

BIOENERGY SUPPORT PROGRAM

4C-104/4C-110

Final report prepared for the Cooperative Research Centre for High Integrity Australian Pork

By Stephan Tait ¹

Project contributors: Sasha Jenkins ², Hugh Payne ³, Stephan Heubeck ⁴, Janine Price ⁵,
Alan Skerman ⁶, Rob Wilson ⁷ and Damien Batstone ¹

¹ Advanced Water Management Centre, University of Queensland
Phone: (07) 3346 7208, Mobile: 0466 699 817, Email: s.tait@uq.edu.au

² University of Western Australia, M087 35 Stirling Highway
Crawley, WA 600

³ Department of Agriculture and Food Western Australia (DAFWA), 3 Baron-Hay Court, South Perth, WA
6151, Phone: +61 (0)8 9368 3576, Fax: +61 (0)8 9368 2095, Email: hugh.payne@agric.wa.gov.au

⁴ National Institute of Water and Atmospheric Research (NIWA), Gate 10 Silverdale Road, Hillcrest,
Hamilton, NZ, Phone +64-7-856-1766, E-mail: Stephan.Heubeck@niwa.co.nz

⁵ Australian Pork Limited, Level 2, 2 Brisbane Ave Barton ACT 2600, Australia
Phone: +61 (0)2 6270 8827, Fax: +61 (0)2 6285 2288, Email: janine.price@australianpork.com.au

⁶ Department of Agriculture and Fisheries
PO Box 102, 203 Tor Street, Toowoomba Qld 4350
Phone: +61 (0)7 4529 4247, Email: alan.skerman@daf.qld.gov.au

⁷ Rob Wilson Consulting
5 Beagle Close, Mosman Park WA 6012
Phone: +61 (0)8 9384 9758, Email: rob@robwilsonconsulting.com.au

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Outcomes Overview

Using biogas as a fuel at Australian piggeries is very important to achieve emissions reduction to less than 1 kg CO₂-e/kg pig meat. For this reason, the Pork CRC formed the Bioenergy Support Program (BSP) to promote and support the uptake of biogas across the Australian and New Zealand (NZ) pork sectors. Since the inception of the BSP, 11.8% of the Australia's overall pork industry has adopted biogas technology. This compares to an estimated 1.7% of the overall industry who had been capturing biogas in the prior 20 years. By the end of the present project, one-on-one contact and assistance to producers by the BSP covered an estimated >15% of the pork sector. The capturing and combustion of biogas (in flares, generators or hot water systems) have to date reduced greenhouse gas emissions from pork production by 207,617 tonnes CO₂-e (Federal Clean Energy Regulator, 2016). These emissions savings have earned piggeries an estimated \$2.96M of carbon credit income to date. There are 11 active piggery projects registered under the Emissions Reduction Fund (formerly the Carbon Farming Initiative), which is a federal government platform for tracking and recompensing emissions reduction in agriculture. Additional emissions savings of 698,750 tonnes CO₂-e have been committed under auction (Federal Clean Energy Regulator, 2016) and, if sold at average auction prices, will result in a further \$8.76M of carbon credit income to the pork industry. Also, because as much as 75%-82% of odour emissions from piggeries originate from uncovered manure treatment lagoons (Smith et al., 1999; Camp Scott Furphy Pty Ltd., 1993), the capture of off-gases such as biogas could reduce piggery odour by a similar percentage. The use of biogas to produce electricity at Australian piggeries has also resulted in an estimated \$2.2-2.8M in utility savings to date, with the further income from renewable energy certificates also paying for a large proportion of the on-going running costs of the on-farm biogas systems.

Steered by Pork Producers for Targeted Research to benefit the Pork Industry

The BSP originated out of a producer group affiliated with Australian Pork Limited (APL), which was named the Australian Biogas Group. This group of producers travelled to NZ in 2010 for biogas illustration field days and presentations from NZ producers with biogas systems. These activities sparked great interest in covered lagoon methods of capturing and using biogas on-farm, because the relatively low-cost of such systems appeared to provide attractive payback periods of 3 to 4 years. From its inception, the BSP was steered by a group of pork producers, some of whom were from APL's Australian Biogas Group. These producers on the steering group were themselves planning on using or were already using biogas at their piggeries. These producers were instrumental for the outcomes of the BSP, because they made their piggeries available as Pork CRC biogas demonstration sites providing invaluable data freely for use in Pork CRC communications and research. The demonstration sites paid for and tested biogas technology on-farm to identify options particularly suitable for the Australian context from a cost and technical perspective. In return, the BSP provided additional targeted support to the demonstration piggeries to establish their biogas projects and, once installed, to ensure that the infrastructure became fully operational as soon as possible. Support in this regard included research and testing and expanded advice to a piggery in Victoria (VIC), which was experiencing issues with desludging of a covered lagoon. This formed part of an APL sludge management study at this piggery to which the BSP provided research support, and from which an APSA paper was presented. Another example is where the BSP provided advice during start-up of a covered lagoon at a very large demonstration piggery in New South Wales (NSW), in

particular about microbial seeding. Lastly, the BSP visited and assessed odour at a major breeder piggery in NSW and provided a set of recommendations on effluent management to reduce the odour onsite.

The Carbon Farming Initiative

The learnings at the demonstration piggeries were instrumental to enable the BSP and APL (Janine Price) to work with the federal government and refine a Carbon Farming Initiative (CFI) Method. This same CFI Method has since enabled pork producers to produce and sell carbon credits from biogas capture and use. As noted above, income to date from carbon credits under this Method is estimated at \$2.96M. This carbon credit income greatly facilitated adoption, completely paying for biogas equipment at one larger Pork CRC demonstration piggery, and paying for up to 40% of the capital investment at other demonstration piggeries. One of these other demonstration piggeries achieved payback within 2.5-3.5 years (completely paid back by 2015). With the CFI/Emissions Reduction fund, it was possible to reduce payback periods by 1 to 3 years.

A Central Knowledge Centre

The BSP acted as a central source of information on biogas for producers interested in exploring biogas and developing biogas projects. Information collected from demonstration sites and elsewhere was widely disseminated via Australian Pork Newspaper (nine technical articles), Pork CRC roadshow presentations in all states of Australia and NZ (2012), Carbon Farming Initiative roadshow presentations in all states of Australia and a Carbon Farming Initiative webinar held in Canberra, state-based producer meetings, presentations at the annual Bioenergy Australia conference, quarterly meetings and workshops (2012, 2013, 2014, 2016), workshops affiliated with the carbon abatement modelling tool of APL called PigGas, and presentations at Pan Pacific Pork Expo (2014), VIC Pig Fair (2013), APSA2013 and APSA2015. An expanded Environmental Module was also added to the Pork CRC/SARDI Pig Science Course held annually at Roseworthy, South Australia. These presentations also attracted the broader community of industry, government, regulators and carbon financiers, and thus showcased the progress of biogas in the pork industry and the Pork CRC's impact.

