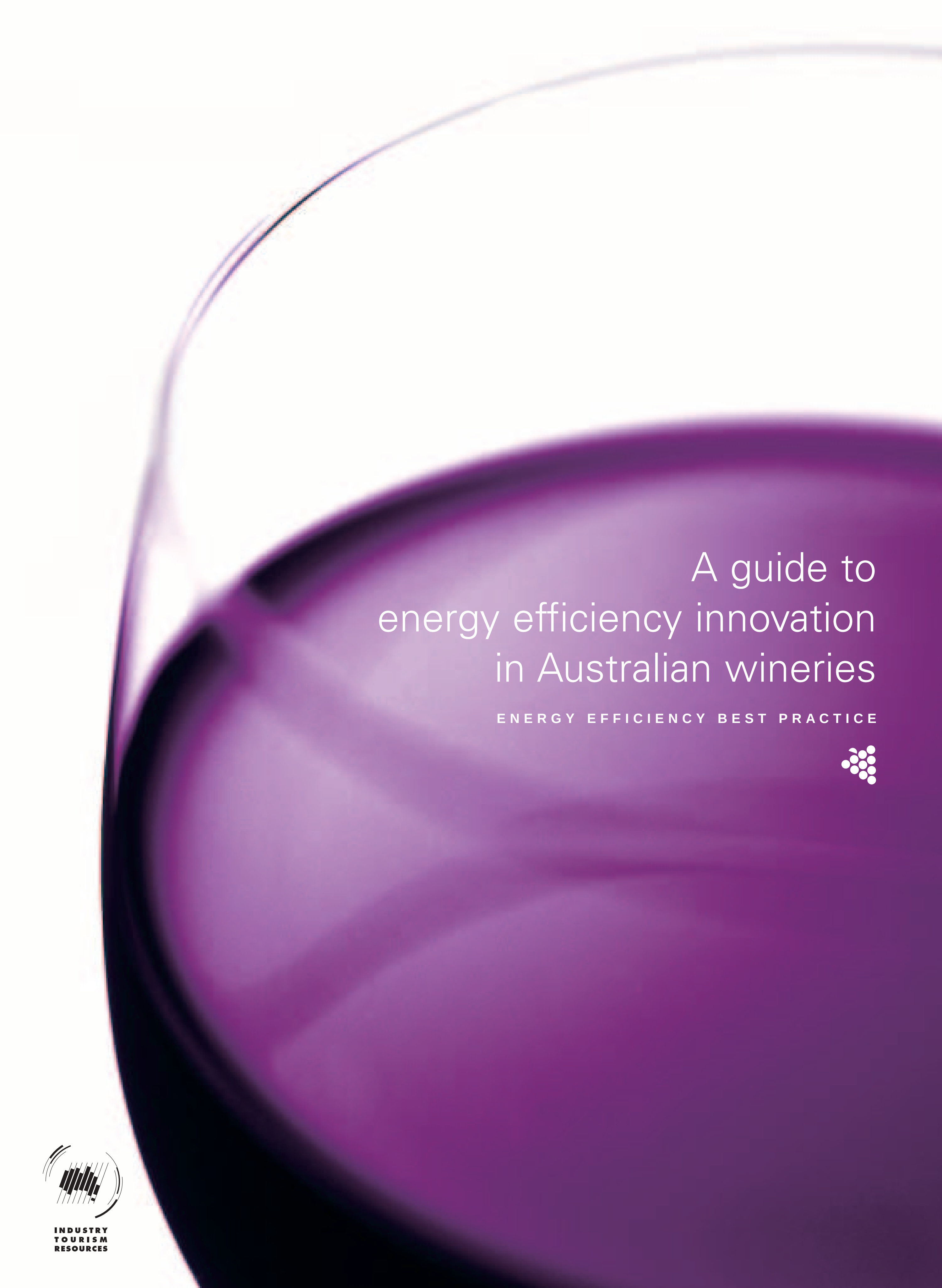

A guide to energy efficiency innovation in Australian wineries

ENERGY EFFICIENCY BEST PRACTICE

INDUSTRY
TOURISM
RESOURCES

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This guide has been prepared for the Energy Efficiency Best Practice (EEBP) program of the Department of Industry, Tourism and Resources (ITR) by Connect Innovation, with contributions from Increasing Returns, Sustainable Business and Sustainable Solutions.

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Purpose of the Guide

To support the development of best practice wineries by distributing the knowledge developed through the Wineries of the Future project by

- Communicating the value of best practice energy management and efficiency to the success of Australian winery operations
- Encouraging wineries and wine industry businesses to support energy management and energy efficiency projects and to incorporate energy information into their decision-making criteria
- Providing winery owners and managers with an overview of energy efficiency opportunities and best practice for new plant, major upgrades and plant operation
- Demonstrating how leading wineries in the industry are improving their operations to reduce energy costs of production, improve efficiency and reduce the impact of greenhouse gas emissions on future business performance
- Supporting changes that lead to continuous improvement in reducing energy consumption and environmental emissions from winery operations
- Outlining processes applicable to a number of other sustainability issues facing the wine industry


…Australia’s approach has been to listen to the consumer’s desires and strive to meet those through application of innovation
The Australian wine industry—Success through innovation

Overview

Wineries of the Future and Energy Efficiency Best Practice

The Energy Efficiency Best Practice program, an initiative of the Commonwealth Department of Industry, Tourism and Resources, in collaboration with the South Australian Wine and Brandy Industry Association has linked energy management to innovation and competitiveness—benchmarking against "best possible", not "best existing". It has worked with and built on existing Commonwealth and State programs that provide overall frameworks for companies to reduce energy consumption and achieve greenhouse goals.

Energy Efficiency Best Practice (EEBP) has added value by supporting companies to take the next step—identifying innovative solutions through the provision of hands-on training and practical assistance and tools. This Guide draws together the experience gained through EEBP's working partnerships with some of Australia's leading wine companies.

Why Take Action on Energy?

A number of factors affect energy consumption, cost and supply, for example:

- a more open and contestable energy market
- higher expectations of the environmental performance of companies
- policies to address greenhouse gas emissions

In this context, wineries can ask themselves some pertinent questions:

- How much are we prepared to pay for electricity on a hot day during vintage?
- What are the costs of a power outage for a few minutes...a few hours?
- What sort of resilience do we need to build into our production system and business model?
- How can we be pro-active in managing our exposure to any increases in energy costs?

Energy efficiency is now smart business. Companies need to manage risk exposure to energy prices, supply reliability and costs of greenhouse response. Energy management is a key to productivity improvement, quality and positive public image. The Australian wine industry has shown itself to be sensitive to its environmental responsibilities. Energy efficiency has been shown to be one of the most cost-effective mechanisms to address these issues, especially greenhouse gas reduction.

> ***"With rising energy costs and the industry's long-term prosperity at risk though global warming and climate change, decisions made today will have a significant impact on operating costs over the next 5 to 20 years. So it makes sense to look at energy efficiency now, while the industry is investing heavily in plant expansion and new sites."***
>
> **Keith Jones, Environment Program Manager, South Australian Wine & Brandy Industry Association**

Wineries of the Future and the Energy Efficiency Best Practice Approach

Under the Wineries of the Future project, the Energy Efficiency Best Practice program formed partnerships with five major Australian wine companies—Beringer Blass Wine Estates, Hardy Wine Company, Orlando Wyndham Group, Southcorp Wines and Yalumba Wine Company—to reduce energy consumption and greenhouse gas emissions, save money through an innovative approach to energy management and explore energy and resource efficiency implications for new winery design. The aim of this unique project has been to improve the sector's competitiveness and sustainability through best practice energy management and innovation.

The Energy Efficiency Best Practice approach

- targets processes with the greatest potential for achieving cost-effective energy savings and greenhouse gas emission reductions
- focuses on monitoring, measuring and benchmarking; encourages innovation, training and best practice; as well as building in-house capability
- involves company management and site personnel to:
  - examine in detail actual energy usage
  - identify, analyse and cost potential energy saving projects
  - set in place implementation strategies

> ***"EEBP's holistic treatment of environmental issues—including energy—often reveals startling financial savings when all of the factors are properly considered. The financial savings can then be used to drive even better environmental outcomes."***
>
> **Leon Deans, Viticulture & Winemaking Development Manager, Orlando Wyndham**

Two processes—Big Energy Project and Best Practice People and Processes—have been developed to achieve these results. Either can stand alone or work in tandem to enable companies take a fresh look at energy management and to utilise their own people and their own knowledge to develop lateral and perhaps unexpected solutions to energy use issues. [See Appendix 1 for detailed descriptions]

> ***"The workshop model involving selected consultants and facilitators working with our employees was a rewarding experience for all participants and has had added benefits for design and implementation of other projects in our business."***
>
> **Brian Walsh, Director of Winemaking, Yalumba Wine Company**

The Big Energy Project (BEP) identifies specific energy-intensive activities within an organisation and seeks to achieve "big-step" energy efficiency improvements. A staged process conducted over several months, the BEP facilitates big-step savings by creating an environment where organisations step back and take a whole-of-systems approach to improving energy efficiency.

> ***"The workshops encourage you to step back from the day-to-day and think ahead. Wineries of the Future provides a framework for involving winemakers, cellar operations and engineers in an innovative process that will identify major efficiencies in time and energy. It is a quality investment in our future."***
>
> **Alan W Edward, GM Production and Engineering (Asia Pacific), Beringer Blass Wine Estates**

The main characteristics of BEP include:

- Preliminary discussions with key company staff
- A background paper which brings together existing data and information on potential areas for investigation on a system flow basis
- Participation from key staff and technology specialists outside the industry
- A 2-day workshop working through the issues, generating ideas and producing action plans
- A workshop outcomes report including timing, costs and responsibilities
- Follow-up support

One of the key success factors of this process has been the use of contributions from specialists who have not necessarily worked within the sector to bring outside perspectives and fresh approaches to what may have become accepted wisdom or placed in the "too-hard basket".

The first BEP focused on refrigeration, estimated to account for greater than 50% of the winemaking sector's electricity use and a major contributor to peak electricity demand. Participants from Beringer Blass, Hardy Wine Company, Orlando Wyndham and Southcorp crossed the spectrum of winemakers, winery management, engineering, maintenance, electrical supervision and contract management. They were joined by refrigeration equipment suppliers and outside specialists who offered expertise in refrigeration technology; heat pumps; thermodynamics; and sustainable power systems and supply. This innovation workshop examined efficient technology options and means to reduce demand for refrigeration by making production management changes and adjustments to winemaking practice. (See Part 3)

> ***"The BEP project opened our eyes to new processes for improved design, modelling of the process flow, questioning of established paradigms, careful analysis of existing practices and blue sky dreaming. This has allowed us to set some high goals in waste and energy management, which we would not have set with confidence in the past."***
> **Andrew Murphy, Operations Manager, Yalumba Wine Company**

A second Big Energy Project was conducted with the Yalumba Wine Company, focusing on production performance, energy and water efficiency and functional design for their proposed new winery. Workshop participants from Yalumba included senior managers, technical staff, winemakers and environmental personnel, as well as outside specialists with knowledge in sustainable energy, water management, heat transfer and refrigeration, process and chemical engineering. (See Part 4)

Best Practice People and Processes (BPPP) is an organisational development program designed to assist companies systematically address the development and implementation of technical, communication and policy or procedural projects to improve energy efficiency. The key elements are:

- formation of a site-wide, cross-functional Energy Management Team
- delivery of an energy management workshop to senior management
- technical workshops on relevant topics, eg refrigeration, compressed air or steam & boilers

> ***"The biggest impact EEBP has had on us is the way we are thinking……"***
> **Graham Whitfield, Electrical Supervisor, Southcorp Wines (Karadoc)**

A set of integrated modules cover issues such as general energy principles, energy market directions, technical aspects of energy systems, change management, communication and stakeholder relations. The major aims are to establish the attitude that energy is a variable cost and build organisational capacity to develop and sustain effective energy management capabilities at a site level; reduce costs of production; improve plant capacity and performance; and reduce greenhouse gas emissions.

The centrepiece of the BPPP is a series of five workshops developed for the Energy Management Team (EMT). These facilitated work sessions maximise the potential of site-based expertise to identify and implement major energy efficiency initiatives. The role of the Energy Management Team is intended to be ongoing and central to increasing site awareness of energy issues and continuing the development and implementation of new energy efficiency initiatives. [See Appendix 1]

> ***"What I really like about this training program is that it is putting in place systems and structures that can be applied to any aspect of our business. The bonus this time is that we are winning with energy"***
> **Paul Kassebaum, Manager/Winemaker, Hardy Wine Company (Berri)**

Two companies have participated in the BPPP program—Hardy Wine Company at Berri and Stonehaven; and Southcorp at Karadoc. The Energy Management Teams at these sites have developed a strong understanding of the potential for energy efficiency in their wineries, implemented a number of trials and are achieving significant gains in efficiency, plant capacity and cost savings. [See Part 3]

Structure of the Guide

FORMAT

Key	Description
◗	Indicates best practice consideration
■	Indicates important point
Boxes	Boxes cover details of different initiatives undertaken by wineries through their involvement in the Wineries of the Future Project. These Boxes are distributed throughout Part 3 and Part 4 to demonstrate how different wineries are addressing energy efficiency and energy management issues in their particular situations. While the situation in your winery may be different from that described, the experience and approach of different wineries to specific issues can offer a useful guide and be a source of ideas for action.

1 Energy management and innovation

Innovation in response to competition, environmental pressures and increasing costs of energy

The Australian wine industry has a long history of innovation. For over 150 years this prospering industry has created new ways and locations to make quality wine. It has developed a world class reputation for successfully producing a large selection of wine styles from a wide variety of grape cultivars, using many winemaking methods, satisfying different markets from the boutique to the supermarket at home and abroad. This strength has been achieved through the construction of wineries throughout the nation, with crushing capacities of just a few tonnes to major operations with an annual tonnage of over 100,000.

During this long period innovation has been directed primarily at the multiple challenges of improving wine quality while expanding production capacity, developing new wine producing sites and the diversification of wine style, brands and markets. While many of these familiar challenges will exist into the future, the wine industry must respond to:

- Strong market competition based on quality, costs of production and environmental performance
- Government and community pressure for measuring and reducing impact on the environment
- Increasing cost of energy, water resources, waste disposal and treatment
- Significant changes to energy pricing and energy supply arrangements
- Limits to growth created by diminishing supplies of clean and fresh water resources

> ***'The Australian wine industry's current success is, to a large extent, built on the technical ability to respond to the world's consumers' sentiments and deliver products at a superior quality/price ratio, presented in consumer friendly packaging. In other words, Australia's approach has been to listen to the consumer's desires and strive to meet those through application of innovation.'***
>
> **The Australian Wine Industry—Success Through Innovation**
> **A paper prepared by an independent working group for consideration by the Prime Minister's Science, Engineering and Innovation Council at its fourth meeting, November 1999.**

What is energy management about?

Good energy management enables businesses proactively to:

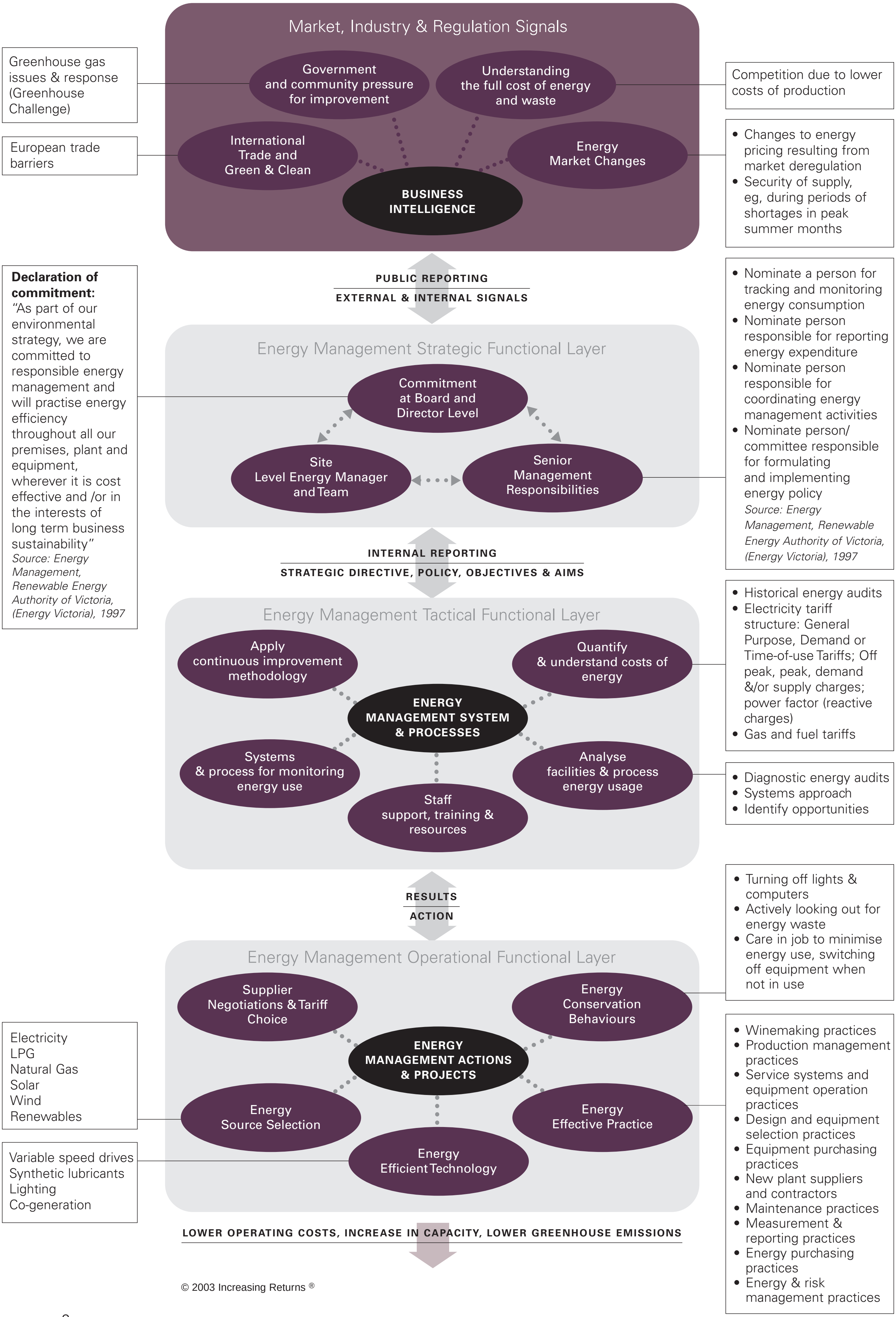
- reduce energy consumption
- reduce expenditure on energy (especially peak period pricing)
- reduce energy-related greenhouse emissions
- alleviate overloaded electrical transformers and circuits, or refrigeration and other service equipment
- shift to energy sources with a low environmental impact
- shift to energy sourced from high efficiency systems (such as combined heat and power systems/cogeneration), thereby increasing security of supply
- ensure energy is available when you need it

Energy is a variable cost, not an overhead

Best practice energy management is about knowing and understanding

- the impacts of energy costs to the bottom line
- how energy is used in your business
- ways to reduce energy consumption, purchase price and greenhouse gas emissions

Cross-Functional Energy Management



From market signals to energy management at the organisation's key functional layers

Successful energy management and energy efficiency improvement result from building a cross-functional approach that enables the organisation to respond to external market, industry and regulation signals of change. The chart on the left highlights the major elements of energy management and shows how the strategic, tactical and operational functional layers of the organisation could work together to create an integrated approach to effectively respond to external signals and improve energy consumption performance. This chart is designed to assist companies understand, organise and communicate energy management to engage people at all levels in the organisation.

Evaluation of energy management activities at the strategic, tactical & operational layers

The following chart identifies a list of possible indicators for outputs, outcomes and impacts at the strategic, tactical and operational layers. These indicators can act as goals to guide implementation and provide measures to evaluate the success of energy management implementation. This list is not definitive and should only be used to stimulate the creation of a set of company specific indicators.

Strategic/Tactical/Operational Layers

Layer	Output	Outcome	Impact (Objective)
Strategic	• Strategic directive • Company and site policy • Energy management program objectives and aim • Company and/or site energy manager engaged or responsibility allocated to existing person • Resources committed • Training and staff development plans	• Development & implementation of energy management systems and processes • Reduction in energy consumption per unit of product • Reduction in energy expenditure per unit of product • Reduction in greenhouse gas emissions per unit of product • Increase in production capacity, efficiency, with overall reduction in production costs • Individual job satisfaction	• Increase profits • Maximise returns for shareholders • Achieve Greenhouse Challenge targets • Build image as environmentally responsible wine producer • Increase organisational performance
Tactical	• Communicate message and plan • Identify behaviour, practices and technology opportunities • Staff support, training and resources • Company and site energy monitoring and reporting system	• Increased understanding by company and site personnel • Increased staff capacity to achieve best practice energy efficiency	• Reduce cost of energy • Reduce greenhouse emissions
Operational	• Communicate with energy supplier to achieve best tariff rate structure • Identify energy efficiency opportunities • Promote energy conservation behaviours • Establish agreements, policy and procedures on best practice winemaking and process/plant operations • Install new energy efficient technology • Implement process and plant control systems to optimise efficiency and low tariff operation	• Lower energy bills • Lower emissions • Reduced peak demand • Reduced loads on internal utility systems • Reduced load • Flatten load profile • Reduced energy consumption • Reduced peak period electricity consumption • Obtain more favourable energy rates	• Avoid capital costs of increasing capacity of utility system • Increase communication and cross-functional team interaction

Business case for energy efficiency and energy management in wineries

Based on the demonstrated improvements achieved by participating wineries in the Wineries of the Future Project, there is the potential to reduce energy expenditure by 15–30% or more, while gaining the benefits of reduced greenhouse emissions and productivity enhancements. The larger savings are more likely to be captured in parallel with investment in new plant or major re-fits.

From a business perspective companies have a lot to gain or lose, in terms of energy management, at the design and equipment selection stage. Incorporating energy management into decision-making at this early stage provides the best opportunity to gain by reducing costs of production and environmental impact while improving production performance.

