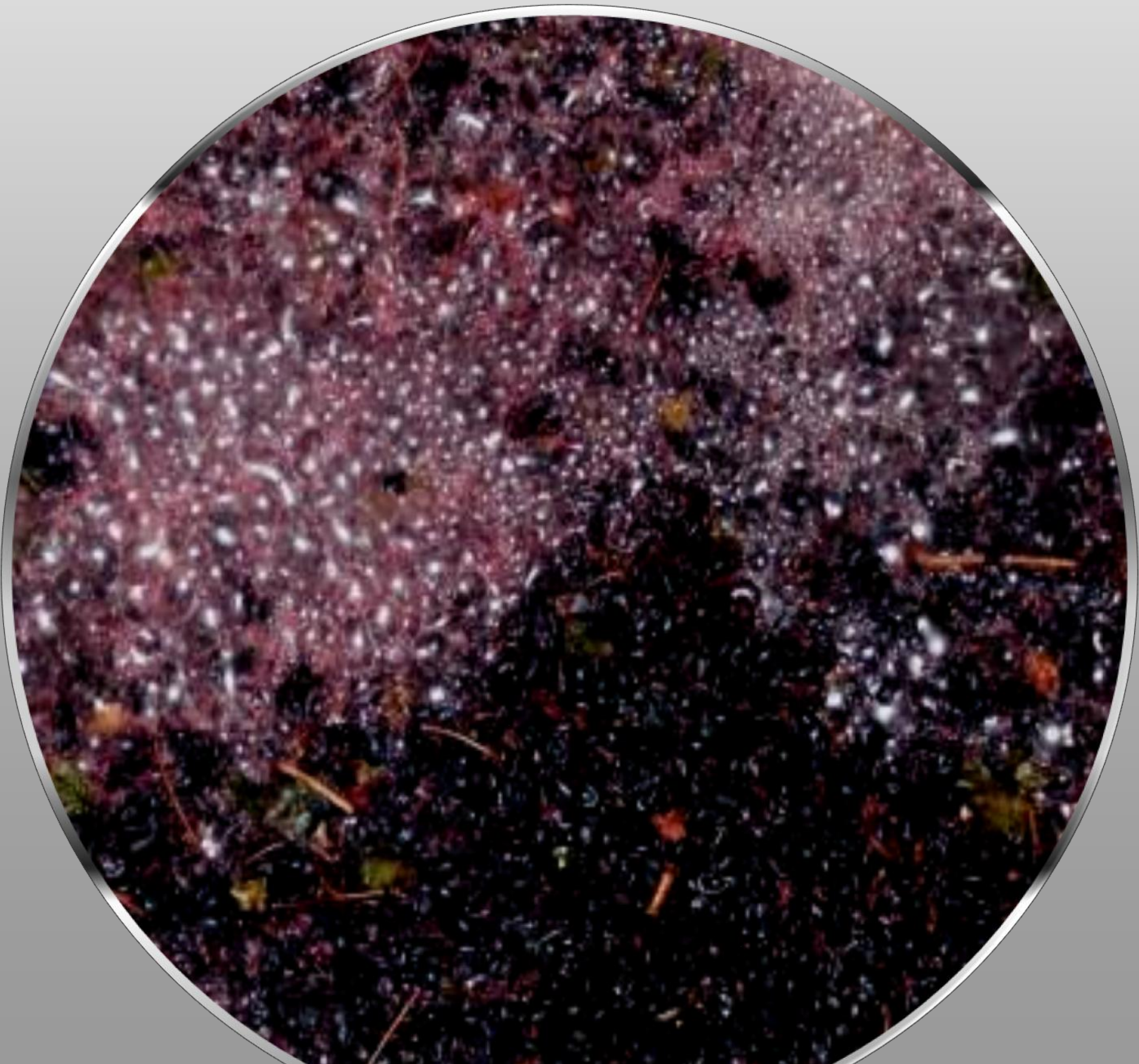
Winery Energy Management Project:

Ferngrove Winery

June 2010



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1. Introduction

This winery energy audit is funded by the Grape Wine Research Development Corporation (GWRDC) Regional program. The GWRDC WA program is managed by the Wine Industry Association of WA (WIAWA) and the winery energy management project component aims to help producers reduce the energy component of their production costs. The energy audit was developed with Perth Region NRM.