Over the period 2012-2015 it is estimated that the BSP addressed more than 300 individual enquiries about biogas in Australia. This reflects the momentum that was building, with more than a doubling in biogas uptake across the Australian pork sector during the period 2012-2015, as compared to the 20 years before then. One-on-one support to producers included multiple piggery site visits to speak to producers about their site-specific opportunities and effluent management. These site visits were usually timed around major pork industry events to increase the value for money affiliated with travel. Services offered by the BSP were met with producer feedback such as *“(the BSP) has helped us with information and ideas for planning a biogas project at our pig breeding unit...I value the independent advice very highly and the Pork CRC funding for (the BSP) has made this possible.”* Since this feedback, this same producer has gained approval for another major biogas project at a green field grow-out piggery. The BSP also provided advice into that project to reduce project risk.

The BSP further provided direct advice and technical input to suppliers developing commissioned biogas projects for pork producers in Australia. This was considered important to build a critical mass of supplier base to support further uptake of biogas in

the future. One of the major suppliers (not a participant to the Pork CRC) later invested cash in Pork CRC research, which indicated a collaborative relationship built with the BSP.

The BSP further contributed to key industry guidelines such as; Tucker RW and Tait S. (2015). New design guidelines for anaerobic ponds. Australian Pork Ltd Project: 2013/031. Australian Pork Ltd, Barton, ACT, 2600.

http://australianpork.com.au/wp-content/uploads/2013/10/BMP03_NDGA_04_lr.pdf

Engaging with Regulators

The Clean Energy Regulator: The BSP had a positive impact in two main areas dealing with legislation and policy, namely; (1) the Carbon Farming Initiative (CFI) and (2) State-based fuel-gas safety regulations.

During the early days of the CFI, the BSP acted together with APL (Janine Price) on an advisory group of the Clean Energy Regulator for the preparation of extension and explanation materials for producers wishing to participate in the CFI. This quickly developed into a collaborative effort with the Clean Energy Regulator. The BSP toured to all states of Australia with the Clean Energy Regulator on CFI roadshows (WA, SA, QLD, NSW, VIC), delivering technical presentations about biogas on-farm at piggeries with details of actual infrastructure and “the way it’s done”, in support of Clean Energy Regulator staff’s presentations about how the CFI regulatory and administration side works. This involvement with the Clean Energy Regulator was well-accepted as indicated by the following written words; *“I am writing on behalf of the Clean Energy Regulator Carbon Farming Branch to thank you for your contribution to making the first series of our Plan to Practice workshops such a success. The four workshops drew a total of 118 attendees and another 101 tuned in to watch the webinar. There was an overwhelming positive response with many attendees indicating how much they valued your presentation and the opportunity to talk to you directly....The input you provided based on your practical experiencewas invaluable and helped make the guides relevant and appropriate for stakeholders.” Acting General Manager, Carbon Farming Branch, Federal Clean Energy Regulator.*

This collaborative relationship with the Clean Energy Regulator was instrumental in reconsidering the legislation by which piggeries earn carbon credits. The BSP and APL (Janine Price) was then able to work with the Clean Energy Regulator and the Federal Department of Environment to amend the existing legislation as needed, to generate carbon credits while maintaining the technical and scientific robustness of the CFI. The legislation was amended and passed in record time, to allow the first piggery project to successfully create and sell their carbon credits. This same piggery is one of the Pork CRC biogas demonstration sites. Since then, 10 more piggeries registered for the CFI and earned over \$2.96M as indicated above.

Fuel-gas safety legislators: Earlier work by APL identified that fuel-gas safety legislation in Australia could be excessive/impractical for on-farm biogas. The reason being that the regulatory framework had to accommodate both large fuel-gas infrastructure projects and the comparatively small on-farm biogas systems. These discrepancies caused uncertainty about how safety is to be managed/regulated for on-farm biogas systems. To bring clarity, the BSP worked with APL to develop a Code of Practice. The BSP together with APL facilitated a number of workshops with pork producers and gas safety regulators in WA, SA,

QLD, NSW and VIC, to discuss the safety of on-farm biogas and the draft version of the Code of Practice. The Code of Practice was subsequently refined by the BSP and a final version was launched at VIC Pig Fair 2015 by an official hand-over by APL to the Victorian gas safety regulator (<http://australianpork.com.au/wp-content/uploads/2013/09/Aussie-Pork-Industry-Develops-First-Biogas-Code-of-Practice1.pdf>).

The Queensland (QLD) gas safety legislator has since earmarked the Code of Practice for inclusion into state-based gas safety regulations as a preferred standard. The Victorian gas safety legislator has since proposed that the Code of Practice be expanded into a future Australian Standard. In QLD, on-going negotiations between the BSP, APL and the gas safety regulator has sought to make the Code of Practice the basis for safety for on-farm biogas at piggeries in QLD, to reduce or suspend a pending license fee of \$3,731 per site per annum. This fee would be a great disincentive to biogas use, especially at small-to-medium sized piggeries.

Approvals: The BSP also assisted with smaller specific cases (WA, SA, NSW), where piggeries proposed biogas use to reduce odour with current production or proposed expansions. In such cases, the BSP acted as an independent third-party, providing clear and transparent information about the real benefits and limitations of biogas in odour management. This typically strengthened producer claims, and helped regulators (typically regional or local government) to better guide the development and applications, and relieved some of the anxiety around biogas as a new technology to encourage acceptance. As an example, written feedback from the Shire of Kojonup, WA “*Dear, A short note to thank you for taking the time to assist me with my recent council report.....I feel I have learnt a lot more about animal effluent quality - one might suggest an “enriched” appreciation! The piggery expansion has received council approval and is awaiting state environmental approval*”. This same piggery application has since gained state environmental approval, again with input from the BSP.

Identifying and Fostering Targeted Research

Masters research: The BSP developed industry-specific capacity by coordinating an agricultural engineering Masters research project in collaboration with the National Institute of Water and Atmospheric Research (NIWA) NZ, to identify and research low-cost options for cleaning of biogas on-farm. Early estimates suggested that the current cost of cleaning biogas significantly reduced the financial benefit of biogas use. The Masters research project (reported separately) was able to identify low-cost cleaning options which can greatly facilitate biogas uptake and make biogas use much safer. The outcomes of the Masters research were disseminated via a Talking Topic booklet on the Pork CRC website (Talking Topic 4). The research/technology has already been adopted by Pork CRC demonstration piggeries and has been published in an international peer reviewed journal paper (Skerman et al., 2016), with another journal paper currently in preparation.

