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Guidelines for energy management in the South African wine industry

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Abstract

Pressure is mounting on the wine industry to consider energy management interventions to, inter alia, reduce energy consumption – to be more competitive, become more self-reliant, and to reduce the carbon footprint of the sector. This paper summarises the process undertaken to develop an appropriate energy management guideline for the South African wine industry. It is based on a literature analysis of best practices elsewhere, and a number of case studies across different sizes of winery operations in South Africa. The positive outcomes from energy management interventions at these cases are demonstrated, but a number of challenges are also highlighted. Recommendations are made accordingly.

Keywords: energy management; energy efficiency; cost cutting; wine industry

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1. Introduction

The South African wine industry has had an increased focus on energy efficiency, contributable to a number of drivers, as listed below (Brent, 2011).

Rising cost of electricity

Two factors influence the cost of energy in South Africa: the security of electricity supply (capacity), and the rising energy resource prices due to limited availability. The majority of electricity in South Africa is generated from (old) coal-fired power stations. Recently, Eskom has been under pressure to guarantee security of supply, and the addition of new assets that are dependent on variable resource prices has meant inevitable increases in electricity prices.

Climate change

The South African wine industry is vulnerable to climate change as this will directly affect grape-growing, since a consequence of climate change is an increase in extreme weather events, such as droughts and floods. South African electricity has a high carbon emissions factor in a world context. These factors make it essential for energy users to adopt more sustainable methods of utilising energy.

Political landscape

The South African government has set carbon emissions reduction targets through the National Development Plan. This has led to stricter energy regulations, as well as subsidies and rebates that have been made available through green economy initiatives. Internationally, carbon taxation is a threat for South African wine producers as their wine has an inherently high carbon footprint due to Eskom electricity and the distance to market.

Consumer awareness

Consumers are increasingly becoming aware of the impact of their product choices. They are then asking more questions than ever, while the internet and social media have made ethical consumer behaviour easier. The growing prevalence of 'green marketing' is indicative of this trend. Informed consumers are likely to give preference to a product produced by a company that is making an effort to use sustainable production methods.

Competitive advantage

Improving energy efficiency will reduce the cost of production, which will in turn increase the profit margin on a bottle of wine. Wineries that are taking action to become more energy efficient may be eligible to benefit from financial incentives provided by the government, such as subsidies and rebates. By investing in renewable energy, a winery is also likely to improve energy security in the long term.

1.1 Towards best practice energy management

These drivers mean that energy performances in the wine industry need to be improved. Typically, better energy performances can be attained in two ways: behavioural change, and technical interventions. It is, however, often difficult to sustain improvement efforts over a period. Common pitfalls when attempting to improve energy performances include these factors:

- Not enough resources are allocated – there is insufficient time to focus on energy and limited finance is available for energy efficiency projects.
- Improvements are focused on technical interventions only – employees are not aware of energy or the influence they have as end users.
- One person is responsible for energy in the winery – all knowledge resides with one person and that knowledge is not easily accessible to the rest of the winery.
- Improvements are not measured – there seems to be no change in the energy consumed although energy savings projects have been implemented.

The wine industry, through Winetech, then identified the need to develop an appropriate guideline to implement an energy management system, based on best practice elsewhere, but tailored for the South African context. The objectives and benefits of such a system include that it:

- is designed to save money;
- is based on world-class, best-practice, and tried and tested methods;
- based on a continuous improvement (plan–do–check–act) cycle;
- has a focus on improving energy performance and not on developing a management system; and
- has sustainability built into it.

2. Literature review

As a starting point to develop energy management guidelines for the South African wine industry, a literature review was undertaken of energy-related guidelines that exist internationally in order to define the typical elements that they contain (see Table 1). The documents examined included guidelines from northern hemisphere regions, namely California, England, and the European Union, and Australia in the southern hemisphere, as well as the ISO50001 standard, which is regarded as international best practice for energy management for industry (McKane, 2010). The majority of documents refer to the environmental impacts of the wine industry, the links to climate change, and the need to optimise water and energy usage. The guidelines reviewed can be grouped into two cate-

Table 1: Analysis of elements in energy-related international guidelines.

Elements	*Galitsky et al., 2005, USA*	*Commonwealth of Australia 2003, Australia*	*Perth Region NRM, n.d. Australia*	*Ecofys, 2008, EU*	*'WineSkills Work-book', Plumpton College, 2011, UK*	*Smyth & Nesbitt, 2012 UK*
Wine industry energy information	x		x		x	
Information on billing		x				
Best practice tips	x	x	x	x	x	
Significant energy users are highlighted	x	x	x	x		x
Process steps that use energy in the winery are highlighted	x		x		x	
Set targets				x		
Action plan				x		
Energy balance		x	x			x
Plan–do–check–act methodology		x				
List of 'more info' with hyperlinks		x				
Templates/worksheets		x		x		
Energy efficient winery design		x		x		
Behaviour change					x	
Staff training and maintenance	x		x	x		
System approach – design/optimisation	x		x		x	
Renewable energy	x		x	x		
Energy management system	x		x	x		
Includes water	x		x	x		
Includes examples from othernon-wine industries	x		x			

gories: those that present information in a fact-based manner as best practice tips; case studies and fact sheets; and those that are designed to be more interactive, such as benchmarking tools, checklists and workbooks. The most prevalent form of energy guideline outlines best practice related either to winery systems (e.g. refrigeration, lighting) or winemaking activities.

