SOUTH AUSTRALIAN WINE INDUSTRY
ASSOCIATION INCORPORATED

# WINERY ENERGY SAVER TOOLKIT [WEST]

VERSION 1.1 JULY 2014

Australian Government
Department of Industry

This Activity received funding from the Department of Industry as part of the Energy Efficiency Information Grants Program. The views expressed herein are not necessarily the views of the Commonwealth of Australia, and the Commonwealth does not accept responsibility for any information or advice contained herein.

Government of South Australia
Zero Waste SA

START HERE

# HOW TO USE THIS TOOLKIT

## WHAT'S IN THIS TOOLKIT?

The Winery Energy Saver Toolkit (WEST) is designed to help you identify, prioritise and action energy efficiency improvements for wine manufacturing. It covers energy efficiency opportunities in six key technology areas that have been identified by the South Australian Wine Industry Association (through engagement with its members) as representative of over 90% of an SME winery's energy consumption.

| TECHNOLOGY AREA | APPLICABLE AREA OF THE WINERY PROCESS | TYPICAL PROPORTION OF ENERGY CONSUMPTION |
|---|---|---|
| 1. Refrigeration & Tank Storage | » Must chilling<br>» Fermentation<br>» Cold stabilisation<br>» Wine storage | 50-70% (electricity) |
| 2. Pumping | » Wine transfers & pump overs<br>» Cleaning<br>» Wastewater treatment | 10-20% (electricity) |
| 3. Compressed Air | » Tank presses<br>» Cleaning | 5-10% (electricity) |
| 4. Hot Water & Steam | » Cleaning & sterilisation | 5-10% (electricity)<br>70-80% (gas) |
| 5. Heating, Ventilation & Air Conditioning (HVAC) | » Barrel stores<br>» Warehouses<br>» Offices | 5-15% (electricity) |
| 6. Lighting | » Warehouses<br>» Barrel stores<br>» Processing shed & plant room<br>» Offices<br>» Security & floodlights | 5-10% (electricity) |

## EACH TECHNOLOGY AREA IS DIVIDED INTO THREE KEY STEPS:

STEP 1: Explore Options to Optimise Equipment

This step explains opportunities to 'tweak and fine-tune' existing processes to improve energy efficiency. We ask wineries to begin with this step as it usually results in low-cost, 'quick wins' in energy efficiency without the risk of disrupting production due to equipment installation/replacement.

STEP 2: Explore Options to Upgrade Equipment

This step explains options to retrofit existing equipment or upgrade to new systems to improve energy efficiency. These opportunities do come at a higher cost, however the energy efficiency gains are often more significant than those found in Step 1.

STEP 3: Collect data and engage with supplier

This step provides businesses with guidance on which information to collect from within their business and from the equipment supplier to assist with assessment of the selected energy efficiency opportunities.

Some useful notes regarding the Toolkit content:

» The Toolkit is primarily focused on equipment optimisation and upgrades (excludes activities associated with process improvement or housekeeping), in order to assist SMEs with identifying the 'big ticket' energy efficiency opportunities and being more informed in their dealings with suppliers
» The scope of energy efficiency opportunities covered in this Toolkit is focused only on winery operations, and excludes options relating to the bottling/packaging process (SME wineries typically outsource this process)
» Some energy efficiency options are repeated across Technology Areas (e.g. installation of Variable Speed Drives on motors) to provide users with the full breadth of opportunities across each Technology Area
» The Toolkit provides an extensive list of energy efficiency opportunities that is constantly expanding and evolving; for future updates and additions to this content, visit the Online Portal via www.winesa.asn.au.

In addition to this content, the following tools and templates that form part of the Winery Energy Saver Toolkit can be accessed via the Online Portal to assist with choosing and evaluating energy efficiency opportunities:

» Energy efficiency opportunities modelling tool, which can be used to test potential savings resulting from key energy efficiency improvements outlined in the Winery Energy Saver Toolkit
» Energy Resource Use Data tool, which can be used by businesses to collect and analyse their own baseline electricity, gas and fuel consumption data
» Business case template, which businesses can populate (and edit as required) to assist with presenting their business case for energy efficiency upgrades to the CEO, peers or grant programs.
» Case studies
» Lists of formulas and calculations for each Technology Area (for businesses who wish to use these formulas in future assessments).

## ADOBE ACROBAT

The hyperlinks and internal navigation in this document are best utilised in Adobe Acrobat Reader - available for free download. Please click here to download the latest version for your system.

## HOW TO NAVIGATE THIS TOOLKIT

This Toolkit is designed to help you access the information you need, as quickly as possible. It can be navigated in two ways:

1. If you are interested in a specific Technology Area, you can get to it quickly by clicking its tab located on the top of the Toolkit page and following the links on the top for further information.
2. If you want to scan through the entire Toolkit from start-to-finish, you can do so by scrolling down (like a normal electronic document) or use the buttons at the bottom-right of the document.

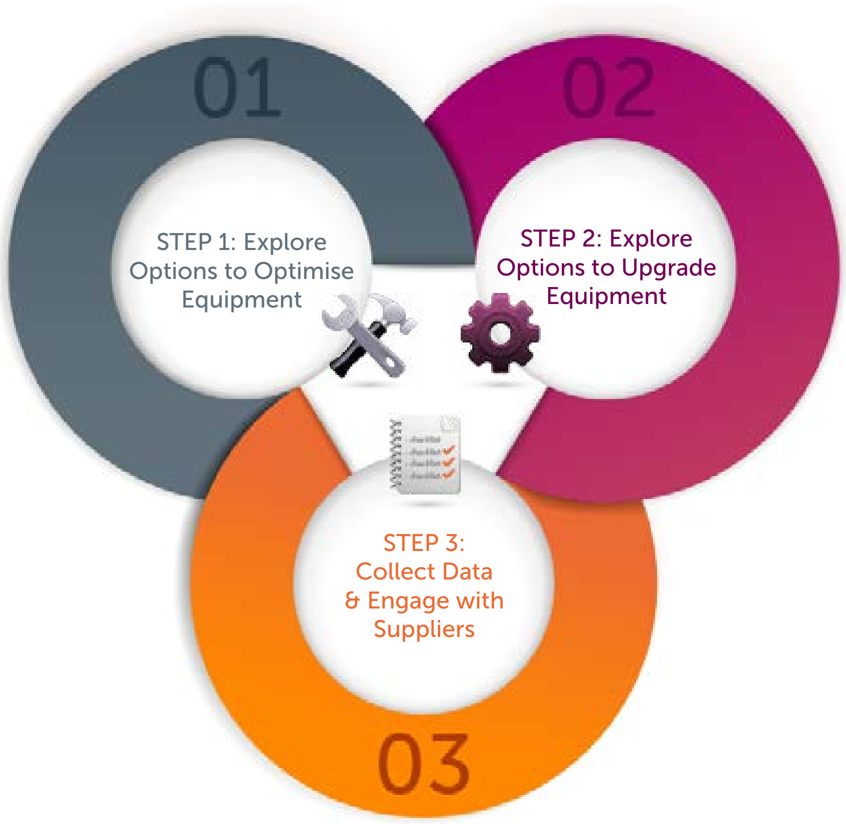
We have designed this document for easy on screen reading. However, if you feel compelled to print this Toolkit, you may print it like a normal Adobe.pdf document.

You can choose full-screen view by going to View/Full ScreenMode in your Acrobat Reader. Shortcut: Ctrl + L. To get out of this view, hit the Escape button.

Whenever you roll your cursor over a button, an arrow (like the 'NEXT PAGE' button bottom right), or words that are underlined, you are able to jump to the hotlink - just like a web page.

# TABLE OF CONTENTS

# REFRIGERATION & TANK STORAGE




Energy efficiency improvements most relevant to the following winery processes:

- Must chilling
- Fermentation
- Cold stabilisation
- Wine storage

---

## Refrigeration: 50-70% of energy consumption

---

# STEP 1: EXPLORE OPTIONS TO OPTIMISE EQUIPMENT

## OPTIMISE OPERATING CONDITIONS

### USE MAXIMUM TEMPERATURE SETTING

Refrigeration power consumption decreases with increasing evaporation-temperature setting (set-point). Improve operating efficiency (reduce energy use) by using the highest acceptable evaporation-temperature setting, especially during non-critical periods, even if only briefly.

Energy saving: Every 1°C increase in temperature setting will reduce refrigeration energy consumption by 2-4%.

Other benefits from making this improvement may include:

- More refrigeration air capacity
- Lower maintenance costs due to reduced load on the refrigeration system
- Longer operating life of refrigeration equipment due to less wear-and-tear.

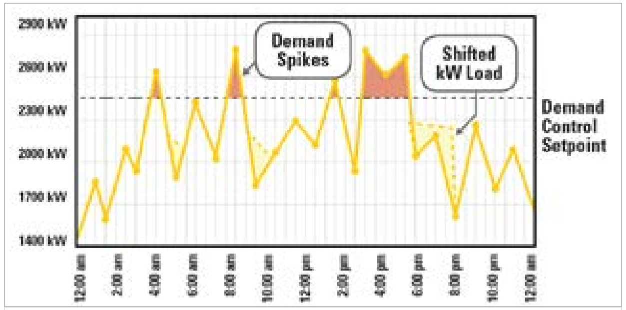

USE THE HIGHEST ACCEPTABLE TEMPERATURE SETTING

## LOAD MANAGEMENT

### ADJUST THE PROCESS SCHEDULE TO FLATTEN THE COOLING LOAD

Compared with a variable cooling load, a flat (constant) cooling load for the same tasks will use a similar amount of energy, but it could avoid high power costs (resulting from peak demand electricity consumption). Reduce power costs by:

- Scheduling processes to minimise overlap between intensive cooling processes during vintage, such as the cold stabilisation process and the filtering and blending processes; and
- Scheduling fermentation loads throughout the day
- Investing in demand management control systems that limit peak demand electricity consumption and help shift refrigeration loading throughout the day.




LOAD MANAGEMENT TO REDUCE PEAK DEMAND SPIKES THROUGH LOAD SHIFTING

Energy saving:
varies for different circumstances

Other benefits from making this improvement may include:

- Lower capital costs of refrigerator due to smaller required capacity (by reducing peak demand)
- More refrigeration air capacity
- Lower maintenance costs
- Longer operating life of refrigeration equipment
- Less downtime.

## USE VARIABLE CHILLER FLOW

In a refrigerator that uses a chiller, the chiller requires less power if the refrigerant circuit allows for a variable flow of primary refrigerant (or a constant flow of primary refrigerant and a variable flow of secondary refrigerant) to match the cooling load required, rather than only a constant flow of primary refrigerant. Reduce chiller energy consumption by converting the refrigerator system to variable flow.

Energy saving:
5-20% of chiller energy consumption.

To estimate energy savings, consider:

- Part-load efficiency of the chiller (vs. efficiency at full load)
- Existing reliance on bypass flow control
- Load profile.

## USE NIGHT TIME AIR FOR VENTILATION

At night, outside air might be sufficiently cool for use in aging and storing, and cold stabilisation. The use of outside air reduces the need for refrigerated air.

Energy saving: up to 20% of refrigeration energy consumption.

## SCHEDULE MULTIPLE REFRIGERATION COMPRESSORS IN PARALLEL

Multiple refrigeration compressors used in parallel can allow each compressor to operate efficiently, rather than one compressor operating at sub-optimal loads. Use multiple compressors where varying loads are required, for example, one set of screw compressors could meet the base load while another set of reciprocating compressors meets the variable load.

Energy saving: 3% of refrigerator energy consumption.

Other benefits from making this improvement include a higher reliability of refrigeration supply due to redundancy (multiple compressors in place means that if one compressor breaks-down, the remaining compressors can compensate for the loss of load).


COMPRESSORS CAN BE TURNED ON OR OFF DEPENDING ON FLUCTUATING LOAD

## OVERCOOL THE PRODUCT AT NIGHT

Cooling the wine to the minimum allowable temperature at night, when ambient temperatures and electricity costs are low, will delay the need for active refrigeration during the day. Furthermore, a low condenser temperature at night saves power. Every reduction in condensing temperature of 1°C can reduce energy use by 2-4%.This strategy requires continuous monitoring and control of the cold store temperature.

Energy saving: up to 5% of refrigeration energy used for cold storage

Other benefits from this improvement include lower capital costs of refrigerator due to smaller required capacity.

## REPAIR REFRIGERATOR COMPONENTS

### MANAGE AND SEAL DOORS

Heat infiltrates cold stores though unsealed and open doors, which increases the power required to maintain the cooling load. Cooling load can increase by 10% due to faulty door seals and by a further 10% due to improper door management. Avoid 75% of this infiltration by installing tight seals and plastic strip curtains; and by implementing proper door management, including training staff to close doors and installing automatic door closers or alarm systems.

Energy saving: up to 15% of refrigeration energy consumption. (Savings depend on the number of cold stores and frequency of access to the cold stores).

Other benefits from making this improvement include an increase in the refrigeration cooling capacity by up to 15%.

Equipment requirements:

» Door seals
» Automatic door closer or alarm system

DOOR SEALS

# STEP 2: EXPLORE OPTIONS TO UPGRADE EQUIPMENT

## INSTALLING EVAPORATIVE COOLING OR ICE STORAGE TO PRE-COOL GRAPES AND MUST

Pre-cooling grapes and must reduces the peak load for refrigeration. The best options are usually evaporative cooling and ice storage. Evaporative cooling is most effective in hot weather, usually the time of year for crushing.

Ice storage uses spare refrigerator capacity to make ice that is then used to make chilled water for cooling. This option allows the refrigerator to continuously run at full load, which is more efficient than running at part-load. Other suitable cooling options include the use of mains water (at ambient temperature).

Energy saving:
varies for different circumstances

Other benefits of this improvement include lower capital costs of refrigerator due to smaller required capacity (pre-cooled grapes means lower cooling requirements).

## INSTALL INSULATION ON REFRIGERATOR EQUIPMENT

### INSTALL INSULATION ON REFRIGERATORS AND PIPE NETWORKS

Insulation prevents heat transfer into cooling fluids. It can often be cost-effectively installed or improved on suction lines and other pipes; heat exchangers; pumps; tank doors; valves; flanges and other fittings; walls and roofs of barrel stores and fermentation rooms; and areas of thermal bridging, such as bolts and brackets. Insulating interior cold store equipment—such as pipes, heat transfer equipment and vessels, pumps, and motors—has the added benefit of reducing the cooling load. Insulating suction lines has the added benefit of reducing the suction temperature, increasing the compressor efficiency.

Energy saving: 10% of
refrigeration energy consumption

TABLE: LOW-TEMPERATURE INSULATION MATERIALS AND THEIR TYPICAL APPLICATIONS

| Insulation | Maximum temperature (°C) | Application |
|---|---|---|
| Polyethylene | 80 | Internal and external locations (joints sealed) |
| Synthetic rubber | 105 | Internal and external locations (joints sealed) |
| **Ball blankets** | **Maximum temperature (°C)** | **Application** |
| Polyethylene | 110 | Metal treatment tanks) |
| High density polypropylene | 230 | External freezing prevention, UV stabilised |

Equipment requirements:

- Insulation
- Thermal imaging camera to find where existing insulation is degraded.

THERMAL IMAGING CAMERA

### INSTALL INSULATION ON TANKS

Three main types of tank insulation are available, each with varying costs and benefits depending on the size and type of the tank:

- Spray-on, for large applications
- Foil over bubble wrap
- A rigid foam with an outer shell.

Energy saving: 20-33% (25% average) of refrigeration energy consumption.

Equipment requirements:

- Insulation

EXAMPLES OF INSULATED TANKS

### REPLACE INSULATION ON COLD STORE WALLS

PIR (polyisocyanurate) insulates up to 40% better than the polystyrene typically used on cold stores walls. Decrease heat lost through walls by installing PIR insulation.

Energy saving: varies for different circumstances

## REARRANGE REFRIGERATION CIRCUIT

### MINIMISE THE PRESSURE-DROP OF THE REFRIGERATION CIRCUIT

Reduce the pressure-drop of the circuit (an reduce energy required for pumping) by reducing friction with the following features:

- Pipe diameter: even a small increase in pipe diameter (including heat exchangers) will lead to a relatively large reduction in friction (since, for circular pipes, friction is inversely proportional to the fifth power of the internal pipe diameter), which results in more efficient operation.
- Pipe roughness: Internal pipe roughness depends on the material and finish, and also the amount of fouling and corrosion, which creates rough surfaces. Smooth pipes (including heat exchangers) have much less friction than rough pipes, resulting in more efficient operations.
- Pipe length: Pipe networks (including heat exchangers) can be unnecessarily long due to bypass loops, bend components, and the location of the refrigeration unit and end uses. Pipe friction increases with increasing length, and therefore, a reduction in pipe length can increase operational efficiency.
- Pipe components: Each component adds friction losses.
  - Bends, branches, and joins should be eliminated or, if they are required, should be gradual (large radius).
  - Inlets should be rounded, and constrictions should be gradual.
  - Valves and restrictors should be used minimally.

Reduced pressure-drop has some added benefits to other refrigeration components:

» In a refrigerator that uses a direct expansion system, the compressor operates most efficiently when the suction pressure is high. A low pressure-drop retains pressure in the suction line, thereby improving overall efficiency.
» Reduced pressure-drop enables suction pressure, which makes variable flow of refrigerant easier to achieve (refrigeration chillers require less power if the refrigerant circuit allows for a variable flow of the refrigerant to match the load).

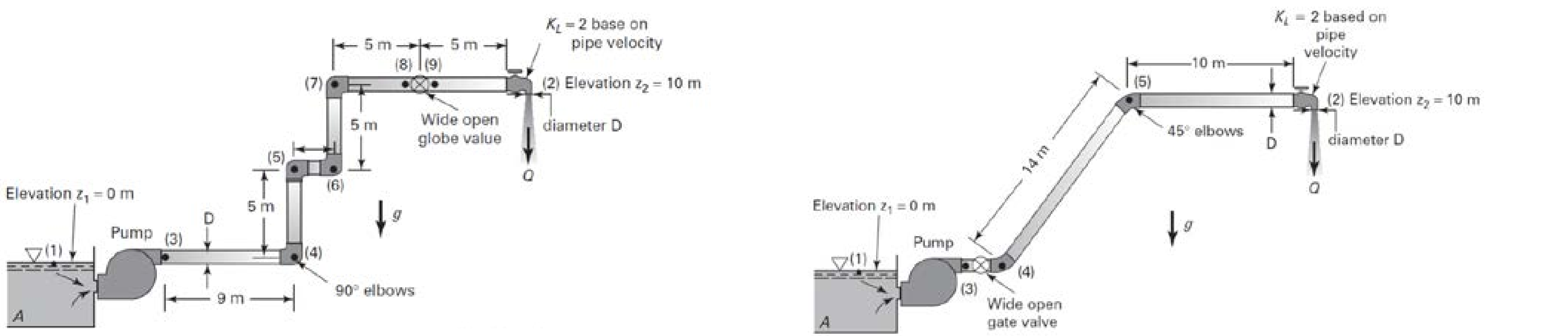
Energy saving: varies for different circumstances

## DELIVER THE PRIMARY REFRIGERANT TO THE END USE

Cooling by heat exchange with the primary refrigerant, such as ammonia, is more efficient than with a secondary refrigerant, such as brine or chilled water. Primary refrigerants remove more heat (per unit mass) and require less energy to pump. The use of primary refrigerants is appropriate for end-uses that require continuous cooling, such as fermentation and storage. It also enables a higher suction pressure. Primary refrigerants are not as efficient in part-load cooling situations, and are not appropriate for immersion chillers.

Energy saving: varies for different circumstances

*AN EXAMPLE OF PIPE NETWORK REARRANGEMENT TO REDUCE BENDS AND LENGHT (LEFT – EXISTING NETWORK; RIGHT – REARRANGED NETWORK)*



### INSTALL A SECOND BRINE TANK

A second brine tank allows for pre-cooling of the warm, returned brine before going to the chilled brine tank. It also increases the store of brine that can be chilled with off-peak energy and night-time cooling.

Energy saving:
varies for different circumstances

BRINE TANK

### RELOCATE REFRIGERATOR

Compressors operate more efficiently in cooler surroundings, and condensers expel heat more efficiently to cooler surrounding. Increase refrigerator efficiency by locating refrigerator units in areas that are cool, well-ventilated, and out of direct sunlight (e.g. shaded, enclosure with reflective paint, or underground).

Energy saving:
varies for different circumstances

## REPLACE INEFFICIENT REFRIGERATOR COMPONENTS

### REPLACE INTERNAL COOLING WITH EXTERNAL COOLING

The cooling of screw compressors is more efficient with external oil coolers than with liquid-injection oil cooling (the direct injection of high-pressure liquid refrigerant into the compressor). Liquid-injection oil cooling can decrease the efficiency of screw compressors by up to 5-10%. External oil coolers usually remove heat through the use of water or a refrigerant (usually ammonia) in a shell and tube heat exchanger on the oil circulation system. The refrigerant can be passively circulated by a simple process called thermosiphon.

Energy saving: 3-15% of refrigeration energy consumption (savings depend on the size of screw compressors).

EXAMPLE OF AN EXTERNAL OIL-COOLER FOR COMPRESSORS

Other benefits of this improvement include:

- Increase in refrigeration capacity of the compressor by 5-10%
- Increase in discharge temperature from 50°C to around 70°C, which is more cost-effective for heat recovery.

Equipment requirements:

- A water or refrigerant/thermosiphon oil cooler
- For refrigerant/thermosiphon oil cooler: a refrigerant liquid-and-vapour return pipe between the liquid receiver and the oil cooler
- For water oil cooler: a cooling water pipe between the evaporative condensers and the oil cooler.

## INSTALL AN ELECTRONIC EXPANSION VALVE

Thermostatic expansion valves can be problematic under conditions of varying pressure. In a refrigerator that uses a direct expansion evaporator and experiences varying pressure, balanced port or electronic valves, such as electronic expansion valves (Tx valves), efficiently control the quantity of refrigerant.

Energy saving: up to 20% of refrigeration energy consumption

Other benefits from this improvement include preservation of compressor equipment and less downtime due to no chance of liquid refrigerant returning to the compressor, which can otherwise cause damage or failure.

*EXAMPLE OF AN ELECTRONIC EXPANSION VALVE*

## REPLACE CENTRIFUGAL FANS WITH AXIAL FANS IN CONDENSERS

Axial fans are suitable for air-cooled and evaporative condensers, which do not usually require the high pressure air generated by centrifugal fans. Axial fans use up to 50% less energy than centrifugal fans.

Energy saving: up to 50% of condenser fan energy consumption

*EXAMPLE OF A CENTRIFUGAL FAN (LEFT) AND AN AXIAL FAN (RIGHT).*

# INSTALL NEW REFRIGERATOR COMPONENTS

## INSTALL AN AUTOMATIC PURGER

Automatic purgers remove contaminants (air, nitrogen, waste refrigerant, other non-condensable gases, oil, water) that circulate with the refrigerant and accumulate in the condenser. Purging increases refrigerator efficiency by about 1% for every 1% of contaminant removed. Simple purgers are often inadequate to remove all contaminants.

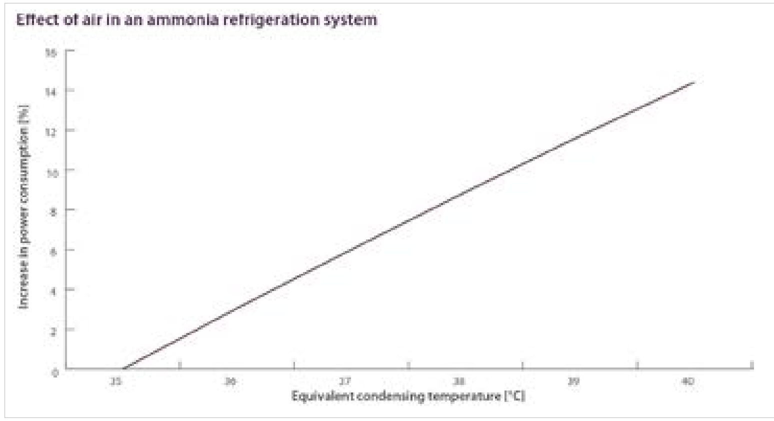
Energy saving: 5% of refrigeration energy consumption, or 10-50% of chiller energy consumption (Automatic purgers are usually cost effective on refrigerators of capacity greater than 500kW).