Uniquely, the Masters research project has given Mr Alan Skerman, Principal Environmental Engineer at the Department of Agriculture and Fisheries QLD (DAF QLD), the opportunity to further develop his skills and knowledge in the biogas area. Alan has now taken over the coordination role of the BSP, while in an on-going extension officer role at DAF QLD. Thus, the longer-term capacity building is likely to benefit the pork industry well beyond the life of the Pork CRC.

Apart from the major financial impact that the BSP has made indirectly via earnings under the CFI, the BSP has also made two additional attempts at raising capital funding through the Federal Government's Extension and Outreach Program, in order to boost biogas demonstration piggery projects, but unfortunately both the Round 1 and Round 2 applications were unsuccessful.

The BSP did successfully raise research funds from other industries including chicken egg production, the meat processing sector, and municipal wastewater treatment sector, to deal with research topics of mutual importance to the pork sector, including anaerobic co-digestion and anaerobic digestion of spent eco-shelter bedding. The Federal government also invested a significant proportion in this collaborative Pork CRC project via the National Agricultural Manure Management Program. Overall, the extent of cash leveraging achieved was 1-part Pork CRC cash to 3 parts Other-party cash.

Lastly, the BSP has value-added to other Pork CRC and APL projects dealing with effluent management at piggeries. Specific examples are the lagoon sludge management study of APL (<https://australianpork.infoservices.com.au/items/2012-1029-REPORT>), and the Z-Filter project of the Pork CRC 4C-112 (<http://porkcrc.com.au/wp-content/uploads/2015/01/4C-112-Final-Report-.pdf>), providing analytical capacity and collaborative technical input to these projects and preparing a scientific paper for each of these project which were presented at APSA2013 and APSA2015.

The remainder of this report provides specific links and details of the project outcomes. Also, resources produced by the BSP can be downloaded from the Pork CRC's website.

Table of Contents

Outcomes Overview	i
1. Introduction.....	1
2. Pork CRC Biogas Demonstration Piggeries.....	2
3. Dissemination of Information	11
4. Engaging with Regulators	14
5. Attempts at Securing External Funding towards Pork CRC Research	15
6. Comparison of Actual Project Activities compared with those Stipulated in the Funding Deed16	
7. Recommendations	21
8. Acknowledgements	21
9. References	21

1. Introduction

The Pork CRC formed the Bioenergy Support Program (BSP) to promote and support the uptake of biogas across the Australian and NZ pork sectors. The roles/purpose of the BSP were to include;

1. being a central source of reputable information,
2. understanding the true economic and technical feasibility of biogas and promoting this to the pork sector in a transparent and clear way,
3. establishing of Pork CRC demonstration sites to showcase feasible infrastructure and approaches to using biogas at piggeries and to provide benchmark data to the pork sector about the Pork CRC's impact,
4. identifying key barriers to adoption of biogas in the pork sector and investigating and identifying possible ways to deal with these barriers,
5. identifying and fostering of Pork CRC research in the area of biogas, and
6. building of longer-term industry capacity via a postgraduate research project.

2. Pork CRC Biogas Demonstration Piggeries

Much of the activity of the BSP has been focussed on establishing operational and cost-feasible biogas demonstration sites at Australian piggeries. The purpose for this included;

1. to showcase biogas to the pork sector, using approaches that are technically and economically feasible for the Australian pork industry;
2. to provide bench-mark data on emissions reduction affiliated with biogas use at piggeries and thus the impact of Pork CRC research on emissions reduction;
3. to trial and potentially validate approaches and technology to handle and use biogas on-farm at piggeries;
4. to achieve early success case studies in terms of benefiting from biogas at piggeries; and
5. to provide relevant information and data that could be used to inform further research and policy development.

As a result of these aims, the demonstration piggeries committed to implementing biogas systems progressively with on-going support by the BSP and specifically aimed to identify low-cost approaches that could work for and make feasible biogas projects at smaller piggeries (<500 sow farrow-to-finish). The resulting financial commitment and sacrifice of these demonstration piggeries should not be underestimated. These demonstration piggeries paid for all the biogas infrastructure that they installed, and yet made data from the operation of the infrastructure freely available for use by the BSP. Because biogas systems were carefully selected with cost-feasibility in mind, progress was slow, and, for one of these piggeries, every month of delay literally costed tens of thousands of dollars' worth of energy savings. The demonstration piggeries further gave free and open access to the BSP to collect extensive footage and data and to interview the producers themselves for the preparation of technical dossier and video materials. The following is a profile of three of these demonstration sites.

Demonstration Site 1

A 2,200 sow farrow-to-finish (22,000 Standard Pig Units or SPU), near Young, NSW. Feed is mostly milled triticale, mixed with dairy and other by-products, dispensed via a liquid feeding system. All conventional flushed sheds, with manure flushed into unmixed unheated covered lagoons. Near-daily direct flushing of shed under floors using pumped recycled effluent from greywater dams. \$980,000 investment in 2011-2012 to build biogas system (Figure 1). 2.5-year payback (fully paid back by July 2015), so biogas use is now financially positive for this piggery as the piggery now has no net energy expenses.

First piggery to register for CFI (now ERF) and the BSP assisted with the registration. About 8,500 tonnes CO₂-e per annum of greenhouse gas emissions abated. Total earnings to date under CFI (ERF) is estimated at \$627,000. Total savings from using biogas energy equals \$180,000 per annum. 60% of electricity produced from biogas onsite is exported to the grid, but unfortunately at a low sale price (additional financial benefit of \$60,000 income per annum).

The piggery operates as an all-in all-out multi-site. Biogas captured at the grower-finisher site is used in two 80kWe internal combustion engine generators, with heat recovered from the generator engines in the form of hot water which is circulated through long delta-pipe radiant heaters to heat weaner sheds. This displaces LPG formerly used at this piggery. Part of the biogas captured at the grower-finisher site is also piped to the breeder site via 3.5km underground pipelines and for a short length under a main public road. One 80kWe internal combustion engine generator at the breeder unit (boosted to 110kWe by recent refurbishment) uses biogas for electricity for heat lamps in the farrowing sheds. Heat is recovered from the engine as hot water circulated through underfloor ceramic heat pads for further heating of farrowing crates.

Before use in the generators, the biogas is treated to remove a corrosive and toxic trace ingredient called hydrogen sulphide, and also moisture. Part of the system used for hydrogen sulphide treatment was developed and demonstrated via Pork CRC research affiliated with the BSP. Further details are provided in Talking Topic 4 on the Pork CRC website (Tait S and Skerman AG (2016). Pork CRC Talking Topic 4 Cleaning piggery biogas).