The most widely cited guideline is the BEST winery guidebook developed for the Californian wine region. Significantly, it has been adapted for use in Europe as the AMETHYST 1.0 benchmarking and self-assessment tool (Spigno et al., 2009). The main differentiating factor of the latter is that wineries can score themselves against a benchmark energy-efficient winery (the 'BEST' winery) that is theoretically optimally efficient. Although this method offers a winery the opportunity to engage interactively with the information, a criticism of it might be that the BEST model would need to be updated at regular intervals as new, more efficient technology becomes available.

The Australian guideline (Commonwealth of Australia, 2003) is highlighted in this review because of climatic similarities with South Africa, meaning that the Australian wine industry has similar energy requirements for the winemaking process. Notably, the Australian guideline estimates that refrigeration accounts for an estimated 50% of the industry's peak demand. Two approaches are included in the guideline: a project-based approach that focuses on significant energy users such as refrigeration, and a continuous-improvement approach focused on behaviour change and capacity building within the organisation. As part of their industry-wide energy-efficiency campaign, Australian wineries specifically regard refrigeration as an improvement project involving specialists from outside the sector.

The ISO 50001 (2011) standard for energy management systems is based on the plan–do–check–act cycle for continual improvement, which is also used in other standards such as ISO 9001 and ISO 14001. The system is designed to assist companies to identify energy conservation opportunities and to prioritise the allocation of resources to maximise energy efficiency. The cycle for continual improvement relies on feedback loops generated by monitoring of energy performance and the regular communication of results. Although the energy management system is designed to fit into the organisation's existing quality and environmental management framework, it does not explicitly acknowledge the links between energy, water and waste. Thus, opportunities such as generating electricity from a waste-stream may be overlooked.

In summary, the South African guideline could potentially include information that is prevalent in several international guidelines. Firstly, in the majority of the guidelines reviewed, a link is made between energy and the wider sustainability discourse and how this relates to the wine industry. Energy management information is mostly presented as best practice tips or as practical examples in the form of case studies. A number of guidelines include an interactive element such as a benchmarking tool (Galitsky et al., 2005) or a workbook (Plumpton College, 2012). Although elements of the ISO50001 standard are included in a number of guidelines, the link is not explicitly made. Further investigations were then required to gather specific technical information that can be included based on the South African context.

3. Methodology

For this study, it was decided to use a multiple embedded case study design. The use of multiple rather than single case study designs is advisable, because they make it possible to directly replicate case studies and improve generalisability if a common conclusion can be reached in different contexts (Yin, 2003). As the study focused on energy efficiency interventions in the South African wine industry, it was decided that the multiple cases would be different sized wineries. The units of analysis were the different intervention opportunities across the wineries. Four wine farms were selected and visited for the case studies, based on their production capacity (see Table 2).

The overall purpose of the system assessments during the site visits was to:

- assist the wine farms to quantify their energy consumption and identify major consumers within their processes;
- use the assessment as a tool to identify potential opportunities for the reduction and more efficient use of energy within the plant;
- verify the energy efficiency in the facility and that there is an on-going programme to monitor and improve the performance of the facility; and
- assist in identifying opportunities to recover energy from processes wherever feasible.

Based on the type of wine that is produced by a particular winery and the capacity, a winery will utilise different energy systems, but the analysis of them for energy efficiency is similar. The following aspects were identified as crucial to understand from an operational perspective:

- How much energy am I using?
- Am I on the suitable (electricity) tariff?
- Where am I using the most energy?
- Which are significant energy users?
- What are the best opportunities?

Table 2: Case study wineries.

Winery designation	*Capacity (rounded tonnes per annum pressed)*
Winery 1	400
Winery 2	1000
Winery 3	2000
Winery 4	20 000
Winery 5	140 000

3.1 How much energy am I using?

Energy consumption on wine farms is based on seasonal activities. Figure 1 shows the annual energy consumption pattern of one wine farm, with most energy consumed during the harvest season. Understanding the energy consumption trend will assist the winemaker to pick up any changes in the consumption patterns and identify energy-saving opportunities.

3.2 Am I on the suitable tariff?

Eskom tariffs for rural consumers with a supply size of above 25 kVA, which is the case for all the wine farms in this study, are Ruraflex and Nightsave. The billed contents of the two tariffs are shown in Table 3.

The Ruraflex tariffs' active energy charge is dependent on the time of usage, which is split into season (High demand season Jun-Aug; low demand season Sep-May) and the time of the day (Peak, Standard, or Off-peak) as shown in Figure 2.

