NATIONAL BUSINESS INITIATIVE

PRIVATE SECTOR ENERGY EFFICIENCY

REFRIGERATION SYSTEMS

Guide to key energy saving opportunities.

Contents

Preface

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

Plug into energy efficiency with the Private Sector Energy Efficiency (PSEE) project and get simple, effective advice to help your business take action to improve energy efficiency and reduce carbon emissions.

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

Introduction

Reducing energy use makes perfect business sense. It saves money, enhances the reputation of your business and promotes the fight against climate change.

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

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

Energy consumption

Refrigeration is the process of mechanically cooling or reducing the temperature of a space, a product or a process. In some industries, most notably food and drink and chemicals, refrigeration accounts for a significant proportion of overall site energy costs. This is also the case for a number of commercial sectors.

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

Sector	Proportions of energy costs that can be accounted for by refrigeration
Meat, poultry and fish processing	50%
Ice cream manufacturing	70%
Cold storage	90%
Food supermarkets	50%
Small shops with refrigerated cabinets	70% or over
Pubs and clubs	30%

Summary of key areas

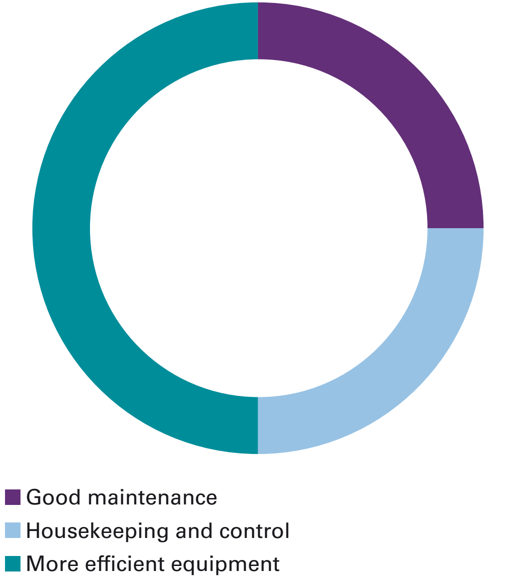
Energy saving doesn't need to be expensive. Up to 20% can be cut in many refrigeration plants through actions that require little or no investment.

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

Figure 1 indicates how most organisations can save energy and money on refrigeration.

This publication provides an overview of the operation of refrigeration systems, identifies where you can make savings, and will help you to present an informed case on energy savings to key decision makers within your organisation.

Figure 1 Typical sources of savings



Energy saving doesn't need to be expensive. Up to 20% can be cut in many refrigeration plants through actions that require little or no investment

Checklist

This is a checklist of seven ways of reducing the energy used by your refrigeration systems.

	What	Why
1	Inspect	Get into the habit of inspecting your system regularly – early warning signs allow you to take action before any problem gets worse. Look for ice build-up on evaporators, debris on condensers, broken fans, and snow and ice in cold stores. Bubbles in sight glasses can indicate a refrigerant leak. Marking pressure gauges for summer and winter can help you identify when compressors are working too hard. Listen for unusual noises, which could suggest damaged fans, out of balance motors, worn bearings or short-cycling compressors. If you're familiar with your own refrigeration plant you're more likely to recognise when it is working well and when it needs attention.
2	Maintain	Like cars, refrigeration systems need regular maintenance to ensure they continue to perform efficiently and reliably. Set up a maintenance contract with an experienced contractor to make sure that your plant is safe, efficient and reliable. This will also reduce the cost of breakdowns and emergency service calls.
3	Control	Get to know your system controls. Most refrigeration systems are automatic, with controls that switch the compressors and fans on and off. Basic controls work off a thermostat, while more advanced controls monitor factors such as the cooling load, the build-up of ice, and weather conditions. For freezer rooms and cabinets, electric heaters are normally used to stop surfaces such as hand rails from getting too cold, and also to prevent condensation on glass. These heaters can often be pulsed on and off, or switched off altogether when the store is closed.
4	Reduce the load	Only refrigerate your product, space or process where you really need to. Many applications (such as factory production areas) only require refrigeration at certain times. No matter how efficient your refrigeration system is, it will still use energy, so if you don't need refrigeration, turn it off. Where refrigeration is required, keep it at the highest possible temperature. Turning up the thermostat will reduce the load on the refrigeration system and cut energy costs.

	What	Why
5	Cut your losses	Refrigeration is expensive. Contain it as much as possible. Keep cold room doors closed, and keep seals in good repair. Use strip curtains or air-locks, and make sure that insulated rooms are properly air tight. Invest in sound pipe insulation. Insulation that is badly applied and maintained adds to your energy costs, through lost cooling capacity and reduced compressor efficiency.
6	Better housekeeping	Don’t overstock cabinets. Keep air grilles clear. Close blinds and night covers. Close doors and maintain door seals.
7	Good design	If you are investing in a new refrigeration system, ask the contractors for a high-efficiency option. A good contractor will be happy to quote for an efficient system which will also last longer. Weigh up the extra capital cost and lower running cost of the energy saving options against the poor efficiency of the lowest capital cost system.

Top 12 ways to save

We’ve identified the top 12 areas where you can significantly cut your energy use. These are:

1 Display cabinets

2 Cold rooms

3 Compressors

4 Condensers

5 Evaporators

6 Heat recovery

7 Reducing refrigerant leaks

8 Free cooling

9 Chillers

10 Pipe insulation

11 Maintenance

12 Monitoring

If you have display cabinets or cold rooms, the sections on compressors, condensers, evaporators and reducing refrigerant leakage will be particularly helpful.

Take action

For each area we have compiled a list of ways to reduce wasted energy and give examples of bad and good practice to help you identify how best to improve the efficiency of your refrigeration system and start making savings now.

Refrigerated display cabinets

Refrigerated display cabinets use over a third of all the electricity used for refrigeration in the food chain.

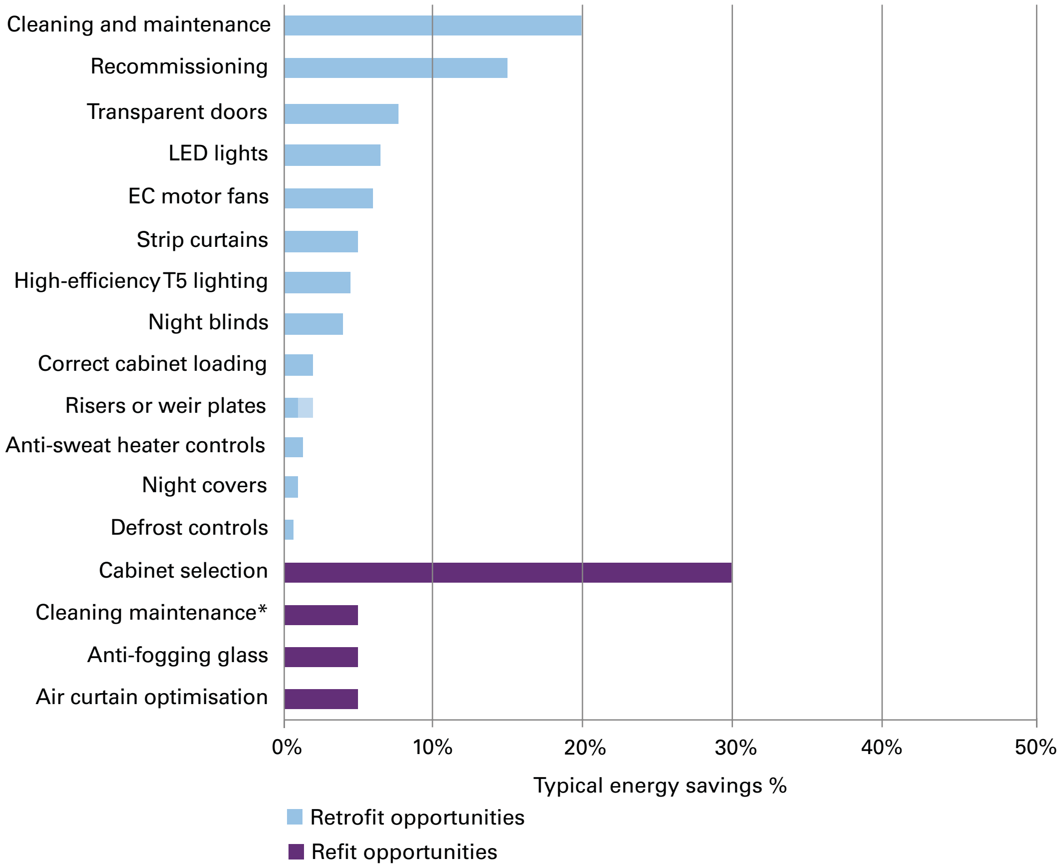
Summary

Top tip	Buy high-efficiency cabinets which have been tested under European test standards and maintain them well.
Typical saving	Efficiencies can vary by as much as 30%
Cost to implement	Can be as little as 10% in extra capital cost.
Payback time	Less than two years for an efficient cabinet; variable for other energy saving measures.
Key considerations	Choose and control cabinets according to the temperature needed by the food. For instance, don't use a drinks temperature cabinet to store or display meat products – or vice versa.