The area surrounding the covered lagoons and biogas equipment has minimal odour, because odorous gases are contained. The producer has successfully extracted sludge from the covered lagoon using irrigation-style HDPE poly pipe guided into the lagoon sludge layer via a surrounding PVC sludge extraction port. The PVC extraction port protrudes through the pond bank (under the cover trench) and deep into the sludge layer. The advantage of this set-up is that the natural hydraulic pressure from the liquid contents in the lagoon assists in pushing the thick sludge up into the extraction port. Also, the extraction port experiences a much lower pressure than if the sludge was to be drawn up directly through the extraction port connected to a vacuum tanker.

Maintenance of the biogas system includes a generator engine oil change of 1 hour every 500 hours, and about 30 minutes a day for general inspection. The hydrogen

sulphide removal system requires a major clean-out once every 6 to 10 months, with a pressure hose-down of part of the system using fresh water. The sale of renewable energy credits (Large Scale Generation Credits or LGCs) mostly pays for the on-going operating and maintenance costs of the biogas system.

The piggery on-average uses 25% fresh water and 75% bore water for the fresh water supply, but mostly uses treated effluent for flushing and so greatly minimises water use onsite.



Figure 1: Biogas infrastructure at Pork CRC Demonstration Piggery 1

Useful videos showing infrastructure and project activities at Demonstration Site 1:

- <https://youtu.be/KLvSGvw279k>
- <https://www.youtube.com/watch?v=4BASwiMcLJE>

Demonstration Site 2

A 2,000 sow farrow-to-finish piggery (20,000 SPU), near Yarrawalla, VIC. Feed is grain-based dispensed via a liquid feeding system. All conventional flushed sheds, with manure flushed into unmixed unheated covered lagoons. \$900,000 investment to date. Anticipate a further \$800,000 of investment to be completely energy self-sufficient. Estimate \$240,000 to date from sale of carbon credits. It is estimated that this site can use biogas to displace 633,366 kWh per annum electricity and 44,744 L per annum of LPG, potentially worth \$390,000 per annum including carbon and renewable energy credit value.

Biogas treatment uses biology, trialling the same concept as at Demonstration Site 1). Also, passive cooling in underground pipelines is used to save on electricity requirements for operating the biogas system. Only a gradual slope is provided for the 1 km or so long underground pipeline with a condensate collection drum along the way to collect moisture. The pipeline takes the biogas to a different piggery where a 54 kWe biogas generator is located using the biogas to produce hot water for heating of weaner sheds.

With the generator system, the producer worked with a company HydroMax Environmental to develop a modular generator package suitable for 500 sow farrow-to-finish piggeries. The idea was to have a low cost reciprocated motor (piston type) attached to a DC generator with an inverter so that the motor would run (ramp up and down) according to the hot water and electricity demands onsite. The first set-up at the site used a Ford Falcon AU LPG specific motor which could run on a lower biogas quality down to around 42% methane. The engine was fitted with a Dizzy distributor. The electronic ignition system continuously optimises the ignition timing and intensity, the air to fuel ratio as well as camshaft timings to maximise the mechanical power and life expectancy of the engine over a broad range of operating conditions. There was a program designed to control the unit, being able to be monitored and controlled off site if/when needed. The motor responds to the heat requirements and electricity requirements onsite. If the heat requirement is greater than the electricity requirement, the excess electricity is directed to hot water elements in a hot water storage vessel to compliment the heat captured from the motor and generator exhaust. The AU unit was also fitted with a special carburetor and alternatives to the engine water pump and alternator to give more reliable running without belts, having an adequate direct drive. The selected least cost second hand motors allows for replacement and thus reduces the need for costly biogas treatment, because further replacement engines could be acquired for around \$450.00 per motor. The first AU generator engine motor put in place lasted 4,500 hours which at 100km per hour in a taxi equates to 450,000km. This is on top of an unknown previous service history prior to being fitted to the generator. The producer is examining why the motor needed replacing. This set-up provides

54kWe of electricity and 90 to 110 kW of heat energy, which is a suitable size for a 500 sow piggery.

With installations presently going into the other sites of the same piggery, a Ford Falcon BA motor was instead considered as a better option. This is because the BA model is a later model which is easier to access and can accommodate alternative electronic ignition systems. This motor would only be working as required which is especially important where the volume of biogas is limited and where demand fluctuated considerably.

The piggery successfully extracts sludge from the covered lagoon via HDPE sludge extraction pipes (about yearly), but unlike demonstration site 1, this piggery connects a vacuum tanker directly to the sludge extraction port which protrudes through the pond bank (under the cover trench).

Importantly, this site has taken great care in progressively implementing various treatment steps for biogas preparation, ensuring that the incremental investment costs were kept low in order to model a biogas project to be cost-feasible for small-to-medium piggeries (aimed at 500 sow farrow-to-finish). The site has also successfully demonstrated that much of the complexity and parts of a biogas system previously thought to be essential (such as an electrical chiller unit and chemisorption step using purchased iron oxide pellets), may not be needed for an on-farm biogas system at an Australian piggery.



Figure 2: Biogas infrastructure at Pork CRC Demonstration Piggery 2

Demonstration Site 3

This piggery is a breeder unit in QLD, housing 700 sows, with weaned piglets transported to contract grower units. The resulting 1,600 pigs corresponds to 1,400 SPU. The piggery is conventional with a pull-plug effluent system with manure collected in static pits. Effluent is released about weekly and flows by gravity into a partially covered treatment pond. The HDPE floating hood that partially covers the pond captures about 50% biogas produced by the pond, but makes access to sludge very easy because the floating hood can be moved around on the pond surface.

\$259,192 investment in biogas system (2009). It is estimated that the use of biogas at this piggery can displace 1606 MJ/day of LPG, potentially saving \$23,000/annum. The biogas system was originally set-up under the *Rural Industries Research and Development Corporation (RIRDC), Methane to Markets in Agriculture Program*, but has since been extensively used for biogas related research in Queensland and as the main test site for the Pork CRC 4C-104 Masters.

At the site the biogas supply pressure is increased using a blower to 3.5 kPa before the biogas enters underground biogas pipelines to the pig shed where a modified natural gas boiler operates on the biogas. The hot water produced by the boiler is circulated via concrete heat pads in the farrowing house, with this being the only form of heating for little piglets.

