Australian Government
Department of Industry

Dairy Australia
Your Levy at Work

Fact Sheet: Your Levy at Work

Solar energy for dairy farms

Dairy farmers can harness this free resource to potentially reduce their power bills. This fact sheet looks at the suitability of solar photovoltaic (PV) systems for Australia's dairy farms.

Energy is measured in Watts per hour. A kilowatt hour is 1,000 Watts per hour.

Solar radiation

The amount of electricity that can be generated by a solar PV system depends on how much sunlight it receives.

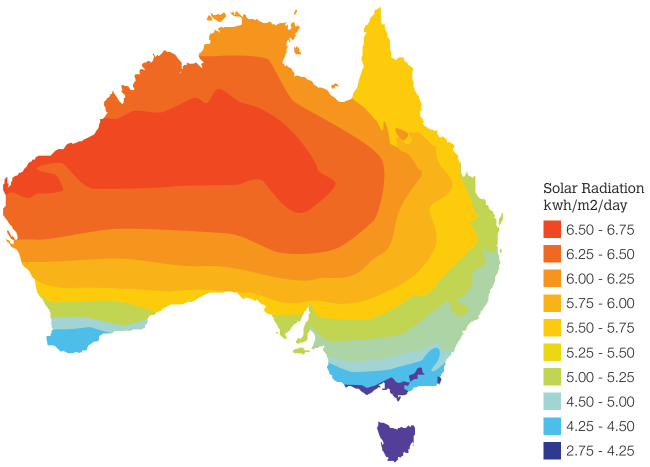


Figure 1: Average daily solar radiation from Australia (Bureau of Meteorology).

Solar radiation – the energy we get from the sun – is measured in kilowatt hours per square metre (kWh/m^2) per day or per year.

Peak Sun Hours

The simplest way to express solar energy is by Peak Sun Hours. This is numerically equal to the daily solar radiation in kWh/m^2. It is the equivalent number of hours per day at a location if the solar intensity was a constant 1 kW/m^2.

Peak sun hours vary:

- **Across the country**
- **During the year depending on the season.**

For example, Perth has an average daily solar radiation of 5.6 kWh/m^2 which is represented by the blue curve in Figure 2; this can be viewed as 5.6 hours of solar radiation at peak solar intensity (1 kW/m^2) or 5.6 peak sun hours (green rectangle).

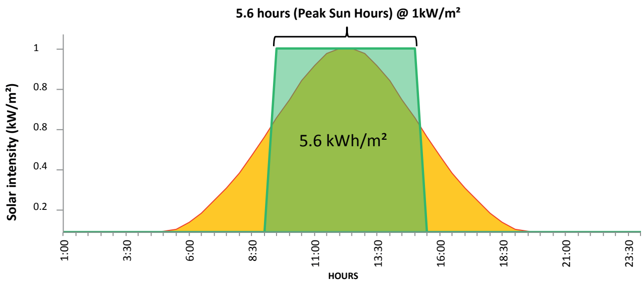


Figure 2: Solar radiation and Peak Sun Hours. NBA Consulting

The practicality of Peak Sun Hours is demonstrated when we want to compare solar radiation from different locations, as in Figure 3.