Business loses when energy management is absent or fails. For example, during the decision to install an electric motor any number of bad practice choices could be made:

- installing a motor purely on the basis that it can be sourced quickly and fits the space available, without consideration of operating load requirements and energy efficient options
- selecting the cheapest available motor without considering lifetime running costs
- ignoring the efficiency of the equipment the motor drives could mean paying for a larger motor than is needed, as well as for its ongoing higher running cost

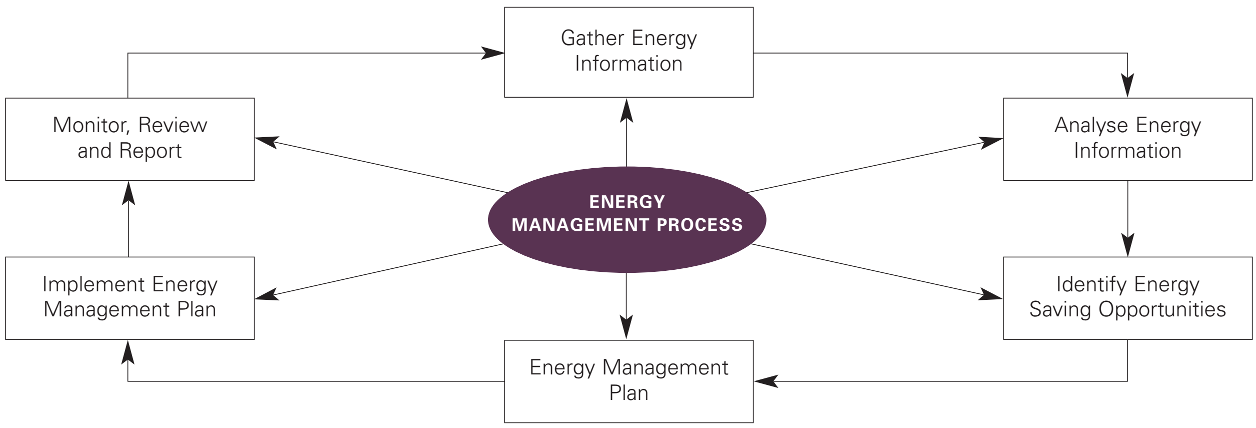
Such decisions can result in a higher energy-consuming winery that costs more to operate, produces more environmental impact from emissions and is likely to have higher maintenance costs. And from an investment perspective, the winery has made an unnecessarily costly capital purchase.

The energy management process

This diagram outlines the key parts of an energy management process and is modeled on the PDCA (Plan, Do, Check, Act) approach commonly used in continuous improvement initiatives. Experience from the Wineries of the Future project indicates that a key step is the gathering of energy information. [See Part 3, Box 2: Initiative to improve access to energy data]

But this does not necessarily mean conducting a comprehensive energy audit of the whole site, which can be costly and time-consuming. It involves collecting enough information about the processes or areas of the plant that the Energy Management Team has agreed to target. As shown in this diagram, ongoing processes are needed. For example, in the first cycle it may be found that there is insufficient metering in place to provide the right information for effective energy management, so metering can be installed. But observations may still allow energy saving measures to be identified that can be implemented immediately.

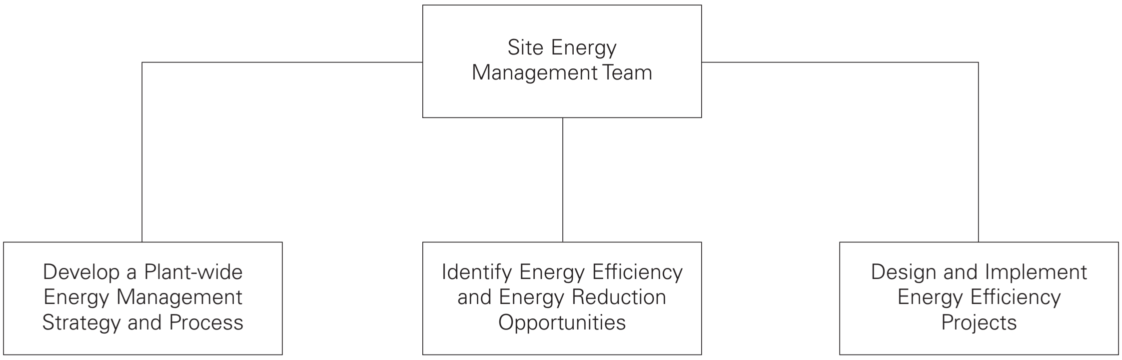
Energy Management Process



The cross-disciplinary Energy Management Team approach

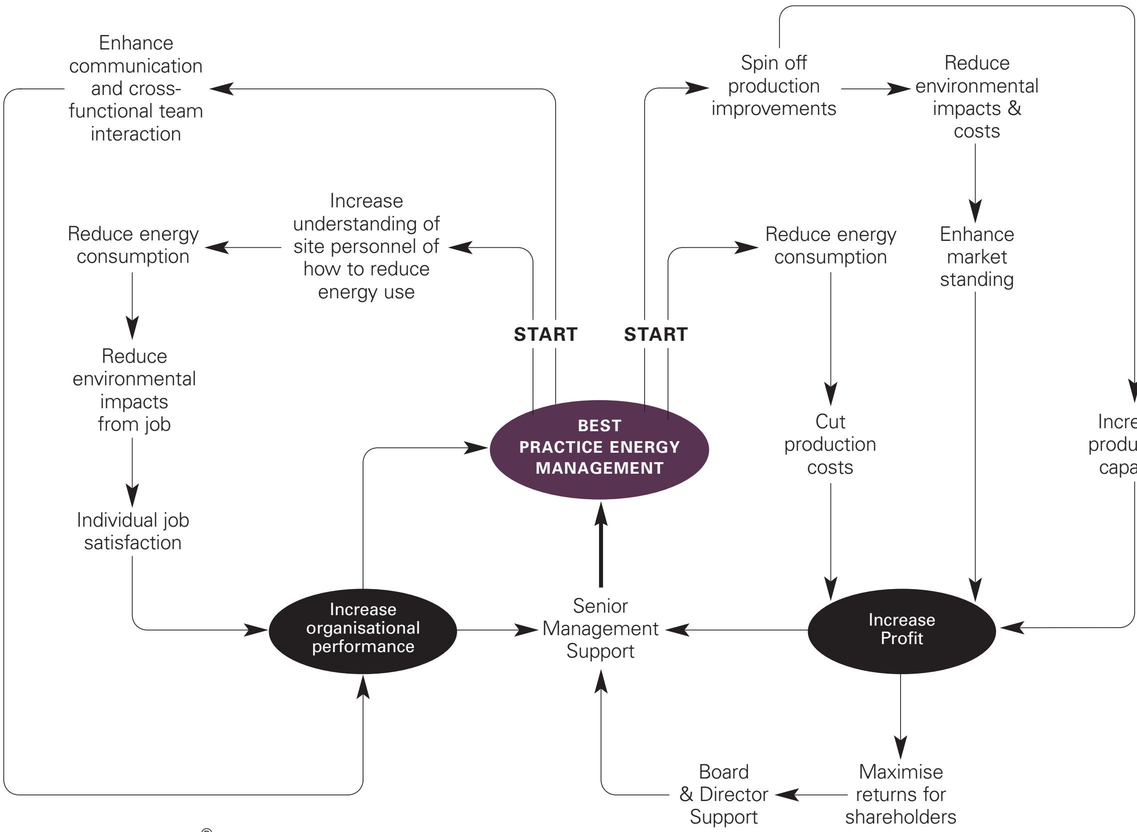
Energy management is best addressed using a cross-functional team-based approach. This approach is essential in larger organisations where knowledge of and responsibility for different systems related to energy consumption is dispersed. The larger the organisation, the greater the importance of communication, stakeholder engagement and cross-functional teams become. In smaller organisations or winery operations, it is often possible to involve the key functional personnel from management to operations and maintenance in the core energy management team.

Site-wide Energy Management Teams have included personnel from all aspects of the winery—winemaking, winery engineering, maintenance, cellar store, environmental management, human resources, management, [See Appendix 1] Setting up such a team means there is an ongoing framework in place that will not collapse if one key person leaves the site. It also underpins ongoing energy action: in today's changing environment, it is not possible to 'fix' energy at one time—a long term strategy is essential.



This diagram describes how implementing best practice energy management in wineries can lead to a flow-on effect with the potential to increase organisational performance and profits.

Energy Management Positive Feedback Snowball Effect



Energy consumption, costs and emissions distribution comparisons

The major energy use in wineries is electricity, with the remainder derived from the combustion of fossil fuels (natural gas, LPG and diesel) used primarily in boilers for heating requirements, forklifts and fuel-fired engines running generators or compressors.

The major energy-using process in a winery is refrigeration due to the importance of operating at temperatures well below climatic temperatures to ensure product quality, reducing product to low temperatures for cold settling and removing the heat produced by fermentation. Electrical power consumption in the winemaking process can be roughly broken into the following end uses:

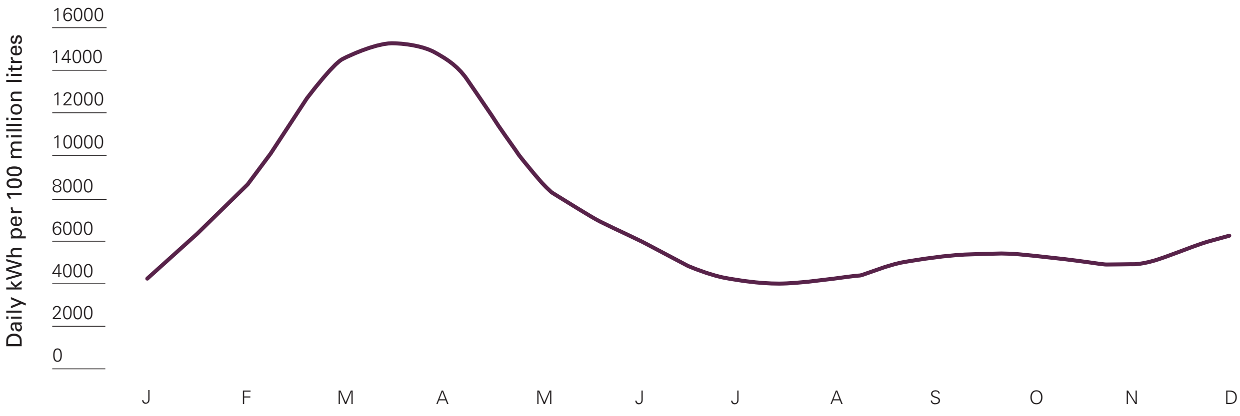
- 40–60% refrigeration
- 10–35% pumps, fans and drives
- 8–20% lighting
- 3–10% compressed air
- 3–15% other (including de-steamers, presses, rotary drum vacuum, high pressure cleaners, battery operated forklifts, package heating and cooling units)
- 8–30% packaging and bottling (including pumps, compressed air, machinery such as fillers, conveyors, labellers, packers and glue melters)

Current practice in wineries is to consume natural gas, where available, for large heating requirements. Due to the relative remoteness of many wineries from fixed gas pipelines, however, LPG (which is much more expensive) is often supplied by tankers. Typical consumption figures for gas fuels depend primarily on the amount of hot water or steam required for process heating; in some cases cleaning and for other requirements that occur on site. Gas fuels may also be used to power combustion engines to drive electricity generation or compressors directly.

While diesel fuel fired engines can also be used in place of gas, their application is usually reserved for backup use in case of electricity restrictions and blackouts.

Availability of the fuel source and risk avoidance against lost or restricted electricity supply, therefore, drives current winery practice in terms of fuel use and use of combustion engines to drive electricity generation or compressors directly.

The breakdown between electricity and natural gas/LPG consumption and associated emissions varies considerably between sites. This variation in relative energy mix for different sites is not expected to change in the near future; however, significant changes to electricity pricing and recent large increases in LPG prices can be expected to begin influencing energy supply decisions by wineries.



Typical yearly variation of electricity consumption

Greenhouse emissions in wineries

In addition to greenhouse emissions produced by the consumption of energy, there are a number of other sources, including direct emissions from fermentation, CO_2 venting, waste and waste-water treatment. Current greenhouse emissions for a medium to large winery typically have the following distribution:

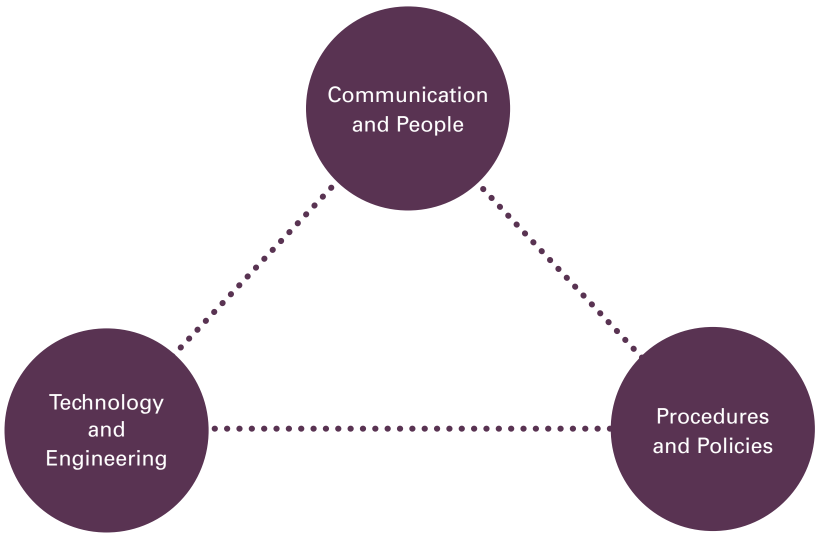
• Electricity consumption	60–75%
• Natural gas	2–5%
• LPG consumption	10–15%
• Direct emissions (fermentation)	10–15%
• Direct emissions (CO_2 venting)	1–6%
• Waste-related emissions	2–12%

From this distribution it is clear that the greatest potential for minimising greenhouse emissions from a winery is through the reduction of energy consumption, especially electrical energy consumption. Further, the emissions from fermentation are generally considered to be offset by the take-up of CO_2 as the vines grow and produce fruit.

2 Achieving best practice and innovation: approaches to optimise existing winery operations, new wineries and major upgrades

Best practice must be strategic in its approach. Three interdependent elements make up the Best Practice Energy Efficiency strategic approach:

- Technology/engineering design and application—the use of new technologies and structured engineering problem-solving to achieve improvements in the way a plant/site uses energy
- Communication with people—making improvement sustainable and on-going requires the involvement of people, which in turn demands effective communication with stakeholders (everyone who will be affected, either positively or negatively, by the development of an energy management strategy) and the engagement of employees at all levels
- Policy/procedural linkages—using internal policy, delegations, accountabilities, rules and procedures to ensure that energy efficiency becomes a part of the way the company does business



Defining winery best practice

Many approaches are used to develop realistic comparisons for assessing winery design, operation and performance against recognised best practice.

Like many manufacturing industries, especially those new to the practice of benchmarking their facilities, the wine industry faces the challenge of developing and defining the criteria on which to determine best practice and to compare performance between facilities and their process operations.

In some ways, the wine industry is quite different to industries such as glass, paper and plastic manufacturing which produce products with well-determined quality characteristics at the cheapest rate. The wine industry uses a diverse variety of processing methods to obtain certain quality characteristics depending on the particular style of wine sought. This diversity of methods in winemaking is a critical character of the wine industry. Best practice in relation to the operation and performance of wineries, therefore, does not mean identifying a single, most efficient process or practice for wine production.

Best practice energy efficiency in wineries involves achieving the desired outcome (in terms of quality and quantity of wine) using the least amount of energy at lowest overall cost.

Understanding energy performance

Variation between wineries makes it particularly difficult to compare figures for a 'high level' measure such as the amount of energy consumed and cost per unit of wine produced. Energy consumption and efficiency can vary widely between wineries due to a number of factors, including

- large variation in crush tonnages—from under 50 tonnes to over 100,000 tonnes—leading to differences in equipment design and economies of scale
- winery age, layout and geographical location
- type and volume of wines produced (production split of red, white, sparkling, premium and commercial wine, wine yield from crush, choice of winemaking method)
- use of centrifuges and/or cold settling for different products
- importation of juice or must from grapes crushed and partly processed off-site, or vice- versa
- type of facility and on-site activities, including:
  - winemaking, cellars and barrel stores
  - bottling, packaging and storage
  - engineering and maintenance workshops
  - administration, sales and marketing
  - water and waste-water treatment
  - cellar door sales, tasting, restaurants and café
  - vineyard

Specific energy consumption (kWh/litre of wine), energy costs/litre and energy emissions/litre are important site benchmarks or key indicators for monitoring energy efficiency improvement. Such benchmarks are best applied locally within a plant to compare efficiency over time, rather than with other operations. Where a company owns multiple sites and is able to make detailed analysis to account for the difference in variations between its sites, it may be possible to make a useful comparison of energy performance benchmarks.

To overcome the difficulty of making 'high level' comparisons that do not consider the wide variations in production operations, determining best practice and benchmarking in the wine industry must occur at the process and sub-process level. Benchmarking and comparison with best practice at these levels involves a detailed assessment of:

- the relative performance of individual process and ancillary equipment; and
- how effectively these individual processes and equipment are integrated with others to deliver overall efficiency.

Benefits of best practice performance indicators and targets for wineries

Defining best practice in wineries offers the industry a valuable tool for improving competitiveness in international markets; enhancing environmental performance; and increasing efficiency and hence capacity of Australian wineries. While examples of best practice can be found on a site-by-site basis, they are generally not company-wide.
A comprehensive energy management program is the first step to implementing company-wide technical, operations and management best practice actions

Best possible practice and best existing practice are usually very different. Best possible provides a much better driver of energy efficiency strategy by creating 'stretch goals'. In working out how to achieve these goals, people may identify radically different solutions, recognising that marginal improvement is unlikely to get them there.

Innovation approach to improving performance

The wide variation in winery sizes and production operations create a wide range of technologies, production plant configurations, end-use energy requirements and operating practices. As a result, many different ways to improve energy efficiency and to identify improvement opportunities are possible. Advocating a **single** practice as being the best for all wineries would be difficult. With this said, however, there are a range of **practices, technologies and behaviours** with the potential to be broadly applied. Some of these are highlighted in Part 3 of this Guide. What is outlined and advocated in this Guide is an **approach** to best energy efficient winemaking practice, winery production technology and staff behaviours for a particular site.

At the core of **Energy Efficiency Best Practice** is the **systems approach**—considering both the energy supply and energy loads within the winery and how they interact, essentially shifting the focus from individual components to performance of the total system. In general, the systems approach provides the most effective way to achieve large gains in performance and optimise production systems. Focusing on making sure the end-use requirement for cooling or other process energy needs are met by the equipment, it is possible to overlook the broader implication of how critical system parameters affect winery equipment performance and energy consumption.

Critical production system parameters for daily operation of a winery include

- Winemaking methods and practices
- Winemaking process conditions (temperatures, cooling rates)
- Operating practices and winemaking process control (micro-control to tenths of a degree)
- Production management practices
- Plant control routines and management
- Maintenance and facilities management practices

Best practice energy efficiency uses a systems approach to consider the effects operating parameters have on overall winery performance and on individual performance of major plant and component equipment. This approach makes it possible to improve the performance of the entire system to achieve the goal of a quality product, while determining how the processing energy demands can be most effectively and efficiently supplied. A systems approach also recognises that system efficiency, system reliability and performance are closely related.

Systems optimisation from daily operation to new wineries and upgrades

Energy Efficiency Best Practice is at its core about optimisation—optimising the entire winery system to produce the required quality of wine with a minimum of inputs and waste outputs. In line with the systems approach, best practice energy efficiency can be achieved by considering the interaction between the critical parameters affecting plant operation (outlined above). Note than additional winery system parameters become relevant for new wineries, expansions and upgrades:

- Design and selection—buildings, product processing systems, ancillary systems and component equipment
- Site layout—buildings, production operations, plant and equipment
- Site characteristics—climatic, geological, topographical, geothermal, hydro-geological and environmental characteristics

The most significant cost savings are possible when best practice energy efficiency measures are included from the ground up, during winery design and construction.

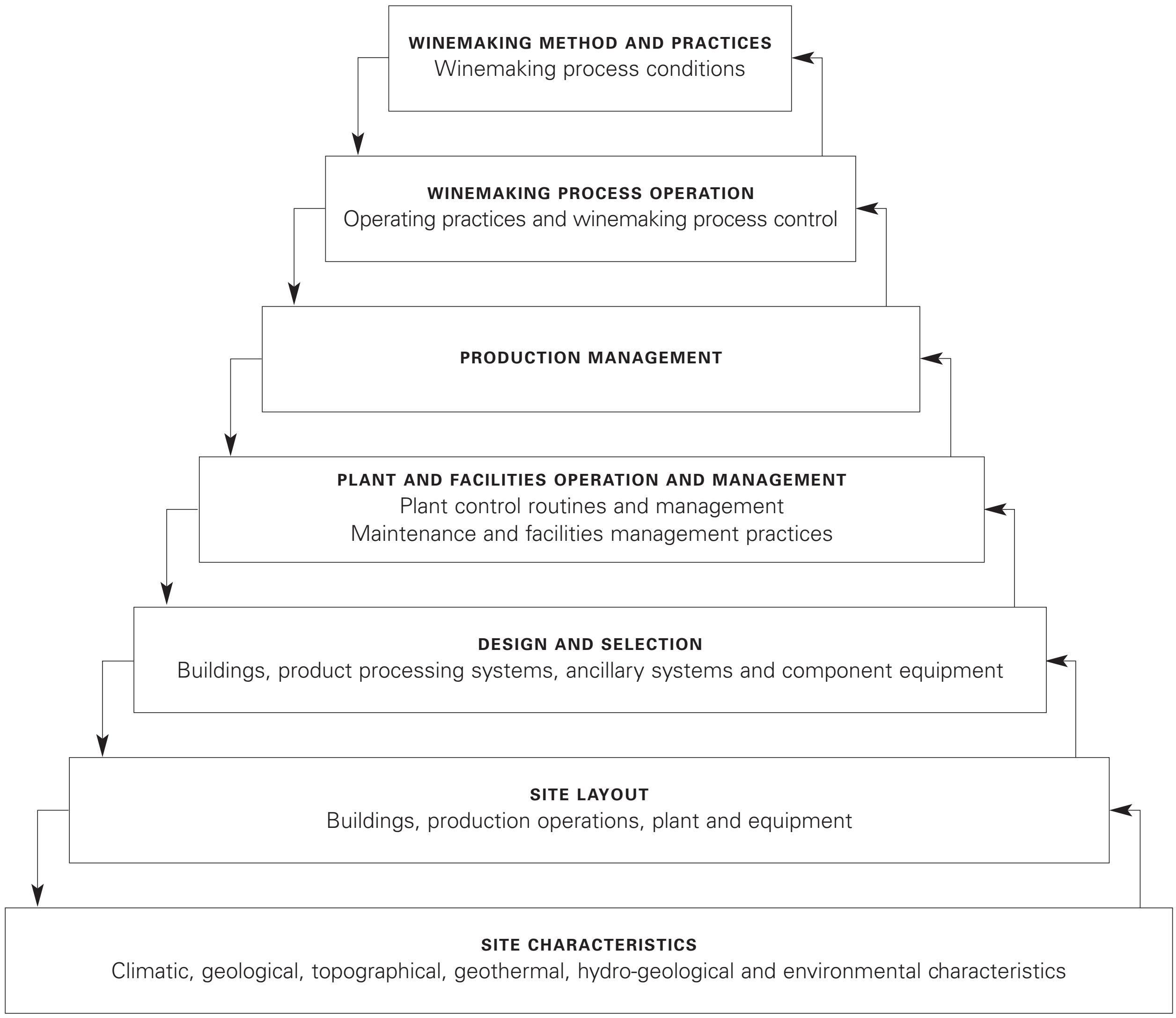
Best practice optimisation and production improvement perspective

To gain the best perspective on approaching winery optimisation and production improvement, it may help to break down the elements involved into a set of *ideal systems.* Each *ideal system* defines a specific set of parameters influencing best practice winery operation and design. The systems approach attempts to understand how conditions in each system influence connected systems and to determine which practices in each system lead to best winery performance. The main value of this definition is to facilitate thinking and interaction among the different stakeholders involved in decision-making at different levels of the system.