Efficiency at a glance

Look for cabinets tested under the European Test Standard, EN 23953 for temperature performance and energy consumption, allowing you to simply compare the efficiency of different cabinets.

Figure 2 Energy saving options for display cabinets



* If the condenser is not being changed during a refit, then cleaning it can offer energy savings.

What works best?

There are several steps you can take to reduce the energy used by existing display cabinets, including low-cost measures such as regular cleaning and making sure the product is loaded correctly. And there are plenty of other design measures that can be built in to new cabinets to achieve significant benefits.

Figure 2 on the previous page shows the key opportunities and the typical energy savings.

The energy savings shown are on the total refrigeration energy use in a typical 5,000m^2 supermarket. They are applicable to stores down to 2,000m^2 and can be used as an indication of savings for smaller stores as well. Savings per cabinet are given later for some of the technologies. These will be of particular interest to users with a small number of cabinets.

Bad practice

- New display cabinets are bought on the basis of lowest capital cost, leading to high energy cost.
- Cabinets are not cleaned or maintained, so efficiency and performance suffer.
- Return air grilles of cabinets are blocked due to poor product loading or over-stocking – increasing energy consumption and compromising food temperatures.
- Old-style T8 fluorescent lights are fitted to each shelf, consuming electricity and adding heat to the cabinet.
- Night blinds or covers are broken or are not used, adding unnecessary load when the store is closed.
- There is no control of anti-condensation heaters when the store is closed, increasing store electricity bills.
- Expansion valves are incorrectly set up, reducing cooling capacity and increasing compressor power.
- Cabinets are located near doorways or ventilation grilles – which can draw cold air into the shopping area.
- Cabinets are not adequately maintained.

Reduce the waste: save energy now

Housekeeping

- Make sure your cabinet isn't over-stocked, and keep the air grilles clear of product and merchandising. A properly stocked cabinet will maintain optimum food temperatures with minimum energy consumption.
- Make sure the product loaded into your cabinets hasn't warmed up by being left in an ambient temperature area.
- When the shop is closed, use any night blinds and covers fitted and switch off lights and anti-condensation heaters.
- If there are lights under the shelves, consider whether these can be switched off and removed.
- Check that the defrost settings for your cabinets are set appropriately to match the conditions and to avoid unnecessary heating.

Maintenance/low cost measures

- Use a good cleaning and maintenance schedule. This will maintain top efficiency and good temperature control.
- Use well-fitting night blinds or covers on all open cabinets to reduce the load during non-trading hours.
- Ensure all trim and anti-sweat heaters are pulsed or switched off automatically when not needed.
- Think about fitting anti-mist film or spray and switching off the heaters permanently.
- Ensure all expansion valves (where fitted) are properly commissioned – use the electronic type where possible.
- Use defrost controls with temperature cut-out to avoid unnecessary heating. If you're using electric defrosting on a chill cabinet, check whether you need it. Natural or off-cycle defrost might be an option.
- Use a glass riser (also known as "weir plate") at the front of the cabinet to save around three per cent of energy costs.

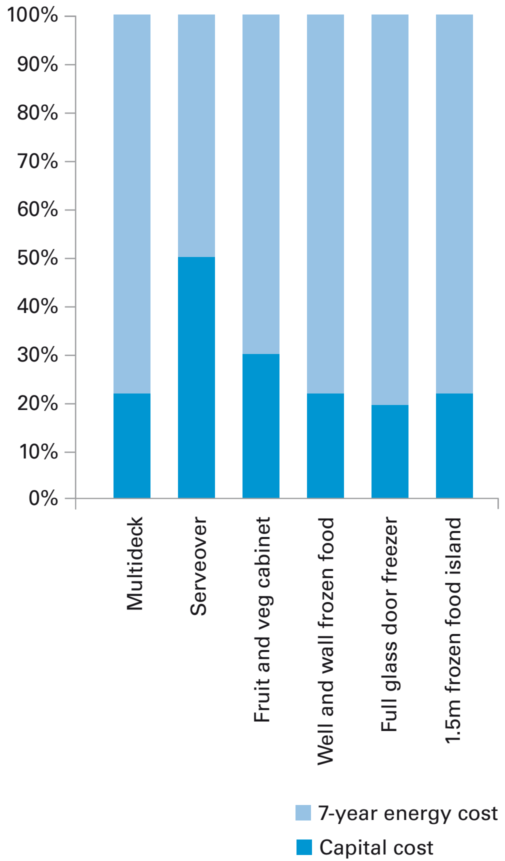
Investment measures

- Use high-efficiency T5 or LED canopy lighting.
- Upgrade the lighting in the cabinet canopy, or in the aisles if necessary, so that lighting under the shelves can be switched off.
- Consider fitting transparent doors to open cabinets.
- If you plan to keep the cabinets for at least five years, look at replacing the lights and fans with low power alternatives.

Case study

A large company recently carried out a major review of its display cabinet procurement. It scored potential manufacturers for both capital cost and projected energy cost over the expected life, looking at 10 different cabinet types. The capital cost for a typical cabinet was found to be just 25% of the total cost over the course of the equipment's life as shown in *Figure 3*. The exercise encouraged the company to select cabinets with a low whole-life cost. The result: energy savings of more than 30%, with virtually no capital cost increase in most cases.

Figure 3 Ratio of capital cost to seven-year energy cost for display cabinets



Efficient stocking

Refrigerated areas and display cabinets have a limited storage capacity. Over-stocking is common in the retail sector, but this radically alters the characteristics of the cabinet. Blocking the grilles at the front of an open-fronted cabinet (such as a 'multi–deck') forces the cold air from the cabinet into the shopping aisle. The refrigeration plant then has to work harder, and might not be able to maintain the correct product temperatures. In addition, the lower temperature in the aisle means the store's heating system will have to work harder to compensate.

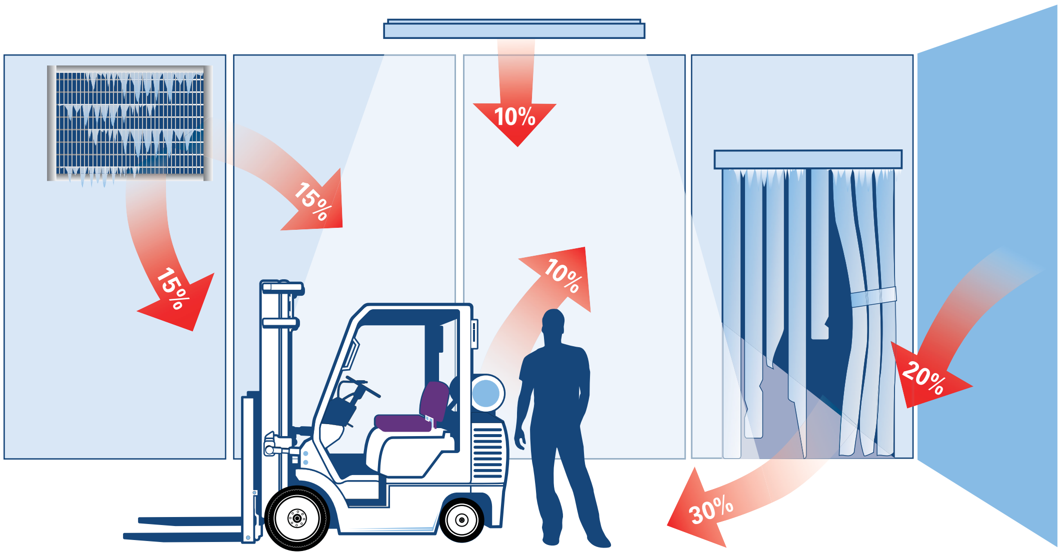
Cold rooms

Chill rooms usually maintain a temperature somewhere between 0°C and +8°C. Freezer rooms typically operate from -18°C down to -23°C.

