



CCRSPI

CLIMATE CHANGE RESEARCH STRATEGY FOR PRIMARY INDUSTRIES



Climate change update: On-farm bioenergy in the pork industry

Bioenergy is renewable energy converted from farm waste such as manure, feed spills, crop residues, offal, and most domestic and industrial organic wastes. Pig production is well suited for bioenergy production, as the controlled waste management systems enable pork producers to convert methane (CH₄) 'digested' from piggery waste into methane gas. This biogas can then be converted into electricity that can be used to power the farm, or sold to the local electricity network, generating on-farm revenue.

Waste management systems can also be used to transform piggery effluent into odourless liquid fertilisers that can be used on pasture and crops. These on-farm waste management practices can help farm businesses improve profitability as well as becoming more environmentally sustainable. This is important, as odour, greenhouse gas (GHG) emissions, surface water and groundwater contamination are major environmental concerns arising from pork production.





Anaerobic digesters (left) and a covered anaerobic pond.

How can bioenergy be part of my business?

Waste management systems need to be considered as part of a treatment, recycling and water use system on-farm. The covered anaerobic pond and the anaerobic digester are two waste management systems that can be successfully used to collect methane for generating electricity.

Covered anaerobic pond — The anaerobic pond has an impermeable cover under which methane and odorous gases are collected. This biogas can be used as an energy source or simply flared (burned) off. The pond cover significantly reduces odour emissions, but adds extra capital cost.

Anaerobic digesters — These specifically designed and insulated tanks are used to convert organic matter such as manure, feed spills and meat processing wastes into methane (CH₄) and carbon dioxide (CO₂) gases. Anaerobic digestion produces a mostly CH₄ rich biogas suitable for energy production. The biogas is similar to that of natural gas and can be used as fuel in boilers, burners, engines and power generators. The nutrient-rich solids left following digestion, known as digestate, have low odour and high nutrient value, and are useful for land applications and soil enrichment.

Matter	%
Methane, CH ₄	55–75
Carbon dioxide, CO ₂	25–45
Carbon monoxide, CO	0–0.3
Nitrogen, N ₂	1–5
Hydrogen, H ₂	0–3
Hydrogen sulphide, H ₂ S	0.1–0.5
Oxygen, O ₂	traces

The typical composition of the resultant gases from anaerobic digestion will vary depending on the digestion process, stock variability and enterprise inputs (see table at left for a 'typical' mix). Water vapour (H₂O), and hydrogen sulphide (H₂S) gases require removal before biogas is used to produce energy.

What should I consider when preparing for a covered anaerobic pond or an anaerobic digester? — The selection of a particular manure management system should consider the local climate, any environmental constraints or regulations, how the effluent nutrients will be used, any capital and taxation costs, labour and skill requirements on-farm, and the convenience of the system to your production process.



Bioenergy is positive for the environment

Anaerobic digesters used in the methane generation process can reduce odour from piggeries, and decrease ground or surface water contamination from pathogens and nutrients leaching into watercourses by run-off. This has positive effects for the environment by improving water quality in nearby rivers and streams.

Bioenergy and the potential for ‘offsets’

Future policy frameworks may set a limit on the amount of methane that can be produced by a business before ‘permits’ or ‘offsets’ must be purchased. Businesses may also be required to report on the level of methane emissions associated with production. In both cases, any future impacts are most likely to initially affect large scale operations, though the ‘thresholds’ for permissible total emissions are likely to decrease over time.

Bioenergy systems are being developed in other countries, including North America, Germany and Malaysia, as well as in other agricultural sectors such as dairy.

Bioenergy systems can also be used for generating ‘offsets’, and can enable producers to generate credits based on the total decrease in methane emissions from their operations. These credits could be sold to a third party organisation that uses them to ‘offset’ against its existing emission levels, thereby enabling the third party to meet regulatory requirements (though it is important to be clear that realising any revenue from ‘offsets’ will depend on future policy decisions by government).