Best practice optimisation and production improvement perspective

This particular hierarchy can be viewed from two perspectives:

demand and supply or optimisation and production improvement.



From a demand and supply perspective, the purpose of the system below would be to supply the platform and satisfy whatever demand the system above it requires in order to function. This perspective on its own does not take into consideration the feedback effect that demand (or load) at one system level creates on those systems below. An example of this approach would be to say that the refrigeration system must be designed to meet whatever demand is required by the production process.

From an optimisation and production improvement perspective, the system approach considers the different interactions and feedbacks within and between the systems. For example, the production process may be designed to reduce load on the refrigeration system at times of high demand or when ambient conditions lessen its efficiency, but to increase load under some other conditions.

Using a best practice systems approach to performance improvement, people seek to understand how the functional requirements or operation of the system at one level can be adapted to reduce the pressures on the supply systems. For example, winemakers might decide to allow overnight chilling of stored wine, knowing that refrigeration plant operation during cool night temperatures and at off-peak electricity rates is more energy efficient and more cost effective. This approach lies at the core of the BEP/BPPP process.

3 Best practice considerations and initiatives

Contents

Introduction

Many of the energy-efficiency and cost-saving opportunities identified in this Guide emerged from a series of workshops involving some of Australia's leading wine companies, research organisations and equipment suppliers —

- Big Energy Project Innovation Workshop on Refrigeration (Beringer Blass Wine Estates, Hardy Wine Company, Orlando Wyndham Group and Southcorp Wines)
- Big Energy Project Innovation Workshop on Winery Design (Yalumba Wine Company)
- Best Practice People and Processes Workshops (Hardy Wine Company's Berri and Stonehaven sites and Southcorp's Karadoc site)

Workshop participants were encouraged to think laterally about how they manage energy and about the methods they use to heat and cool grapes, juice, wine and water. Instead of simply looking at winemaking as a linear process, they looked across the winery to consider the large number of energy-intensive heating and cooling applications occurring simultaneously, especially during vintage. Participants identified a number of production management and operational efficiency solutions with the potential to achieve relatively large percentage savings almost immediately at little or no capital cost. They then went on to identify and trial a number of other opportunities with the potential for significant energy and subsequent greenhouse gas emission savings.

The primary goal of this Guide is to communicate the opportunities generated during these workshops and the subsequent work undertaken by Energy Management Teams and other personnel at the participating wineries.

Structure

This section is organised into Best Practice Considerations under Issues or Opportunities in two key areas of winery operation and design:

- Understanding and managing energy supply and monitoring
- Understanding and managing technologies, processes and procedures

Understanding and managing energy supply and monitoring

Understanding the energy billing structure and unit costs of energy

Since electricity is the largest monthly energy cost, it is important to understand how it is billed and what effect certain strategies will provide in terms of cost, energy and greenhouse savings. Best practice in this area can lead to a decrease in the monthly electricity bill by 15–20% by decreasing the demand cost while continuing to consume the same amount of electricity.

- Depending on the energy supply contract, the cost of electricity is charged to wineries using different cost components. Supply charges are based on the following components:
  - consumption (kWh)—the total quantity of electricity used over the period
  - demand (kW or kVA)—the 15-minute or 30-minute period in a month or year when the rate of electricity use is at its highest at each utility meter. Demand in kilowatts is a measure of the real power used, while demand in kilovolt-amps (kVA) reflects the apparent power (see below).
  - power factor [also called reactive charge or Apparent Power (kVA)]—power factor (PF) is a measure of the extent to which the alternating current is forced out of phase from the alternating voltage. A PF of 1 means both are perfectly in phase. A PF of 0.7 means they are well out of phase. The lower the power factor, the greater the losses in power lines and wiring.
  - standing charges—fixed charges levied each month per utility meter installed or per site
- Wineries that have negotiated a unit price for supplied energy on the basis of a certain minimum level of expected consumption need to consider the possibility of being penalized for reducing energy consumption through energy efficiency to below the minimum contracted consumption quantity. It should be possible to avoid this situation through negotiation with the supplier.
- Best practice can focus on reducing electricity consumption, demand, power factor or a combination.

Electricity Bills

Depending on the size of the winery and supplier contract, electrical energy bills can be based on either:

General Purpose Tariffs	Demand Tariffs	Time-of-use Tariffs (Off-Peak & Peak)
• Most small wineries will be on this tariff. They pay for electrical energy consumed in kWh; usually the more electricity used the cheaper it becomes per kWh. Using more energy, however, does not save the business money. • Wineries that consume a large portion of electrical energy between the hours of 9pm and 7am (Monday to Friday) and on weekends, may qualify for Off-Peak or Time of use Tariffs.	• Electricity charges are partly based on the monthly or annual maximum demand (peak demand) for electricity, either in kW or kVA (see above). • Demand tariffs only become relevant for larger consumers of electricity • In wineries where Demand Tariffs are applied, a best practice approach to reducing electricity energy costs considers changes that reduce peak demands and improve Power Factor.	• Electrical energy is based on Off-Peak and Peak rates, depending on the time of day or day of the week when electricity is consumed. • Shifting energy consumption to Off-Peak times is one of the easiest ways to reduce electrical energy costs.

- Many contracts include a monthly charge based on the annual peak demand, in which case a winery can pay a higher rate all year for a 15 or 30 minute demand peak. This is a very important issue for wineries, which usually have a high demand for one or two months of the year. In this situation, the impact of power spikes in the peak month(s) will flow across the year. Peak demand charges may be applied to each utility meter, so how the load is distributed around the site can also be an issue. Some retailers charge for demand in kVA, which incorporates a price for a poor power factor.
- An underlying peak demand issue for a winery arises where refrigeration plant is running hard at high ambient temperatures when efficiency is low, then adding to that with transient loads such as starting and stopping motors, etc.
- ■ Begin a practice of monitoring and minimising electrical demand. Seek to understand the equipment that is running during the peak demand period identified on your bills.

- Produce the following table to determine average unit electrical energy cost and average demand cost each month:

Month	Consumption—kWh	Cost ($)	Peak Demand—kW	Cost ($)
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				

Average unit energy cost = $_______ per kWh

Average demand cost each month = $_______ per kW per month of peak demand

- Produce a similar table for Natural Gas and/or LPG to determine average unit energy costs = $_______ per GJ for Natural Gas and $______ per litre for LPG. This table will only require three columns for month, consumption and cost.

Month	Consumption—kWh	Cost ($)
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

Fuel or energy source selection

Saving energy can make a shift towards energy with low emissions from renewable sources, including wind, solar, biogas or natural gas more viable.

- Obtaining unit costs of energy from your suppliers is a necessary step in determining the savings involved when switching from one energy source to another.
- Another decision-making factor is the amount of greenhouse emissions released from different energy sources.

Electricity price changes

- Consider feasibility of on-site electricity generation and/or gas engine drives, particularly for equipment that works hard during times of peak electricity demand if demand peak price rises occur or to mitigate energy supply loss.
- Consider standby generators for 'peak lopping'; that is, operating them during peak periods to reduce peak demand from the electrical supply system. The benefits will be seen in lower peak demand charges. Electricity retailers may recognise the value of this by establishing arrangements whereby a winery may be paid if it is prepared to reduce demand at times specified by the retailer.

Energy supply & monitoring	
Issue or opportunity	Best practice consideration
Power Factor Penalties & Savings	■ Power Factor correction increases in importance if a kVA tariff is introduced. A lower Power Factor will increase demand charges (see 'Understanding and managing energy supply and monitoring' above). Eg, if a winery uses 10 kW at a Power Factor of 1.0, its apparent power usage will still be 10 kVA. But if the Power Factor is 0.8, its apparent power will be 12.5 kVA (10/0.8) and if it is paying a kVA-based price, its peak demand charge would increase by 25%. ■ Variable Speed Drives are useful technologies for managing voltage and Power Factor, as well as for limiting peak demand spikes.
Temperature-based electricity tariffs	■ Electricity distributors are moving to time and temperature-based tariffs in summer. Eg, one electricity retailer has increased tariffs between 3–6 pm during the hotter months. The idea is to have the pricing reflect the cost of providing marginal electricity during times of expected peak system demand. This is intended to influence the use of temperature dependent loads such as air conditioner and refrigeration use.
Energy audits and facility evaluation	Historical energy audit ■ Use normally available accounting and production records to show where, when and what source of energy is being consumed by the winery (Electricity, LPG, Natural Gas, Fuel Oil etc.): 1. identify the quantity and cost of the different energy sources used by the winery, based on at least two years of billing and production history 2. identify energy consumption at the departmental and process level 3. relate energy input to production output 4. develop an energy consumption profile for the winery showing the monthly variation in energy consumption over the year. [Comparison of year-to-year variations (taking into account weather and production variations) can also provide useful insights. Your electricity retailer may be able to supply daily load profiles, and you should investigate sample days to identify what loads are most likely to be contributing to peak demand on each utility meter.] See Box 1: Initiatives to understand energy consumption and reduce cost Diagnostic energy audit ■ Provides a technical analysis of an individual component, group of components or a process and is used to identify the amount of energy expended by a certain machine, portion of a process or total process. This is best done using local metering, but estimates are a useful starting point. ■ Useful reference — Rutgers, *A Self-Assessment Workbook for Small Manufactures* (A 'best practice' manual, Office of Industrial Productivity and Energy Assessment, The State University of New Jersey)
Cable sizing	■ Cable sizing should be based on resistive losses, not on the cable's thermal rating. This is most important for long runs. The extra cost of larger copper sections should be compared to the resistive losses for thinner cable. At many sites, 5% of electricity is lost in wiring.
LV or HV	■ The largest winery sites may benefit from sourcing electricity at high voltage. Note that responsibility for the transformer and switchgear then resides with the winery, not the electricity company.
Standby power generation	■ When using standby power generation, consider power outage when switching between power sources. One method of improving changeover is to have large loads drop out quickly and then come back on when the backup plant is on line. Standby power generation capacity can be used for peak demand lopping during the periods of highest electrical demand.

Box 1: Initiatives to understand energy consumption and reduce costs

COMPANY: Southcorp
SITE: Karadoc—Lindemans Winery, Murray-Darling Region

▼ Investigate, audit and review energy use and efficiency opportunities

- Establish the current operational performance or baseline operating conditions for energy use from suppliers' bills and electricity distribution meters to provide load profile information and set a baseline to evaluate the impact of efficiency measures. For process and equipment, including:
  — Centrifuge area
  — Vinomatics
  — East and west tank farm (Agitators, cellar pumps, lighting)
  — Crushing area
  — Administrative area
  - *Gas fired engines.* Investigate the use of gas fired engine to drive ammonia refrigeration compressors for its potential to:
    — reduce CO_2 through a fuel shift, by using natural gas instead of electricity
    — provide waste heat for recovery and production of hot water
    — reduce peak demand, which can result in electricity cost reductions depending on supplier tariffs and contract.
  - *Audit and review of refrigeration plant.* Evaluate refrigeration performance and rewrite compressor sequencing control algorithm.
  - *Heat recovery from refrigeration plant.* Placement of a de-superheater on ammonia compressor discharge line.

▼ Switch to high voltage electricity supply

Winery staff and a consulting firm have assessed cost savings by changing to high voltage supply.
— Budget costing from the energy supply company indicates a capital cost of around $450,000.
— Karadoc would purchase the assets and be responsible for operation and maintenance.
— Under a new energy supply agreement Karadoc would take supply at high voltage through a single meter and benefit from reduced demand (network) charges and a high voltage discount.
— Although the project requires further analysis before proceeding, savings in electricity contracts by a change to HV supply is estimated to be in excess of $240,000 per annum.

▼ Determine energy use and demand spike for process equipment (Westfalia SC150 Centrifuge)

This measurement initiative determined the demand spike generated during start up and energy consumed by an SC150 Centrifuge:
— To start and achieve run status ready for product
— Running while waiting for product and energy use while separating product.

The trial found that on start the centrifuge took 13 minutes to reach operating speed and consumed a total of 9kWh of energy. The demand spike generated during start up (measured over a 30-minute interval) was 36.6kW. When the machine is running and not on product it uses 22.2kW with a power factor of 0.59. When determining when to turn the centrifuge off when no product is available, several factors need to be considered.

1. A demand spike of 36.6 kW created during start up which can affect the site's contracted demand. Careful production management, equipment control and communication with operators are required to ensure 2 or 3 machines are not started at once.
2. The centrifuge taking around 2 hrs to run down when turned off.
3. The mechanical stress and electrical stress created during start up.

In discussions with the manufacturer's service technicians, a minimum time of 3 hours without product would be considered best practice before a machine was shut down. Note: the machine can be restarted at any time during run-down.

COMPANY: Orlando Wyndham
SITE: Rowland Flat and Richmond Grove Sites, Barossa Region

▼ Power Factor Correction

Early audit results for Power Factor Correction indicate insufficient return on investment for retro-fitting PFC (power factor correction) for most switch-boards. One major board has been fitted with PFC in order to defer a major transformer upgrade. This has resulted in significant cash flow benefits ensuing from the deferral of capital investment.

Install metering devices

The installation of a range of metering devices and data collection systems is an essential first step in monitoring and understanding energy usage across the site. While it is possible for obvious inefficiencies to be identified and improved without detailed metering data, it is often difficult to obtain resourcing for projects without data.

Energy use data is critical for quantifying the cost of the energy being wasted and the potential payback of the improvement. In more complex situations, energy use data is essential to understanding best practice for operating the equipment or influencing processing parameters. Without suitable metering the sites will have to rely on estimates to determine the breakdown of energy use across the site and the efficiency of equipment performance.

Site electricity metering can range from a "Smartmeter" to allow generation of load profiles to a site-wide SCADA system allowing real time tracking and report generation for a range of indicators. Best practice in relation to meters in wineries is constrained by costs of implementation and return on investment. In general, the more complex or larger the winery, the more benefit can be gained from better availability of performance and operating data. It is important to remember that data generation and collection is only the first step. The next step requires analysis to understand what the data means and how it can be used to improve performance and efficiency; more data does not naturally lead to improvements. Data must be converted into useful information, and management systems require the knowledge of what to do with the information before the benefits of data gathering are able to be realised.

The extent of metering can range from:

- single, whole-of-site meters (billing meters already exist); or several utility meters across the site (note that some electricity retailers bill for separate demand charges on each meter, and that consolidation of meters can save money)
- metering of production areas
- metering of production processes
- metering of key energy-using pieces of plant
- individual items of equipment in the production process and ancillary support systems
- use of portable metering for indicative data

Some indicative costs for the installation of meters or collection of data are shown below:

- Electricity (Smartmeter): $1,500
- Electricity (kWh meter): $1000–1500
- Water (flow meter): $2000
- Compressed air (flow meter): $2,500–$3,000
- Steam (flow meter): $4000–5000
- Temperature (probe): $600–800
- Light meter (hand held): $200–300
- SCADA systems: $50,000–100,000 for a small number of points; for a more comprehensive system, costs can reach hundreds of thousands of dollars
- One-off testing: $2,000–3,000 for the purchase of a data logger or approximately $400 per week for hire

  Alternatively, an energy engineer can be engaged to perform the data logging for approximately $250 per item of equipment. Note that in many cases, measurement of material flow rates as well as electricity use is needed to estimate efficiency of equipment.

Box 2: Initiative to improve access to energy data

COMPANY: Hardy Wine Company
SITE: Stonehaven Winery, Padthaway Region

▼ Upgrade data presentation software to provide energy monitoring information

Stonehaven have implemented a project to upgrade their data presentation software to overcome the practical challenge of effectively accessing recorded data to conduct energy use analysis and evaluate energy improvement strategies. This project will not lead to direct energy savings, but will provide an important data presentation and analytical support tool to plant operators. Through the application of this tool, plant operators and the Energy Management Team will be more able to implement energy efficiency initiatives that reduce energy consumption, operating costs and improve performance. In the process of determining what software changes should be made, site staff involved in the project have developed a greater understanding of how they can assess energy use.

- The data presentation software system is a graphical interface program and data management package. This software is used to access data recorded and monitored via the CITEC system. Everyday, thousands of data points are recorded from across the site and stored on site or at a central data warehousing location.

Background

Prior to the Energy Efficiency Best Practice project, the only power monitoring involved the monthly collation of power data extracted from the energy supplier's invoices. One of the first things we learned during the initial Energy Management Team training sessions was that our site had plenty of ideas of where our energy was being used, but had no firm data to support our hypotheses. The first direct outcome of the Best Practice People and Processes training was the commissioning of the site's software supplier to develop a monthly power report, along the lines of the monthly water report currently prepared for the EPA, using data from the CITEC system.

Outcome

The power reports generated following the software upgrade led to a greater understanding of site power usage and identification of major energy saving opportunities. Cost of implementation for the upgrade was $18k, which generated a payback from energy saving projects leading to a simple payback period of 1 year.

Once the upgrades were completed, the power reports confirmed that the refrigeration plant is the single largest energy user on site; in some months as much as 50% of all site power is consumed by it. This result led to the "Off-Peak Fridge Plant" initiative discussed in Box 4.

The barrel store coolroom (used for premium white fermentation) was identified as the second largest power consumer. When the operating parameters were examined, it turned out that it was set to 3°C when in fact the finished wine inside can be stored safely at a higher temperature. After consultation with the winemaker, the temperature was increased to 10°C, resulting in a reduction of energy consumption equating to roughly $660/month in energy cost savings, or around 5% of the site's annual electricity bill.

Performance monitoring system and KPI reporting program

KPIs (Key Performance Indicators) are used to track critical data related to production. In most cases, these are already in use for issues such as cost per unit of production, volume of waste per unit of production, etc. This approach can be applied to energy efficiency.

Energy efficiency generally involves three data sets that need to be mapped over time:

- energy consumption, emissions and cost, measured in kWh, CO_2 emissions, $, etc.
- service system performance measures which could be based on energy waste, outages, maintenance requirements, base load needs—any sort of measure which allows site staff to understand how a particular part of the energy system under investigation operates over time
- process performance measures which could be based on units/time, operating/down time, maintenance costs, energy/unit—any sort of measure which will establish how the process performs over time

Due to the general lack of detailed energy related performance monitoring in wineries, it is difficult to determine energy intensity (ie, energy consumption per unit of product processed) of specific processes and sub-processes. All wineries, however, should be able to conduct energy monitoring on a site-wide basis by reference to monthly energy bills. This data will enable Energy Management Teams and managers to track overall site performance improvement over time. As metering is improved, more detailed KPIs can be established and tracked.

Energy-monitoring measures include:

- Installing sub-metering to enable an accurate break down of energy loads into work areas, production sub-processes and service systems
- Establishing monthly energy-based KPI reporting and monitoring program to compare winery performance during variation in operation over the year to better understand energy use in relation to winemaking process operations.
- Identifying power consumption per kL of wine moved; balance of peak to off peak power consumption; CO_2 generated per kL of wine moved, processed or bottled

Understanding and managing technologies, processes and procedures

The wine industry uses many processes and systems common across a wide range of manufacturing industries, including:

- heat exchange equipment
- boilers
- refrigeration systems
- compressed air systems
- motors and pumps

While some specific differences do exist in wineries, much information can be obtained on the best technologies, practices and behaviours for reducing energy consumption and costs from many sources. Although the details provided here are specifically relevant to wineries, they should not be viewed as a complete list of winery best practice. Best practice resources from other industries utilising similar technologies and processes may also provide useful information on energy efficiency initiatives.

> A general introduction and details on analysis and best practice for three major sub-systems (Refrigeration; Compressed Air; Steam & Boiler) are available at www.industry.gov.au/energybestpractice

Processes and procedures

Issue or opportunity	Best practice consideration
Good housekeeping	■ Ensure regular repair and maintenance of energy-using equipment. ■ Develop structured service shutdowns (weekends, after work). ■ Implement monthly monitoring of energy accounts (including comparison with past performance).
Communication	■ Streamline management of communication between the production, engineering and maintenance functions to ensure effective implementation of changes and optimisation of operations. ■ Improve communication—eg, make SCADA controls more user-friendly so that operators can understand and use data, and use it to optimise operations.
Reduce energy loads	■ Reduce energy loads to reduce problems due to overloaded electrical transformers and circuits or insufficient refrigeration capacity during peak cooling periods. ■ Reduced energy load can also limit impacts of energy restrictions or high costs of energy imposed by energy supply companies faced with high demand for electricity or natural gas. ■ In the case of insufficient capacity problems *(such as refrigeration)*, energy upgrade or efficiency measures can potentially eliminate the need for significant capital investments in new systems. See Box 4: Refrigeration energy use and plant operation
Flatten load profiles	■ Flat load profiles will usually result in a lower average cost per unit for electricity when negotiating with electrical suppliers under deregulation. ■ Where load profiles spike or are steeply curved, it will generally help in obtaining lower rates if the load profile is flattened by, for example, controlling compressor and centrifuge start-up sequencing and installing variable speed drives (VSD). ■ Where a winery has high electrical demand charges, finding actions that will reduce the electrical load during peak-demand periods should be a priority.