Summary	
Top tip	Use an air-tight store with good door management, lighting and defrost control.
Typical saving	Open doors can cost you R30 per hour for chill rooms and R100 per hour for freezers.
Cost to implement	Good housekeeping and door management cost very little. Top-of-the-range insulated rapid-rise doors with dehumidification can cost up to R375 000 per door.
Payback time	Less than two years for most measures, if designed from the start.
Key considerations	Good housekeeping and door management need to be enforced constantly.

Loading bay of large cold store.

Figure 4 ***Cold room heat gains***



The single largest load on cold rooms is usually caused by warm air getting through open doors. This typically accounts for 30% of the total heat gain by a cold room as can be seen in *Figure 4*, which also shows the typical heat gain from other sources.

Gaps between insulated panels or at points where pipes penetrate the walls can also allow a small but constant stream of warm moist air into the store.

The 'insulated envelope' is the term given to the room enclosed by insulated walls, ceiling and doors. In freezer rooms, the floor is insulated too. The air-tightness of an insulated envelope when the doors are closed has a direct impact on energy consumption. Ideally, cold rooms should meet the Best Practice air-tightness criteria of the ATTMA (Air Tightness Testing and Measurement Association) Technical Standard TS1.

This section covers the fabric and operation of the cold store. See later sections for the evaporator and other components of the refrigeration plant.

Damaged ceiling in a -18°C cold store

The deflection is caused by a poor vapour seal on the outside of the ceiling panels. This allows moisture to condense and form water inside the insulated panel core, which freezes, and the panels become heavy. Heat and moisture can now freely enter the cold store, adding an unnecessary load to the refrigeration plant, increasing running costs and compromising store temperatures. Ultimately, moisture ingress as illustrated above can lead to structural failure of the ceiling. It represents a serious safety hazard.

Potential savings

By maintaining the thermal integrity and air tightness of a cold store, you can save over 10% of the energy cost. Controlling the doors to reduce the flow of warm air will give you savings of up to 30%. This is typically R30 per hour for chill rooms and R100 per hour for freezers.

Ice on the floor of freezer rooms is a serious safety hazard, so keeping the freezer room ice-free will also reduce the risk of accidents!

Case study

A cold store operator reviewed its refrigeration control system and discovered that upgrading to defrost-on-demand technology would save 91 tonnes of carbon and R250 000 per year in energy costs. Payback would take just one year, and as a knock-on effect the in-store temperature would improve. The company is now rolling out these changes.

Bad practice

- Cold store with build-up of ice caused by air infiltration through doors and gaps in insulation.
- Leaving cold room doors open for extended periods, without strip curtains.
- Low temperature cold stores with heavy forklift traffic but no air-lock.
- Unsealed gaps between panels, doors and wall penetrations, allowing a constant draw of warm moist air into the store.
- Lighting is left on all the time, even when the store is unoccupied.
- Poor defrosting control gradually causes the evaporator to become a solid block of ice, doing little useful cooling.
- No control of anti-condensation heaters when the store is closed, increasing electricity bills.
- Expansion valves are badly set up, reducing cooling capacity and increasing compressor power.
- Cabinets located near doorways or ventilation grilles – which can draw cold air into the shopping area and warm air into the cabinet. For example, severe draughts can increase the energy consumption of an individual cabinet by 95%.
- Cabinets are not adequately maintained.

Reduce the waste: save energy now

Housekeeping

- Introduce good door management and keep the door of your cold store closed whenever possible. This will keep warm air and moisture out, and energy costs down.
- Make sure airflow from the evaporators is not obstructed.
- Run your cold store at the highest possible temperature for the product.
- Ensure the product loaded into your cold room has not warmed up by being left in an ambient temperature area.
- Switch off the lighting in your cold room when it is not in use.

Maintenance/low cost measures

- Repair any damaged door seals. If you have automatic and rapid-closing doors, make sure they are not overridden and are maintained in good working order.
- Fit strip curtains and make sure they are well-maintained. This will keep warm air and moisture out, and energy costs down. Insulated curtains are now available, offering an improved thermal barrier. This makes them ideally suited for freezers.
- Look at the lighting in your cold store. Consider low-power instant-on lighting which switches off automatically if the store is unoccupied.
- Ensure the outside of the cold store is sealed air-tight, with no gaps at panel joints, and is well insulated throughout. This will keep air infiltration and heat gain to a minimum.

Investment measures

- Fit automatic or rapid-closing doors if frequent access to the cold store is required.
- Introduce a defrost-on-demand system which will keep the evaporators in top condition.
- For larger, forklift-accessible cold stores, incorporate an airlock or ante-chamber with dehumidification into forklift entrances if possible. This will reduce ice build-up and the need for defrosting.

Purchasing/design considerations

- On new stores, specify sliding doors. These seal better when closed, and the door seals are less likely to get damaged.

Compressors

The compressor is the heart of the refrigeration system, and is used in all conventional refrigeration plants except absorption chillers.

Summary

Top tip	Introduce head pressure control with a low condensing temperature in cooler weather.
Typical saving	Between 2% and 4% of compressor power for every 1°C reduction in condensing temperature.
Cost to implement	In most cases, virtually nothing – just a refrigeration engineer's time for a half day at most.
Payback time	Almost immediate.
Key considerations	Ensure the temperature is not set too low or there could be problems with some systems.

Compressors are nearly always the single most intensive energy consumer in the system, and often in the entire site.

A refrigeration system removes heat through the evaporator. The compressor raises the pressure of the refrigerant from the evaporator to a level that will allow the heat to be rejected to ambient air at the condenser. The difference between the refrigerant temperature in the evaporator (evaporating temperature) and the condenser (condensing temperature) is often referred to as the temperature lift of the system. This temperature lift determines how hard the compressor has to work. The larger the lift, the more work will be required by the compressor and the more energy it will consume.

A compressor working to cool a freezer to -20°C will have to work harder than one for a chill room at 0°C. One way you can reduce the energy used by the compressors is to raise the room temperature setting as high as possible. You can find more information on this in the later section on evaporators.

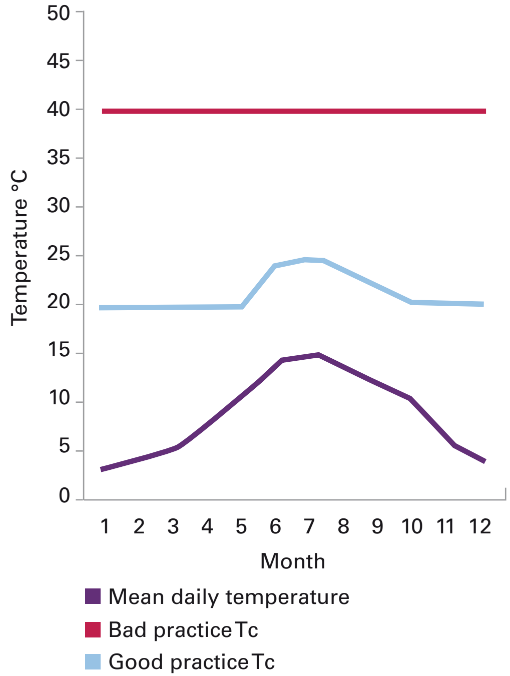
What works best?

In almost all cases, the single most effective energy-saving action you can take is to reduce the temperature lift. For every degree that this lift is reduced, you will save around 4% of the compressor energy for chill temperature systems and 2% for low temperature systems.

