Energy Efficiency Case Study – Freeman Farming

Freeman Farming is a mixed almond and wine grape enterprise located at Renmark and managed by Peter Freeman. As part of the energy efficiency project run by Natural Resources SAMDB, part of the property was assessed in 2016 to determine what measures could be implemented to improve energy costs.

The Dora Block is a 20.76 hectare block of almond trees, with one micro-sprinkler located under the canopy of each tree. Irrigation water is supplied from a pressurised pipeline managed by the Renmark Irrigation Trust (RIT). A Kelly and Lewis pump draws water from the pipeline and delivers it to the orchard through a 200mm PVC mainline, travelling up to 1.6km to the furthest point. The Kelly and Lewis pump is a 100x65-200 pump with a 202mm impeller and a 30kW motor.

The topography of the orchard is flat with a maximum of .5m static from the point of pumping to the farthest emitters. It is estimated that the pressure in the mainline averages around 100kPa or 10m of positive head.

Audit results

In the 2014-2015 financial year, the cost of irrigating the Dora block totalled $11,231 + GST:

- $10,961 + GST for electricity consumption
- $270 + GST for service charges

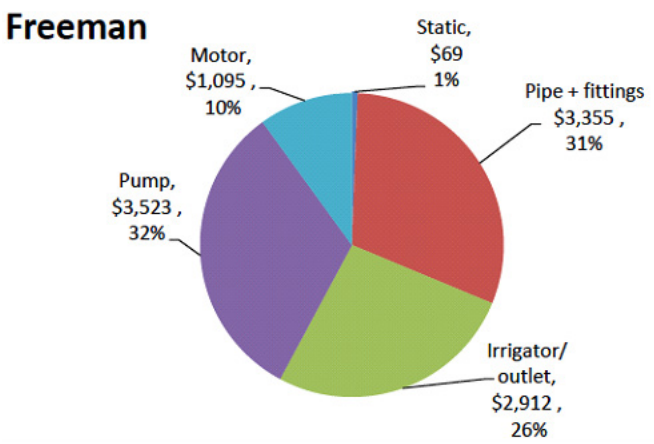

Table 1. Breakdown of irrigation costs by system component. Note that the static shown is net static (2.5 actual static less the assumed positive head pressure available in the RIT pipeline (2m)).

Energy use benchmarks

There are some discrepancies in the energy used to irrigate the Dora block:

- Using on-site measurements of flow (26.2L/s) and the amount of electricity drawn (20.7 kW) the system consumes 220kWhr/ML
- But annual records of water volumes (241.5ML / year) and energy use (44,350kWhr / year) reflect an energy consumption level of 184kWhr / year

This discrepancy could be due to the variation in pressure available in the RIT pressure delivery pipeline. During the audit process, the pressure in the RIT pipeline was minimal. Assuming that available pressure increases during the year, it would be feasible to expect a reduction the power drawn by the pump to deliver the same flow.

Energy use in comparison to other systems is very low in terms of kWhr / ML due to the low static component and also the low consumption by each component (pipe and fittings, micro-sprays, pump and motor).

