Solar irrigation

Dairy farmers must understand their irrigation demand to establish the solar energy or electricity required to meet this demand. This includes analysis of current water and energy usage, as well as an evaluation of energy conservation and efficiency opportunities of the current system, before finally looking at appropriate renewable energy technologies. It is recommended you consult with an irrigation engineer or consultant.

Should I install solar-powered irrigation?

With the installation of a smart solar-powered irrigation system, it is possible for a farmer to do more with less. A good option for dry regions that have high temperatures and scarce water resources, a solar irrigation system can help farmers benefit from efficient water management. It is also beneficial for farmers facing irrigation problems due to energy shortages.

Important question to ask when considering solar irrigation:

- How often do you need to pump/irrigate?
- What is your current energy usage?

Farms that have relatively continuous and predictable daytime irrigation needs are ideal candidates for solar systems that fully replace mains power. However, in most dairy irrigation systems, pumping requirements are seasonal and vary in response to climate. These systems require more complex assessment and design.

Where pumping is irregular or not always in daylight hours, return on investment and optimal system size needs careful consideration. Other factors to consider include electricity demand on-farm, the ability to export and sell unused electricity and the ability to offset night-time mains electricity cost with savings on daytime usage.

For irrigation, hybrid solar systems are generally used. In these systems solar is combined with power from the grid or a diesel generator to allow continuous power delivery for pumping. For more details on potential configurations, refer to Section 3.6 of **Report 1: Solar Power and Solar Irrigation Systems (epw.qld.gov.au)**

When assessing the feasibility of a solar irrigation system, consideration needs to be given to the amount and timing of pumping, the volume and reliability of the water source, water storage capacity and integration into the infield irrigation system.

Most dairy farms only use irrigation for part of the year, so the power generated at other times must be taken into account during the feasibility assessment. Consideration should also be given to integrating solar with other power sources.

Understanding irrigation demand is as important as is understanding of the technologies involved in the conversion of solar energy to electricity to meet this demand. When considering solar irrigation, an analysis of current energy usage is essential.

This should include an evaluation of energy conservation and efficiency opportunities of the current system, before finally looking at appropriate renewable energy technologies.

If you are considering installing a solar or hybrid pumping/irrigation system, it is recommended you consult with an electrician and an irrigation engineer or consultant.

Guidelines on sizing solar pump systems and water storage have been developed by **NSW Farmers Association**. It is also advisable to use a checklist to see if the system stacks up (for an example, refer to NSW Farmers' solar pumping checklist **HERE**.)

DELIVERING for DAIRY

SOLAR IRRIGATION EXAMPLE

Willandra Farms

Milking up to 380 cows year-round, Wilandra Farms installed a system which included 200 kW of solar PV, upgraded irrigation infrastructure and an energy management system to reduce irrigation energy costs. The system helped significantly lower Wilandra's irrigation energy bills, which exceeded $100,000/year (including supplementary diesel power) with an electricity cost to irrigate per kilowatt-hour (kWh) of $0.27 in 2020/21.

After the upgrade, electricity costs for irrigation dropped from around $80,000 to $25,000, however, the savings are variable: in 2022/23, the cost to irrigate was down to $0.06/kWh in 2022/23, while in 2021/22, the cost of power dropped as low as negative $0.04 due to favourable weather and feeding a large amount of power back into the grid.

The system also offers numerous other benefits, which include a lower carbon footprint, labour savings of at least 15 hours/week during the irrigation season, better water use efficiency and better pasture growth.

Steps to take prior to installing solar irrigation

1 Perform a whole farm audit to identify ways to improve energy efficiency.

2 Identify irrigation needs:

1 How much water?

2 How often?

3 Address energy efficiency savings:

1 Installing larger diameter irrigation water pipes.

2 Replacing inefficient pumps.

3 Changing nozzle sizes on pivots.

4 Check capacity of your water storage infrastructure and minimise leakage and evaporation.

5 Repeat – perform a whole farm audit to identify ways to improve energy efficiency.

What are the benefits of installing a solar irrigation system?