The main method of reducing temperature lift is to lower the temperature at which heat is discharged in the condenser (condensing temperature). Traditionally, condenser control (head pressure control) systems were programmed to run all year round at a condensing temperature designed for summer conditions. Often this is still the case. Changing the control to allow the temperature to reduce in cooler weather offers a great potential saving.

Figure 5 shows the seasonal variation in outside temperature and how this can affect the condensing temperature (Tc) in a refrigeration system with good practice head pressure control, compared to one with bad practice control.

Figure 5 ***Effect of seasonal temperature on condensing temperature***



By replacing conventional thermostatic expansion valves with electronic expansion valves you may be able to reduce the head pressure setting, since they can operate reliably with a lower pressure drop (equivalent to the temperature lift).

Potential savings

A typical refrigeration system is set for a condensing temperature of 40°C all year round. Setting this to float down to 20°C when the weather allows would typically reduce compressor energy consumption by between 25% and 35% for a chill temperature system.

There will be a cost for the extra condenser fan power used, but this will be more than offset by the saving in compressor energy.

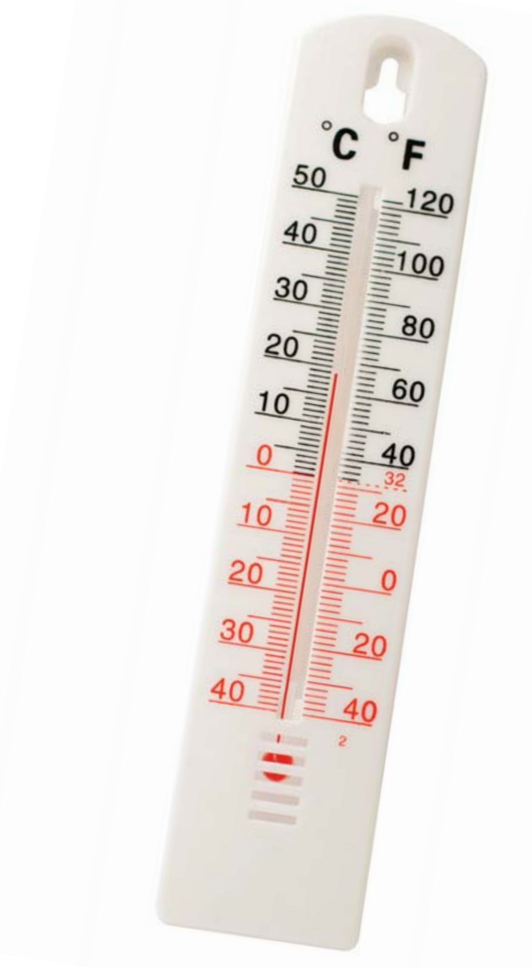
Reduce the waste: save energy now

Maintenance/low cost measures

- Get your technician to set the condensing temperature to the lowest practical level. Once the limit is reached, it may be possible to upgrade control valves or condensing capacity to allow a further reduction.
- On multi-compressor systems, make sure the compressor suction pressure is set only as low as is required. Often the winter set point can be higher than in summer.

Investment measures

- If you can't reduce your condensing temperature for system reasons, liquid pressure amplification can be used. Typical savings are up to 25% with a typical payback of three to five years.
- If your cooling load varies across a wide range, consider using speed controllers for one or more compressors.



Condensers

The condenser is the element that rejects the heat, usually to outside air.

Summary

Top tip	Use a generously-sized condenser with wide fin spacing, and make sure it's kept clean.
Typical saving	Up to 10% energy saving from cleaning alone. 10% saving from increasing the condenser size.
Cost to implement	R1 000 to R7 000 to clean a blocked condenser; R30 000 - R200 000 for a larger size.
Payback time	Almost immediate for cleaning. Less than two years for a condenser size increase.
Key considerations	Ensure the condenser has no air restriction. Clean carefully to avoid driving the dirt deeper into the fins.

Air-cooled condensers are used for most commercial systems, and evaporative for larger industrial systems.

Water-cooled condensers are used on some larger systems, usually in conjunction with cooling towers.

In a domestic fridge, the condenser is the warm grille at the back. For plug-in commercial fridges and domestic cabinets, the condenser is usually packaged with the compressor below or above the fridge. Refrigeration systems with remote condensers have them located outside or in a plant room.

If the condenser is not working properly, it will have to operate at a higher temperature, increasing the condensing temperature. As a result the compressors will have to do extra work. For every 1°C that the condensing temperature rises, the compressor will use between 2% and 4% more energy.

Reduce the waste: save energy now

Housekeeping

- Find out where your condensers are, and check them out. If they're dirty or blocked with debris, they're costing you money. Keep your condenser area clear of leaves, litter and vegetation.

Maintenance/low cost measures

- Have your condensers cleaned by a competent technician as part of regular maintenance. Make sure the cleaning process doesn't just push the dirt deeper between the fins.
- Check that all your fans are working – remember that some may be switched off at times by the head pressure controls.

Investment measure

- If your condenser is likely to accumulate dirt, consider fitting a removable condenser screen which can be hosed down or replaced.
- If your condenser struggles at peak times, consider fitting an extra one.

Purchasing/design considerations

- If you're buying a new refrigeration plant, look at getting a larger condenser than normal. Integrating a separate sub-cooling section will offer further savings of at least 8%.
- Newer condensers with low-energy fans and EC motors offer significant fan power savings and control flexibility. Make sure your contractor offers this option.
- Remember that condensers in saline or corrosive atmospheres need special coatings to maintain their condition.

Bad practice

Build-up of debris on a condenser.

Good practice

Image courtesy of ICS Chillers

Chiller with condenser air intake screen – this screen protects the condenser fins while still allowing air flow across the condenser coils.

Case study

A Dairy

Replacing a condenser at its creamery in 2009, a dairy invested an extra R50 000 to get the next size up. This saved R40 000 in annual energy costs, so the costs were regained in less than 18 months.

Potential savings

For a typical supermarket refrigeration plant, increasing the condenser size by 30% at the time you buy will save 10% of energy use. It will pay for itself in less than two years.

Cleaning a blocked condenser will improve compressor efficiency and save you at least 5% in energy. Replacing a rotting or corroded condenser will restore the original plant performance, and reduce the likelihood of refrigerant leaks too. Take the opportunity to install an extra large condenser with low-power fans and a subcooling section – the total savings can be as high as 40%.

Evaporators

An evaporator is so called because the liquid refrigerant inside evaporates at low pressure. This is what creates the cooling effect.

Summary

Top tip	Make sure your evaporator only defrosts when necessary. This maintains optimum temperatures and keeps energy costs low. Keep set-points as high as possible.
Typical saving	Energy saving of 2% per 1°C increase in thermostat setting. Up to 9% saving from intelligent defrost controls.
Cost to implement	Intelligent defrost should cost R4 000 to R12 000 per evaporator depending on the size.
Payback time	Instant for a set-point increase. Around two years for good controls.
Key considerations	Look at your evaporators regularly. If you can see ice, there could be something wrong.

Evaporators are located inside display cabinets, or are mounted on the wall or ceiling of a cold room.

If the evaporator is blocked or is not controlled properly, the cooling will be inadequate – and your energy costs will rise.

Like any heat exchanger, evaporators must be the right size for the job. If an evaporator is too small, the compressor will have to work harder and longer. It will also have to defrost more often, increasing your energy costs.

Evaporators in most applications need to be defrosted periodically. While this is usually done with timers, intelligent controls can detect when a defrost is required and will 'defrost on demand'.

Reduce the waste: save energy now

Housekeeping

- Keep an eye on your evaporators – if you see a permanent build-up of ice on the coil, something is wrong.
- Consider whether there are evaporators in rooms such as production areas that you can switch off when the rooms aren't being used.
- The evaporator controller is usually the room thermostat – make sure this is set as high as possible without compromising food or process quality.