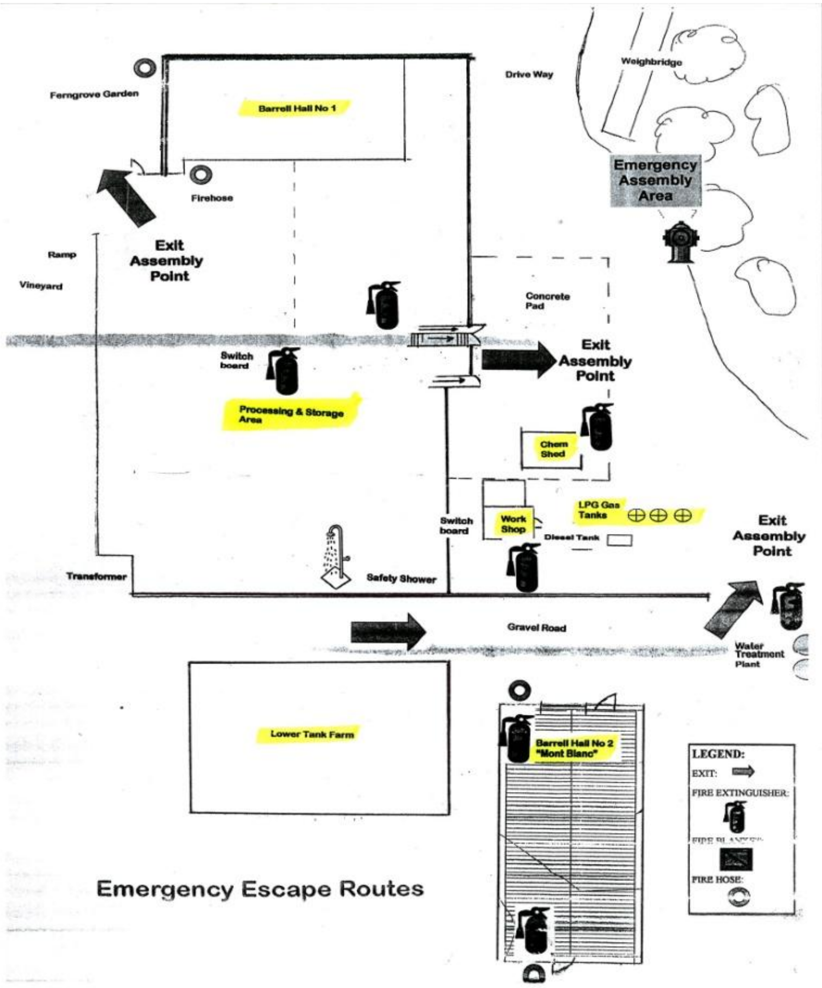
Ferngrove is one of three wineries receiving level 2 energy audits. These audits are aimed at developing the knowledge and understanding of how much and where energy is used in a typical winery. The aim is to review data, develop solutions for reducing energy use and show these as case studies for other wine producers (of different sizes) to assist them with reducing energy use.

The Ferngrove winery and vineyards are based within the Great Southern region of WA and process approximately 6000 tonnes of fruit to produce around 440,000 cases of premium wine annually for domestic and export markets.

2. Site Description

The winery and vineyard are located, at Frankland River on the Ferngrove Road, approximately 360 kilometres south of Perth in Western Australia's Great Southern region. Click on MAP for directions.

Figure 1: Ferngrove site map



3. Methodology

As part of the winery energy management project, this audit followed our standard process as set out below.

- A desk top analysis of energy use data
- Site visit to compile an appliance / equipment list
- Staff interviews
- Data analysis
- Research
- Recommendations

3.1. Review of Billing Information

Prior to the site visit a review of the previous 12 months of energy billing data was analysed to determine energy usage patterns. This data included the 2009 Vintage (considered as a fairly average vintage), though it should be noted that there is always variation between vintages in regard to tonnes of fruit processed and temperature patterns which will impact on energy use.

3.2. Data Collection / Equipment Audit

A list of energy equipment and appliances including their nominal power rating was compiled during an on-site audit. Winemaking and maintenance staff were also interviewed to ascertain the pattern and frequency of use for this equipment. This information was used to estimate the proportion of energy used by each item of equipment in terms of production processes and work areas.

This list is separate to this audit report and has been supplied to Ferngrove in XL format for future use.

3.3. Staff Interviews

Staff interviews (on-site, phone & email) were conducted to develop a good understanding of Ferngrove specific wine making practices and the production processes..

3.4. Data Analysis

The use of utility billing data, combined with the equipment audit and staff interviews provided a good understanding of how much energy is consumed with the various processes within each of the production areas..

Graphs were created to yield the following information:

