	The entry point for vapour into a compressor.
Superheat	A thermodynamic term referring to a vapour at a temperature above the boiling point at the prevailing pressure.
Vapour compression refrigeration cycle (see page 4 for schematic)	A type of refrigeration cycle using a compressor to remove low pressure vapour from an evaporator, where it has absorbed heat, and deliver it to a condenser at a higher pressure, where it rejects heat.
Water cooled condenser	A heat exchanger used to condense refrigerant vapour using cooling water.

Next steps

There are many easy low and no-cost options to help save money and improve the operation of refrigeration systems. Next, assess the condition and operation of your systems and identify where you can improve efficiency. You may be able to make considerable savings by taking action in-house, although you may need specialist support from your contractor or consultant to make other savings.

Step 1. Understand your system

Look at your system and identify where all the components are situated. Check the condition and operation of the key components as described in this document. If possible monitor the power consumption over, say, one week to gain a baseline against which any improvements to energy efficiency can be measured.

Step 2. Understand how you use your system

Examine the way in which your system is used. Think about issues such as doors being left open, setting of temperature controls and loading of warm products into the cooled space.

Step 3. Identify and prioritise your actions

Your investigations could reveal a range of actions for saving energy. Some measures could be simple to implement in-house. Others may require specialist assistance.

Step 4. Seek specialist help

Discuss the more complex or expensive options with your specialist contractor or consultant or contact the Carbon Trust.

If you need to identify a suitable specialist, contact the Institute of Refrigeration or the British Refrigeration Association.

Step 5. Make the changes and measure the savings

Put in place the energy saving actions. Measuring the savings realised will provide useful information and assist in future management decisions about refrigeration systems.

Step 6. Continue to manage your refrigeration system for energy efficiency

Put in place policies, systems and procedures to ensure that your system operates efficiently and that savings are maintained in the future.

For further information...

call the Carbon Trust on 0800 085 2005

You'll find 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 and deals with all kinds of energy saving topics for people at all levels of experience.

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Making business sense of climate change

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