Box 3: Some opportunities for improving energy efficiency towards best practice winery operation

Developed by Hardy Wine Company's Berri site Energy Management Team during involvement in the Wineries of the Future's Best Practice People and Processes program

▼ Establish an Energy Management Team and develop a list of potential energy efficiency projects

Potential energy efficiency projects	Scope	Scale	Impact	Score
Increasing refrigeration efficiency	10	10	10	30
VSD	10	10	6	26
Scheduling of machine & compressor usage to decrease power costs (eg, autocycling)	8	10	7	25
On-site/offsite storage	8	8	7	23
Dedicated cold stabilisation area	6	8	8	22
On-site warehousing to decrease transport	7	8	7	22
Cogeneration	5	8	8	21
Housekeeping, lean practice	7	7	7	21
Insulation of transfer lines	8	5	7	20
Optimise production flow	8	5	7	20
Solar energy usage eg desalination	7	7	5	19
Alternative power sources, eg wine	5	7	7	19
Optimising machine & compressor start/stop & cycles	4	10	4	18
Tank redesign	10	1	7	18
Better control over power peaks	8	8	2	18
Production efficiency measures	6	7	5	18
Lighting (technology, timing, season, natural)	6	6	5	17
Waste reduction, eg packaging	7	7	3	17
Drainage optimisation (recycling excess rain)	7	8	2	17
Supply chain defects/rework/CIT	6	5	6	17
Building design including lighting	3	10	3	16
Refrigeration heat output re-use, eg hot water generation	3	6	7	16
Standardisation of varieties & blends	6	6	4	16
Boiler steam usage	5	5	5	15
Re-use of steam from stills	5	5	3	13
Roof coverage increase for shading and water capture	10	1	2	13
Brine pump shut-off (selective)	4	5	4	13
Power factor correction	10	2	1	13
Generation and storage	3	2	8	13
Expansion forecasting (review procedure—eg switchgear, electrical infrastructure, drainage optimisation)	3	5	5	13
Information management, capture usage by area	4	4	5	13
New technology search	3	5	5	13
Remove/reduce cool rooms	2	1	6	9
Procurement procedures	2	3	4	9
Review core HR procedure for energy	2	3	4	9
Underground cool rooms	2	1	3	6
Fuel optimisation for forklifts etc	2	2	2	6
Solar emergency lighting	2	1	2	5

Box 4: Refrigeration energy use and plant operation

COMPANY: Hardy Wine Company
SITE: Stonehaven Winery, Padthaway Region

▼ Off-Peak cooling and night over chilling

As a result of implementing the software upgrades to deliver monthly power reports (discussed in Box 2) it became apparent that we needed a better way of running our refrigeration plant. Potentially, we see the possibility of getting more cooling from the current refrigeration system without adding an extra compressor. This alone would save around $250k and countless MWh.

Background

The CITECT system in the winery provides an enormous wealth of information, so much data that it was never really looked at until the Energy Management Team was formed.

Data from the upgraded system showed that during the non-vintage season the refrigeration plant was doing a lot of work during the day keeping the brine tank cool when there was no cooling demand in the winery. The plant was also short cycling because the set-point for brine tank temperatures and process temperatures were set too aggressively. In other words, the dead-band given for acceptable fluctuations around the programmed temperature, set by the plant operators in the case of the brine temperature or winemakers in the case of process temperatures, was very small; in some cases only a tenth of a degree for storage tanks. This meant that as soon as the CITECT system detected a variation in brine or tank temperature outside the dead-band, the refrigeration plant and brine cooling system would start up to bring the temperature back within the pre-set conditions. This control-setting issue further increases energy wastage, because each time the plant starts the peak power is 4–5 times the running power.

Implementation and Outcome

We contacted the energy supplier to obtain the exact definitions of peak/off-peak energy, and invited the CITECT system supplier to quote on a system to enable the winery to allow normal on-demand operation of the refrigeration plant or force off-peak-only operation. Part of the off-peak protocol is to perform an automatic chilling cycle one hour before the peak period starts, to ensure that there is a maximum storage cooling capacity prior to start of the day shift or winery cooling operations.

Project baseline as percentage of site electricity energy consumption: 43%
Contribution to peak demand: 70%
Estimated potential for saving: 30–50%
Annual electricity saving: 130,000 kWh
Annual electricity cost saving: $14k
Cost of implementation: $12k
Simple payback: 1 yr

Key Points

- It is quite possible that your site already collects the data required to make decisions, although it may not be presented in a form that allows decisions to be made.
- It is important to understand how your power bill works.
- Simple projects can make reasonably large impacts.

COMPANY: Orlando Wyndham
SITE: Rowland Flat and Richmond Grove Sites, Barossa Region

▼ Thermal storage in wine/night over-chilling

Orlando's site team has modified the software on several Rowland Flat Winery refrigeration plants in order to shift more cooling load out-of-peak tariff periods. The idea is to over-chill the wine during off-peak hours and leave the refrigeration off during peak hours. The expected benefit is significant savings by restructuring the load to the cheaper off-peak tariff. This can be done by minor software changes, at low cost, and is not expected to have an impact on wine quality or risk.

Data is being collected over the next few vintages to build up a representative picture of the cost and capacity benefits. Most importantly, there have been no issues raised regarding wine quality. While it is not expected that kWh of energy consumed will be saved, the load shift from high demand-high unit energy cost period will reduce monthly energy bills. It is recognised that the refrigeration equipment will perform at higher efficiency levels under cooler night operating conditions.

Towards Best Practice Process and Facilities Cooling in Wineries

Modern wineries operating in Australia's hot climatic conditions are generally dependent on the use of refrigeration systems that remove heat energy to control process temperatures and to air-condition offices, barrel stores and wine storage areas. Wineries need to control effectively the removal of energy in the form of heat from the product at the different stages of the process to prevent spoilage and maintain the desired winemaking temperature throughout the process. Refrigeration accounts for 50–70% of electricity costs and is the major energy-using process in wineries. The relatively high-energy intensity of refrigeration reflects the need to chill the white must, cold settle juice prior to fermentation, carefully control tank and fermentation temperatures over extended periods, cold stabilise white and red wine, and air condition storage areas.

Best practice energy efficiency in winemaking process and facilities temperature control focus on:

- reducing the energy consumption of the refrigeration system through improved performance of the system
- minimising the quantity and required rate of heat energy to be extracted by the refrigeration system, particularly at peak periods
- shifting the period of high refrigeration system energy consumption to Off-Peak Tariff periods which generally occur during cooler periods of the day, thus increasing condenser effectiveness and the overall refrigeration plant coefficient of performance

Best practice approach to optimisation of process cooling and refrigeration systems

What demand is the system supplying? What is the cooling system delivering that makes it an important part of the winemaking production? This will involve defining cooling needs (or load) by drawing process flow diagrams for the winery production system and the refrigeration cooling system. At this point it is also important to determine what scope there is to vary these loads in terms of time to achieve cooling and lowest target temperature required.

What are the parameters? What are the critical factors in the winemaking process which depend on cooling? Must these parameters be met exactly or are small variations of plus or minus 1°C or 2°C acceptable for short periods? The winemaking methods and practices that determine winemaking process conditions (temperatures, cooling rates) have a large effect on setting some parameters around what efficiencies are possible in terms of design, operation and control.

Matching supply of cooling to load. Identify the factors that affect refrigeration system performance and production process loads (i.e., weather, production demands, etc.). How does the physical efficiency of the refrigeration plant change in response to changes in weather conditions and production parameters (temperature, quantity, rate of processing)? For example, is the refrigeration plant operating at maximum all the time just in case the production process requires cooling capacity, or does a strong two-way communication (feedback loop or control routine) between production process requirements and site services enable optimal refrigeration plant operation as processing demands change? Are winemaking practices, process conditions, winemaking process operations, production management, plant and facilities operation and management done in a given way because they have to be, or because they have always been done that way? Does flexibility exist within any of the systems identified to allow changes that increase operating efficiency?

Strategies for optimising process cooling and refrigeration in wineries. There are two general approaches:

- reduce the demand for refrigeration-driven cooling in the production process by:
  - changing production parameters
  - better management of production demand and peak loads
  - ensuring efficient heat transfer between coolant/refrigerant and process
  - minimising heat gain through the use of insulated pipes, pumps, heat transfer equipment and vessels
  - minimising solar loads
  - installing pre-cooling systems
  - better housekeeping practices
- optimise the operation of the refrigeration sub-system, components and equipment

What is the best way to deliver the cooling capacity of the refrigerant or secondary refrigerant to the production process? There are essentially two options: either move the refrigerant to the product, or move the product to the refrigerant. Direct ammonia injection in fermentation vessels is an example of moving the refrigerant to the product. Moving liquid and or gaseous ammonia around the plant is far more efficient than brine (usually a mixture of water and

Box 5: Optimise refrigeration efficiency

COMPANY: Hardy Wine Company
SITE: Berri, Riverland Region

▼ Ensure efficient operation of refrigeration systems and proper sizing of component equipment

This initiative examined the operation and performance of a large load refrigeration plant using secondary brine system to determine how to increase performance and save wasted energy.

- Both our North and South plant rooms are equipped with SCADA, giving us the opportunity to record and identify with accuracy the problems in the plant with history. Developing this history has been crucial in enabling us to understand and determine operating problems.

Background

During our current vintage, maintaining the brine temperature at a suitably low temperature to satisfy the heat load or cooling demand from tanks became a real issue. During trials to investigate the potential for off-peak operation of the refrigeration plant, one of the problems identified was the number of tanks that were able to call for brine at any one time. As a result of this observation, we consulted a refrigeration company to inspect our plant and provide advice on the situation.

Findings

The main problem identified was that the capacity of secondary brine pumps (used to circulate the brine around the winery) was greater then the primary brine pumps (used to move brine through the evaporator of the refrigeration plant).

- This condition created a situation where high temperature brine being returned for cooling by the refrigeration plant enters the hot well of the brine storage tank at a greater rate than the primary pumps can move the brine through the ammonia-cooled plate heat exchanger (evaporator) and into the cold well. The inadequate capacity of the primary pumps results in an overflow of brine from the hot well into the cold well. At times when large loads are placed on the plant (secondary pumps running at full speed with pressure below 100 kPa), circulating brine temperature cannot be maintained due to the overflow effect.

In addition to understanding the brine overflow problem, the heat exchangers in the primary circuit were investigated and the most significant losses throughout the system were located.

- Plate heat exchangers are normally designed to operate with a temperature differential of 2°C. In the case where the refrigerant is at say –8°C, it is reasonable to expect that the brine flowing through the exchanger could be reduced to –6°C. When operating with an ammonia refrigerant at –8°C the required suction pressure is 215 kPa.

With the current system design and arrangement of primary circuit plate heat exchangers the operating suction pressure of the compressors during peak loads (eg, vintage) was significantly lower then should be reasonably expected of a well-designed efficient system. Recorded data indicated that suction pressures were as low as 105 kPa. The effect of this is that the refrigeration plant compressors and condensers are operating at a working ammonia temperature of –18°C to achieve a brine temperature of –6°C. When combined with the flow restrictions in the suction of the primary pumps, total plant capacity was found to be limited to 2400kw of cooling rather then the designed 3200–3400 kW. Therefore, under certain operating conditions, up to 350 kW of absorbed power is being consumed with no benefit.

Baseline data	Performance indicators
• Monitoring of the plant suction pressure in line with outlet temperature of plate heat exchangers • Monitoring brine pressure and cold well temperature • Project baseline as % of site: 63% • Data is currently recorded on the site SCADA system	• Compressor run-times • Plant Suction pressure should not be required to go Below 190 kPa (SCADA Trends). • Outlet of plate heat exchanger no greater then 4°C temperature difference between refrigerant and brine • Brine temperature in the cold well • Pressure in secondary brine system in relation to brine temperature • Meter readings on number 3 & 4 power meters • All above are currently recorded on SCADA system

Outcomes

Results expected from the project include :

- higher plant suction pressure, providing greater compressor/plant efficiency and increase in cooling capacity by up to 1000kW of additional cooling
- improved heat transfer from the refrigerant into the brine with the installation of a 3rd Plate heat exchanger
- greater flow rates through the existing exchangers

Annual Electrical Energy Saved: 470,400 kWh
Annual Electrical Cost Savings: $51,744
Cost of Implementation: $150k
Simple Payback: 3years

other chemicals with a freezing point below zero) or chilled water. Refrigerants that undergo a phase transition (transition from a liquid to gas) during heat transfer offer far more cooling capacity per transported mass than a brine solution that only experiences a rise in temperature of a few degrees. Moving ammonia is also more efficient due to lower pumping costs. In other situations, the refrigeration plant evaporator is used to cool a secondary refrigerant medium, such as brine. The brine or chilled water is then pumped around the plant to provide localised cooling for specific applications. Both approaches have strengths and weaknesses.

Seven best practice considerations for energy efficient refrigeration systems

- Reduce the load as low as possible – only that which requires mechanical cooling (refrigeration) as opposed to that which can be pre-cooled using cooling fluids, such as water at ambient temperatures, product to product heat exchange, or water cooled by evaporative chillers.
- Size condensers and evaporators to maintain the lowest practical condensing temperature and the highest effective evaporating temperature; ie, reduce temperature lift.
- Avoid or minimise head pressure control.
- Determine the most efficient compressor/refrigerant combination for the application.
- Insulate the suction line.
- Ensure the system is leak-free and contains the right type and amount of refrigerant.
- Regularly clean condensers and evaporators (air systems only).

Process cooling loads

Issue or opportunity	Best practice consideration
Winemaking decisions	■ Probably the most important issues for energy efficiency in the refrigeration system aspect are winemaking decisions. These determine the allowable temperature of grapes; rate of cooling desired; minimum must temperature; and other process parameters. Timing of cooling loads and allowing variability in storage/process temperatures as a means of thermal buffering will have excellent results in refrigeration system performance. Finding the best practice operating parameters is driven by wine quality; this cannot be compromised by process changes since the cost of quality loss generally exceeds the value of energy saved.
Cooling grapes	**Operation** ■ Improve grape receival and management to reduce waiting time for trucks at the winery and the consequent heat gain of weather exposed grapes. ■ Pre-cooling grapes using evaporatively-chilled water in a heat exchanger prior to must chilling reduces the peak load on the refrigeration plant at the time when it is highest. Evaporative cooling is most effective in the hottest weather, just when the maximum demand for cooling and lowest effectiveness of vapour compression cycle refrigeration coincide. **Research** Find ways to cool grapes prior to reaching the site, such as the use of evaporative cooling while the grapes are being transported. Dry ice or some reusable encapsulated phase change material may be appropriate.
Intake schedule (Production management)	■ Consider flexibility in intake schedules, adjusting time or day of harvest to allow for effects of weather temperature.
Must chiller and cooling	**Design** (New site, Expansions and Upgrades) ■ Optimise pipe size and design for better heat transfer in the must chiller. Give careful consideration to the balance between up-front equipment costs and ongoing operational costs. **Investigation** Must chilling is considered essential for the production of quality wines. However, there may be scope in determining maximum must cooling temperatures and minimum rate of must cooling.

Process cooling loads (continued)	
Issue or opportunity	Best practice consideration
Match refrigeration temperature to process temperatures	Operation ■ Adapt refrigerant temperatures to process temperatures (ie, operate the refrigeration plant at the highest possible evaporation temperature). Design (New site, Expansions and Upgrades) ■ Ensure that separate direct ammonia and brine cooling systems are installed to enable the matching of refrigerant temperature to the process temperatures required in different parts of the winery. See Box 6: Trials to assess use of intermediate temperature for secondary brine refrigeration See Box 7: Refrigeration suction pressure optimisation
Brine system	Operation ■ Reporting and monitoring load to better understand brine delivery temperatures and volumes allows better scheduling of cooling plant. ■ Sub-cooling brine at night and allowing temperature to rise during the day spreads the cooling load out. Some wineries also do this during the non-vintage period to reduce peak electricity charges. ■ Consider varying brine temperatures to higher than –10°C if this level of cooling is not required throughout the year. Split Brine or chilled water systems ■ The warm brine loop could be as high as 0 to 2°C, which would allow chilled water to be used if these conditions could be maintained. Using water allows the same pipes to carry warm water if heating is required. Water's lower viscosity and higher heat capacity per litre enables lower pumping energy per unit of cooling than brine.
Ice slurry storage	■ Ice slurry storage can be more efficient than a big brine tank when maximising off-peak cooling. ■ Ice slurry could be used as the secondary refrigerant loop. Phase change allows the refrigerant to stay at a constant temperature as heat is transferred and to absorb more heat per litre pumped, similar to the effect of direct expansion ammonia. ■ Existing infrastructure must be tested if an ice slurry is considered, especially flow rates and restrictions in dimple jackets. ■ Ice slurry has not been widely used in Australia, so there are some supply and maintenance issues to be considered.
Plant room temperature	■ Plant room temperature should be investigated to ensure operation at the lowest possible naturally-achievable temperature. A greater use of ventilation to remove heat generated and use of light coloured paint and/or insulation to limit solar heat loads may reduce elevated temperatures.
Cogeneration	■ Cogeneration of a few hundred kW as standby power could assist with security of supply. In this size range a diesel-powered electricity generator would be the most appropriate technology. Investigation Cogeneration with absorption cooling to use some of the 'waste' heat has been demonstrated for CHP systems in the range 3.5–7.0MW. Using absorption chillers, up to 5.6MW (1590t) of cooling can be gained using the heat recovered from a 4.5 MWe gas turbine-driven generation set. The principle absorption system is based on the lithium bromide water cycle, and this can provide water chilled to 4.5°C. (Reference: Finding uses for waste heat, The Chemical Engineer, 20 Nov. 1997, p20) ■ The key to successful co-generation is finding a valuable use for the waste heat, displacing some other energy source. Possible uses are for hot water and process heating. The temperature available from diesel engines is from the water jacket at around 80–90°C and possibly some heating off the exhaust at a somewhat elevated temperature.
Evaporative cooling	Design (New site, Expansions and Upgrades) ■ Consider evaporative cooling if water supply allows, eg pre-cooling for incoming grapes and potentially for controlling ferment Investigation Evaporative condensers may be able to provide a low enough temperature to prevent wild fermentation in juice prior to controlled fermentation.
Chilled water	■ Fermentation load could be controlled by chilled water at some intermediate secondary refrigerant temperature, maybe up to 4–6°C.

Process cooling loads (continued)	
Issue or opportunity	Best practice consideration
Thermal storage (Using wine tanks)	**Design** (New site, Expansions and Upgrades) ■ The use of thermal storage requires planning and extensive rethinking of the process. It would be best to incorporate this at the design stage. During the night the temperature would be pulled down to the bottom of the allowable band, thus decreasing daytime refrigeration demand by allowing the wine temperature to rise to the top of the allowable temperature band by late afternoon. **Operation** ■ Consider thermal storage, giving the following opportunities: — Running a low condenser temperature at night saves power and takes advantage of off-peak power. It is estimated that for every 1C° that the condensing temperature is lowered, there is an approximate 2–4% energy saving. — Increasing security of cooling capacity during short periods of power failure may be desirable. See Box 8: Shifting and reducing refrigeration loads
Product-to-product heat exchange	■ Consider adjusting the timing of certain processes to better utilise direct heat exchange between processes. Software and procedures for production planning will improve heat exchange opportunities. ■ Develop key performance indicators (KPIs) for amount of heat recovered and/or energy consumed during vintage. ■ Counterflow heat exchange (into cold stabilisation): many large wineries practice heat exchange into and out of cold stabilisation vessels when they have time to organise simultaneous transfers. Heat recovery is on the order of 80% when it is scheduled. Larger transfer volumes improve effectiveness of heat recovery. This heat recovery is especially valuable when it avoids the need to switch in another compressor to handle cold stabilisation load. See Box 9: Product-to-product heat exchange
Cold settling	■ Consider benefits of replacing cold settling in some situations by mechanical alternatives such as centrifuges. Centrifuge driven separation methods can significantly reduce the load on the refrigeration plant. See Box 10: Application of centrifuge technology
Insulation	As a general principle, insulation improves the effectiveness of refrigeration plant by supplying the cooling to the product and not the atmosphere. Secondly, insulation provides thermal insurance against cooling plant or power failure. The better the insulation, the longer it will take for product temperature to rise. Ice is a better insulator than air, but nowhere near as good as properly-designed insulation systems. If you see ice on pipes and equipment, heat is being lost. Melting of ice at the surface of the ice cover can be a very effective heat transfer mechanism, increasing heat loss. ■ Plant heat exchangers and pumps need to be fully insulated to reduce absorption of heat energy from the surrounding environment. ■ Insulate all pipes if it is cost-effective to do so in terms of life-cycle heat gains and the cost of energy for refrigeration. ■ Consider if insulation could be improved, especially on tank doors, valves, flanges and pumps. For example, an uninsulated tank door is equivalent to 20m2 or more of (75 mm) insulated tank. An insulated cover or reflective flap could significantly reduce this loss. This detail improvement will add many kW cooling over a tank farm at low cost. ■ Thermal bridging, where heat bypasses insulation by flowing through bolts or brackets, can be surprisingly significant. Detail design is critical.
Barrel storage	Opportunities exist for improved building design and insulation performance. ■ Ensure both walls and roofs of barrel stores are insulated. ■ Air leakage from the building can also be a major issue, especially if there are openings on opposite sides of the building or the building is poorly sealed. Leakage of one cubic metre per second at a temperature difference of 10°C adds a cooling load of 12 kW (electrical load of around 4 kW). A store with two $4m^2$ openings on opposite sides can gain 100 kW of heat if the wind speed is 15 km/h and the temperature difference is 10°C. ■ Wine has a high thermal mass or thermal inertia, meaning that the opportunity in building design will be in the insulating properties of the building envelope and control of air infiltration and moisture. More insulation will stabilise wine temperature further.

Process cooling loads (continued)	
Issue or opportunity	Best practice consideration
Solar heating load on tanks and vessels	■ Solar loads on uninsulated tank mays have the potential to raise temperatures by 1° per day. Early in vintage, this heat load may be a larger thermal load than the fermentation load. ■ Maintenance of external surfaces of tanks needs to ensure high reflectivity (shiny surface) and low absorption in the solar radiation wavelengths with high emissivity in infra-red wavelengths (white surface). These characteristics lead to a low surface temperature. ■ Clean external surfaces of tanks to reduce the effects of solar load. ■ Shade tops and walls of tanks exposed to direct sun. ■ Shading of tanks to reduce direct solar gain will have most benefit on the hottest days when refrigeration plant performance is at its lowest.
Condensers	■ Refrigeration condensers provide highest efficiency when they are larger, run at lower temperature and are clean both inside and out. It is also important to keep water and fan systems associated with water-cooled condensers in good working order.
Stable heat sinks	■ Winery refrigeration systems generally reject heat to the atmosphere, providing a variable heat sink temperature. Using the ground or a large body of water as a heat sink will mitigate against the effects of high ambient temperatures and high humidity, and possibly remove a breeding environment for Legionella and associated bugs. ■ Consider dams, ponds, or water treatment sites as potential heat sinks for refrigeration systems; however, they are of benefit only when at a temperature lower than ambient air (at night they may be warmer).
Production synergies	■ Investigate whether complementary businesses may be able to be co-located with a winery to even out power load and infrastructure capacity during non-vintage periods. These may include brewing, champagne or juice production.

Box 6: Trials to assess use of intermediate temperature for secondary brine refrigerant

COMPANY: Beringer Blass Wine Estates
SITE: Barossa Region

▼ Use the highest possible secondary brine temperature that can still satisfy process cooling requirements

This initiative aimed to test the viability of using a secondary refrigerant at an intermediate temperature rather than the nominal –10°C. The results will also test the principle of possibly using chilled water rather than brine.

A trial was conducted where the brine temperature was raised from the normal setpoint of –10°C to 2°C to simulate the use of chilled water. Fermentation trends were monitored using the SCADA system to evaluate process cooling performance between the normal and higher brine temperature. The main performance indicators for the trial include:

- Ability to maintain fermentation set point
- Fermentation cooling load requirement

Data collected from a trial near the end of the 2002 vintage proved to be inconclusive; however, further trials are likely to continue to evaluate the effectiveness of the use of an alternative cooling media.