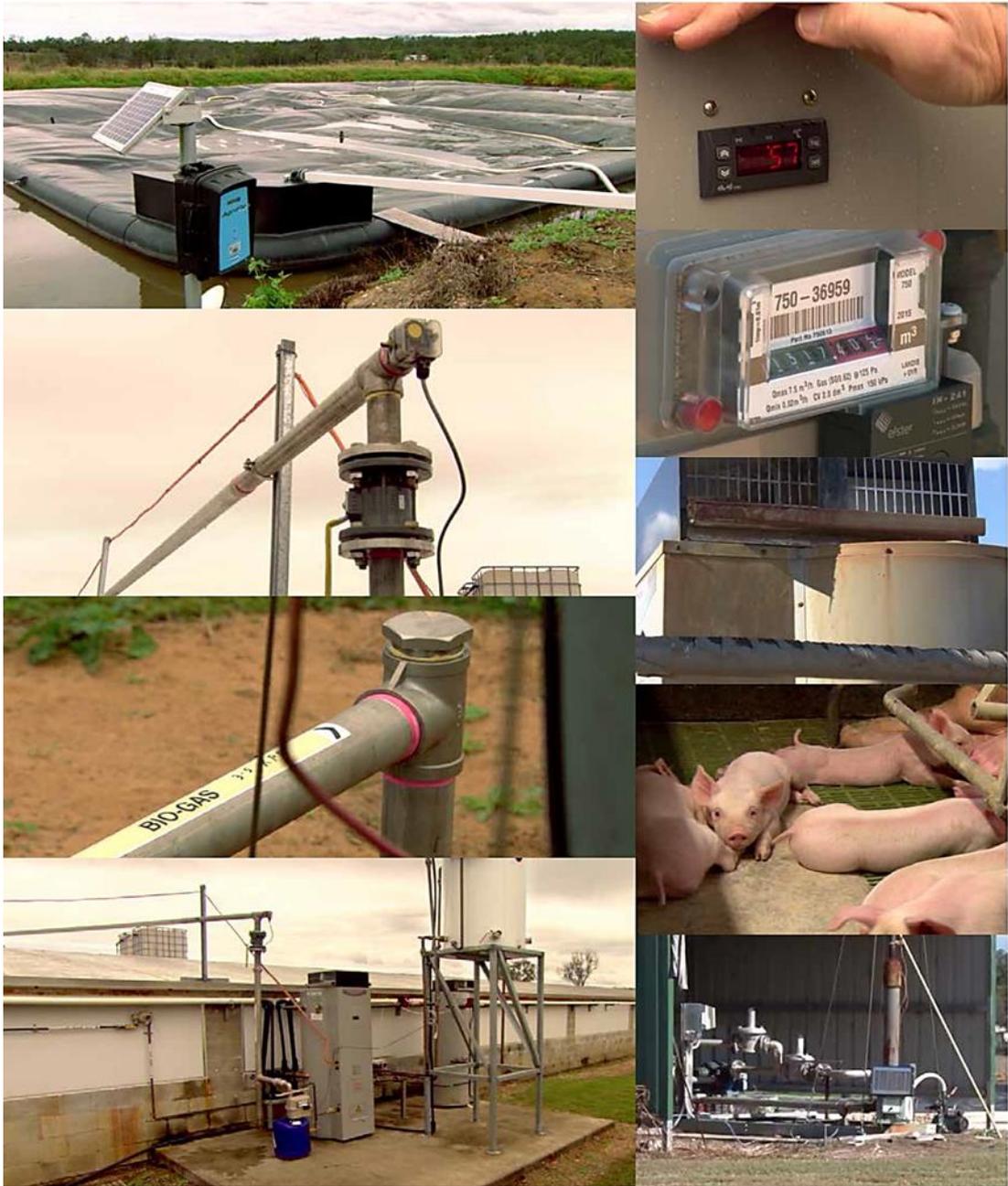


Figure 3: Biogas infrastructure at Pork CRC Demonstration Piggery 3. Some photos are still-shots from footage courtesy Department of Environment, Commonwealth Government.

Other demonstration sites from which information was sourced for Technical Dossier

The following case studies were further developed/assisted and contributed information towards technical dossier of the BSP:

- Medina research station, DAFWA, WA, formerly 150 sow farrow-to-finish with covered lagoon and flare as an illustrative low cost example to industry.
- 5,500 sow breeder unit with weaners sent offsite (12,780 SPUs), NSW. The site has a covered lagoon and flare to proactively reduce piggery odour. This piggery is registered under the Emissions Reduction Fund. To date, this site has abated 5,952 tonnes CO₂-e by capturing and burning biogas from manure treatment.
- 4,800 sow farrow-to-finish (44,000 SPUs), New South Wales. The site has a covered lagoon and flare to proactively reduce piggery odour. This piggery is registered under the Emissions Reduction Fund. To date, this site has abated 58,802 tonnes CO₂-e by capturing and burning biogas from manure treatment.
- Grow-out operation, Victoria (23 000 SPUs). Covered lagoon with enclosed flare for odour management. This site was originally established under the *RIRDC Methane to Markets in Agriculture Program*.
- 300 sow farrow-to-finish, Taranaki, NZ. Direct flush daily with covered lagoon and 40kw internal combustion engine generator.
- 450 sow breeding herd, Wanganui, NZ with covered lagoon and flare. At the time of a site visit, the piggery had underfloor heating installed in farrowing house ready for using hot water produced from biogas, but the biogas system had not been connected yet.

3. Dissemination of Information

The following is a listing of papers and presentations that came specifically from the research of Projects 4C-104 and 4C-110:

