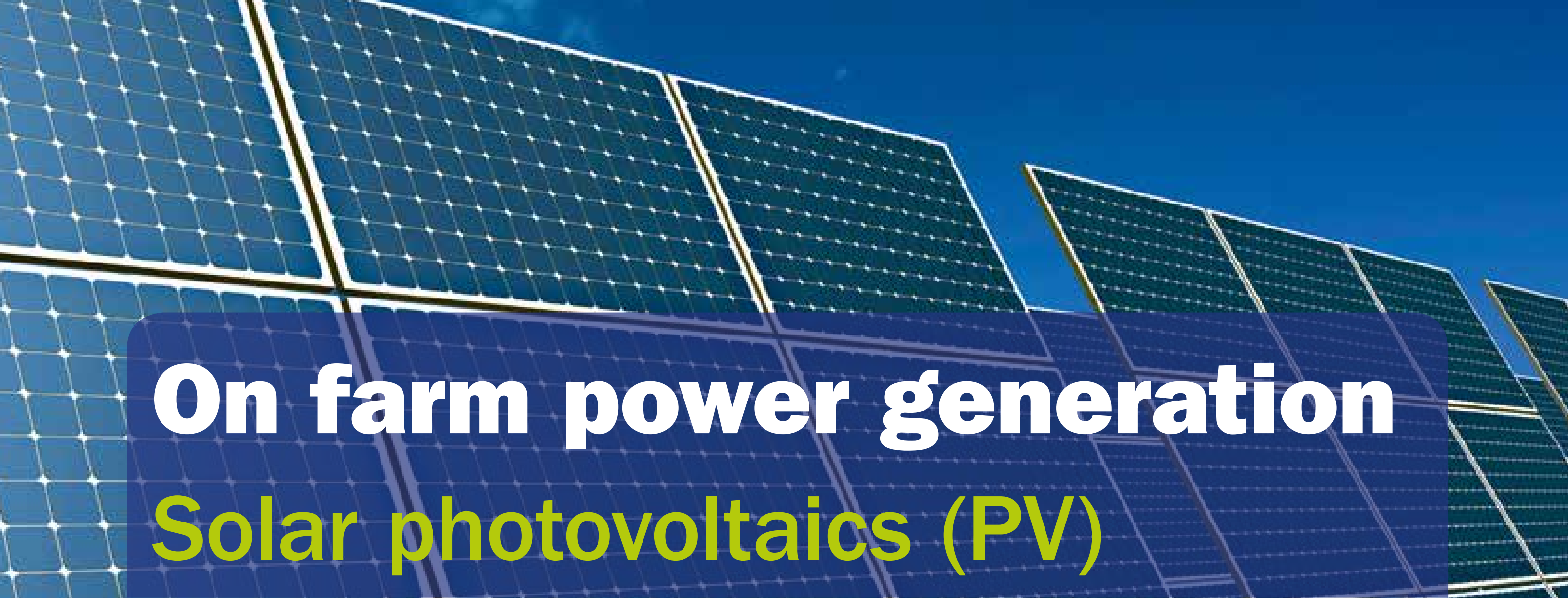

On farm power generation
Solar photovoltaics (PV)

Whilst solar PV currently contributes a small proportion of global electricity generation, there has been remarkable growth in its installed capacity and power generated over the ten or so years to 2014, due largely to rapid evolution in PV technology, significant reductions in cost, and substantial subsidies that renewables have attracted.

Solar PV is one of the key options for on-site power generation, and is already widely used by Australian farmers and growers, especially in the sun-rich states. Poor financial performance of solar PV in some instances was due to the low price of electricity excluding demand charges.

Summary

Solar PV should be economically viable for most vegetable growers, including those in less sunny regions, provided the Small-Scale Technology Certificate (STC) government subsidies paid under the Renewable Energy Target (RET) remain. For example, a solar PV plant with a total establishment cost of $2500 per kW of capacity can be viable at a 10% Internal Rate of Return (IRR) with a 5–7 year payback period if electricity costs more than **12–15 c/kWh**.