The complex tariff composition shows that detailed knowledge on the individual tariff and consumption pattern is crucial to optimise cost savings and thereby improve the payback period. By considering the August 2011 account of one wine farm in the sample, the active energy charge (amount for the consumed kWh) only causes 40% of the total bill. Hence, halving the electricity consumption would only lead to a cost reduction of 20%.

The seasonal changes in tariffs are important to understand, because it allows the winemaker to

Table 3: Elements of Eskom's Ruraflex and Nightsave tariffs.

	Service charge	*Admin. charge*	*Distribution network charge*	*Energy demand charge*	*(Active) energy charge: Non-TOU*	*(Active) energy charge: TOU[1]*	*Reactive energy charge*	*Environ-mental levy*
Ruraflex	R/day	R/day	R/kVA	-	-	c/kWh	c/kWh	c/kWh
Nightsave	R/day	R/day	R/kVA	R/kVA	c/kWh	-	-	c/kWh

[1] *Time of usage defines the billed rate – see Figure 2.*

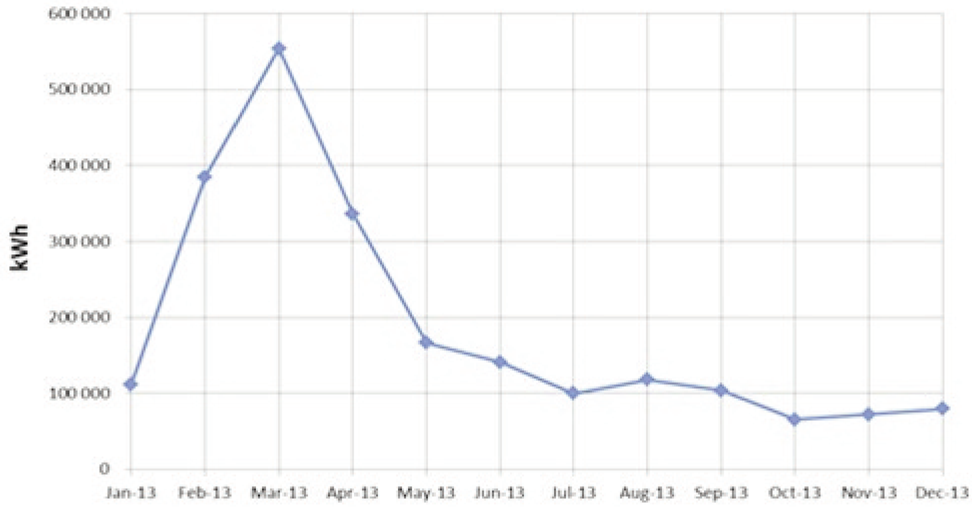

Figure 1: 2013 energy consumption of one winery in the sample.

shift some of the energy demand from winter to summer when there is a lower tariff. Figure 3 shows the annual energy consumption on one of the wine farms. It shows that the annual energy costs are not proportional to the energy consumption patterns. Even though a winery's energy consumption drops during winter in the winery (see Figure 1), costs are still high due to a high winter tariff. By shifting some energy consuming activities from the winter period, or by reducing energy consumption during this period, significant cost savings may be made.

3.3 Where am I using the most energy?

Understanding where the energy is consumed is important for energy-efficiency initiatives. This analysis can be done by dividing the winery into sub-sections based on the energy systems. Sub-metering and smart metering helps the winery to obtain an accurate picture of the current energy consumption patterns: what is spent on energy in different forms and the unit costs, what it is used for, and which are essential and which are not. During the planning phase, it is important to measure and monitor the system, and obtain information/data in order to ascertain the feasibility of an intervention. Information/data that is obtained from the improved process can then be compared to the initial measured data. If there are external operations that are linked to the winery, such as a restaurant, sub-metering and smart metering can be used to obtain accurate electricity billing data.

3.4 Which are significant energy users?

Significant energy users in the winery can either be viewed as the consumers of the largest amounts of energy, or as the energy systems with the greatest potential for improvement. Figure 4 shows the energy consumption distribution in one of the wineries. After establishing the consumption patterns as per Figure 4, the operational manager can prioritise components of the energy system to identify the cost-saving opportunities.

