Renewable energy on farm: overview

Farms and rural locations typically offer a large amount of open, undeveloped space. These large amounts of open space present farmers with great opportunities to explore the development of renewable-energy technologies. Each renewable-energy technology comes with a host of considerations. Explanations for, and the advantages and disadvantages of a variety of technology types – solar, wind, biogas, and ground-sourced heat pumps – are outlined below.

Introduction

Renewable-energy technologies hold promise to generate energy at prices that are competitive with current electricity rates, and generally offer cleaner, more environmentally friendly ways of meeting energy demands. They also offer means of reducing your exposure to rising conventional fuel, gas and electricity prices.

Evaluating these options and developing a sound business case for your farm involves detailed planning and analysis. There are a number of technologies at varying stages of maturity available in today's marketplace.

While there are several renewable-energy technologies that can work in farming applications – and that, in some cases, are being aggressively promoted – the true costs and benefits of renewable, as opposed to conventional technology can be difficult to assess.

Careful consideration should be given to the situation of each individual farm and whether it makes sense to switch all or some of a farm's energy supply from conventional to renewable sources. For example, the case of a farm with existing grid electricity connection is different to that of a farm with no feasible grid connection and that relies currently on diesel fuel for pumping.

This paper outlines the key issues and aims to provide a 'mud map' for navigating this complex field. More detailed information is provided in the supplementary papers.

Types of renewable energy

The term 'renewable' is used to describe a range of different technologies. The following technologies may be viable on Australian farms.

- solar photovoltaic power,
- solar-thermal power,
- wind power,
- ground-sourced heat pumps, and
- waste-to-energy fuels, e.g. biogas and bio-fuels.

Each of these technologies comes with its own set of challenges and provides an array of potential opportunities.

Solar photovoltaics

How it works

Solar photovoltaics (PV) involve the collection of solar radiation from the sun. Solar panels and other types of PV systems are composed of layers of semi-conductor material – usually silicon. When light from the sun shines on this material, the material absorbs energy from the light, generating a 'direct current' (DC) which is fed into an inverter and converted into alternating current (AC) electricity. This AC electricity is then available to power electrical appliances on farm. If more energy is generated by the system than is currently used by the household/farm it will usually feed back into the electricity grid. (PV Education, n.d.).

Advantages

Anytime there is sun shining on a solar PV system, it is generating energy. This means you don't have to rely on fuel deliveries, fuel price fluctuations or electrical grid demand. Historically, there have been a number of government incentives available to help offset the installation costs of solar PV systems. These incentives have been wound down in recent years, which has had a significant negative impact on the business case for solar PV system installation. For example, the generous feed-in tariff initially offered in NSW (offering payment for supplying power from solar PV to the grid) has been reduced, and is set to be terminated completely in 2016.

Additional opportunities for government incentives, including renewable energy credits, may be available, depending on the current political landscape. NSW Farmers is active in this space, and encourages members to check websites for the most current information.

Disadvantages

Although fuel is free, solar PV systems rely on sunlight to generate power. This means that such systems generate less power on cloudy and rainy days and no power at night. PV panels must also be free from shading as this negatively impacts performance. Power storage is expensive. Additionally, solar PV requires a lot of space if it's to generate sufficient power, as each panel generally measures around 1,600 mm x 1,020 mm, and generates between 175 and 250 watts of electricity per hour.

Refer to supplementary paper, *Solar photovoltaic energy on a farm.*

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Wind power

Wind power systems exist in a variety of sizes. In this paper, we refer to farm-scale wind-powered electricity generators. These are smaller-scale generators not typically associated with community impact issues. Issues surrounding utility-scale wind power are addressed in the NSW Farmers guide to wind power (NSW Farmers, 2012).

How it works

Wind generates energy by turning the blades of a wind turbine, which are connected to a shaft. As the blades spin, they spin the shaft, which spins a series of magnets around a conductor – typically some type of wire –a within a generator. The generator creates an AC-voltage current, which can be utilised as a source of energy (Layton, 2013).

Advantages

Wind power, like solar power, runs on a free fuel source. It doesn't rely on sunshine so you can generate power when it is dark or cloudy. Price fluctuations will not affect your input costs so once you have a wind system, power will be free (aside from maintenance and upkeep). Generally, farm-scale wind plants can be sited in locations in which the turbines have no negative impacts on neighbours and do not require planning approval.

Disadvantages

Wind, like sun, is not constant, nor is it within operator control. If there is no wind, a turbine will produce no power. For this reason, it is essential to locate any wind turbine in an area that typically experiences a lot of wind.

Prior to investment and the selection of wind technology, however, it is essential to obtain objective data (in the form of existing wind maps and other resources) regarding the strength, direction and reliability of winds on and around your farm.

Farm-scale plants should be permanently sited in locations with maximum wind. On farms with significant seasonal variation in prevailing winds, mobile plants are recommended; several of these are currently available on the market.

Larger-scale wind turbines require significant up-front investment as well as and careful planning to ensure that the site and power needs are adequate to justify the proposed install.