A key consideration in this analysis is that 90% of the electricity produced can be consumed on site.

Should the RET be repealed, this same solar PV plant then requires the current cost of electricity to be more than **19–22 c/kWh** to be viable, so solar PV may remain financially viable for some growers even if the RET is repealed.

Battery storage is not currently viable. It costs about $800 per kWh to set up, and required a current electricity price of more than 35 c/kWh before it would be economically viable. Further, given the significant uncertainty in the full cost of battery storage systems, battery storage cannot be recommended at present.

THE TECHNOLOGY

Solar photovoltaics (PV) generate electricity by converting solar radiation into direct current.

Key strength and benefits

- Renewable
- Cost-effective at all sites evaluated on the mainland, especially in Queensland, South Australia and Western Australia
- Environmental, and therefore marketing benefits to use of cleaner energy

There are drawbacks however:

- Intermittent
- Uncertain financial viability if incentives are removed
- Uncertain regulatory environment in Australia

Economics of solar PV

The economics of solar PV are generally positive in most situations. The key factors in determining economic viability are:

- the price currently paid for electricity from the grid
- the zone for small scale technology certificates (STC) government subsidies
- the capital cost of the installation
- how much of the power generated can be used on site, during daylight hours

Some key indicators:

- A moderately priced ($2500 per kW capacity) debt financed solar installation, up to 100 kW in size can produce electricity for **12–16c per kWh** with current STC government subsidies.
- Farms in STC zone 3 should be able to produce electricity on farm for about **12–13c/kWh.**