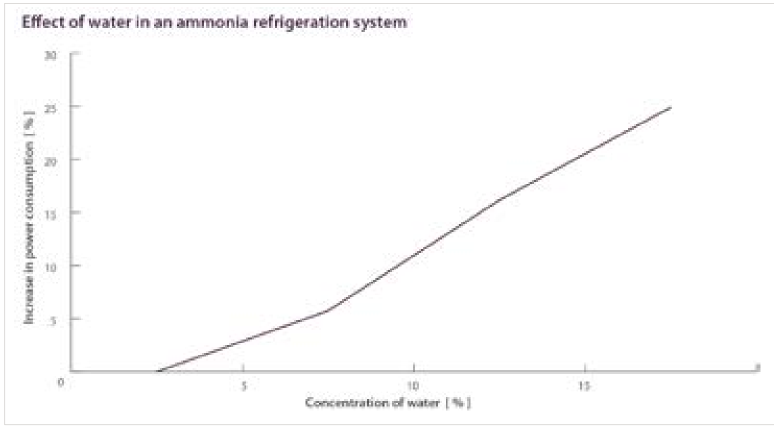
To estimate energy savings, consider:

» Effectiveness of existing contaminant removal and prevention procedures
» Load profile
» Contaminant content (this can be difficult to estimate)

Three general types of automatic purgers are available:

» Automatic air purgers, which remove most gases but not water vapour.
» Water purgers (ammonia anhydrators), which remove water vapour.
» Some more-expensive purgers remove air and water vapour.




*THE EFFECT OF CONTAMINANTS (WATER & AIR) ON AMMONIA REFRIGERATION SYSTEM*

## INSTALL VARIABLE SPEED DRIVES ON REFRIGERATOR REFRIGERATOR COMPRESSORS OR FANS

EXAMPLE OF AN AUTOMATIC PURGER

Many refrigerator motors have soft start features that gradually ramp up the motor speed. They can decrease energy consumption when loads vary infrequently, but they can increase energy consumption when loads vary frequently.

Variable speed drives (VSDs) on the other hand continually adjust motor speed to match the component (compressor, condenser fan, or evaporator fan) output to the load. Even a small reduction in speed will lead to a relatively large reduction in power (since component power is proportional to the cube of the motor speed), hence VSDs can result in significant energy savings. VSDs are well suited to components that, due to variable loads or infrequent high loads, operate at part-load for up to 95% of the time. At full-load, VSDs are about 3% less efficient than constant speed drives and should therefore be avoided where full-loads are required most of the time. VSDs on evaporator fans have the added benefit of reducing the cooling load.

A VSD eliminates the need for flow-control devices, such as dampers, which results in further energy efficiency improvements as the removal of unnecessary flow-control devices reduces pressure-drop in the pipe network.

VSDs reduce component power only when an appropriate control strategy is implemented. Finding the best strategy involves using a control signal and iteratively adjusting the set-point and other settings to achieve optimum performance.

Some additional control strategies help to optimise the VSD control of fans:

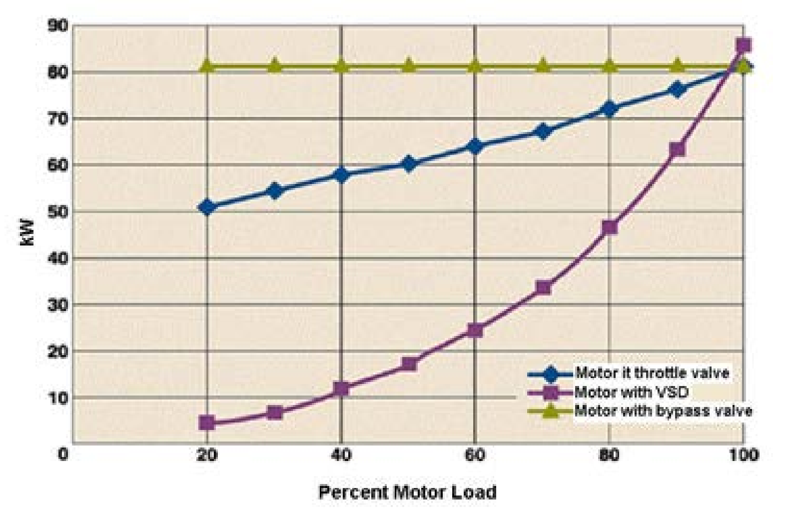
» Condenser fans need to operate only when the compressors operate. Decrease condenser fan power by coupling control of condenser fans to the control of compressors.
» If evaporator fans are off for too long, the air in cold storage can stratify (warm layer on the top and cool layer on the bottom), leading to poor wine cooling. Optimise cooling and power consumption by running the evaporator fan regularly. Fans of flooded and recirculated evaporators should be run for a period after solenoids are turned off to allow the refrigerant to drain out of the evaporator.

Energy saving:
- 10-60% (20% average) of motor energy consumption
- 4-5% of refrigeration energy consumption for fans

Savings depend on size, number, and use patterns of the motor, as well as the number of cold stores.

Other benefits from this improvement may include:
» Lower maintenance costs, due to less wear-and-tear on the motor
» Longer operating life of refrigeration equipment.

Capital cost: $200-$500/kW, about the same as the motor. Capital costs depend on the size (cost per kW decreases with increased motor size ), number, and use patterns of the motor.




*COMPARISON OF MOTOR POWER WITH VSD AND WITHOUT VSD*

## INSTALL MULTI-SPEED MOTOR ON FANS

Multi-speed motors use a different set of windings to operate efficiently at each speed, and typically have higher capital costs and slightly lower efficiency than single-speed motors. However they are well-suited to fans for which for VSDs are too expensive, and to fans that operate at a particular load for long periods.

Energy saving:
varies for different circumstances

## INSTALL AUTOMATED COMPRESSOR STAGING AND CAPACITY CONTROL

Compressors are more efficient when running at full load than at part-load. Therefore, the use of multiple, small compressors to meet a large refrigeration load enables high efficiency at peak load—which lasts only six to eight weeks of the year, during the crush—and also at part load.

This strategy is suitable when the load is consistently above 50%. The availability of compressors of different capacities enables greater flexibility in efficiently matching the compressor capacity to the required load.

An automatic controller can optimise energy use by turning compressors on and off as needed, usually resulting in only one small compressor operating inefficiently at part-load (rather than one large compressor operating inefficiently, or several smaller compressors operating inefficiently).

The controller, however, should also account for the efficiency losses during compressor start-up and shut-down. Control logic should be optimised over the full range of the refrigerator cooling loads and climatic conditions. Fine-tuning may be required.

Energy saving: 5% for refrigerator that's already partly optimised (most common); 15% for un-optimised refrigerator. Savings depend on load profile and number, size and condition of compressors.

Other benefits of this upgrade include longer operating life of compressors.

Equipment requirements:

» A suction pressure transmitter
» A slide valve potentiometer, connected to the automatic controller, for each screw compressor
» Capacity control solenoids for reciprocating
» Compressors, connected to the automatic controller
» Variable speed drive(s) on compressors
» Control hardware and software capability (to define the logic).


*AUTOMATED COMPRESSOR STAGING AND CAPACITY CONTROLLER*

## SPEED REFRIGERATION TIME

### INSTALL A CENTRIFUGE

Centrifuges can speed cold settling, reducing the period of high cooling load for the refrigerator thereby reducing energy use. Final separation requires an additional separator, such as a conventional decanter or belt press.

Energy saving:
varies for different circumstances

*EXAMPLE OF A CENTRIFUGE*

### INSTALL A CROSS FLOW FILTER

Cross flow filters are emerging as a technology that can speed cold settling. They can reduce cooling load and energy use of the refrigerator by 50% more than centrifuges. The equipment costs and processing time of cross flow filters are similar to centrifuges. For wine, stainless steel and titanium metallic membranes for cross flow filters are robust and have good self-cleaning properties.

Energy saving:
varies for different circumstances

*EXAMPLE OF A CROSS-FLOW FILTER*

### REPLACE REFRIGERATOR AND COMPONENTS

Replacing old refrigerators with new refrigerators (such as chilled water or glycol) is usually cost effective if the existing refrigerator is more than 10 years old.

Energy saving: up to 30-40% of refrigeration energy consumption

Assess cooling applications to determine whether a central or distributed refrigeration system is most appropriate. Select a system that is designed for high efficiency at the most common part load but can also meet peak load. Select condensers and evaporators that provide a low temperature lift. Every reduction in temperature lift of 1°C can reduce energy use by 2-4%.

## INSTALL AN EFFICIENT CHILLER

The efficiencies of chillers fall in a wide range. Depending on the application, high-efficiency chillers (despite being high-cost) use 20-75% less power than low-cost chillers.

Chillers are designed for specific applications, such as air-conditioning or chilled glycol/water. Efficient chillers are also designed for specific operating temperatures and load profiles so you need to consider:

- Fluid temperatures: If fluid temperatures are non-standard, then order a special chiller to suit
- Annual load profiles: If the chiller is used during winter, when ambient temperature is low, then seek a chiller that can operate at low condensing temperatures to maximise energy savings
- Daily load profile: Chillers often run at part-load. Good chillers are more efficient at part load than at full load. High-efficiency chillers have a Coefficient of Performance (COP, a measure of efficiency) of up to 6 at full load and 12 at part load, while low-cost chillers have a COP of up to 4 at full load and 2 or less at part load.

Energy saving: 10-50% of chiller energy consumption

Other benefits of this improvement may include lower maintenance costs.

## INSTALL AN EFFICIENT EVAPORATOR

Generally, large evaporators are more efficient than small evaporators, but some evaporators achieve higher efficiency through specific design features. Many types of evaporators are available, some of which are suited to specific applications:

- Direct expansion coolers
- Pumped liquid air coolers
- Shell and tube liquid coolers
- Plate heat exchanger liquid coolers
- Baudelot liquid coolers

Energy saving: varies for different circumstances

EXAMPLE OF AN EVAPORATOR

## INSTALL AN EFFICIENT CONDENSER

EXAMPLE OF A CONDENSER

Generally, large condensers lead to less energy use than small condensers because they produce lower-temperature cooling fluid for the refrigeration system. Large condensers, however, require a higher flow of cooling fluid (air or water).

Best practice aims to balance water and energy use. Select a condenser with high part-load efficiency because peak cooling load, which occurs during grape crush, lasts only six to eight weeks of the year.

Three types of condensers are most common, each of which has specific performance, efficiency, and equipment:

- Air cooled: uses a fan
- Water cooled: uses a circulating pump and, usually, a cooling tower
- Evaporative: uses a fan and a pump.

Energy saving:
varies for different circumstances

## USE AN EFFECTIVE PRIMARY REFRIGERANT

Ammonia (R717) is currently the dominant refrigerant for industrial refrigeration in Australia. It is the cheapest of the common refrigerants, has good properties, and is thermodynamically 3-10% more efficient than some HCFCs (R22, R134a). In some cases, compared with the use of HCFCs (R134a, R407C, R404A, R507), the use of ammonia can require 30-50% less power in summer and 50-60% less power in winter. Carbon dioxide (R744) is once again emerging as a good refrigerant. It is substantially cheaper than ammonia.

Propane has similar efficiency to ammonia – the refrigerants, as well as hydrocarbons (R600a, R290, R1270), are not affected by carbon price, whereas HCFCs are affected.

Note: select the most biologically benign refrigerants for refrigerators with high leakage.

Energy saving:
varies for different circumstances

# ALTERNATIVES TO REFRIGERATION

## INSTALL A FLOTATION UNIT FOR CLARIFICATION

Flotation separation is a processing method that is widely used in the wastewater treatment and mineral processing industries that can be used to separate solids from liquids in grape juice or must. It requires less refrigeration energy than other must clarification techniques such as cold settling because it takes only several hours, while cold settling can take up to 3 days. It can also be more effective in removing solids and preserving aromas. In flotation, a fining agent is added to the juice to adhere to and improve the buoyancy of particles and a gas is injected at the bottom of the tanks. The gas bubbles collect the solids as they float to the top, depositing the solids to form a froth that can then be removed.

Flotation is suited to white and rosé juices, and red musts that have undergone thermal processing, such as flash extraction. It can be optimised through the choice of gas (compressed air or nitrogen gas), which can be recovered, and through the choice of fining agent (bentonite, gelatin, silica, or carbon).

Energy saving: equivalent to up to 90% of refrigeration energy for cold settling

Other benefits from this improvement may include:

- Faster process time
- Improved efficiency of subsequent processing (e.g. filtration)
- Less space due to fewer tanks
- Lower maintenance costs due to fewer tanks.

ELECTRODIALYSIS UNIT

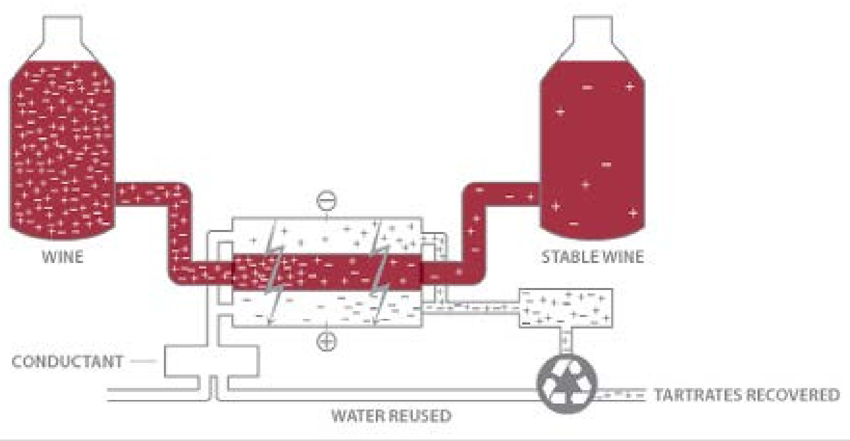
## INSTALL AN ELECTRODIALYSIS UNIT FOR TARTRATE STABILISATION

Electrodialysis removes tartrates from wine. It requires much less energy than cold stabilisation because it doesn't require freezing and reheating. The total operating cost of electrodialysis (25-30c/L), however, is similar to that of cold stabilisation (28-35c/L) due to the costs of replacement membranes and large volumes of water. Electrodialysis also saves on costs by preventing the 0.5% loss of wine associated with cold stabilisation. Electrodialysis units can process wine at a rate of 1,000-12,000 litres of wine per hour, while cold stabilisation for similar volumes may take between 6-9 days.

Energy saving: 90%+ of refrigeration energy used for cold stabilisation

Other benefits from this improvement may include:

- Faster process time (up to 97% time saving)
- More consistent product due to minimal effect on pH.




ELECTRODIALYSIS

## USE ADDITIVES FOR TARTRATE STABILISATION

Chemical additives can inhibit potassium bitartrate crystal growth without affecting the quality of wine. Their use can eliminate the need for cold stabilisation or electrodialysis. Additives are suited to some, but not all, varieties of wine. Examples of additives authorised in Australia include:

» Yeast mannoproteins (e.g. Mannostab).
» Carboxymethyl cellulose (e.g. Celstab)

Carboxymethyl cellulose is suitable for relatively unstable wines, but yeast mannoproteins are not.

The total operating cost of Celstab (8-10c/L) is lower than that of cold stabilisation (28-35c/L). The use of Celstab requires time only for addition and homogenisation, while cold stabilisation takes 6-9 days.

Energy saving: nearly 100% of refrigeration energy consumption for cold stabilisation or electrodialysis.

Other benefits include a faster process time, and more consistent product due to no effect on pH.

## INSTALL AN UNDERGROUND COOL ROOM

Underground cool rooms (or ‘caves’) provide an excellent climate for aging and storing wine by achieving almost-constant temperatures of about 15-16°C throughout the year, and humidity of 80-90%.

Energy saving: 100% of refrigeration energy used for cold storage (cost savings depend on whether the underground cool room is a new facility (faster payback) or a replacement for an existing building (slower payback)).

# STEP 3: COLLECT DATA AND ENGAGE WITH SUPPLIER

## SUPPLIER CHECKLIST

The following checklist provides guidance on which information to collect from within the winery and from the equipment supplier, in order to assess the winery's refrigeration system for potential improvements in energy efficiency.

Important to note:

» Some of the information suggested below may be difficult or impractical for SME wineries to collect. We do not expect you to be an expert in refrigeration – instead, the intention of this checklist is to give you a snapshot of what may be required to properly assess the opportunity, and to then have an informed discussion with the supplier to explore what may be possible.

» This checklist can be given directly to the supplier to assist them with providing the winery with an appropriate energy efficiency solution.

» An editable (Microsoft Word) and print-version of this checklist is available via the WEST Online Portal, accessible via www.winesa.asn.au.

## 1. DETERMINE THE END-USES OF YOUR REFRIGERATOR

*Check the following end-uses:*

| | | | |
|---|---|---|---|
| Fermentation | | Cold store (aging/barrel rooms) | |
| Cold stabilisation | | Cooling water pumping/circulation | |
| Electrodialysis | | Cooling offices | |
| Other: | | | |

## 2. COMPILE A REFRIGERATOR INVENTORY

*Compile a list of the following equipment:*

| | |
|---|---|
| Compressors: number, make, model, type (screw or reciprocating), power rating (kW), efficiency, flow rate (l/s), speed (rpm), & number of pump stages | |
| Condensers: number, make, model, type (air cooled, water cooled or evaporative), and age (y) | |
| Pumps: number, make, model, type, power rating (kW), efficiency, flow rate (l/s), speed (rpm), and number of pump stages | |
| Fans: number, make, model, type, power rating (kW), efficiency, flow rate (l/s), speed (rpm), and number of pump stages | |
| Pipes: diameter of main high-pressure refrigerant liquid line (m) | |
| Refrigerator: time in use (h/y) | |
| Other: | |

*Choose an approach to estimate time in use:*

| | |
|---|---|
| Record readings on hour-run meter (h) at regular intervals | |
| Divide the hour-run meter reading (h) by the total time (h) that the refrigerator has been installed | |
| Compare the energy (kWh) and power readings (kW) (can be obtained visually if the system has an electricity meter) | |
| Examine electricity meter load profiles (kW) | |
| Use existing control systems and manual procedures | |
| Check control settings (if the system has controls) | |

## 3. ESTIMATE THE COOLING LOAD

*Compile a list of the following information:*

| | |
|---|---|
| Major end-uses (which comprise at least 70% of the total cooling load (kW)) | |
| Specific cooling requirements (temperature (°C) and cooling time (h)) for each end-use | |

*Choose an approach:*

1.For an initial estimate of theoretical cooling requirements (kW), review equipment manuals and process specifications.

| | |
|---|---|
| » If budget and time allow for a more-accurate estimate of actual cooling requirements (kW), which include undesirable heat gains (kW), install metering and monitoring equipment, such as data-loggers. For this procedure, collect the following data at the end-uses, for either the secondary refrigerant or the product, to calculate the heat removed: | |
| Volumetric flow rate (m3/s) (measure) | |
| Temperature rise (°C) (measure) | |
| Specific heat capacity (kJ/kg°C) (look up data sheet or estimate) | |
| Fluid: refrigerant / product | |

*This list enables you to:*

- » estimate the cooling load (kW), including the base load (kW) and peak load (kW);
- » identify the end-uses that dominate the cooling load (kW);
- » identify the end-uses that can be rescheduled from peak times to off-peak times; and
- » group together end-uses that require similar cooling temperatures (°C).

## 4. ESTIMATE THE REFRIGERATOR PERFORMANCE

Measure indicators of refrigerator performance

*Choose an approach:*

1. For an initial estimate, measure the following parameters, and compare them to their design values:

| | |
|---|---|
| Condensing temperature (°C) at the inlet | |
| Condensing temperature (°C) at the outlet | |
| Evaporator temperature (°C) at the inlet | |
| Evaporator temperature (°C) at the outlet | |
| Compressor pressure (kPa) and temperature (°C) at the inlet | |
| Compressor pressure (kPa) and temperature (°C) at the outlet | |
| Power to the compressor (kW) | |
| Ambient temperature (°C) | |
| Brine temperature (°C) | |

2. For a more-accurate estimate, perform an energy consumption assessment. For this procedure, log the energy use of the refrigerator and/or specific components against the ambient temperature (°C) and cooling load (kW), and then compare these graphs to the design values.

| | | | |
|---|---|---|---|
| Equipment: | | Pumps | |
| Refrigerator | | Fans | |
| Compressors | | Other: | |

These indicators enable you to:

- » identify inefficient equipment and processes;
- » assess the effectiveness of the energy efficiency measure implemented; and
- » monitor for unexpected changes in the performance of equipment and processes.

## 5. DETERMINE THE BUSINESS PARAMETERS OF THE REFRIGERATOR

*Quantify or qualify the following values:*

- Energy price(s) ($/kWh; $/l) ☐
- Capital budget ($) ☐
- Targets for running costs ($/y) ☐
- Required level of redundancy in the system ☐
- Acceptable level of risk for new technologies ☐
- Equipment constraints, such as: specific brands of equipment; specifications for electrical wiring; compatibility with existing infrastructure or floor space; and adaptability to future upgrades ☐
- Scope of energy efficiency opportunities to consider: If the existing equipment needs to be replaced, then calculate the payback period (y) based on the extra (rather than total) costs ($) (if any) of the efficient equipment ☐

## 6. CONFIRM REFRIGERATOR PERFORMANCE

*Check the following conditions:*

- The refrigerator meets peak cooling load (kW) ☐
- The refrigerator is optimised for the most common cooling loads (kW) ☐

## 7. SELECT A SERVICE PROVIDER

*Select a refrigeration service provider that can provide the combination of services that you seek:*

- Measurement and analysis of the cooling load profile (kW), and power (kW) of the refrigerator and end-uses ☐
- Reporting on equipment and process performance ☐
- Optimisation of the refrigerator system, including: optimisation of the control system, pressure levels (kPa), temperature levels (°C), and flows (l/s); management of refrigerant leaks; and assessment of heat recovery potential ☐
- Supply, service, and installation of refrigerator components (e.g. compressors, evaporators, filters, and pipes) for optimal energy efficiency (%) ☐
- Supply of spare parts, including shipping ☐
- Guarantee of minimum efficiency (%) of the proposed system ☐
- Guarantee of maximum running costs ($/y) of the proposed system ☐
- Technical support and after sales service ☐
- In-house repairs and onsite service ☐
- Emergency service ☐
- Remote monitoring ☐
- Appropriate removal and disposal of old equipment ☐
- Other: ☐

## 8. NEGOTIATE A CONTRACT

*Determine your preferred type of contract:*

» Service contract: the supplier performs certain actions for a fixed price ($). ☐

» Energy performance contract: the supplier performs certain actions that meet certain levels of energy reduction (kWh) for a lower upfront price ($) and a share of the cost savings ($/y). ☐

## OTHER TOOLS

To further assist with evaluating opportunities to improve Refrigeration and Tank Storage energy efficiency, the Winery Energy Saver Toolkit provides the following tools (available via the Online Portal, www.winesa.asn.au):

» Energy efficiency opportunities modeling tool, which can be used to test potential savings resulting from key energy efficiency improvements outlined in the Winery Energy Saver Toolkit

» Energy Resource Use Data tool, which can be used by businesses to collect and analyse their own baseline electricity, gas and fuel consumption data.

## SUPPORTING REFERENCES

The following references were used in the development of the Refrigeration and Chilling section of the WEST toolkit. We encourage you to access these references as they may provide additional useful information for your business in evaluating energy efficiency opportunities.