Electricity generation from methane reduces GHG emissions. Flaring, for example, reduces the global warming potential of methane, as flaring converts methane into less harmful carbon dioxide (CO₂) and water vapour (H₂O). Using these practices makes it less likely that a business will be subject to reporting requirements or need to buy permits.

How have pig producers used anaerobic digesters? What were the costs?

Charles Integrated Farming Enterprises (I.F.E.), who operates Berrybank Farm in Victoria, received financial grants from both the Victorian and Federal Government for the farm’s on-site biodigester systems. The following case study demonstrates the gains that can be made by integrating bioenergy systems into on-farm pork production.



From left:

- raw effluent
- grit removal
- rundown screen

Bioenergy case study — Charles I.F.E. Berrybank Farm

Charles I.F.E., the company that runs Berrybank Farm at Windemere in Victoria, decided to seek ways to improve the efficiency of pig production and wanted to eliminate pollution problems associated with the odorous waste from the piggery, and to find ways of reducing its consumption of 400,000 litres of bore water per day.

Berrybank Farm is home to 15,000 pigs with an estimated live weight of 800 tonnes. It produces a daily average of 275,000 litres of sewage effluent with an organic solids content of approximately 2%. To put this in context, this is roughly the same as the sewage output of a town with a population of about 50,000 people. Berrybank has developed a sophisticated waste management system to recover all the waste from the pigs, and to treat it so that the various by-products can be used on the farm (as flush water, gas for electricity, and fertiliser), or sold for profit.

The waste management system is a seven-stage process including automatic and continuous waste collection, grit removal, slurry thickening, primary digestion, secondary digestion, biogas purification and a co-generation thermic plant. The process was implemented in November 1989 and electricity production started in 1991.

The farm modified the existing drainage around and under the piggery to recover the waste products, and installed automatic flushing valves and linked them to the main pumping station. The valves are solenoid-activated and enable remote-controlled flushing at various times of the day, working in a somewhat similar way to an automatic watering system in a domestic garden. Meat and bone meal fed to the pigs contains granules of bone, and this passes through the pig and into the effluent. The grit from these granules resides in the slurry and is removed by simple sedimentation. This is important, as the grit can damage the internal pump mechanisms. The slurry is then pumped to the thickening plant, where the finer suspended solids are separated from the water. The clarified water is recycled, either as flush water in the piggery, put into storage, or applied directly to the land as fertiliser.



Organic fertiliser from Berrybank is used for a variety of purposes.

The thickening plant separation process is a combination of an existing screen and a newly developed flotation system. Flotation allows the separation of water from the smaller suspended particles; this is not always possible using other processes.

The primary and secondary digesters are where the anaerobic digestion takes place. A digester simply provides the ideal conditions for the process to proceed at a faster, more controlled rate, by excluding air, thoroughly mixing the contents, and maintaining optimum temperatures.

The biogas is then purged of potentially damaging sulphur by scrubbers, traps and a dehumidifier, before being pumped to the co-generation thermic plant, where it is converted into thermic heat and electricity. The plant produces 180 kW/hour of electricity for 16 hours per day (enough to power over 400 households), and has the potential to considerably boost this output. Heat is used for the primary digester, while electricity not used on the farm is sold to large power producers. The farm's feed mill consumes 60% of the electricity generated during the day.

The solid and colloidal parts of the digested slurry are separated from the water by centrifuge. This reduces the bulk of the slurry by up to 90%. The end result is composted humus — a valuable fertiliser for the farm and the domestic potting mix market. The separated water also has enough residual nutrients to replace the use of chemical fertiliser when applied to cropping land. The farm can use this fertiliser (both liquid and solid) on 80% of their cropping land.