Maintenance/low cost measures

- Evaporators should be cleaned when they get dirty. They lose performance as dirt builds up. Fans lose performance in the same way. Get your technician to include a thorough deep-clean of the evaporator coils when necessary.
- Check that all the fans are working – remember that some may be off at times if there is a controller for the evaporator fans.
- Evaporator drains should be fitted with traps to prevent air being drawn in from outside.
- Heat and insulate evaporator drains in freezer rooms.

Potential savings

Many fridges and cold rooms are set too low – set the temperature only as low as needed.

Turning the thermostat up by just 1°C will reduce energy use by up to 2%.

A defrost on demand system on a freezer cabinet has been shown to save 9% on the energy consumption of the cabinet.

This will improve room temperatures too.

Bad practice

Poor control of doors and of defrosting in a cold store – a dangerous combination. This evaporator is completely iced up, meaning that it will be providing a fraction of the necessary cooling, but with increased energy consumption.

Good practice

A freezer room with a nicely defrosted evaporator and a well insulated drain – as well as low-power fans. No evidence of ice.

Heat recovery

Refrigeration systems can't make heat disappear – they just move it from one place to another. It's possible to recover some or all of this heat for useful heating of air or water.

Summary	
Top tip	Fit your new refrigeration system with an energy saving 'desuperheater' to heat water.
Typical saving	Heat recovery can usually provide pre-heating of boiler feedwater and reduce boiler energy consumption by 30%.
Cost to implement	Around R30 000 - R60 000 for a high-performance heat recovery plant to serve a small site.
Payback time	Three to five years, but an interest-free loan could be available.
Key considerations	Make sure the compressors are not operating at an artificially high pressure just for the heat recovery system – this is usually a false economy.

Most businesses that use commercial or industrial refrigeration also require heat, either to heat space, for processes or for hot water. Yet all the heat removed by the refrigeration system (plus the energy used by the compressors) is usually wasted. Some or all of this heat can be recovered and used to provide useful heating, reducing your gas or oil heating bills.

What heat is available?

A typical mid-size supermarket or a small food factory could have a cooling load of around 230kW. The heat rejected to the atmosphere would be around 310kW. Around 10% of this is relatively high-grade heat (known as superheat) and will be available at 50-60°C. The rest can also be recovered, but it is relatively low-grade heat, at a temperature of 20-30°C.

Using recovered heat

You could use the high-grade heat to provide a small amount of domestic hot water for washing and cleaning.

Low-grade heat can be used for pre-heating boiler feedwater in factories that use a lot of hot water – for instance, for cleaning at the end of production shifts. If the boilers are heating water from 7°C to 80°C in winter, and the heat recovery system pre-heats this water to 20°C, that's an 18% reduction on the load on the boilers (and the corresponding oil consumption).

Low-grade heat can also be used for underfloor heating in cold stores or dry goods stores.

It's possible to duct the warm air from the external condensers into a warehouse, for example, to provide heating. Alternatively, you could install a separate condenser inside the warehouse to provide direct heating in winter.

Some systems use a heat pump to raise the temperature of the recovered low-grade heat to exactly that required by the factory processes. One factory uses an ammonia heat pump to generate 1.8MW of hot water at 62°C.

When implementing a heat recovery system it is recommended that you use an experienced contractor who is familiar with heat recovery.

Potential savings

In general, the payback on a good quality heat recovery system is three to five years. This length of time is due to the high capital cost of the heat exchangers and the additional pipework and controls. The savings are significant though, as any heat recovered is essentially free.

Case study

While upgrading its refrigeration plant, a meat processing facility fitted a 15kW heat recovery unit which heats water from 12°C to 52°C. Once commissioned, it will cost nothing to operate, and will yield a constant saving of 15kW in boiler fuel consumption.

Reduce the waste: save energy now

Purchasing/design considerations

- First establish your heating needs – how much heat you require, for how long, at what temperature. Then design the heat recovery system to match the demand. Possible options include:
  - Small desuperheater used for hot water for hand-washing;
  - Large full-scale recovery system re-heating boiler feed water; and
  - Heat pump converting waste condenser heat to a useful high temperature.
- If the demand for heating coincides with the heaviest running of the refrigeration system, the heat you recover can be used immediately. If not, you may need a thermal storage system. This will increase the cost.
- If the refrigeration plant is close to the boiler room, costs will be reduced and payback improved.

Bad practice

- No heat recovery employed.
- Heat recovery system used but at artificially high condensing pressures.
- Installing a geothermal or air-source heat pump for heating when there is a good supply of waste heat from a refrigeration system.

The image shows an electric underfloor heater installed in a large cold store to prevent frost heave. These 8kW electric heaters were running for over 15 years!

Good practice

Underfloor heating system installed in a cold store. This system uses heat recovered from the refrigeration plant and costs virtually nothing to run.

Reduce refrigerant leakage

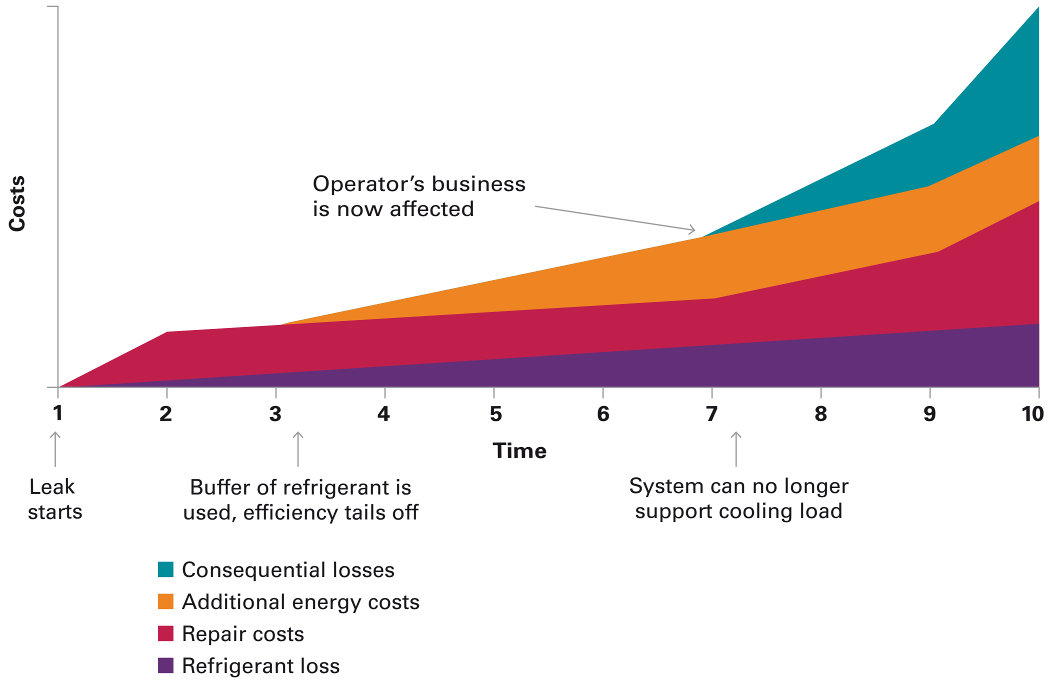
Hydrofluorocarbon (HFC) refrigerants are now known to cause significant environmental damage. When released to the atmosphere, they have a global warming potential over 3,000 times that of CO_2. This has led to urgent action to reduce leakage from refrigeration systems.

Summary

Top tip	Make sure you have a well-installed and maintained system with refrigerant leakage reduced to zero.
Typical saving	Up to 15% of the energy costs.
Cost to implement	Depends on the size of the system and the number of leaks. The cost to locate and repair a leak, including replacing any lost refrigerant, is typically R10 000 for a commercial refrigeration system.
Payback time	Savings in energy costs and consequential losses means that the payback time is typically two to three years for small leaks, and less than one year for large leaks. In addition, you will also save the cost of the replacement refrigerant gas.
Key considerations	Recent European law aims to reduce refrigerant leaks due to their effect on climate change.

Most refrigeration systems have some leakage. Studies have suggested average annual leakage rates of 20%. In a typical system, this loss would mean an 11% reduction in efficiency, and a direct increase in energy cost.