*DSM Food Specialties:* Wine ingredients news: floatation, http://www.oenobrands.com/en/home/wine-ingredients-news

*Carbon Trust:* How to implement process thermal insulation http://www.carbontrust.com/media/147127/j7959_ctl038_process_thermal_insulation_aw.pdf

*Malherbe, D & O'Kennedy, K: Comparing:* Comparing traditional cold stabilisation, electrodialyses and carboxymethyl cellulose addition (CMC) for tartrate stabilisation in terms of wine quality and cost

*Department of Resources, Energy and Tourism (Australian Government):* EEX website http://eex.gov.au

*Department of Industry, Tourism and Resources (Australian Government):* A guide to energy efficiency innovation in Australian wineries – energy efficiency best practice www.ret.gov.au/energy/Documents/best-practice-guides/energy_bpg_wineries.pdf

*Zoecklein, B:* Enology notes #163: http://www.apps.fst.vt.edu/extension/enology/EN/163.html

*Dharmadhikari, M:* Methods for tartaric stabilization of wine http://www.extension.iastate.edu/NR/rdonlyres/173729E4-C734-486A-AD16-778678B3E1CF/73965/MethodsforTartrateStabilizationofWine.pdf

*Lawrence Berkeley National Laboratory*: BEST Winery Guidebook – Benchmarking and Energy and Water Savings Tool for the Wine Industry, http://industrial-energy.lbl.gov/node/41

*Lawrence Berkeley National Laboratory:* Energy Efficiency Improvement and Cost Saving Opportunities for the Fruit and Vegetable Processing Industry http://industrial-energy.lbl.gov/drupal.files/industrial-energy/Fruit-Vegetables.pdf

*Lawrence Berkeley National Laboratory:* Energy Efficiency Improvement and Cost Saving Opportunities for the Dairy Processing Industry http://www.energystar.gov/ia/business/industry/downloads/Dairy_Guide_Final.pdf

*NSW Office of Environment and Heritage:* Technology Report: Industrial refrigeration and chilled glycol and water applications, www.environment.nsw.gov.au/sustainbus/energyeffrefrig.htm

*Origin Energy:* Energy Efficiency Fact Sheet - Refrigeration http://www.originenergy.com.au/files/SMEfs_Refrigeration.pdf

*Perth region NRM:* Energy Management Guidelines for Wineries for chillers, refrigeration, hot water, lighting, compressed air, HVAC, www.perthregionnrm.com/media/4851/iv%20guidelines%20for%20wineries%20-final%20draft.pdf and www.perthregionnrm.com/media/5733/attachment%2011%20-%20energy%20management%20guidelines%20for%20wineries.pdf

*Working Group for Cleaner Production:* Eco-Efficiency Resources for the Queensland Food Processing Industry http://www.sd.qld.gov.au/dsdweb/docs-bin/v2/food/ecoeftk_prelims.pdf

Stasinopoulos, P. et al (2010) *Whole system design: an integrated approach to sustainable engineering,* Earthscan Publishing http://www.naturaledgeproject.net/Whole_System_Design.aspx

*Sustainability Victoria:* Energy Efficiency Best Practice Guide – Industrial Refrigeration, www.resourcesmart.vic.gov.au/for_businesses/energy_efficiency_4597.html

*Sustainability Victoria:* Energy Efficiency Best Practice Guide – Pumping Systems, www.resourcesmart.vic.gov.au/for_businesses/energy_efficiency_4597.html

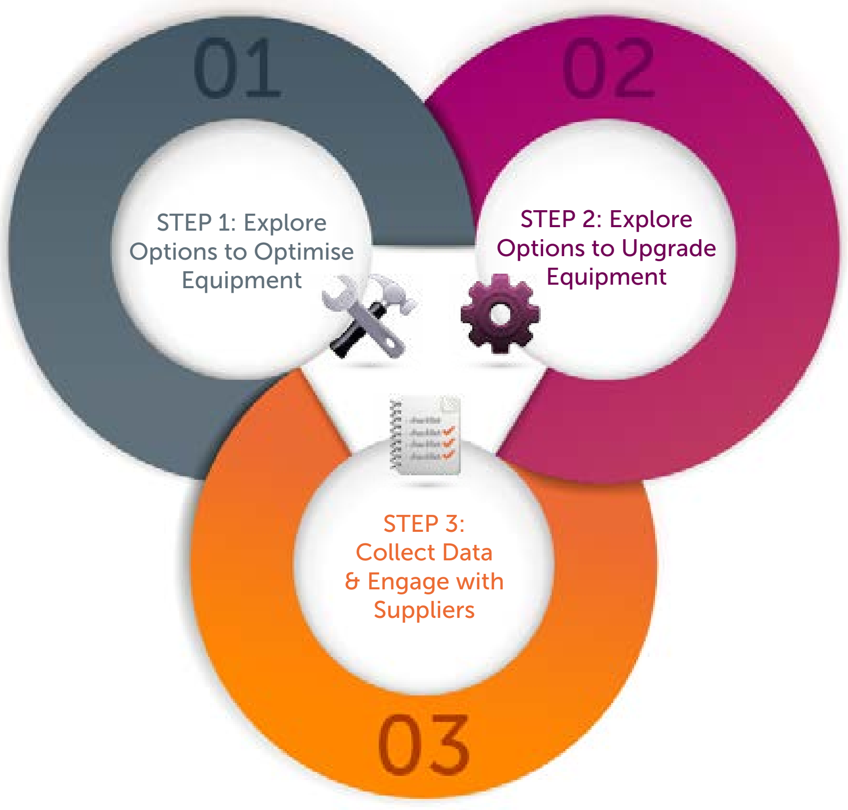
*US Department of Energy:* Improving Pumping System Performance - A Sourcebook for Industry www.pumps.org/content_detail.aspx?id=5841

*Working Group for Cleaner Production:* Eco-Efficiency Manual for Meat Processing http://www.enve.metu.edu.tr/people/gndemirer/links/temizuretim/doc/Eco-Efficiency%20Manual%20for%20Meat%20Processing.pdf

# PUMPING

Energy efficiency improvements most relevant to the following winery processes:

- Wine transfers and pump overs
- Cleaning
- Wastewater treatment




**Pumping: 10-20% of energy consumption**

# STEP 1: EXPLORE OPTIONS TO OPTIMISE EQUIPMENT

## LOAD MANAGEMENT

### SCHEDULE THE MOST EFFICIENT PUMPS FOR A GIVEN LOAD

Different pumps operate at different efficiencies for a given load. Even pumps that seem identical can have different efficiencies due to wear and damage. Reduce pump power consumption by prioritising the most efficient pump for the load. Use less-efficient pumps for standby.

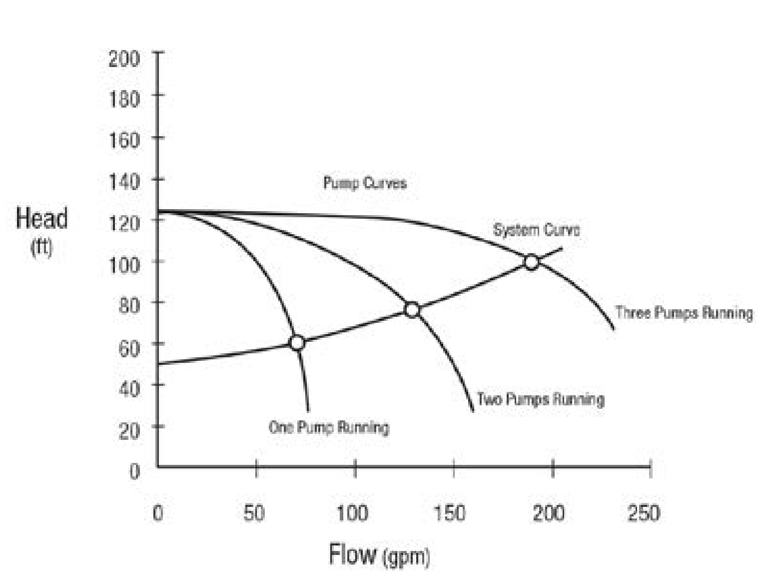
Energy saving: varies for different circumstances

### SCHEDULE MULTIPLE PUMPS IN PARALLEL

Multiple pumps used in parallel can allow each pump to operate efficiently (since different pumps will have different efficiencies), rather than one pump operating at sub-optimal loads. Use multiple pumps where varying loads are required, for example, one set of pumps can be used to meet base load while another set of pumps meets the variable load.

Energy saving: 10-30% of pump energy consumption

Other benefits from making this improvement include higher reliability of refrigeration supply due to redundancy (multiple compressors in place means that if one compressor breaks-down, the remaining compressors can compensate for the loss of load).




*DEPENDING ON THE REQUIRED FLOW AND HEAD (PRESSURE), THE USE OF MULTIPLE PUMPS CAN PROVIDE GREATER EFFICIENCIES*

# STEP 2: EXPLORE OPTIONS TO UPGRADE EQUIPMENT

## MINIMISE THE PRESSURE DROP OF THE PIPE NETWORK

A pump must generate fluid flow at a rate and pressure that meets the demands of the end-use and overcomes the friction and gravitational losses in the pipe network. Unless the pump curves are exceptionally flat, every 1% (up to 20%) reduction in flow (possibly due to friction and gravitational losses) will decrease pump effectiveness by 2%. Reduce losses with the following features:

- Pipe diameter: even a small increase in pipe diameter will lead to a relatively large reduction in friction (since, for circular pipes, pipe friction is inversely proportional to the fifth power of the internal pipe diameter) and therefore improve efficiency.
- Pipe roughness: internal pipe roughness depends on the material, finish and other maintenance-related factors such as corrosion and fouling. Smooth pipes have much less friction than rough pipes and are more efficient.
- Pipe length: pipe friction increases with increasing length. Pipe networks can be unnecessarily long due to bypass loops, bend components, and the location of the pumps and end-uses. Reduce pipe length, and pipe network length to improve efficiency.
- Pipe components: each component adds friction losses, so the following should be considered:
  - Bends, branches, and joins should be eliminated or, if they are required, should be gradual (large radius); in some cases, the use of turning vanes can be used to improve flow in bends
  - Inlets should be rounded, and constrictions should be gradual.
  - Valves and restrictors should be used minimally. Throttling valves should be eliminated. Even a fully open valve can add 70 kPa of pressure drop.
- Elevation: losses increase with increasing elevation from the pump to the end-use (these are gravitational losses). Eliminate these losses by having the pump at least as high as the end-use. Alternatively, a gravity feed arrangement can eliminate the need for a pump.

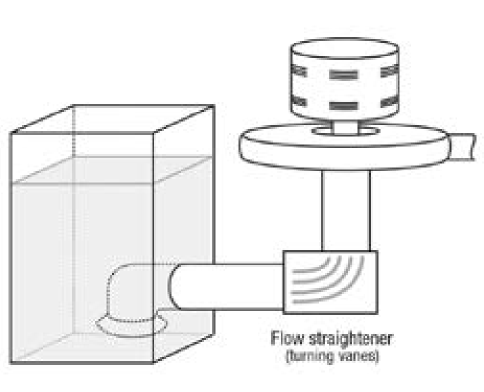
For water distribution, mains pressure might be sufficient if the pipe network losses are low enough to enable adequate flow, thereby eliminating the need for a pump. In this situation, pressure sensors and controls might be required to regulate flow.

When deciding which of these features to include, consider the combined costs of the pipe network, pump, and energy. Rearranging the pipe network, especially installing larger-diameter pipes, is well suited for new or replacement networks but may be cost prohibitive for existing systems (refer to the Refrigeration section of this toolkit for diagrams describing pipe rearrangement).

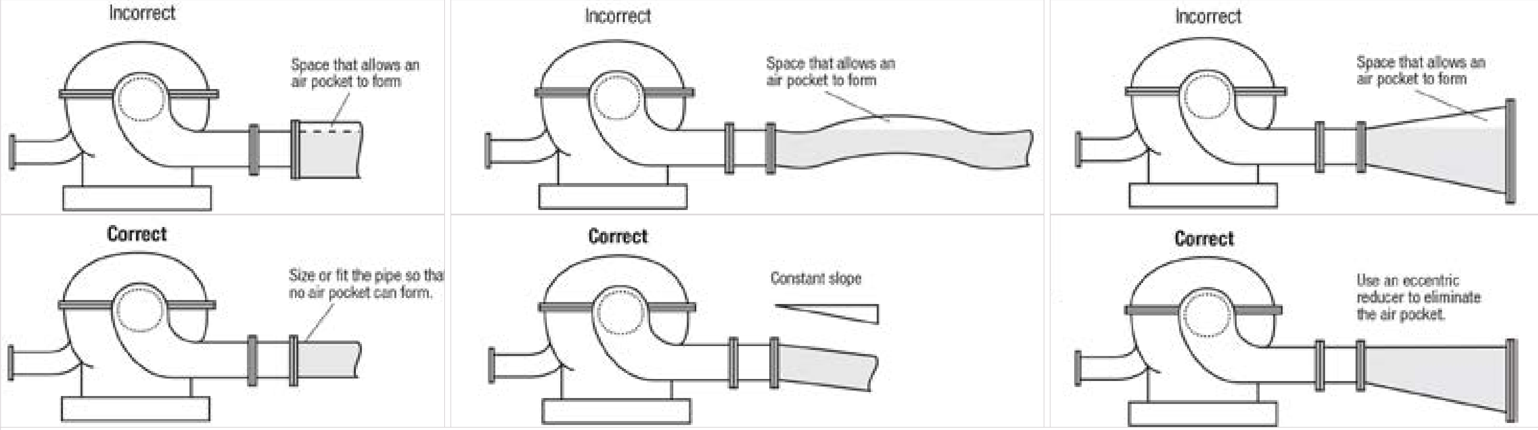
Energy saving: Increasing pipe diameter alone can result in 5-20% reduction in pump power consumption

Other benefits from making this improvement include:

- Lower capital costs due to smaller pumps required to provide the same pumping load
- Lower maintenance costs and longer operating life of pump system equipment due to less wear-and-tear.




THE USE OF A FLOW STRAIGHTENER IN PIPE BENDS TO MAINTAIN UNIFORM FLOW

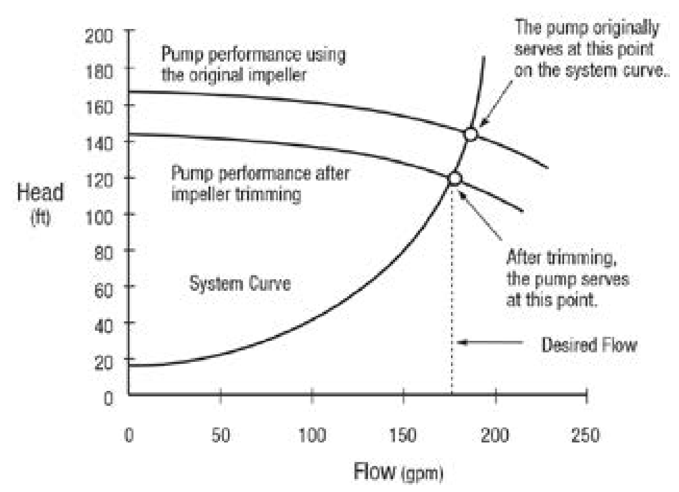



CORRECT VS INCORRECT APPROACHES TO PUMP/PIPE FITTING ARRANGEMENTS TO MINIMISE PRESSURE DROP

## REPLACE PUMP COMPONENTS

### TRIM OR REPLACE THE IMPELLOR

The flow generated by a pump impellor decreases with decreasing impellor diameter. A smaller impellor is suitable only if the diameter is reduced by less than 20%; excessive reduction (i.e. greater than 20%) will reduce the pump efficiency by allowing recirculation within the pump. Reduce pump energy use by installing a smaller impellor or trimming the existing impellor in oversized pumps. Replacing or trimming an impellor is a specialised task that should be performed by a competent supplier.




*IMPELLOR TRIMMING CAN RESULT IN REDUCED ENERGY CONSUMPTION FOR OVERSIZED PUMPS*

Energy saving: varies for different circumstances

## INSTALL NEW PUMP COMPONENTS

### APPLY PRECISION CASTINGS, COATINGS, AND POLISHING

Smoother internal pump components generate flow more efficiently than rough components. Increase pump efficiency by applying castings, coatings, or polishing on smaller pumps.

Energy saving: 2-3% of pump energy consumption

Other benefits of this improvement include longer operating life of pumps due to slower degradation.

### INSTALL CONTROLS TO OPERATE PUMPS ONLY WHEN REQUIRED

Pumps use energy even on standby (i.e. when left switched on, but not actively running). Decrease pump energy use by installing automatic control systems or time switches to turn pumps off when not required for long periods, such as outside of business hours.

Energy saving: varies for different situations

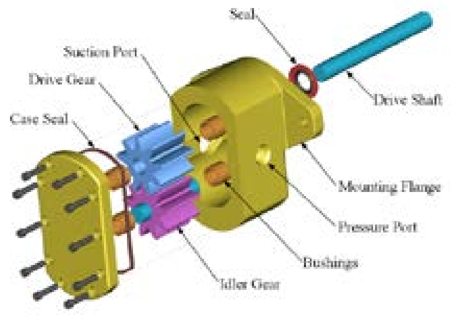
Other benefits of making this improvement include lower maintenance costs and longer operating life of pump system equipment due to less wear-and-tear on the pumping system.


*AUTOMATIC CONTROL SYSTEMS CAN REDUCE ENERGY CONSUMPTION OF EQUIPMENT ON STANDBY*

## INSTALL CONSTANT SPEED DRIVES

Constant speed drives (CSDs) use gears to reduce the speed of the pump impeller, which saves power without compromising performance. CSDs are well suited to oversized pumps with a constant load.

Energy saving: up to 20% of motor energy consumption




*DESCRIPTION OF A CONSTANT SPEED DRIVE (CSD)*

## INSTALL A DIRECT DRIVE (FOR PUMPS WITH VARIABLE LOADS)

Direct drives couple the motor shaft directly to the pump impellor. They transmit power with 100% efficiency, making the impellor speed match the motor speed. Other drives—such as belts, gearboxes, and chains—lose 1-3% of power, and even more if not properly fitted and maintained. Reduce pump energy use by installing direct drives on pumps with constant loads.

Energy saving: 1-3% of motor energy consumption

Other benefits of making this improvement include:

- Lower maintenance costs
- Longer operating life of pump system equipment
- Higher reliability than other drives
- Lower safety hazards

## INSTALL A VARIABLE SPEED DRIVE ON PUMPS

Variable speed drives (VSDs) continually adjust the motor speed to match pump output to the load. Even a small reduction in speed will lead to a relatively large reduction in energy use (since pump power is proportional to the cube of the motor speed). VSDs are well suited to pumps that, due to variable loads or infrequent high loads, operate at part-load for up to 95% of the time. At full-load, VSDs are about 3% less efficient than CSDs, and therefore should be avoided where full loads are required most of the time.

Warning: Care must be taken regarding the sizing of the motor. For example, if the pump provides fluid at a pressure that exceeds the rated pressure of the end-use, leaks or rupture could occur.

Energy saving: 10-60% (20% average) of motor energy consumption (Savings depend on the size, number, and use patterns of the motor)

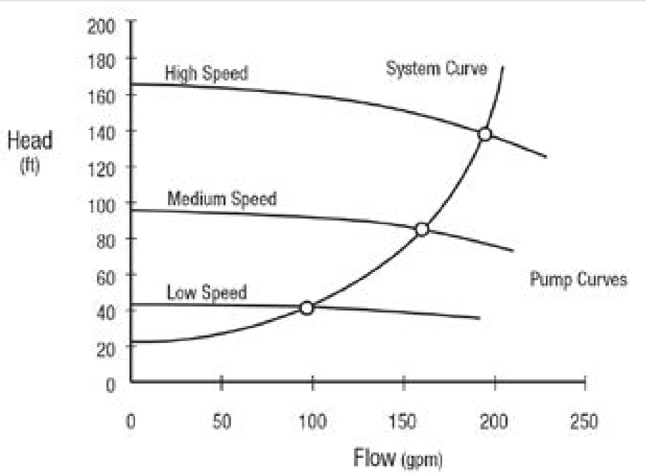
For more information on Variable Speed Drives, refer to the ‘Refrigeration and Cooling’ section of this toolkit.

*VARIABLE SPEED DRIVES*

## INSTALL A MULTI-SPEED MOTOR ON PUMPS

Multi-speed motors use a different set of windings to operate efficiently at each speed. Multi-speed motors have higher capital costs and slightly lower efficiency than single-speed motors, but they are well suited to pumps for which VSDs are too expensive; and to pumps that operate at particular loads for long periods.

Energy saving:
varies for different circumstances




*MULTI-SPEED MOTORS CAN OPERATE EFFICIENTLY AT DIFFERENT SET-SPEEDS*

# STEP 3: COLLECT DATA AND ENGAGE WITH SUPPLIER

## SUPPLIER CHECKLIST

The following checklist provides guidance on which information to collect from within the winery and from the equipment supplier, in order to assess the winery's pumping systems for potential improvements in energy efficiency.

Important to note:

» Some of the information suggested below may be difficult or impractical for SME wineries to collect. We do not expect you to be an expert in pumping – instead, the intention of this checklist is to give you a snapshot of what may be required to properly assess the opportunity, and to then have an informed discussion with the supplier to explore what may be possible.

» This checklist can be given directly to the supplier to assist them with providing the winery with an appropriate energy efficiency solution.

» An editable (Microsoft Word) and print-version of this checklist is available via the WEST Online Portal, accessible via www.winesa.asn.au.

## 1. DETERMINE THE END-USES OF YOUR PUMPING SYSTEMS

*Check the following end-uses:*

| | |
|---|---|
| Receiving | |
| Presses | |
| Must pump | |
| Winery pumps | |
| Mobile pumps | |
| Cellars/barrel rooms | |
| Refrigeration/cooling circulation | |
| Bottling | |
| Hot water & steam | |
| Wastewater (if water is treated onsite) | |
| Other: | |

## 2. COMPILE A PUMP SYSTEM INVENTORY

*Compile a list of the following equipment:*

| | |
|---|---|
| Pumps: number, make, model, type, power rating (kW), flow rate (l/s), speed (rpm), head (m; kPa), number of pump stages, and time in use (h/y) | |
| Motor (if it is a separate unit): number, make, model, type, power rating (kW), efficiency (%), speed (rpm), and time in use (h/y) | |
| Pipes: diameter (m) | |
| Valves: number, make, model, type | |
| Other: | |

*Choose an approach to estimate time in use:*

| | |
|---|---|
| Record readings on the hour-run meter (h) at regular intervals | |
| Divide the hour-run meter reading (h) by the total time (h) that the pump has been installed | |
| Compare the energy (kWh) and power readings (kW) (if the system has an electricity meter) | |
| Examine electricity meter load profiles (kW) | |
| Use existing control systems and manual procedures | |
| Check control settings (if the system has controls) | |

## 3. ESTIMATE THE PUMPING REQUIREMENTS

*Compile a list of the following information for each end-use:*

| | |
|---|---|
| Fluid: name, temperature (°C), viscosity (Pa.s), solids concentration (%) and particle size (m), and density (kg/m$^3$) or specific gravity | |
| Flow rates (l/s) and head (m; kPa) required now | |
| Location of end-use | |
| Operating times or events that require pumped fluid | |
| Reason the end-use requires pumped fluid | |
| Flow rates (l/s) and head (m; kPa) required in the future | |

*This list enables you to:*

» Identify the end-uses that dominate the pumping requirements (kW);

» identify wasteful and unnecessary uses of pumped fluid; and

» estimate the base and peak pumping requirements (kW), and the variation in pumping requirements (kW), now and in the future.

## 4. ESTIMATE THE EFFICIENCY OF YOUR EXISTING PUMP SYSTEMS

*Measure the following parameters:*

| | |
|---|---|
| Flow rate (l/s) | |
| Head (m; kPa) | |
| Electrical energy use (kWh) | |

*Choose an approach:*

| | |
|---|---|
| 1.Traditional approach: For permanent monitoring, install pressure tappings on either side of the pump, away from regions where pipe components disturb the fluid flow. For critical pumps, consider continuous monitoring by installing: ammeters on the motor, pressure gauges on the pump inlet and outlet, energy meters on large pumps, and a flow meter. Also, consider electronic data-logging. | |
| 2.Thermodynamic approach (pump): Install temporary pressure probes and sensitive temperature probes at the pump inlet and outlet to determine the energy losses (energy not converted to flow and pressure) (kWh). Calculate the flow rate (l/s) by also measuring the power (kW) used by the pump. | |
| 3.Thermodynamic approach (single pump system): Install meters to measure the motor input power (kW). Install a flow meter at the pipe outlet to determine the flow rate (l/s). Install a pressure probe at the pipe outlet to determine the fluid pressure (kPa). Calculate the fluid power (kW) using the pressure (kPa), flow rate (l/s), and specific weight (kN/m3). Calculate pump efficiency (%) by taking the ratio of the fluid power (kW) and the motor input power (kW). | |

## 5. DETERMINE THE BUSINESS PARAMETERS OF THE PUMPING SYSTEM

*Quantify or qualify the following values:*

| | |
|---|---|
| Energy price(s) ($/kWh; $/l) | |
| Capital budget ($) | |
| Targets for running costs ($/y) | |
| Required level of redundancy in the system | |
| Acceptable level of risk for new technologies | |
| Equipment constraints, such as: specific brands of motors or pumps; specifications for electrical wiring; compatibility with existing infrastructure or floor space; and adaptability to future upgrades | |
| Scope of energy efficiency opportunities to consider: If the existing equipment need to be replaced, then calculate the payback period (y) based on the extra (rather than total) costs ($) (if any) of the efficient equipment | |

## 6. DEVELOP A MODEL OF THE PUMPING SYSTEM

Use data about the fluid, and pumping system components and configuration to calculate friction losses (kW), resistance curves of the system, & running costs ($/y).