Advantages
Renewable source of energy - reducing greenhouse gas emissions A solar irrigation system will reduce your carbon footprint and support the farm through the uncertainties of farming in the face of climate change.
Reduced energy costs (fuel or electricity) Solar energy is a stable, predictable and cost-effective source of energy. Solar pumping can reduce your irrigation energy bill if it can: • pump many months of the year and mostly during the day • join a community solar project, sharing costs and power • use solar to load shift and lower network charges • have substantial and efficient water storage.
Flexibility and accessibility You can customise the irrigation system according to your needs. A small-scale irrigation system can be set up with much lower initial cost, to be upgraded later. Solar water pumps are lighter and more portable than previous generations and can be easily moved to different locations.
Low maintenance costs Solar irrigation systems are designed to go on for decades, with 20 to 25-year warranty period and with minimal maintenance costs (periodic checks and cleaning).
Multi-purpose application Energy generated from the solar irrigation system isn't limited to irrigation purposes only. Excess solar generation can be used for other purposes and sold to grid.
Versatility Solar irrigation can be installed using hybrid power sources. A diesel-fuelled irrigation system is one-dimensional, limits your power source and leaves you fully exposed to fuel cost volatility.
Self-regulated irrigation Solar-powered irrigation systems now allow for self-regulated irrigation of the land based on the environmental conditions, crop water requirements and water availability when connected to appropriate sensors and systems controls.
Remote monitoring There are now apps that allow you to read and analyse metrics from your monitoring system. This means that you can adjust pressure and level control, as well as access timers and speed control to manage water resources without needing to visit often remote areas of your property, saving time for other jobs and for family.
Reduce labour input for irrigation Remote control and less need for refuelling pumps saves time. Willandra Farms dropped by about 15 hours a week.
Farmers wellbeing Farmers can get more sleep at night because most irrigation now happens during the day.

What are the disadvantages of installing a solar irrigation system?

Disadvantages
High initial cost The cost of installation is directly related to the scale of the irrigation system.
Weather-dependent The system will be dependent on sunlight for energy, it is non-functional at night, it is also weather-dependent only working at full capacity only when the sky is clear and sunny. On cloudy days energy produced is lower (there is a noticeable drop in the efficiency of the system).
Needs more space Many solar panels are required to generate enough energy to power an entire irrigation system. Solar panels are generally bulky, so space management is critical in solar irrigation systems because the panels need to be appropriately positioned to get maximum exposure to sunlight.
Higher energy storage costs Energy generated during day can be stored in batteries for use later in the day or night. The cost of installing large batteries for power storage can be higher than using electricity directly from the grid.
Environmental impact Environmental footprint linked to manufacturing process as well as the transportation and installation of solar panels.
Water vs energy Irrigation during daytime hours exposes the system to greater evaporation rates.

Tips for maximising benefit of solar on dairy farms

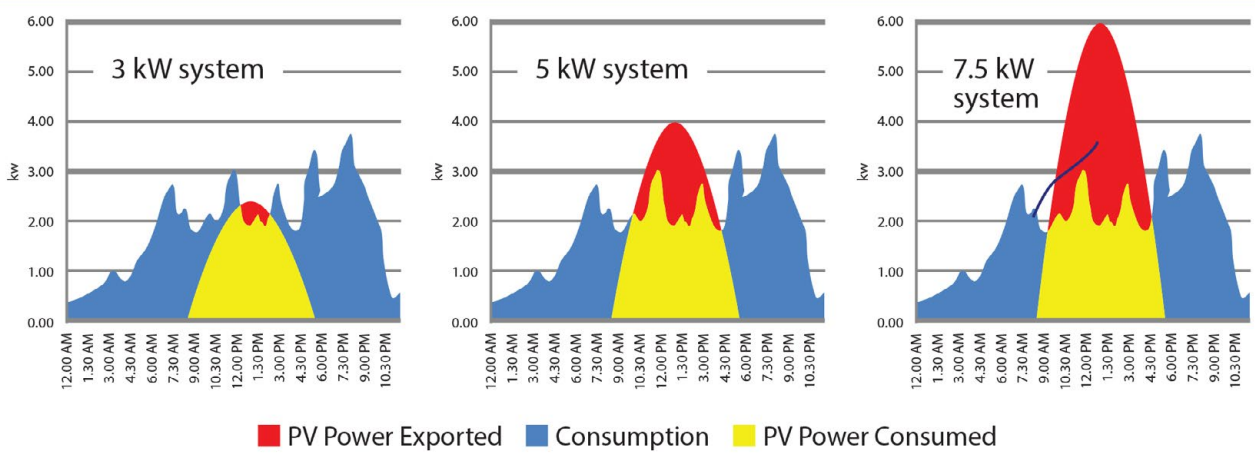
Adapting the installation of solar panels to the ebb and flow of the dairy farm's operations is key to maximising their utility (See Solar photovoltaic (PV) section in the '**Saving energy on dairy farms**' booklet).