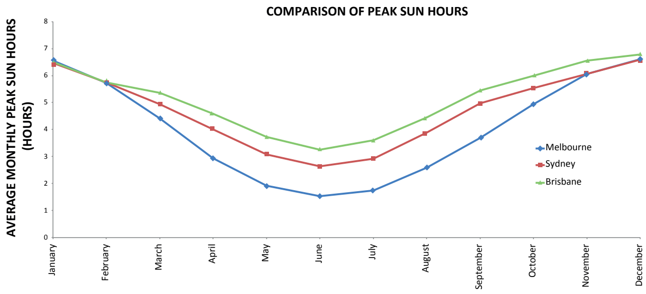


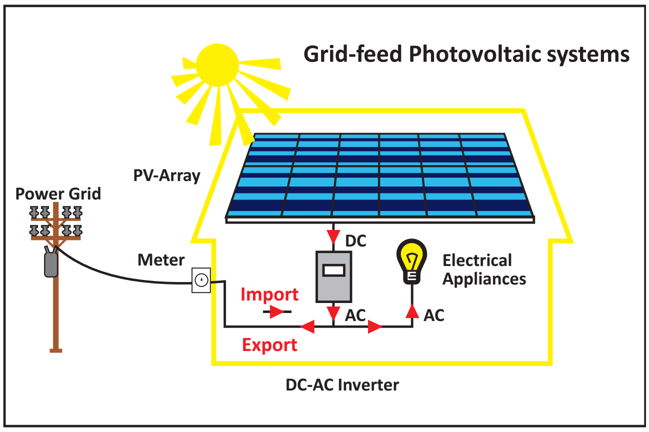
Figure 3: Comparison of Peak Sun Hours for the eastern capitals of Australia. NBA Consulting

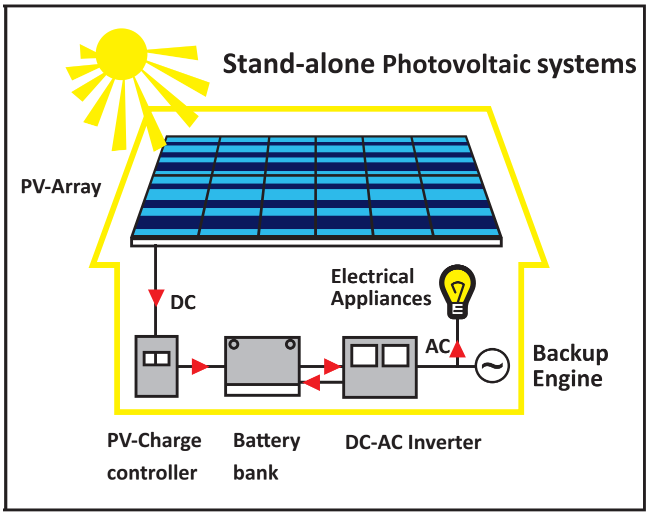
Components of a solar system

The components in a solar system will depend on whether it is designed to feed power back into the mains grid or is a 'stand alone' system.
All systems have:

- **Solar panels** – convert solar radiation into electrical energy.
- **Mounting frames** – house the solar panels.
- **Inverter** – transforms the electricity produced by the solar panels from direct current (DC) to alternating current (AC) at 240 volts. The dairy plant and most electrical equipment require alternating current.
- **Wires** – transmit electricity from the PV system to the equipment that is drawing the load.
- **Meter** – measures the amount of power produced by the PV system.

Grid-feed systems need a special grid-interactive inverter and special meters. Stand-alone PV systems require deep-cycle batteries to store electricity (for cloudy days and at night) and a control system to prevent the batteries overcharging or completely discharging. Batteries can also be charged by other sources, such as wind and diesel, in a hybrid PV configuration.





Grid-feed systems
Stand alone system
Figure 4: Photovoltaic systems. Source?

Site requirements

Solar systems should be sited to maximise the available incoming solar radiation. It is vital to avoid shade from trees and neighbouring buildings. Orientation and tilt are also important:

Orientation – In Australia, it is recommended that solar panels face north so that they are in full sun from 9 am to 3 pm in mid-winter. They can be turned more to the east or west to provide more power when energy use is high. For example, solar panels on a dairy farm might be oriented to the north-west to catch maximum sunshine to power the afternoon milking.

Tilt – Solar panels should be tilted at an angle which maximises the performance throughout the year. In some cases, the angle is fixed; in others it can be changed manually or automatically (called altitude tracking).

