Bioenergy Support Program

Talking Topic 1

Collecting the biogas benefits of pig manure

What is biogas and why do we need it?

Biogas is produced naturally when pig manure decays in places where oxygen is absent (such as at the bottom of a treatment lagoon). Biogas can often be seen bubbling on the water surface of active piggery lagoons.

Biogas is a source of renewable energy for a pork producer and can reduce or eliminate energy costs or earn income from export of electricity to the grid. However, if untapped, biogas contributes about 60% of the total on-farm greenhouse gas emissions for Australian pork production.[1] Capturing and burning biogas makes sense at piggeries because it can improve the environmental and business performance of a piggery.

If you have piggery lagoons fed with flush manure, you probably already make biogas, but you're just not using it. So, let's talk about how you can collect biogas benefits.

For an overview of piggery biogas as an energy source, consider the scenarios in Table 1.

Emissions from uncovered primary lagoons at piggeries are a significant source of odour and capturing and burning biogas can greatly reduce this odour.

Capturing and burning of biogas DOESN'T usually change the natural decay of the manure. The pond sludge and treated effluent water still has the same nutrient value as always and beneficial use of these nutrients should be encouraged. Sludge can be readily extracted from a covered lagoon.

TABLE 1 Piggery scenarios for biogas energy

SCENARIO*	BIOGAS ENERGY*	AVERAGE DAILY ENERGY USE*	COMMENTS
100-sow farrow-to-finish conventional	170kW.h/day electricity + 180kW.h/day heat	120kW.h/day total	Supply of biogas energy can exceed demand
500-sow farrow-to-finish conventional	840kW.h/day electricity + 880kW.h/day heat	600kW.h/day total	Supply of biogas energy can exceed demand
500-sow specialised breeder unit (growers offsite) conventional	280kW.h/day electricity + 290kW.h/day heat	500kW.h/day total	Supply of biogas energy only meets energy demand if also heating with hotwater
500-sow-equivalent grow-out unit (progeny only) conventional	400kW.h/day electricity + 440kW.h/day heat	100kW.h/day total	Lots of manure, lots of biogas, little energy demand (feedmill options?/electricity export options?)

*These scenarios are extrapolated from typical observations. Energy use and methane yields for pig manure can vary widely from site to site. Energy use would be much greater with a feedmill onsite.

Benefits to You!

Table 2 below presents five Pork CRC feasibility studies on a variety of Australian farms.[2] All the prospective projects were economically feasible, with some showing short payback periods of 1.8-4.7 years and all delivering a substantial positive return on investment over a 10 year project life.

Direct on-site use of biogas energy provides the greatest financial benefit. This is clearly shown in Figure 1, which presents a percentage breakdown of the financial benefits of piggery biogas (the relative $-value of savings or earnings). On-site use of biogas energy saves on energy costs of production which will always increase.

Exports of electricity provide income, but with a significantly lower $-value than the savings associated with on-site energy use (Figure 1). This is because feed-in tariffs in Australia have typically been relatively poor (4-8cents per kW.h).

There are two renewable energy initiatives that pork producers can take part in when they capture and use biogas. These initiatives can provide substantial financial benefit to pork producers adopting biogas projects.

1. The Carbon Farming Initiative provides Australian Carbon Credit Units (ACCU), a tradeable financial product which can be sold for income.

2. Renewable Energy Certificates (RECs), earnt by using a renewable energy source and can also be sold for additional income. Like ACCUs, the value of RECs is subject to market conditions.

The value of the renewable energy and carbon farming initiatives are highly subject to carbon market conditions and government policy. Therefore, economic feasibility is best assessed without initially considering the income from carbon and renewable energy credits, to assess whether projects are economically viable purely based on energy costs (which are sure to increase) and energy sales. If projects are shown to be economically viable without a need for income from renewable energy initiatives, it is known that these renewable energy initiatives can greatly enhance project value.

Fig 1 – A percentage breakdown of the $-value of savings/earnings to a pork producer implementing a biogas project. The relative $-value for ACCUs and RECs given in Figure 1 represents the observed return from these initiatives for existing piggery projects and within the year 2012-2013.