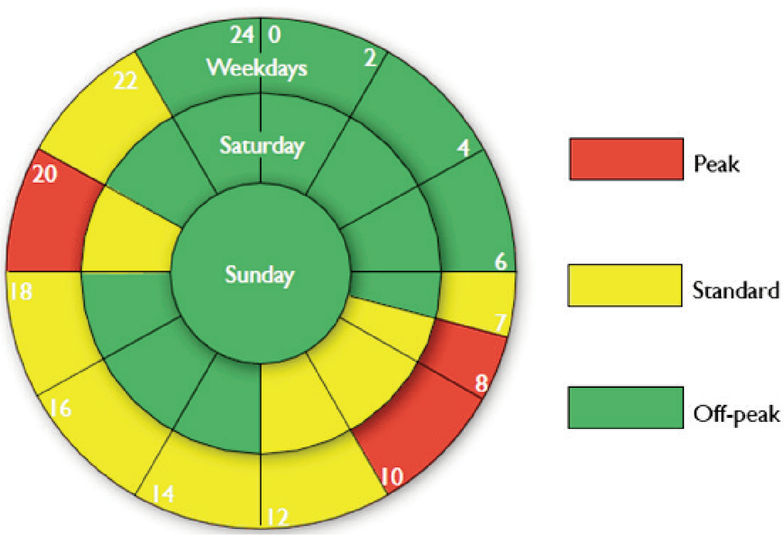

Figure 2: Eskom Ruraflex time of usage periods (Eskom, 2011).

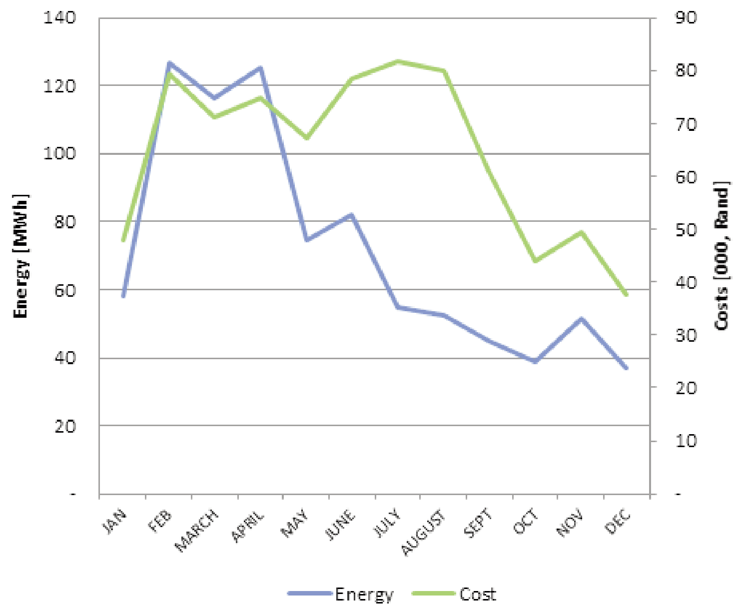

Figure 3: Typical annual tariff structure and costs on a wine farm.

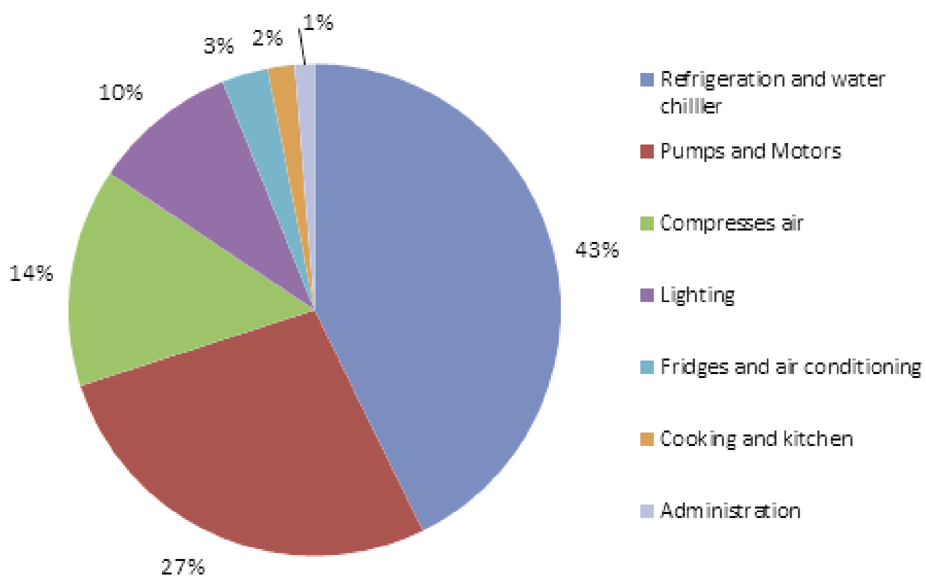

Figure 4: Typical winery energy consumption distribution.

3.5 What are the best opportunities?

The energy management system initiatives, or energy costs saving initiatives, that require capital expenditure are almost certain to be identified. This makes it crucial to conduct a proper analysis of the technological viability and financial feasibility of the identified projects. This analysis will help in identifying the benefits of the project and inform a decision on whether the project should go ahead, and internally prioritising the project and allocating resources for the project uptake.

Financial criteria are always given a high priority when accessing the feasibility of the energy cost saving project. Utilising an appropriate technique allows the organisation to embark on projects that are consistent with a system that is used within the organisation. Two commonly used techniques are: simple payback period, and life-cycle costing. There are various methods of obtaining finance for the energy cost-saving projects: internally financed, externally financed, and contract energy management.