*Choose an approach:*

| | |
|---|---|
| 1. Software (most common): requires pump system design software, which provides a list of suitable pumps and is usually linked to a particular pump manufacturer | |
| 2. Manual: requires calculations and graphs | |

*This list enables you to:*

» compare the current operating points of the pump with the peak-efficiency point (rpm).

## 7. REVIEW MANUFACTURER DATA

*Review the following data:*

| | |
|---|---|
| Pumps: Pump manufacturers supply graphs of ‘pressure versus flow rate’, at various speeds (rpm), that include efficiency curves. Pump efficiency (%) varies widely with speed (rpm). It usually peaks near the middle of the range of speeds (rpm). | |
| Variable speed drives: VSD manufacturers supply information about the load characteristics for which their VSDs are designed. VSDs are most effective when installed on a pump that is designed for the same load characteristic. Most pumps are designed for a specific quadratic load. | |

## 8. CONFIRM PUMP SYSTEM PERFORMANCE

*Check the following conditions:*

| | |
|---|---|
| The pump meets the peak pumping load (kW) | |
| The pump is optimised for the most common pumping loads (kW) | |

## 9. SELECT A SERVICE PROVIDER

*Select a pump service provider that can provide the combination of services that you seek:*

| | |
|---|---|
| Measurement and analysis of the pumping requirements profile, and power (kW) of pumps and end-uses | |
| Reporting on equipment and process performance | |
| Optimisation of the pumping system, including: optimisation of the control system, flow rates (l/s), and head levels (m; kPa); management of fluid leaks; and minimisation of the pumping requirements at end-uses | |
| Design of a pumping system that aims to minimise losses from the end-use to the pump | |
| Supply, service, and installation of pumping system equipment (e.g. pumps, pipes, and valves) for optimal energy efficiency (%) | |
| Supply of spare parts, including shipping | |
| Guarantee of minimum efficiency (%) of the proposed system | |
| Guarantee of maximum running costs ($/y) of the proposed system | |

| | |
|---|---|
| Technical support and after sales service | |
| In-house repairs and onsite service | |
| Emergency service | |
| Other: | |

## NEGOTIATE A CONTRACT

*Determine your preferred type of contract:*

| | |
|---|---|
| » Service contract: the supplier performs certain actions for a fixed price ($). | |
| » Energy performance contract: the supplier performs certain actions that meet certain levels of energy reduction (kWh) for a lower upfront price ($) and a share of the cost savings ($/y). | |

## OTHER TOOLS

To further assist with evaluating opportunities to improve Pumping energy efficiency, the Winery Energy Saver Toolkit provides the following tools (available via the Online Portal, www.winesa.asn.au):

- Energy efficiency opportunities modelling tool, which can be used to test potential savings resulting from key energy efficiency improvements outlined in the Winery Energy Saver Toolkit
- Energy Resource Use Data tool, which can be used by businesses to collect and analyse their own baseline electricity, gas and fuel consumption data.

## SUPPORTING REFERENCES

The following references were used in the development of the Pumping section of the WEST toolkit. We encourage you to access these references as they may provide additional useful information for your business in evaluating energy efficiency opportunities.

*Department of Resources, Energy and Tourism (Australian Government):* EEX website http://eex.gov.au

*Lawrence Berkeley National Laboratory:* BEST Winery Guidebook – Benchmarking and Energy and Water Savings Tool for the Wine Industry, http://industrial-energy.lbl.gov/node/41

*Lawrence Berkeley National Laboratory:* Energy Efficiency Improvement and Cost Saving Opportunities for the Fruit and Vegetable Processing Industry
http://industrial-energy.lbl.gov/drupal.files/industrial-energy/Fruit-Vegetables.pdf

*Lawrence Berkeley National Laboratory:* Energy Efficiency Improvement and Cost Saving Opportunities for the Dairy Processing Industry
http://www.energystar.gov/ia/business/industry/downloads/Dairy_Guide_Final.pdf

*Sustainability Victoria:* Energy Efficiency Best Practice Guide – Pumping Systems, www.resourcesmart.vic.gov.au/for_businesses/energy_efficiency_4597.html

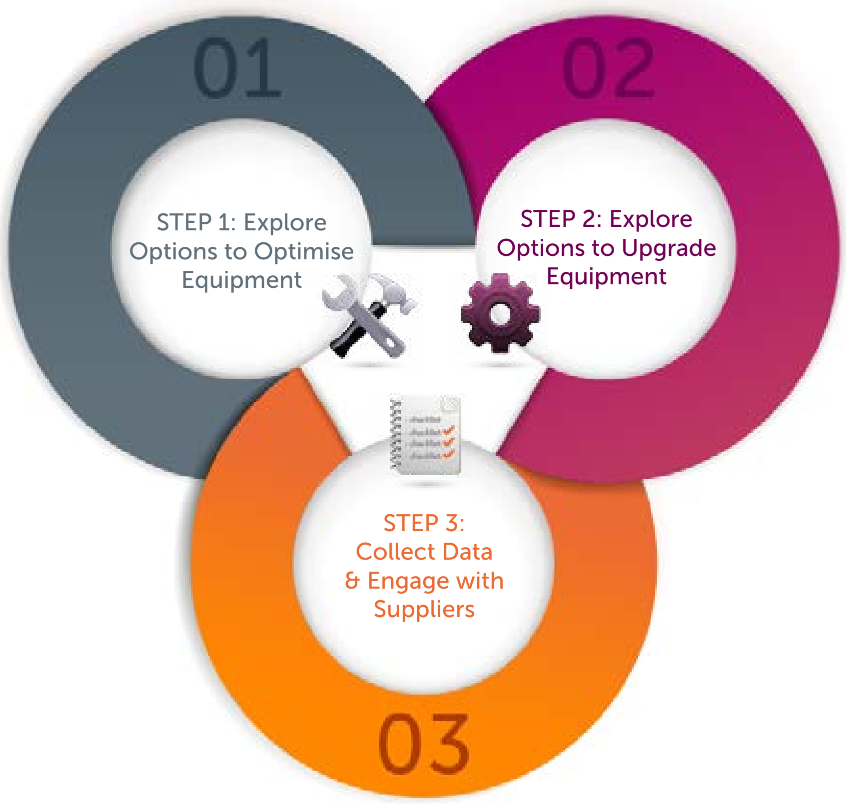
*US Department of Energy (2007):* 'Energy Tips – Pumping Systems', Tip Sheet 10: 'Energy Savings Opportunities in Control Valves'. Industrial Technologies Program, Energy Efficiency and Renewable Energy.
www1.eere.energy.gov/industry/bestpractices/pdfs/control_valves_pumping_ts10.pdf

*US Department of Energy:* Improving Pumping System Performance - A Sourcebook for Industry
http://www1.eere.energy.gov/manufacturing/tech_deployment/pdfs/pump.pdf

# COMPRESSED AIR

Energy efficiency improvements most relevant to the following winery processes:

- Tank presses
- Cleaning




## Compressed air: 5-10% of energy consumption

# STEP 1: EXPLORE OPTIONS TO OPTIMISE EQUIPMENT

## OPTIMISE OPERATING SETTINGS

### USE MINIMUM DISCHARGE PRESSURE

Reduce compressor power consumption by using the lowest required discharge pressure. For compressors operating at around 700kPa, every 100kPa reduction in pressure will decrease compressor power consumption by 8%.For compressor systems with a high proportion of unregulated end-uses and many leaks, this percentage is even greater.Check compressor performance curves for more-accurate estimates.

Energy saving: Every 100kPa reduction in pressure will decrease compressor energy consumption by 8% (for compressors operating at 700kPa).

*USE MINIMUM DISCHARGE PRESSURE*

Other benefits from making this improvement include:

» More compressed air capacity for new end-uses
» Lower maintenance costs
» Longer operating life of compressors system equipment.

### USE MINIMUM WORKING TEMPERATURE

Compressor energy use decreases with decreasing working temperature. Reduce compressor power consumption by maintaining intercoolers (used to remove waste heat in the compressor).

Energy saving: Every 6°C decrease in compressor working temperature will decrease compressor energy by 1%.

### USE MINIMUM INLET AIR TEMPERATURE

Compressor power decreases with decreasing inlet air temperature. Reduce compressor power consumption by drawing inlet air from a cool space, such as a shaded, outside area. Every 3°C decrease in temperature will decrease compressor energy use by 1%.

Energy saving: Every 3°C decrease in temperature will decrease compressor energy use by 1%

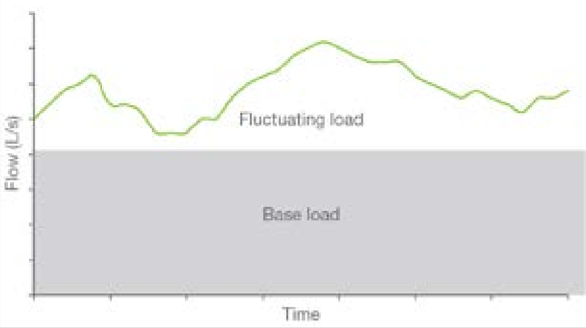
## LOAD MANAGEMENT

### SCHEDULE MULTIPLE AIR COMPRESSORS IN PARALLEL

Multiple compressors used in parallel can allow each compressor to operate efficiently, rather than one compressor operating at sub-optimal loads. Use multiple compressors where varying loads are required, for example, one set of screw compressors could meet the base load while another set of reciprocating compressors meets the variable load.

Energy saving:
varies for different circumstances

Other benefits include higher reliability of the air compressor system due to redundancy (i.e. if one compressor breaks-down, other compressors can compensate for the lost-load).




*COMPRESSORS CAN BE TURNED ON OR OFF DEPENDING ON FLUCTUATING LOAD*

## REPAIR DISTRIBUTION NETWORK

### REPAIR LEAKS

Leaks in the distribution network (caused by holes) make the compressor produce more air than required. The leak rate depends on hole size, which grows with use. Leaks are most common at joints, connections and components, such as couplings, hoses, tubes, fittings, pressure regulators, open condensate traps and shut-off valves, pipe joints, disconnects, and thread sealants. Decrease compressor power consumption by identifying and repairing leaks.

| EQUIVALENT HOLE DIAMETER (sum of all leaks) | QUANTITY OF AIR LOSS PER LEAK ($m^3$/year) | COST OF LEAK ($/year) |
|---|---|---|
| Less than 1mm | 6,362 | $95 |
| From 1 to 3mm | 32,208 | $483 |
| From 3 to 5mm | 117,633 | $1,764 |
| Greater than 5mm | 311,738 | $4,675 |
| Assumption: 700 kPa system, operating 2000 hrs/year, electricity costs 10 cents/kWh | | |

*OUTLINE OF POTENTIAL COST/YEAR FOR COMPRESSOR LINE LEAKS*

Identify leaks with the following methods:

- Listen for hissing (air escaping). This method will identify only the most-obvious leaks.
- Brush soapy water over common places of leakage and then look for bubbles. This method is time-consuming, but likely to uncover more leaks than simply listening for air escape.
- Use an ultrasonic acoustic detector, which detects the high-frequency sounds of leaks. These devices can be hired, and user-training requires less than an hour. This method is relatively fast.

Repair leaks by tightening the leaking connection; or replacing faulty sections and components with high-quality, clean sections and components, using the appropriate thread sealant. When leak repair takes a long time, lower the compressor discharge pressure (if possible) to reduce the air losses. Re-optimise the compressor control system after leaks are repaired.

*COMPRESSED AIR LEAK DETECTION AND REPAIR CAN LEAD TO ENERGY EFFICIENCY GAINS WITH QUICK PAY-BACKS*

Energy saving: 20% of compressor energy consumption, (in many cases leading to a 2-month payback, due to low repair costs)

Other benefits from making this improvement include longer equipment life and lower maintenance costs due to less stress on the compressor system to provide the desired pressure.

# STEP 2: EXPLORE OPTIONS TO UPGRADE EQUIPMENT

## REARRANGE PIPE/HOSE NETWORK

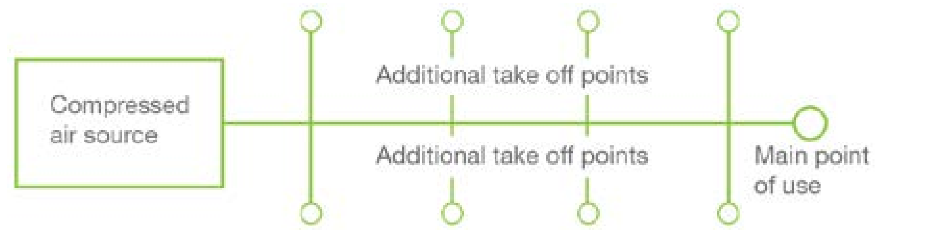
### MINIMISE THE PRESSURE DROP OF THE PIPE/HOSE NETWORK

A compressor must generate air flow at a rate and pressure that meets the demands of the end-use and overcomes the friction and gravitational losses in the pipe/hose network. Reduce losses with the following features:

- Pipe/hose diameter: even a small increase in diameter will lead to a relatively large reduction in friction (since, for circular pipes, friction is inversely proportional to the fifth power of the internal pipe diameter), and thereby increase efficiency. In addition, since larger pipe/hose diameters carry air at lower pressure, they are less likely to develop leaks.
- Pipe/hose roughness: internal pipe/hose roughness depends on the material, finish and other factors such as corrosion and fouling. Smooth, rigid pipes have much less friction than rough or flexible pipes and hoses, and therefore have higher efficiencies.
- Pipe/hose length: pipe/hose friction increases with increasing length. Pipe networks can be unnecessarily long due to bypass loops, bend components, bends in flexible ducts/hoses, and the location of the compressor and end-uses. Reduce pipe length or pier network length (where possible) to improve efficiency.
- Pipe/hose components: each component adds friction losses and should be avoided, where possible:
  - Bends, branches, and joins should be eliminated or, if they are required, should be gradual (large radius).
  - Valves should be used minimally.

'Ring system', 'single main system', and 'grid distribution system' pipe/hose arrangements provide the most efficient compressed air layout as they require few bends to supply air. They also allow for a lower compressor pressure by providing multiple supply lines to each end-use.

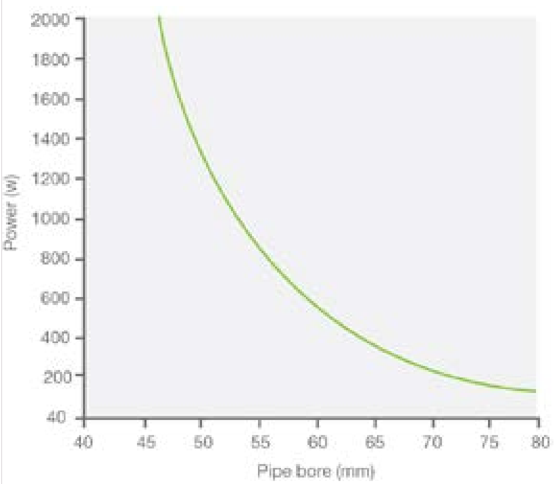
Energy saving: Increasing the compressed air pipe/hose diameter alonge can result in 3% reduction of compressor energy consumption




*SINGLE MAIN COMPRESSED AIR PIPE LAYOUT WITH BRANCH LINES*

Other benefits could include:

- Lower capital costs associated with smaller compressor systems, or foregoing the need to upgrade to a larger compressor system by getting more capacity out of your existing system
- Lower maintenance costs and longer operating life of the system due to less wear-and-tear




*THE AMOUNT OF AIR COMPRESSOR POWER REQUIRED DECREASES WITH INCREASING DIAMETER*

### RELOCATE COMPRESSOR

Increase compressor efficiency by locating the compressor in areas that are cool, well ventilated, and out of direct sunlight (e.g. shaded, enclosure with reflective paint, or underground).

## INSTALL NEW AIR COMPRESSOR COMPONENTS

### REPLACE INTERNAL COOLING WITH EXTERNAL COOLING

The cooling of screw compressors is more efficient with external oil coolers than with liquid-injection oil cooling (the direct injection of high-pressure liquid refrigerant into the compressor). Liquid-injection oil cooling can decrease the efficiency of screw compressors by up to 5-10%. External oil coolers usually remove heat through the use of water or a refrigerant (usually ammonia) in a shell and tube heat exchanger on the oil circulation system. The refrigerant can be passively circulated by a simple process called thermosiphon.

Energy saving: 3-15% of air compressor energy consumption (savings depend on the size of screw compressors).

Other benefits from making this improvement include:

- Increase in capacity of the air compressor by 5-10%
- Increase in discharge temperature from 50°C to around 70°C, which is more cost-effective for heat recovery.

Equipment requirements:

- A water or refrigerant/thermosiphon oil cooler
- For refrigerant/thermosiphon oil cooler: a refrigerant liquid-and-vapour return pipe between the liquid receiver and the oil cooler
- For water oil cooler: a cooling water pipe between the evaporative condensers and the oil cooler

## INSTALL CONTROLS TO OPERATE COMPRESSORS ONLY WHEN REQUIRED

Compressors use energy even on standby (i.e. when switched on but not actively running). Decrease compressor power consumption by installing automatic control systems or time switches to turn compressors off when not required for long periods, such as outside of business hours.


COMPRESSOR CONTROL

Other benefits from making this improvement include:

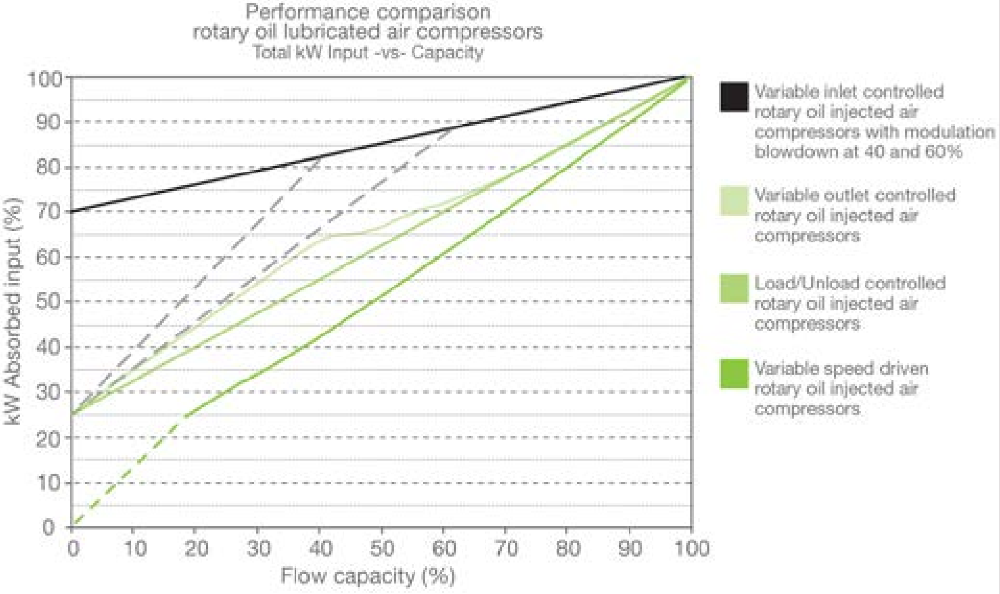
» Lower maintenance costs
» Longer operating life of compressors system equipment.

## INSTALL A VARIABLE SPEED DRIVE ON COMPRESSORS

Variable speed drives (VSDs) continually adjust the motor speed to match compressor output to the load. Even a small reduction in speed will lead to a relatively large reduction in energy use. VSDs are well suited to compressors that, due to variable loads or infrequent high loads, operate at part-load for up to 95% of the time. At full-load, VSDs are about 3% less efficient than CSDs, and therefore should be avoided where full loads are required most of the time.

Energy saving: 10-60% (20% average) of motor energy consumption (Savings depend on the size, number, and use patterns of the motor)

Capital cost: $200-$500/kW, about the same as the motor(Capital costs depend on the size (the cost per kW decreases with increased motor size ), number, and use patterns of the motor).




ENERGY EFFICIENCY IMPROVEMENTS FOR AIR COMPRESSORS WITH VSDs

For more information on Variable Speed Drives, refer to the 'Refrigeration and Cooling' section of this toolkit.

## INSTALL AUTOMATED COMPRESSOR STAGING AND CAPACITY CONTROL

Compressors are more efficient when running at full load than at part load. Therefore, the use of multiple, small compressors to meet a large air compressor load enables high efficiency at peak load—which lasts only six to eight weeks of the year, during the crush—and also at part load. This strategy is suitable when the load is consistently above 50%. The availability of compressors of different capacities enables greater flexibility in efficiently matching the compressor capacity to the required load.

An automatic controller can optimise energy use by turning compressors on and off as needed, usually resulting in only one small compressor operating inefficiently at part-load (rather than one large compressor operating inefficiently, or several smaller compressors operating inefficiently). The controller, however, should also account for the efficiency losses during compressor start-up and shut-down.

## ALTERNATIVES TO AIR COMPRESSORS

### USE COMPRESSED AIR ONLY WHEN MOST APPROPRIATE

Depending on the application, air compressors can be an inefficient use of energy compared to other equipment. Reduce compressor power consumption by considering alternative compressed air options (either in conjunction-with, or instead-of, compressed air systems), as outlined in the table below.

Energy cost savings: varies for different circumstances (but in most cases results in a <12 month payback)

TABLE. ALTERNATIVES TO COMPRESSED AIR EQUIPMENT

| COMPRESSED AIR USE | EQUIPMENT USED | SOLUTIONS/ALTERNATIVES |
|---|---|---|
| Blowing, cleaning, removing debris | Nozzle, gun | Air knife, induction nozzle, low-pressure blower, vacuum pump systems, broom/brush |
| Aspirating, agitating, mixing | Nozzle | Low-pressure blower |
| Package inflating | Nozzle | Low-pressure blower |
| Cooling | Cooling induction system, vortex tube | Air conditioning systems, chilled water, fresh air ventilation, fans |
| Drying water | Nozzle, gun | Solenoid control, air knife, induction nozzle |
| Screw driving, drilling | Screwdriver, drill | Battery-electric portable drill, screwdriver |
| Vacuum generation | Venturi methods | Vacuum pump system |
| Moving parts | Nozzle, gun | Blowers, electric actuators, hydraulics |


BLOWER


SCREWDRIVER


PORTABLE DRILL


VACUUM PUMP

# STEP 3: COLLECT DATA AND ENGAGE WITH SUPPLIER

## SUPPLIER CHECKLIST

The following checklist provides guidance on which information to collect from within the winery and from the equipment supplier, in order to assess the winery's compressed air systems for potential improvements in energy efficiency.

Important to note:

» Some of the information suggested below may be difficult or impractical for SME wineries to collect. We do not expect you to be an expert in compressed air – instead, the intention of this checklist is to give you a snapshot of what may be required to properly assess the opportunity, and to then have an informed discussion with the supplier to explore what may be possible.

» This checklist can be given directly to the supplier to assist them with providing the winery with an appropriate energy efficiency solution.

» An editable (Microsoft Word) and print-version of this checklist is available via the WEST Online Portal, accessible via www.winesa.asn.au.

## 1. DETERMINE THE END-USES OF YOUR COMPRESSED AIR SYSTEMS

*Check the following end-uses:*

| | |
|---|---|
| Receiving | |
| Presses | |
| Winery | |
| Cellars/barrel rooms | |
| Bottling | |
| Cleaning | |
| Other: | |

## 2. COMPILE A COMPRESSED AIR SYSTEM INVENTORY

*Compile a list of the following equipment:*

| | |
|---|---|
| Compressor: number, make, model, type, power rating (kW), flow rate (l/s), speed (rpm), operating pressure (kPa), number of compressor stages, and time in use (h/y) | |
| Motor (if it is a separate unit): number, make, model, type, power rating (kW), efficiency (%), speed (rpm), and time in use (h/y) | |
| Dryer: number, make, model, type, power rating (kW), flow rate (l/s), purge flow rate (l/s), pressure dew point (°C), pressure drop (kPa) | |
| Pipes: diameter (m) | |
| Hoses: diameter (m) | |
| Valves: number, make, model, type | |
| Other: | |

*Choose an approach to estimate time in use:*

| | |
|---|---|
| Record readings on the hour-run meter (h) at regular intervals | |
| Divide the hour-run meter reading (h) by the total time (h) that the air compressor has been installed | |
| Compare the energy (kWh) and power readings (kW) (if the system has an electricity meter) | |
| Examine electricity meter load profiles (kW) | |
| Use existing control systems and manual procedures | |
| Check control settings (if the system has controls) | |

## 3. ESTIMATE THE COMPRESSED AIR REQUIREMENTS

*Compile a list of the following information for each end-use:*

| | |
|---|---|
| Air: quality—pressure dew point (moisture) (°C), and dirt and oil concentration | |
| Average flow rates (l/s) and maximum pressure (kPa) required now | |
| Location of end-use | |
| Operating times or events that require compressed air | |
| Reason the end-use requires compressed air | |
| Average flow rates (l/s) and maximum pressure (kPa) required in the future | |

*Choose and approach:*

| | |
|---|---|
| 1. For an initial estimate of compressed air requirements of major end-uses, record the time of day and length of time (h) that the major end-uses need compressed air over a production cycle. This approach is convenient for end-uses with short demand cycles. | |
| 2. For an initial estimate of total the compressed air requirement, record the readings of the outlet pressure gauge (kPa) at regular intervals over a production cycle. Use these readings with the 'pressure vs. flow' curve for the compressor (available from the manufacturer) to determine the corresponding flow rates (l/s). | |

3. For an initial estimate of the total compressed air requirement, install power demand analysers or power meters on the compressor and dryer to measure the power (kW) over a production cycle. This data indicates times of peak and low load (kW).