In addition, larger-farm scale wind plants may trigger planning controls. It is essential that you check with your local council before investigating this option (NSW Office of Environment and Heritage, 2010).

Refer to supplementary paper, *Farm scale wind power.*

Ground-coupled heat pumps

How they work

Networks of pipes are buried in the soil surrounding buildings and connect to pipes routed through the building.

Water in the pipes is kept relatively cold during the day by the natural insulating properties of the soil. Conversely, in winter, water in the pipes in the soil remains relatively warmer.

Heat and cold is exchanged between the ground and the building, buffering temperature extremes and reducing the need for primary heating and cooling.

Advantages

Ground coupled heat pump systems are a relatively cheap and simple technology that can be used to reduce both operating and capital costs of integrated heated and cooling systems significantly. For example, including heat pump systems in buildings at the design stage enables you to reduce the size and power of those buildings' heating, ventilation and cooling (HVAC) systems.

Disadvantages

Ground-source heat pumps can be expensive to retrofit. These types of systems are unlikely to offer a complete heating and cooling solution. Heat pumps may not enable you to make sufficient total energy savings to warrant the investment. (To establish whether it makes sense to invest in such a system, a heat building, heat load calculation is required.)

Solar-thermal hot water

How it works

Solar-thermal systems generally consist of a series of conductive pipes that house a fluid. This fluid is heated by light and heat from the sun, and then flows into a storage container. Typically, solar-thermal systems are installed on roofs or other areas that receive high levels of sun, and can account for a significant portion of a building's hot-water needs.

Advantages

Solar-thermal systems have many of the same advantages and disadvantages as solar PVs. Solar-thermal systems offer the potential for significant energy savings on hot water but will not provide electricity or other power. Generally, up-front costs for solar-thermal systems are much lower than other renewable-energy options, but unless there is a significant demand for hot water, savings opportunities are limited.

Disadvantages

As does solar PV, this type of system relies on exposure to adequate amounts of sunlight. In very cold conditions (below 0 degrees Celsius), solar-thermal systems will not work well, and some systems can even freeze or crack from low temperatures.

Refer to supplementary paper, *Solar hot water.*

Waste to energy (biogas/bio-fuel)

How it works

There are two main 'waste-to-energy' strategies. Biogas is the collection of methane gases from organic waste material, while biofuel is the fermentation of organic waste into ethanol. Both materials can be burned in engines to create heat, propulsion or electricity, depending on the set-up of the machine that is using the bio-material.

When enzymes break down organic matter such as animal waste, grasses or other plant by-products, methane is released. Within the proper system, this methane can be stored and pressurised for future use. The amount of energy

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potential within the organic matter depends on the chemical composition of the matter itself.

Ethanol is an alcoholic liquid fuel that is made in a similar way to other types of alcoholic spirits. Organic matter and sugars are exposed to yeast and go through a process of fermentation. Microbes feed on the sugars in the material, converting it to carbon dioxide and ethanol. The ethanol is then filtered to remove impurities so that it can be burned in traditional combustion engines.

Advantages

In many cases, material which would otherwise have to be disposed of at the owner's expense can be transformed into a fuel that can be used to create energy. This means that farmers can harness their existing agricultural by-products to help reduce their reliance on external energy sources.

Disadvantages

The processes for capturing and producing biogas and biofuel aren't simple and can present a number of challenges. In order to have a steady supply of energy from these materials, a constant input supply is required. Smaller producers may generate insufficient waste to justify the capital expense of waste collection, treatment and harvest.

In addition to being a complicated process, there are potential negative impacts from large-scale fermentation and organic decomposition. Odours from this process can be a concern if it is not contained properly. In reality, however, if digesters are built correctly and fermentation methods are carried out properly, there will be no outside smell. In biogas production, the by-products of the waste material can be used as a relatively odourless fertiliser once methane has been harvested (Skott, 2006).

Within certain regions, the opportunity for larger, enterprise-level waste-to-energy may exist as farmers can pool their resources into a central process facility, which can then provide energy to surrounding communities. In this way, farmers may be able to begin looking at waste by-products as viable investment materials.

Further information

Clean energy council – renewable technologies
www.cleanenergycouncil.org.au/technologies.html

Solar PV

The Australia clean energy regulator
Information about government incentives.
ret.cleanenergyregulator.gov.au/

Solar-thermal

Solar schools – solar thermal energy
http://www.solarschools.net/resources/stuff/solar_thermal.aspx

Wind

Geoscience Australia – wind energy
www.ga.gov.au/energy/other-renewable-energy-resources/wind-energy.html

Biofuel

Growing a green fuel industry in Australia
ecosmagazine.com/paper/EC10107.htm

Biogas

Biogas Australia
www.biogasaustralia.com.au/biogas-generation/digester/digester.html

Australian Pork Limited: Renewable energy (biogas)
http://australianpork.com.au/industry-focus/environment/renewable-energy-biogas/#

Edwina Beveridge: 'Turning pigs' poo into power'
NSW farmer discusses her farm biogas facility
https://www.youtube.com/watch?v=DbV_ebILwsA

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