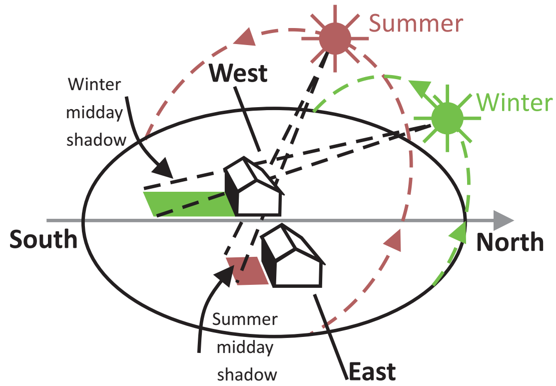


Figure 5: Changes in the sun's position according to the season.

Location – Most solar systems are installed on roofs. The weight of the panels, and the strength of the roof and its frame need to be taken into consideration.

Roofs can get very hot in summer, especially when made from iron. Anodised aluminium PV frames could help dissipate heat. With the extra space available on farms, there may be suitable sites on the ground to set up the arrays to maximise insolation and efficiency. Ground systems would need to be fenced off from cattle and be sited where there was no risk of damage from machinery.

Ground-based PV system

Roof-based PV system

Figure 6: Different PV array locations. Source?

Supply, installation and maintenance

All products used in solar systems in Australia, and their installation, must meet Australian Standards. Australian Government rebates will only be paid if the systems are installed by accredited individuals. The Clean Energy Council has compiled lists of approved products and accredited installers (http://www.cleanenergycouncil.org.au/).

As most solar systems have no moving parts, there is little ongoing maintenance. However, the solar panels must be kept clean to maximise efficiency. Panels that are installed with a minimum tilt of 10° will clean themselves when it rains.

They should also be wiped over periodically with a damp cloth, especially during dry periods, after bushfires and if smoke from a fuel stove or heater, fumes from machinery or dust from dirt roads or a hammer mill regularly blow in their direction.

What reduces solar PV potential?

- **Atmospheric attenuation** – Clouds, dust in the atmosphere and even high humidity can reduce the amount of sunlight reaching the panels.
- **Shading** – probably the worst enemy because partial shading on one panel can reduce the efficiency of the whole system.
- **Incidence angle** – Unless fitted with a solar tracker, panels are only perpendicular to the sun's rays for a short time each day.
- **Dust and dirt** – Panels must be kept clean to maximise the amount of light they receive.
- **Temperature** – the output power reduces with temperature. Solar cells also produce their own heat. As the air temperature increases, they become less efficient. Long summer days may provide plenty of sunshine, but solar cells do not work well in the heat.
- **Inverters** – Some of the power produced by the PV system is needed to run the inverter. Peak efficiency occurs when the inverter is running at two-thirds of its capacity.
- **Transmission** – Electricity is lost as it is transmitted along wires. The greater the distance, the greater the loss.

Costs

The cost of a solar PV system can vary greatly, depending on its size and type, location, site characteristics and installation requirements.

In 2012, systems that might suit a dairy and were connected to the grid ranged from $2,000 to $4,000 for each kW installed, before rebates2. At these prices, a 10 kW system would cost between $20,000 and $40,000 and produce 16,000 kWh of electricity each year.

Stand-alone systems can cost 5-10 times as much as grid-feed systems because they need large banks of batteries, which can cost as much or even more than the actual solar system.

Renewable energy incentives

Small-scale Renewable Energy Scheme –
Renewable systems that produce less than 250 MWh of electricity each year are eligible for a financial incentive under the Small-scale Renewable Energy Scheme (SRES).

Each MWh of renewable electricity that can be produced by the system creates one small-scale technology certificate (STC). The value of solar STCs depends on the amount of solar radiation received at a particular location in Australia which is divided into four zones.

These STCs have a dollar value that is paid for the energy produced over a 15-year period. STCs can be traded, usually to the company supplying the system, for a reduction on the initial purchase cost.

STCs can worth up to $40 each if traded through the STC Clearing House. Common values are close to $30. The STC scheme can save dairy farmers a lot of money on the purchase price of a solar PV system.