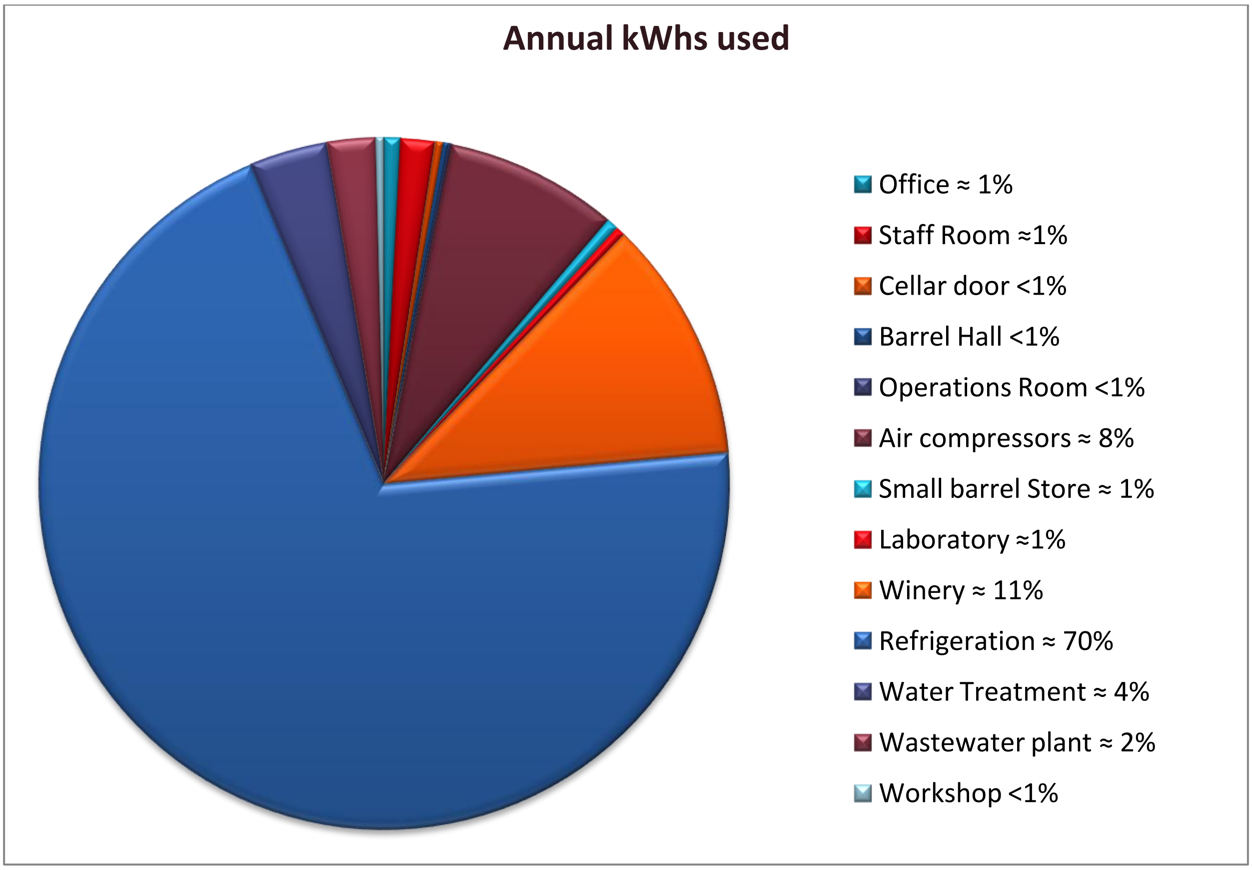
- Electricity use
- Greenhouse gas emissions
- Peak / off peak energy use and cost analysis

4. Results and discussion

4.1. Energy use by location

A total of 994,510 kWh were used throughout the 12 month energy audit review period. Chart 1 provides details on where energy is used throughout the site, based on the equipment audit and staff interviews.

Chart 1: Annual kWhs used by site location (does not include hot water generation)



4.1.1. Refrigeration

Ferngrove has a typical air cooled brine refrigeration system designed to chill the brine (water and 24% ethanol) down to minus 7°C. The chilled brine is circulated throughout the winery through a network of brine lines. The heat transfer process occurs when the brine is allowed to pass through the wine tank's brine jacket or when both the product and the brine pass through a separate heat exchanger. The warmed brine then returns to the chiller brine tank for refrigeration.

4.1.2. Plant equipment

Air compressors: The predominant use of compressed air is to provide air to the four rotary presses during vintage with the supply requirement being high volume with low pressure. At peak times there are two 37kW compressors in operation to meet demand.

Nitrogen: This is not a nitrogen generation unit and used as storage only.

CO2: This has a compressor attached to the storage unit to maintain temperature.

4.1.3.Cellars

Cellar energy use includes:

- Lighting
- Equipment (other than pumps)

4.1.4. Barrel storage

The two main energy items in the barrel shed are:

- Lighting
- Electric forklift charger

4.1.5. Product transfer

Energy use from transfer pumps totals approximately **26,500kWh** per annum. This has been based on 46 ML of juice / wine transferred; average pump size of 4kW; average transfer rate of 7kL /h (including cleaning time).

5. Energy use by processes

5.1.1.Fermentation process

The largest energy use for wine production occurs during the winemaking processes, which occurs during the vintage period. The fermentation process where juice is converted into wine uses refrigeration energy for the cooling phase/s and hot water (see 3.2.2) in the warming phase/s of this process. The flow chart over-page follows the heating / cooling processes involved in converting 100 tonnes of white wine fruit into finished wine.

5.1.2. Hot Water

This has not been included with the appliance / equipment list as different greenhouse gas accounting formula apply for the diesel fuel that is used to generate hot water.

Hot water is required for cleaning barrels, tanks and for the warming of juice in the fermentation process.