Figure 6 The effect of refrigerant leakage on refrigeration performance and energy consumption



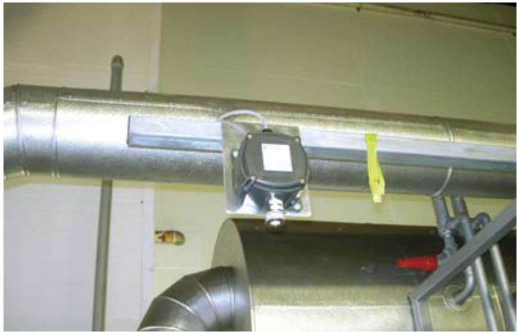
If a refrigerant leak is not promptly repaired, it will start to affect system efficiency and the energy cost for the refrigeration system will increase. Eventually the refrigeration system will no longer be able to provide enough cooling, which could lead to product or other losses. The longer you leave the leak before repairing it, the higher the costs for repairs, refrigerant loss, additional energy usage and other consequential losses.

In addition, companies that use HFC refrigerants should consider their responsibilities. Including record keeping and leak testing. Equipment containing 3kg or more of F gas refrigerant should be checked for leakage by certified personnel on a regular basis. This threshold rises to 6kg for hermetically sealed systems that are labelled. If a leak is found it must be repaired by an appropriately qualified person as soon as possible and the repair must be retested for leakage within a month. The recommended leakage checking frequencies are shown in *Figure 7* on the following page.

Figure 7 ***Leak testing frequencies***

Frequency	Normal systems	Hermetically sealed systems
None	Less than 3 kg	Less than 6 kg
Annual	3 kg to 30 kg	6 kg to 30 kg
6-monthly*	30 kg to 300 kg	30 kg to 300 kg
Quarterly*	Greater than 300 kg	Greater than 300 kg

* Half this frequency if fitted with automatic leak detection.



Refrigerant leak detector in a compressor plant room

Bad practice

Oil stains on a condenser coil indicating a refrigerant leak

- System installed in a hurry, without proper tightness testing.
- Excessive use of flare joints.
- Oil stains on condensers go unnoticed.
- Low refrigerant level alarms ignored.
- Leaks repaired eventually, but with no follow-up check.
- No leak detection system.
- Valves not capped.

Reduce the waste: save energy now

Housekeeping

- First find out your refrigeration leakage rate. This should be easy to do – the information will be in the refrigerant logs kept at the plant by the refrigeration contractor.
- Investigate any change in the system so that if it has been caused by a leak, this can be repaired promptly.

Maintenance/low cost measures

- If you have systems with a charge of less than 300kg, you must check for leaks at least once a year. Systems over this size must have a permanent leak detection system and be checked for leaks every six months.
- If there are leaks, find and repair them.
- Work with your contractor to set up a leak test regime and fix leaks as they appear.
- All leaks must be rechecked around a month after the repair to ensure it is leak-tight.
- The plant should be maintained in good condition and all valves should be sealed.

Investment measures

- Good practice would be to install a comprehensive leak detection system at your site with sensors at critical locations.

Purchasing/design considerations

- Your system should be well installed, with full tightness testing to ensure pipework integrity.
- Use brazed joints wherever possible.

Potential savings

A typical 300 kW refrigeration system with a small but continuous leak unrepaired for three months could incur an energy penalty of 10kW in electricity once the leak becomes critical, meaning an increased energy cost of R20 000. And the repair cost will be even higher as much more refrigerant gas will be needed. Larger factories and shops could contain between five and 10 such systems, each with the potential for leaks.

Chillers

Most people choose a chiller on the basis of the maximum load and the warmest weather. In these conditions, a chiller may well be quite efficient, but most of the time the load will be lower and the temperature cooler.

Summary

Top tip	Use a chiller engineered for SA temperatures, with good part-load capacity and efficiency.
Typical saving	As much as R350 000 a year for a typical 800kW process chiller.
Cost to implement	Up to R650 000 for a 600kW cooling load.
Payback time	Around two years.
Key considerations	The chiller should be designed for both maximum and minimum loads.

Chillers are used in both industrial and commercial situations to produce chilled water, glycol or another chilled fluid for use in process or air conditioning equipment. Packaged chillers are factory assembled self-contained units which include the refrigeration compressor(s), controls and the evaporator. The condenser may be built-in or remote.

Typically, chillers are chosen to meet the maximum cooling load during the warmest weather. However, for 99% of the time, the chiller will not be running in these conditions – the load will be smaller, or the weather will be cooler.

Of course, a chiller must be the right size to cope with peak loads. But it should also be designed to work efficiently with reduced loads and in cooler weather.

You will probably need to ask your chiller supplier to offer this functionality.

The efficiency of a chiller is typically expressed as an energy efficiency ratio (EER).

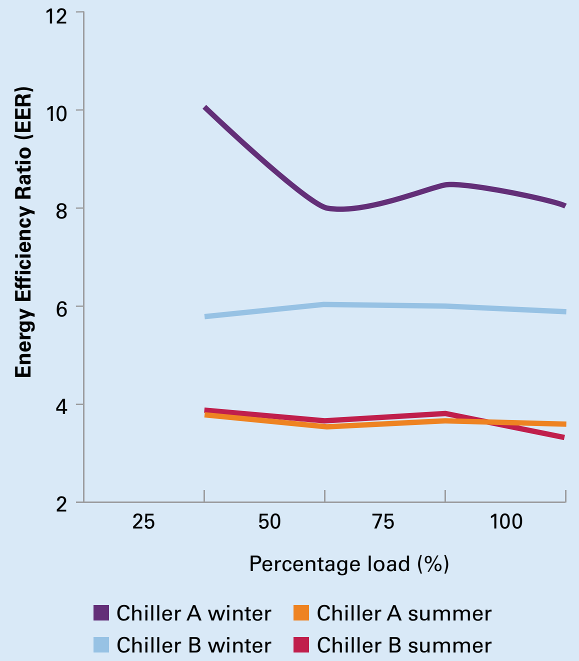
Figure 9: Chiller part load performance in summer and winter

Case study

Figure 8 shows two chillers with a similar summer EER (energy efficiency ratio) – shown in red and orange.

Chiller A has been engineered to maximise efficiency at part load in cooler weather. This isn't clear when the load and temperature are at their highest.

In winter, however, the EERs (shown in blue) tell a different story. Chiller B shows a modest improvement in EER. Chiller A's vastly superior performance will actually be realised for most of the year. It has a cost premium of R750 000, but this was saved within two years.



Reduce the waste: save energy now

Purchasing/design considerations

- Find out the maximum design load and ambient temperature that your new chiller will require.
- Ask potential suppliers to state their product's performance with a part load, in cooler weather.
- Choose chillers which adjust according to the load, and which make the best use of heat exchangers.
- Think about integrating a free cooler into the chiller. Many chiller manufacturers offer this feature.

Potential savings

A chiller designed to be efficient with a part load and in cooler weather will cost more than a standard packaged chiller – but it will usually pay for itself within two years.

Pipe insulation

All refrigerated pipework should be insulated to prevent unwanted heat gain. The colder the pipe, the more insulation is required.

Summary	
Top tip	Ensure pipe insulation thickness is generous, and if the pipes are outside, protect the insulation against the weather and sunlight.
Typical saving	Up to 5% for suction line insulation.
Cost to implement	Insulation is expensive to retrofit so it is important that it is correctly specified and fitted at the installation stage.
Payback time	One to two years for new systems, four to eight years for existing systems.
Key considerations	Watch out for quality issues – standards for insulation are often low, as defects can take a year or so to become apparent.

Your insulation needs to be sufficient to stop condensation forming on the surface. This is a heat gain in itself. The condensation can also make the insulation wet. Your refrigeration contractor should be able to advise on the how thick your insulation needs to be.

Pipework in sub-zero temperatures requires special care, to stop moisture freezing inside the insulation. Low-temperature insulation has to be air-tight as well as thermally sound, or the insulation will break down.

To stop moisture vapour from entering the insulation, all seams and joints need to be completely sealed. This is normally done with contact adhesive, which should be applied to both surfaces.

Steel pipework can start to corrode if the insulation breaks down, leading to leaks.