4. If budget and time allow for a more-accurate estimate of compressed air requirements,install metering and monitoring equipment, such as: flow meters on the main compressed air branch lines, electronic pressure meters on the main lines, power meters on the compressor and dryer, and data-loggers. This approach also provides data about other aspect of performance and assists in the diagnosis of problems.

*This list enables you to:*

- Identify the end-uses that dominate the compressed air requirements;
- identify wasteful and unnecessary uses of compressed air;
- estimate the base and peak compressed air requirements, and the variation in compressed air, now and in the future; and
- compare the current operating points of the compressor and dryer with the peak-efficiency points (rpm).

## 4. ESTIMATE THE EFFICIENCY OF EXISTING COMPRESSED AIR SYSTEMS

*Choose an approach:*

| | |
|---|---|
| Install a power demand analyser or a suitable meter to measure the average power (kW) of, or the energy (kWh) used by, the system over a test period. | |
| Install a clip-on ammeter to measure the instantaneous currents (A) of each of the three phases with the compressor running at the most common load. Calculate the average phase current (A). Repeat this process with the compressor at no load and at full load. Multiply the average phase currents (A) by the time (h) that the compressor runs at each load (kW). | |
| For compressors with control systems, record energy use (kWh) readings weekly to determine annual energy use (kWh). | |

## 5. DETERMINE THE BUSINESS PARAMETERS OF COMPRESSED AIR SYSTEM

*Quantify or qualify the following values:*

| | |
|---|---|
| Energy price(s) ($/kWh; $/l) | |
| Capital budget ($) | |
| Targets for running costs ($/y) | |
| Required level of redundancy in the system | |
| Acceptable level of risk for new technologies | |
| Equipment constraints, such as: specific brands of motors, compressors, or dryers; specifications for electrical wiring; compatibility with existing infrastructure or floor space; and adaptability to future upgrades | |
| Scope of energy efficiency opportunities to consider: If the existing equipment need to be replaced, then calculate the payback period (y) based on the extra (rather than total) costs ($) (if any) of the efficient equipment | |

## 6. CONFIRM COMPRESSOR SYSTEM PERFORMANCE

*Check the following conditions:*

| | |
|---|---|
| The compressor meets the peak compressed air load (kW) | |
| The compressor is optimised for the most common compressed air loads (kW) | |
| The pipe/hose network has a pressure drop (kPa) of less than 10% of the compressor discharge pressure (kPa) | |
| The air filter, oil filter, and oil separator are easily accessible | |

## 7. SELECT A SERVICE PROVIDER

*Select an air compressor service provider that can provide the combination of services that you seek:*

| | |
|---|---|
| Measurement and analysis of the compressed air requirements profile; and power (kW) of compressors, dryers, and end-uses | |
| Reporting on equipment and process performance | |
| Optimisation of the pumping system, including: optimisation of the control system, flow rates (l/s), and pressure levels (kPa); management of air leaks; minimisation of the compressed air requirements at end-uses; appropriate treatment of air; and assessment of heat recovery potential | |
| Design of a compressed air system that aims to minimise losses from the end-use to the compressor | |
| Supply, service, and installation of compressed air system equipment (e.g. compressors, filters, drains, and pipes) for optimal energy efficiency (%) | |
| Supply of spare parts, including shipping | |
| Guarantee of minimum efficiency (%) of the proposed system | |
| Guarantee of maximum running costs ($/y) of the proposed system | |
| Technical support and after sales service | |
| In-house repairs and onsite service | |
| Emergency service | |
| Emergency rental compressors | |
| Remote monitoring | |
| Other: | |

## NEGOTIATE A CONTRACT

*Determine your preferred type of contract:*

| | |
|---|---|
| » Service contract: the supplier performs certain actions for a fixed price ($). | |
| » Energy performance contract: the supplier performs certain actions that meet certain levels of energy reduction (kWh) for a lower upfront price ($) and a share of the cost savings ($/y). | |

## OTHER TOOLS

To further assist with evaluating opportunities to improve compressed air energy efficiency, the Winery Energy Saver Toolkit provides the following tools (available via the Online Portal, www.winesa.asn.au):

» Energy efficiency opportunities modelling tool, which can be used to test potential savings resulting from key energy efficiency improvements outlined in the Winery Energy Saver Toolkit

» Energy Resource Use Data tool, which can be used by businesses to collect and analyse their own baseline electricity, gas and fuel consumption data.

## SUPPORTING REFERENCES

The following references were used in the development of the Compressed Air section of the WEST toolkit. We encourage you to access these references as they may provide additional useful information for your business in evaluating energy efficiency opportunities.

*Department of Resources, Energy and Tourism (Australian Government):* EEX website http://eex.gov.au

*Department of Industry, Tourism and Resources (Australian Government):* A guide to energy efficiency innovation in Australian wineries – energy efficiency best practice www.ret.gov.au/energy/Documents/best-practice-guides/energy_bpg_wineries.pdf

*Lawrence Berkeley National Laboratory:* BEST Winery Guidebook – Benchmarking and Energy and Water Savings Tool for the Wine Industry, http://industrial-energy.lbl.gov/node/41

*Lawrence Berkeley National Laboratory:* Energy Efficiency Improvement and Cost Saving Opportunities for the Fruit and Vegetable Processing Industry http://industrial-energy.lbl.gov/drupal.files/industrial-energy/Fruit-Vegetables.pdf

*Lawrence Berkeley National Laboratory:* Energy Efficiency Improvement and Cost Saving Opportunities for the Dairy Processing Industry http://www.energystar.gov/ia/business/industry/downloads/Dairy_Guide_Final.pdf

*Sustainability Victoria:* Energy Efficiency Best Practice Guide: Compressed Air Systems http://www.sustainability.vic.gov.au/resources/documents/best_practice_guide_compressed_air.pdf

*US Department of Energy*: Improving Compressed Air System Performance - A Sourcebook for Industry http://industrial-energy.lbl.gov/node/228

*Working Group for Cleaner Production*: Eco-Efficiency Resources for the Queensland Food Processing Industry http://www.sd.qld.gov.au/dsdweb/docs-bin/v2/food/ecoeftk_prelims.pdf

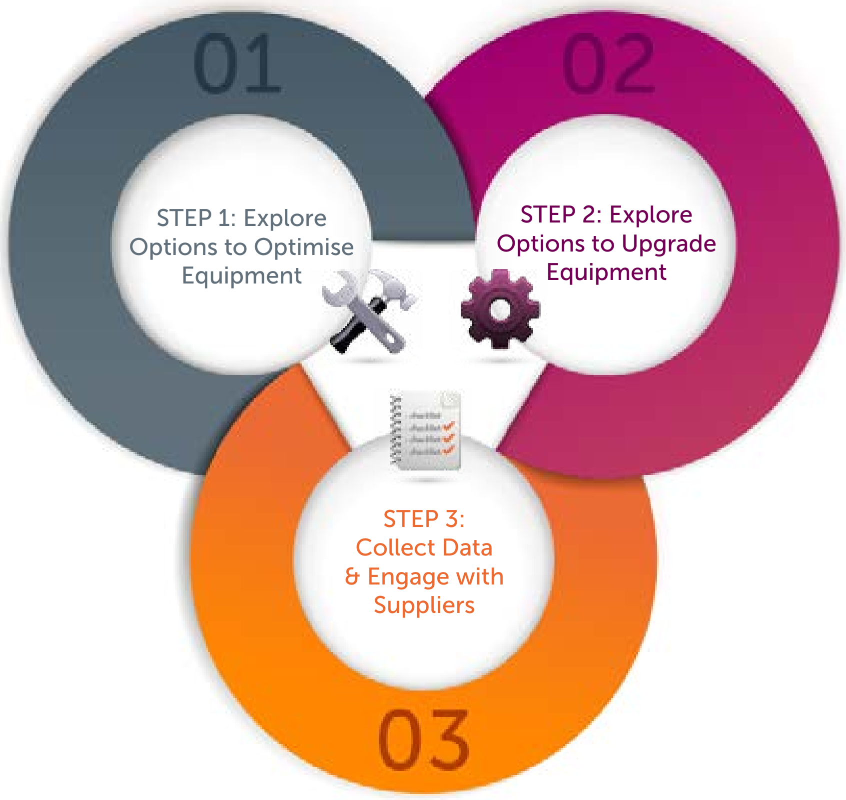
*Working Group for Cleaner Production*: Eco-Efficiency Manual for Meat Processing http://www.enve.metu.edu.tr/people/gndemirer/links/temizuretim/doc/Eco-Efficiency%20Manual%20for%20Meat%20Processing.pdf

# HOT WATER & STEAM

Energy efficiency improvements most relevant to the following winery processes:

» Cleaning and sterilisation

Hot water & steam: **5-10%** of electricity consumption, and/or **70-80%** of gas consumption



# STEP 1: EXPLORE OPTIONS TO OPTIMISE EQUIPMENT

## OPTIMISE OPERATING CONDITIONS

### USE MINIMUM TEMPERATURE SETPOINT

Boiler power decreases with decreasing hot water & steam temperature setpoint. Reduce boiler power consumption by using the lowest acceptable temperature setpoint.

Energy saving: varies depending on type of boiler and temperature setpoint.

USE LOWEST ACCEPTABLE TEMPERATURE SETPOINT IN BOILER

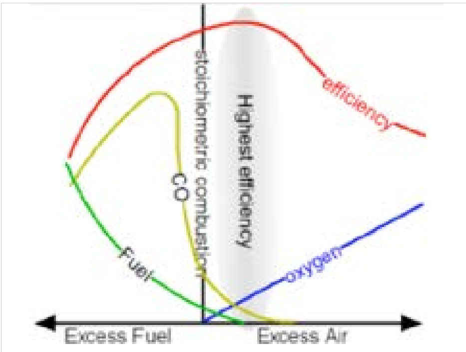
Other benefits from this improvement include lower maintenance costs and longer operating life of equipment (as the boiler isn't working as hard to provide the desired temperature).

### OPTIMISE INLET AIR

Steam boilers that operate with too much 'excess air' consume unnecessary fuel because they heat and then exhaust the extra air through the stack rather than use the air to generate more steam. Optimal amounts of excess air enable boilers to operate most efficiently and minimise nitric oxide emissions. Optimal excess air is 5-10% for natural gas, 5-20% for oil, and 15-60% for coal, though most boilers already operate within these limits.

A symptom of excess air is a high stack temperature. The optimal stack gas temperature is the temperature generated immediately after the boiler is serviced and cleaned. Every 15% decrease in excess air or 5-22°C reduction in stack gas temperature will increase boiler efficiency by 1%. Another symptom of excess air is a high concentration of oxygen in the flue gas, which is measured using a flu gas analyser. Every 1% decrease in oxygen in the flue gas will increase boiler efficiency by 2.5%.

Energy saving: varies for different circumstances (but, for most boilers that use excess air, leads to a <1-year payback)




THE OPTIMAL RANGE OF EXCESS AIR

A FLU GAS ANALYSER

## LOAD MANAGEMENT

### SCHEDULE MULTIPLE BOILERS IN PARALLEL

Multiple boilers enable each boiler to operate efficiently. They are well-suited to varying loads. One boiler meets the baseload while other boilers meet the variable load.

Energy saving:
varies for different circumstances

Other benefits from making this improvement include higher reliability due to redundancy.

## REPAIR PIPE NETWORK

### REPAIR LEAKS IN PIPE NETWORK

Leaks in the pipe network require the boiler to produce more hot water & steam than required. For example, a 1 mm diameter hole on a steam line at 700 kPa will lead to an annual loss of 300 L of fuel or 4300m3 of natural gas.

Encourage staff to monitor the pipe network and report leaks.

Energy saving: 3% of
boiler energy consumption

Other benefits from this improvement include cost savings from longer equipment life and lower maintenance costs.

*BOILER LEAKS CAN WASTE ENERGY AND ARE EASY TO FIX*

# STEP 2: EXPLORE OPTIONS TO UPGRADE EQUIPMENT

## REARRANGE PIPE NETWORK

### MINIMISE THE PRESSURE DROP OF THE HOT WATER & STEAM PIPE NETWORK

In a hot water & steam system, a pump must generate fluid flow at a rate and pressure that meets the demands of the end-use and overcomes the friction and gravitational losses in the pipe network. For most pumps, every 1% (up to 20%) decrease in flow will decrease pump power consumption by 2%.

Energy saving: Increasing pipe diameter alone can result in 5-20% reduction in pump power consumption.

For suggestions on how to minimise the pressure drop and improve efficiency of hot water & steam pipework, refer to the Pumping section of this toolkit.

In a steam system, a boiler must generate steam flow at a rate and pressure that meets the demands of the end-use and overcomes the friction and heat losses in the pipe network. Decrease losses with the following features:

- Pipe diameter: Since pipe friction is inversely proportional to the fifth power of the internal pipe diameter (for circular pipes), even a small increase in diameter will lead to a relatively large reduction in friction.
- Pipe slope: Pipes must slope down in the direction of flow, ideally at a slope of at least 1:100. Install a vertical 'relay point' to direct a pipe near the floor to a higher elevation.
- Steam velocity: Since pipe friction increases with the cube of fluid velocity, the maximum velocity should be limited to about 40m/s in general, to 15-25m/s in main distribution lines, and to even lower velocities in very long pipes. Install nozzles to generate higher velocities at end uses.
- Pipe components: Each component adds friction losses.
  - Control valves should usually be 1-2 sizes smaller than the diameter of the (large) pipes.
  - Valves should be installed on outlets of the distribution headers, the vessel to which steam from all boilers converge before entering the distribution system, to allow unused boilers to be turned off easily.
  - Bellows-sealed valves, rather than gland-sealed valves, should be installed because they do not leak and no not require maintenance.
  - Efficient nozzles and taps, if required, should be installed at end uses.
  - Automatic air vents should be installed on terminal ends and remote or high points pipe network.

*BELLOWS-SEALED VALVE*

- Relay points and other low points, where condensate could accumulate, should be a pocket shape of the same diameter as the pipe. Steam traps should be installed on these pockets, at a maximum of 50m apart, to automatically drain condensate.
- Steam separators should be installed when steam quality might be lower than required or when the maximum boiler output is required to remove water droplets. Baffle-type separators are well-suited over a wider range of flow rates and pressures.

Other benefits from making this improvement include lower maintenance costs and lower water use

### RELOCATE BOILER

Friction and heat losses increase with pipe length. Increase boiler system efficiency by locating the boiler near the major end-users of hot water & steam.

Energy saving: 5% of boiler energy consumption (savings depend on the layout of the pipe network).

## INSTALL NEW PIPE NETWORK COMPONENTS

### INSTALL A STEAM ACCUMULATOR

A steam accumulator in a boiler system helps to deliver high-quality steam for short peaks in the loads, such as when a large end-use is turned on. Thus, accumulators enable the boiler system to meet loads that are beyond the capacity of the boiler. They are well-suited to varying loads.

An accumulator is a pressurised vessel that contains water. Steam from the boiler, prior to being distributed to the end-use, first passes through the accumulator to heat and maintain the water at the steam temperature. The water is then ready to be 'flashed off' at lower pressure to meet peaks in the load. Install a steam accumulator to meet variable loads efficiently.

A STEAM ACCUMULATOR

Energy saving: varies for different circumstances

## INSTALL INSULATION ON PIPE NETWORK AND BOILER

Insulation prevents up to 90% of heat transfer out of hot water & steam. It can often be cost-effectively installed on boilers, pipes, heat exchangers, valves, flanges and other fittings, and areas of thermal bridging such as bolts and brackets.

New boilers usually have sufficient insulation, but older boilers might need additional insulation or replacement insulation. Heat and energy losses due to degraded or insufficient insulation can be up to 10%. Reduce heat loss by installing insulation on any surface over 50°C.

The most important characteristics of good insulation are low thermal conductivity, dimensional stability under temperature change, resistance to water absorption, and resistance to combustion. Other important characteristics, depending on the application, are tolerance of wide temperature variation and system vibration, and compressive strength where insulation is load bearing. Decrease degradation by eliminating sources of moisture.

Energy saving: 3-8% saving of boiler energy consumption can be achieved through insulation on pipe networks

Other benefits from this improvement include improved productivity of hot water & steam production by reducing the time to reach the desired temperature set-point on start-up

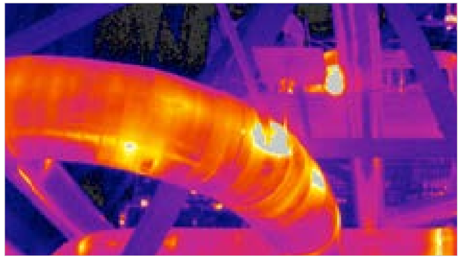
Equipment requirements:

» Insulation (refer to the table for suggested insulation options)
» A thermographic camera to find where existing insulation is degraded.

| LEVEL OF INSULATION | HEAT LOSS (MJ/m/h) | STEAM LOSS (kg steam/m/h) | EQUIVALENT FUEL COST (gas per 50m of pipe/year) |
|---|---|---|---|
| Uninsulated | 2.83 | 1.0 | $3396 |
| Insulated with mineral fibre | 0.138 | 0.05 | $165 |
| Insulated with polystyrene | 0.096 | 0.03 | $115 |

*HEAT LOSS FROM STEAM LINES (for a 125 mm steel pipe at 150°C; natural gas cost of $0.012/MJ of boiler operating 8 hours/ day, 250 days/year.)*

A thermographic camera can be used to find areas of the boiler pipe network where heat loss is significant (and where insulation will be required).



# RECOVER HEAT

## INSTALL AN ECONOMISER

In a steam system, an economiser recovers heat from the flue gas to preheat the inlet water or inlet air, requiring the boiler to use less fuel. Economisers are usually used to heat a small volume of water to a high temperature. Condensing boilers have built-in economisers. Some non-condensing boilers cannot be retrofitted with economisers. Every 4.5°C decrease in flue gas temperature or 20°C increase in inlet air temperature will decrease boiler input energy consumption by 1%.

AN ECONOMISER

Installation might require modification of the burner and controls of the boiler. For oil-fired burners, contaminants in the flue gas can create acidic conditions, which can cause problems.

Energy saving: 4-6% of boiler energy consumption (in many cases, leading to a 2-year payback or better)

Savings depend on the stack temperature, the water volume, and the operating hours.

## INSTALL A FLUE GAS CONDENSER

In a steam system, a flue gas condenser recovers heat from the flue gas heat to water for other processes. Condensers are usually used to heat a large volume of water to a moderate temperature. A single condenser can be used on multiple boilers.

A FLUE GAS CONDENSER

Energy saving: 10% of boiler energy consumption (in many cases, leading to a 1-year payback or better)

Savings depend on the stack temperature, the water volume, and the operating hours.

## INSTALL A RECUPERATOR

In a steam system, a recuperator recovers heat from flue gas to preheat the combustion air. In a recuperator, combustion air temperature can reach up to 540°C while flue gas temperature decrease from 1000°C to 700°C.

A RECUPERATOR

Energy saving:
varies for different circumstances

## RECOVER CONDENSATE

### INSTALL A CONDENSATE RETURN SYSTEM

A CONDENSATE RETURN SYSTEM

A condensate return system recovers condensate and flash steam (which forms when high-pressure condensate is released into the lower-pressure atmosphere) for reuse as inlet water, requiring the boiler to use less fuel to generate steam. Since the condensate contains about 26% of the energy used to generate steam in the boiler, every 5°C increase in inlet water temperature will decrease boiler energy consumption by 1%. Flash steam often escapes through flash tanks and from vents in the pipe network. Condensate—being hot, distilled water—requires much less heat and chemical treatment than mains water.

Energy saving: 10% of boiler energy consumption (in many cases, leading to a 1-year payback or better)

Other benefits from making this improvement include lower water use, lower water treatment costs, and lower wastewater charges.

### INSTALL STEAM TRAPS

Steam traps in the pipe network discharge condensate while retaining steam. Thermostatic steam traps are usually more effective and reliable than thermodynamic steam straps and mechanical steam traps. They are appropriate for a wide range of steam pressures and remain open to enable the steam system warm-up quickly. The condensate discharged from steam traps can be recovered for use in heating application, such as space heating or water preheating.

A THERMOSTATIC STEAM TRAP

Energy saving:
varies for different circumstances

Other benefits from making this improvement include lower water use, lower water treatment costs, and lower wastewater charges.

### RECOVER BLOWDOWN STEAM

Water blown from a boiler often forms flash steam. This steam condensate discharged from steam traps can be recovered for use in heating application, such as space heating or water preheating. With less water present, the pipe network is less susceptible to corrosions.

A BLOWDOWN RECOVERY SYSTEM

Energy saving: 1% of boiler energy consumption for small boilers

Other benefits from making this improvement include lower water use, lower water treatment costs, lower wastewater charges, and longer operating life of pipe network.

# STEP 3: COLLECT DATA AND ENGAGE WITH SUPPLIER

## SUPPLIER CHECKLIST

The following checklist provides guidance on which information to collect from within the winery and from the equipment supplier, in order to assess the winery's hot water & steam system for potential improvements in energy efficiency.

Important to note:

» Some of the information suggested below may be difficult or impractical for SME wineries to collect. We do not expect you to be an expert in boiler systems – instead, the intention of this checklist is to give you a snapshot of what may be required to properly assess the opportunity, and to then have an informed discussion with the supplier to explore what may be possible.

» This checklist can be given directly to the supplier to assist them with providing the winery with an appropriate energy efficiency solution.

» An editable (Microsoft Word) and print-version of this checklist is available via the WEST Online Portal, accessible via www.winesa.asn.au.

## 1. DETERMINE THE END-USES OF YOUR BOILER

*Check the following end-uses:*

| | |
|---|---|
| Cleaning | |
| Heating tanks for malolactic fermentation | |
| Preheating wine before bottling | |
| Preheating wine after cold-stabilisation | |
| Other: | |

## 2. COMPILE A BOILER INVENTORY

*Compile a list of the following equipment:*

| | |
|---|---|
| Boilers: number, make, model, type(water tube or fire tube, condensing),fuel, power rating (kW), efficiency, flow rate (kg/s), pressure (kPa), and time in use (h/y) | |
| Pipes: diameter (m) | |
| Valves: number, make, model, type | |
| Other: | |

*Choose an approach to estimate time in use:*

| | |
|---|---|
| Divide the total fuel use (kWh) by the total time (h) that the boiler has been installed | |
| Use existing control systems and manual procedures | |
| Check control settings (if the system has controls) | |

## 3. ESTIMATE THE HOT WATER OR STEAM LOAD

*Compile a list of the following information:*

| | |
|---|---|
| Flow rates (kg/s) required now | |
| Location of end-use | |
| Operating times or events that require hot water or steam | |
| Reason the end-use requires hot water or steam | |
| Flow rates required in the future | |

*This list enables you to:*

- estimate the hot water or steam load (kW), including the base load (kW) and peak load (kW);
- identify the end-uses that dominate the hot water & steam load (kW);
- identify the end-uses that can be rescheduled from peak times to off-peak times; and
- group together end-uses that require similar heating temperatures (°C).