In 2001, Charles I.F.E. supplied liquid and solid organic fertiliser from the Berrybank piggery to two garden product companies, who use the organic fertilisers in their potting mixes and soil conditioners. The final product is sold to numerous sporting fields, bowls greens, golf clubs and racecourses. Notably, organic fertilisers have been found to have advantageous properties over chemical fertilisers, in that grass roots penetrate deeper and turf recovers faster.

Photos Allison Mortlock and Roger Charlton (centre).



From left:

- secondary digester
- organic fertiliser
- generators

Each day, the farm now recovers:

- approximately 7 tonnes of waste solids at 35% dry matter (used as fertiliser),
- 100,000 litres of recyclable water,
- 100,000 litres of mineralised water (used as fertiliser), and
- 1700 cubic metres of biogas, able to run a co-generation electricity program with a daily output of 2900 kW.

The environmental benefits are enormous. As a result of cleaner production, Berrybank Farm has also achieved:

- 70% reduction in water usage,
- improved stock conditions,
- improved working conditions for staff, and
- elimination of odour.

Annual estimated savings as a result of cleaner production are shown below.

- | | |
|------------------------|------------------|
| • electricity | \$125,000 |
| • water | \$50,000 |
| • fertiliser | <u>\$250,000</u> |
| • total annual savings | \$425,000 |

Berrybank Farm has proven that both financial and environmental benefits can be achieved from investment in an anaerobic digester. Berrybank has also changed its image in the community — from being seen as an environmental problem to becoming a welcomed industry that offers a good working environment.

For more information on Charles I.F.E.'s Berrybank Farm and methane mitigation in Australian agriculture you can access the Rural Industries Research and Development Corporation (RIRDC) report, *Using Methane in Intensive Livestock Industries* at <https://rirdc.infoservices.com.au/downloads/08-050.pdf>

Another useful publication is the RIRDC report, *Assessment of Methane Capture and Use from the Intensive Livestock Industry* at <https://rirdc.infoservices.com.au/downloads/08-025.pdf>



What does the research say about the cost of renewable energy generation?

Research was conducted into the technical, economic and financial implications of using piggery waste to generate electricity.⁽¹⁾ The study concluded that covering existing lagoons and collecting the methane for generating electricity is viable for most piggeries with a capacity exceeding about 8000 Standard Pig Units (SPU) or more (6000 SPU in New South Wales because of the NSW Greenhouse Gas Abatement Scheme).

1. *Renewal energy industry development report on technical, economic and financial implications of using piggery waste to generate electricity*; Bob Lim & Co Pty Ltd and Headberry Partners Pty Ltd, available from — rirdc.infoservices.com.au/downloads/08-050.pdf

Only piggeries with a capacity exceeding 40,000 SPU (or 25,000 SPU in New South Wales because of the NSW Greenhouse Gas Abatement Scheme) could viably install a digester. Once a capacity of about 70,000 SPU is reached, the installation and use of a digester is more financially viable than a lagoon system. The sale price of the solid by-products of the process affected the financial viability of each option. The digested waste was valued at \$17/tonne or \$9/pig place/year in 2004.

What challenges do producers face?

The pork industry must overcome a number of challenges to achieve its full potential as a sustainable supplier of protein and renewable energy. These include:

- current liquid effluent systems are malodorous, emit large quantities of greenhouse gases and are poorly designed to manage accumulated lagoon sludges,
- some piggeries are failing to use their waste streams sustainably,
- production systems are not always extended to effluent and farm management,
- significant elements of the community perceive intensive animal production to be polluters and inefficient in their use of water, energy and resources,
- there is significant capital outlay required to plan and establish biodigester infrastructure, a long lead time for a return on investment and there are also specific requirements to 'sell' generated electricity back into the grid, and
- further research and development into the value of bioenergy needs to be undertaken and incentives created by governments to encourage pig producers to become more energy efficient and environmentally sustainable operations.



Sludge from a digester:

What is Australian Pork Limited (APL) doing to respond to these challenges?