COMPANY: Orlando Wyndham
SITE: Rowland Flat and Richmond Grove Sites, Barossa Region

▼ Increase brine temperature at Richmond Grove

Richmond Grove has implemented a temperature increase (2°C) for its circulating brine. This has resulted in some positive outcomes with respect to load management, mainly through a gain in capacity. No quantitative data is currently available, due to the difficulty in accurately measuring the improvement with existing metering systems. There is, however, significant understanding of the impact in efficiency and the theory is being utilised to estimate efficiency gains. The Key Performance Improvement Indicators for this initiative are:

- Reduced energy use per quantity of product produced
- Increased refrigeration capacity

Box 7: Refrigeration suction pressure optimisation

COMPANY: Southcorp
SITE: Lindemans—Karadoc Winery, Murray-Darling Region

▼ Run suction pressure of ammonia compressors as high as possible, within the limits of the production process requirements

This initiative focused on the optimisation of the suction pressure of the refrigeration plants to suit the different process requirements as they vary throughout the year.

Background

Raising the suction pressure of the refrigeration system increases the capacity of the system; with the end result being that the compressors will run for less time, reducing energy consumption. Due to variations in loads and operating conditions, the expected savings are extremely difficult to estimate. We are, however expecting savings of around 0.5%.

Implementation and Outcomes

- Contact stakeholders explaining the project, its aims/benefits/implementation plans etc, Encourage feedback, including concerns, and ensure all parties are comfortable with the proposal and the condition that it will have zero effect on production. All relevant site personnel were informed via management meeting and site Bulletin. In close liaison with the winemakers, the cellar processes are to be monitored throughout the year and the refrigeration system parameters adjusted accordingly. The object is to keep the suction pressure as high as possible. The big change comes when cold stabilisation is complete, which eliminates the need for the wine to be cooled to such a low temperature.

Annual electrical energy saved: 18,681 kWh
Annual electrical cost saving: $1,961
Cost of implementation: Employee time
Annual CO_2 emissions reductions: 26,975 kg

Box 8: Shifting and reducing refrigeration energy loads

COMPANY: Beringer Blass Wine Estates
SITE: Barossa Region

▼ Off-peak cooling and night over-chilling

Investigation of cooling load requirement profile and application of refrigeration control system to conduct night over-chilling. Over-chilling product at night, during off-peak electricity rates, seeks to minimise operation of the refrigeration plant during the day.

Background

The key indicators that will be monitored to show that the actions of the project have had an effect will be the *refrigeration plant time of operation* and *time of off peak operation*. The main performance indicator that will be used to evaluate the *amount* of improvement *is energy use per quantity of product produced*. Baselines for the project, include:

— Current cooling load requirement data

— Current refrigeration plant time of operation and off-peak operation

Outcome

Implementation at this stage has been limited to conducting a trial during the 2002 off-vintage period. The trial consisted of writing PLC code to adjust the override on the refrigeration plant to allow tank temperature set points to be reduced so that over-chilling can occur at night.

The 2002 off-vintage period trials have resulted in a reduction of the operation of the plant during the day. It has been estimated that savings of up to 9% on refrigeration electricity costs are available. However, work is still required to evaluate any potential impact on the winery production processes and will need a cross-functional team to address that issue.

- Changes, such at this, which have an impact on winery production process operating conditions (product processing temperature), need to be evaluated and conducted with a cross-functional approach. It is important to get the full understanding and commitment from the key stakeholders to be able to implement a change across the site.

Continued next page

Box 8: (continued)

COMPANY: Southcorp
SITE: Lindemans—Karadoc Winery, Murray-Darling Region

▼ Direct fill of wine from the cellar to the packaging line.

This project is being developed to supply wine direct from the cellar to the packaging line without being sent to the packaging centre, where it is held and further processed as well as cooled and heated if stored for an extended period.

COMPANY: Southcorp
SITE: Lindemans—Karadoc Winery, Murray-Darling Region

▼ Compare the difference in energy use and cost between day and night rate

Background

A refrigeration energy use trial was set up to run on Plantroom #1. To conduct this trial it was necessary to ignore background refrigeration load and assume this to be the same during both the day and night shifts. This project was driven by the members of the refrigeration training group with assistance from a site winemaker to work with cellar cooling operators to set up the trial and record the results.

Outcomes

Due to the electricity tariff structure, it was expected that the cost of operating the refrigeration plant during off-peak periods would be lower. However, the difference in co-efficient of performance of the refrigeration plant during the day compared to night was found to be significant. Not only is the cost of electricity consumed cheaper, we are also achieving more cooling for each kilowatt of electricity consumed.

Total refrigeration energy use for 2002 was 3,736,362 kWh for a total compressor run time of 23,847 hrs requiring 156 kW/hr average. By maximising the refrigeration plant operation during the off-peak tariff period (and cooler night conditions), it is expected that we can achieve a 5% saving in energy input from the more efficient operation of the plant, in addition to the cost savings from lower cost power. With the information available from this trial and the completion of 24hr operation, the cellar in co-operation with the winemakers plan to work together to maximise the use of refrigeration during off-peak electricity tariff periods to achieve:

Annual electrical energy saved: 186,812 kWh

Annual electrical cost saving: $19,000

Cost of implementation: Employee time

Annual CO_2 emissions reductions: 269,756 kg

COMPANY: Southcorp
SITE: Lindemans—Karadoc Winery, Murray-Darling Region

▼ Determine ammonia compressor energy use and performance under various loads

This project sought to determine the energy use of the different Make Ammonia compressors at various loads. This information will enable more informed decisions to be made in programming the operation of the refrigeration plant.

Background

A standard 200 ton-ammonia compressor with a 265kW drive at 0% load draws approximately100kW; and at 100% load, approximately 200kW. Power to start a compressor with an auto transformer starter is minimal because of the very short start time; while the unit with an electronic soft starter used considerably more energy because of the longer start time. Another compressor with a 2-speed motor that can be run at 1500rpm (half speed), at 0% load the unit draws 50kW and at 100% load the unit draws 100kW. For the calendar year 2002, the refrigeration plant used 3,736,362 kWh at 10.5 cents per kWh. By using the data gained from the energy measurement of the compressor and retuning the system using this data, the site is aiming for a 1% increase in efficiency.

Annual electrical energy saved: 37,363 kWh
Annual electrical cost saving: $3,923
Cost of implementation: Employee time
Annual CO2 emissions reductions: 53,952 kg

Box 8: (continued)

COMPANY: Orlando Wyndham
SITE: Rowland Flat and Richmond Grove Sites, Barossa Region

▼ Agitation of white ferments

White ferment agitation initiative is being implemented during the 2002 vintage. From the results gained during this work, it should be possible to quantify the improvement in heat transfer at the inside surface of the tank. It is known that the greatest resistance to heat transfer in the tank farm is the heat transfer coefficient on the inside of the tank-wall. This initiative seeks to improve the energy efficient transfer across this barrier.

Using the information gained from this initiative the winery staff will attempt to identify plausible brine and refrigeration temperature increases and prove it in 2003. The basis for this approach is the well-known capacity efficiency impacts of increased refrigerant temperatures (25% more capacity for every 5°C rise in the refrigeration operating temperature set-point).

Box 9: Product-to-product heat exchange

COMPANY: Southcorp
SITE: Lindemans—Karadoc Winery, Murray-Darling Region

▼ Maximise utilisation of cooling potential from cold product streams and minimise heat requirements

Background

Product-to-product heat exchangers purchased in late 2001 were being trialed during the 2002 vintage. Product-to-product heat exchange involves the simultaneous transfer of a ‘cold’ product that requires heating and ‘hot’ product that requires cooling. During the transfer each product stream is brought together using a heat exchanger to transfer the heat from the hot stream to the cold stream. The objective of this project is to develop an understanding of the potential to save on refrigeration electricity costs and gas fired heating costs, and the operational management challenges of matching heat loads for simultaneously transferred product streams.

Baseline data for evaluating the potential energy recoverable through this initiative is based on:

— Product stream temperature change (ΔT) in °C;
— Volume of product being transferred (V) in cubic meters (m^3);
— Density of the product (r) in kg/m^3; and
— Specific heat of the product (C_p) in kJ/kg.°C.
— Heat transferred: $Q \text{ (kJ)} = VrC_p\Delta T$ or $Q\text{(kWh)} = VrC_p\Delta T/3600$

	Temp (°C)	Density kg/m³	Specific Heat kJ/kg.°C		Temp (°C)	Density kg/m³`	Specific Heat kJ/kg.°C
Must	0	1095	3.65	Wine	0	982	4.25
	10	1090	3.7		10	978	4.30
	20	1085	3.75		20	975	4.35
	30	1080	3.8		30	972	4.40
Juice	0	1100	3.56	Water	0	1000	4.21
	10	1095	3.58		10	1000	4.20
	20	1090	3.6		20	998	4.18
	30	1085	3.62		30	996	4.18

Implementation and Savings

Issues needing to be addressed:

— Number and volume of potential streams that can be used for product-to-product heat transfer
— Challenges and issues related to the effective introduction and operational management of this energy efficiency strategy
— Potential size refrigeration and heating load reductions and associated cost savings

Recoverable energy has been calculated by site engineers to be 350kW for one stream and up to 1000kW for another stream. The reported figure in kW (kJ/s) represents a rate of heat transfer and does not indicate how much energy can be saved. The amount of energy that can potentially be saved is dependent on the amount of product that can be brought into contact with another product stream during product transfer operations. This presents not a technical challenge, but a production management challenge for the site. *(Continued next page)*

Box 9: (Continued)

COMPANY: Beringer Blass Wine Estates
SITE: Barossa Region

▼ Utilising heat exchange between wine entering and leaving cold stabilisation

Utilising heat exchange between wine entering and leaving cold stabilisation seeks to reduce the peak energy load by cooling down the incoming wine with wine that has completed cold stabilisation; and subsequently saving energy cost to reheat cold outgoing wine with the heat available in the incoming wine.

Currently the planning and production scheduling processes are not in place to enable this initiative to be implemented. The success of this initiative is largely a function of winery design and layout, together with scheduling and production management to make sure two or more product streams are available at the right temperature, the right time and place for heat exchange to be handled. A Wine Inventory Management system is currently being developed which hopefully will provide the appropriate tools and systems to be able to manage production schedules and thus enable product-to-product heat exchange to be implemented.

Box 10: Application of centrifuge technology

COMPANY: Beringer Blass Wine Estates
SITE: Mildara, Riverland Region

▼ Application of centrifuging technology to reduce energy consumption from cold settling processes

Centrifuging trial to utilise centrifuge to remove lees rather than cold settling and racking: if lees can be effectively removed utilising latest centrifuge technology rather than cold settling and then racking off, there can be a saving on energy needed to cool product down from 15°C to 6°C and hold for 36 hours and then heat back up to 15°C.

Initial data being used to determine the feasibility of the project are based on wine quality; ie, is the wine quality resulting from centrifuge solids removal as good or better than wine quality resulting from solids removal by cold settling?

Success indicator
Reduced energy requirement for cold settling while maintaining, or improving, wine quality

Performance indicator to be used to evaluate the amount of improvement
Energy requirement for cold settling

Post-implementation
Wine quality analysis by the winemaking team

Other benefits
Reduction in Diatomaceous Earth
Improved wine recovery due to higher solids contents achieved from new centrifuge

Typical flow rates: 20,000 l/hr

Refrigeration system and components	
Issue or opportunity	Best practice consideration
Refrigeration system	■ Is there enough opportunity for heat recovery from the refrigeration system, such as de-superheaters, to reduce or avoid the need to import natural gas or LPG for heating? ■ Exploring refrigeration load levelling; loads can be shifted, or avoided to create a (lower) constant demand for cooling rather than a fluctuating load. ■ Comparing satellite versus centralised plants; each has its strengths and weaknesses for different loads. ■ Conducting familiarisation training for operators of the refrigeration system can make savings. ■ Utilising heat recovered from refrigeration plant to heat water for cleaning and process operations on site. **Research** Use of absorption systems that use waste heat for higher temperature process cooling requirements.
Load scheduling	■ This has two aspects: — First: around management of peak daily demand, particularly on hot days when the refrigeration system is at the margin of its performance — Second: concerns the overlap of high energy intensity cooling processes during the vintage, in particular, the onset of cold stabilisation before the end of filtering and blending.
Load	■ The maximum process-cooling load on the refrigeration system determines the size of the refrigeration plant in kW, and therefore, its capital cost. ■ Cooling loads are determined by the processing parameters that dictate the amount of time in which a specified amount of heat must be removed. ■ As a general point, it was noted that end-use efficiency improvements free up capacity, meaning less primary energy would be needed.
Temperature lift (fundamental and essential concept)	■ Temperature lift is the difference between the evaporating and condensing temperatures. ■ The temperature lift reduces if the condensing temperature is lowered and/or the evaporating temperature is raised. ■ A decrease of 1°C on temperature lift can cut energy consumption by 2–4%.
General factors	■ The condenser rating ■ Whether condensing temperature is permitted to float with ambient temperature ■ frost on evaporator equipment ■ Amount of refrigerant in the system and presence of leaks—a leaking system consumes more power than is necessary and wastes expensive (sometimes toxic) refrigerant (leakage can push operating costs up by 10–15%) ■ Insulation on suction lines
Evaporator	The idea is to have the evaporating temperature (the temperature at which the refrigerant evaporates) as high as possible to maintain evaporator efficiency. The size of the evaporator will determine much of this. As well: ■ In a direct expansion air cooler, the fin block should be kept clear of dirt and slime and adequately defrosted when necessary. ■ The tubes in a shell and tube evaporator should be cleaned to prevent fouling and corrosion (water quality may also be an issue) ■ The flow of the cooling medium should be maintained—pumps and motors must work efficiently ■ The flow of refrigerant through the evaporator should be controlled to ensure full use of its capacity.
Compressor	For applications where there is a large load, it is usually most efficient to split up the load between smaller compressors with a control system that will ensure capacity and operation are matched to load. If the compressors are different sizes, the degree of control is increased. Take into account any increased frequency in starting and stopping compressors, as this can erode efficiency. Efficiencies include: ■ Avoiding the use of a single, large compressor ■ Selecting a combination of compressor sizes which avoids the need for one or more machines to operate on capacity control

Continued next page

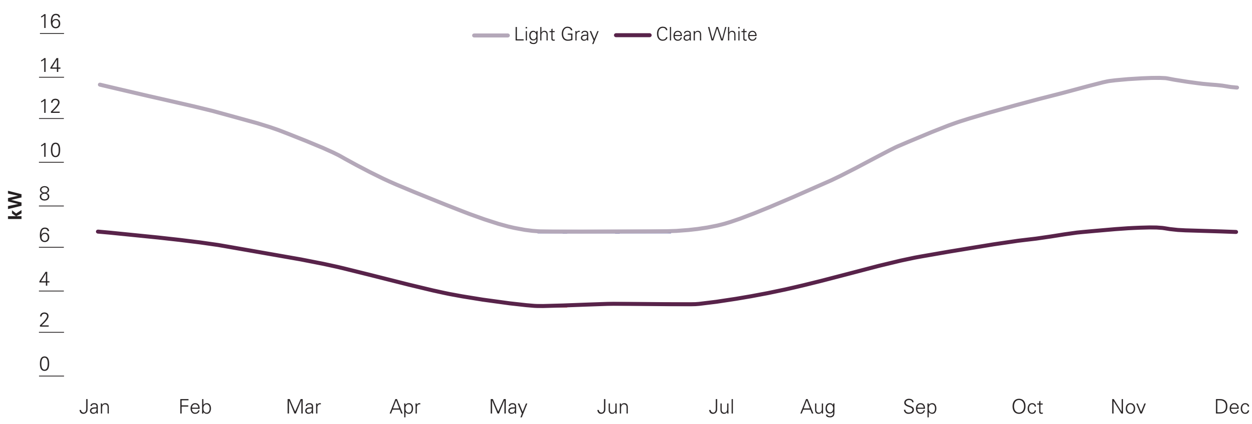
Refrigeration system and components (continued)	
Issue or opportunity	Best practice consideration
	■ Where multiple compressors are used, developing a control strategy which minimises the operation of compressors on part-load (in particular, not allowing two compressors to operate on 50% capacity rather than one operating on 100% capacity). ■ Screw compressors have higher full load efficiency than reciprocating units, but poorer part load efficiency. VSD can be installed to improve part load efficiency of screw compressors. ■ Compressor cooling—direct injection is less efficient than water-cooling ■ Variable volume ratio compressors allow a floating head pressure; so during periods of lower ambient temperature or lower cooling loads, the compressor work can be reduced. ■ Ensure adequate machines to enable flexibility as duty varies. Fully loaded compressors are more efficient that part loaded machines. Compressor scheduling needs to be appropriately controlled to realise this opportunity.
Condenser	There are three types of commonly used condensers, each of which has different performance and efficiency characteristics: ■ air cooled— consumes fan power; ■ water cooled—consumes circulating pump power and, usually, cooling tower components; ■ evaporative—consumes fan and pump power. The more surface area a condenser has, the closer the condensing temperature is to the temperature of the cooling medium, whether air or water. Lower condensing temperatures mean better energy efficiency. The heat transfer of all condenser types is reduced if they are dirty: ■ air-cooled condenser fin blocks should be free of dirt and in good condition; ■ water-cooled condenser tubes should not be fouled, corroded or scaled. Air in the system will increase the condensing temperature and reduce efficiency. Good installation and commissioning practices can avoid this; however, commissioning is more often a task which comes at the end of a long hard job and can receive less attention than it really warrants. Large systems which work with suction below atmospheric pressure can also draw air in during operation. This should be removed with a refrigerated air purger. ■ The condensing pressure should be allowed to float with ambient temperature so as to take advantage of lower ambient temperatures overnight and during winter. This causes the pressure ratio to vary slightly, which may cause problems with some types of expansion valve. Place de-superheaters prior to condensers to generate hot water. ■ To reduce the solar load on condensers, they should be shaded but in a way that does not restrict airflow to inlets and from outlets.
Expansion device	Refrigerant quantity is critical to capacity and efficiency of the expansion device. With thermostatic expansion valves, the superheat setting has a significant effect on efficiency and reliability. ■ If the superheat setting is too low, liquid refrigerant may return to the compressor, causing damage or failure. ■ If the superheat setting is too high, capacity and efficiency are unnecessarily reduced. Thermostatic expansion valves do not work well when there are widely varying pressure differences. In this situation, balanced port or electronic valves should be used. ■ Electronic expansion valves (Tx valves) allow improved control and higher efficiency.
Direct heat exchange with ammonia	■ The use of direct heat exchange with ammonia rather than brine allows higher suction pressure, but reduces storage and part load performance. This may be most appropriate for process operations that require continuous cooling, such as fermentation and storage. ■ Where large temperature drops are required in short periods, such as cold stabilisation, ammonia systems can be less effective unless the product is cooled by cycling it through an external heat exchanger. Immersion chillers are not recommended for this application. ■ Rationalise refrigeration systems to separate brine and direct expansion ammonia systems. This could allow highest evaporator temperature for each system, reducing the temperature lift that the compressor has to drive.

Continued next page

Refrigeration system and components (continued)	
Issue or opportunity	Best practice consideration
Thermal storage and distribution	■ Quantity of thermal storage should be reviewed and optimised. ■ The wine in storage provides some thermal inertia that can be used to manage daily demand cycles. (This is covered in the section on wine processes.) ■ Decentralised v central plant or mixture/hybrid: Given the variation in process temperatures, as well as some cooling loads being localised and rapid while others are expansive and slower, suggests that a 'horses for courses' rather than 'one size fits all' approach may be optimal. This is a question of detailed design.
Heat transfer to product	■ Improve jacket heat exchange by agitating tank contents and increasing brine flow rate and brine temperature. ■ Must chillers—changes to pipe work and materials selection may improve effectiveness of heat exchange. (Higher surface area and flow rate will improve heat exchange efficiency—this means larger heat exchangers with more material.) At the time of specifying and purchasing, give consideration to the balance of expenditure on heat exchangers and refrigeration plant. Larger heat exchangers save on running costs. Biasing spending towards larger refrigeration plant at the expense of heat exchanger size will lead to higher running costs.
Refrigerant maintenance	■ The system needs the correct amount of refrigerant. This is called the 'charge'. Both too much and too little reduce efficiency. ■ Insufficient refrigerant (lost through leakage) results in increased superheat of the refrigerant. This reduces suction pressure to the compressor and increases temperature lift, reducing efficiency. ■ Refrigerants may also be less effective through contamination. This may be caused by air trapped in the system during plant replacement, or nitrogen may remain after pressure testing. Gases trapped in the system means the compressors have to use more power because they effectively raise the total condensing pressure. ■ Simple purging systems don't remove all the air and waste refrigerant. Automatic purging systems should be installed on plants greater than 500kW where a 3-year payback can be expected from more efficient operation.
Technologies for Further Investigation	■ Recovering heat from refrigeration condensers. ■ Gas engines to drive chillers, with heat recovery used to heat water or as heat source for an absorption chilling system, dessicant wheel or ejector cooling plant. ■ Economiser port on screw compressors may enable different brine and cold water temperatures from the same compressor. ■ Cogeneration utilising heat recovery either for hot water or in a cooling application. ■ Application of transcritical CO_2 heat pumps to allow generation of hot water at up to 90°C with cooling. These operate at high pressure, but Mycom (compressor manufacturer) have systems sized around 400kW cooling and 600kW heating.

Solar Energy Loads on Tanks and Equipment

When considering solar loads, even a small build-up of dirt can significantly increase heat absorption. For example, looking at roof colour: a white roof runs 11.7°C above ambient, while light beige runs 19.4°C above and very light grey 22.8°C above ambient. This indicates a significantly higher level of solar absorption. The following graph demonstrates the solar load on the top of a 278-kilolitre tank with a diameter of 7.3 meters and a height of 12 meters. This graph demonstrates the dramatic increase when the tank is only slightly dirty (light grey).



Typical daily peak solar load

Box 11: Supplementary heating of juice using solar hot water

COMPANY: Southcorp
SITE: Lindemans—Karadoc Winery, Murray-Darling Region

▼ Use of low cost solar heating system to deliver supplementary heating loads

Use of solar heating to boost supply of heating capacity from Plant-room #2 condenser waste heat for heating juice imported to site from tankers. There are also additional opportunities to use this warming system post-vintage for other warming jobs (eg, warm malolactic reds, warming oak wines).

Background

During vintage the site receives approx 9Ml of juice at approx 9–11°C (or colder). This juice then requires warming to 16°C. The site receives approximately 200kl of juice per day, which is unloaded at 35kl/hr to achieve temperature increase. Warming capacity only exists for 50–70kl of the juice as the hot water source is depleted. This leads to a need to warm tanks once unloaded, delaying fermentation and creating another process. The project aims to achieve unloading at a rate of 50kl/hr with an outlet temperature of 16°C.