## 4. ESTIMATE THE EFFICIENCY OF YOUR EXISTING BOILER SYSTEMS

*Measure indicators of refrigerator performance*

For an initial estimate, measure the following parameters, and compare them to their design values:

| | |
|---|---|
| Flow rate (kg/s) | |
| Pressure (kPa) | |
| Fuel energy use (l/kg) | |

## 5. DETERMINE THE BUSINESS PARAMETERS THE BOILER SYSTEM

*Quantify or qualify the following values:*

| | |
|---|---|
| Energy price(s) ($/kWh; $/l) | |
| Capital budget ($) | |
| Targets for running costs ($/y) | |
| Required level of redundancy in the system | |
| Acceptable level of risk for new technologies | |
| Equipment constraints, such as: specific brands of equipment; specifications for electrical wiring; compatibility with existing infrastructure or floor space; and adaptability to future upgrades | |
| Scope of energy efficiency opportunities to consider: If the existing equipment need to be replaced, then calculate the payback period (y) based on the extra (rather than total) costs ($) (if any) of the efficient equipment | |

## 6. CONFIRM BOILER SYSTEM PERFORMANCE

*Check the following conditions:*

| | |
|---|---|
| The boiler meets the peak hot water & steam load (kW) | |
| The boiler is optimised for the most common hot water & steam loads (kW) | |

## 7. SELECT A SERVICE PROVIDER

*Select a boiler service provider that can provide the combination of services that you seek:*

| | |
|---|---|
| Measurement and analysis of the hot water & steam load profile (kW), and power (kW) of the boiler and end-uses | |
| Reporting on equipment and process performance | |
| Optimisation of the boiler system, including: optimisation of the control system, flow rates (kg/s), and pressure levels (kPa); management of hot water & steam leaks; assessment of heat recovery potential; location of the boiler; and compatibility of the boiler with the existing heating system | |
| Design of a boiler system that aims to minimise losses from the end-use to the boiler, including the selection of the most appropriate fuel | |
| Supply, service, and installation of hot water & steam equipment (e.g. boilers, pipes, and valves) for optimal energy efficiency | |
| Supply of spare parts, including shipping | |
| Guarantee of minimum efficiency (%) of the proposed system | |
| Guarantee of maximum running costs ($/y) of the proposed system | |

| | |
|---|---|
| Technical support and after sales service | |
| In-house repairs and onsite service | |
| Emergency service | |
| Other: | |

## NEGOTIATE A CONTRACT

*Determine your preferred type of contract:*

| | |
|---|---|
| » Service contract: the supplier performs certain actions for a fixed price ($). | |
| » Energy performance contract: the supplier performs certain actions that meet certain levels of energy reduction (kWh) for a lower upfront price ($) and a share of the cost savings ($/y). | |

## OTHER TOOLS

To further assist with evaluating opportunities to improve hot water & steam system energy efficiency, the Winery Energy Saver Toolkit provides the following tools (available via the Online Portal, www.winesa.asn.au):

- Energy efficiency opportunities modelling tool, which can be used to test potential savings resulting from key energy efficiency improvements outlined in the Winery Energy Saver Toolkit
- Energy Resource Use Data tool, which can be used by businesses to collect and analyse their own baseline electricity, gas and fuel consumption data.

## SUPPORTING REFERENCES

The following references were used in the development of the Hot Water & Steam section of the WEST toolkit. We encourage you to access these references as they may provide additional useful information for your business in evaluating energy efficiency opportunities.

*Department of Industry, Tourism and Resources (Australian Government):* A guide to energy efficiency innovation in Australian wineries – energy efficiency best practice www.ret.gov.au/energy/Documents/best-practice-guides/energy_bpg_wineries.pdf

*Lawrence Berkeley National Laboratory:* BEST Winery Guidebook – Benchmarking and Energy and Water Savings Tool for the Wine Industry, http://industrial-energy.lbl.gov/node/41

*Lawrence Berkeley National Laboratory:* Energy Efficiency Improvement and Cost Saving Opportunities for the Dairy Processing Industry http://www.energystar.gov/ia/business/industry/downloads/Dairy_Guide_Final.pdf

*Muller, MR, Simek, M, Mak, J & Mitrovic, G., (2001):* Modern industrial assessments: a training manual, version 2.0, Rutgers University, New Jersey. http://www.engr.colostate.edu/IAC/pdfs/OIPEA_Modern_Industrial_Assessments_Training_Manual.pdf

*Pacific Northwest Pollution Prevention Resource Center (2005):* Pollution Prevention Technology Profile Conductivity Controls in Water Rinsing, Cooling Towers, and Boilers www.pprc.org/pubs/technologies/conductivity.pdf

*Queensland Government:* Eco-efficiency opportunities in Queensland Foundries – Boiler Efficiency (F7) Fact sheet http://www.ecoefficiency.com.au/Portals/56/factsheets/foundry/00976%20F7%20Boiler%20efficiency.pdf

Sustainable Energy Authority Victoria (2002): Energy and Greenhouse Management Toolkit.

*Sustainability Victoria:* Energy Efficiency Best Practice Guide - Steam, Hot Water and Process Heating Systems http://www.sustainability.vic.gov.au/resources/documents/best_practice_guide_heating.pdf

*US Department of Energy (US DOE) (2001):* Green Federal Facilities An Energy, Environmental, and Economic Resource Guide for Federal Facility Managers and Designers - 5.2.1 Boilers

*Working Group for Cleaner Production:* Eco-Efficiency Resources for the Queensland Food Processing Industry http://www.ecoefficiency.com.au/Ecoefficiencystages/OpportunitiesforImprovement/FoodProcessing/tabid/3639/language/en-US/Default.aspx

*Sustainability Victoria:* Energy Efficiency Best Practice Guide – Steam, Hot Water and Process Heating Systems, www.resourcesmart.vic.gov.au/for_businesses/energy_efficiency_4597.html

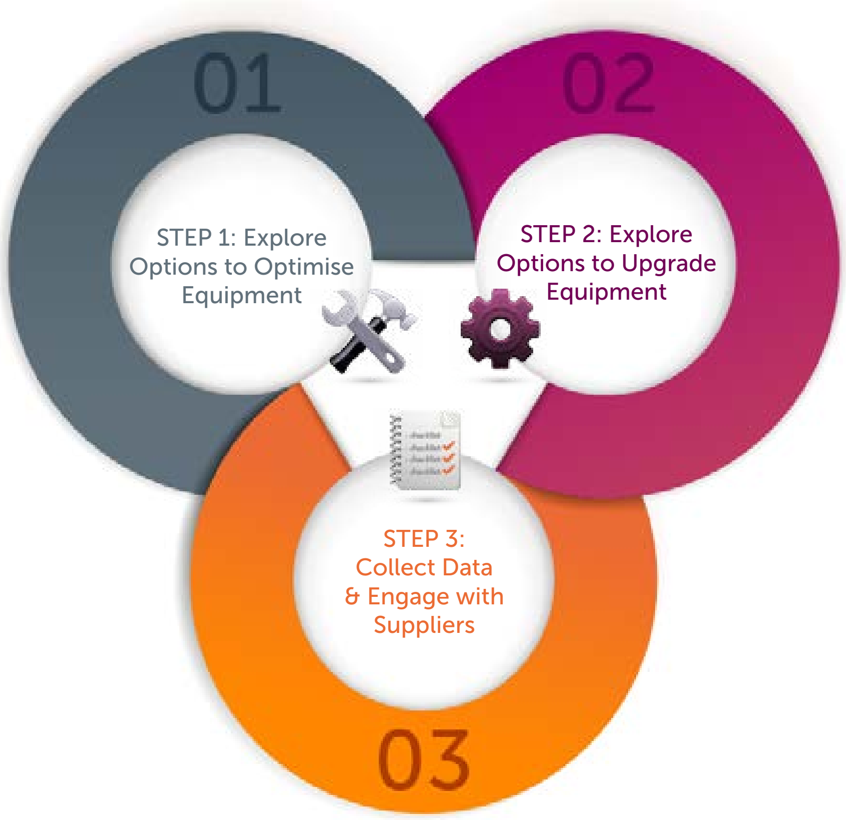
*The Natural Gas Boiler Burner Consortium:* Index efficiency, www.cleanboiler.org/Eff_Improve/Efficiency/Index_Boiler_Efficiency.asp

# HEATING, VENTILATION & AIR CONDITIONING (HVAC)

Energy efficiency improvements most relevant to the following winery processes:

» Barrel stores
» Warehouses
» Offices

## Heating, Ventilation & Air Conditioning: 5-15% of energy consumption



# STEP 1: EXPLORE OPTIONS TO OPTIMISE EQUIPMENT

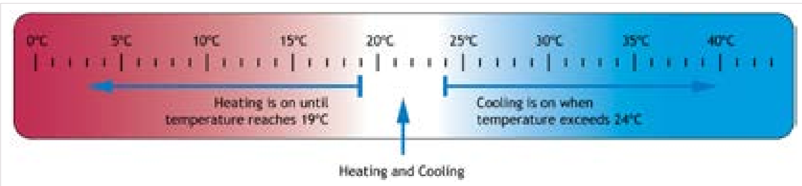
## OPTIMISE OPERATING SETTINGS

### ADJUST TEMPERATURE SETPOINTS

The energy used by air conditioning decreases with increasing width of the temperature band when space cooling (or heating) is not required. Reduce air conditioner power consumption by using the widest acceptable temperature setpoints, especially during non-production and non-occupied periods. You can also think of this as having temperature settings as high as possible in warm weather/surroundings, and as low as possible in cool weather/surroundings (thus reducing how hard the air conditioning has to work to achieve the desired temperature). A temperature band of 19-26°C could be acceptable.

Energy saving: varies depending on set-point and other factors

Other benefits of this improvement may include lower maintenance costs and longer operating life of air conditioner equipment (as the equipment does not need to work as hard to provide the desired temperature).

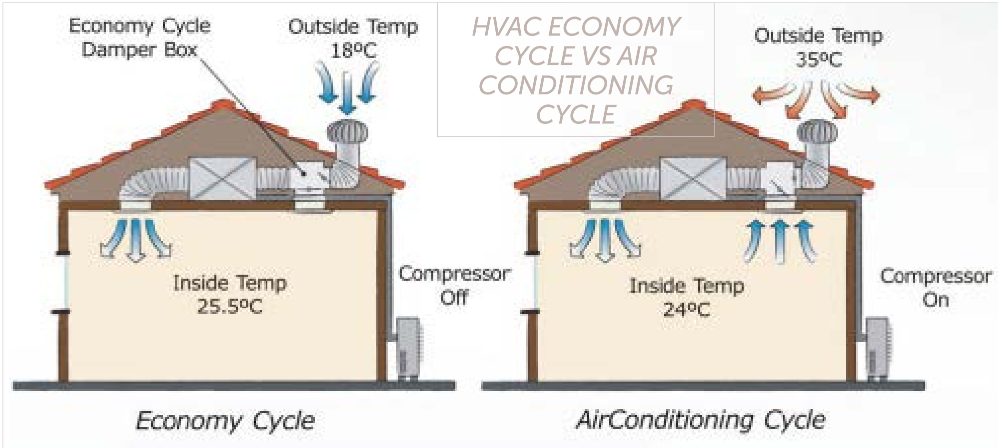



### USE THE ECONOMY CYCLE

The economy cycle of an air conditioner draws-in cooler outside air and circulates it indoors. It requires less power because the air is not actively cooled by the air conditioning units (its only circulated by the system). Reduce air conditioner power by using the economy cycle during cool periods, such as at night time.

Energy saving: varies for different circumstances

Other benefits of using the economy cycle include lower maintenance costs (and longer operating life) due to lower loads (and wear-and-tear) on HVAC equipment.



# STEP 2: EXPLORE OPTIONS TO UPGRADE EQUIPMENT

## INSTALL BUILDING SEALS

Unwanted air infiltrates air conditioned spaces though unsealed and open doors and windows, increasing the load and power consumption. Avoid some of this infiltration by installing tight seals; and by implementing proper door and window management, including training staff to close doors and windows, and installing automatic door closers.

Energy saving:
varies for different circumstances

Other benefits from making this improvement include a higher and more effective air conditioning (heating/cooling) capacity due to less heat/cooling loss, which improves the space environment and working conditions.

Suggested equipment requirements :

» Door seals
» automatic door closers

*INSTALL BUILDING SEALS TO REDUCE INFILTRATION*

## REARRANGE DUCT NETWORK

### MINIMISE THE PRESSURE DROP OF THE DUCT NETWORK

A fan must generate air flow at a rate and pressure that meets the demands of the end-use and overcomes the friction in the duct network. Reduce losses and improve efficiency with the following features:

» Duct width: even a small increase in width will lead to a relatively large reduction in friction (since, for square ducts, friction is inversely proportional to the fifth power of the internal duct width), and thereby improve efficiency.
» Duct roughness: internal duct roughness depends on the material, including internal insulation, and finish. Smooth, rigid ducts have much less friction than rough or flexible ducts and should be used where possible.
» Duct length: pipe friction increases with increasing length. Pipe networks can be unnecessarily long due to bypass loops, bend components, bends in flexible ducts, and the location of the fans and end-uses. Recue length where possible.
» Duct components: each component adds friction losses and should be avoided (where possible):
  · Bends, branches, and joins should be eliminated or, if they are required, should be gradual (large radius).
  · Dampers should be used minimally.

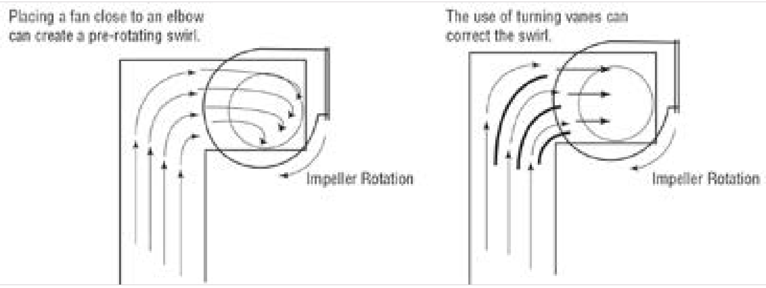
## Energy saving: Increasing duct width alone can result in 5-20% reduction in HVAC power consumption.

Other benefits from this upgrade may include:

» Lower capital costs associated with smaller fans, or foregoing the need to upgrade to a larger HVAC by getting more capacity out of your existing system

» Lower maintenance costs

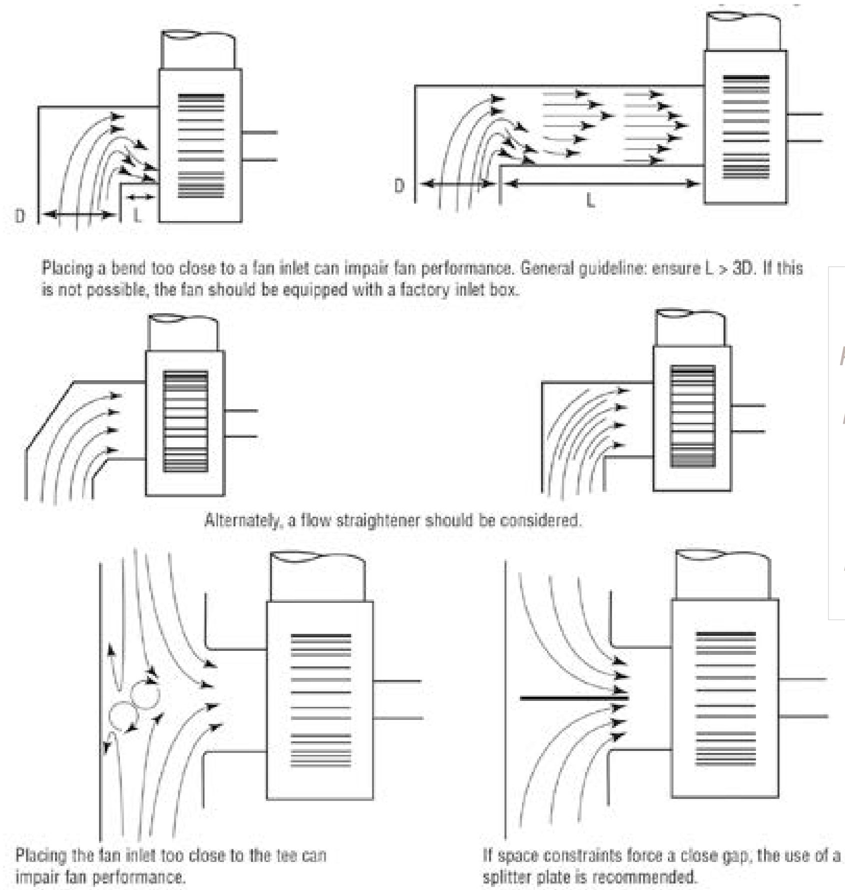
» Longer operating life of HVAC system equipment.




USING TURNING VANES IN HVAC DUCT ELBOWS TO IMPROVE EFFICIENCY

| Relative pressure loss for various elbow design | | | |
|---|---|---|---|
| Best | Good | Fair | Worst |
| x 1.0 | x 1.3 | x 4.7 | x 13.0 |

COMMON TO HVAC DUCT NETWORK




THE PLACEMENT OF HVAC BENDS AND TEES TOO CLOSE TO FANS CAN AFFECT EFFICIENCY

## RELOCATE HVAC UNIT

Compressors operate more efficiently in cooler surroundings, and condensers expel heat more efficiently to cooler surrounding. Increase HVAC efficiency by locating HVAC units in areas that are cool, well ventilated, and out of direct sunlight (e.g. shaded, enclosure with reflective paint, or underground).

# INSTALL NEW HVAC COMPONENTS

## INSTALL INSULATION ON HVAC AND DUCT NETWORKS

Insulation prevents heat transfer into cooling fluids. It can often be cost-effectively installed or improved on ducts and fittings located outside of the air-conditioned space (in the ceiling or outside).

Energy saving:
up to 10% of HVAC power consumption

*INSULATION ON HVAC DUCT WORK*

## INSTALL CONTROLS TO OPERATE HVAC ONLY WHEN REQUIRED

All types of active HVAC equipment use energy even on standby. Decrease HVAC power consumption by installing automatic control systems or time switches to turn off when not required for long periods, such as outside of business hours;and by installing zone control for unoccupied areas.The conditioned space might retain comfortable conditions even without the HVAC on for the last business hour of the day.

Energy saving:
varies for different circumstances

Other benefits from this improvement may include:

» Lower maintenance costs
» Longer operating life of HVAC equipment

## INSTALL A VARIABLE SPEED DRIVE OR MULTI-SPEED MOTOR

Variable speed drives (VSDs) continually adjust the motor speed to match the component (compressor or fan) output to the load. Since component power is proportional to the cube of the motor speed, even a small reduction in speed will lead to a relatively large reduction in power. VSDs are well-suited to HVAC components that, due to variable loads or infrequent high loads, operate at part-load for up to 95% of the time.

For more information on Variable Speed Drives and Multi-speed motors, refer to the 'Refrigeration and Cooling' section of this toolkit.

# STEP 3: COLLECT DATA AND ENGAGE WITH SUPPLIER

## SUPPLIER CHECKLIST

The following checklist provides guidance on which information to collect from within the winery and from the equipment supplier, in order to assess the winery's HVAC system for potential improvements in energy efficiency.

Important to note:

» Some of the information suggested below may be difficult or impractical for SME wineries to collect. We do not expect you to be an expert in air conditioning – instead, the intention of this checklist is to give you a snapshot of what may be required to properly assess the opportunity, and to then have an informed discussion with the supplier to explore what may be possible.

» This checklist can be given directly to the supplier to assist them with providing the winery with an appropriate energy efficiency solution.

» An editable (Microsoft Word) and print-version of this checklist is available via the WEST Online Portal, accessible via www.winesa.asn.au.

## 1. DETERMINE THE END-USES OF YOUR HVAC SYSTEM

| *Check the following end-uses:* | |
|---|---|
| Offices | |
| Factory floor | |
| Warehouses | |
| Store rooms | |
| Plant rooms | |
| Other: | |

## 2. COMPILE A HVAC INVENTORY

| *Compile a list of the following equipment:* | |
|---|---|
| Compressors: number, make, model, type(screw or reciprocating), power rating (kW), efficiency (%), flow rate (l/s), speed (rpm), and number of pump stages | |
| Condensers: number, make, model, type (air cooled, water cooled or evaporative), and age (y) | |
| Pumps: number, make, model, type, power rating (kW), efficiency (%), flow rate (l/s), speed (rpm), and number of pump stages | |
| Fans: number, make, model, type, power rating (kW), efficiency (%), flow rate (l/s), speed (rpm), and number of pump stages | |
| Ducts: diameter of main high-pressure refrigerant liquid line (m) | |

| | |
|---|---|
| HVAC unit: time in use (h/y) | |
| Electric heaters: number, make, model, type, power rating (kW), efficiency (%), time in use (h/y) | |
| Other: | |

*Choose an approach to estimate time in use:*

| | |
|---|---|
| Record readings on the hour-run meter (h) at regular intervals | |
| Divide the hour-run meter reading (h) by the total time (h) that the HVAC unit has been installed | |
| Compare the energy (kWh) and power readings (kW) (if the system has an electricity meter) | |
| Examine electricity meter load profiles (kW) | |
| Use existing control systems and manual procedures | |
| Check control settings (if the system has controls) | |

*Determine variation in cooling, heating, and ventilation loads under the following conditions:*

| | |
|---|---|
| Seasonal variation in ambient temperatures (°C) | |
| Variation in occupancy | |
| Variation in vehicle movement | |

## 3. ESTIMATE THE COOLING AND HEATING LOADS

*Compile a list of the following information:*

| | |
|---|---|
| Major end-uses (which comprise at least 70% of the total cooling and heating loads (kW)) | |
| Specific cooling and heating requirements (temperature (°C), and cooling and heating times (h)) for each end-use | |

*Choose an approach:*

| | |
|---|---|
| a. For an initial estimate of theoretical cooling requirements (kW), review equipment manuals and process specifications. | |
| b. If budget and time allow for a more-accurate estimate of actual cooling and heating requirements (kW), which include undesirable heat gains and losses (kW), then install metering and monitoring equipment, such as data-loggers | |

*This list enables you to:*

» estimate the cooling and heating loads (kW), including the base load (kW)and peak load (kW);

» identify the spaces that dominate the cooling and heating loads (kW); and

» identify the conditioning of spaces that can be rescheduled from peak times to off-peak times.

## 4. ESTIMATE THE HVAC UNIT PERFORMANCE

Measure indicators of HVAC unit performance

*Choose an approach:*

a. For an initial estimate, measure the following parameters, and compare them to their design values:.

| | |
|---|---|
| Condensing temperature (°C) at the outlet | |
| Evaporator temperature (°C) at the inlet | |
| Evaporator temperature (°C) at the outlet | |
| Compressor pressure (kPa) and temperature (°C) at the inlet | |
| Compressor pressure (kPa) and temperature (°C) at the outlet | |
| Power to the compressor (kW) | |
| Ambient temperature (°C) | |

b. For a more-accurate estimate, perform an energy consumption assessment. For this procedure, log the energy use of the HVAC unit and/or specific components against the ambient temperature (°C), and cooling and heating loads (kW); and then compare these graphs to the design values.

| *Equipment:* | | | |
|---|---|---|---|
| HVAC unit | | Fans | |
| Compressors | | Other: | |
| Pumps | | | |

*These indicators enable you to:*

- identify inefficient equipment and processes;
- assess the effectiveness of the energy efficiency measure implemented; and
- monitor for unexpected changes in the performance of equipment and processes.

