Saving energy in irrigation

Farmers can achieve significant energy savings through reviewing and modifying their irrigation and other water distribution systems. The relationship between water efficiency and energy efficiency is a key factor when designing or modifying irrigation solutions. Opportunities for savings include devising efficient pipe layouts, sizing pumps correctly, introducing variable speed drives and switching from diesel to electric pumps. Electricity is more cost-efficient for pumping than diesel but not all farms are able to connect to the network. Alternative electricity sources such as solar photovoltaic may be a viable option in such cases.

Moving water

Water is heavy so moving it is energy-intensive. Approximately 65 percent of all bulk water in Australia is used by farms (ABS, 2010) and a majority of this water is pumped in some way.

Irrigation farms typically move many megalitres (ML) of water, with application rates for different crops ranging from two to 10 ML per hectare (ABS, 2013). Audits of irrigation farms have found that energy used in irrigation can account for upwards of 50 percent of a total farm energy bill. Additionally, all farms pump water for stock and domestic needs. While this is likely to be a small component of total farm energy use, there are worthwhile savings achievable in stock and domestic pumping, including renewable energy power sources.

Energy efficiency in irrigation has three key aspects.

- **Needs analysis, design and planning.** It is essential that farmers and their irrigation engineers consider and balance water-efficiency and energy-efficiency objectives when designing or modifying irrigation solutions.
- **Optimising equipment.** Ensure that pumps and control systems optimise return on energy inputs.
- **Energy source.** Electricity is more cost-efficient for pumping than diesel but not all farms are able to connect to the grid. Alternative energy sources, such as solar, may be a viable option in such cases.

Figure 1: A traditional windmill irrigation set-up, in which wind drives a displacement pump and pulls water to the surface. Although this system uses no energy (other than the wind), it is incapable of moving sufficient amounts of water for most irrigation farms.

Why create an irrigation plan?

Irrigation planners can help you determine the correct layout, pump sizes and configurations, as well as when and how long to run your irrigation systems to maximise profitability and energy efficiency.

Design and planning

If you have not already done so, engage a specialist irrigation engineer to review your irrigation system for both water and energy efficiency.

Basic principles

The key variables affecting energy efficiency when moving water are gravity, pressure and friction.

When designing water distribution systems and specifying pumps, engineers consider the distance water has to be lifted and transferred, the depth below and height above sea level, and the friction caused within pipes and channels by layout, diameter and operating pressures. Further complications may arise from policy constraints on pump size, pipe diameter and allowable pumping hours.

A further consideration is the trade-off that may apply between water-efficiency and energy-efficiency aims. For example, forcing water through a drip irrigation network will use more energy that running it through channels and furrows, but this type of system will apply water more efficiently than a more energy-efficient centre pivot irrigation system.

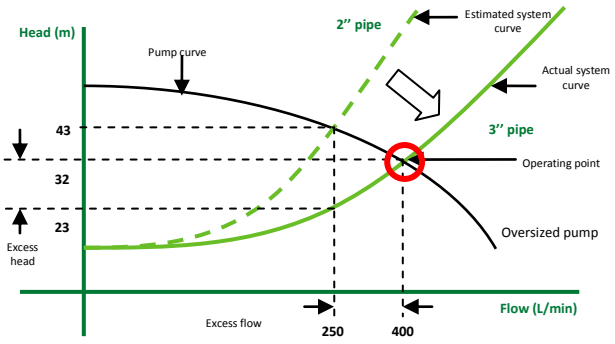

Figure 2: Optimising a system by changing the width of piping from two inches to three inches.

Saving energy in irrigation

Initial assessment and irrigation planning

While many irrigation systems are superbly designed, others may have evolved incrementally and without systematic engineering analysis. If you suspect that your system is not ideally configured, it may be time to consult a specialist irrigation engineer. A more efficient layout, for example, could enable lower specification pumps, shorter duty cycles and major energy savings.

An initial irrigation assessment is a good first step in understanding potential savings opportunities in an existing irrigation system set-up. A qualified irrigation planner may be able to identify opportunities for additional irrigation efficiencies and recommend alternative items to investigate.

If you are creating a new system, new technologies such as sensor networks, smart metering and automation can enable non-conventional approaches with gains in both water and energy efficiency.

The relationship between your system and upstream water delivery systems should also be considered, since matters such as timing, variability and flooding may all have bearing on system design.

Figure 3: A diesel pump outside Gunnedah, NSW, diverts water from a nearby river up into an irrigation channel. The water then flows down the channel and is used to flood-irrigate the surrounding fields. Excess water from the channel is stored in an open reservoir.

Optimising equipment

Variable speed drives on pumps

Traditional pump motors have two speeds: on and off. To achieve maximum efficiency, a higher level of precision is useful. Variable speed drives (VSDs) provide a variety of speeds so that pumps can run at the optimal rate for the amount of water they are moving. The installation of VSDs on pumps is an important energy-saving measure, as lowering the speed of a motor by just 20 percent can produce an energy saving of up to 50 percent.