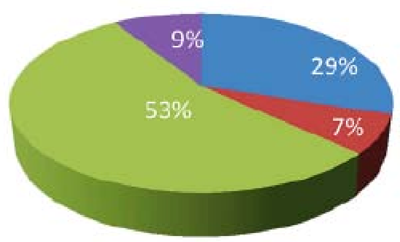

TABLE 2 Results from Pork CRC feasibility studies of various Australian piggeries.[2]

PIGGERY	SOW-EQUIVALENTS*	PAYBACK PERIOD (YEARS)	10-YEAR RETURN ON INVESTMENT (%)	TOTAL CAPITAL COST ($)
Multi-site farrow-to-finish	1,190 (12,692SPUs)	4.2	198	411,900
Grow-out unit	510 (5,112SPUs)	8.5	7	279,400
Sow multiplier	700 (7,089SPUs)	1.8	597	170,200
Farrow-to-finish	540 (5,432SPUs)	4.7	151	345,600
Farrow-to-finish	700 (6,975SPUs)	7.2	64	298,300

* An equivalent farrow-to-finish herd size that produced the same amount of flush manure as what is produced by the pig herds at each of these piggeries. SPUs stands for Standard Pig Units. A 100-sow-equivalent farrow-to-finish herd size is equal to about 1000 standard pig units or SPUs.

Technical Overview

How do I use piggery biogas?

EQUIPMENT OVERVIEW

Figure 2 summarises all the equipment needed to most simply capture and use piggery biogas. Manure is drained into a pond with a plastic cover over the top. The manure decays into biogas. The biogas is collected through pipework under the cover and through the pond bank. Depending on the use of the biogas, the biogas may be dried, cleaned of corrosive contaminants, sent to a flare or to a boiler or to a generator to recover useful energy. Coarse solids in the flush manure such as barley husks may be taken out upfront with a solids screening step, because these solids often contribute little to the biogas produced and can accumulate as a float layer under the cover.

CAPTURING THE BIOGAS

Biogas is most simply captured by placing a plastic cover over treatment lagoons, as shown in Figure 3. The cover is usually made of low density or high density polyethylene and is trenched in around the rim of the lagoon to form a gas-tight seal. Above-ground mixed and heated digesters work similarly to covered lagoons in that manure is still decayed naturally to produce biogas, but the regulated temperature of mixed/heated digesters allows a more constant biogas flow year-round. In contrast, the biogas produced by covered lagoons varies with seasonal temperature changes, with colder months giving about 20% less biogas than the average yearly flow, and warmer months giving about 20% more biogas than the average yearly flow.[3]

PIPING THE BIOGAS

The biogas is conveyed through sealed pipework (underground HDPE, PVC or stainless steel; above-ground stainless steel) to an engine or boiler. Usually, the biogas has to be pushed along the pipework with a biogas blower (Figure 4) to get the biogas to where it is used. The motor of biogas blowers and any other electrical equipment located near piping and equipment containing biogas (within about 5m) is spark-proof/intrinsically safe to prevent biogas flash fires. Importantly, the biogas equipment described here is usually at low pressure (<100kPa or 14.5Psi), including the cover over the pond which rarely exceeds (50 Pascals or 0.007Psi) even when severely bloated.

