Fact sheet 1: Refrigeration in packing sheds

The 'Watts in Your Business' project has completed energy audits of 30 packhouses and orchards Australia-wide. This fact sheet shows how refrigeration changes can cut energy use and save money.

Refrigeration is the biggest energy cost for fruit production, storage and packing businesses. On average, 64% of the audited businesses' electricity was consumed by refrigeration, costing $85,000 a year. However, energy efficiency of refrigeration systems can be improved and costs saved.

Common refrigeration systems

Package units

Package units have set level cooling capacities, with a compressor, condenser, evaporator and distribution component. They mostly use Hydrogen-chloro-fluoro-carbon (HCFC) refrigerants, although some new ones use ammonia. Thirty per cent of refrigeration systems audited were solely operated by package units.

Top tips to cut energy costs:

- Optimise head pressure on refrigeration system.
- Install variable speed drives on evaporative fan motors.
- Automate cold storage doors.
- Replace old inefficient compressor motors with high efficiency ones.
- Replace HCFC refrigeration with ammonia refrigeration systems.

Bernard Hall, of Bonny Glen Fruits in Orange, shows the button on the forklift in his packing shed that automatically opens the cool store — saving energy and time.

Refrigeration in packing sheds

Bespoke systems

Bespoke systems can meet the specific requirements of an application and the components are sized and selected to suit. Typically, bespoke systems use ammonia as their refrigerant, although some use HCFC or hydrocarbons. Of the audited sites, 47% of refrigeration systems were solely operated by bespoke cooling systems. The remaining 23% of the sites use both bespoke systems and package units.

Problem spots

Head pressure set points

Most refrigeration systems operate from a fixed head pressure set-point with the condenser fans cycled to maintain this set-point. When there is higher than necessary head pressure the refrigeration system can operate inefficiently.

Evaporative fan motor size

Motors for evaporative fans are often sized to meet the maximum cooling demand, which is typically immediately after harvest to quickly cool fruit. However, the fans are often unnecessarily large to maintain the room at the required temperature after this, resulting in higher electricity consumption.

Cold storage door operation

Poor door seals and leaving the cold storage room door open allow unwanted heat to enter the room, which uses excessive electricity.

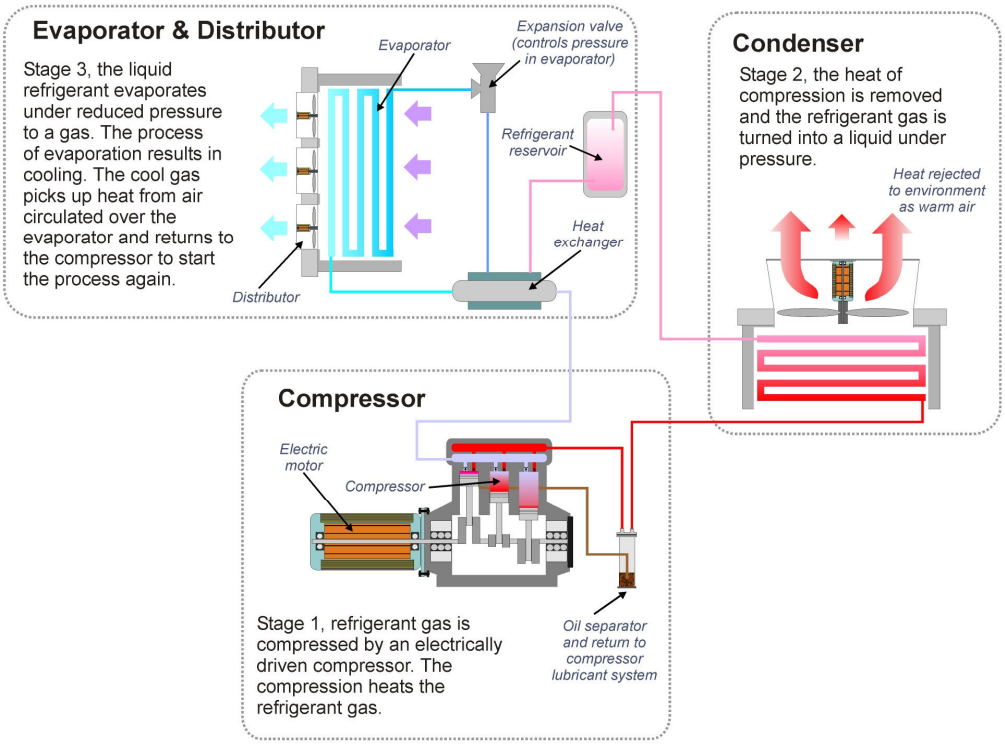
Aged, inefficient equipment

Some motors used for small refrigeration compressors are standard motors that have been rebuilt and rewound many times. Each time a motor is rebuilt or rewound, efficiencies in motor operations are lost.