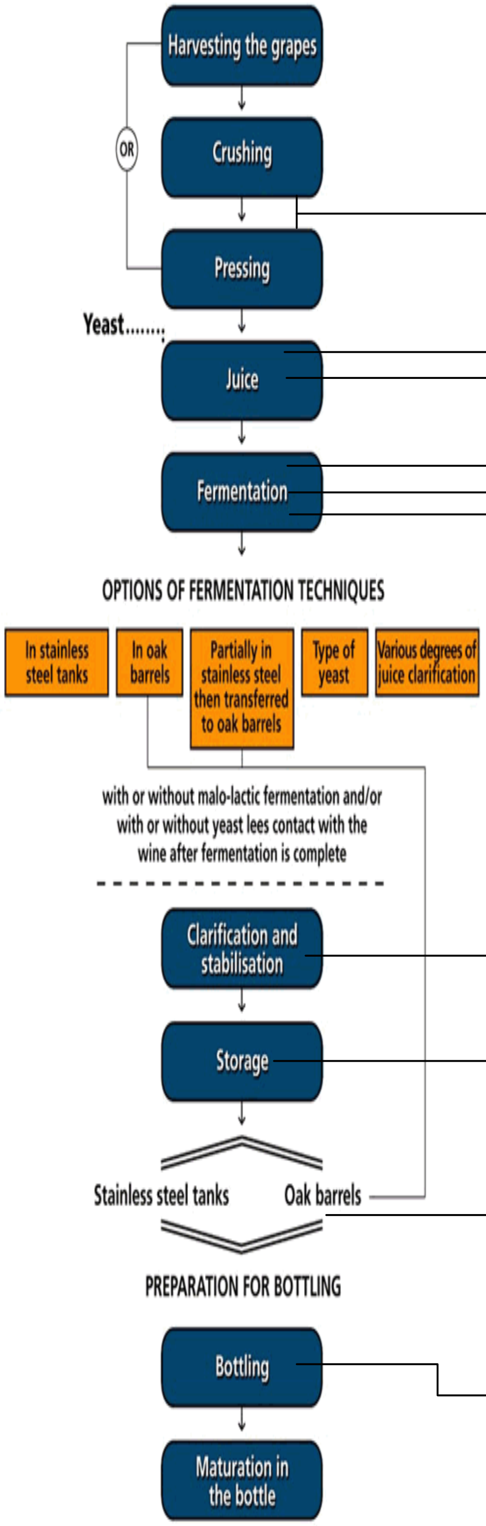
5.1.3.Vineyard water / energy use

The Ferngrove vineyard is irrigated at a rate of 0.6 – 0.8 ML/ha/year.

Energy use for the pumping of irrigation water has not been included in this report.

When assessing energy use for pumping irrigation water, it is worth taking into account if it is pumped more than once, how far it’s pumped, line diameters, the use of variable speed drive pumps and using off peak power (if available). Vineyard irrigation uses approximately 300 – 400 kWh per hectare /year.

Linking white wine fruit processing with temperature management at Ferngrove (Grt Southern)



100 tonne of fruit chilled from ambient temp (night time 15°C) down to 8°C. After de-stemming & pressing left with ≈ 60,000 L/t of free run and ≈ 15,000 L/t of pressings juice (total 75,000 L/t)

Free run and pressings juice chilled further and held in a tank for 4 days at 5°C for settling of solids

≈ 3,500 (5%) litres of juice removed to yeast inoculation tank which is then warmed to 15°C to promote growth of introduced yeast. Some chilling required to limit heat generation from yeast activity

The "mother" tank is now warmed up to ≈15°C prior to the yeast inoculated wine being reintroduced back into this tank.

After ≈24 hours cooling is applied to control fermentation. Process takes 7 – 8 days with brine jacket cooling on ≈ 50% of the time

20% of ferments are chilled to 0°C to artificially stop ferment and retain residual sugars

Cold stabilising or chilling to -2°C is required to remove tartrates and possibility of secondary ferment

≈ 79,000 L/t of white wine is stored for up to 9 months in stainless steel storage tanks or oak barrels at ≈15°C

Wine is left chilled for transport to Perth, where it is warmed to 18°C for bottling. The finished product is warehoused in Perth.

Ferngrove process ≈ 4,000 tonne (2,750,000 litres) of whites each vintage (February – May)