Implementation and Outcomes

The net was searched for a company that appeared to have suitable experience in providing and installing solar water heaters in an industrial environment. The company was contacted and offered data on performance and installation and cost (around $90 per square meter installed). Using black solar heaters laid on the roof, a 4°C temperature rise can be expected. At 28°C water per square meter of collector, a total of 200kWhrs per year can be absorbed.

- In discussions with a swimming pool solar heater supplier, low grade heat can be obtained by installing solar matts on building roofs or suitable structures. The quoted amount of solar heat energy captured equates to 220kWh per year per square meter of collector installed. If sufficient matting were installed to cover 50% of the tanker loading bay roof, this would provide an area of 300sq meters. Unfortunately, the 220 kWh is the amount captured over the whole year, while the site needs maximum energy for 8 week during vintage with random use during the rest of the year.

Performance Indicators:

- Increase in speed of unloading tankers, while maintaining desired outlet temp of 16°C.
- Can warm approx 200kl of juice per day to 16°C unloading at a rate of 35–50kl/hr.

COMPANY: Orlando Wyndham
SITE: Rowland Flat and Richmond Grove Sites, Barossa Region

▼ Improved surface on insulation cladding

Contact has been made with a major insulation contractor and SA Wine & Brandy to begin development of an improved cladding surface to lower cleaning costs and maintain the heat reflective value to reduce heat absorption. This is expected to generate significant savings in cleaning and refrigeration costs, as well as extending the lifespan of a major investment in tank insulation.

Cogeneration or combined heat and power (CHP) systems

Best practice application of fuel-fired engines in some winery situations (beyond an emergency back-up duty) is beginning to emerge. While careful assessment, technology integration and management is required, these systems have the potential to reduce significantly energy consumption, costs and greenhouse emissions by lowering peak-demand and electricity consumption during periods of peak tariffs and by energy source substitution (from coal fired centralised electricity to natural gas). If these systems are installed, the gas fuel to electrical energy consumption, cost and greenhouse emissions profile will shift towards higher gas fuel consumption and lower overall t-CO_2-e emissions.

Best practice applications of combined heat and power (CHP) or cogeneration systems utilise waste heat produced by the engine for water heating, steam production and, in some cases, for cooling using absorption chillers or other types of cooling systems. They are being evaluated for use in larger Australian wineries to reduce fuel costs, increase security of refrigeration and energy services against utility supply shortages and improve overall energy efficiency and greenhouse emissions.

Sizing a cogeneration plant can be done by considering base electrical load or base thermal load. Exporting surplus electricity is possible, but generally avoided by industrial cogenerators. The usual approach is to displace a portion of the existing electrical and thermal load so as to achieve cost, greenhouse and security of supply benefits. The best source of support for potential cogenerators is the Business Council for Sustainable Energy (formerly the EcoGeneration Association) at www.bcse.org.au.

Box 12: Cogeneration

COMPANY: Beringer Blass Wine Estates
SITE: Barossa Region

▼ Feasibility of cogeneration

The initial feasibility study for a 1MW cogeneration plant at the Wolf Blass Winery has been completed, but has not established a sufficient basis for justification to proceed at this stage. The main limitation has been availability of gas to the site, which we currently do not have. An extension of the natural gas distribution network is required. There are plans in place for a new winery to be built nearby to the Wolf Blass site, and we will be investigating a joint venture for a cogeneration plant.

Performance indicators include:

- Energy use per quantity of product produced
- Greenhouse emissions reduced (%)

Air compressor system

Compressed air is one of the most expensive sources of energy in most plants. The overall efficiency of a typical compressed air system will vary between 10–20%. For example, to operate a 1 hp air compressor at 100 psi requires an electric motor that can deliver approximately 7–8 hp to the compressor.

The Sustainable Energy Authority of Victoria (www.seav.vic.gov.au) offers the following advice to make an air compressor system more energy efficient:

- Check for leaks and pressure losses throughout the system regularly (monthly).
- Ensure the entire system is monitored for good housekeeping practices.
- Ensure condensation can be removed swiftly from the distribution network, or does not occur.
- Reduce pressure settings to the minimum where possible.
- Use high quality air only when necessary-filters and dryers reduce pressure, increasing energy consumption.
- Reduce the compressor intake air temperature by ducting outside air (preferably from the south side of the building) into the compressor inlet.
- Check that receivers are sized to store air for short heavy demands.
- Check that the size of your compressor meets current demands only.

Compressed Air Wise Rules

- Efficiency improvements can reduce compressed air system energy use by 20–50%.
- Using cooler intake air for compressors can reduce compressed air system energy use by 1% per 1.7°C reduction in intake air temperature. The payback period for this measure is usually less than two years.
- Installing or adjusting unloading controls can reduce compressed air system energy use by about 10%.
- Upgrading controls on screw air compressors can reduce a facility's total energy use by about 1% with an average simple payback of 8 months.
- Reducing air compressor pressure by 2 psi (x kPa) can reduce compressor energy use by 1% (at 100 psi or v kPa).
- Repairing air leaks can reduce compressed air system energy use by 30% or more.
- For every 1 psi increase in air compressor pressure gained by periodic filter changes, air compressor energy use is reduced by about 0.5%. Changing dryer filters at 8 or 10 psi drop per filter can eliminate this waste.
- For every 6°C decrease in air compressor working temperature, gained by careful maintenance of intercoolers, air compressor energy use will decreased by 1%.

Improving pumps, fans, motors and drive efficiency

Motor and drives	
Issue or opportunity	Best practice consideration
Minimise ancillary loads	■ Minimise ancillary loads; eg, by installing variable speed drives on brine pumps and condenser fans and by reducing overall load on condenser so that fan loads are reduced.
Variable Speed Drives (VSDs)	■ Variable Speed Drives are useful technologies for managing voltage and improving site Power Factors. VSD technology matches motors to the load, reducing losses. 'Soft start' features also reduce demand spikes, too.
Pump monitoring	■ Implement a system for pump monitoring to optimise pump sizing.
High efficiency motors	■ Install high efficiency motors; although their higher purchase cost makes them appear less attractive in the first instance, the full life cycle cost should be considered. ■ High efficiency motors can save 2–3% in running costs over their lifetime. Even this small saving can add to significant savings in energy use and running costs. Appropriate sizing of motors can be even more important, as motor efficiency drops off markedly at low levels ■ See the Australian Motor Systems Challenge website www.industry.gov.au/motors. A Motor Selector program can also be downloaded to assist in the correct sizing of motors for the job.

Box 13: Variable Speed Drives for condenser fan control

COMPANY: Southcorp
SITE: Lindemans—Karadoc Winery, Murray-Darling Region

▼ Install variable speed drives on plant motors

Background

Refrigeration Plantroom #1 uses four 200tonR fan-forced water-cooled condensers running in the proximity of the administration building and engineering workshop. The fans on these units create considerable noise that disturb both areas all year. Site staff have looked at the possibility of installing variable speed drives on all the fans (8 x 7.5kW) to minimise energy use and noise pollution.

Performance Indicator

- Overall plantroom energy use and lowering of the noise levels in the general area

Post Implementation Data

- Monitoring energy use and sound levels over the year

Implementation and Outcome

After reviewing information and trials from the installation of the VSD drives on the new condensers on Plantroom #2 and additional research, the proposed strategy involves the installation of VSD drives on all the Plantroom #1 condenser fans. These will be configured so that all fans run at as low a speed as possible. This will reduce energy consumption and also minimise the noise in the surrounding work areas.

▼ The energy consumed by the axial flow fans on the condensers varies to the 3 (cube) of the speed.

Estimated savings by reduced condenser fan speeds would be 7.5kw average over the year.

Trial on power consumption of 15kW drive on Plantroom #2 Aquacool condenser, manually operated the VS drive over its speed range to produce the following power consumption figures at different operating speeds: 5HZ—0.23KW, 10HZ—0.4KW, 15HZ—0.45KW, 20HZ—0.95KW, 25HZ—1.66KW, 30HZ—2.8KW, 35HZ—4.2KW, 40HZ—6.26KW, 45HZ—8.8KW, 50HZ—12.6KW.

Annual electrical energy saved: 65,520 kWh
Annual electrical cost saving: $6,879
Cost of implementation: $25,000
Simple Payback: 3.6 years
Annual CO_2 emissions reductions: 94,610 kg

Box 14: Tank Agitator Selection

COMPANY: Southcorp
SITE: Lindemans—Karadoc Winery, Murray-Darling Region

▼ Install tank agitators that minimise energy consumption while achieving effective mixing

Background

This project set about to trial the latest designs being offered by various manufactures to enable the selection of the most suitable tank agitator unit to satisfy our specification.

Implementation and Outcomes

Each agitator was installed as per the manufacturer's specification in a 270kl tank. The tank was then filled with base white wine and the concentrate added in the bottom of the tank. The agitator was then run. Samples were taken at set intervals to determine how well the agitator had mixed the tank.

- The standard agitator in use for a 350kl tank consumed 4kW while the new units consume 1.1kW.

As a result of the trial, 18 low-energy units were purchased and installed in the 350kl tanks prior to the 2003 vintage. In future, all agitators purchased will be of the low-energy design. Assuming that each agitator runs for a total of 504 hrs/year, the energy consumption difference is:

Old style agitators (504hrs/yr x 4kw x 18tanks) = 36,288kWh
New style agitators (504hrs/yr x 1.1kw x 18tanks) = 9,979kWh
Annual electrical energy saved: 26,308 kWh
Annual electrical cost saving: $2,762
Annual CO_2 emissions reductions: 37,988 kg

Lighting efficiency and control

Up to one fifth of a winery's electricity budget is spent on lighting, yet much of this expense is unnecessary. New developments in lighting technologies can help cut lighting costs up to 80%.

Box 15: Site lighting opportunities

COMPANY: Southcorp
SITE: Lindemans—Karadoc Winery, Murray-Darling Region

▼ Review area lighting requirements and implement savings measures

We looked at the lighting on site with the view of finding opportunities to reduce usage and improve efficiencies. Several projects have been identified:

- Promoting energy conservation behaviours to turn off lights and computer monitors through the use of stickers located at visible points and bulletin notices.
- Installing lumitrols to control the lighting in Cellar.
- Engaging a consultant to review the lighting on site to identify opportunities where improvements can be made.

Lumitrols have been installed to turn off the lighting in the Cellar. They have been set-up so that the lights are turned on manually when required, but turn off automatically when the light lighting is no longer required. The estimated savings over a one-year period consisting of 284 days operation with a total load of 12kW at 10.5cents/kWh and assumed reduction of light on time of 20 mins per day equates to a saving of $120.

The packaging lunchroom was identified as having an excess of light: 28 x (2 x 40watt fluros). By cleaning the fittings and turning off 1 tube in 20 fittings, a saving of 800 watts per year has been achieved. When losses are included, that equates to around a 900 watt reduction. Lights operate 24hrs/day 6 days/week, which converts to a saving of 6600kWh/yr or around $706.

Annual electrical energy saved:
— Southpark lighting 136kWh
— KPC lighting 6,600 kWh
— Total saving / year 7,736kwh

Continued next page

Box 15: (continued)

Annual electrical cost saving: $826
Cost of implementation: $1,014
Simple Payback: 1.2 years
Annual CO_2 emissions reductions: 11,170 kg

COMPANY: Hardy Wine Company
SITE: Stonehaven Winery, Padthaway Region

▼ Examination of energy consumption by site lighting and development of indicators

When the numbers were crunched on the number and rated power of the fittings, it was found that 108 x 450W lights (48.6 kW total) contribute 8% to the annual power bill. The security lights contribute 0.36% per annum of this total lighting energy consumption.

Indicator	Measure to be assessed	Performance Indicator
Physical lighting effectiveness	No. of fittings required to light a given area (zone)	No. of fixtures/m^2
Quality of lighting	Luminance	cd/m^2 (cd-candela) or lux?
Lighting power effectiveness	Wattage power of lights required to light a given area (zone)	W/ m^2 for each zone
Lighting zones with EMS (energy management system) in place	No. of lighting zones with EMS in place out of total no. of lighting zones	No. with EMS : Total No.

4 Towards Best Practice New Winery Design

Selection of outcomes and thinking from the new winery design Big Energy Project (BEP) workshop

The second Big Energy Project two-day workshop focussed on production performance, energy and water efficiency and functional design for a new winery. Participants spanned the production, winemaking, maintenance, project management and environmental management functions of The Yalumba Wine Company, as well as several external technology and equipment specialists.

The points and discussion in this section reveal the thinking, ideas and issues generated during the workshop and indicate how some of the key energy efficiency considerations fit together in the context of building a winery at a new development site. Energy efficiency initiatives undertaken by Yalumba in their design of a new winery are described at the end.

Workshop participants selected four key areas for consideration in relation to energy efficiency in new winery design;

- Process control and modelling
- Energy end use and alternate sourcing
- Buildings
- Maximising yield

Process control and modelling

Understanding the way a winery as a whole could work can inform a raft of different aspects of building and operating a new facility. Below are several different ways of understanding the process of making the wine.

Winemakers process model

Most winemakers already have a general model of the grape inflow and processing stages. This model is used to help plan when various tanks and equipment will be free. It is thus used as a simple scheduling tool. This tool can form the basis of both a more complete and formalised scheduling tool for a new site, as well as provide input to other activities required to bring the site online. Existing models can be enhanced to model specific wine styles, winemaking methods and specific situations such as peak grape influx and other peak demands on processing equipment.

Process flow diagram

A process flow diagram is a schematic line diagram that includes all the pieces of equipment on the site and their interconnection. This is an essential first step towards building more useful models of how a site will work. A process flow diagram should be built from the existing winemakers' model, as grape input is the start of the process. Process conditions such as temperatures, flow rates, and residence times are generally included in the diagram.

Mass and energy balance

Mass and energy balance is based on a simple idea: what goes in must come out. Completing a detailed mass and energy balance can provide insights into where losses really happen and which processes are creating waste. Some of these are intuitively obvious, but a formal chemical engineering exercise to quantify heat and mass balance will inform both design and operation of a new facility.

An equipment spreadsheet can be built based on the process flow diagram and mass and energy balance used to model the response of the winery to changes in operating conditions. In effect, if each piece of equipment has a functional representation on the spreadsheet, then it is possible to 'see' wine passing through the various items of equipment. This is invaluable in identifying bottlenecks and rectifying them, as well as identifying the most used equipment and pipes enabling them to be located in the premium spaces. Less important or less used equipment can thus be placed in other less central spots. The sizing/specification of equipment can be later added to this spreadsheet to assist with ordering. Pipe sizing and pressure drops, etc can also be generated to inform pump specification.

Automation

There may be a desire for automated monitoring and data gathering. This can assist with good decision-making for operators, as well as formalising a system for quality and performance tracking.

Scheduling tool

The above process models feed into scheduling and production planning because they help in building understanding of both the available capacity and how that will become available over time. They allow tracking of current production and when vessels and equipment will become available, enabling quick 'what ifs'. The scheduling procedure can extend to accommodate post-vintage preparation for bottling.

Getting what you want—a design review team

When embarking on the venture to construct an energy-efficient, environmentally-sound winery, it is worth establishing a 'Green' review team mandated with the task of ensuring that the design and construction achieve the best possible outcome. A structured review process will help to ensure that environmental goals are achieved and existing best practice is achieved or bettered.

Energy end use and alternate sourcing

This is a broad topic, so several key aspects are considered here: firstly, the pros and cons of cogeneration; secondly, managing peak demand, particularly cooling grapes/must; thirdly, thermal storage. Finally, a few sundry items are presented.

Cogeneration

The argument for cogeneration revolves around identifying a valuable way to use heat produced while generating electricity. The temperature from diesel fired engine driven cogeneration equipment is about 80–85°C off the cooling jacket, and possibly up to a few hundred degrees off the exhaust manifold. Other options include micro-turbines (in the range up to 50kW electrical output), and a little further in the future are fuel cells. Both these are higher temperature devices.

Options for using heat at a new winery include: heating wash water to around 50–55°C; heating waste-water to around 25°C to speed treatment processes; distilling waste-water for recovery; and for absorption or ejector cooling. Heating water for cleaning or prior to treatment are not large users of heat. Heating hot water for cleaning can come from de-superheaters on refrigeration plant. Distilling water is a very heat energy intensive way to create clean water. Absorption is the more usual approach but requires large engines to become practical. The intention of cogeneration is to use gas that would have been burned anyway, not to create a use for waste heat.

Another way of shifting electrical load to other energy sources is by using a gas engine to drive refrigeration compressors directly. This idea suffers similar problems as electrical energy cogeneration, in that there is insufficient requirement for heat. Aside from not having a necessary and valuable load for low grade heat, there is the cost of piping gas to a new site.

Other factors that influence cogeneration or peak gas-fired electricity generation include possible reduction in insurance costs if on-site generation is available to maintain basic services; possible contractual arrangements with electricity retailer to reduce power demand at times of high system load; or demand for heat by a neighbouring facility that exists or could be developed. Also, if the cost and effectiveness of cooling technologies using waste heat declines over time, cogeneration may look more attractive.

Managing peak demand

Refrigeration load is a dominant factor in peak electrical demand. In designing a new winery, there is scope to shift some of the fermentation loads across the day, provide supplementary pre-cooling for must, and create thermal ice storage for must chilling.

Starting with pre-cooling must, the primary options are evaporative cooling and ice storage. They are not mutually exclusive and in fact may be complementary. Ice storage works by providing a load for the refrigeration plant to fill in the troughs in the process cooling demand. In other words, a smaller refrigeration plant runs at full load all the time by creating ice when spare capacity is available. The ice is then used to make chilled water for circulation to the point of process cooling. A possible alternative is not to distribute the cooling but to pass the must lines through the ice storage vessel prior to trimming in a conventional heat exchanger. In this arrangement the must temperature change would be controlled by modulating the pumping speed (ie, residence time).

A point to note is that during the bulk of the vintage crushing period, the lowest process temperature sought is significantly above the cold stabilisation temperature. All vapour compression refrigeration equipment performs better as the evaporator (ammonia side) temperature is raised. Basically, the compressor does not have to do as much work to raise the temperature (pressure) of the gas through as large a temperature lift. Higher evaporator temperature means higher efficiency or more capacity or maybe a bit of both. This is a very important concept in the planned operation of the refrigeration plant.

Associated with these refrigeration load management techniques will be a requirement to integrate with the control systems across the plant. The ability to know various loads and shed non-essential loads will be an increasingly important management tool. The benefits are to be able to plan contingencies for power outage and for managing peak demand to lower running costs. In addition, product quality and production efficiency improvements are likely to arise with improved monitoring, recording and control systems. This has been a common experience at sites where upgrades have been made with operational personnel involvement. (See the section on process control and modelling above.)

Pre-treatment module for must

Peak refrigeration load is often created by the need to quickly cool must produced from warm grapes that have just been crushed. Strategies that allow pre-cooling of the grapes or must, or reduce peak demand for cooling of the must, can save refrigeration capital costs and reduce the consumption of electricity at peak tariff charge rates.

From the previous concept of load management emerges the idea of a pre-treatment module for must cooling. This could be a system perhaps around the size of a shipping container (or appropriate size for the typical crush tonnages) with fans in the lower sides and vented at the top. Provision would be made to trickle water across an array of product pipes in the middle layer of the box. That water could be chilled by passing it through an ice bank, or by using a water sump and switching on the fans to create an evaporative cooling effect similar to a cooling tower, or using irrigation water/bore water for pre-cooling. The most appropriate system would need to be designed for the specific conditions. This system could also use warm water to heat must later in the vintage if necessary.

The possibility of using evaporative cooling in this way is extremely attractive because the match between effectiveness of the technique and demand for cooling is very good. Grapes received at high temperatures can have this higher level of heat removed, without using a high energy consuming refrigeration system, prior to final cooling in a conventional must chilling system. As a result, the design temperature (and therefore the size) of the must chilling arrangement can be made smaller, saving on capital.

Sundries

- Solar hot water for use within the winery may be worthwhile. If not, then since they are able to be retro-fitted, design should consider possibility of solar hot water (SHW) to avoid simple and preventable obstacles if it becomes attractive in the future. SHW on amenities is likely to be viable now. A local SHW provider should be able to advise on this now.
- Alternative to SHW is the use of local instantaneous (LPG) units or central heat pump systems. Solar hot water will have to be carefully compared with other water heating options. Heat pumps are efficient users of electricity, but greenhouse performance is not superior to gas when coal fired power is used due to the large outputs at the power station. Note that hot water will be sourced from the refrigeration plant and is likely to be adequate for current planned needs. Hot water cleaning may alter this.
- Pipes → pressure drops in lines. All pipes from product lines, refrigerant, water, fire fighting pipes, etc should be designed for minimum pressure drop and pumps then sized according to volume flow and pressure drop expected. This will mean smaller and cheaper pumps to buy; better power factor due to more fully loaded motors; and reduced wear and tear.
- Allow optimal piping in layout. Make space for adequate pipe sizing. Specify minimum radius and do not allow sharp bends. Reduce the number of bends and length of runs. These details will add up to reduce the size of the electrical supply infrastructure from the transformer right through the switch gear, cable sizing to the end uses themselves.

- Review of planned electrical capacity requirement and further inquiry to the local distribution company may show that as maximum demand rises, there will be particular price points at which transformer upgrades are required. These points should be known for sensible planning and design decisions, as using efficiency options to avoid the need for transformer and infrastructure upgrade can be the best strategy.
- Energy generation from renewable (wind and solar) sources include symbiotic activity such as outsourcing with a wind farm operator. The evolving electricity market allows this type of arrangement and may be a successful way of sourcing greenhouse-free skills/experience for the renewable energy technology.

Buildings

Capturing rain water

Rain water capture and segregation of stormwater including a first flush diversion system has benefit. The water can be of good quality, potentially useful for tank rinsing and cleaning. Covering the winery allows better control of spills and external washdown run-off. Segregating stormwater may be worthwhile in the interests of keeping this potentially low contamination water separate for suitable uses. Mixing all waste streams together and including stormwater reduces the value of much of the waste water and increases energy use in the treatment before re-use or disposal.

Insulation/enclosure

The BEP workshop investigated the pros and cons of 1) enclosing the winery in a building and 2) insulating only the roof.

Enclosing the winery

The thermal argument for enclosing wineries is founded on managing desired process temperatures in fluctuating weather conditions. Essentially, there is less surface area exposed to ambient conditions (in particular, solar radiation and hot winds). When the winery is enclosed in an insulated building, it reduces the environmental heat load placed on the refrigeration plant.

Some negatives commonly reported for an enclosed winery tank farm include:

- OHS impacts on work environment
- exhausting the ferments (CO_2)
- cleaning the air in the building
- removal of moisture to mitigate against mould
- radiant heat transfer between tanks that effects the individual control of tank temperatures
- potential loss of control in maintaining tanks at different temperatures

While many of these problems can be addressed with adequate control of humidity in the building, certain issues need addressing. It is also important to consider where the benefits arise when considering buildings to house a winery.