Unfortunately the standard of pipe insulation for chilled service lines can be quite poor. In many cases contractors simply apply the same standards to insulating cold services as they would to hot. In fact, insulation of refrigeration and chilled water lines requires careful attention, at installation and over the life of the system.

Low-temperature insulation has to be air-tight as well as thermally sound, or the insulation will break down

Reduce the waste: save energy now

Purchasing/design considerations

- The best chance to get the insulation right is when it is being installed. A little extra attention here will go a long way.
- Make the quality of insulation a priority for your new refrigeration system.
- Ensure that your pipework and insulation are designed for the full life of the system – typically 15 years for a commercial plant and 25 years for an industrial plant.
- Even badly applied insulation will look good for the first few months, so have it checked before the warranty expires. Thermal scans can reveal hidden defects.
- Standard insulation for refrigerated pipework is designed for indoor use only. If you use it outside, it must be protected from weathering.

Bad practice

Typical external refrigerated insulation – the insulation has been secured using cable ties that have crushed it, so the insulation has broken down. In addition, it is unprotected against weathering.

Good practice

Good quality low-temperature insulation inside a plant room – no evidence of ice or condensation.

Potential savings

Many chilled water systems operate with flow temperatures of 7°C and return temperatures of 12°C. These are the temperatures at the chiller. If the supply temperature is measured at the end of the pipework at the cooling load, it has usually increased by almost a half a degree. That heat has been gained without any useful cooling having been done. A similar heat gain is experienced at the return lines.

If the total heat gain is 0.75°C, the system has lost 15% of its cooling capacity.
If the deterioration of insulation is severe, the losses can be up to 25%.

If you're insulating compressor suction lines, a heat gain will make the compressor less efficient, so it makes sense to have as much insulation as possible, and to have it properly installed and maintained.

Maintenance

Appropriate regular plant maintenance will save money by ensuring the refrigeration plant operates efficiently, reducing service costs and making interruptions to your business by breakdowns less likely.

Summary

Top tip	Regularly monitor the key performance parameters for your refrigeration systems.
Typical saving	On average 5% of the energy cost, but can be much higher for some plants.
Cost to implement	Monitoring can be done in-house at minimal cost.
Payback time	Payback period will be very short if monitoring is done in-house. You can also make savings through reduced production losses.
Key considerations	Monitoring frequency should increase with the size and energy usage of the plant. Changes in the data recorded should be looked at to establish if there are any problems.

Maintenance schedules

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

- Refrigerant levels in the receiver and the liquid line sight glass.
- Refrigerant leak testing and repair
- Condenser cleaning, especially air cooled types (the frequency of cleaning will depend on the condenser location and its surrounding environment).
- Condenser fan and pump condition and condition of safety equipment such as fan guard.

- Evaporator cleaning.
- Operation of the defrost system. Condition of fans and safety equipment should be covered as per the condenser (above).
- Compressor oil levels and on systems which have suitable gauges fitted, suction and discharge temperatures and pressures.
- Accuracy of gauges.
- Guards.
- Operation of all safety controls.
- Checking of control parameters to the optimum set point.
- Suction superheat to ensure that the expansion valves operate properly.
- Checks for undue noise and vibration.
- Condition of insulation.
- Condition of door seals on cold stores.

Regular leak tests should be carried out and any leaks found should be repaired by appropriately qualified personnel as soon as possible. The repair must be retested for leakage within a month of the repair. See the Reduce Refrigerant Leakage section for more information.

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

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.

Selecting a contractor

Refrigerator system suppliers should be able to recommend a good refrigeration service technician. 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 you to compare quotes and tenders for a maintenance contract and will provide a reference against which future performance and delivery can be measured.

- Do they hold a company certificate?
- Are the technicians suitably trained in handling refrigerants effectively and safely?
- 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.

Bad practice

- No regular inspections done.
- Minimum maintenance done.
- No preventative maintenance programme in place.
- Equipment serviced only when it fails or problems are reported.

Reduce the waste: save energy now

- Find out if your existing maintenance schedule covers the minimum work listed above.
- Find out when your existing contract is due for renewal.
- Choose the contract type that provides appropriate cover for your refrigeration systems.
- Decide on the contract duration required.
- Decide criteria for selection of contractor(s).
- Clearly specify your energy efficiency requirements.
- Choose a suitable high-calibre contractor.

Potential savings

Cost savings of up to 50% are possible by making sure that your refrigeration plant is well operated and maintained. Also, improved reliability will reduce the chance of unplanned stoppages or business interruption. Appointing a good maintenance contractor is key to achieving these savings. Also, it is possible to reduce running costs by up to 15% by re-commissioning equipment, especially multi-compressor systems, so this should be included in your maintenance contract.

Good practice inspections and maintenance

Regular inspections – during these you should do the following:

- Check liquid line sight glass, if fitted, to ensure a full level of liquid.
- Look out for debris/dirt build-up on the condenser and evaporator fins and ice build-up on the evaporator. This will hinder heat extraction.
- Listen for excessive noise coming from compressors. It could mean that the bearings are worn and they may need to be replaced by a technician.
- Listen for rapid cycling of compressors.
- If the compressor restarts after having been stopped for only a brief period of time, it could lead to premature failure of electrical/mechanical parts.
- Listen for excessive noise coming from fans – it could mean that the bearings are worn or the fan is loose on the motor, which may result in reduced heat transfer.
- Check evaporators and condensers for damaged /corroded fins which make it more difficult to transfer heat.

Regular maintenance – this should include the following elements:

- Leak test.
- Have compressor units checked and serviced regularly.
- Regularly clean condensers and evaporators.

You can reduce your energy costs by 50% or more by making sure that your refrigeration plant is well operated and maintained

- Ensure that condensate 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 to be removed following the manufacturer's guidelines for defrosting the equipment. Never use sharp objects when de-icing – this could puncture the evaporator leading to refrigerant loss.

Monitoring

Monitoring helps to maintain efficient operation and prevent unwanted interruptions to your business through failure of the refrigeration plant.

Summary

Top tip	Regularly monitor the key performance parameters for your refrigeration systems.
Typical saving	On average 5% of the energy cost, but can be much higher for some plants.
Cost to implement	Monitoring can be done in-house at minimal cost.
Payback time	Payback period will be very short if monitoring is done in-house. You can also make savings through reduced production losses.
Key considerations	Monitoring frequency should increase with the size and energy usage of the plant. Changes in the data recorded should be looked at to establish if there are any problems.

Monitoring is used to detect trends in the performance of the refrigeration system, expose developing problems and prompt timely intervention. All businesses can benefit from keeping track of the energy used by their refrigeration system. The amount and frequency of monitoring needed will depend on the size and complexity of the system.

Smaller systems may not have pressure gauges installed, but fitting them is not expensive and the information provided could save a lot of money. Changes in pressures and temperatures can indicate a problem, as the examples below show.

- A drop in suction pressure suggests 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 show you whether it is overcooling, or if the cooling capacity of the refrigeration system has been reduced.

You may want to introduce computerised monitoring with automatic fault alarms if 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 your system.

Bad practice

- No pressure gauges installed (these will be a benefit to all but the smallest systems).
- Pressure and temperature gauges inaccurate.
- No regular monitoring done of key data for refrigeration systems.
- No analysis done to detect changes in the key parameters of the refrigeration systems.

Reduce the waste: save energy now

- Find out what monitoring is done by your engineers and your maintenance contractor.
- Find out what instrumentation is available for your refrigeration plant e.g. to measure pressures, temperatures, power, hours run etc.
- Find out how often the installed instrumentation is calibrated.
- Decide on, and implement, any improvements to the instrumentation installed and calibration procedures.
- Decide on a suitable monitoring routine and frequency for your refrigeration plant – this may vary depending on the size of the plant. Good practice would be to do the following:
  - log suction and discharge pressures
  - record temperature inside the cooled space and the ambient temperature
  - record kWh, power or amp meter readings
  - keep a weekly or preferably daily log sheet of key data for smaller systems
  - record data more frequently, say once per shift, for larger systems.
- Produce a suitable log sheet if you plan to monitor manually.
- Establish a suitable system for storing monitoring records and analysing any trends in key data. Good practice would be to plot power consumption against an appropriate operating parameter, such as outside temperature or product throughput, in order to identify periods of high energy consumption.