5.1.4. Seasonal variations to energy use

Figure 2: Energy use in relation to time of year

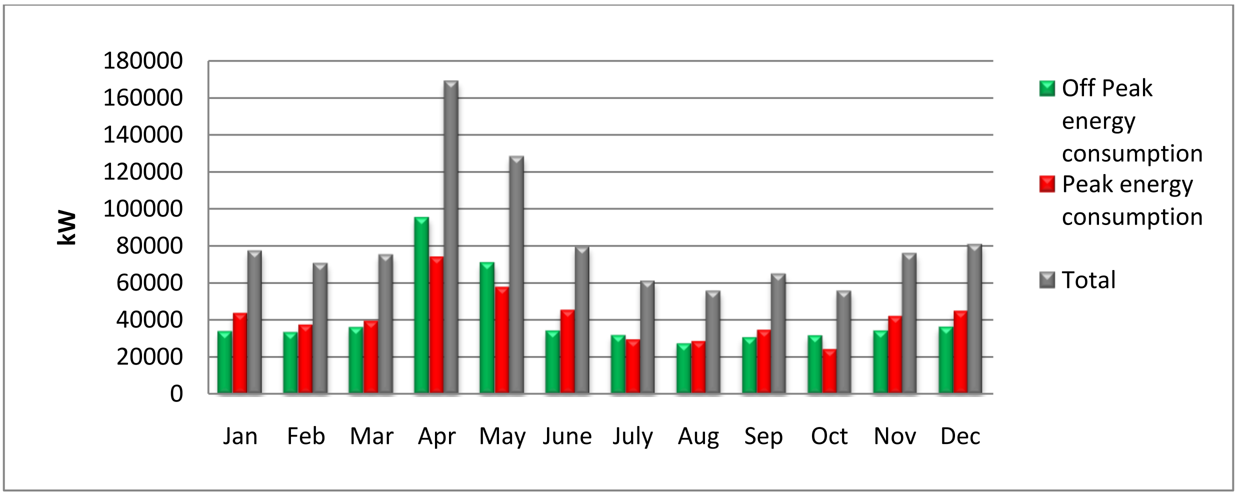


Figure 3: Mean Minimum / Maximum monthly temperatures at Ferngrove site

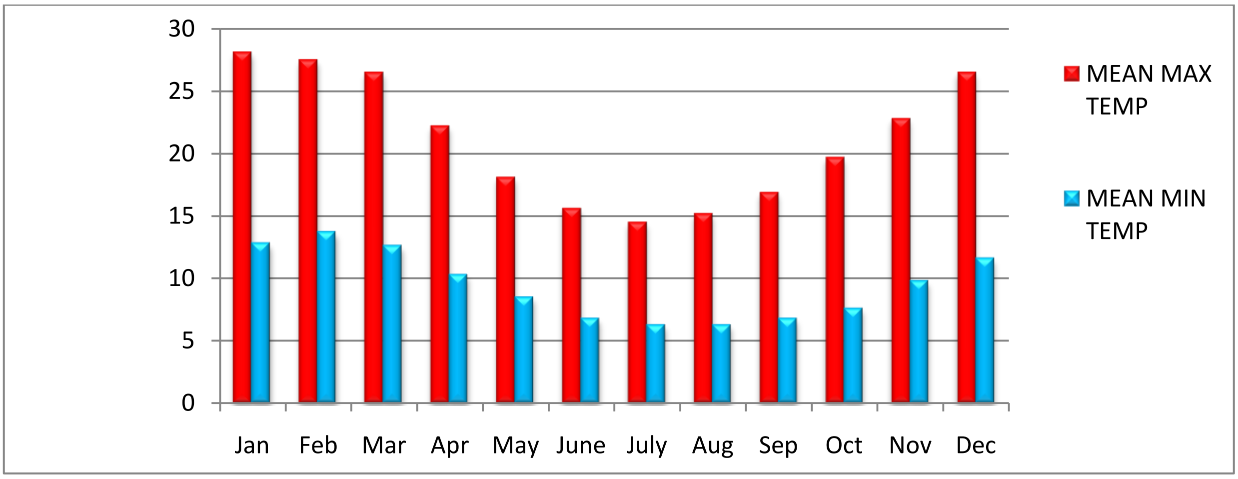
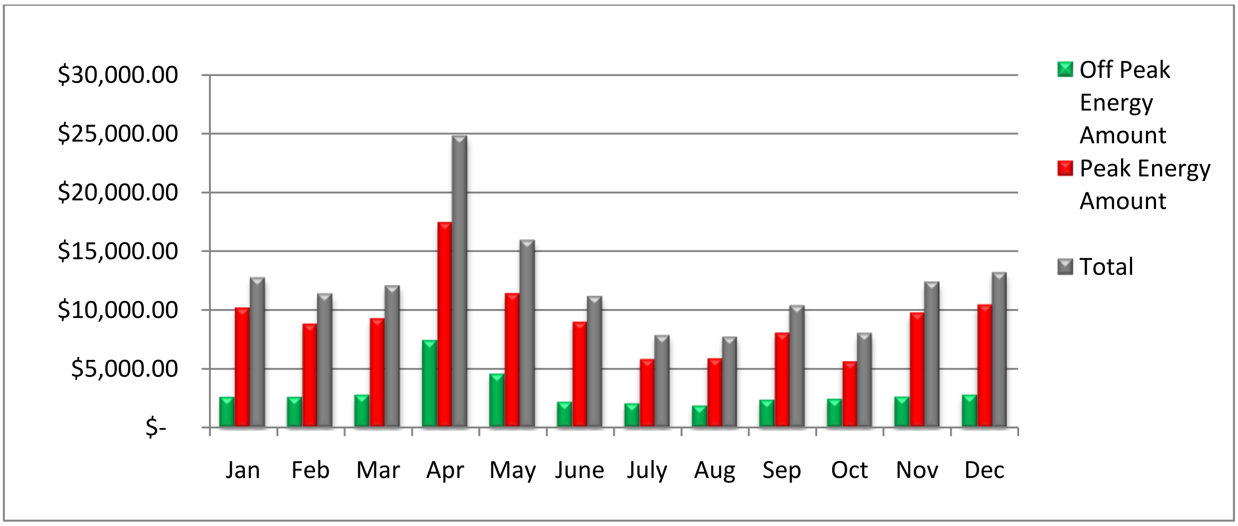


Figure 4: Cost of energy in relation to time of Year



6. Energy consumption and green house gas emissions

Ferngrove purchased 994,510 kWh units of energy in the 12 month audit assessment period. The National Greenhouse Accounts (NGA) Factors are used to calculate Green House Gas (GHG) Emissions. For this assessment, combined NGA scope 1 and scope 2 emission factors have been taken into consideration.

