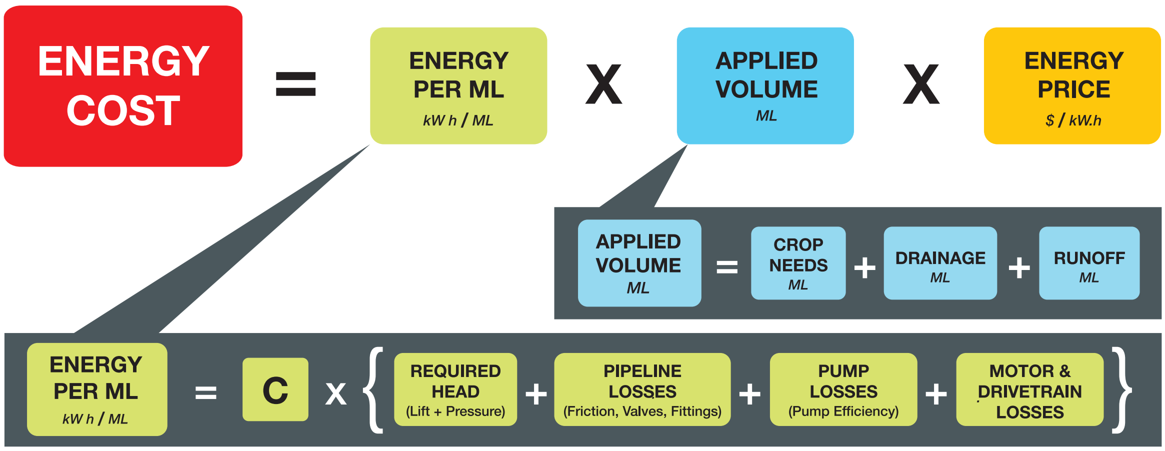
Factors affecting energy costs

Energy represents a significant cost for any irrigated cropping system. Every litre of water must be lifted, transported to the field and supplied to the irrigation system at the correct pressure. Each of these steps requires energy to be added via a pump.

Energy cost varies according to the energy price, the volume of irrigation water applied and the energy required to pump the applied volume of water (see the equation below). There are a number of requirements (green boxes) and losses (red boxes) that affect the energy required to shift the applied volume.



There are generally five ways to reduce irrigation related energy costs

1	**Tariffs**	Transition to a more suitable electricity tariff
2	**In-field management**	Improve in-field management
3	**Pump & pipelines**	Improve pump and pipeline hydraulic performance
4	**Efficiency of the pump motor**	Improve motor (drive) efficiency
5	**Alternative energy**	Choose an alternative energy source such as solar

Transition to more suitable electricity tariff

There is a wide range of electricity tariffs available for irrigators including both fixed rate, time of use and seasonal options. Unfortunately, there is no 'best' tariff that suits every scenario. Choosing the correct tariff requires information on energy (measured in kWh) used and the timing of irrigations throughout the day and across the season. Evidence from past tariff reviews has shown that cost savings of up to 20 per cent are possible through switching to a more suitable tariff. Unlike most other changes, switching tariffs can be implemented rapidly and at minimal cost.

Improve in-field management

Obviously, the purpose of irrigation is to optimise sugarcane production and profitability. Energy costs can be reduced by maximising water use efficiency (WUE), which will also maximise returns per megalitre applied. By applying the correct amount or improving the timing should lead to maximised production per hectare or maintaining the same level of production whilst using less water.

Example – Adjust water application to match crop demand

Current situation: Furrow irrigation applying 0.7 ML/ha on a 7-day cycle with 15 irrigations per season. Pump operating cost is $16/ML.

Energy cost = 0.7 x 15 x 16 = $168 per ha

Observation: Crop demand was actually 42 mm per week (0.42 ML/ha) so water use can be reduced by optimising flow and altering cut-off time whilst achieving the same or better yield.

Improved management: Furrow irrigation applying 0.53 ML/ha on 7-day cycle with 15 irrigations per season. Pump operating cost is $16/ML.

Energy cost = 0.7 x 15 x 16 = $127.20 per ha

Result: Saving of $40.80/ha (24%) in energy cost alone, without considering water cost saving of 2.55 ML/ha, across the season.

This example shows the potential cost savings possible when water use efficiency increased from 60 to 79 per cent.

Improve pump and pipeline hydraulic performance

The energy required to deliver each megalitre of water to the field is determined by how much pressure head is required at the field and the energy losses that occur through the pipeline, pump and motor.

