Energy Efficiency Case Study – Craig and Sheridan Alm

At New Residence in the Riverland region, Craig and Sheridan Alm operate a 200 hectare irrigated property including wine grapes and young almond trees.

The property is irrigated by a drip irrigation system, with water supplied from the Murray River by four Flygt brand submersible pumps, supplying the suction manifold for four Kelly and Lewis main lift pumps via 475m of 400mm diameter pressure poly pipeline. The Kelly and Lewis pumps deliver irrigation water through a 400mm diameter mainline, reducing to smaller sub-mains to supply DM2025 non-compensating drip lines.

A 13.5 kW motor drives each Flygt pump and the Kelly and Lewis pumps are Hydrotitan 125x80 315 units with 289mm impeller and 75kW motors. One of the Kelly and Lewis pumps is connected to a variable speed drive.

Audit results

In the 2014-2015 financial year, electricity charges for the meter supplying both the Flygt submersible pumps and the Kelly and Lewis lift pumps totalled $180,846 + GST.

- $16,920 + GST for the Flygt pumps
- $93,764 + GST for the Kelly and Lewis pumps
- $66,827 + GST for demand charges, based on peak demand kVa, for all pumps
- $3,335 + GST for service fees and charges

Table 1 (below) shows how electricity charges are broken down into the cost to overcome static, and pipe and fitting friction losses as a result of pump and motor inefficiencies.

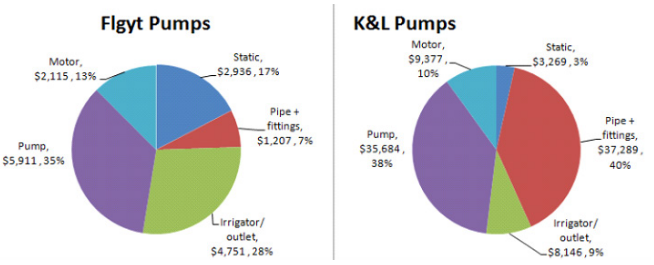

Table 1: Breakdown of irrigation costs by system component

Energy use benchmarks

In the 2015-2016 financial year, electricity consumption supplying the Flygt and Kelly and Lewis pumps totalled 785,000 kWhr / year, comprising:

- 120,000 kWhr / year for the Flygt pumps
- 665,000 kWhr / year for the Kelly and Lewis pumps

The pumping systems used:

- 88 kWhr / ML (Flygt pumps)

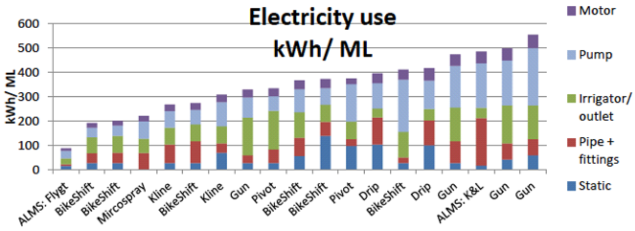

Table 2: Comparison to other irrigators with component breakdown

- 486 kWhr / ML (Kelly and Lewis pumps between 4 pumps)
- Table 2: Electricity use (kWh/ML) in comparison to other South Australian irrigation systems

In comparison to other similar systems, the Flygt pumps use a low amount of energy to operate. This is because these pumps are simply transfer pumps with low outlet pressure. In addition, the pipe and fitting losses are low per ML because the diameter of the pipe is consistent.

The Kelly and Lewis pumps, however, are in the higher range in terms of kWhr/ML. This is partially attributable to the relatively high pipe and fitting friction loss components and the substantial conveyance distances and static lift requirements required to move water around the property (up to 2km).

Table 2 shows the breakdown of the pumping and emitter systems compared to the other systems audited in the within the region. In comparison to the other audited systems, static load is generally lower, while pipe and fitting friction losses are higher.

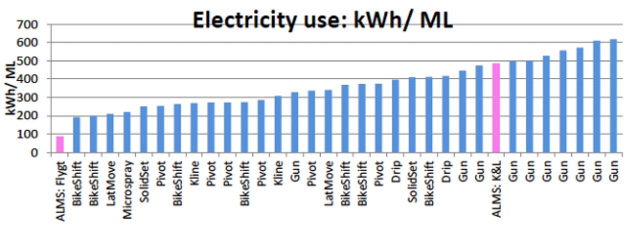

Table 3: Energy use (kWh/ML) in comparison to other audited irrigation systems

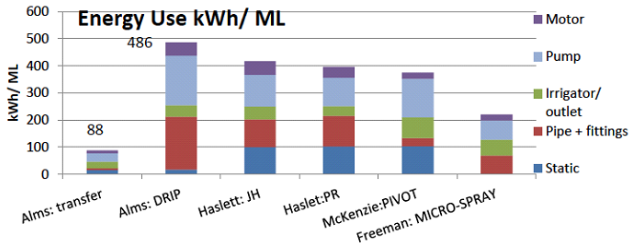

Table 3: Energy use (kWh/ML) in comparison to other audited irrigation systems

Energy cost benchmarks

The audit on the Alm's property focussed on consumption charges rather than demand fees. Demand fees are heavily influenced by irrigation practises and are harder to reduce compared with remedial solutions of system components.