Scope 2 emissions: *The Indirect emissions from consumption of purchased electricity. The factors estimate emissions of CO2, CH4 and N2O expressed together as carbon dioxide equivalent (CO2-e).*

Scope 3 emissions: *For organisations that consume purchased electricity: to estimate their indirect emissions from the extraction, production and transport of fuel burned at generation and the indirect emissions attributable to the electricity lost in the delivery network.*

The combined emissions factor at the Ferngrove site is 0.94 CO_2-e/kWh, which equates to 935,000 kg CO_2-e (935 tonnes CO_2-e GHG emissions each year)

NOTE: This does not take into consideration the additional CO_2-e emissions from on-site LPG use, diesel use and winery wastewater emissions (methane).

7. Utility tariffs from provider

Figure 5: Cost of Peak / Off Peak energy

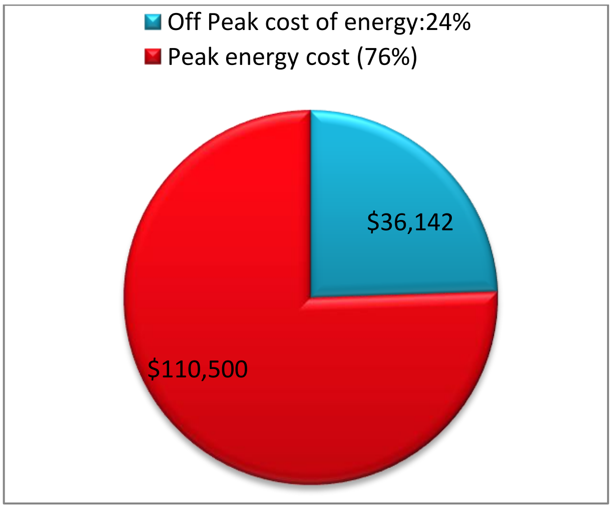


Figure 6: Ratio, Peak / Off Peak energy use

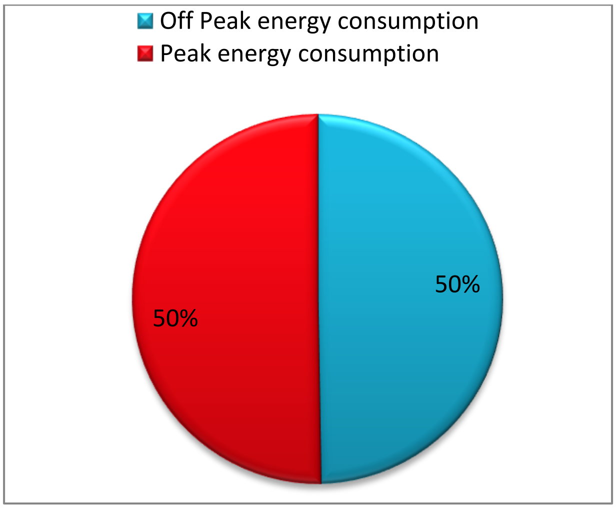


Figure 7: Utility tariffs and cost forecast

Tariffs Rates Energy use based on 12 months billing data	Cost of Peak energy use (7:00 AM – 11:00 PM)	Cost for Off Peak Energy use (11:00 PM – 7:00 AM + weekends)	**Total cost**
Cost of energy for audit period Peak tariff: **23.589** c/kWh Off Peak tariff: **7.76** c/kWh	$110,500	$36,142	**$146,142**
Cost of energy for the next 12 months with <u>new</u> tariffs, assuming same energy use. Peak tariff of **29.73** c/kWh Off-peak tariff of **9.02** c/kWh	$147,834	$44,852	**$192,686**

7.1. Benchmarking energy use

Benchmarking is important for continual improvement and a guide to reducing costs.

It is also useful when comparing your winery with wineries of similar size, production methods, product quality, climatic conditions, etc. Medium sized premium producers tend to be the most inefficient in regard to energy use as they don't have economies of scale that larger producers have and usually don't have the business owner on site driving efficiencies and providing direct accountability that the smaller producers have.

The preferred wine industry benchmark for quantifying energy use is kWh per litre of wine produced.

Though limited, existing benchmarks suggest that similar producers to Ferngrove (in size) range between 0.5 and 1.5 kWh/L. Ferngrove use 0.25 kWh/L wine. This does not take into consideration energy used with off-site bottling processes, LPG use, and diesel / petrol use. For benchmarking between wineries to be effective it needs to take into account all energy using practices.