Parkside Energy
HAL Horticulture Australia
ahr applied horticultural research

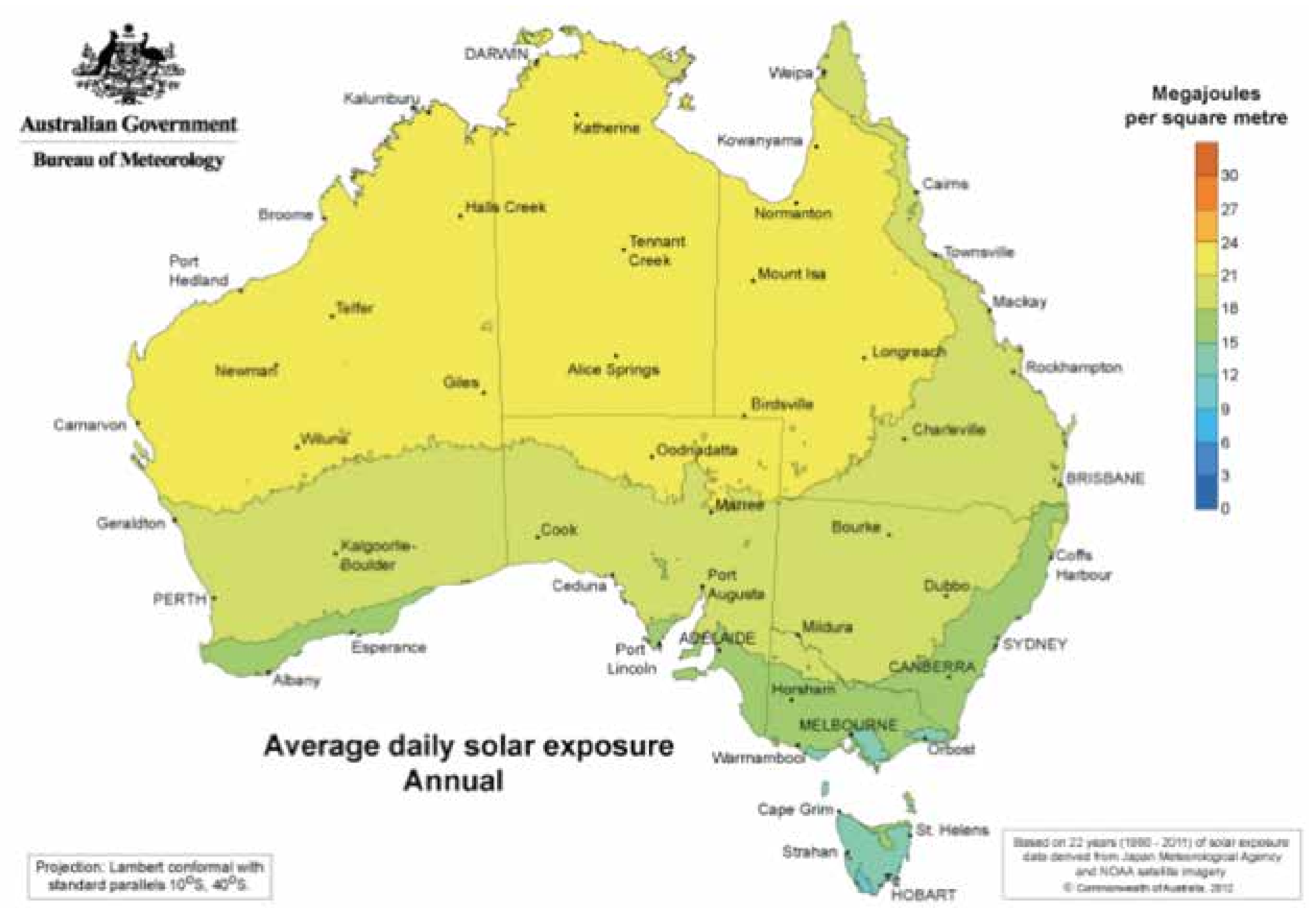

Figure 1: Average solar exposure in Australia

- Farms in STC zone 4 should be able to produce electricity on farm for about **15–16c/kWh**.
- If the STC subsidies are removed, the capital cost of solar PV increases. In this case, solar in zone 3 will cost about **19c/kWh**, and in zone 4, about **22c/kWh**.
- For growers paying more than these amounts for electricity, solar PV generation may be a viable option.
- Payback periods depend on many factors, but are typically in the range **5–7 years** for solar PV.

Assumptions:

Re Figures 2 and 3 on next page

- A 10% Internal Rate of Return (IRR), which is normally acceptable
- Payback period of between 5 and 7 years
- Feed in tariffs (the amount the electricity supplier will pay for power fed back into the grid) of 5–8c/kWh
- Financed by debt at an interest rate of 6.5% pa over 10 years

CASE STUDIES

Case studies on solar PV on farm power generation were conducted in Queensland (Gatton, Kalbar and Bundaberg); Western Australia (Gin Gin), and Victoria (Clyde, near Melbourne). The findings of three of these case studies are summarised below.

Case study: Solar PV in WA

The loose leaf lettuce company in Gin Gin, WA, grows and packs gourmet fresh salad vegetables year round (average 4t salad leaves daily). The farm has been trying to reduce energy costs on its two sites over a number of years. The case study focused on solar PV, storage for solar PV, and simple generation and cogeneration from LPG. The electrical load at the main facility in 2013 was around 390MWh, of which nearly 70% was consumed as peak energy. Usage was concentrated in summer, which suits solar PV.

Energy consuming processes include irrigation and pumping, washing, processing and packing processes in the factory, and cooling and refrigeration in the factory and for the five cool rooms, including a vacuum cooler used predominantly during summer.