- Solar irradiation is the amount of energy received from the sun at a given location. It determines how much power each solar module will generate in a day and the size of array needed to pump a required volume of water. A site with low solar irradiation levels (~15 MJ/m^2) will need a larger array than a site with high radiation levels (~30 MJ/m^2).
- Irrigation can be changed from mainly at night use (to benefit from off-peak power) to during the day using solar.
- Ensure panels have been fenced off to avoid damage from cattle.
- Install panels to face north, east and west to make the most of them across the day. Dairy farmers need power as early and as late in the day as possible, which will also allow a greater irrigation window.
- Install software controlling the solar network that communicates with the upgraded infrastructure to trigger irrigation with the power available in the system at any one time. Automation will also stop the system drawing on energy and water resources when something goes wrong, reducing waste and costs.

Payback periods

Payback periods will vary depending on how the system is sized. Figure B shows how the grid-connected solar system can be scaled according to the requirements, costs and proportion of power that could be exported back to the grid (**Report 1: Solar Power and Solar Irrigation Systems (epw.qld.gov.au)**).

Figure B An example comparing three grid-connected solar solutions, the expected power that will be consumed, the generated power that will be exported back and the simple payback rates for each system (from NSW Farmers' *Renewable energy in agriculture: A farmer's guide to technology and feasibility, 2015*).



3 kW System	5 kW System	7.5 kW System
System Cost: $4,800	System Cost: $8,000	System Cost: $12,000
Portion of power offset: 94%	Portion of power offset: 73%	Portion of power offset: 52%
Portion of power exported: 6%	Portion of power exported: 27%	Portion of power exported: 48%
Savings per day: $3.52	Savings per day: $4.76	Savings per day: $5.45
Savings per year: $1,286	Savings per year: $1,738	Savings per year: $1,988
Simple payback (years): 3.7	Simple payback (years): 4.6	Simple payback (years): 6

Design consideration of irrigation pumps – diesel vs solar

An important aspect of irrigation energy efficiency is ensuring the right amount of water is supplied to the crop at the right time. The pump must be suited to the job of matching supply with demand. Irrigating 12 megalitres (ML) per hectare when the crop needs eight megalitres per hectare means that you are using one-third more energy than is necessary.

Diesel pumping systems are generally more expensive to operate and maintain than electric systems, as there are more moving parts. Electrical pumping has the advantage of easier integration with solar, lower running costs and less maintenance.

Key differences between solar electric and diesel pumps

- Solar pumps use sunlight to power their operation, while a diesel pump uses fossil fuels.
- Diesel pumps can emit smoke and fumes that are bad for your health and the environment, solar does not.
- Solar pumps are quieter than diesel pumps.
- Diesel pumps are more costly due to their reliance on fossil fuel, the pricing of which is affected by uncontrollable factors like politics, economics, war and natural disasters.

Solar energy products and solar water pumps have evolved dramatically in just the past decade. The Internet of Things, or the use of internet technology to sync with hardware, can now be integrated with solar water pump systems. This means you can now use apps on your smartphone to monitor and control your water pump systems.

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