## 5. DETERMINE THE BUSINESS PARAMETERS THE HVAC SYSTEM

*Quantify or qualify the following values:*

| | |
|---|---|
| Energy price(s) ($/kWh; $/l) | |
| Capital budget ($) | |
| Targets for running costs ($/y) | |
| Required level of redundancy in the system | |
| Acceptable level of risk for new technologies | |
| Equipment constraints, such as: specific brands of equipment; specifications for electrical wiring; compatibility with existing infrastructure or floor space; and adaptability to future upgrades | |
| Scope of energy efficiency opportunities to consider: If the existing equipment need to be replaced, then calculate the payback period (y) based on the extra (rather than total) costs ($) (if any) of the efficient equipment | |

## 6. CONFIRM REFRIGERATOR PERFORMANCE

*Check the following conditions:*

| | |
|---|---|
| The HVAC unit meets the peak cooling and heating loads (kW) | |
| The HVAC unit is optimised for the most common cooling and heating loads (kW) | |

## SELECT A SERVICE PROVIDER

*Select boiler service provider that provides combination of services that you seek:*

| | |
|---|---|
| Measurement and analysis of the cooling and heating load profiles (kW), and power (kW) of the HVAC unit and end-uses | |
| Reporting on equipment and process performance | |
| Optimisation of HVAC system, including: optimisation of control system, temperature levels (°C), flows (l/s); management of air leaks; assessment of heat recovery potential; minimisation of cooling & heating requirements (kW) | |
| Supply, service, and installation of HVAC components (e.g. compressors, evaporators, filters, and ducts) for optimal energy efficiency (%) | |
| Supply of spare parts, including shipping | |
| Guarantee of minimum efficiency (%) of the proposed system | |
| Guarantee of maximum running costs ($/y) of the proposed system | |
| Technical support and after sales service | |
| In-house repairs and onsite service | |
| Emergency service | |
| Remote monitoring | |
| Other: | |

## NEGOTIATE A CONTRACT

*Determine your preferred type of contract:*

| | |
|---|---|
| » Service contract: the supplier performs certain actions for a fixed price ($). | |
| » Energy performance contract: the supplier performs certain actions that meet certain levels of energy reduction (kWh) for a lower upfront price ($) and a share of the cost savings ($/y). | |

## OTHER TOOLS

To further assist with evaluating opportunities to improve Heating, Ventilation and Air Conditioning energy efficiency, the Winery Energy Saver Toolkit provides the following tools (available via the Online Portal, www.winesa.asn.au):

» Energy efficiency opportunities modelling tool, which can be used to test potential savings resulting from key energy efficiency improvements outlined in the Winery Energy Saver Toolkit

» Energy Resource Use Data tool, which can be used by businesses to collect and analyse their own baseline electricity, gas and fuel consumption data.

## SUPPORTING REFERENCES

The following references were used in the development of the Heating, Ventilation & Air Conditioning section of the WEST toolkit. We encourage you to access these references as they may provide additional useful information for your business in evaluating energy efficiency opportunities.

*Architectural Energy Corporation:* Design Brief: Integrated Design for Small Commercial HVAC, Energy Design Resources http://www.energydesignresources.com/media/1747/EDR_DesignBriefs_hvac.pdf?tracked=true

*Carbon Trust:* Heating, ventilation and air conditioning overview http://www.carbontrust.com/media/7403/ctv046_heating_ventilation_and_air_conditioning.pdf

*Department of Resources, Energy and Tourism (Australian Government):* EEX website http://eex.gov.au

*Department of Industry, Tourism and Resources (Australian Government)*: A guide to energy efficiency innovation in Australian wineries – energy efficiency best practice www.ret.gov.au/energy/Documents/best-practice-guides/energy_bpg_wineries.pdf

*Lawrence Berkeley National Laboratory:* BEST Winery Guidebook – Benchmarking and Energy and Water Savings Tool for the Wine Industry, http://industrial-energy.lbl.gov/node/41

*Perth Region NRM:* Energy Management Guidelines for Wineries www.perthregionnrm.com/media/5733/attachment%2011%20-%20energy%20management%20guidelines%20for%20wineries.pdf

*Sustainability Victoria:* Energy Efficiency Best Practice Guide – Pumping Systems, www.resourcesmart.vic.gov.au/for_businesses/energy_efficiency_4597.html

*US Department of Energy:* Improving Fan System Performance - A Sourcebook for Industry http://industrial-energy.lbl.gov/node/297

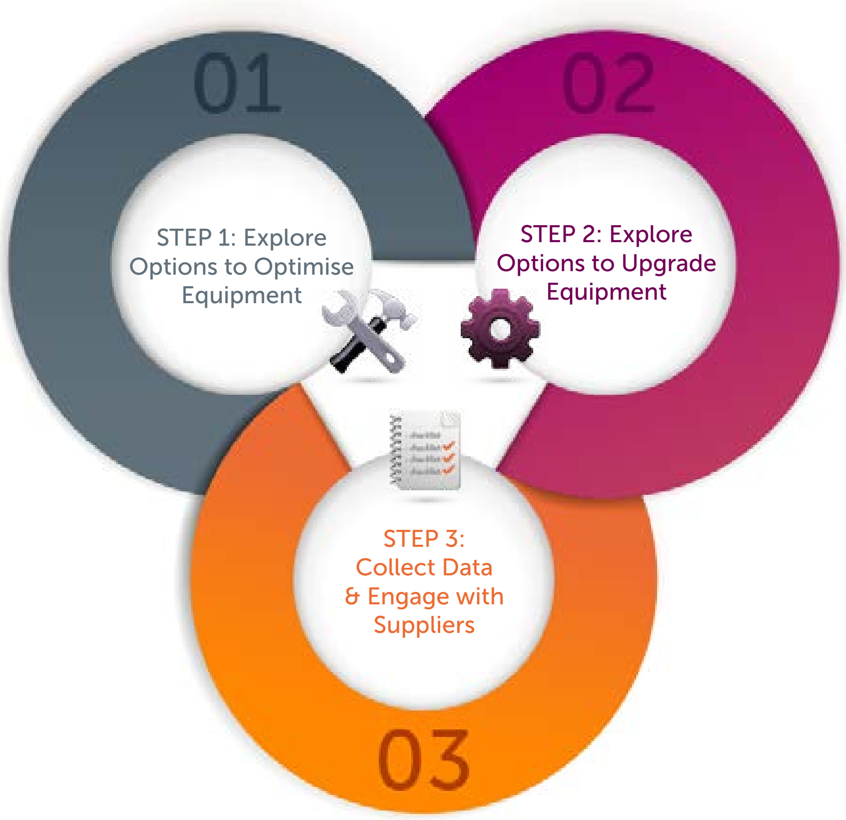
*Working Group for Cleaner Production:* Eco-Efficiency Resources for the Queensland Food Processing Industry http://www.ecoefficiency.com.au/Ecoefficiencystages/OpportunitiesforImprovement/FoodProcessing/tabid/3639/language/en-US/Default.aspx

# LIGHTING

Energy efficiency improvements most relevant to the following winery processes:

» Warehouses
» Barrel stores
» Processing shed and plant room
» Offices
» Security and floodlights

## Lighting: 5-10% of energy consumption



# STEP 1: EXPLORE OPTIONS TO OPTIMISE EQUIPMENT

## LOAD MANAGEMENT

### USE LIGHTS ONLY WHEN REQUIRED

Lighting may not be required in unoccupied spaces (e.g. after hours or when areas are vacant for long periods of time), nor is it required where sufficient natural lighting is available. Staff should be encouraged to switch off lighting when its not needed. Through an understanding of the energy costs of leaving lights on or excessive lighting, staff are more likely to manage lighting responsibly.

Reduce lighting power consumption by using lights only when required, and encouraging others to do the same. Automatic lighting controls can also assist this process by being programmed to switch off during times of inactivity.


Energy saving:
varies for different circumstances

### USE MINIMUM LEVEL OF LIGHTING

Lamps are most effective when they produce the appropriate amount of light in the task location. Under-lighting and over-lighting can adversely affect staff productivity. The light is brightest near the lamps. Use a calibrated light meter to measure illumination and adjust lighting to recommended levels.


Reduce lighting power by:

» Accessing daylight wherever possible (skylights and windows can reduce artificial lighting requirements)
» Repositioning lamps so they're above work spaces, but avoid glare;
» Lowering the height of high bay lighting
» Removing excess lamps (de-lamping).
» Using a light metre to ensure that the most efficient lighting levels are provided to suit the working environment.

## MAINTAIN LIGHTING EQUIPMENT

### CLEAN LIGHTS

Dust accumulates on lamps and luminaires (compact lighting units), blocking up to 20% of light. Maintain appropriate illumination by regularly cleaning the surfaces of lighting equipment.

Energy saving: up to 20% of
lighting energy consumption

Other benefits include:

» Improved staff productivity through better lighting to suit the task
» Cleaner working environment

TABLE: RECOMMENDED ILLUMINATION LEVELS TO BE MAINTAINED FOR VARIOUS ZONES AND TASKS IN BUILDINGS (THESE CAN BE MEASURED WITH A LUX METER) (*AS/NZS 1680.1:2006 – Interior and Working Lighting*)

| CLASS OF TASK | | RECOMMENDED ILLUMINATION LEVELS (LX) | ZONE/TASK CHARACTERISTICS | EXAMPLES |
|---|---|---|---|---|
| Movement and orientation | | 40 | Interiors that are rarely visited and where visual tasks are limited to movement and orientation. | Corridors; cable tunnels; indoor storage tanks; walkways. |
| Rough intermittent | | 80 | Interiors that are visited intermittently and where visual tasks are limited to movement, orientation and coarse detail. | Live storage of bulky materials; dead storage of materials needing care; locker rooms; loading bays. |
| Normal range of tasks and work places | Simple | 160 | Any continuously occupied interior where there are no tasks requiring perception of other than coarse detail. Occasional reading of clearly printed documents for short periods. | Waiting rooms; staff canteens; rough checking of stock; rough bench and machine work; entrance halls; automated process monitoring. |
| | Ordinary or moderately easy | 240 | Continuously occupied interiors with moderately easy visual tasks - high contrasts or large detail. | Food preparation; counters for transactions. |
| | Moderately difficult | 320 | Areas where visual tasks are moderately difficult - moderate detail or with low contrasts. | Routine office tasks, e.g. reading, writing, typing, enquiry desks. |
| | | 400 | | Inspection of medium-detail work. |
| | Difficult | 600 | Areas where visual tasks are difficult - small detail or with low contrast. | Drawing boards; most inspection tasks; proofreading; fine machine work; colour matching. |
| | Very difficult | 800 | Areas where visual tasks are very difficult - very small detail or with very low contrast. | Fine inspection; fine manufacture; grading of dark materials. |
| Extremely difficult | | 1200 | Areas where visual tasks are extremely difficult - extremely small detail or of low contrast. Visual aids may assist. | Graphic arts inspection; inspection of dark goods; extra-fine bench work. |
| Exceptionally difficult | | 1600 | Areas where visual tasks are exceptionally difficult - exceptionally small detail or with very low contrasts. Visual aids will be an advantage. | Assembly of minute/small mechanisms. |

# STEP 2: EXPLORE OPTIONS TO UPGRADE EQUIPMENT

## USE DAYLIGHT

### INSTALL DAY-LIGHTING DEVICES

The use of daylight helps to avoid the use of artificial light.

Reduce lighting power consumption by installing some of the following devices:

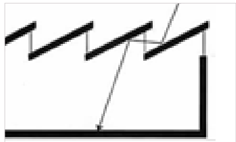
- Side lighting: windows, light shelves, clerestories, light guiding shades, and optical venetian blinds.
- Top lighting: sawtooth rooves, roof monitors, and glare-reducing skylights.
- Core lighting: light pipes.

Day-lighting devices are most cost effective for new buildings and warehouses with large roof areas and open spaces.

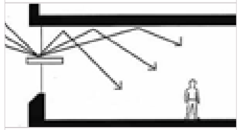
Energy saving: average of 14% of lighting energy consumption; 30-70% of lighting energy in office spaces

Other benefits from making this improvement include:

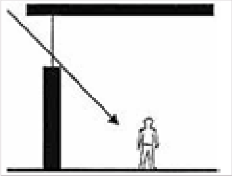
- Higher staff productivity and improved working environment due to better lighting
- Aesthetics (reduced number of light fittings and switches; perception of more open space)



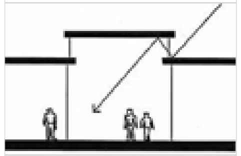
*SAWTOOTH ROOF*



*LIGHT SHELF*



*CLERESTORY*



*ROOF MONITOR*

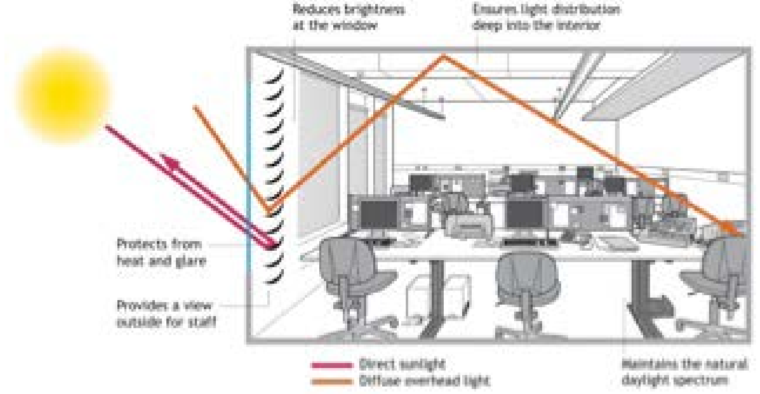
### DISTRIBUTE DAYLIGHT INTERNALLY

Daylight requires purposeful facilitation to penetrate deep into the indoor space. Reduce lighting power consumption by painting walls, ceilings, and floors in light colours (to aide reflection within spaces); and installing curved ceilings.

Energy saving:
varies for different circumstances

Other benefits from making this improvement:

- Higher staff productivity due to better lighting (natural lighting is often better for a person's vision than artificial lighting)
- Aesthetics.




*USE OF DAYLIGHTING DEVICES TO REDUCING LIGHTING ENERGY CONSUMPTION*

## INSTALL EFFICIENT LAMPS AND LUMINARIES

Reduce lighting power consumption by installing energy efficient lamps and luminaries when cost effective. Efficient lighting equipment often has significantly greater energy cost saving over its lifetime than capital cost. This equipment is especially cost effective when existing lamps are due for replacement because installation (labour) costs, which are often greater than equipment costs, do not count as an additional capital cost (because the work was required).

Efficient lighting equipment has the added benefit of reducing the HVAC cooling load.

To minimise recurring installation costs, prioritise equipment with a long life. For flexibility in future use, prioritise equipment that is compatible with a control system, whether or not the control system is installed yet.

Energy saving: 30-80% of lighting energy consumption (savings depend on the types of lamp and luminaires installed)

Other benefits from making this improvement include lower maintenance costs due to less-frequent replacement – in many cases, the costs for replacement is greater than the cost savings gained through energy efficiency, so ideally a lamp option with longer-life should be considered.

TABLE: EQUIPMENT OPTIONS FOR GENERAL INTERIOR LIGHTING

| LUMINAIRE | LAMP COST | POWER | LAMP LIFE | LUMINOUS EFFICACY (amount of light per unit of power) |
|---|---|---|---|---|
| *Typically installed* | | | | |
| T8 linear fluorescent luminaires (36W) (need 2 lamps for comparison) | $5 | 36W + 9W | 6000-8000h | 80-100lm/W |
| *Recommended options* | | | | |
| T5 linear fluorescent luminaire (28W) | $7.50 | 28W | 9600-12,800h | 70-104lm/W |
| *Alternatives options* | | | | |
| T8 lamp (36W) with high efficiency reflector and electronic ballast | $5 | 36W | 9600-12,800h | 80-100lm/W |
| Linear LED lamps (24W) | $100 | 24W | 30,000-50,000h | 55-93lm/W |

## TABLE: EQUIPMENT OPTIONS FOR INTERIOR DISPLAY LIGHTING

| LUMINAIRE | LAMP COST | POWER | LAMP LIFE | LUMINOUS EFFICACY (amount of light per unit of power) |
|---|---|---|---|---|
| *Typically installed* | | | | |
| MR16 low voltage dichroic halogen lamps (50W) | $6 | 50W + 15W | 2000-3000h | 20-30lm/W |
| *Recommended options* | | | | |
| LED luminaire (16W) | $6 | 16W | 30,000-50,000h | 55-93lm/W |
| *Alternatives options* | | | | |
| LED lamp (10W) | $6 | 10W + 5W | 25,000h | 55-93lm/W |
| Infra-red coating (IRC) halogen lamp (35W) | $12 | 35W + 10W | 2000-3000h | 25-35lm/W |
| Infra-red coating (IRC) halogen lamp (35W) with an electronic transformer | $12 + $20 (transformer) | 35W + 3W | 2000-3000h | 25-35lm/W |
| Compact fluorescent luminaire (13W) | $5 | 15W | 6000-16,000h | 46-75lm/W |
| Compact fluorescent lamp (15W) and lamp holder | $6 + $29 (lamp holder) | 15W | 6000-15,000h | 46-75lm/W |

## TABLE: EQUIPMENT OPTIONS FOR LOW BAY LIGHTING

| LUMINAIRE | LAMP COST | POWER | LAMP LIFE | LUMINOUS EFFICACY (amount of light per unit of power) |
|---|---|---|---|---|
| *Typically installed* | | | | |
| Mercury vapour luminaires (400W) | $40 | 400W + 32W | 6400-24,000h | 15-70lm/W |
| *Recommended options* | | | | |
| Metal halide luminaire (250W) | $50 | 250W + 20W | 8000-9600-16,000h | 65-115lm/W |
| *Alternatives options* | | | | |
| T5 fluorescent luminaire (54W) | $5 | 36W | 9600-12,800h | 80-100lm/W |
| (need 4 lamps for comparison) | $7.50 | 54W + 3W | 9600-12,800h | 70-104lm/W |
| LED luminaire (150W) | $500 | 150W | 30,000-50,000h | 55-93lm/W |
| Induction lamp luminaire (200W) | – | 200W + 10W | 100,000h | |

TABLE: EQUIPMENT OPTIONS FOR HIGH BAY LIGHTING

| LUMINAIRE | LAMP COST | POWER | LAMP LIFE | LUMINOUS EFFICACY (amount of light per unit of power) |
|---|---|---|---|---|
| *Typically installed* | | | | |
| Metal halide luminaire (400W) | $60 | 400W + 54W | 8000-16,000h | 65-115lm/W |
| *Recommended options* | | | | |
| Pulse-start metal halide luminaire (320W) | $90 | 320W + 29W | 16,000-32,000h | 65-115lm/W |

TABLE: EQUIPMENT OPTIONS FOR EXTERIOR LIGHTING

| LUMINAIRE | LAMP COST | POWER | LAMP LIFE | LUMINOUS EFFICACY (amount of light per unit of power) |
|---|---|---|---|---|
| *Typically installed* | | | | |
| Linear halogen lamp shovel and box floodlight (500W) | $5 | 500W | 2000h | 17-20lm/W |
| *Recommended options* | | | | |
| LED luminaire (90W) | $50 | 90W | 30,000-50,000h | 55-93lm/W |
| *Alternatives options* | | | | |
| High pressure sodium luminaire (120W) | $50 | 120W | 14,000-24,000h | 85-150lm/w |
| Metal halide luminaire (150W) | $50 | 150W + 20W | 8000-9600-16,000h | 65-115lm/W |


*DICHROIC HALOGEN LAMPS*


*COMPACT FLUORESCENT LAMP*


*FLUORESCENT TUBE*


*MERCURY VAPOUR LAMP*


*SODIUM VAPOUR LAMP*


*METAL HALIDE LAMP*


*LINEAR LED LAMP*


*LED LAMP*

## INSTALL LED OR SELF-LUMINOUS EXIT SIGNS

Reduce lighting power consumption by installing efficient Exit signs. In comparison to traditional incandescent signs that use about 40W and have a useful life of about 1 year, LED signs use about 4-8W and have a useful life of about 10 years; self-luminous do not require any power and have a useful life of about 10 years. It's most cost-effective to install these when existing signs require replacement (so there is no additional labour cost).

**Energy saving: 80-90% of sign energy consumption**

Other benefits include lower maintenance costs due to less-frequent replacement.

# STEP 3: COLLECT DATA AND ENGAGE WITH SUPPLIER

## SUPPLIER CHECKLIST

The following checklist provides guidance on which information to collect from within the winery and from the equipment supplier, in order to assess the winery's lighting systems for potential improvements in energy efficiency.

Important to note:

- Some of the information suggested below may be difficult or impractical for SME wineries to collect. We do not expect you to be an expert in lighting – instead, the intention of this checklist is to give you a snapshot of what may be required to properly assess the opportunity, and to then have an informed discussion with the supplier to explore what may be possible.
- This checklist can be given directly to the supplier to assist them with providing the winery with an appropriate energy efficiency solution.
- An editable (Microsoft Word) and print-version of this checklist is available via the WEST Online Portal, accessible via www.winesa.asn.au.

## 1. COMPILE A LIGHTING INVENTORY

*Compile a list of the following lamps, luminaires, and controls:*

| | | | |
|---|---|---|---|
| Incandescent | | Mercury vapour | |
| Compact fluorescent | | Metal halide | |
| Dichroic halogen | | High pressure sodium | |
| LED | | Incandescent Exit signs | |
| T12 fluorescent | | Fluorescent Exit signs | |
| T8 fluorescent | | LED Exit signs | |
| T5 fluorescent | | Other: | |
| Linear LED | | | |

*Choose an approach to estimate time in use:*

| | |
|---|---|
| Use existing lighting timer settings | |
| Examine logs | |
| Consult staff | |

## 2. COMPOSE A MAP OF YOUR LIGHTS

*Specifying the following characteristics of each light:*

| | |
|---|---|
| Type | |
| Power rating (kW) | |
| Time in use (h/y) | |
| Location | |
| Illumination in spaces: use a calibrated light meter | |

## 3. DETERMINE THE BUSINESS PARAMETERS OF THE LIGHTING SYSTEM

*Quantify or qualify the following values:*

| | |
|---|---|
| Energy price(s) ($/kWh; $/l) | |
| Capital budget ($) | |
| Targets for running costs ($/y) | |
| Required level of redundancy in the system | |
| Acceptable payback period or Internal Rate of Return (IRR) | |
| Acceptable level of risk for new technologies | |
| Equipment constraints, such as: specifications for electrical wiring; compatibility with existing infrastructure or floor space; and adaptability to future upgrades | |
| Scope of energy efficiency opportunities to consider: if the existing equipment need to be replaced, then calculate the payback period (y) based on the extra (rather than total) costs ($) (if any) of the efficient equipment | |

## 4. DETERMINE THE LIGHTING REQUIREMENTS

*Quantify or qualify the following values:*

| | |
|---|---|
| Financial: lifetime (h), efficacy (lm/W) | |
| Physical environment: surrounding, users, glare, ambient temperature (°C), fire safety, time of day | |
| Ecological: disposal, emissions (kg), embodied energy (J) | |
| Operational: colour rendering, colour preference (°C), illumination (lx), spectrum | |
| Purpose: ambient, task, accent, decorative | |

## 5. ACCOUNT FOR NON-ENERGY BENEFITS

*Quantify or qualify the following values:*

| | |
|---|---|
| Employees: higher productivity, better mood, lower absenteeism, fewer errors | |
| Higher safety | |
| Improved colour rendering | |
| Improved aesthetics / ambience | |
| Smaller cooling load (kW) for the HVAC and refrigerator systems | |

## 6. MANAGE THE COMMISSIONING PROCESS

*Once the space is occupied, adjust the following features of the system to efficiently meet actual use patterns:*

| | |
|---|---|
| Switching times | ☐ |
| Time delays | ☐ |
| Sensor placement | ☐ |
| Zoning | ☐ |

## 7. CONFIRM LIGHTING SYSTEM PERFORMANCE

*Check the following conditions:*

| | |
|---|---|
| Light quality and quantity (lx) is meets the requirements of AS1680.1: use a calibrated light meter | ☐ |
| Daylight does not cause discomfort or make tasks difficult | ☐ |

## 8. SELECT A SERVICE PROVIDER

*Select a lighting service provider that can provide the combination of services that you seek:*

| | |
|---|---|
| Measurement and analysis of the lighting requirements | ☐ |
| Reporting on equipment and process performance | ☐ |
| Optimisation of the lighting system, including: reduction in lighting requirements; and optimisation of the control system and illumination levels (lx) | ☐ |
| Supply, service, and installation of lighting components (e.g. skylights, lamps, ballasts, and controls) for optimal energy efficiency (%) | ☐ |
| Guarantee of minimum efficiency (%) of the proposed system | ☐ |
| Guarantee of maximum running costs ($/y) of the proposed system | ☐ |
| Technical support and after sales service | ☐ |
| Emergency service | ☐ |
| Work done by lighting professionals who are registered with the Illumination Engineering Society of Australia and New Zealand | ☐ |
| Other: | ☐ |

## 9. NEGOTIATE A CONTRACT

*Determine your preferred type of contract:*

| | |
|---|---|
| » Service contract: the supplier performs certain actions for a fixed price ($). | |
| » Energy performance contract: the supplier performs certain actions that meet certain levels of energy reduction (kWh) for a lower upfront price ($) and a share of the cost savings ($/y). | |

## OTHER TOOLS

To further assist with evaluating opportunities to improve Pumping energy efficiency, the Winery Energy Saver Toolkit provides the following tools (available via the Online Portal, www.winesa.asn.au):

» Energy efficiency opportunities modelling tool, which can be used to test potential savings resulting from key energy efficiency improvements outlined in the Winery Energy Saver Toolkit

» Energy Resource Use Data tool, which can be used by businesses to collect and analyse their own baseline electricity, gas and fuel consumption data.