8. Energy saving opportunities

Although energy efficiency opportunities may be made across the board in any business, the greatest effort should be directed to where the most energy is used. Opportunities are identified as a result of analyzing data and understanding the production processes. The opportunities for improved efficiencies and cutting costs are outlined below and are a point of reference for continuous improvement in energy management. As energy is also linked to water and waste management these should also be incorporated into the same continuous improvement program. Energy saving options range from low cost in-house strategies to the higher cost options that require longer term financial planning, logistical planning and specialist technical advice.

It is important to develop a forum to engage staff for ideas, and assistance for reducing energy use. Other than financial savings, drivers include reducing your carbon footprint to meet market expectations and social / environmental considerations. The forum can be used to:

- Engage staff and developing energy management ideas and strategies.
- Set achievable energy reduction targets.
- Develop strategies for Implementing practice change
- Ensure that the process for continuous improvement is sustainable.

8.1. Practice Change

The importance of practice change cannot be underestimated as a low or no cost solution for achieving significant reductions in energy use, unfortunately it can also be one of the hardest things to achieve and maintain. The benefits of achieving real practice change are realized when staff and management are actively participating in energy reduction practices and finding solutions for continuous improvement in energy management. Practice change is more sustainable when starting with 'easy win' achievable changes such as turning off appliances when not in use, setting appropriate equipment to energy save mode and reprogramming or installing timers to reduce hours of use.

8.2. Refrigeration

Figure 8: Refrigeration plant

For this audit report, refrigeration has been separated into refrigeration plant and refrigeration system.

Refrigeration at Ferngrove uses approximately 598,000 kWh a year which works out to well over half of the winery's energy use. The cost of operating this system will increase by approximately $22,000 over for the next 12 months (with tariff increases and assuming same peak / off peak usage). Setting an initial, achievable energy reduction target of 24% (150,000 kWh) for this system will offset these tariff increases.

NOTE: As this equipment is a major user of energy, it is worth installing a sub-meter on the unit to gain more detailed and accurate data which in turn assists with better systems management.

Figure 9: Damaged condenser

8.3. Refrigeration Plant

This is a relatively new, well maintained air cooled system; however there are still issues that impact on energy use. Examples include:

- Damage to condenser (figure 9).
- Though it has good air movement to and from the unit, it would benefit from shading to reduce heat load on the unit during peak energy use (summer).
- Damaged or missing insulation on brine lines between brine tanks and refrigeration unit.
- In the absence of variable speed drives the valves (figure10) on brine lines are partially closed to reduce flow or cavitation. This means that the brine pump doesn't match demand requirements and therefore not running efficiently.

Figure 10: Using valve to adjust flow rate

Options to better manage energy use for this system include:

- Repair or install insulation
- Install sub-metering as an important energy management tool.
- Install variable speed drives on circulation pumps from / to refrigeration unit.
- Consider changing temperature set points to minimum requirements.
- With an appropriate refrigeration management system, process specific programs can be installed such as a cold stabilizing program. This can be set to preferred temperature set points and startup times to take advantage of off-peak power.

Figure 11: Icing up of brine pumps and lines

- Where possible, schedule cold stabilizing for the cooler months.
- Investigate the potential for preheating water to reduce energy use in generating hot water.
- Incorporate appropriate recommendations from the GWRDC funded refrigeration efficiencies project (when published) or manuals like; Energy Efficiency Best Practice Guide: Industrial Refrigeration

8.4. Refrigeration System

Issues with the refrigeration system include:

Figure 12: Uninsulated wine tank with brine jacket for cooling

- Fixed speed brine pumps: The brine pumps are using around 20% of the combined refrigeration plant / systems energy. At present outlet valves (figure 4) are partially closed to adjust flow / pressure or reduce cavitation.
- Lack of insulation on stainless wine tanks: There is a substantial loss of cooling potential and energy through damaged or missing insulation which means that the refrigeration systems lower set point has been set very low to account for heat gain as the brine travels through the system.
- Damaged or missing insulation on brine lines: As above, though probably more of an issue than lack of tank insulation. This is due to the brine lines being in constant (24/7) use and the ratio of exposed surface area in relation to brine line size (ratio increases as the ice builds up).

Options to better manage energy use for this system include:

Figure 13: Missing insulation on brine lines

- Variable speed controllers on brine pumps: Installation of variable speed controllers on these brine pumps can reduce their energy use by up to 50%, while maintaining a set flow rate or pressure against a variable demand. The installation of variable speed drive controllers will give an expected payback period of approximately 12 – 18 months.
- Install or repair damaged insulation: This will have the added benefit of being able to lift the refrigeration systems lower temperature set point setting from the -8 degrees (site visit setting) to a more appropriate setting. The lower the set point the higher the ratio of energy used to achieve the desired temperature.
- Incorporate appropriate recommendations from the GWRDC funded refrigeration efficiencies project (when published) or manuals like; Energy Efficiency Best Practice Guide: Industrial Refrigeration

Figure 14: Brine tank temperature setting

8.5. Hot water supply

Energy management should focus on hot water temperature requirements and review what practices require hot water and how efficiently this is used.