Fig 2 – A schematic overview of a covered lagoon biogas set-up at a piggery

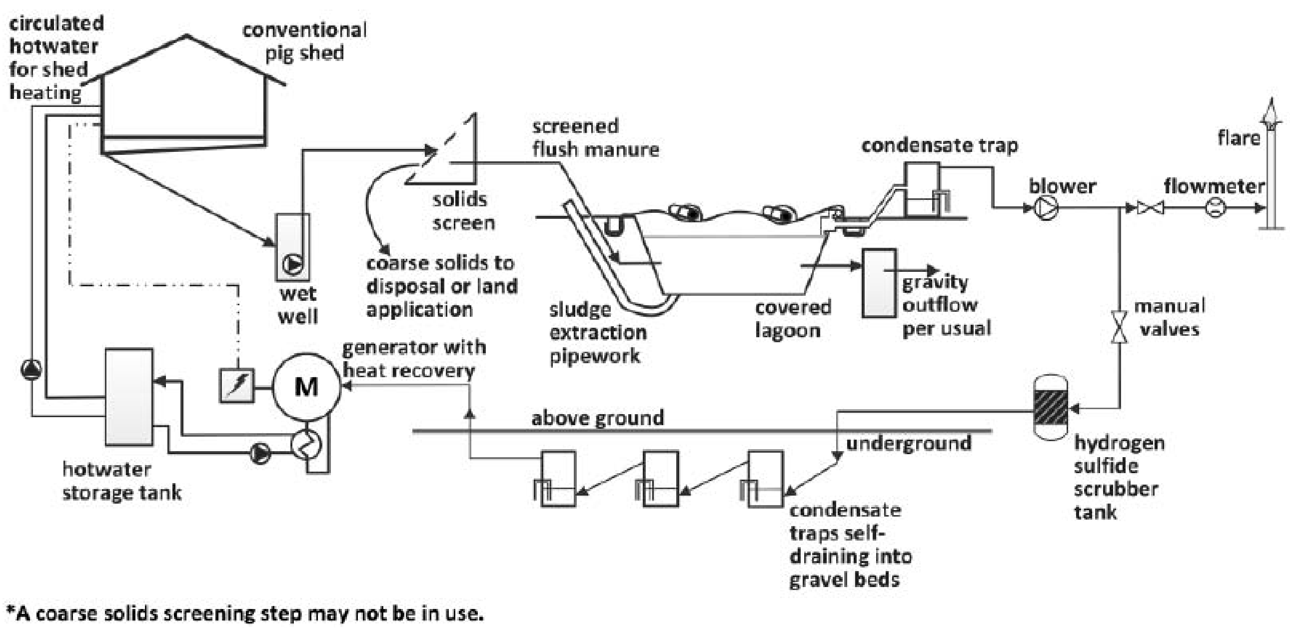

Fig 3 – Covered lagoons at various piggeries in Australia

Fig 4 – Centrifugal fan-type blowers used at Australian piggeries to pump biogas from a covered lagoon to a boiler, engine or flare.

CLEANING THE BIOGAS

Biogas has corrosive ingredients. To protect engines or boilers from corroding, these corrosive ingredients are often removed from the biogas before use. This is done by contacting the biogas with a liquid or solid cleaning-medium (Figure 5) which strips the corrosive ingredients from the biogas without removing the methane. Usually these cleaning systems use chemicals/solid media that become spent with use and require replacement which costs money. These additional costs must be justified by the savings in maintenance costs or by delayed replacement value of engines or boilers.

DRYING THE BIOGAS

Where biogas is conveyed in long sections of underground pipework, cooling of the biogas to the soil temperature can cause moisture to condense and collect in the underground pipework. This water in the underground pipework obstructs the flow of biogas. To prevent this, the biogas is often chilled above-ground with chilled water before being sent underground. This chilling of the gas causes condensation above-ground, and the condensate is then collected before the biogas is sent underground (Figure 6).

Fig 5 – Biogas cleaning equipment.[4]

Fig 6 – Equipment used to encourage condensation by cooling the biogas and for collecting the condensate that forms before the biogas enters underground pipework.

Fig 7 – Biogas-fired generators at piggeries in Australia and New Zealand

USING THE BIOGAS ENERGY

Biogas is used at Australian piggeries to produce electricity with biogas-fired generators (Figure 7). This electricity is used for on-site power and grid exports. Electricity is currently sold back to the grid at a much lower price than when bought off the grid, so returns on grid exports are currently marginal.

Only a portion of the biogas energy can be turned into electricity. The remainder is released as heat which ends up in the engine cooling circuit, radiates off the engine block or exits with the burnt exhaust gasses. To recover and use this waste heat, biogas-fired engines at Australian piggeries have been fitted with heat exchangers on the engine cooling circuit or exhaust. The waste heat is then recovered in the form of 70-80˚C water, which can be used for floor heating in farrowing sheds, or for compartment heating in weaner sheds (Figure 8). This reduces or eliminates grid or diesel generator power.