HCFC systems

Refrigeration systems that operate using HCFC refrigerants present a risk to the business due to the scheduled 90% phase out of HCFCs by 2016 and reduced availability.

The stages of cooling in a packing shed refrigeration system.



The main upgrades to refrigeration systems that will save money:

Area	Ave cost of upgrade (once off)	Value of average annual energy saving	Average simple payback period (yrs)
Head pressure reduction	$2,948	$876	3.4
Variable head pressure control	$28,350	$6,036	4.7
Variable speed drives for evaporative fan motors	$37,090	$6,024	6.2
Electronic sliding doors	$7,435	$1,624	4.6
Rapid lift roller doors	$20,292	$1,743	11.6
High efficiency motors for compressors	$9,531	$619	15.4
Replacing HCFC systems with ammonia systems	$273,500	$6,817	***

*** Rising HCFC prices and the scheduled removal of HCFC supplies from 2016 mean this option will become extremely viable in addition to energy consumption savings.

Solutions and opportunities

Change the head pressure

Head pressure is the pressure in the high pressure side of the refrigeration system (i.e. the condenser). Minimising the head pressure can maximise the systems cooling capacity and reduce energy costs.

Head Pressure Reduction or Variable Head Pressure Control allows a user to lower or vary the head pressure to reduce the temperature at which the condenser operates, which can increase the efficiency of the refrigeration system.

Reducing the head pressure of a refrigeration system can reduce energy consumption between 2% and 4% for every 1°C reduction in condensing temperature (www.carbontrust.com).

Optimising head pressure reduces power consumption by 3-12%. Of the business audited, 97% could benefit from implementing this technology.

Install variable speed drives

To achieve necessary fan speed and save electricity usage, variable speed drives can be installed to meet the varying cooling requirements of the cold storage rooms. When a variable speed drive is fitted to the evaporative fan motor, it regulates the frequency of the electrical power supplied to match the volume requirements of the refrigeration system.

Savings from installing variable speed drives vary depending on fan motor size, set speeds, run hours and other settings. For example, if a variable speed drive reduces speed by 7-10% this equates to a 20-27% reduction in electricity consumption.

Retrofitting of variable speed drivers to existing evaporative fan motors could be done at 63% of the orchards audited.

Automate cold store doors

Automated doors on cold stores, either a sliding door or rapid lift roller, enables staff to access the room and minimise warm air from entering. Automated doors can be controlled by motion detectors, remote clickers, push buttons, photo cells, radio control or induction floor loops.

In 90% of businesses audited, automated doors would save energy.

Install high efficiency motors

Modern motors, or High Efficiency Motors, are built from materials that allow for greater operational

efficiency as compared to older units that have been rebuilt. Standard electric motors generally operate at an 88% efficiency to convert electrical energy to rotational energy, and this reduces each time a motor is rebuilt and/or re-wound. High Efficiency Motors generally operate at a much higher efficiency of 93%.

Retrofitting existing motors with High Efficiency Motors could be done in 43% of businesses audited.

Replace HCFC with ammonia

At 63% of sites audited, at least one refrigeration system used HCFC refrigerants for the cold storage rooms. Most HCFCs are due for final phase-down in 2016, so systems relying on them should be replaced.

The majority of the existing package unit systems identified during audits operate by using old, open drive, belt-driven reciprocating compressors. If these systems were changed to use ammonia as the refrigerant, the existing compressors and other components would need to be replaced. There are a variety of options for replacing the current compressor, however the most common is a pump recirculated, water cooled, ammonia plant or an ammonia chiller generating chilled brine solution which is then pump circulated to the cool rooms.

Converting to an ammonia system will not only achieve efficiencies in energy usage, but will also future-proof the availability of the refrigerant so a site's refrigeration requirements can be met.

Some open drive reciprocating compressor units can be replaced with semi hermetic compressors that can use alternative synthetic refrigerants. The few semi hermetic units can also be converted to alternate refrigerant such as R407F. However, this is likely to cost approximately 30-40% of the cost of installing a new ammonia system whilst providing little benefit in terms of energy efficiency and/or maintenance.

Retrofitting variable speed drives to evaporative fan motors can save an average of $6,000/yr.

In 53% of the businesses audited there was an opportunity to upgrade the current HCFC refrigeration system to ammonia.

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