Roof only

Many of the benefits of having a winery inside stem from it being under cover, rather than entirely enclosed.
The benefits of a roof are:

- Potable water capture
- Potential creation of microclimate by misting water underneath creating local evaporative cooling, with captured stormwater a possible source for misting requirements
- Improved visual/aesthetic appearance; eg, the silhouette using rolled Colorbond to mimic the local environment form and colour
- Improved working conditions, especially reduced exposure to the sun, cooler environment during hot days, dry working conditions year round
- Containment of light spill at night, especially during vintage
- Green barriers such as vines on trellis a short distance away from the roof, enhancing microclimate by moderating air flow in strong winds. Careful placement of these 'walls' should allow natural light to enter the perimeter of the covered space, and in fact would allow more light in during the winter than summer.
- Opportunities for solar energy capture devices in the future, with roof orientation allowing north or north-west capture of solar energy by photo-voltaic panels or thermal hot air/water heat collectors in the future

- Daylighting provided with clear roof sections, with movable shading to control heat gain and/or deal with excessive light or glare. Reducing direct solar gain to tanks is good from a thermal/refrigeration point of view, but also helps with reducing glare for operators when working near white tanks.

Budget costs for roofing are estimated to be half that for an enclosed building. The insulation requirements are for simple reflective foil, as the intention is to reduce radiant heat gain from the sun. A light-coloured roof with this foil could provide effective heat protection.

Layout

Site layout should be considered from three primary perspectives: how grapes will be received and processed during vintage; during wine preparation; and for delivery or exit from the site.

An interesting concept is using green belts. These could be arranged between different functional areas, such as crushing, grape receival bays, tank farms, and utility buildings. They would add to the aesthetic appeal and enhance working conditions, while providing reserve space for special or unexpected pieces of equipment needing to be installed. Also, tanks could be spread out a little to give operators space to move without bumping valving and agitation motors on adjacent tanks.

Service alleys could have colour-coded drains for various flows. These might lead to an industry standard (a similar concept perhaps to green for water, pale blue for compressed air, and red for steam in industrial piping).

Maximising yield

Cross flow filters

Cross flow filters could replace the need for centrifuges. Approximate energy saving over centrifuge could be a 50% reduction in energy demand and consumption. The process would take about the same amount of time, while the capital cost of centrifuge and cross flow clarification equipment are similar. Stainless steel and titanium metallic membranes for cross flow filters were identified in the BEP workshop as being more robust and having better self cleaning properties for both wine and first stage treatment of waste water. Final separation would still need a further separator to remove the remaining liquid from the sludge exiting the cross flow or centrifuge. Conventional decanter or belt press are likely options.

Pigging systems

Pigging systems should be used on new sites having considerable processing capacity. Specification of a single pipe size and minimum bend radius, as well as design for pig capture are critical to making this efficient product-handling procedure effective and efficient. A fundamental principle to establish is how best to move the pig through the pipe. Options are the next product where possible, rinse water or compressed gas.

Reticulated CO_2 venting system

Consider a reticulated CO_2 venting system—although it is not essential in a design that does not include a building. If included, the manifold, or collection pipe, could be designed so that capture of CO_2 can occur in the future. In addition, space for the capture, cleaning, compression and storage should be allowed in the site layout plans. Note that breweries capture their CO_2 by-product and some sell their excess. Also, organically-derived CO_2 has the potential to be of higher quality than petrochemically-derived CO_2. The expense of capture, processing and storage may be worthwhile in the future as a cost avoidance and quality assurance measure.

Hot water cleaning

Hot water cleaning requires considerable thought, taking into account the potential for tanks to collapse inward due to vacuum when they cool down, as well as from an OHS view. Irrespective of cleaning temperature, separate caustic piping may make sense. An attractive alternative to fixed cleaning systems is having a number of mobile cleaning trolleys with a knock-down spray head on an arm, with dial-up dosing for the cleaning agent of choice. These reduce fixed piping costs, provide flexibility and adaptability.

Yalumba Wine Company energy efficiency initiatives in winery design

The Yalumba Project Team is incorporating a number of energy efficiency initiatives identified in the Big Energy Workshop into the design of their new winery (see Box 16):

Box 16: Initiatives to bring energy efficiency into new winery developments

COMPANY: Yalumba Wine Company
SITE: New site, Barossa region

▼ Establish the broad design parameters and efficiency goals for the new winery

At Yalumba, the case for a new winery grew from review of current operating difficulties including overcrowding and capacity at their existing site, a desire not to further expand this historical site, and to bring all production 'in-house.'

The first steps in the new winery Big Energy Project involved:

- Establishing the current operational performance or baseline operating conditions for existing operations. These are likely to be well known, and they form a baseline from which to describe the performance targets and expectations for a new winery.
- *Settling on the headline parameters for the new winery.* This is obviously a longer term strategic decision based on expected growth, market positioning, and production requirements. Yalumba appointed a project team at this point to carry the new site through to its first production. The new winery team started by defining the purpose of the new site and its relationship to the existing site. They also drafted a 'workhorse' new site plan to identify the main features and equipment that would be required.

▼ Conduct an internal stakeholder review and draw on the expertise of external specialists in refining the proposed design.

A cross functional winery staff team was drawn together to conduct a review of the new site design prior to settling on the final proposal to be put to the company board and then to the local council for design approval.

The process for this review included:

- Develop and circulate a ten page pre-reader in preparation for a two-day intensive workshop.
- Identify suitable external specialists as well as key internal stakeholders to participate in the review.
- During the workshop:
  - — Build a broader and deeper 'vision' for the new site built on consideration of what it will be like to actually work in it and how it will complement the business imperatives already included in the initial project headline parameters.
  - — List potential improvements and opportunities and cluster them into four themes for more rigorous consideration.
  - — Draw on the expertise of external specialists in areas such as refrigeration, engineering, equipment suppliers, water treatment, and energy markets. The cross fertilisation of the internal expertise applied to the new site design and specification is not to be underestimated. Not only is there a vast pool of knowledge to draw on, but doing so builds common understanding of what detail aspects of the operation of the new winery will mean in practice.
  - — Consider the interaction of the various energy and greenhouse saving improvements with each other, as well as with the winemaking process. Also consider changing the winemaking process to improve environmental performance.
  - — Refine the list of opportunities to an achievable list of potential improvements and new ideas for inclusion in the final design. A more complete description of the outcomes is included in Part 4.
  - — Assign time-lines for follow-up actions, and nominate/volunteer those responsible for carrying outcomes forward.

▼ Refine the design to incorporate improvements over the initial 'workhorse'.

Workshops with twenty people rarely reach detail decisions, so the project team had considerable work to do coming out of the two-day BEP workshop. Yalumba took the specific workshop outputs, as well as the general intent and objectives of the new Yalumba winery, and came up with a final design concept for the new winery. Changes over the original 'workhorse' site plan included:

- Greenbelts through the working area of the site. These will provide relief from the 'industrial' feel of modern large wineries, as well as providing plenty of space for utilities expansion if required.
- Several roofed areas. These will reduce light spill, collect rainwater, shade working staff, reduce glare in the workspace, provide a surface for future solar collection, and soften the silhouette of the new site.
- Provision for extra water holding tanks to enable separation of waste-water streams for multiple use.
- Provision of space for a must pre-cooler that will use evaporative cooling to reduce peak refrigeration demand on the hottest days.
- Re-aligned tank distribution to reduce noise envelope size in critical directions as well as enabling expansion of tank farm size.

The project team put the final draft design to the Company Board and then to the local council, EPA etc. for development approval. The new site was approved on 6th May 2003.

5 Concluding comments

Applying the Energy Efficiency Best Practice approach, wineries participating in the Wineries of the Future project are experiencing real change in the way they view and deal with energy. As shown by the energy management initiatives described in Parts 3 and 4, companies are achieving significant energy cost and greenhouse emission savings and in some cases reducing previously-expected capital expenditure investment.

Through the two Big Energy Projects and Best Practice People and Processes workshops focusing on the role of site Energy Management Teams, participating wineries are:

- developing proactive and strategic approaches to managing energy use and greenhouse gas emissions;
- building internal capacity to identify and implement energy efficiency projects through Energy Management Teams who will drive energy management on an ongoing basis;
- developing staff understanding of internal processes and strategies for gaining internal support for energy efficiency projects;
- raising organisational awareness of the opportunities presented by energy efficiency projects, as well as increasing understanding of how these projects can support existing production and other business issues;
- identifying and implementing 'big step 'innovative energy efficiency projects delivering measurable financial savings and greenhouse gas reductions;
- recognising that improving energy efficiency can offer spin-off benefits of far greater value than just the energy saved, including reducing capital investment, improving product quality and productivity, reducing risk and enhancing organisational performance;
- seeing the value of applying the Energy Efficiency Best Practice approach to other aspects of their business.

Toward the Future

The publication of this Guide concludes the Energy Efficiency Best Practice program's funding of the Wineries of the Future project. However, the EEBP approach is continuing through

- implementation of already-identified and future initiatives by participating wineries
- projected self-funded roll-out of the EEBP approach to their other sites
- sharing project outcomes and opportunities with wineries throughout Australia

The materials produced by the Energy Efficiency Best Practice program are currently available on the Department of Industry, Tourism and Resources website www.industry.gov.au/energybestpractice. In addition, a stand-alone innovation and training resource kit providing information on running the Big Energy Project (BEP) and Best Practice People and Processes (BPPP) will be provided via the internet or CD-ROM.

The achievements of the Wineries of the Future project and the best practices identified in this Guide are a result of the commitment of all involved to exploring a new approach to energy management. We would like to thank everyone who has participated in this very exciting and successful program.

6 Appendices

Appendix 1: Energy Efficiency Best Practice Approach

(Big Energy Project, Best Practice People and Processes and Energy Management Team)

Big Energy Project (BEP)

Big Energy Project (BEP) is designed to achieve 'big step' energy efficiency outcomes. The BEP process develops practical and innovative solutions to technology challenges with a particular focus on achieving effective energy efficiency outcomes. It is targeted at companies looking to:

- invest in new plant or equipment
- upgrade existing systems
- develop innovative technology solutions for problems that do not present obvious practical answers or that cross organisational boundaries.

The BEP process brings key company staff and external technology specialists together to develop a 'whole of system' understanding of the issue in question, as the basis for jointly developing new and innovative solutions. BEP uses stretch targets like 50 per cent savings and comparing current energy use to ideal energy use to generate innovative, yet practical, energy savings opportunities. Typical outcomes include a reduction in operating costs and greenhouse gas emissions from 20 to 50 per cent, as well as other benefits such as reducing capital investment costs, improved organisational communication, improving product quality and achieving productivity gains.

The BEP process

Lean organisations and a multitude of competing priorities mean that opportunities for significant innovation are often lost, along with the benefits of energy efficiency. Major decisions are often limited by the prior experience of internal staff and external consultants that are under pressure to provide 'quick solutions' without adequate scoping of a problem or exploration of alternative options. This is particularly the case with traditional energy efficiency approaches, which often focus on single items of equipment and goals of five to twenty per cent savings, with paybacks of two years and an internal rate of return of 50 per cent. Traditional approaches to business cost cutting look at the most expensive cost/unit resources first and many other input/unit costs come in higher than energy. In both cases the opportunities for maximising cost reductions and productivity improvement through synergies with energy efficiency are often lost.

The BEP process offers a proven approach to developing new and innovative solutions that incorporate energy efficiency considerations. The process acknowledges that:

- Technological and people/organisational issues should be addressed together
- Complex problems should be understood and explored from a 'whole of system' perspective
- Effective solutions require dialogue between a range of internal stakeholders who each provide an important perspective of the problem in question
- External specialists can bring fresh eyes to existing problems or opportunities. They should not just be used to provide answers, but to work collaboratively with internal staff to identify 'best solutions'
- Innovation and larger than expected savings come from aiming for stretch targets, exploring existing energy use relative to ideal energy use and identifying the core purpose of using energy in the first place.

The BEP core process is made up of six key steps, which typically occur over a 15-week timeframe. Within each step there is flexibility to ensure that the process matches the specific requirements of each organisation.

1. Project set-up and identification

Companies may face a variety of energy issues. In some cases, energy wastage has been identified, but comprehensive and cost-effective solutions have not been found. Many companies need to invest in new plant or equipment, or to upgrade existing systems. As these investments may have to accommodate environmental concerns, it is important that they be energy efficient and that they contribute to improvement in productivity and quality.

A project is determined through discussion between internal company stakeholders and consultants experienced with the BEP approach. There needs to be a defined need, something that matters to the company and participants and is going to generate substantial savings. The BEP is not set up to solve all the issues on a site. In some cases preliminary discussions and work undertaken by the consultant will outline the impact on the company of current energy market and greenhouse policies, providing the company with the justification for a stronger focus on energy efficiency issues. For example, lists of energy efficiency opportunities may be re-examined in the light of changes to the energy market and environment policy presenting greater opportunities or risks to the organisation than was previously perceived.

2. Company Commitment

Before the BEP proceeds the company needs to be committed to implementing the improvements identified from the process. The company also needs to ensure that the right people in the company are behind the process, will allocate the appropriate human resources and are committed to implementing improvements identified and reporting on outcomes achieved. Senior management with financial delegations and site and operations managers need to be behind the initiative.

It is also vital that the right people are involved in the workshop itself. Senior managers, operations and energy managers and suppliers of services/equipment that use energy all need to be part of the process. Since solutions may involve action that crosses traditional organisational boundaries and may be quite radical, they will need to work closely together and be committed to implementing new and challenging solutions. Typically, four to six company representatives from the company are involved in the workshop and it is recommended that they be active participants rather than observers.

3. Background Paper and Identifying Technical Specialists

The background paper provides an opportunity for the topic to be scoped by an external consultant. The paper takes a whole of system/production process approach—looking at the production process from an energy flow perspective—starting from the end-use service required of energy and working back through the means to supply it and finally to the purchased energy service. The background paper brings together existing data and information on the issue in question, both from within the company and from sources around the world. It also highlights potential areas for investigation.

Typically, the background paper reviews the problem and opportunities available by asking and exploring:

- what is the essence of this system, what are the basic principles underlying it—physically, chemically, materials and energy flows
- If we were trying to do this perfectly or using zero energy—benchmarking the ideal, how would we do it? This can be compared to actual energy used and the greatest areas of wastage identified. In malting, for instance, it was realised that the process is one of heating, cooling, heating and then cooling again and yet there was little or no reuse of heat
- What am I using energy or this process to do—could I achieve the same outcomes in a different way?
- Broad definition of the 'problem or opportunity'
- Production requirements for energy use and associated systems, as well as any constraints or issues related to existing plant, industry circumstances, etc.
- Current operating efficiency in comparison to best industrial and theoretical benchmarks
- Options and alternatives in broad terms

The background paper is intended to open up and identify opportunities and possibilities. This is very different from the usual consultant report, which tends to focus on narrowing down options to a shortlist based on many judgements (both conscious and unconscious). The process of preparation of the background paper is also used to identify the internal and external stakeholders who should be involved in the subsequent BEP workshop. The final paper is also used as a means of providing each of those stakeholders with an overview of the issue in question.

4. Workshop Day 1—Understanding the system

Prior to the workshop starting, external specialists, facilitators, ITR personnel and ideally internal workshop attendees, undertake a site visit. The site visit should be the first part of the workshop; if it involves a lot of time, it may occur late the day before the full workshop commences, but ideally it occurs on the morning of the first day. The questions that outsiders raise as they tour the site often start the process of questioning existing procedures that on-site staff take for granted. The visit also allows specialists to focus their general knowledge onto the specific circumstances. And of course, it's a chance for workshop participants to start to get to know each other! A workshop may also be formally launched to publicly acknowledge the commitment and leadership of senior management from the company and government.

An early session after the site visit sets the scene through a presentation, which highlights the risks, and opportunities the business faces as energy markets evolve and greenhouse policy develops. This session is important in that it clearly identifies the risks and opportunities to be had by either avoiding or addressing energy. It also provides participants with a perspective on what areas are important to focus on and encourages participants to consider a longer term, more strategic perspective on energy issues.

The first half day of the workshop works through the background paper incorporating the perspectives of the external specialists and internal staff, so that a consensus understanding of the system in question is developed. An energy flow diagram or production flow diagram is drawn up with energy use associated with each phase of production. External expertise may provide insights into how the same objectives could be achieved using alternative mechanisms. A process facilitator ensures that there is an open and supportive environment in which perspectives can be explored and assumptions gently challenged.

Dialogue between internal staff, such as production, engineering, maintenance and energy service areas, brings a range of internal perspectives to the topic in question. The external specialists provide broader perspectives. Overall, the dialogue ensures that core assumptions that may be held within a functional group, the company or industry overall are challenged, opening up greater opportunities for new and innovative solutions.

5. Workshop Day 2—Developing solutions

Building on the consensus view of the system established on day one, throughout day two, internal staff and external specialists work together through a series of small and large group activities to identify and develop possible solutions and paths for their application to the specific circumstances of the organisation. After a night's sleep (or research!) many more opportunities may be thought of, and day two really explores which ideas are going to deliver some big gains and which are worth delving into more deeply. The options with most potential are then thoroughly evaluated within the framework of the company and the specific sites, and action plans are developed.

Action plans might include the immediate areas of action, areas for further work and areas of potential R & D. If suppliers have been involved, they may also have identified practical ways in which they can improve their equipment. The technical specialists have also picked up areas of potential opportunity and further explored and developed these in their own research organisations.

In many cases, there is obvious potential for immediate application. The action plan would focus on allocation of responsibility, resources, and timelines for progress. In other cases, a need for research partners or additional monitoring and analysis may be identified. In several cases, equipment specifications provided to suppliers were to be revised and used as a basis for redesign or incorporation of new features in future purchases.

6. Outcomes Report and follow-up

An outcomes report summarises the processes, key findings and provides the organisation with guidance on the next steps towards energy savings. Typically a variety of outcomes result: some ideas are ripe for immediate implementation, possibly in existing plants; other ideas require further evaluation or development, or will be incorporated into future developments. The company and consultant generally develop a follow-up schedule together so that progress is monitored and any implementation problems are addressed.

Characteristics of companies suitable for undertaking a BEP process

The BEP process is suitable for companies with energy-intensive processes where there are opportunities for innovation that will lead to significant savings: these savings may come through replication at many sites, or through application in large plants. Previous BEP processes in different industries have addressed issues as diverse as industrial refrigeration, new winery design, pasteurisation processes, bakery oven design and cogeneration.

The types of companies that can benefit most from the BEP process are those in which:

- the culture of the company is open to change and wider thinking
- there is an enthusiastic internal BEP sponsor to promote the BEP approach and implementation of the outcomes
- the project is of current concern for the company and implementation is likely to take place in the short term.
- The company has clear goals with regard to the environment, energy or greenhouse
- there are systems in place to measure, monitor, recognise and communicate energy performance improvement
- internal stakeholders including corporate senior management, site management and key energy and operations personnel are committed to identifying and implementing major savings opportunities
- open to significant capital investment and greater than two year payback periods if the benefits are significant

BEP is not able to solve all the technical and energy management issues at a given site; rather, the process focuses on a specific process or technology. When BEPs try to do too much and with too many people who are not responsible for delivering outcomes, they may not work as effectively. Lack of support from key people in an organisation can also seriously impact on the success of BEP.

Best Practice People and Processes (BPPP)

Best Practice People and Processes (BPPP) is an organisational development program that aims to build capacity within organisations to apply and sustain effective energy management practices. BPPP helps organisations redefine best practice in energy management and to achieve financial savings and greenhouse gas reductions through innovation and training interventions.

BPPP is targeted at organisations where:

- site-level energy expenses are greater than $750,000 annually or there is significant energy use across a large number of sites
- there is senior management commitment to improve energy and environmental outcomes
- there is a commitment to developing the internal capacity of staff to manage energy more effectively

The underlying characteristics of BPPP that differentiate it from other energy efficiency related interventions are its focus on:

- developing an organisation's internal capacity to identify and implement energy efficiency projects in the short and medium term
- addressing the internal communication and cultural barriers that limit the identification and implementation of energy initiatives through an emphasis on cross-functional and cross-organisational activity
- ensuring that the program is tailored to the existing capability within the organisation with a particular emphasis on linking energy management to current production and business imperatives

BPPP Outcomes

BPPP aims to create both short and long terms wins for organisations that include:

- enhanced internal capacity to identify, plan for and implement energy efficiency projects
- motivated teams to drive energy management at site level
- productivity improvement
- enhanced understanding of production processes and the practice of implementing process improvement
- bottom line savings

The BPPP Workshops

The core element of BPPP is a series of facilitated training and project development workshops, divided into six modules:

Module 1: Potential Energy—Managing Energy Systems and Processes is the core module of the program. The module is targeted at a newly-formed or existing site-based Energy Management Team (EMT). Over a series of 5 half-day or day workshops participants identify and develop a business and implementation plan for a major energy efficiency project. They also develop a plan outlining their ongoing role in leading and driving energy management on site.

The role of the Energy Management Team (EMT) in BPPP

Most organisations have data collection systems associated with energy. To a greater or lesser extent they will be able to tell how much energy is used and what it costs. However, unless someone—individual or group—is accountable for managing the cost of energy, then energy use will remain a 'background' issue. People will just assume that it is a fixed cost component of plant operation or production output.

Establishing an Energy Management Team with specific accountabilities is the first step in reframing energy as a variable production input that can be measured, managed and improved in the same way that other aspects of production or supply are conducted.

Most companies will fall into one of four categories as far as an Energy Management Team is concerned:

- The Team is established and functioning well
- The Team is formally established but has lapsed or is struggling
- Responsibility for energy has been delegated formally to an Energy Manager or a senior manager such as the Site Services Manager who works alone within the existing organisational structure
- No team has been established and no individual has a formal role in energy management

Tasks and functions of the Energy Management Team (EMT)

The Energy Management Team has a range of tasks, depending on the level of internal support and the degree to which energy efficiency is on the 'corporate radar'. One effective way of gaining organisational engagement is to identify EMT projects that benefit the business in critical areas and also deliver energy savings. Projects in wineries, for example, that have a large energy dimension might address the critical areas of refrigeration plant capacity, product yield, or reducing water consumption and wastewater production.

Typical tasks of the EMT include:

- identifying current energy performance and understanding energy flows
- setting up effective monitoring and reporting systems and policies
- developing an organisation-wide Energy Management Strategy;
- ensuring the Strategy is supported at the Senior Management level, especially across internal barriers
- securing the support of front line supervisors and employees
- researching, designing and implementing projects and policies that will achieve energy savings;
- ensuring the Energy Management Strategy is integrated with other organisational processes such as supply and procurement, facilities design and construction, and other strategic management activities

Composition of the Energy Management Team

Depending on the size of the site/plant, a group of between 6–10 people may be appropriate.