Biogas is also currently used at one Australian piggery to produce hot water with a conventional gas-fired boiler (Figure 9). The efficiency for the biogas energy conversion with a boiler is marginally better than with combined heat and power from a generator, but the energy is then only available as hot water. The hot water is used for floor heating in farrowing sheds, but can be used for heating weaner sheds. In such cases, the biogas is used instead of LPG.

Real piggery scenario NSW

- 2100-sow farrow-to-finish (22,000 SPU) with all pigs on slats and with direct flushing
- Average Biogas Energy Available = 4500 kW.h/day electricity
- Average daily energy usage = 2000kW.h/day electricity (energy replacement saves $15,000/month; excess electricity is exported to the grid earning $5,000/month)
- Carbon farming Initiative Credits = $160,000/year (actual earnings in last year was $185,000 for 14 months operation)
- Total capital investment: $960,000 (May 2011 – Mar 2012)
- Estimated payback period: 2-3 years

Fig 8 – Hot water heating in pig sheds in Australia and New Zealand. The hot water is produced with waste heat from generators burning biogas.

Real piggery scenario WA

- Odour control was driver
- Secured DAFF Farm Ready Grant to demonstrate carbon emission reduction technology on a small-sized piggery
- Fire damage provided additional funds to refurbish existing lagoon into a new pond
- 70-sow-equivalent specialised grow-out unit/agricultural testing facility
- Flare only, would be eligible to participate in the Carbon Farming Initiative.
- 37-75m^3/day biogas with 70% methane

FLARING THE BIOGAS

Biogas can also be simply burnt with a flare flame (Figure 10). While the biogas energy is then not used, burning biogas in a flare reduces odour associated with pond emissions and also greatly reduces greenhouse gas emissions. Flaring can be a safe method to dispose of unwanted biogas. Also, by capturing and flaring biogas, carbon credits can be generated and sold. However, the payback periods for flare-only scenarios (no biogas energy recovery) are usually long and rely completely on the sale of carbon credits (greater risk and uncertainty).

Fig 10 – Biogas flares at piggeries in Australia.

Other Talking Topics

Talking Topic 1
Collecting the biogas benefits of pig manure.

Talking Topic 2
Deals with biogas safety – The essentials… Raw biogas is extremely dangerous, being highly toxic and highly flammable, but it can be handled safely.

Talking Topic 3
Looks at designing a covered lagoon for biogas… What are the unique features of covered lagoons over conventional piggery lagoons?

Talking Topic 4
Reviews the uses of piggery biogas: Power generation and heating options… How is piggery biogas used for energy?

Talking Topic 5
Deals with biogas cleaning... Why clean biogas before using it and how?

Talking Topic 6
Looks at Carbon Farming with pig manure... How does it work?

References

1. Wiedemann, S.G., McGahan, E.J., Grist, S. and Grant, T. (2009). *Environmental Assessment of Two Pork Supply Chains using LCA.* Report prepared for Australian Pork Limited and RIRDC.

2. Eugene McGahan, John Valentine, Stephan Heubeck and Caoilinn Murphy. (2013). *Biogas Capture and Energy Generation Feasibility Studies for Five Piggeries*. FSA Consulting. Report prepared for the Co-operative Research Centre for an Internationally Competitive Pork Industry.

3. Scott Birchall (2010). *Biogas Production by Covered Lagoons: Performance data from Bears Lagoon piggery*. RIRDC Publication No 00/023. RIRDC Project No. PRJ-002705.

4. Some of the photos used in Figure 5 were provided by Alan Skerman (2012). *Methane recovery and use at a piggery near Grantham Queensland.* Presentation delivered at Bioenergy Australia 2012 Conference, Melbourne, Australia.

Dr Stephan Tait

For more information, contact:

Dr. Stephan Tait
Pork CRC Research Fellow and leader of the
Pork CRC's Bioenergy Support Program

c/o AWMC, Level 4 Gehrmann Building (61)
The University of Queensland
St Lucia, QLD, 4072, Australia

Mobile: 61 (0)466 699 817 (preferred)

Direct: 61 (0)7 3346 7208

Fax: 61 (0)7 3365 4726

s.tait@uq.edu.au

www.porkcrc.com.au