Options for improvement:

- Preheat water supply by cogeneration from refrigeration system or solar. For this to be effective an insulated holding tank and circulating pump would be required. Return water from the barrel ferment room and tank warming would go to the holding tank. **NOTE:** As a rule of thumb it takes 11.6 kW of energy to raise 1000 litres of water 1 degree.
- If funding is available, implementing a separate warming system (40 degrees) and hot water system for cleaning would be a more manageable and efficient option.
- Insulation quality on copper hot water lines needs to be assessed and improved where applicable, to minimize heat energy loss to the environment.
- Assess run times and amount of hot water used in the cleaning processes for barrel and tank washing and reduce if appropriate.

8.6. Nitrogen irrigation system

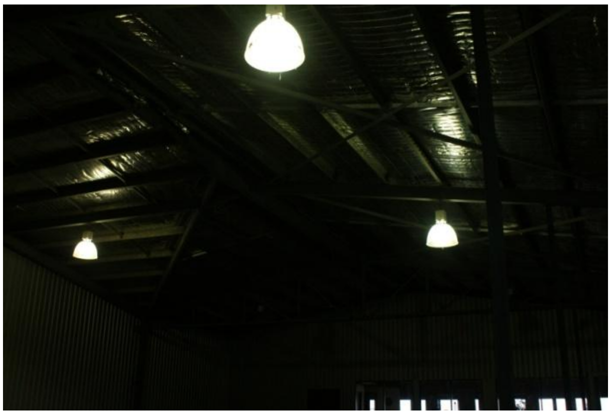
Nitrogen is a difficult gas to use for head space protection. The reason for this is that the tank needs some venting mechanism within the head space to allow for contraction / expansion within the tank and nitrogen as a light gas is the first gas to escape through this vent.

Options to reduce nitrogen loss include:

- Check for leaks in the system and ensure lids are secure.
- Ensure tanks are isolated when empty or when doing additions from the top.
- Check regulator pressure, although as it’s already at a very low pressure, this may be hard to adjust. The tank vent needs to vent at a higher pressure than the nitrogen regulator to avoid continual flow through of nitrogen.
- **Argon gas.** Argon is a heavy inert gas that can be dosed into the head space and has proven to be more cost effective while providing better protection to the wine. Cost of leasing nitrogen generator needs to be factored in.

8.7. Lighting

Figure 15: Lighting in barrel shed 1



The energy use for **lighting** when calculated separately **accounts for 8% of the sites energy use**. There are now available effective, viable lighting options that will enable energy reductions of up to 40%. Before replacing existing lights it is worth determining lighting requirements for each work area, while keeping in mind AS1680 workplace lighting requirements.

A good example of viable, alternative lighting is to replace the existing 450 W (with ballast) high bay lights in barrel shed 1. This area is under lit due to a number of the existing lights not working. As a scissor lift needs to be hired to replace these lights it is worth installing 120 W magnetic induction lamps. The main benefit (other than energy savings) is that these lamps *last up to 10 times longer* than the existing metal halide high bay lights with minimal loss of light output capacity.

Figure 16: Magnetic induction lamp

8.8. Compressed air supply

The two 37kW air compressors meet vintage supply demand and general requirements throughout the year. One unit is i used for non – vintage.

Figure 17: Compressor, pressure gauge

Energy saving measures include:

- Trialing reduced set point pressures for both vintage and non-vintage periods (set at 750 kPa during site visit). As a rule of thumb; **a 14 kPa reduction** in pressure results in a **1% reduction in energy** use. In this case a setting of 550kPa will reduce energy use of these units by around 15%.
- Turning off on weekends or when not required.
- Check for leaks at a time when the workplace is quite.
- Taking note of supply system pressure at the end of the day and first thing in the morning on a regular basis to determine compressed air loss rates. Air leaks often account for 20% - 30% of compressed air energy use.

9. Conclusion

This report has identified a number of energy saving opportunities at Ferngrove and provides the foundations for ongoing energy management at this site.

In all areas, energy efficiency improvements can be achieved at no or low cost. Behavior change such as improved work scheduling and turning off equipment that is not in use can be embedded in staff training and induction. These can be put into immediate action for early results.

Low cost actions such as equipment or system repairs can be implemented as part of a general maintenance program through scheduling and prioritising, to ensure cost effective outcomes.

Long- term actions require careful planning, balancing the need to keep potential energy savings in context with financial outlay and the life cycle costs of alternative options. When replacing plant or equipment it is important to understand the demand requirements on the system first. For example if replacing the refrigeration plant it would be logical to minimise demand or energy loss by improving the refrigeration system first. Additionally this can lead to savings on plant and equipment purchase costs, as a smaller replacement unit may then be more appropriate to meet demand.

Sub-metering of major energy use items, benchmarking energy use and setting achievable energy reduction targets are important aspects to a sustainable, continuous improvement program and improving your bottom line savings.