Having identified the potential cost-cutting areas or energy systems, the next step is to conduct a pre-feasibility study of the cost cutting initiative. This study should detail how the organisation will implement the initiative, and how it will justify the capital expenditure.

4. Case study outcomes

The five case studies identified the following potential improvement opportunities:

- Chilled water system.

- Refrigeration and air conditioning.
- Plant equipment:
  - pumps and motors;
  - insulation;
  - hot water supply; and
  - lighting.
- Compressed air system.
- Renewable energy systems.

Only some of the detailed opportunities are highlighted in this paper. Further details can be found in the complete guideline (Centre for Renewable and Sustainable Energy Studies, 2014).

4.1 Chilled water system

Optimising the chilled water system should result in a performance improvement. As an example, at one winery, the option was identified to have separate chilled water tanks. During the off-season, when the demand drops, it is possible to use one smaller tank, which will reduce the energy demand. The winery uses a 70 000 litre tank. By reducing the storage size by half, a 135 kWh cooling reduction is achieved, which equates to a saving of R130 950 per annum; for its specific tariff structure.

Another potential opportunity for performance improvement of the chilled water system is on the control of the water temperature. It is crucial to know the required process temperature. If the water temperature is increased, savings can be achieved. The beforementioned 70 000 litre tank was operating at 4°C. By increasing the temperature to the required 6°C, R140 000 per annum of savings could be achieved.

Other water improvements opportunities are:

- Minimise cooling loss from the system – install door closers, and insulation for storage.
- Educate staff – ensure that staff do not leave chilled area room doors open.
- Turn off or raise temperature set points of the chilled water system during non-critical times.
- Maintain and check chillers regularly – check cooling tower for damage, check for ice build-up on evaporators and delivery lines (should be suitably lagged), keep external coils clean and free from litter and regularly check system pressure.
- Ensure that chiller tank and refrigeration plant is shaded from direct sunlight – this reduces radiant heat gain and increases energy efficiency.

4.2 Refrigeration and air conditioning system

Refrigeration and air conditioning is probably the most expensive energy system in the winery, so a relatively small energy consumption improvement in the system may result in relatively large improvements. This then requires a proper, in-depth analysis and understanding of the system.

4.3 Pumps and motors

Pumps are usually selected with safety margins in order to ensure sufficient capacity. The selected pump for an operation may be efficient, but in general there is wasted energy consumption. Irrespective of the type of pump that is used for an operation, the following factors may assist in saving energy:

- Reducing excess flow rate – installing pumps that operate at flow rates close to the required system flow rate.
- Reducing the pipe resistance – reducing the number of bends, Ts, and fittings.
- Efficient motor control – installing variable speed drives (VSDs), where necessary.

These will ensure that the pump speed will be controlled according to the pressure needed in the system. Thus, if the cooling on all tanks is off, the motor on the pump will reduce its speed. A VSD will only ramp up the motor when cooling on a tank is opened, in order to supply the necessary pressure in the system to supply the tank with chilled water. However, even though the VSDs improve the efficiency of the energy system, more financial analysis will be necessary over the lifecycle of the energy system. For example, consider a circulation pump (5.5 kW) running 24/7 for 4 months. If the cost of 1 kWh = R1, it would cost R15 840. By installing a VSD on one of the circulation pumps it is generally accepted that this would save 25%, which equals R3960.

4.4 Insulation

Insulation is essential in thermal applications, because it prevents heat gain and heat losses, thereby saving on fuel and energy costs. Insulating hot surfaces and cold rooms is one of the simplest and most cost-effective ways of increasing energy efficiency. The payback time for insulating a pipe is generally less than one year. For tanks, valves and fittings, immediate savings can be realised from insulating where no insulation existed. Apart from the insulation itself, housekeeping provides opportunities for costs savings. For example, damaged insulation and damaged covering and finishes were identified in a number of the cases. Retrofitting the existing system also provides an opportunity. This can be done by upgrading the existing insulation levels or review the thickness requirements.

4.5 Hot water supply

As with domestic geysers, when water is heated with a heating element or boiler, it can be very costly. Saving opportunities therefore exist in matching the water heated with the required temperature and amount needed:

- Avoid installing oversized or in-efficient hot water services – consider the benefits of solar,

instant gas/electric, storage and heat pump units when determining hot water provisions.
- Use waste heat waste from refrigeration systems to pre-heat hot water.
- Insulate hot water lines.

Opportunities can also be realised by adopting other systems, such as heat pumps and excess steam from the boiler. Consider a typical 200 litre geyser with an electrical element, rated at 4 kW. A heat pump uses 30% of the electricity of a heating element, and thus a replacement with a heat pump will yield a cost saving in the order of 30%.

