



Smarter energy use on Australian dairy farms

Feasibility of biogas technology in the Australian dairy industry

Since 2012 almost 1,400 dairy shed energy assessments have been conducted in all dairy regions across Australia as part of the national Dairy Australia project *Smarter energy use on Australian dairy farms*, funded by the Department of Industry and Science as part of the Energy Efficiency Information Grants Program.

During the project, the potential for implementation of biogas technology for specific situations on dairy farms was raised. This fact sheet summarises information on the feasibility of this technology for the dairy industry.

Introduction

Biogas technology can simplify on-farm waste management and improve the fertilizer value of manure and other by-products, the technology can reduce farm odour and Greenhouse Gas (GHG) emissions and provide renewable energy for energy self-sufficient farms or for export, to name just a few advantages. However in the field, biogas technology is first and foremost characterised by one feature: it is a very site specific technology that has to be selected and tailored carefully to meet on-site needs. Biogas technology doesn't have to be complex or cumbersome to manage, but the decision of what configuration is right for your farm needs to be managed carefully.

Biogas basics

Biogas formation

Biogas is one end product of Anaerobic Digestion (AD), and consists chiefly of 50–70% methane and 30–50% carbon dioxide as well as minor gas components, such as water vapour, nitrogen and hydrogen sulphide. AD can be carried out on a very wide range of organic materials, basically all organic matter except woody biomass, and is therefore applicable to wastewater solids, manures, food processing by-products, green waste, certain energy crops and many other materials.

Anaerobic Digestion (AD) technology

The most common technologies for anaerobic farm waste treatment and recovery of biogas are engineered, heated and Completely Stirred Tank Digesters (CSTD), and “passive” Covered Anaerobic Ponds (CAP). CSTD have much higher investment costs, require careful management and require more maintenance than CAP systems.

CAP have an upper dry matter limit of ~5% (total average) for the input substrate and are susceptible to a high proportion of long, fibrous input material, i.e. bedding material in the input substrate. CAP are therefore best suited to be added to a “liquid” effluent management system where input and output substrates are handled as liquids already, or where a certain proportion of higher strength waste (i.e. feed pad scrapings) is envisaged to be reliably handled through a liquid management system (i.e. land irrigation).

Biogas substrates

In an Australian dairy farming context, the main substrates that will be considered for AD are dilute cow shed effluent and more solid manure scrapings/slurries from dairy cow housing systems or feed pads.

These wastes are easy to digest and low tech covered pond digesters as well as mesophilic tank digesters can be employed for obtaining biogas from these wastes.

The amount of manure available for anaerobic digestion on a dairy farm is difficult to estimate. Small management differences can lead to up to ± 50% differences in available manure volume between otherwise identical farms, for example the difference once a day and twice a day milking. Therefore daily available manure volumes need to be accurately measured before embarking on any biogas project.

Changes to the substrate during digestion

Anaerobic digestion of farm wastes typically reduces the solids content by 50%–80%, which simplifies handling of the digested waste for uses such as recycled flush water or land irrigation. Anaerobic digestion leaves the fertilizer nutrient content of organic wastes largely unchanged, however a large proportion of nutrients contained in the waste are transformed into simple, more plant-available forms – specifically ammonium-N and soluble phosphate. These transformations can make the digested waste/manure more usable and help to reduce fertilizer import. Reduction of odour emissions can be a prime driver for the adoption of AD technology, and were for example the key aspect for the adoption of CAP technology by the pork industry in Australia and New Zealand.

Rule of thumb biogas yields

Under field conditions dairy cow manure has a rather modest methane yield of 0.18–0.25 m³CH₄/kgVS,¹ which is mainly a result of its relatively high lignin content.

Biogas energy use in the Australian dairy industry

In situations where biogas technology is mainly applied to address odour emissions, or where the reduction of fugitive methane GHG emissions is the primary goal of a biogas scheme, biogas flaring without energy utilisation will remain a possible biogas use option, due to its inherent simplicity, low investment costs and very low ongoing operational costs.

In the context of dairy farming in Australia, two end uses will be the predominant option for biogas utilisation for the vast majority of possible schemes:

1. Combustion for hot water generation, and
2. As fuel for combined heat and power (CHP) generators.

The use of biogas as CHP generator fuel is most common around the world, and does require a moderate level of biogas quality improvements (i.e. condensate removal, reduction of hydrogen sulphide to < 200 ppm, etc.).

Advantages of and drivers for AD on my farm

One of the fundamental dilemmas of AD and biogas technology is that it is addressing a whole range of issues and is so flexible that it is easy to lose focus. However each individual benefit may be not sufficient to justify an AD system or a particular configuration of AD for an individual farm, which is why any AD development should focus on multiple benefits and the most appropriate way of combining these.

While a CAP system can in some cases assist with regulatory problems, such as farm odour emissions or fixed water use reduction targets (via recycling), tank digester systems are generally not able and/or are too expensive and sophisticated to help address such problems. However CAP systems are applicable to almost any farm size if the goal is to address environmental issues such as odour emissions or improved effluent management.

To make CHP energy recovery, with the focus on a certain level of farm energy self-sufficiency, viable requires roughly 100t of manure VS (volatile solids) which is available from ~500 pasture feed dairy cows, if a moderately intensively used feed pad is on-farm. For dairy farms where more manure is collected due to more (intensive) housing, the minimum number of cows is reduced accordingly.

1. The observed biogas yield is measured as m³CH₄/kgVS = cubic meter methane (standard gas conditions) per kilogram volatile solids (= kg ash free dry weight) introduced to the digester. The yield of a given substance is not a fixed number, but is influenced by many factors, such as retention times, operating temperatures, pH level, trace nutrients and management of the digester.

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