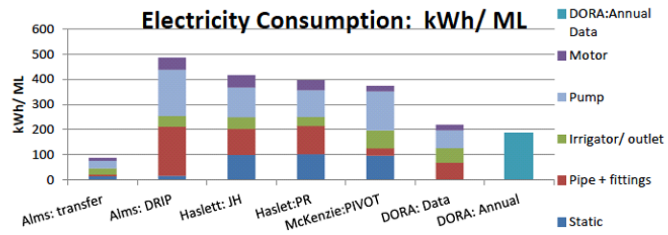

Table 2: Energy use (kWh/ML) in comparison to other audited irrigation systems

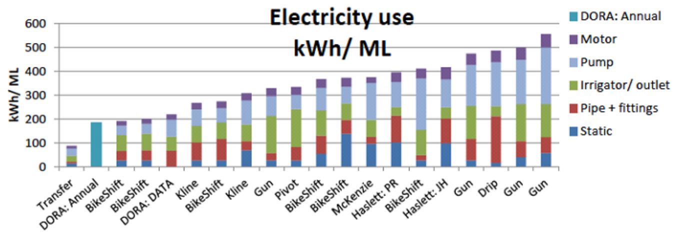

Table 3: Energy use (kWh/ML) in comparison to other audited irrigation systems

Energy cost benchmarks

The Dora block has an energy cost of between $45.5/ ML (annual data) and $54.4 / ML (monitored data). Compared to other systems, this is at the lower end of the range in terms of $/ML. However, when compared in terms of $/ML/m, the Dora block is slightly higher than average.

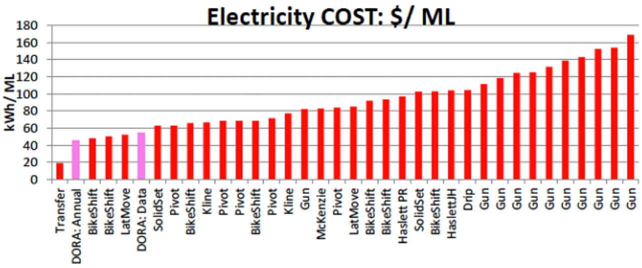

Table 4: Total electricity cost ($/ML) in comparison to a National average

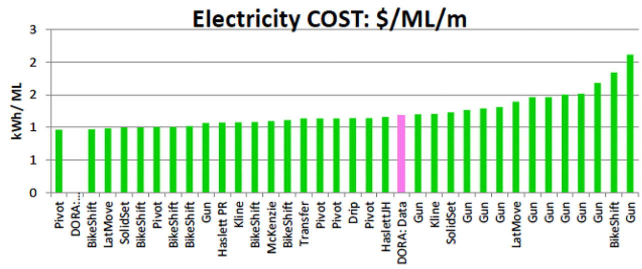

Table 5: Total electricity cost ($/ML/m) in comparison to other irrigation systems Nationally

Irrigation System Analysis

The Dora block irrigation system has a low energy consumption benchmark indicating that there are no large unaccounted for losses in the system. Energy is consumed evenly between the system components, meaning that no one component is the single largest user of power.

Looking at the breakdown of electricity consumption shows that although the electricity use for the Dora block is low-range in terms of kWhr/ML, it is mid range in terms of kWhr/ML/m when compared to other irrigation systems Nationally.

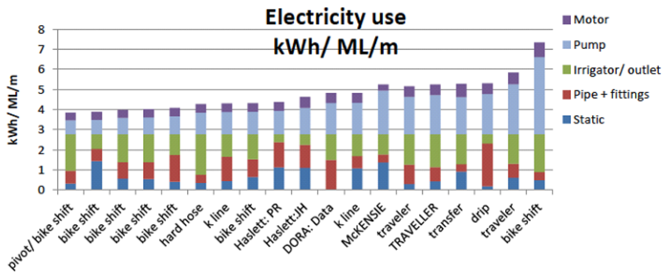

Table 6: Total electricity use (kWhr/ML/m) in comparison to other South Australian irrigated systems

Improving energy efficiency

Overall the audit found that the system worked at a relatively efficient level and so there are limited options in terms of improving the current system in a cost effective way. The cost of friction losses in the pipeline and fittings account for $3,355 per year (64.3% energy efficiency rating). While duplicating the mainline could cut friction losses in half, 1.6km of 200mm PVC pipeline would likely cost around $56,000 plus installation and fittings.

Inefficiencies in the pump account for $3,523 per year with an energy efficiency rating of 64.3%. Operating at the ideal efficiency rating (69%) could result in a saving of $753/year, so it could be worth investigating why the pump is working at a lower level of efficiency. If the pump impeller is the cause, it could be worth replacing it at a cost of $1,500-$2,000. Certainly when the pump reaches the end of its natural life, upgrading to a more energy efficient unit would be very worthwhile.