Refer to supplementary paper, *VSDs in pumps.*

Controls and smart systems

Sensors on irrigation systems help eliminate inefficiencies by providing feedback on key performance parameters. Soil moisture sensors, in conjunction with advanced controls, can stop a system from overwatering already damp ground. Bore sensors can alert controls on bore pumps to shut off automatically when water levels drop below a certain point. Timers and temperature sensors can help ensure that fields get irrigated at optimal times and under optimal conditions.

Correctly sized pumps

Oversized pumps use far more energy than is necessary, while undersized pumps cannot always provide the volume of water needed. To ensure that your pumps are properly sized, it is recommended that you consult with an irrigation engineer, who can help determine the correct total dynamic head (TDH) for your pumps and the proper layout of your irrigation system.

Refer to supplementary paper, *Oversized pumps.*

Pump maintenance

Pumps have a number of moving parts which deteriorate over time. It is common for efficiency losses of five to 15 percent to appear after 10 years of operation. This is due to dirt and particle build-up increasing friction, cavitation from high water pressures and other wear and tear. Regular maintenance not only extends pump life but ensures optimal energy efficiency for the age of the machine.

Refer to supplementary paper, *Pump maintenance.*

Energy source

Pumps can be powered by diesel or electrical energy, with the latter supplied from the grid or from renewable energy sources. All farmers currently using diesel for pumping should consider the feasibility of switching from diesel to electric pumps.

Diesel versus electricity

Diesel is a versatile energy source that is ideal for use in remote locations and can be sourced from the farm's general diesel supply. However, diesel pumps are less efficient than electric pumps and typically require more maintenance. Further, diesel is generally more expensive than electricity on a dollar-per-power basis.

Feasibility of switching depends on access to the electricity network and the cost of additional infrastructure for connecting pumps, which can be substantial.

Electric pumps also have the advantage that they can run on electricity generated by renewable technologies such as solar, wind and biomass. As these technologies mature, it may become cost-effective to supplement network power with power generated on farm.

Refer to supplementary paper, *Diesel versus electric pumps.*

Saving energy in irrigation

Solar power
NSW Farmers is researching the feasibility of solar energy solutions for pumping. The time-critical nature of irrigation and high power requirements of irrigation systems generally limits the potential of solar; however, hybrid solutions can be cost-effective in some situations.

Pure solar solutions may be feasible for low-volume and non-time-critical applications – for example, replenishing gravity tanks, or for stock and domestic applications.

Refer to supplementary paper, *Solar PV pumping.*

Figure 4: After transitioning from diesel to electric pumps, there may be an opportunity to incorporate solar power into your pumping energy needs.

Technologies to watch

There are a number of emerging technologies relevant to irrigation and energy in agriculture. Some of these include:

- solar/diesel hybrid irrigation pumps,
- gas injection in diesel pumps,
- the use of recycled materials for enhanced water storage/reduction of evaporation, and
- sensor technology and digital control systems.

The effectiveness and affordability of such technologies is improving steadily. While the investment numbers might not yet make these attractive financial options, we encourage all farmers to keep a watching brief on these areas.

Further information

Farm Energy Innovation papers

Oversized pumps
The importance of matching pump size to required pumping volume.

Variable speed drives (VSDs) in pumps
Digital control systems can adapt pump engine speed continuously to pumping load, saving energy.

Pump maintenance
Maintenance is essential if you're to retain the rated operating efficiency of both diesel and electric pumps.

Electric versus diesel pumps
Electric pumps are cheaper to power, cheaper to maintain and easier to control. The only problem is sourcing the electricity.

Solar energy in irrigation
There is potential to use solar-generated power for all or some of your farm's pumping duties.

Other sources

Irrigation Australia
The website of this national body covering urban and rural irrigation throughout Australia includes figures and resources for irrigators.
irrigation.org.au

NSW Irrigators' Council
The NSW Irrigators' Council is a peak body that represents irrigators throughout NSW, with a focus on water-use management and irrigation policy for NSW stakeholders.
www.nswic.org.au

Energy-saving tips for irrigators
A terrific in-depth report addressing various efficiency measures and tools for irrigators.
attra.ncat.org/attra-pub/summaries/summary.php?pub=119

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References

ABS, 2010. *Irrigation on Australian farms.* [Online]
Available at:
www.abs.gov.au/ausstats/abs@.nsf/7d12b0f6763c78caca257061001cc588/a1372142a0cca480ca2573d200111005!OpenDocument
[Accessed February 2014].

ABS, 2013. *Water Use on Australian Farms 2011-12.* [Online]
Available at:
www.abs.gov.au/ausstats/abs@.nsf/Lookup/4618.0main+features62011-12
[Accessed January 2014].

National program for sustainable irrigation, 2008. *Irrigation in Australia: Facts and figures.* [Online]
Available at:
lwa.gov.au/files/products/national-program-sustainable-irrigation/pn22088/pn22088.pdf
[Accessed February 2014].

NSW Government Energy Savings Scheme, 2014. *List of accredited certificate providers.* [Online]
Available at:
www.ess.nsw.gov.au/Overview_of_the_scheme/List_of_Accredited_Certificate_Providers
[Accessed January 2014].

Head Office: 02 9478 1000
Energy Info Line: 02 9478 1013
www.nswfarmers.org.au

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