1. Tait S and Skerman AG (2016). Pork CRC Talking Topic 3 Covered lagoons.
2. Tait S and Skerman AG (2016). Pork CRC Talking Topic 4 Cleaning piggery biogas.
3. Skerman AG, Heubeck S, Batstone DJ and Tait S (2016). Low-cost filter media for removal of hydrogen sulphide from piggery biogas. *Process Safety and Environmental Protection Official journal of the European Federation of Chemical Engineering: Part B*. Accepted for publication.
4. Skerman AG, Heubeck S, Batstone DJ and Tait S (2015). Alternative low-cost solid media for scrubbing of hydrogen sulphide from piggery biogas. APSA Manipulating Pig Production XV, 22-25 November 2015, Melbourne, Victoria, Australia.
5. Tait S, Payne H, Cole B and Wilson RH (2015). A novel separation system removes solids from pig effluent more effectively than other systems in common use. APSA Manipulating Pig Production XV, 22-25 November 2015, Melbourne, Victoria, Australia.
6. Batstone DJ, Gopalan P, Jensen PD and Tait S (2013). Options for anaerobic digestion of piggery waste manures. *APSA Manipulating Pig Production XIV*, 24-27 November 2013, Melbourne, Victoria, Australia.
7. Tait S, Birchall S and O'Keefe M. (2013). Sizing pumps for desludging of covered piggery ponds. *APSA Manipulating Pig Production XIV*, 24-27 November 2013, Melbourne, Victoria, Australia.
8. Yap M, Tait S, Price J, Wilson R, Ponder S, Jeffrey G, Heubeck S and Davidson A (2015). Australian Pork Limited (2015). *Code of practice for on-farm biogas production and use at piggeries*. APL Project 2011/1013.423. Available at http://australianpork.com.au/wp-content/uploads/2013/10/2011_1013-423-CoP-Final-April15.pdf
9. Tucker RW and Tait S (2015). *New design guidelines for anaerobic ponds*. Australian Pork Ltd Project: 2013/031 - Demonstrations of How to Achieve Best Management Practices - Environmental Management, Australian Pork Ltd, Barton, ACT, 2600.
10. Skerman AG, Heubeck S, Tait S (2014). Alternative biogas purification media for farm installations, International Conference: Progress in Biogas III - Biogas production from agricultural biomass and organic residues, 10-11 September 2014, Stuttgart, Germany.
11. Skerman AG, Heubeck S, Tait S (2014). Developing low cost options for on-farm biogas cleaning at piggeries, Bioenergy Australia 2014 Conference, 1-3 Dec 2014, Glenelg, Adelaide, South Australia.
12. Tait S, Batstone DJ, Astals S and Jensen PD (2014). Biochemical methane potential tests in determining anaerobic digestion process parameters. Bioenergy Australia 2014 Conference, 1-3 Dec 2014, Glenelg, Adelaide, South Australia.
13. Tait S (2014). Biogas. *PigGas Workshop*. 1 July 2014. Kingaroy, QLD, Australia, Invited Talk.
14. Tait S (2014). Biogas. *Pan Pacific Pork Expo*. 21-22 May 2014. Gold Coast, Broadbeach, QLD, Australia, Invited Talk. Available at <http://www.screencast.com/t/1imM72moMJBm>.

15. Tait S (2014). Pork CRC Talking Topic 2 Biogas Safety - the essentials. Available at <http://porkcrc.com.au/wp-content/uploads/2014/11/Talking-Topic-2.pdf>
16. Tait S (2014). It's a gas column - Cleaning up biogas. *Australian Pork Newspaper*, July 2014, 18(7): 8.
17. Tait S (2014). It's a gas column - Safety first, second and third with biogas. *Australian Pork Newspaper*, June 2014, 18(6): 11.
18. Tait S (2013). Pork CRC Talking Topic 1 Collecting the biogas benefits of pig manure. Available online at <http://porkcrc.com.au/wp-content/uploads/2013/11/Bioenergy-Support-Program-Talking-Topic-1.pdf>
19. Tait S (2013). A typical piggery biogas project, Presentation at *the Australian Pork Limited Regulator Consultation Workshops for Code of Practice for On-farm Biogas Production and Use (Piggeries)*. Workshop Co-facilitator; 20 September 2013, Brisbane Queensland; 10 October 2013, Adelaide, South Australia; 11 October 2013, Southbank, Victoria; 17 October, Perth, Western Australia; 14 November 2013, Parramatta, New South Wales.
20. Tait S (2013). It's a gas column - Biogas simply makes sense. *Australian Pork Newspaper*, September 2013, 17(9): 1.
21. Tait S (2013). It's a gas column - Payback time for carbon credited pig producer. *Australian Pork Newspaper*, July 2013, 17(7): 15.
22. Tait S (2013). Biogas energy for an innovative pork industry. *Bioenergy Australia Quarterly Meeting*. 27 June 2013, The University of Queensland, Brisbane, QLD, Australia. Invited Talk.
23. Tait S (2013). Technical aspects of a piggery biogas project. *Clean Energy Regulator Carbon Farming Initiative Roadshows*. 14 June 2013, Medina, Western Australia. Invited Talk.
24. Tait S (2013). Technical aspects of a piggery biogas project. *Clean Energy Regulator Carbon Farming Initiative Roadshows*. 7 June 2013, Roseworthy, South Australia. Invited Talk.
25. Tait S (2013). A piggery biogas project. *Clean Energy Regulator Carbon Farming Initiative Roadshows*. 17 May 2013, Toowoomba, Queensland, Australia. Invited Talk.
26. Tait S (2013). Invited technical panel member for *Carbon Farming Initiative Webinar by the Clean Energy Regulator*, 8 May 2013, Canberra, Australia.
27. Tait S (2013). It's a gas column - Put your foot on the gas with Carbon Farming Initiative. *Australian Pork Newspaper*, April 2013, 17(4): 14.
28. Tait S (2013). A piggery biogas project. *Clean Energy Regulator Carbon Farming Initiative Roadshows*. 23 April 2013, Young, New South Wales, Australia. Invited Talk.
29. Tait S (2013). A piggery biogas project. *Clean Energy Regulator Carbon Farming Initiative Roadshows*. 17 April 2013, *Victoria Pig Fair*, Bendigo, Victoria. Invited Talk.
30. Tait S (2012). It's a gas column - Pork CRC mastering biogas. *Australian Pork Newspaper*, December 2012, 16(12): 7.
31. Tait S (2012). It's a gas column - Keeping a safe watch on biogas. *Australian Pork Newspaper*, September 2012, 16(9): 8.
32. Tait S (2012). It's a gas column - Biogas options now on table. *Australian Pork Newspaper*, August 2012, 16(8): 14.
33. Tait S (2012). It's a gas column - The business of biogas. *Australian Pork Newspaper*, July 2012, 16(7): 1.

34. Tait S (2012). Update: Biogas use at Australian piggeries. *Bioenergy Australia Conference 2012*. 26-27 November 2012. Melbourne, VIC, Australia.
35. Tait S (2012). Pork CRC Bioenergy (Biogas) Support Program. 30 November 2012, *Pork CRC Roadshow presentation*, Palmerston North, New Zealand.
36. Tait S (2012). Pork CRC Bioenergy (Biogas) Support Program. 27 November 2012, *Pork CRC Roadshow presentation*, Christchurch, New Zealand.
37. Tait S (2012). Pork CRC Bioenergy (Biogas) Support Program. 18 September 2012, *Pork CRC Roadshow presentation*, Shepparton, Victoria, Australia.
38. Tait S (2012). Pork CRC Bioenergy (Biogas) Support Program. 12 September 2012, *Pork CRC Roadshow presentation*, Young, New South Wales, Australia.
39. Tait S (2012). Pork CRC Bioenergy (Biogas) Support Program. 11 September 2012, *Pork CRC Roadshow presentation*, Longford, Tasmania, Australia.
40. Tait S (2012). Pork CRC Bioenergy (Biogas) Support Program. 5 September 2012, *Pork CRC Roadshow presentation*, Roseworthy, South Australia, Australia.
41. Tait S (2012). Pork CRC Bioenergy (Biogas) Support Program. 31 August 2012, *Pork CRC Roadshow presentation*, Perth, Western Australia, Australia.
42. Tait S (2012). Pork CRC Bioenergy (Biogas) Support Program. 27 November 2012, *Pork CRC Roadshow*, Christchurch, New Zealand.

