Power Bills and Energy Efficiency for Irrigation

James Curran, Agricultural Resource Management

Why Bother?

- Farm irrigation power costs are typically around 70 to 80% of the total farm electricity usage!
- Poor attention to detail will lead to substantially higher costs

The Main Opportunities – What are they?

1. What we pay for our energy
2. The use of more electrically efficient equipment
3. Reduced or reducing actual power usage

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1. What we pay for our energy use

i.e. the tariffs or contract price per unit. *(these are not the focus of this discussion)*

Main points:

1. Correct tariff or contract arrangement based on total usage and usage pattern
2. Check the simple things, ie:
    - Do you have the full 11hrs of Tariff 73/74 available?
    - Ensure auto start timers for pumps match the off peak metering
    - Is the site contestable?

2. The use of more electrically efficient equipment

- The right Pump
    - What is **'Pump Efficiency'**?

... the water or liquid power divided by the power input at the pump shaft

The use of higher electrically efficient equipment (cont)

- Principal causes of power loss / efficiency loss in a pump:-
    - Friction loss in the pump passages
    - Disc friction from the impeller rotating in the water
    - Internal leakage of water from the discharge back to the suction side of the pump via balance holes and sealing clearances
    - Shaft Bearing losses
    - Seal / Gland losses
    - Coupling windage

The use of higher electrically efficient equipment (cont)

- In practice, what is good pump efficiency?
  - Greater than 70% at the duty point
  - Better than 80% is extremely good

The maximum you will see from an end suction pump is around 88%

- What effect does pump efficiency have on actual pumping cost?
- Some practical examples

The use of higher electrically efficient equipment (cont)

Assumptions:

- Duty of 40 litres per second
- 60 metres head
- Based on current Tariff 73/74
- Off peak power at 10.908 c/kWh
- Peak at 24.824 c/kWh

Off peak only

Example Comparison of Pump Efficiency				
Duty	40 l/s @	60 mtrs Head		
Pump 1			***Pump 2***	
Pump Efficiency	**65**		Pump Efficiency	**80**
Motor Efficiency	**91**		Motor Efficiency	**91**
Pump input kW	36.22		Pump input kW	29.43
Unit at Meter	39.80		Unit at Meter	32.34
Cost per hour off peak	$ 4.34		Cost per hour off peak	$ 3.53
Cost per hour Peak	$ 9.89		Cost per hour Peak	$ 8.03
Hours Per Day	**11**		Hours Per Day	11
Cost per day	$ 47.76		Cost per day	$ 38.80
Cost per ML	$ 30.15		Cost per ML	$ 24.50

The difference is $5.65 per ML

The use of higher electrically efficient equipment (cont)

Assumptions:

- Duty of 40 litres per second
- 60 metres head
- Based on current Tariff 73/74
- Off peak power at 10.908 c/kWh
  Peak at 24.824 c/kWh

A combination of peak and off peak

Example Comparison of Pump Efficiency				
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Cost per hour off peak	$ 4.34		Cost per hour off peak	$ 3.53
Cost per hour Peak	$ 9.89		Cost per hour Peak	$ 8.03
Hours Per Day	**16**		Hours Per Day	16
Cost per day	$ 97.20		Cost per day	$ 78.98
Cost per ML	$ 42.19		Cost per ML	$ 34.28

The difference is $7.91 per ML

The use of higher electrically efficient equipment (cont)

- Electric Motors

Not all electric motors are the same!

- As of Oct 2001 all three phase electric motors from 0.73 to 185 kW either manufactured or imported into Australia must comply with minimum energy performance requirements as set out in AS/NZS 1359.5-2000. This was made even more stringent in April 2006, when the previous high efficiency level became the new minimum standard.
- Essentially all three phase electric motors since 2006 are typically around 2 to 3% more efficient that those prior to 2001.

The use of higher electrically efficient equipment (cont)

Off peak Example:-

Example Comparison of Motor Efficiency				
Duty	40 l/s @	60 mtrs Head		
Pump 1			***Pump 2***	
Pump Efficiency	**80**		Pump Efficiency	**80**
Motor Efficiency	**90**		Motor Efficiency	**93**
Pump input kW	29.43		Pump input kW	29.43
Unit at Meter	32.70		Unit at Meter	31.65
Cost per hour off peak	$ 3.57		Cost per hour off peak	$ 3.45
Cost per hour Peak	$ 8.12		Cost per hour Peak	$ 7.86
Hours Per Day	**11**		Hours Per Day	11
Cost per day	$ 39.24		Cost per day	$ 37.97
Cost per ML	$ 24.77		Cost per ML	$ 23.97

The difference in power cost is 80 cents per ML

The use of higher electrically efficient equipment (cont)