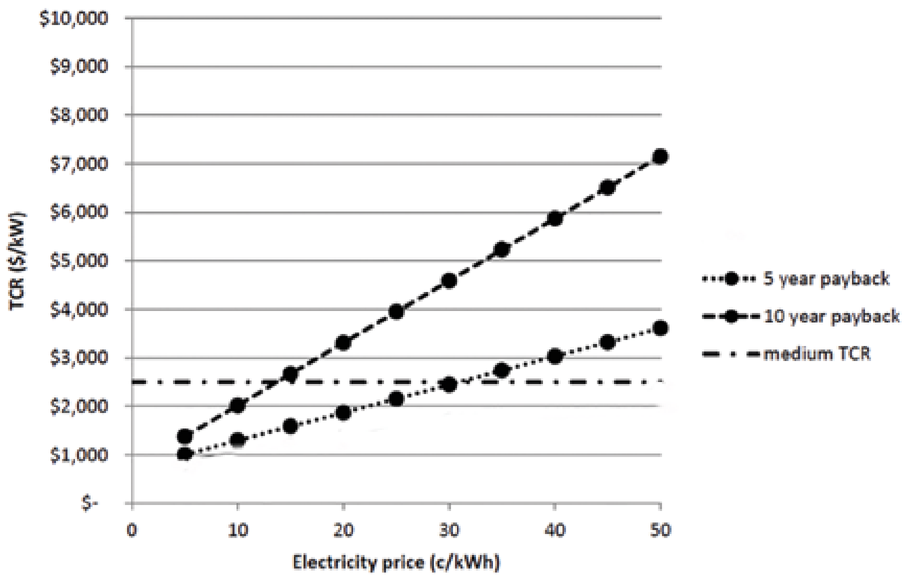

Figure 2: The break-even electricity price required for payback periods of 5 and 10 years for solar PV generation at different capital costs (Total Capital Required). A medium TCR of 2500 $/kW is shown on the figure. Analysis assumes a zone 3 STC region and all other assumptions above.

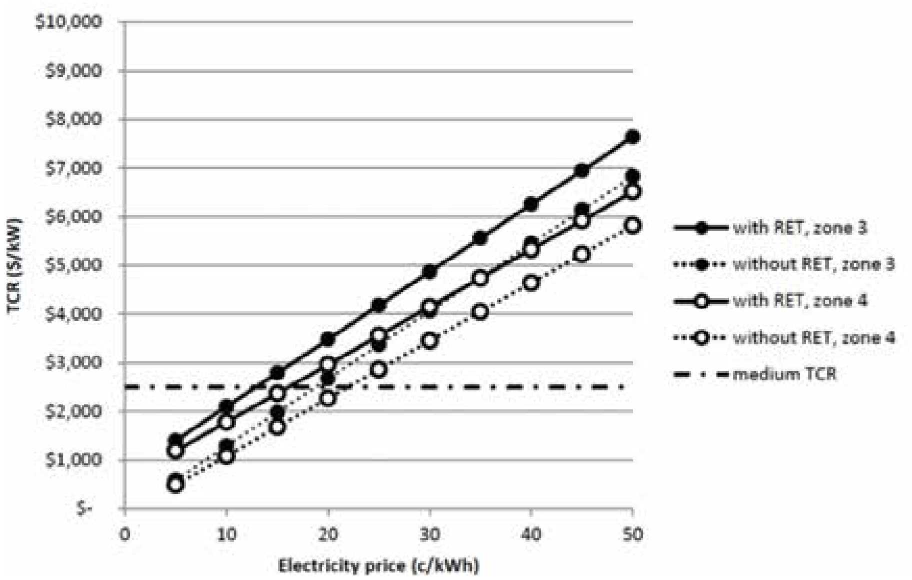

Figure 3: The impact of removing the government subsidies (STCs) on the break-even electricity price required for solar PV to be economically viable. Analysis assumes a zone 3 STC region and all other assumptions above.

A 100 kW solar PV system was installed in December 2013. The owner worked with a solar energy company and an energy consultant to determine the right system for her energy needs and to cost effectively offset her power bill. The main focus was the efficient operation of the cool rooms.

Network rules in WA do not allow such a system to export excess power to the grid, so it includes reverse power protection. Four hundred polycrystalline panels were flush mounted on sheds (to minimise installation costs) in an east/west orientation to produce a flatter production curve so that more of the energy produced by the system could be consumed on site over the whole day.