Other prominent industry reports influenced by BSP information:

1. Climate Works Australia (2013). Tracking progress towards a low carbon economy. Available at http://www.climateworksaustralia.org/sites/default/files/documents/publications/climateworks_trackingprogress_land_full_report_july_2013_1.pdf.

4. Engaging with Regulators

Figure 4 and Figure 5 show the title pages of the Carbon Farming Initiative legislation developed with BSP technical support and the Code of Practice for On-farm Biogas Production and Use (Piggeries) (2015), co-developed by the BSP.



Figure 4: Front-page of Carbon Farming Initiative legislation developed with BSP technical support, available at:

<https://www.legislation.gov.au/Details/F2015C00574/Download>

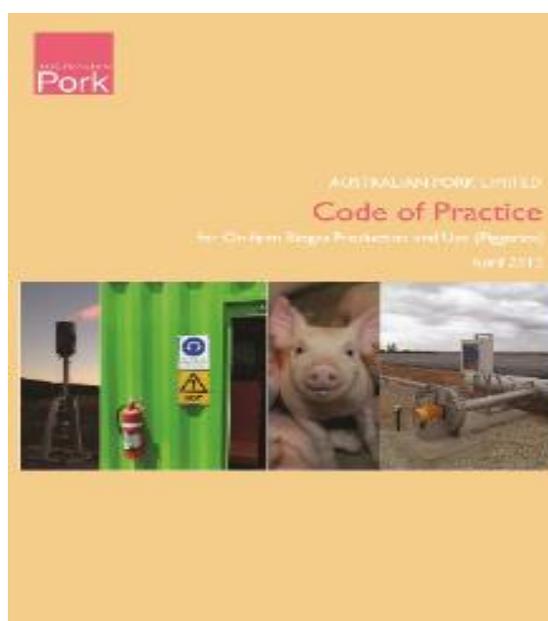


Figure 5: Front cover of the Code of Practice for On-farm Biogas Production and Use (Piggeries) (2015) co-developed by the BSP, available at:

http://australianpork.com.au/wp-content/uploads/2013/10/2011_1013-423-CoP-Final-April15.pdf

5. Attempts at Securing External Funding towards Pork CRC Research

The following were attempts at securing external funding to support Pork CRC research and demonstration sites.

Successful

- *Anaerobic treatment for emissions reduction from solid manure residues.* Filling the Research Gap Round 2. National Agricultural Manure Management Program. Federal Department of Agriculture and Water Resources (\$331,800 cash), Australian Egg Corporation Limited (\$10,000 cash), Quantum Power Limited (\$15,000 cash, In-kind \$15,000), Pork CRC (\$40,000 cash, In-kind \$112,500). Australian Pork Limited (In-kind \$15,000), Addresses Pork CRC Milestone 4.5.6.
- *Enhanced Energy Recovery in Australian Industry through Anaerobic Co-digestion.* Collaborative Research Project. Australian Meat Processor Corporation (\$150,000 cash), Queensland Urban Utilities (\$170,000 cash), Melbourne Water Corporation (\$60,000 cash), Pork CRC (\$150,000 cash). Addresses Pork CRC Milestone 4.5.3.

Unsuccessful

- *Sustainable Industry through Anaerobic Co-digestion.* Queensland Accelerate Partnerships Project. QLD Department of Science, Information Technology, Innovation and the Arts. Australian Meat Processor Corporation (\$150,000 cash), Queensland Urban Utilities (\$50,000 cash), Melbourne Water Corporation (\$50,000 cash), The University of Queensland (\$68,000 cash), Pork CRC (\$150,000 cash).
- *Hydrothermal processing of solid manures to reduce agricultural GHG emissions.* Filling the Research Gap Round 2. National Agricultural Manure Management Program. Federal Department of Agriculture and Water Resources (\$331,800 cash), Australian Egg Corporation Limited (\$10,000 cash), Quantum Power Limited (\$15,000 cash, In-kind \$15,000), Pork CRC (\$40,000 cash, In-kind \$112,500). Australian Pork Limited (In-kind \$15,000).
- *Advancing uptake of emissions reduction initiatives at piggeries.* Carbon Farming Futures, Extension and Outreach Round 2 (2013). Federal Department of Agriculture, Fisheries and Forestry (\$347,000 cash), Pork CRC (In-kind \$65,000), Australian Pork Limited (In-kind \$19,000).
- *Streamlined delivery of the Carbon Farming Initiative at Australian piggeries.* Carbon Farming Futures, Extension and Outreach Round 1 (2012). Federal Department of Agriculture, Fisheries and Forestry (\$432,500 cash), Pork CRC (\$86,500 cash, \$48,200 In-kind), Australian Pork Limited (\$5,500 cash, In-kind \$12,800).

6. Comparison of Actual Project Activities compared with those Stipulated in the Funding Deed

Table 1 compares the scope of actual completed project activities, with the scope of activities as defined in original Funding Deed.

Table 1. Comparison of actual project activities with that stated in the Funding Deed.	
Funding Deed(s) for Projects 4C-104 and 4C-110	Actual Project Activities Carried Out
<p><u>Feasibility Assessments</u></p> <ul style="list-style-type: none"> Collaborate on project 4C-102 to develop a framework for feasibility study development and demonstrate this on two sites as case studies. Carry out sustainability and feasibility assessments of technology options and projects with cost-benefit analysis for both conventional and deep litter waste systems. 	<ul style="list-style-type: none"> As stated. Also summarized outcomes from 4C-102 in Talking Topic 1. As stated. Also developed a feasibility calculation spreadsheet tool which was calibrated using demonstration piggery data and subsequently used to provide advice to other piggeries exploring/developing biogas projects. A cost benefit analysis for spent litter waste was carried out via spin-off research in Project 4C-111.
<p><u>Collation and dissemination of information</u></p> <ul style="list-style-type: none"> Conduct on farm visits in Australia and NZ and compile supplier and technical dossiers on baseline information for use by the Biogas Groups and the wider pork industry. Identify and review appropriate suppliers of biogas generation systems and components for use by industry following feasibility recommendations. Deliver two industry information sessions to provide detailed information on AD biogas generation and utilisation systems. Disseminate biogas systems information to the Biogas Groups and wider industry to enhance adoption of AD biogas generation and utilisation. Provide a database and technological assessment of equipment and service providers. Presentations at the Annual Pork CRC pig production course, APL/Pork CRC roadshows, at state-based producer meetings, APL/Pork CRC Technical update Oct. 2014, PPPE May 2014. 	<ul style="list-style-type: none"> As stated. See Section 3 for Technical Dossier. As stated. Supplier details provided as a listing as/when requested by producer enquiries. As stated. See Section 3 for Presentations. As stated. See Section 3 for Technical Dossier and presentations also to wider community. Very active collaboration with the producers in the Australian Biogas Group. Technical information provided to the Clean Energy Regulator led to the successful revision of Carbon Farming Initiative legislation as noted above. Supplier details provided as a listing as/when requested by producer enquiries. As stated and as detailed in Section 3.