In 2007, APL assisted the Federal Government to establish the *Methane to Markets in Agriculture Program (M2MA)*. The M2MA Program seeks to assist the commercialisation of on-farm anaerobic digestion. APL has been the largest co-contributor to this program and more than half the funds allocated, up to June 2008, have been to pig-specific projects, or to projects that benefit all industries seeking to implement on-farm bioenergy.

The M2MA collaborative program included Australian Lot Feeders Association, Australian Pork Limited, Dairy Australia, Meat and Livestock Australia, and the Rural Industries Research and Development Corporation, and was seeded with \$1 million of Federal Government funding.

Other research projects underway to complement the M2MA Program are:

- establishment of guidelines for the safe application of piggery waste to pastures,
- refinement of environmental management system (EMS) tools to provide industry with a better understanding of the benefits and costs of different EMS approaches, as well as to build environmentally sustainable piggeries,
- use of lagoon solids on crop yields,
- design of heavily loaded anaerobic ponds,
- low cost alternatives for reducing odour generation, and
- a study on the physical, technical and financial factors that need to be considered by a piggery seeking to generate renewable energy.

APL has also undertaken work to develop life cycle assessment information and tools for the pig industry, in order to provide greater understanding of the environmental challenges and opportunities facing producers. The issues of measurement and labelling are becoming increasingly important in light of regulatory pressures and product labelling trends. More information on these projects is available from APL's research database at www.australianpork.com.au



What role may bioenergy production play in the Carbon Pollution Reduction Scheme?

The introduction of a greenhouse emissions trading scheme in the form of the Carbon Pollution Reduction Scheme (CPRS) in 2011 will necessitate some policy decisions that will have major and long-term implications for the Australian pork industry. The current policy position is that the agriculture sector's inclusion in the CPRS will not be decided until 2013, though government is 'inclined' to include agriculture either directly in the Scheme, or through the use of 'alternative measures' that complement the policy objectives of the Scheme (specifically reduction of greenhouse gas emissions). If included as part of the CPRS, agriculture will not be required to be a direct participant in the Scheme until 2015 at the earliest.

From 2011, the CPRS will have an indirect impact on pork production as inputs and energy costs will rise.

Producers whose operations result in emissions above a specified 'threshold' may have to purchase permits and/or report on their emissions. It is likely that the threshold for being included ('covered') under the Scheme will be progressively reduced over time (meaning that an increasing number of producers are covered and must report on and manage their emissions). If agriculture is covered under a CPRS from 2015, then producers may be able to participate in a carbon trading market.

Next steps

Piggeries provide a valuable niche role in Australia's agricultural production by beneficially reusing and value adding low return agricultural products, by-products and wastes. This means that pork has the potential to be one of the most greenhouse friendly sources of energy for the future. APL's research projects support the industry as it looks to improve productivity and environmental outcomes for producers.



Who is Australian Pork Limited?

Australian Pork Limited (APL) is the national representative body for Australian pork farmers and works with the broader pork industry. It is a producer-owned, not-for-profit company combining marketing, export development, research and innovation, and policy development to assist in securing a profitable and sustainable future for the Australian pork industry.

Additional information, fact sheets and consumer information on various pork related issues can be accessed through APL's website www.australianpork.com.au, or contact APL on freecall 1800 789 099 or email apl@australianpork.com.au

What is the Climate Change Research Strategy for Primary Industries (CCRSPI)?

CCRSPI works through collaboration, coordination and communication.

CCRSPI is a collaborative partnership between all state and territory governments; the rural research and development corporations; experts from the university sector and the Federal Government (through the Department of Agriculture, Forestry and Fisheries and the CSIRO). CCRSPI was set up in recognition of the need for a national response to the challenges of climate change, and the reality that research dollars are better invested when duplication is avoided and knowledge is shared.

APL is a partner of CCRSPI and has been a strong supporter of the need for coordinated research and sharing of knowledge between primary industries in this important topic.

For more information www.lwa.gov.au



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