A combination of peak and off peak

Example Comparison of Motor Efficiency				
Duty	40 l/s @	60 mtrs Head		
Pump 1			***Pump 2***	
Pump Efficiency	**80**		Pump Efficiency	**80**
Motor Efficiency	**90**		Motor Efficiency	**93**
Pump input kW	29.43		Pump input kW	29.43
Unit at Meter	32.70		Unit at Meter	31.65
Cost per hour off peak	$ 3.57		Cost per hour off peak	$ 3.45
Cost per hour Peak	$ 8.12		Cost per hour Peak	$ 7.86
Hours Per Day	**16**		Hours Per Day	16
Cost per day	$ 79.85		Cost per day	$ 77.28
Cost per ML	$ 34.66		Cost per ML	$ 33.54

The difference in power cost is $1.12 per ML

The use of higher electrically efficient equipment (cont)

- Motor size v/s load
  - Electric motors increase in efficiency as they near full load i.e. an electric motor operating at only 50% of full load will not be as efficient as one operating at close to 100% of full load. The difference will depend on the actual size and make of the motor. That said it will often be between 2 and 5% difference.
  - Therefore only utilise a motor large enough for the actual job!

3. Reduced or Reducing Actual Power Usage

How? *Two ways:*

- Reduce (where practical and feasible) actual system pressure (head)
    - Change of system from high to lower operating pressure i.e. Convert from Travelling irrigator to Centre Pivot system or Lateral or pod system to Centre Pivot
- Reduce system flow rate or the total volume of water pumped

Example of potential pumping cost saving (Converting from Travelling Irrigator to Centre Pivot)

Pump Duty & Power Calcs (20ha system)					
Item	**Travelling Irrigator**			**Centre Pivot**	
End Pressure	52	m		14	m
Friction in irrigator or hose	28	m		0.73	m
Static Head	15	m		15	m
fh mainline (150mm)	4.1	m		2.8	m
Sundry Losses	7	m		7	m
Total Head	106.1	m		39.53	m
Pump Duty	**17.1 l/s @**	**106.1mtrs head**		**18.5 l/s @**	**39.5mtrs head**
Pump efficiency	65.5	%		80.5	%
Motor efficiency	92	%		92	%
Net Efficiency	60.26	%		74.06	%
kWh @ the meter	29.53			9.70	
Cost per hour off peak	$ 3.22			$ 1.06	
Cost per hour Peak	$ 7.33			$ 2.41	
Hours Per Day	15			15	
Cost per day	$ 64.77			$ 21.27	
Cost per ML	$ 70.16			$ 23.04	
Cost Difference per ML	$ 47.12				

Reduced or reducing actual power usage (cont)

- Review / Audit the existing system for areas of potential improvements. For example:-
  - Does the system pump deliver more head than is required? (i.e. discharge valve always partially closed)
  - Pipe design – high friction loss
  - System design areas of high loss – fittings, suction
  - Does the system have significant variation is elevations i.e. due to topography or dam water level. Consider the use of VSDs, also consider the use of boost pumps for higher elevated areas
  - System maintenance – build up of iron bacteria in pipelines, blocked suction screens, impeller wear etc
  - Incorrect pump for the duty, incorrect impeller size etc

Reduced or reducing actual power usage (cont)

- Reduce system flow rate or the total volume of water pumped

How?

- Irrigation scheduling
  - Apply the right amount of water at the right time! i.e. minimise the time the soil is either too wet or too dry, and therefore maximise the time water is available to the plants
  - Poor scheduling often results in excess drainage, runoff, ponding of low lying areas and nutrient leaching
  - It also results in reduced yields and profit
  - It can also result in under-watering and missed start up times
  - Good scheduling should result in higher water use efficiency i.e. more production per ML of water applied.

Reduced or reducing actual power usage (cont)

- Key considerations when selecting soil moisture monitoring equipment
  - Suitability for the soil type and irrigation system utilised
  - Reading range
  - Volume of soil measured
  - Sensitivity to salinity
  - Installation method required
  - Technical support, training and backup
  - Usage cost (labour)

Reduced or reducing actual power usage (cont)

- Uniformity of application
  - "The evenness of the water application to the plants throughout the area of irrigation"
  - No irrigation system applies water completely uniformly!
  - Non-uniformity results in poor water use efficiency through over and under watering
  - It is usually managed by overwatering parts of the area to ensure the remainder receive adequate water
  - Measure of uniformity – DU or Distribution Uniformity
  - DU – is the average of the lowest 25% / the average of all
  - The bench mark for Centre Pivots in non-wind conditions is 90%

Reduced or reducing actual power usage (cont)

- Implications by example:-
  - Assuming the aim is to not under irrigate, and the target application rate is 15mm
  - System has a DU of 90%, gross application rate required is 15 / 90 X 100 = 16.6mm
  - If the system had a DU of only 70%, gross application rate required would be 15 / 70 X 100 = 21.4mm
  - Additional water required is around 30%
- In reality what often happens is simply under irrigation occurs, resulting in productivity losses.

Questions?

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