Farm Power: Energy Efficiency and Renewable Technologies

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National Vegetable Extension Network

VICTORIA - NORTHERN, WESTERN & SOUTH EASTERN

Key messages

- **Energy costs continue to rise for vegetable growers**
- **Energy savings can be made with improved efficiency**
- **On-farm energy production can also reduce costs**
- **Viable methods for vegetable growers include solar photovoltaics, solar thermal, wind and ground-sourced heat pumps**
- **Batteries may become practical in the near future as costs continue to fall**

The situation

Electricity retail prices have increased on average by more than 60% since 2012 and are likely to continue to rise.

Renewable energy technologies can help reduce vulnerability to rising electricity prices. They also offer cleaner, more environmentally friendly ways of meeting energy demands.

Falling installation costs of some renewables and incentive schemes have created opportunities for growers to reduce energy costs and meet sustainability goals by adopting on-farm power generation.

What are the energy requirements of growing vegetables?

Australian vegetable growers are major consumers of electricity, gas and petroleum.

Activities with energy demands include irrigation, heating (e.g. greenhouses), cooling (e.g. refrigeration and storage), machinery operations (e.g. field preparation, planting, cultivation, harvesting), packing and transporting produce.

Considering average electricity usage highlights two major operations that could greatly benefit from improved efficiency: cooling/storage and irrigation pumps (see Figure 1).

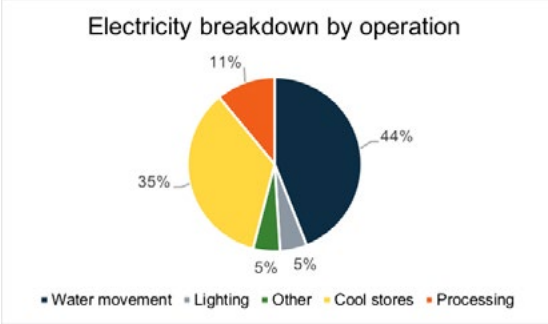

Figure 1: Breakdown of electricity use by operation on vegetable farms (Source: Infotech Research)

Improving energy efficiency usage on the farm

Energy savings can benefit both the bank book and the environment.

An energy audit on vegetable growing farms suggested the best returns on investment were achieved through prevention of energy losses followed by energy efficiency improvements (see example below).

The key areas of potential gains in energy efficiency are:

- Diesel plant efficiency;
- Refrigeration efficiency;
- Cool room energy loss reduction;
- Irrigation pump and system efficiency.

Check out these energy efficiency calculators from Growcom and AUSVEG VIC.

Cost-effective upgrades can help too. Could you switch to energy efficient LED lighting in the packing shed? Is your pump the right size and operating effectively? Could you insulate refrigerant piping for cool rooms? Or, similarly, insulate hot water supply and return piping for greenhouses?

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RMCG

Example: Improving efficiency by refrigeration systems

An energy audit was undertaken by the Australian Government Department of Industry on orchards Australia-wide. On an orchard in Tasmania that produced ~900 tonnes of fruit per year with four cool store rooms, the site used over 428,000 kWh of electricity at a cost of over $90,000 (excluding GST). Refrigeration comprised 58% of the total electricity use. The benefits below were made after the head pressure was lowered to reduce electricity consumption.

Change – reduce head pressure on refrigeration system

Outcome – save $2500–$3500 per year from $5000 outlay

Payback period – 1–2 years

[Source: Apple and Pear Australia]

Renewal energy technologies

In addition to improving energy efficiency, huge benefits can be gained from on-farm energy production.

'Renewable energy' includes a range of technologies, some of which may be economically viable for vegetable growers:

- Ground-sourced heat pumps;
- Solar thermal power;
- Solar photovoltaics (PV);
- Wind power;
- Waste-to-energy fuels (e.g. biogas).

Each of these technologies is outlined in further detail below.

Ground-sourced heat pumps

For farm owners, ground-sourced heat pumps can yield great results in terms of efficiency and energy cost savings.

Sometimes incorrectly called 'geothermal heating' – which uses heat directly from natural sources like hot springs, geysers and volcanic hot spots – ground-sourced heat pumps are heating and/or cooling systems that transfer heat to or from the ground.

One benefit of installing a ground-sourced heat pump on farm land is that systems are typically buried 1.2–1.5 metres below ground, so the land above can still be used for crops or other activities.

Solar thermal

Like ground-sourced heat pumps, thermal solar panels heat up water that flows through a circuit of pipes, but with heat from the sun rather than from the ground.