4.6 Lighting
Lighting provides many cost-saving opportunities, ranging from simply switching off the light to utilising more efficient types. Winery employees play a large role in this form of cost saving, as does installing automatic lighting controls. Harvesting daylight with the installation of skylights can be considered where heat ingress is not a problem. Replacing existing lights with more efficient/low energy-consuming lights may provide an opportunity for cost-cutting. Savings are realised as soon as the new lights are installed. The most efficient lighting sources that are commercial may last longer than the existing less-efficient lighting, which justifies the capital expenditure. Special care needs to be taken when deciding and selecting efficient lighting sources. They need to comply with Occupation Health and Safety Act requirements concerning light-intensity levels in the workplace. It is critical to do the lighting design in advance to ensure that the replacements comply with the regulations.

4.7 Compressed air
A compressed air system is used to supply service air to the various pneumatic valves and cylinders throughout the plant. However, during the harvest season the compressed air is also utilised to fill the bag/batch presses for pressing the juice from the grapes. This is done in cycles, with each cycle being at a slightly higher pressure, up to a maximum of 2 bar. Consider a 20 tonne capacity press using six cycles. Typically, for this capacity, the requirements are a flow rate of 21.23 m^3/min and a storage capacity of 56.78 m^3 at 7.5 bar. From one case study, what was found is that the compressor system had a storage capacity that equates to 26% of the required capacity. Having the right operational parameters is crucial. By increasing the storage capacity to the required capacity may result in energy savings.

High blower fans can be installed to pre-fill the bags and using the compressors for the final pressure. A typical blower fan can achieve an energy efficiency of 75% ,whereas a compressor can only achieve 15% energy efficiency. This bag pressing operation is a high volume low pressure application, whereas a compressor delivers high pressure low volume. Some of the bag presses do have initial filling using blowers, but this method could potentially fulfil the majority of the requirements. The exhaust air from the bags could then also be re-used by introducing it at the inlet to the proposed blower fans. The cycles of the individual presses would have to be synchronised to take maximum advantage of this, but the savings would be good, as the blower fan would only have to raise the pressure of the air by whatever was lost during the process.

Another example of the compressor optimisation was observed at one of the site visits. The compressors were situated outside in dusty conditions. This may reduce the efficiency of the compressors. Under these conditions, compressors can draw in warm air. Also, the dusty conditions may cause clogging of air filters. As the filters are on the inlet side of the compressor, the effect is to reduce compressor performance. Generally it is accepted that a dirty filter can reduce the performance by up to 5%. This could potentially allow further savings of up to 4 000 kWh over the season.

Cooler air can also be ducted from the cooler room. The increased performance due to the cooler air can be estimated at 1% benefit for every 5°C reduction in inlet temperature. At present, harvest-time temperature is around 30°C and the room temperature is closer to 15°C, so the potential energy reduction would be 3%. This equates to savings in the order of 4 500 kWh for the harvest season.

Air leaks are amongst the major factors that reduce compressor performance. They can be managed by a tagging system and a maintenance plan, which would see that each leak is noted and repaired. In general, leaks account for 10% of a typical plant's air consumption, and repairing at least 70% of these would achieve a savings of 10 000 kWh over the same period.

During the harvest season, when the compressor is run continuously, cycling is not an issue. During the rest of the year, the cycle times may need to be monitored and other ancillaries such as refrigeration dryers can be switched off with the compressors when the required pressure is achieved. Reducing the output pressure of the compressors could possibly be targeted if the capacity of the storage is large enough to allow storage at a lower pressure and still achieve the results required. Every 0.1 bar reduction in pressure from the system would reduce the energy consumption by approximately 1%. Thus, reducing the pressure from 7.5 bar to 7.0 bar would achieve an energy saving of 5% and hence a further reduction of 4 000 kWh.

An illustration of the potential energy saving from the compressor is maintaining the compressor pressure at the required pressure. For a compressor that has 2 x 75 kW capacity – a typical size that is used at a winery, that operates for five days a week and 20 weeks per year, the energy costs are expressed as follows: (2 x 75 kW) x 60% load x 24 hours 5 days/week x 20 weeks/year x tariff (R1/kWh) = R180 000. If the set point was reduced from 8.5 bar to 7.5 bar the saving would be 7%, or R12 600.

4.8 Energy efficiency measuring and monitoring

As was noted above, measuring and monitoring are essential during energy efficiency initiatives, allowing the winemaker to see the impact of the energy efficiency and compare the improvements. Figure 5 shows the measured energy efficiency improvements at one of the case study farms. The graph shows how the energy efficiency initiatives have yielded results. When there is proper measurement in place, trends can be observed and reported for further decision-making.

4.9 Renewable energy systems

An assessment of renewable energy technology uptake in the wineries was also done. The main aim was to address the risks and uncertainty that are associated with the integration of renewable energy systems in the wine industry. The assessment considered the solar resource availability in the Western Cape Province and showed it to be adequate, indicating considerable potential for integrating solar thermal energy or photovoltaic (PV) technology. Solar thermal can be used to supply solar thermal process heat, or used to pre-heat boiler-heated water or to drive a chiller. PV technology could be used to generate electricity for the winery (see Table 4).

Except for the high electricity demand months in the winery, the PV system results in high solar share.