The cost to irrigate crops on the Alm's property per megalitre of water is:

- $12.40 / ML (Flygt pumps)
- $65.80 / ML (Kelly and Lewis pumps)

Considering the energy costs involved with the delivery of water and comparing those with similar irrigation systems, it is possible to develop an idea of how cost effective the Alms' irrigation system is:

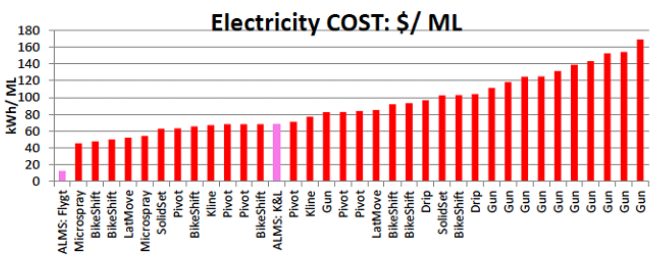

Table 4: Total electricity cost ($/ML) in comparison to other South Australian irrigation systems

Taking into account the distance between the shows that the Alms' system is at the lower end of the scale, in comparison with similar irrigation systems.

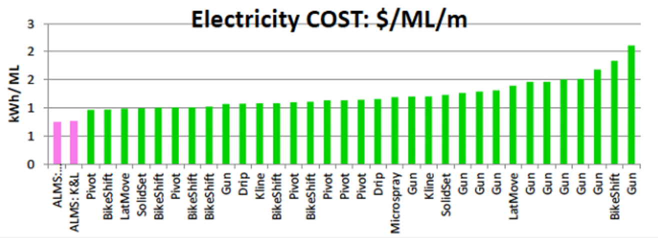

Table 5: Total electricity cost ($/ML/m) in comparison to other South Australian irrigation

Improving energy efficiency

Lift pumps - Kelly and Lewis pumps

While the Kelly and Lewis pumps and associated components ranked poorly in terms of energy efficiency, there are a number of strategies that could result in significant savings.

Inefficiencies in the pumps are estimated to account for approximately $35,684 per year, with an energy efficiency rating of 57.7%. If this figure could be increased to 74% (ideal energy efficiency rating), the bill would be reduced by $20,636 per year. It is therefore worth investigating what changes are required to increase pump performance.

An additional $3,990 could be saved per year by installing high efficiency motors. The current units have an energy efficiency rating of 88% (motor plaque data) at a cost of $9,377 per year. High efficiency motors can deliver up to 94% efficiency. However it is unlikely that savings would be greater than the upfront cost of the capital outlay.

The costs incurred to overcome friction losses through the mainline totalled $37,289 (2014-2015 financial year). Duplicating the pipeline could save $35,907 / year, assuming the pumps remain operating at 57.7% energy efficiency level. Because the length and diameter of some of the mainlines are not known, further investigations would be needed to ascertain whether mainline duplication would be worthwhile.

	Current energy efficiency rating	Inefficiency costs	Ideal energy efficiency rating	Potential savings
Pumps (Kelly and Lewis)	57.7%	$35,684	74%	$20,636
Motors (Kelly and Lewis)	88%	$9,377	95%	$3,990
Pumps (Flygt)	60.1%	$5,900	No data	No data
Motors (Flygt)	87.5%	$2,115	90%	$470
	Total current inefficiency costs	$53,076	Total potential savings	

Table 6: Potential costs savings through improved energy efficiency measures

Flygt system

Inefficiencies in the pumps account for $5,900 / year in electricity costs, at an assumed efficiency rating of 60.1%. Some pump and motor data was unavailable at the time of the audit being undertaken, so this figure is not as accurate as it could be.

Based on the age and manufacture of the pumps, the assumed efficiency rating of the motors is 90% at a cost of $2,115 / year. This suggests that until a motor fails, there is limited worth in investing in high efficiency motors at this point in time based on likely replacement costs.

The costs of friction losses in the pipelines and fittings supplied by the Flygt pumps account for charges of $1,200 / year which are negligible and preclude any requirement for change.