Buying new equipment

The greatest and easiest opportunity for maximising refrigeration plant operational efficiency is at the specification and purchase phase of its life.

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

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 making sure that a new system meets your 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 and whatis the load profile?
- 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.

Key elements of an energy efficient plant

The following are the key elements which should be incorporated into your new refrigeration plant to ensure it is energy efficient.

1. Minimise cooling loads.
2. Maximise system efficiency at the prevalent load and ambient.
3. Optimise running conditions.
4. Select and match refrigeration system components for efficient operation. This includes the refrigerant.
5. Provide sufficient control and monitoring equipment.
6. Install and commission the refrigeration plant properly.
7. Use heat recovery, free cooling and thermal storage opportunities where appropriate.

Example

Refrigerated display cabinet A has a purchase cost of R100 000, which is R16 000 more than the cost of a similar cabinet B at R84 000. Cabinet A consumes 44kWh per day, whereas cabinet B consumes 55kWh. During its 10-year life, cabinet B has energy costs over R28 000 (@ R0.70/kWh) in excess of those for cabinet A.

The lifetime energy savings achieved by choosing the more efficient option will repay the premium in purchase cost for cabinet A nearly twice.

Consider the lifetime costs

Work out the real cost of your refrigeration plant. 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 refrigeration plant. Take the total consumption (for a year) and multiply it by the cost of electricity, 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 an indication of the total lifecycle costs of the unit.

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

Use supplier information to get details of the energy consumption of each system or model.

Also, look for the CE mark and EN23953. These don't necessarily indicate greater efficiency but they do show that the product has been correctly pressure tested, which will reduce potential leakage, along with meeting 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 you require

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

Glossary

Air cooled condenser
A condenser in which all the heat is rejected to air.

Air cooler
A heat exchanger for cooling air, for example in a chill or cold store.

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. For example, 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.

Air honeycomb
A component of a refrigeration display cabinet, fitted beneath the top canopy, used to direct the cold air flow across the face of the cabinet in a smooth laminar 'curtain'.

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.

Brazed joint
A joint obtained by the joining of metal parts by alloys which melt at 450°C or higher, but less than the melting points of the joined parts.

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.

Condensing temperature and condensing pressure
The temperature and pressure at which the refrigerant condenses to form liquid.

Condensing unit
Combination of one or more compressors, condensers and liquid receivers (when required) and the regularly furnished accessories.

Defrost
Removal of frost or ice from the surface of an evaporator.

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.

Desuperheater
A heat exchanger used to remove sensible heat from compressed vapour before it enters the condenser.

Discharge
The high pressure exit from a compressor.

Electronic Expansion Valve
An expansion valve which is controlled electronically to give the required level of superheat.

Energy Efficiency Ratio (EER)
Measure of energy efficiency used for example for packaged chillers. Calculated as EER = net cooling capacity (kW)/effective power input (kW).

Evaporator
A heat exchanger in which a liquid refrigerant absorbs energy from its surroundings and vaporises, producing a cooling effect.

Evaporating temperature and evaporating pressure
The temperature and pressure at which the refrigerant evaporates.

Evaporative condenser
A condenser in which refrigerant within tubes is cooled by a falling water spray and a counter-current flow of air.

Expansion valve
A valve through which liquid refrigerant passes and reduces in pressure and temperature. The flow is controlled to maintain a set superheat.

Flared joint
A metal to metal compression joint in which a conical spread is made on the end of a tube.

Floating head pressure
A refrigeration system that allows the head pressure to vary in line with ambient temperature conditions (i.e. a plant that does not use head pressure control to artificially hold the condensing pressure at unnecessarily high levels).

Free cooling
A method of cooling that does not require refrigeration.

Halocarbons
A family of primary refrigerants which are compounds comprising carbon and halogen(s). Halocarbons include HCFCs and HFCs.

Head pressure (or discharge pressure)
Pressure at compressor outlet. Approximately equal to (and usually synonymous with) the condensing pressure.

Heat exchanger
A device for transferring heat between two physically separate streams.

Heat pump
A refrigeration cycle used for delivering useful heat from the condenser.

Hermetic compressor
A compressor and motor enclosed in an all-welded, leak-proof housing.

HC Hydrocarbon
A primary refrigerant such as propane, isobutene and propene.

HCFC Hydrochlorofluorocarbon
A primary refrigerant of the halocarbon family. A common HCFC refrigerant is R22.

HFC Hydrofluorocarbon
A primary refrigerant of the halocarbon family, including R134a, R404A, R407C and R410A.

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 use 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.

Saturation condition
Also known as the boiling point – the condition at which a phase change occurs (liquid evaporating to vapour or vapour condensing to liquid). The saturation temperature varies with pressure.

Semi hermetic compressor
A compressor and motor enclosed in a housing with removable bolted gasketed covers.

Suction
The entry point for vapour into a compressor.

Sub cooled
A liquid at a temperature below the saturation temperature (boiling point) at the prevailing pressure.

Superheat
A vapour at a temperature above the saturation temperature (boiling point) at the prevailing pressure.

Thermostatic Expansion Valve
A mechanically controlled expansion valve which is regulated by using a temperature sensing bulb to give the required level of superheat.

Vapour compression refrigeration cycle
A type of refrigeration cycle using a compressor to remove low pressure vapour from an evaporator, where it has absorbed heat, and discharge 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.

Welded joint
A joint obtained by the joining of metal parts in the plastic or molten state.

Weir Plate
A glass plate fitted to the front well of an open refrigerated display case, to reduce the open gap height, so reducing air spillage into the shopping area.

Next Steps

There are many easy low and no-cost options to help save money and improve operations.

Step 1 Understand your energy use

Look at your store and identify the major areas of energy consumption. Check the condition and operation of equipment and monitor the power consumption over say, one week to obtain a base figure against which energy efficiency improvements can be measured.

Step 2 Identify your opportunities

Compile an energy checklist. Walk around your building and complete the checklist at different times of day (including after hours) to identify where energy savings can be made.

Step 3 Prioritise your actions

Draw up an action plan detailing a schedule of improvements that need to be made and when, along with who will be responsible for them.

Step 4 Seek specialist help

It may be possible to implement some energy saving measures in-house but others may require specialist assistance. Discuss the more complex or expensive options with a qualified technician.

Step 5 Make the changes and measure the savings

Implement your energy saving actions and measure against original consumption figures. This will assist future management decisions regarding your energy priorities.

Step 6 Continue to manage your business for energy efficiency

Enforce policies, systems and procedures to ensure that your business operates efficiently and that savings are maintained in the future.

Plug into energy efficiency with PSEE

The Private Sector Energy Efficiency (PSEE) project aims to improve energy efficiency in industrial and commercial sectors across South Africa. PSEE offers a variety of services to help companies plug in to energy efficiency:

Website – Visit us at www.psee.org.za for our full range of advice and services.
↘ www.psee.org.za

Remote advice – Call us on 0801 113 943 or visit www.psee.org.za to access independent, authoritative advice and our publications and tools.

Publications – We have a library of publications detailing energy saving techniques for a range of sectors and technologies.
↘ www.psee.org.za/Resouces

Survey-based support – Review of energy use for medium-sized companies to identify energy savings opportunities and develop a suggested implementation plan.
↘ www.psee.org.za/Services/Medium-Companies

Case Studies – Our case studies show that it's often easier and less expensive than you might think to bring about real change.
↘ www.psee.org.za/Resouces

Strategic energy management – Holistic engagements for large companies to help improve operational energy efficiency and support the development of a comprehensive energy and carbon strategy.
↘ www.psee.org.za/Services/Large-Companies

The Private Sector Energy Efficiency (PSEE) project aims to improve energy efficiency in commercial and industrial companies in South Africa through the provision of various services to assist companies in identifying and implementing energy saving measures. The PSEE project is implemented by the National Business Initiative (NBI), supported by the Department of Energy, and funded by the UK Department for International Development (DFID).

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