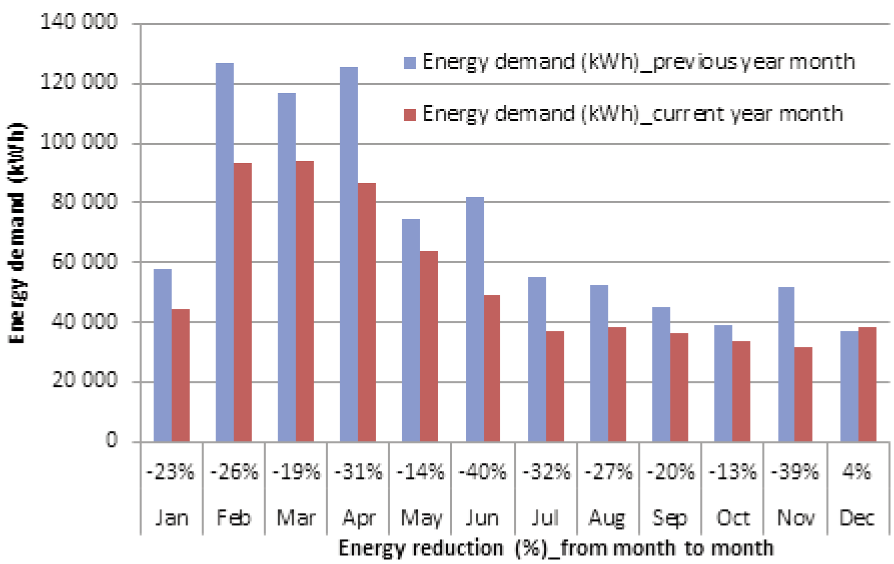

Figure 5: Energy efficiency initiatives comparisons at one wine farm.

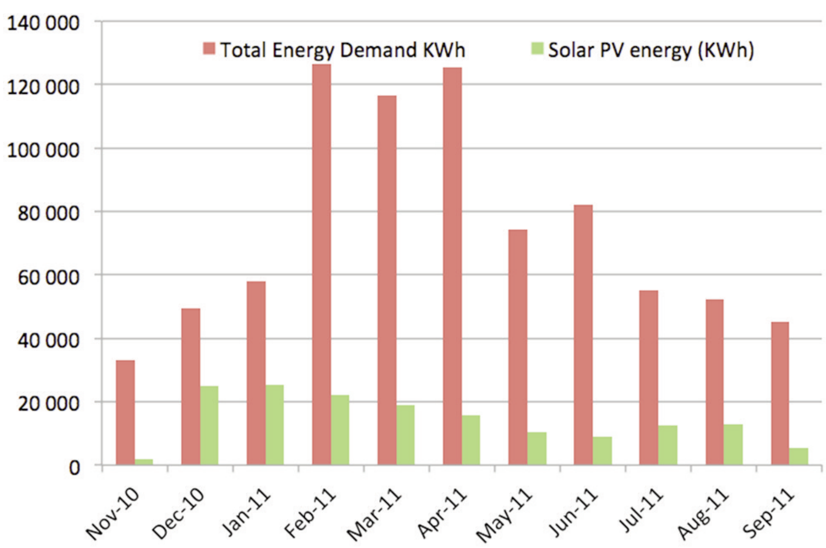

Figure 6: PV energy share on total energy demand at one winery.

Table 4: PV system operating parameters at a medium-sized winery.

Item	Description
System size	132 kWp
System type	Grid tired
Module type	Polycrystalline photovoltaic modules
Mounting type	Roof mounted, extruded aluminium track system
Inverter type	3-phase grid tired inverter
Payback period	6–7 years

Figure 6 shows the electricity delivered by the PV system (of Table 4) compared to the total electricity demand. The PV system is optimised for annual energy delivery, but it is possible to optimise it for the period of high energy demand. That would mean, however, that the PV system would generate excess electricity at other times, which could make business sense if the excess electricity could be sold to the grid. To this end the National Energy Regulator of South Africa has released a discussion document of tariffs and other regulatory issues to allow grid-tied systems.

5. Conclusion

A number of drivers have resulted in the need for a guideline for energy management for the South African wine industry. In contrast to other international energy efficiency guidelines for wineries, the developed document (CRSES, 2014) attempts to explain the principles and steps of an Energy Management System (EnMS), as outlined in the ISO50001 standard, and illustrates how an EnMS may be applied to a winery situation. Furthermore, it shows by way of case studies from South African wineries, typical energy savings opportunities that exist. However, the energy efficiency and cost cutting initiatives can be capital intensive. It is then advisable that the winemaker approaches the EnMS systematically. The first step would be, after identifying low hanging fruit (potential savings), to engage with a service provider. This would be on a high level where the winery can pose all the relevant questions that would assist in decision-making. The key critical aspects – summarised in Table 5 – would be useful to the winemaker or operations manager in deciding whether to go ahead with a project; and thus to engage with the service provider.