Reducing costs in operation

Drip system - Application Uniformity

Catch can measurements were taken across a number of valve sections and laterals. Distribution uniformity results of between 37% and 63% were obtained, indicating uneven output of water throughout the system. Some emitters applied less than 50% of the average application and in one valve a lack of residual head resulted in no emitter outputs in a higher elevation area of some valves. To compensate for these irregularities significant additional pumping costs can be incurred if the system is run for longer periods of time:

- Valves 1+2: 0.56 to 1.06l/hour, compared to the average of 2.32l/hour
- Valves 12+13: 1.24 to 1.45l/hour, compared to the average of 2.65l/hour

If the system runs longer in order to apply at least the average (7.1ML/hectare/year) less 5%, the system would have to be operated for an additional:

- Valves 1+2: 681 hours / year
- Values 12+13: 747 hours / year

These estimated extra pumping costs could equate to $21,000 - $30,000 per year, in addition to increasing operational stress of the irrigation system and potential negative environmental outcomes.

Scheduling

If scheduling is based upon the average application rate from Valves 1 and 2, there will be an over application through valves 12 and 13, equating to an additional 76 hours of pumping per year. Assuming this applied to 50% of the area irrigated, this could be responsible for charges of $1,680 per year.

Tariffs

The annual energy consumption for the Alms' system is greater than 100MWhr, so the bills are termed as 'contestable'. This means that the network and distribution costs are itemised separately and the bills have three components: consumption charges (kWhr), peak demand charges (kVa) and daily fees.

Consumption tariffs were 19.5 cents/kWhr (peak demand) and 12.5 cents/kWhr (off peak demand). This includes network charges, which have been proportioned between the peak and off-peak components.

The peak demand billed each month was 395kVa, at a total of $5,569 per month or $66,827 each year:

Peak demand band	Price per kVa	Cost
First 100 kVa (0-100)	$20.37	$2,037
Next 150 kVa (101 – 250)	$13.36	$2,004
Next 140 kVa (251 – 390)	$10.72	$1,501
Remaining kVa (390+)	$5.43	$27.15
	Total monthly peak demand fees	$5,569

Table 7: A breakdown of peak demand fees per demand band.

A review of options showed that the current model used (VLVS tariff – agree demand) is the most appropriate, and is significantly cheaper than the alternatives. The alternative is a VLVS tariff (actual demand), but the summer peak demand rate is so high that it would negate savings made through the winter peak demand rate.

Craig and Sheridan Alms have engaged an energy broker to review tariffs and ensure they are using the most cost effective option on the market. This is highly recommended for irrigators consuming this scale of electricity.

Power Factor Correction

The current power factor (the ratio of reactive power and real power) is 90-91%, with peak demand at 395 kVa. Installing a 50kVAr power factor correction (PFC) unit would improve the power factor to 95%, reducing peak demand to 373kVa and saving approximately $2,500 per year. A 50 kVAr PFC unit typically costs approximately $4,000 + GST and installation costs, so obtaining a quote would be worthwhile.

Alternative energy sources

Diesel

In the 2014-2015 financial year, the Alms' property used 785,000 kWhr of electricity at a total cost of $180,846 + GST – an average of 23 cents per kWhr. A highly efficient diesel genset can generate electricity at approximately 25-26 cents / kWhr, assuming the price of diesel is between $1-1.05 per litre. This suggests that at the time of the audit that a diesel genset was not a feasible alternative to the current power source, without also factoring in the cost of purchasing, maintaining and upgrading a generator.

Solar PV

There is generally little value in investing in solar photovoltaic (solar PV) systems for irrigated systems because irrigating is a seasonal activity and is generally undertaken at night. In the case of the Alms' property, irrigation shifts are generally set to start at 9pm at night for 10-12 hours each.

In addition, the current tariff used by the Alms may work against any cost savings realised by a solar system. For example, on a cloudy day, pumping water may cause a demand spike that will increase grid-sourced electricity costs.

If irrigation applications can be scheduled to maximise the power generated (i.e. irrigation occurs during sunlight hours), solar PV could offer a cost effective alternative to only grid-based power. A simplified analysis was carried out assuming power use remains consistent and there is no reduction in peak demand fees. A 300kWp solar system would have a payback period of 12 years.

Solar PV + batteries

Given the large amount of power drawn to irrigate this property, a case for a solar system with batteries may be worth exploring. Such a system would greatly reduce the risk of a spike in power during peak demand times, and store energy that can be access as required. A detailed feasibility study is required to weigh up the costs and benefits.

For more information

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This project is supported by the South Australian Murray-Darling Basin Natural Resources Management Board, through funding from the Australian Government's National Landcare Programme and the NRM Levies.