The Clean Energy Regulator has a calculator for Small Generation Units at https://www.rec-registry.gov.au/sguCalculatorInit.shtml. It can be used to estimate the number of STCs produced by solar PV systems of different capacities. Systems over 100kW are considered to be power stations and therefore are eligible for large-scale generation certificates (LGCs). For more information on renewable energy incentives, refer to the factsheet 'Renewable energy incentives'.

Advantages of solar PV for dairy farms

- Most dairy regions have sufficient sunlight to power a PV system
- Most farms have suitable sites
- After installation there are virtually no running costs
- Systems can be expanded by adding more panels
- They can reduce electricity bills

Disadvantages of solar PV for dairy farms

- Peak electricity production each day may not match loads
- High initial cost
- Can be a lengthy payback period

Feed-in tariffs – A feed-in tariff is a price paid to producers who feed some or all of their electricity back into the mains grid. Premium feed-in tariffs were originally designed to encourage small businesses and householders to install renewable energy systems and help the states reach their mandatory renewable energy targets.

Each state sets its own rates, which vary depending on the type and size of the renewable system. Rapid uptake of the various schemes and changes in state government policies have seen feed-in tariffs fall dramatically.

For more information on feed-in tariffs, refer to the factsheet 'Feed-in tariffs'.

Does solar power suit dairy farms?

The main challenge in using solar power as an energy source for dairy farms is the hours of use. Solar energy is produced only during the day, reaching its maximum point around midday.

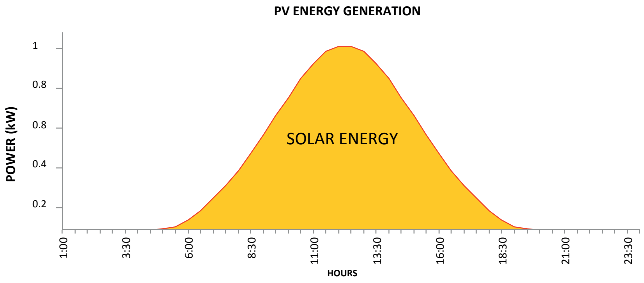


Figure 7: Solar energy generation.NBA Consulting

Energy consumption for a dairy farm occurs typically during milking, generating a peak early in the morning and during the late afternoon. Other loads, such as hot water heating, are generally carried during the night, taking advantage of off-peak tariffs.

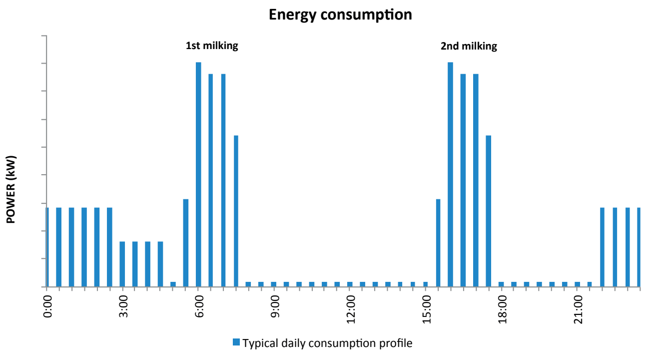


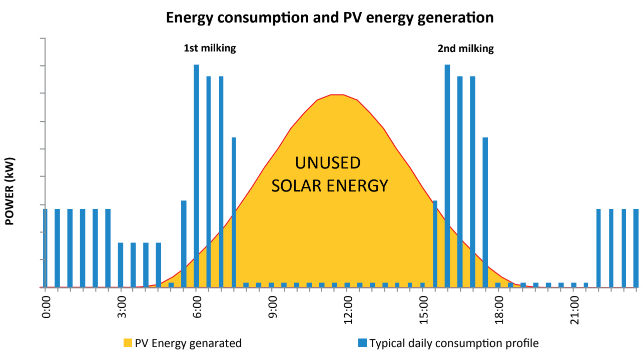
Figure 8: Typical dairy shed energy consumption. NBA Consulting

Three different scenarios highlight the importance of matching energy supply and demand.

Conventionally, dairy farm's energy consumption does not match solar energy production, even at peak annual generation times.