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Table 5: Key aspects to engage with a service provider (continued overleaf).

Energy efficiency plan The winemaker or operations manager should have a written energy efficiency plan that details the methods of energy consumption reduction within the wine operations. This should include an energy consumption reduction strategy, training of personnel to improve energy consumption, and monitoring programmes. A documented energy efficiency plan will assist the wine farm to achieve the energy efficiency and cost reduction in a formal manner. A plan will document how, when and where energy use will be monitored and how the results will be used to improve energy efficiency. • Do you have an executive level commitment to a successful energy management? • Have you assigned an in-house energy manager to oversee management of energy at your winery? • Do you track costs and benefits of energy management? • Have you developed an inherent system for continuous improvement of energy management?
Energy monitoring Energy consumption data should be collected to enable detailed analysis of the winery energy usage. Real time data will allow the winemaker or operations manager to identify peak demands and high energy usage processes that could be targeted for energy reduction. The energy consumption records could be in the form of monthly financial statement or in the form of electricity usage (kWh), diesel usage (litres), petrol (litres), coal (tonnes), etc. • Have you established baseline using appropriate measures of performance for each system? • Have you quantified current energy used and losses? • Do you shift electricity consumption into less expensive off-peak times? • Have you evaluated using alternative and/or renewable energy like wind, solar, biofuels, others? • Do you incorporate carbon footprint information in all energy management evaluations?
Equipment servicing and optimisation Energy efficiency should be put on high priority when purchasing new equipment. Also, the existing equipment should be serviced regularly and repaired whenever necessary to ensure optimum energy consumption.

Table 5 (continued).

Optimisation of refrigeration and cooling efficiencies Refrigeration and cooling system provide an opportunity for cost reduction and energy efficiency. This can simply be achieved by optimising the existing equipment. • Have you reduced suction pressure to reduce compressor power and save energy? • Do you variably adjust condenser set-point temperature to optimise compressor pressure difference for varying ambient temperatures? • Have you reduced excess heat gain from: interior lights (replace with LED), inadequate defrosting, inadequate insulation, excessive air exchange, worn weather stripping, etc? • Have you insulated refrigeration lines? • Do you optimise tank volume? • Have you installed variable speed controls (where necessary) on condenser and evaporator?
Are you using the most efficient lighting sources? Space lighting provides an opportunity for cost reduction and efficient energy use. This can be achieved by replacing the existing light bulbs with more energy-efficient ones. Also, the existing energy equipment can be optimised for better operation. • Have you established necessary light levels for specific areas when used and unused? • Have you reduced lighting levels where appropriate? • Do you utilise lighting controls (time clocks, by-pass/delay timers, motion detectors)? • Do you make use of natural lighting (daylighting – windows and skylights)?
Utilisation of programmes to maintain and operate all motors, belts, drives, fans, pumps and compressors for optimum energy use Overall, there should be programmes in place for all the energy-consuming equipment in the wine farm. Energy reduction and cost cutting will not occur homogenously, but the combination of these programmes may result in breakthrough improvements. • Have you installed properly sized premium efficiency motors? • Have you installed timers and sensor controls to turn off during idle time? • Have you installed properly sized energy efficient pumps and fans? • Do you perform regular preventative maintenance?

References

Brent, A.C. 2011. The feasibility of alternative energy options. Paper presented at the annual conference of the South African Society of Enology and Viticulture, Stellenbosch.

Commonwealth of Australia. 2003. A guide to energy efficiency innovation in Australian wineries. Department of Industry, Tourism and Resources, Canberra.

Centre for Renewable and Sustainable Energy Studies (CRSES). 2014. Energy Management Guideline for South African Wineries. Winetech document, available from: http://www.winetech.co.za.

Eskom (2011). Tariffs & Charges Booklet 2011/2012. Johannesburg, available from: http://www.eskom.co.za.

Galitsky, C., Worrel, E., Radspieler, A., Healy, P. and Zechiel, S. 2005. BEST winery guidebook: Benchmarking and energy and water savings tool for the wine industry. Lawrence Berkeley National Laboratory, available from: www.energy.ca.gov/2005publications/CEC-500-2005-167/CEC-500-2005-167.PDF.

International Organisation for Standardisation (ISO) 2011. 50001: 2011. Energy management systems – Requirements with guidance for use. Paris.

McKane, A. 2010. Thinking globally: How ISO 50001-Energy management can make industrial energy efficiency standard practice. Lawrence Berkeley National Laboratory, California.

Spigno, G., Mazzoleni, M., Neelis, M. and Graus, W. 2009. Integrated benchmarking and self-assessment tool for the wine industry: The amethyst project. Ecofys Netherlands BV, Utrecht, Netherlands.

Plumpton College, 2012. Wineskills sustainability workbook. Available from: www.wineskills.co.uk/sustainability/guidelines/using-guidelines.

Yin, R.K., 2003. *Case study research: Design and methods*. Volume 5: Applied social research method series. 3rd edition. SAGE, Thousand Oaks, California.