- Required head is generally higher for pressurised systems such as travelling guns.
- Pipeline losses can be significant if the system is running higher than the design flow or if a valve is partially shut.
- Every pump has an optimal efficiency point and pump losses will increase the further the system deviates from this optimal flowrate.
- Motor losses are generally low but small gains are possible.

Example – Increased energy per ML

Initial situation: A furrow irrigation system was designed to supply water at 40 L/s, and operated efficiently. The energy cost was $16.37/ML.

Current situation: The farmer now uses the same pump and pipeline to deliver 60 L/s. Energy costs have increased to $31/ML.

The farmer might consider five options to reduce costs given the higher flowrate required and the higher energy cost per ML applied.

Option	Energy cost	Saving
Replace motor with a higher efficiency motor (variable flow drive or VFD)	$29.28/ML	5.6%
Replace pump with a model better suited to the new flowrate	$24.80/ML	20%
Replace 225 mm pipeline with 315 mm diame-ter pipe suited to new flowrate	$15.73/ML	49%
Replace pump + pipeline	$12.59/ML	59%
Upgrade motor + pump + pipeline	$11.89/ML	62%

Clearly the farmer should consider upgrading the pipeline, pump and motor rather than one component in isolation.

Improve motor (drive) efficiency

A standard electric motor will only operate at a single speed (RPM). There are many situations where it might be useful to vary the motor speed, such as where a single pump supplies two or more fields with different flows or heads.

Example – Variable frequency drive (VFD) for centre pivot

A centre pivot (CP) is connected to a pump operating at 60 L/s @ 50 m head and with an energy cost of $60/ML. The centre pivot only requires 30 m head and the extra 20 m of head is being burnt off by partially closing a valve or through the pressure regulators.

Would changing to a variable frequency drive makes sense here?

Option	Energy cost	Saving
Replace motor + install VFD (maintain existing speed/head)	$56.70/ML	5.6%
Reduce speed of pump using VFD (risk that this pump might run at low efficiency at this speed)	$38.93/ML	35.2%
Replace pump (do not install VFD or new motor)	$36.02/ML	40%

Before replacing the motor or installing a VFD, consider the condition of the current pump and whether this pump is likely to be required to operate at both 50 m and 30 m in the future.

Choose an alternative energy source

Question: Would you install a brand new motor in your 15 year old farm ute without getting a mechanic to check the ute over?

Alternative energy sources such as solar are a significant long-term investment. It makes sense to review the performance of the whole current irrigation system before making any major decisions.

If you are considering an alternative energy source, such as solar energy systems, it is a good idea to consider:

- Is the current flow and pressure adequate to meet peak crop demand?
- Can hydraulic losses be reduced?
- Is the current motor and pump performing well, and are they suited to the task?
- Is it possible to adjust irrigation management to irrigate mostly in daylight hours?
- What is the long-term plan for the irrigated area?

If you address these questions you should ultimately end up with a smaller solar system better suited to the task and therefore more cost effective. Unfortunately, these assessments are out of the scope of most solar providers.

Conclusions

There are several ways in which irrigation energy costs can be reduced. Some options, such as tariff reviews can be implemented with a minimal time and effort while other options require careful consideration but offer significant potential savings.

Irrigators need to consider the entire irrigation system from water source to crop before making any changes to one part of the system.

<table>
<tr><th colspan="2">Factor</th><th>Details</th><th>Potential impact on energy cost</th><th>Cost to implement</th><th>Speed to implement</th></tr>
<tr><td>1</td><td>Tariffs</td><td>Possibly a new meter</td><td>Up to 20%</td><td>Low</td><td>Rapid</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">In-field management</td><td>Improved management</td><td rowspan="2">Up to 50% + potential yield increase</td><td>Increased labour</td><td>Rapid</td></tr>
<tr><td>Automation to assist management</td><td>$500 - $2,000 per ha</td><td>Several months</td></tr>
<tr><td>3</td><td>Pump & pipelines</td><td>Pump, pipelines and infield infrastructure</td><td>Up to 50%</td><td>Variable</td><td>Several months</td></tr>
<tr><td>4</td><td>Efficiency of the pump motor</td><td>Motor and VFD</td><td>Up to 5% (existing speed)
Up to 50% (speed change)</td><td>> $5,000</td><td>Medium</td></tr>
<tr><td>5</td><td>Alternative energy</td><td>Solar Panels and regulator</td><td>Uncertain</td><td>$1,000 per kW</td><td>Medium</td></tr>
</table>

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