First scenario (Typical dairy farm)

Figure 9 NBA Consulting



Typical dairy farms will have maximum energy demand during morning and evening milking, whereas solar energy generation has its peak around the middle of the day (Fgure 9). This means that most of the PV energy generated will not be consumed and, if possible, this can be sold back to the grid. However, current feed-in tariffs are low, if available at all.

Second scenario (Loads switched in order to match PV generation)

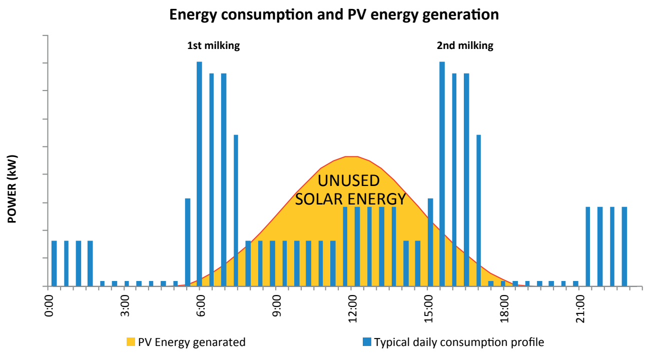


Figure 10 NBA Consulting

If you are thinking of buying a PV system, first you may need to have some equipment (motors, pumps, vats) running consistently during the day. Figure 10.

If this is not the case, you may need to investigate rescheduling operating loads to match solar generated power. A good example of this may be moving the operational times of water heaters or stock water.

Third scenario (All PV generation is used on farm)

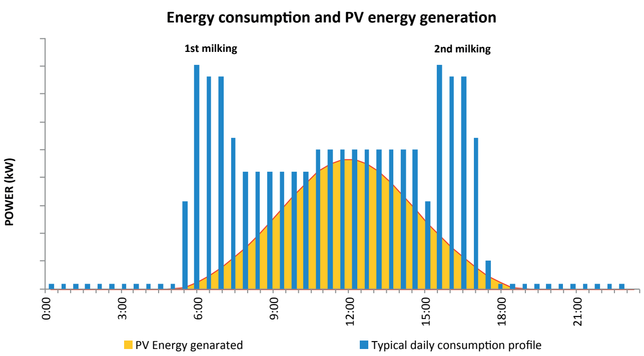


Figure 11 NBA Consulting

Investing in solar PV generation is more cost effective when the highest proportion of generated supply can actually be utilised on farm (Figure 11). Quicker return on investments and higher net present values are achievable.

When power demand is moved from a low-tariff period, it is this lower tariff that must be used in calculating cost effectiveness of the investment.

Conclusion

Sunlight is an abundant and free source of power, and the prices of solar systems have fallen dramatically during the past few years. Typical solar systems do not have any moving components, require minimum maintenance and can last for more than 25 years.

The viability of a solar system is highly dependent on the consumption on farm of PV-generated power, and should be investigated on an individual basis with a detailed analysis of dairy shed demand and the pattern of solar energy generation.

For many dairy farms, the demand does not match the energy generated by the solar system. To improve the cost effectiveness of the system, rescheduling dairy energy consumption may be investigated.

Current feed-in tariffs are much lower than the price of electricity so it is generally most effective to have a solar system that displaces the use of grid electricity rather than create surplus energy that is sold to the grid and bought back at much higher prices.

References

Bureau of Meteorology (2012) Average daily solar exposure – annual; http://www.bom.gov.au/jsp/ncc/climate_averages/solar-exposure/index.jsp

1. UTS (2012) Solar photovoltaic (PV) systems factsheet (draft). Institute for Sustainable Futures, University of Technology Sydney.
2. Noble, C. (2011) Evaluating solar and wind systems for use on Australian dairy farms. RMIT Melbourne.

> **Note**
> Information and technology is changing rapidly in this area. Make sure you consult an expert about your individual circumstances to see whether renewable energy is an efficient and economic option for your farm.

Acknowledgements

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