		Power use (peak)	Power use (off-peak)	Service	Average tariff cost	Total	Saving
	kWhr / year	10,531	33,819	365 days		$44,350	
Current contract (Origin Energy)	$/kWhr	0.407	0.197	0.740	24.72c/kWhr	$11,231	
	$	$4,285	$6,667	$270			
Option 1 Origin Energy + 20% discount	$/kWhr	0.286	0.152	0.740	18.35c/kWhr	$8,410	$2,821
	$	$3,013	$5,127	$270			
Option 2 Pacific Hydro (1 year contract)	$/kWhr	0.304	0.104	0.740	17.93c/kWhr	$8,221	$3,010
	$	$3,202	$4,748	$270			

Table 7: A comparison of available tariff charge options applicable to Freeman Farming. (Note, current at the time of audit).

Motor inefficiencies cost $1,095 per year with an assumed energy efficiency rating of 90%. Although the existing motor has a nominal high efficiency rate, replacing the motor with one that can operate at 94% efficiency could save $467 / year.

Freeman Farming is a mixed almond and wine grape enterprise located at Renmark in South Australia.

Reducing costs in operation

Distribution uniformity

Dora block is irrigated with Nelson R10 turbo under-canopy sprinklers. P6 blue rotators have been installed, but with a mixture of jet sizes (dark blue #78 and grey #65). The distribution of the two jet sizes and their proportions were not gathered at the time of the audit.

To ensure consistency during the audit process, grey jets were installed on all test micro-sprinklers. Testing revealed a distribution uniformity (DU) of 95%, indicating strong regularity across the jets. The measured average application was 3.8mm/hour, with a normal design range of 3.61 – 3.99 mm/hour. If the system was to be run longer so that the minimum application sprinkler applies at least the average less 5% (3.61mm/hour), an additional $57 / year would be added to the current charges.

Given the system is being run with a mixture of jets, the actual variation in performance would be significantly greater than measured. The average pressure measured against all laterals was 194kPa, therefore the blue and grey jets are delivering the following application rates per hour:

- Grey: 148L / hour, or 3.86mm / hour
- Blue: 215L / hour, or 5.60mm / hour

If the system is run so the grey nozzles apply the intended application of the blue nozzles (215l/hour), significant over-application would occur.

Tariffs

The annual energy consumption is less than 100MWhr, so the billing is based on consumptive charges only and does not have a contestible component.

In the 2014-2015 financial year, the meter worked on a Time of Use (TOU) tariff model, charging 40.7 cents / kWhr (peak power) and 19.7 cents / kWhr (off-peak power). As a percentage, 24% of power consumed was charged at the peak rate, and 76% was charges at the off-peak rate, with a resulting average tariff of 24.72 cents / kWhr.

Given the high proportion of off-peak power used, the TOU is the most cost effective tariff model at this time. However, several companies offer power on a TOU arrangement at lower prices than the current contract.

Alternative energy sources

Diesel

Given the low cost of electricity in this case, it is unlikely that diesel power represents a viable alternative for the site. The cost to generate electricity with an energy efficiency diesel genset is around 25-26c/kWhr, if diesel is available at $1-$1.05/l. This does not take into account the cost of buying, maintaining and replacing the genset unit.

Solar PV

The peak and trough nature of the power requirements of an irrigated farm means that a conventional solar photovoltaic (solar PV) power is not a natural fit in these circumstances. However, if some changes can be made to irrigation practises, it is possible for solar power could be used in conjunction with grid-sourced power to reduce the annual cost of electricity.

Using the average hours pumped per day for the 2014-2015 financial year, a 30kWp solar system would have a payback period of about seven years, based on current tariff charges. This is based on the assumption that irrigation scheduling can be programmed so that the Dora block is irrigated during daylight hours.

Overall the audit found that the system worked at a relatively efficient level and so there are limited options in terms of improving the current system in a cost effective way.

For more information

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