To achieve an effective energy management strategy, the type of people who could be involved include:

- the Energy Manager or manager with formal accountability for energy management—if there is one
- a Sponsor—an executive or senior manager who will be available to support and promote initiatives of the Energy Management Team
- a Gatekeeper—someone who will be able to ensure cross-organisational support for the work of the Energy Management Team
- representatives from finance, facilities, supply or procurement, and planning
- marketing and public relations expertise to help promote energy management internally and beyond the organisation
- a Strategist—someone who is able to integrate the work of the Energy Management Team with the strategic and business planning cycle of the organisation

- key representatives from site services and production, as these groups comprise most of the energy 'end-users' and 'owners'
- front line supervisors and employees who understand the systems and processes of production
- outsourced services—for example, it is becoming increasingly common to outsource specialist services such as compressed air maintenance and nitrogen production.

Module 2: Make the Connection—Energy Management for Managers is a single workshop of 2–4 hours for senior management. It outlines current and future greenhouse and energy issues that affect business at a strategic level and links energy management to the organisation's business imperatives.

Module 3: Arc Up! is a 3-hour energy awareness workshop for operational workers and other staff within the organisation.

Modules 4–6: Steam Point, Ice Point and Air Power provide staff with technical information to help them understand their steam, refrigeration or compressed air systems and to identify where energy efficiency opportunities lie.

The selection and sequence of modules is adapted according to the specific needs of each organisation.

The BPPP Process

There are a number of important stages involved in ensuring that delivery of the workshop modules provides a strong foundation for ongoing energy management in the client organisation resulting in the achievement of quantifiable savings through energy efficiency projects implemented in the short to medium term. This process is summarised below.

1. Company Engagement

Once an organisation demonstrates a commitment to improving their energy management capability through development of people within the organisation, experienced BPPP consultants can be engaged to work with the company throughout delivery of the program.

As part of the engagement process organisations need to provide:

- a corporate sponsor as a key point of contact and to drive the program internally and provide ongoing support to energy management initiatives
- relevant staff to participate in and between workshops
- a commitment to implement identified savings where they are commercially viable

2. Pre-Workshop Assessment & Planning

To ensure that the workshops are effectively targeted to the needs of the company's people and sites, consultants begin with a half-day on-site assessment that considers both technical and organisational issues, which influence the detailed design and delivery of the program. Workshop planning takes place in consultation with the client organisation and on the basis of information gathered in the Pre-Workshop Assessment.

Key considerations at this stage are:

- data and knowledge gaps—significant gaps that may impact on the program require a strategy for addressing these limitations to be negotiated with the company
- selection and adaptation of workshop modules
- selection and make-up of an energy management team and other workshop participants to ensure an appropriate mix of cross-functional and cross-organisational participation and involvement
- identification of potential project areas that are of interest or concern at the site.

3. Workshop Delivery

It is important that the site provides a suitable training venue and time between workshops for participants to gather information and apply skills and knowledge developed in the workshops.

Throughout the delivery of the program it is important that ongoing communication exists between the consultants, corporate sponsor and site team leaders to ensure the program remains appropriately targeted and to ensure that as issues arise they are addressed promptly.

4. Post-workshop follow-up and support

Two follow-up workshops are generally employed in the months following the core energy management team training and project development sessions to ensure that the team is progressing as planned and to celebrate their achievements. In some cases ongoing coaching and mentoring can be arranged to support the implementation of identified projects.

5. Periodic progress reporting and evaluation

In collaboration, the company, site Energy Management Team and consultants develop a 3, 6, 12 and 24 monthly reporting program that monitors and evaluates outcomes such as potential savings identified and savings realised.

Appendix 2: Site Energy and Project Reporting Tools

The project and site reporting pro-forma tool is intended to provide Energy Management Teams with an effective way to internally record and report site energy efficiency initiatives. Documenting site summary details will also provide critical information that will enable better analysis of site/process energy performance and comparison of the energy efficiency and performance of sites. The project reporting tool is designed to support site teams to focus on investigating and documenting projects, while also ensuring that they have a mechanism to show the scope of their actions to gain proper recognition from senior management.

In addition, the documentation of projects by site teams will enable companies with multiple sites to transfer the learning and outcomes achieved through a single project at one site to other sites within their company.

SITE SUMMARY SHEET

(Processing, Production, and Energy Use)

Site Location	Site Name		Nearest Town		State	
Report Contact Details	Person Name					
	Title/Position					
	Telephone					
	Email					
Reporting Year/Date	Original Report Date		Date Updated		Data Year	

Production, Process & Developments Summary	White grapes tonnes crushed		Red grapes tonnes crushed	
	White juice import (kL)		Red juice import (kL)	
	White juice export (kL)		Red juice export (kL)	
	White wine output (kL)		Red wine output (kL)	
	Quantity of wine packaged (kL)		Type of packaging	

In this space: Please provide a brief overview of the production processes completed on-site. If some processing is completed at site and further processing is completed at another location or vice-versa, please detail where, what and the quantities involved (exported and or imported, red, white, juice, wine etc.). In addition, indicate any developments or major changes that are planned or being considered in relation to production at the site.

Continue over page if required.

Site Energy Use Summary

Site Annual Electricity Use (kWh)		Annual Cost ($)	
Site Power Factor		Annual Peak Demand (kW)	
Site Natural Gas/LPG Use		Annual Cost ($)	

In this space: Please describe what areas of the site are metered separately? (Please list the different meters and detail what processes, equipment or activities energy use are measured by each separate meter)

Are packaging activities separately metered for: **LPG** Y / N **Nat. Gas** Y / N **Elec** Y / N

Packaging Electricity Use (kWh)		Packaging LPG/Nat. Gas Use (include units)	

SITE ELECTRICITY and FUEL CONSUMPTION and COST PROFILE (BY MONTH)

Month Yr = 00-00	Peak Consump-tion(kWh)	Off-Peak Consump-tion (kWh)	Cost ($) from bills	Peak DEMAND (kW)	Cost ($) from bills	Fuel Use Type: Units:	Fuel Cost ($) from bills
Jan							
Feb							
Mar							
Apr							
May							
Jun							
Jul							
Aug							
Sep							
Oct							
Nov							
Dec							
Total = T Max = M Av = A	T: M: A:	T: M: A:	T: M: A:	M: A:	T: M: A:	T: M: A:	T: M: A:

PROJECT SUMMARY SHEET

(Energy Efficient Actions)

Project Name/ Focus				
Project Overview	In this space: provide a brief overview of the project, ie. the opportunity being addressed, and scope:			
Project Team	In this space: identify the key people driving the project:			
Baseline Data	In this space: please detail what baseline data and/or operating performance will be used to measure/indicate the impact/improvement of the project.			
	ENERGY SOURCE — TYPE ONE		ENERGY SOURCE — TYPE TWO	
	Energy Type (Elec./nat. gas/LPG/other)		Energy Type (Elec./nat. gas/LPG/other)	
	Supplier Name		Supplier Name	
	Fuel Price (include units, ie. c/kWh)		Fuel Price (include units, ie. c/kWh)	
	Site Usage		Site Usage	
	Project Baseline Usage		Project Baseline Usage	
	Project baseline as % of site		Project baseline as % of site	
	Contribution to peak demand		Contribution to peak demand	
	Estimated Potential for Saving		Estimated Potential for Saving	
Performance Indicator(s)	In this space: Identify and list the indicators that will show that the actions of the project have had an effect. In this space: Determine and list the performance indicators will be used to evaluate the amount of improvement.			
Post Implementation Data	In this space: Please explain what post implementation data will be collected and used to demonstrate the improvement. When will this be available, who will be responsible for collecting, analysing and reporting the results of this data.			

<table>
<tr><td>Approach used to address the following systems:

1. Communication and People
2. Technology and Engineering
3. Procedures and Policy</td><td colspan="2">In this space: Please provide details on your approach including, reference to 1, 2, and 3.</td></tr>
<tr><td rowspan="4">Project Implementation</td><td colspan="2">In this space: Please provide details of the implementation process for the project, remember this document is meant to assist others in the development of their own projects. The more detail you can convey here the more people can learn from your experience.</td></tr>
<tr><td>Design Work Done By (Suppliers/Internal)</td><td></td></tr>
<tr><td>Installation Done By (Suppliers/Internal)</td><td></td></tr>
<tr><td>Main Equipment Specifications & Brands</td><td></td></tr>
<tr><td>Results</td><td colspan="2">Please provide details in relation to what result has already been achieved and/or expected. This may be qualitative only or may be quantitative. In the case of expected results please quantify estimates and indicate when final quantifiable results will be available.</td></tr>
<tr><td colspan="3">Energy Efficiency Actions Summary</td></tr>
<tr><td rowspan="2">Energy, Emissions and Cost Savings</td><td>Annual Electrical Energy Saved (kWh)</td><td></td></tr>
<tr><td>Annual Electrical Cost Savings ($)</td><td></td></tr>
<tr><td rowspan="2">Energy</td><td>Annual Gas/LPG Energy Saved</td><td></td></tr>
<tr><td>Annual Gas/LPG Cost Savings ($)</td><td></td></tr>
<tr><td rowspan="2">Cost & Savings ($)</td><td>Cost of Implementation ($)</td><td></td></tr>
<tr><td>Simple Payback (years)</td><td></td></tr>
<tr><td rowspan="2">Greenhouse</td><td>IRR</td><td></td></tr>
<tr><td>Annual CO_2 emissions reductions</td><td></td></tr>
<tr><td>Other Benefits</td><td colspan="2">Please provide details of other benefits achieved by the project that go beyond energy efficiency; quantify if possible, for example improved production efficiency or capacity, greater sense of morale:</td></tr>
</table>

Appendix 3: Useful conversion, SI Prefixes and Symbols

Conversions

- To convert energy use measured in kWh from power measured in kW (where 1kW = 1 kJ/s) multiply power usage (kW) by time of operation in hours (Energy (kWh) = Power (kW) x Time (hrs)).
- To convert kWh to MJ, multiply by 3.6.
- To convert from litres to cubic metres (m^3) multiply the amount in litres by 0.001 to get an amount in metres cubed (m^3).
- To convert from litres of LPG to tonnes of LPG divide the amount of LPG in litres by 1962 to get an amount measured in tonnes of LPG.

SI Prefixes and Symbols Etc.

Symbol	Prefix	Multiplication Factor
E	exa	10^{18}
P	peta	10^{15}
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
c	centi	10^{-2}
m	milli	10^{-3}

Appendix 4: Summary of on-line information sources

At publication

Site has information relevant to:	Website hotlink and address
Energy Efficiency Best Practice Program (Department of Industry, Tourism and Resources) Motor Solutions Online	http://www.industry.gov.au/energybestpractice http://www.industry.gov.au/motors
Energy SA—Sustainable and Renewable Energy Industry & Commerce—Advisory Section: has been designed to offer current and comprehensive information and advice on energy efficiency and greenhouse mitigation measures for South Australia. In addition there are links to appropriate external web-sites and answers to frequently asked questions.	http://www.sustainable.energy.sa.gov.au
Industrial Energy Use: Energy is an important input to your business and opportunities to save energy exist across almost every type of energy use from motor systems to boilers.	http://www.sustainable.energy.sa.gov.au/dhtml/ss/section.php?sectID=61&tempID=7
Energy Management is making the best possible use of the energy consumed by organisations. A variety of tools are included here to assist you in this ongoing process.	http://www.sustainable.energy.sa.gov.au/dhtml/ss/section.php?sectID=63&tempID=7
Contestable Electricity Market Contracts—Overview and Brochure National Electricity Market—Understanding your Contract	http://www.sustainable.energy.sa.gov.au/pages/advisory/industry/elec_contracts.htm
Wine Production Energy Use—Overview and Brochure. South Australia's wine and brandy industry is an important segment of the state and nation's economy.	http://www.sustainable.energy.sa.gov.au/pages/advisory/industry/pdf/wine.pdf
Sustainable Energy Authority Victoria The Sustainable Energy Authority (SEAV) is a State Government Authority. SEAV's objective is to accelerate progress towards a sustainable energy future by bringing together the best available knowledge and expertise to develop leading-edge initiatives that significantly improve energy efficiency.	http://www.seav.vic.gov.au
The Energy and greenhouse management toolkit is designed to help businesses reduce their energy consumption and greenhouse gas emissions. The Toolkit provides information tools, case studies and guidance to help you achieve real cost savings, improved productivity, and compliance with legislation and licence conditions (if relevant). The Toolkit was developed by the Sustainable Energy Authority Victoria in partnership with EPA Victoria, and funded through the Victorian Greenhouse Strategy.	http://www.seav.vic.gov.au/advice/business/EGMToolkit.html
Sustainable Energy Development Office—Western Australian Government SEDO provides information on energy efficient products, best practice energy management and greater use of renewable energy for Western Australia.	http://www www1.sedo.energy.wa.gov.au/business.asp

Site has information relevant to:	Website hotlink and address
Publications Section The Sustainable Energy Development Office has developed a range of brochures to help businesses better manage energy consumption, as well as save the environment through reduced greenhouse gas emissions. The brochures provide some of the tools needed to assess opportunities for improving energy efficiency within your organisation.	http://www1.sedo.energy.wa.gov.au/publications.asp
Sustainable Energy Development Authority—NSW Government EDA runs a number of business programs, including the Energy Smart Business program, Energy Smart Government program and the Australian Building Greenhouse Rating scheme, to help NSW businesses, commercial buildings and Government agencies cut costs, save energy and help the environment. SEDA can help companies of any size Work Energy Smart. Here's how: • SEDA's **Energy Smart Business Program** helps companies with annual energy bills of $200,000 or more save money and help the environment through energy efficiency projects • **Australian Building Greenhouse Rating** (ABGR) scheme helps commercial building owners and tenants benchmark their greenhouse performance • **SEDA'S Energy Smart Government Program** assists NSW Government agencies to reduce energy costs and greenhouse emissions • **SEDA's Cogeneration Program** can assist your organisation save energy and greenhouse gas emissions through cogeneration. • **General tips** and information to save energy and money for your business,	http://www.seda.nsw.gov.au/ http://www.energysmart.com.au/wes/default.asp
Office of Energy—Queensland Government The Office of Energy is responsible for developing and implementing strategic policies, processes and legislative arrangements to further progress the development and delivery of energy to the Queensland community. The Office of Energy promotes sustainable development within the Queensland energy sector and is involved in a range of activities that reflect the importance of a sustainable approach. Programs for the built environment are being delivered by the Department of Public Works. A number of the initiatives and programs underway can be seen on their Building Division website. The Environmental Protection Agency's Sustainable Industries Division has a number of programs targeting household energy efficiency. More information on these programs can be found on their website or by calling the Queensland Government Energy Advisory Service on 1300 369 388 between 8am and 6pm. The Sustainable Industries Division also operates a cleaner production partnerships program for target industries, which includes energy efficiency.	http://www.energy.qld.gov.au/ http://www.energy.qld.gov.au/sustainable/index.htm http://www.build.qld.gov.au/ http://www.env.qld.gov.au/sustainable_energy/

Site has information relevant to:	Website hotlink and address
Australian Greenhouse Office, Greenhouse Challenge Factor and Methods Workbook Version 3—December 2001 The Greenhouse Challenge Factors and Methods guide contains technical information to help you prepare your cooperative agreement and progress reports. There is provision in the HTML version to make available in WORD format data on SF6 and vegetation sinks in the forms provided. It can also be downloaded as a PDF Document (220kb). This guide is designed to assist users calculate greenhouse gas emissions and sink estimates using appropriate methods and emission factors. If you require any further assistance please contact a Greenhouse Challenge Adviser on (02) 6274 1229 or email greenhouse.challenge@greenhouse.gov.au	http://www.greenhouse.gov.au Online HTML Version: http://www.greenhouse.gov.au/challenge/html/member-tools/factorsmethod.html PDF Version (220kb): http://www.greenhouse.gov.au/challenge/html/member-tools/fmw_v3.pdf
Carbon Dioxide Emissions	http://www.epa.gov/oppeoee1/globalwarming/emissions/national/co2.html
Global Warming: Publications Links to selected publications related to global warming.	http://www.epa.gov/globalwarming/publications/index.html
Energy Efficiency Planning and Management Guide CIPEC (Canadian Industry Program for Energy Conservation)	http://oee.nrcan.gc.ca/publications/infosource/pub/cipec/managementguide
Energy Efficiency Best Practice Program (UK)	http://www.energy-efficiency.gov.uk
US EPA—Information resources	http://www.epa.gov/epahome/resource.htm
Department of Energy (USA), Office of Industrial Energy Technologies. US Dept of Energy—OIT—This clearinghouse maintains a comprehensive warehouse of resources for the Department of Energy's efficiency and renewable energy information. The web resource maintains more than 600 links and the clearinghouse maintains over 80,000 documents. ASD Master ASDMaster is a windows-based software package consisting of six different modules designed to educate and assist users in the proper application of adjustable speed drives (ASDs). Insulation Assistance Examine industrial insulation guidelines and download North American Insulation Manufacturers Association (NAIMA) software. Pumping System Assessment Tool The PSAT software tool helps industrial users assess the efficiency of pumping system operations. PSAT uses achievable pump performance data from Hydraulic Institute standards and motor performance data from the MotorMaster+ database to calculate potential energy and associated cost savings. BestPractices also offers a PSAT workshop that reviews the basics of pumping system performance and field measurement considerations and provides an overview of the PSAT software.	http://www.oit.doe.gov/bestpractices http://www.eren.doe.gov/ ASD Master Insulation Assistance Pumping System Assessment Tool (Continued)

Site has information relevant to:	Website hotlink and address
Energy Efficiency Publication Subject Portals This portal provides electronic access to current energy-related, subject-specific collections of bibliographic citations with abstracts and full-text reports, when available, compiled from a variety of available resources. Topics include biofuels, biopower, solar energy, geothermal, wind, and several others.	Energy Efficiency Publication Subject Portals
CADDET (Centre for the Analysis and Dissemination of Demonstrated Energy Technologies)	http://www.caddet-ee.org
Wise Rules for Industrial Efficiency: A Tool Kit for Estimating Energy Savings and Greenhouse Gas Emissions Reductions. This is a guide for estimating greenhouse gas emissions reduction and energy savings. (PDF format, 1998, 1.4Mb)	http://www.epa.gov/oppoeel/globalwarming/publications/actions/wiserules.pdf
Self-Assessment Workbook for Small Manufacturers gives plants a methodology to perform a self-assessment to identify and calculate energy savings, waste reduction opportunities and production enhancements. Besides a general procedure for performing assessments of manufacturing plants, the reader is supplied with the information needed to implement several specific cost savings projects that are common to most plants. **Modern Industrial Assessments: A Training Manual** is aimed at providing technical training to those interested in performing industrial assessments at small- and medium-sized manufacturing plants.	oipea—http://www.rutgers.edu/documents/selfassess.html
Steam Resources—Office of Industrial Technology (USA).	http://www.oit.doe.gov/bestpractices/explore_library/case_studies.shtml http://www.oit.doe.gov/bestpractices/software_tools.shtml
Steam System Survey Guide DOE's BestPractices Steam program has developed the *Steam System Survey Guide* to help operations personnel and energy managers in identifying significant opportunities to improve their steam systems.	http://www.oit.doe.gov/cfm/fullarticle.cfm/id=646
Guide to Low-Emission Boiler and Combustion Equipment Selection A new guide, developed with DOE, offers help in choosing low-emission boilers and combustion equipment. The guide discusses boiler and combustion equipment that can be operated in compliance with regulatory emission standards.	http://www.oit.doe.gov/cfm/fullarticle.cfm/id=653
Updated Steam System Scoping Tool (version 1.0d) DOE has just released the latest version of the Steam Scoping Tool to help industrial steam users assess their steam systems.	http://www.oit.doe.gov/cfm/fullarticle.cfm/id=663
Steam Sourcebook Guides Users to Improved Performance, Lower Costs OIT's BestPractices Steam program announces *Improving Steam System Performance, a Sourcebook for Industry*, a new publication that offers valuable performance-enhancing information to both novice and experienced steam system managers.	http://www.oit.doe.gov/cfm/fullarticle.cfm/id=673

Site has information relevant to:	Website hotlink and address
Steam Challenge Energy Efficiency Handbook This book helps owner/operators get the best and most energy-efficient performance out of their steam systems. Included are helpful operational tips on virtually every aspect of steam system operations from water treatment through combustion and heat recovery, to flue gas treatment, steam trap maintenance, steam pipe insulation, and cogeneration.	http://www.oit.doe.gov/catalog/tools.shtml
The Compressed Air Challenge is a voluntary collaboration of industrial users; manufacturers, distributors and their associations; consultants; state research and development agencies; energy efficiency organizations; and utilities. This group has one purpose in mind—helping you enjoy the benefits of improved performance of your compressed air system.	http://www.compressedairchallenge.org/
Compressed air system—assessment and analysis software A software package to help you maximize the efficiency and performance of your compressed air system(s) through improved operations and maintenance (O&M) practices.	See toolbox at: http://www.compressedairchallenge.org/
A Process Design Engineer's Perspective on Using Equivalent Lengths of Valves and Fittings in Pipeline Pressure Drop Calculations.	http://www.cheresources.com/eqlength.shtml
Centrifugal Pumps: Basic Concepts of Operation, Maintenance, and Troubleshooting (Part I)	http://www.cheresources.com/centrifugalpumps1.shtml
Optimisation "Optimised integration of processes and utilities is a key factor for profitability in the process industries. Linnhoff March pioneered and still leads the world in process and utility integration and offers a range of products and services to help clients significantly reduce capital expenditure and energy/utility requirements. Since 1984 we have successfully carried out over 1200 studies for more than 400 clients throughout the world. Typical *implemented* benefits include:" • 10–30% energy and CO_2 savings • 20–50% water and effluent savings • increased throughput at minimal capital cost • 30% reduction in capital expenditure	http://www.cheresources.com/optzz.shtml http://www.linnhoffmarch.com/
Practical Process Integration—An Introduction to Pinch Technology By Su Ahmad, PhD, Stephen G. Hall, PhD, Steve W. Morgan, and Stuart J. Parker, PhD, Aspen Technology, Inc	http://www.aspentec.com/index.asp?menuchoice= ap9pinch
Software tools for process integration—On this site users' experience with software tools for process integration is presented: "Novem charged Interduct to develop and maintain these pages. The personal opinion and experience of the employees of Interduct have not been taken into account in the specific evaluation of the software tools. The software tools are not rated. Although this Internet site has been prepared with the greatest possible regard for accuracy, neither Novem nor Interduct can be held responsible for any errors it may contain. This site is the follow-up of an earlier study on users' experience with software tools."	http://www.interduct.tudelft.nl/PItools/

Site has information relevant to:	Website hotlink and address
Online Calculator for Chemical Engineers	http://www.cheresources.com/onlinecalc.shtml
Experienced-Based Rules of Chemical Engineering	http://www.cheresources.com/exprules.shtml