The heat collected from these systems can be used to generate electricity, but in single farm applications the most common use is to supplement hot water requirements.

Solar PV

Solar PV convert ultraviolet (UV) radiation from the sun into electricity, for example, using solar panels (see Figure 2).

There has been remarkable growth in power generated by solar PV over the past decade due largely to rapid evolution in PV technology, significant reductions in cost and substantial government subsidies.

Solar PV is one of the key options for on-farm power generation and is already widely used by Australian growers. According to the Commonwealth Bank's latest Agri Insights report, 76 per cent of Australian farmers plan to use solar renewables to reclaim control over their energy costs.

Figure 2: Solar panels on farm rooftops

Wind power

Wind generates energy by turning the blades of a wind turbine, which are connected to a shaft.

Wind power systems come in a variety of sizes. Here, we refer to farm-scale wind-powered electricity generators that are smaller-scale (for example, AWS wind turbines) than commercial turbines and so are not usually associated with community impact issues.

The two types of modern designs are horizontal-axis (as seen in commercial-scale wind turbines) and vertical-axis (see Figure 3) wind turbines. Although vertical-axis turbines are more suitable for the domestic market as they are quieter and more efficient in turbulent winds, they are much less cost effective than horizontal-axis turbines, which are extensively used across the world and in Australia for on-farm energy generation.

Rural areas are often ideal for wind turbines as there a fewer buildings to obstruct wind flow. However, wind generation is most suitable for growers with consistent demands throughout the year.

Figure 3: Modern vertical-axis wind turbine

Comparing solar and wind power

So, how do solar and wind compare on your vegetable farm? Table 1 sets out some practical guidance on comparing the alternatives.

Table 1: How do solar and wind compare for your farm?

	SOLAR	WIND
Requirements	Sunshine	Frequent wind greater than 5 m/s
Output	Intermittent - only when sunny	Intermittent - only when windy
Maintenance	Minimal	Some
Cost	About $6,800 for a 5kW system	About $4,800 per kW (second-hand turbines cost much less)
Space needed	Large horizontal space required	Small footprint required
Longevity	Solar panels typically have an output warranty of 25 years	20+ years if quality system
Payback period	Depends greatly on energy demand and local conditions	

Or choose both

There are disadvantages of both solar and wind technologies. So why not use both?

Hybrid systems harness the advantages of several energy technologies, usually solar and wind.

Biogas

Some growers overseas are successfully using innovative systems to turn vegetable waste into a source of energy.

Instead of throwing vegetable waste away, they treat it to produce ‘biogas’ – methane and carbon dioxide produced from the bacterial degradation of organic waste. Using anaerobic digestion, the process produces electricity, heat and a residual organic product that can be used on-farm as an organic fertiliser.

Although this is not considered a feasible option for most Australian growers right now, skyrocketing energy costs may yet make it an attractive option in the future, for example, in ‘clusters’ of local growers.

How can I convert to renewable energy?

Add solar PV, solar thermal, wind turbines or ground-sourced heat pump systems to augment your energy demands.

Alternatively, you can retrofit existing diesel-generator systems with renewable sources.

Cool rooms may be one of the best places to reduce energy demands using renewable energy. Either add solar PV or wind turbines to your cool room roof or install a ground-sourced heat pump to provide cool or cooler air, thus reducing energy requirements of air-conditioner systems.

The Federal Government's Small-scale Renewable Energy Scheme supports the installation of solar rooftop panels and solar hot water systems. The scheme is intended for homes or businesses with no more than 10 kW rating for solar PV and 100 kW for wind from a small renewable energy system, primarily seeking to use the power generated by their premises.

What does the future of energy look like?

Energy is likely to look quite different in the future, as populations continue to grow and energy production shifts.

The relatively new technology of energy storage in batteries is still not feasible for many. Current battery systems cost about $800 per kWh to set up and require an electricity price greater than 35 c/kWh to be economically viable. However, batteries may become practical in the near future as costs continue to fall.

Further information

For further information on energy in horticulture, the following resources may be of interest:

- Reducing energy consumption in horticulture – DELWP.
- Energy saving workbook for Australian vegetable growers – Infotech Research.
- On-farm power generation options for vegetable growers – AHR and Parkside Energy.
- A farmer's guide to technology and feasibility – NSW Farmers Association.
- Biogas production fact sheet – HAL, AHR.
- Biogas generation feasibility study – RMCG, Horticulture Australia.
- The Australia Government Clean Energy Regulator.