## SUPPORTING REFERENCES

The following references were used in the development of the Lighting section of the WEST toolkit. We encourage you to access these references as they may provide additional useful information for your business in evaluating energy efficiency opportunities.

*Abraham, LE* (1996) '*Daylighting*', in Public Technology Inc. and US Green Building Council (1996) Sustainable Building Technical Manual, Public Technology Inc.
www.smartcommunities.ncat.org/pdf/sbt.pdf

*Carbon Trust:* Heating, ventilation and air conditioning overview
http://www.carbontrust.com/media/7403/ctv046_heating_ventilation_and_air_conditioning.pdf

*Lawrence Berkeley National Laboratory:* BEST Winery Guidebook – Benchmarking and Energy and Water Savings Tool for the Wine Industry, http://industrial-energy.lbl.gov/node/41

*NSW Office of Environment & Heritage:* Energy efficient lighting – Technology Report
http://www.environment.nsw.gov.au/resources/sustainbus/120434EnEffLight.pdf

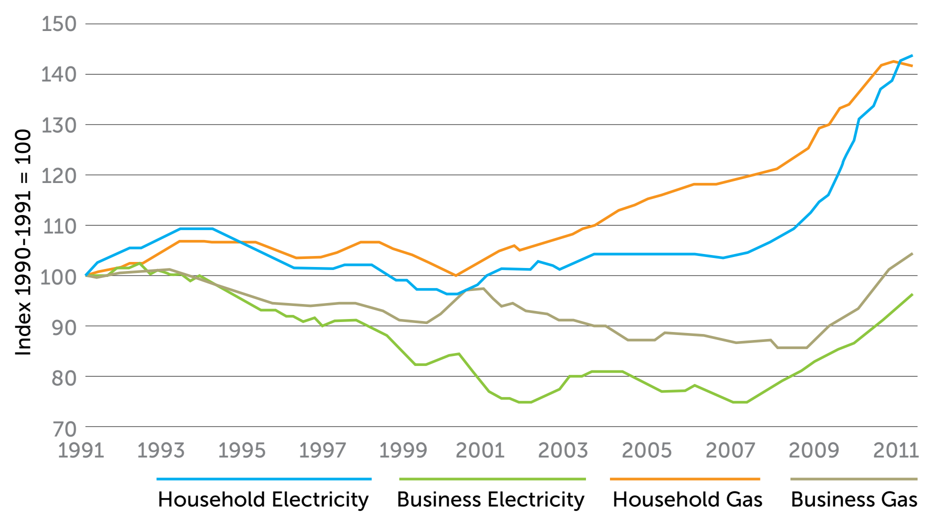
*Standards Australia and Standards New Zealand (2006)*: AS/NZS 1680.1:2006 – Interior and Working Lighting, Part 1: General Principles and Recommendations, Standards Australia and Standards New Zealand.

*Sustainability Victoria:* Energy Efficiency Best Practice Guide – Lighting
http://www.sustainability.vic.gov.au/resources/documents/best_practice_guide_lighting.pdf

# BUSINESS CASE ASSESSMENT

## Energy efficiency is now a critical issue for wineries

Over the three years to 2013, the cost of electricity for households and businesses has increased by 40% on average. An increasing trend is expected to continue (as shown in chart at right), with electricity prices expected to increase by an additional 37% by 2014.Gas prices are also likely to surge in the coming years as the gap narrows between domestic and international LNG prices.




ELECTRICITY & GAS RETAIL PRICE INDEX (REAL) – AUSTRALIAN CAPITAL CITIES

## 1. ENERGY EFFICIENCY IS NOW A CRITICAL ISSUE FOR WINERIES

Over the last three years, the cost of electricity for households and businesses has increased by 40% on average. This trend will only continue, with electricity prices expected to increase by an additional 37% by 2014.Gas prices are also likely to surge in the coming years as the gap narrows between domestic and international LNG prices.

Network infrastructure costs are the biggest driver of this trend. Australia's large geographic size means we have to maintain one of the world's largest electricity networks. Spreading the associated maintenance costs (as network charges) across our small and distributed population means that network charges make up a much bigger proportion of electricity bills when compared to other countries. For example, Australia has around the same amount of network infrastructure as the United Kingdom, but with a third of the population to share the costs. With most of Australia's electricity networks built throughout the 1960s and 1970s, major investment is now needed to replace and upgrade these networks as they reach the end of their service life. The cost is then passed on to consumers via increased electricity prices.

The need to replace and maintain ageing infrastructure is made even more costly by the need for the grid to cope with increasing peak electricity demand (particularly during summer). Network companies must build their infrastructure to meet energy demand at its forecast peak – much higher than the average – meaning around $11 billion worth of infrastructure across Australia is only being used for 100 hours each year.

### ELECTRICITY ON THE RISE: WHAT GIVES?

Businesses are naturally curious as to why electricity prices are increasing the way they are – the following is a general breakdown explaining the main factors:

» WHOLESALE COSTS (40% OF THE PRICE INCREASE) - the costs associated with generating electricity and trading it in a wholesale market. The wholesale component is projected to increase to allow for changes in sources of electricity generation, higher capital and operational costs for generation, and higher hedging costs. The price on carbon also increases the wholesale component, accounting for about 10% of the electricity bill.

» NETWORK CHARGES (40% OF THE PRICE INCREASE) - the costs associated with building and maintaining electricity networks. The network component will increase due to required investments in infrastructure upgrades to cope with increased peak demand, replacing aged assets, higher commodity prices (steel, copper, labour), and a higher cost of accessing capital for investment due to the Global Financial Crisis. Network charges account for around half of the total cost of a company's electricity bill.

» RETAIL COSTS (12% OF THE PRICE INCREASE) - the costs relating to the 'shop-front' for a consumer's electricity supply. This component will increase because the retail margin is calculated as a percentage of the total cost to supply residential customers – as this total cost increases, retail costs increase.

The South Australian wine industry it is currently under a lot of pressure with increasing energy costs (carbon price or not) and rising costs of labour, combined with the strong Australian dollar impacting export revenues. The result is a squeeze in the profit margins of many local wineries – most of which are SMEs that live (and die) by cash flow. Given that energy costs can be as high as 15% of total operational costs of a wine business, energy efficiency improvements are critical to future competitiveness of every winery.

In assessing the business case for any energy efficiency project, wineries may benefit from understanding that there are two key parts to this assessment:

1. The Strategic Case, which verifies the winery's long-term reasons behind investing in equipment upgrades for energy efficiency. In assessing the Strategic Case, the business must answer questions such as:
   - How will the upgrade make our business better in the long-term?
   - How will the upgrade help our business meet its short- and long-term goals?
   - Can our money be put to better use, or is this upgrade the best use of our funds at this point in time?
2. The Financial Case, which tests the financial rigour and profitability of the business opportunity that has been identified in the Strategic Case. There are a number metrics that can be used to create a sound financial case for any business decision – one of the most common every-day metrics is the Return On Investment (ROI) formula,

$$\text{ROI}(\%) = \frac{\text{INVESTMENT GAIN} - \text{INVESTMENT COST}}{\text{INVESTMENT COST}} \times 100\%$$

The Various types of Investment Gain (Business Benefits) and Investment Cost (Costs & Risks) are explored in the following sections.

## 2. ASSESSING BUSINESS BENEFITS

Energy Efficiency upgrades can yield a variety of benefits to the business:

- Cost savings associated with energy consumption
- Reduced costs associated with water, materials and waste consumption
- Reducing maintenance costs and downtime
- Improving productivity
- Enhancing brand and company profile

The most obvious reason for adopting energy efficiency upgrades is to reduce the cost of energy consumption. However these types of solutions, if investigated and implemented correctly, can hit 'multiple birds with one stone' – that is, create additional benefits for the business such as improving productivity or reducing the cost of labour. In many cases, businesses will find that these additional benefits are often bigger than the cost savings achieved from reduced energy consumption. The more benefits that can be counted, the better the business case for the upgrade.

## COST SAVINGS ASSOCIATED WITH ENERGY CONSUMPTION

The most obvious benefit resulting from energy efficiency upgrades is reducing the business' operational costs through reductions in energy consumption, such as electricity, gas, and other fuels.

### ESTIMATING COST SAVINGS FROM REDUCED ELECTRICITY CONSUMPTION

Estimating the cost savings associated with electricity consumption involves comparing the electricity consumption of the current equipment versus the new equipment to be installed. The exact process for calculating these savings depends on the equipment, but generally savings can be calculated in the following ways:

PR: Equipment Power Rating → measured in kW
EE: Equipment Efficiency → usually measured as a percentage or fraction; assume EE to be 1.0 unless otherwise specified by equipment supplier/specification sheet
RT: Running time per year (hrs/year)
kWh: Electricity consumption
$/kWh: Cost per unity of electricity consumed (note that this number can be found on your quarterly electricity bill)

*Electricity Consumption of Current Equipment:* $PR_{current} \times EE \times RT = kWh_{current}$ p/a

*Electricity Consumption of New Equipment:* $PR_{new} \times EE \times RT = kWh_{new}$ p/a

*Total electricity consumption saved per year:* $kWh_{current} - kWh_{new} = kWh_{Saved}$

Estimated electricity cost savings per year (\$) = $kWh_{Saved} \times \$/kWh$

## COST SAVINGS ASSOCIATED WITH OTHER RESOURCES: WATER, MATERIALS AND WASTE CONSUMPTION

Replacing old manufacturing equipment with newer, more efficient equipment can not only reduce energy consumption, but also the consumption of other resources related to the process, making the cost savings of such upgrades even more attractive. In some cases, these savings can be even more significant than the energy savings.

For example, a winery that replaces an old refrigeration system using R-22 refrigerant with a new ammonia-based (R717) system may not only gain cost savings from energy efficiency, but will also benefit from reduced costs of purchasing refrigerant. R22 is currently being phased out due to its high ozone-layer depleting potential, and coupled with the price of carbon, the current cost of R22 refrigerant is around $180/kg (as of 2013). R717 on the other hand has no ozone depleting potential and no global warming potential – currently costing $9-11/kg. In addition, old R22 refrigeration systems can have high leakage rates, meaning that additional 'top-up' amounts of R22 refrigerant will need to be purchased each year (adding to the ongoing costs of the system). New systems with lower leakage rates will reduce these recurring costs.

### ESTIMATING COST SAVINGS FROM REDUCED MATERIALS CONSUMPTION

Estimating cost savings associated with reduced materials consumption can be calculated based on the cost per unit of the materials or water reduced, such as:

- kg refrigerant
- kL water savings
- Tonnes of grape crush
- Tonnes of waste

## REDUCING MAINTENANCE COSTS

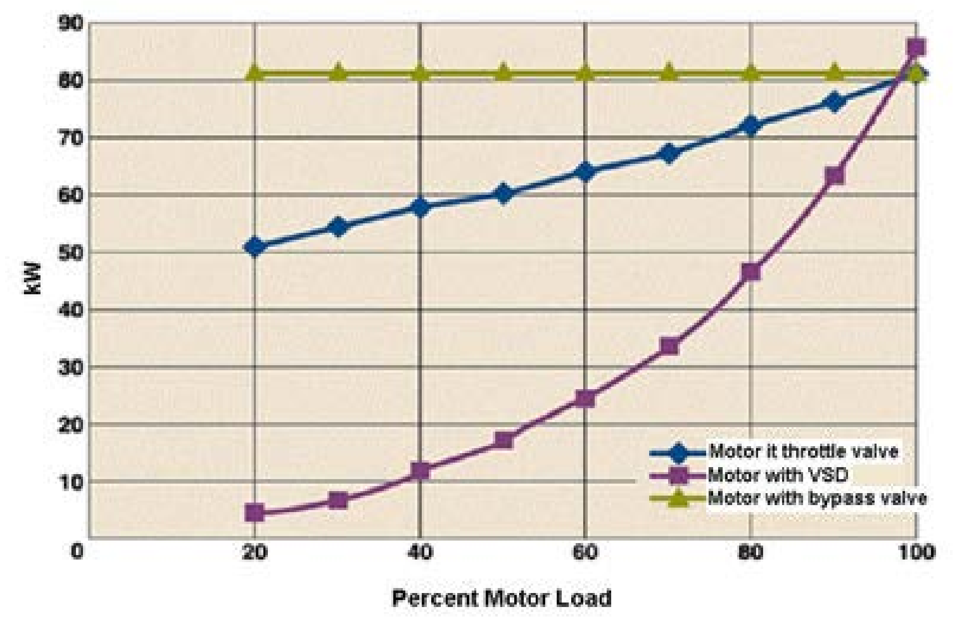
More energy-efficient equipment means more useful energy delivered as output (e.g. heating, cooling power), which means less energy wasted as waste-heat or wear-and tear on equipment, resulting in reduced repair/maintenance costs and extending the useful life of the equipment.

For example, single-speed compressors start abruptly, subjecting the motor to a high level of starting torque and current surges up to 10 times the full-load current, which increases wear-and-tear of the motor mechanics.Installing a variable speed drive on the compressor enables the motor to ramp up to the desired operating speed, which lessens mechanical and electrical stress and reduces electricity consumption.

### ESTIMATING COST SAVINGS FROM REDUCED MAINTENANCE COSTS

Estimating cost savings associated with reduced maintenance can be calculated by looking at the following costs:

» Cost of parts replacement
» Cost of external service providers (time/labour)
» Cost of staff required to maintain equipment (time/labour)
» Cost associated with equipment replacement due to shorter equipment life




*COMPARISON OF MOTOR POWER WITH VSD AND WITHOUT VSD*

## IMPROVING PRODUCTIVITY

Replacing inefficient equipment with newer, more efficient alternatives provides the opportunity to put in place upgrades that improve productivity – that is, improving wine production such that the process can deliver the same or more product volume with less energy. For example, replacing the refrigeration compressors with larger models (higher kW cooling load) fitted with variable speed drives enables wineries to efficiently manage increased throughput during vintage, and ramp down refrigeration load to suit non-vintage demand.

Besides increasing product volumes to meet demand, the resulting improvements in productivity may lead to cost reductions in labour and the need for overtime to product the required volumes.

Energy efficiency upgrades can also assist with reducing load on the manufacturing facilities power infrastructure. As wineries grow, they experience increasing pressure to reduce electricity to remain within the limits of their transformer capacity; when a winery business exceeds this transformer capacity, blackouts and power-shortages are likely to occur, which affects production.

### ESTIMATING COST SAVINGS FROM IMPROVED PRODUCTIVITY

Estimating cost savings associated with improved productivity can be calculated by looking at the following costs:

» Cost of labour & overtime (refer to wage statements)
» Cost of lost production due to blackouts/brownouts
» Cost of sales lost due to insufficient volumes
» Cost of back-up generators

To make sure that the equipment upgrade makes both an energy saving and a productivity improvement, 'energy intensity' metrics such as "kWh/Tonne of grape crush" or "kWh/$ of maintenance cost", can be used for measurement. If the upgrade results in a reduction in energy intensity, the upgrade is making more product with less energy consumed per unit of product.

## ENHANCING BRAND AND COMPANY PROFILE

Depending on the winery's market and target audience (e.g. organic), the communication and demonstration of the company's commitment to energy efficiency can go a long way to improving the value of the brand and positioning of the business in the market as a winery committed to sustainable practices.

Adopting energy efficiency improvements in the business can do much to support this brand positioning, and although this is difficult to quantify, wineries that have used energy efficiency in this way have gained through improved relationships with customers, regulators and Government, and easier access to sources of funding and support.

## 3. ASSESSING COSTS & RISKS

Energy efficiency improvements present a significant opportunity to improve the profitability and productivity of any winery.

Businesses however should be equally wary about the costs and risks of making investments in energy efficiency, let alone any major upgrade to their business. Most SME wineries are cash-flow sensitive – every investment decision needs to be the right one, or else it may have a severe impact on the overall health of the business. The best approach is to get a full understanding of all the costs and risks involved with making an upgrade, and incorporating these into the business case assessment.

### ASSESSING COSTS

The following table outlines a number of common costs that wineries may incur when implementing an equipment upgrade. Businesses should familiarise themselves with these costs before making an investment in energy efficiency.

TABLE. COMMON COSTS INCURRED WITH EQUIPMENT UPGRADES

| COST TYPE | DESCRIPTION | HOW TO IDENTIFY |
|---|---|---|
| Capital Cost | The cost of purchasing the equipment – which may be driven by the Australian dollar, whether the equipment is available in Australia (freight costs), and wether the technology is common/ standard or new to the market | Provided by the supplier and/ or the installer |
| Installation Cost | The cost of installing the equipment – normally driven by labour costs and materials, sometimes also considers building/construction costs | Provided by the installer, or internally by the operational staff managing the installation |
| Recurring Costs | The ongoing/recurring cost of running the equipment – driven mostly by consumables, such as energy, water, waste and other materials | Provided by the equipment supplier and/or company responsible for servicing the equipment |
| Mainte-nance Costs | Labour and materials costs associated with regular maintenance and/or adhoc repairs | Provided by the company responsible for servicing the equipment, or calculated based on estimated staff time allocated to maintenance |
| Downtime Costs | Costs associated with production downtime due to the shut-down of old equipment, and to enable installation of new equipment | Estimated by the number of days of shut-down, multiplied by the revenue generated per day through production |
| Finance Costs | Costs associated with accessing finance/loans to secure the equipment i.e. interest payable | Provided by the bank/lender |
| Opportunity Cost | The value of an alternative upgrade/ investment that your business is foregoing (e.g. product marketing campaign) in order to invest in the energy efficiency upgrade. | Determined by the CEO and/ or Financial Officer of the business, and depends on the cash-constraints of the business. |

## ASSESSING RISKS

Asides from assessing the costs associated with the energy efficiency upgrade, it is important for the business to identify the full suite of potential risks it may be exposing itself-to through the implementation of new equipment. Once these risks are understood, risk management strategies can be put in place (throughout the equipment purchase, installation and operation) to mitigate negative impacts on the business.

Common types of risks to consider include:

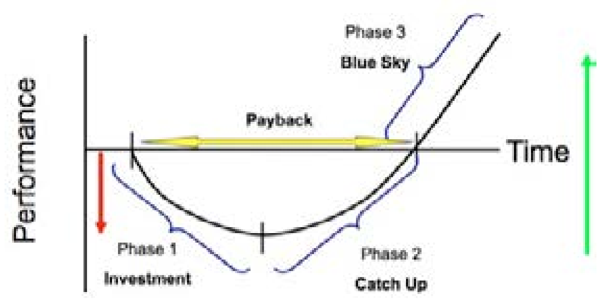
- Financial – includes the impact of the upgrade on cash flow, budgetary requirements, tax obligations, creditor and debtor management, remuneration and other financial management concerns. Refer to the previous section on 'Assessing Costs' to assist with identifying financial risks
- Equipment – risks that may affect the reliability of the new equipment to 'operate as planned', and the effect of the new equipment on the day-to-day operations of the business
- Organisational – risked related to the cultural, structural and human resources of the business, that may affect or be affected by the success of the equipment upgrade (such as a lack of staff understanding about how to operate the new equipment properly, or concerns about the job security of staff with the introduction of equipment automation)
- Commercial – risks associated with the impact of the new equipment on product quality and safety (and ultimately reputation and customer retention/ relationships), growth and diversification plans
- Legal & regulatory compliance – risks associated with legislation, regulations, standards, codes of practice and contractual requirements that are applicable to the business, and which may be compromised with the introduction of new equipment.
- Project – risks associated with the management of equipment, finances, resources, technology, timeframes and people involved in the management of the upgrade (refer to next Section, Assessing Capabilities).
- Safety – risks associated with the impact of the new equipment on the health and safety of everyone associated with the business: individual, workplace as well as public safety.

## 4. PLANNING FOR IMPLEMENTATION

Once the benefits and costs of the energy efficiency upgrade have been quantified, the business should then put in place a plan to see the upgrade through to success.

### J-CURVE MANAGEMENT

Any strategic decision to spend money today for a benefit tomorrow is called a J Curve investment. J Curve investments create short term financial loss with the intention of recovering the investment in the future, and overriding it with long term strategic gains. Most energy efficiency upgrades are J Curve investments.




*J-CURVE MODEL (Source: Nick Setchell, Realtimeceo Www.realtimeceo.com)*

In order to see energy efficiency upgrades through to a successful outcome, businesses must recognise that there are three phases to a J Curve investment (figure below). Each phase requires a different set of tasks, skills and capabilities:

1. **Investment** – Cash going into the investment. This phase may begin with purchasing the new equipment, or possibly beforehand i.e. money and time spent in identifying energy efficiency opportunities (such as paying for energy audits), investigating technologies and scoping the new equipment upgrade. This step also involves time/money spent in installing and testing the new equipment.
2. **Catch Up** – Investment begins to produce cash – in this case, cost savings from reduced energy consumption as well as other benefits (e.g. improved productivity, reduced labour costs). During this stage, the equipment is operational and being used by staff on a daily basis.
3. **Blue Sky** – Investment has paid back the initial cash outlay and is generating value for the business.

In order to move from Phase 1 to Phase 3 as quickly and safely as possible, the following rules should be adhered-to:

1. **Measure and manage depth and breadth of the J-Curve valley.** Be prepared for the valley to be deeper and wider than anticipated. Encourage discussion about costs and create an environment where new ideas are welcomed.
2. **Do NOT become emotionally connected to a J Curve.** Watch out for ski slopes and emotional arguments to keep them going. Examples are sunken costs and people management.
3. **Do NOT take on too many macro J Curves at once.** Identify, prioritise, and stagger J Curves. Understand how many your company can handle at one time. Understand "aggressive" versus "passive" introduction, and ask two questions when considering any new J Curve – Will it benefit the business? Is now the right time?
4. **Create and manage a plan to quickly move from Phase 1 to Phase 3.** Focus on the critical transition between the innovator and the implementer by using clear communication, documentation, and procedures. And beware of innovators who will not let go of their baby!
5. **Update your J Curve register.** A J Curve register helps to track the number of active J Curves in the business. Maintain the register in a spreadsheet and update it every 30 days. The register isn't a project management system; it's a higher level view of all strategic investments in the business.

## SOURCES OF FUNDING

The most critical capability of implementing the energy efficiency upgrade is cash flow -- money to fund both the purchase of the equipment and any other costs associated with the project.

For many SME wineries, this type of cash flow is difficult to come-by. There are however a variety of funding options available to assist businesses with implementing energy efficiency:

- Grant programs – grant programs offered by Commonwealth and state/territory governments can reduce the payback period of energy efficiency projects and support investment in clean technology projects.
- Loan financing – Financing arrangements can be designed to suit different business requirements, including avoiding upfront costs and repaying loans with the savings generated from the energy efficiency project.
- Tax incentives – The R&D tax incentive provides tax offsets to encourage more Australian companies to invest in research and development.
- Mandatory obligation schemes – Tradeable certificates provide a financial incentive for energy users to invest in clean energy initiatives, on top of the ongoing energy savings generated by the project.
- Transitional assistance schemes – The Australian Government's Clean Energy Future Package contains a series of assistance measures to support energy intensive industries transform to a low carbon economy.

For further information on these opportunities, refer to the Energy Efficiency Exchange website: http://eex.gov.au/business-support/grants-funding.

## 5. TOOLS & TEMPLATES

The following tools and templates that form part of the Winery Energy Saver Toolkit can be accessed to help you build the business case for energy efficiency upgrades:

- Energy efficiency opportunities modeling tool, which can be used to test potential savings resulting from key energy efficiency improvements outlined in the Winery Energy Saver Toolkit
- Energy Resource Use Data tool, which can be used by businesses to collect and analyse their own baseline electricity, gas and fuel consumption data
- Business case template, which businesses can populate (and edit as required) to assist with presenting their business case for energy efficiency upgrades to the CEO, peers or grant programs.

AusIndustry Clean Tech Return on Investment Calculator to assist with modeling the payback and ROI of energy efficiency improvements (in Microsoft Excel format) .

These tools and templates are accessible online via the Online Portal, available at www.winesa.asn.au.

SOUTH AUSTRALIAN WINE INDUSTRY
ASSOCIATION INCORPORATED

Australian Government
Department of Industry

This Activity received funding from the Department of Industry as part of the Energy Efficiency Information Grants Program. The views expressed herein are not necessarily the views of the Commonwealth of Australia, and the Commonwealth does not accept responsibility for any information or advice contained herein.

Government
of South Australia
Zero Waste SA