The system is anticipated to produce around 160,000 kWh per year which will offset up to half of the energy needs of the home farm operations. Since late February 2014 it has significantly reduced the load at the site by taking out the peaks in the middle of the day, reducing peak consumption. From date of installation, electricity costs are down 28% compared to the same four months in the year prior.

This plant has a strongly positive NPV (net present value), with a short payback period of 5.4 years. This excellent financial performance is the result of the fully installed cost and the displaced electricity price, making the PV plant an excellent investment. It would still have been an attractive investment even if the small scale technology certificates (STCs) had not been claimed.

The study shows that, given the right conditions, solar PV can be economic today without any subsidy.

Battery storage systems were examined, but were not a viable option under any plausible current conditions, particularly given the uncertainty in the full cost of installed battery storage systems as well as the uncertain battery life. Likewise, an analysis of simple and cogeneration using LPG fuelled reciprocating engine generators showed these perform very poorly on all metrics, suggesting that cogeneration without supply of network delivered natural gas delivery is always likely to be unviable.

Case study: Lockyer Valley

In 2010, a Lockyer Valley vegetable grower installed a 30 kW solar plant on his farm. Rather than install solar panels on farm buildings or sheds, he worked with an engineer to connect a single axis tracking plant which tilts the panels to track sunlight over a day and hence maximise the power generated (increase of 20–30% over fixed). The total cost of the system was $167,000.

At the time, the Queensland Government offered feed-in tariffs of 44c/kWh to encourage installation of solar panels under the Solar Bonus Scheme. These are legislated to run until 2028, so electricity exported from his system attracts this rate provided he remains eligible for the Solar Bonus Scheme. New projects will not attract the same feed-in tariff.

The property has around 900 acres planted with vegetables under irrigation, which, depending on rainfall, is required throughout the growing season, February to November. Pumping and irrigation consume most of the energy on the farm, which is around 470 MWh annually, half consumed off-peak, at a cost of around $98,000 pa.

Neither wind nor biomass were viable options, so the study focused on the existing 30 kW and proposed 100 kW solar PV installations. Power use is not constant or predictable since the irrigation needs vary over the growing season and with actual local weather conditions.

Performance of the solar plant to date

From April 2012 to end January 2014 the power output was over 62 MWh. Due to the generous feed-in tariff, pump use during daylight hours is minimised to maximise financial returns, and pumps run up to 40% of the time that the solar system is generating power. The analysis shows that this plant was a good investment with an estimated payback period of 10.2 years. If pumping was done using only network electricity, with all solar PV generated electricity fed back into the grid, financial performance would be even better.

Case study: Solar PV and cogeneration in Bundaberg

A vertically integrated vegetable and herb grower and innovative processing company in Bundaberg, Queensland, is committed to reducing its environmental footprint.

It supplies a wide variety of fresh chillies year round, vegetable and herb purees to food manufacturers and the food service sector, and provides high pressure processing (HPP) facilities. The processing facility uses over 90% of the company's electricity (approximately 865 MWh), with just over 60% consumed during peak periods.

Solar PV was considered because the company's operation is over daylight hours, and there is significant roof space. Cogeneration was explored because the processing plant has significant heating and cooling loads in addition to power needs.

An analysis of the financial performance of a proposed 100 kW capacity solar PV installation indicated that cheaper installations would have payback periods of eight to eleven years, an investment that could be attractive with 100% debt financing. (The less attractive performance of solar PV at this site is due to the structure of the company's electricity tariff and the low cost for their electricity consumption.)

Cogeneration of electricity and cooling—the most viable of three engine based options considered—is very unlikely to be viable under any circumstances.

Financial details are available in the detailed case studies report.

This project is funded through Horticulture Australia Limited (HAL) by the National Vegetable Levy with matched funds from the Australian Government.