<ul style="list-style-type: none"> • Monthly biogas columns to Australian Pork Newspaper. • A web-based video with technical information will be prepared in conjunction with a professional marketing firm. The video will make use of professional video-photography, voice-over technical commentaries, and animation (where required to visually communicate about hidden infrastructure) to highlight the requirements of a CFI project at a piggery. The video will include a walkthrough of the infrastructure at a piggery demonstration site, explaining the key elements of the carbon abatement project, and the CFI registration, monitoring. A link to the video will be published on the Pork CRC Biogas Support Program website, and in the monthly Australian Pork Limited Technology Transfer & Adoption Network e-mail. 	<ul style="list-style-type: none"> • As stated and as detailed in Section 3. • https://www.youtube.com/watch?v=4BASwiMcLJE
<p><u>Engaging with Regulators</u></p> <ul style="list-style-type: none"> • Auditor training and support to Clean Energy Regulator. • Work with the Clean Energy Regulator and the federal Department of Environment to amend/correct the piggery Carbon Farming Initiative (CFI) methodology determination. Contribute to the CFI user group, providing technical peer review on publications around piggery biogas. Run 4 workshops on piggery biogas projects and the CFI, working through the requirements of the two CFI rule books for piggeries. • Guiding regulatory development process around biogas safety. Support Australian Pork Limited with technical advice and by preparing safety factsheets and information to guide negotiations around safety legislation. The BSP will continue to act as technical advisor to APL on development of the Biogas Safety Code of Practice document. 	<ul style="list-style-type: none"> • As stated, except that support was instead provided directly to the Clean Energy Regulator. • As stated. • As stated.
<p><u>Technical support</u></p> <ul style="list-style-type: none"> • Provide guidance on specific issues such as pond management, gas utilisation and compliance and process monitoring. • Provide advice to reduce operational and financial risk, enhance value of co-products and services associated with biogas systems. • Provide engineering operational support and ‘troubleshooting guides’ to monitor the health of ponds and nutrient recovery infrastructure. • Provide technical advice and training to producers and commercial equipment and system providers. 	<ul style="list-style-type: none"> • As stated. • As stated. • As stated. As a specific example, one specific site visit to the largest Australian piggery with a biogas system involved a discussion and recommendations about a suitable sampling and monitoring campaign. • As stated.
<p><u>Pursue and foster targeted research and funding</u></p> <ul style="list-style-type: none"> • Identify and assess relevant funding opportunities available to producers and service or equipment suppliers. • Develop industry-specific capacity through support to engineering or agricultural Masters or PhD students. 	<ul style="list-style-type: none"> • As stated. See Section 5 for further details. • As stated.

<ul style="list-style-type: none"> Raising capital and developing low-cost flagship projects. 	<ul style="list-style-type: none"> As stated. See Section 5 for further details.
<p><u>Project steering</u></p> <ul style="list-style-type: none"> Industry steering committee. This will meet twice in a year (one face-to-face and one teleconference). A quarterly update memo will be sent to members of the steering committee. A steering committee will oversee the development and direction of the project. 	<ul style="list-style-type: none"> As stated, except that some formal meetings were instead replaced with one-on-one site visits and extensive e-mail and phone input into the compiled technical dossier.
<p><u>Supplier growth and development.</u></p> <ul style="list-style-type: none"> The BSP will work with suppliers that have proposed to the pork industry, to refine and tailor project scope and help clarify the needs and characteristics of the pork industry. The BSP will facilitate correspondence between interested producers and suppliers. The BSP will peer review design calculations and proposals to do engineering health checks, to ensure that the numbers are in the right ballpark and to reduce technical risk. The BSP will maintain independence. 	<ul style="list-style-type: none"> As stated.

Table 2. Comparison of actual project outcomes with proposed/stated in the Funding Deed.	
Funding Deed(s) for Projects 4C-104 and 4C-110	Actual Outcomes
<ul style="list-style-type: none"> Independently compiled technical dossier on AD biogas systems as case studies that will enable the Biogas Group and early adopters to better understand the technical and commercial challenges and opportunities. Independently compiled dossier on AD biogas generation and utilisation system components suppliers. Co-ordinate with 4C-102 on feasibility studies for the Biogas Group and compilation of recommendations into a workable framework for future options and feasibility studies. Two biogas information dissemination and training meetings to the Biogas Group and early adopters of the technology. Other information articles to the wider industry. Delivery of practical industry information on AD biogas technologies and best practise. Identification of opportunities and gaps (including funding and research) for Bioenergy technologies in the Australian Pork Industry to foster innovation within the industry. Website, fact sheets or booklets addressing topics such as: Background to Bioenergy, Challenges for development, Wet wastes-issues and opportunities, How much energy can be developed?, Types of systems/technologies and costs, Production methods- (AD overview, direct combustion, Co-gen), Developing a project, Getting started, Things to consider i.e. site selection and feasibilities, Connecting to grid, Economics on what options are suitable for what size farm, Planning and environmental issues, General energy conversions. Information and advice on funding opportunities and support for biogas systems i.e. Carbon Farming Initiative. 	<ul style="list-style-type: none"> As stated. See Section 3 for details. As stated and as detailed in Section 3. As stated. As stated, except with multiple biogas information sessions, with extensive one-on-one discussions with producers about biogas. As stated and as detailed in Section 3. As stated and as detailed in Section 3. As stated and as detailed in Section 5. As stated and as detailed in Section 3. As stated.

<ul style="list-style-type: none"> • One-on-one advice to producers on questions relating to Biogas including pond management, gas utilisation, compliance, monitoring, design, construction, feasibilities and trouble shooting. • An analytical and diagnosis service (including sampling kit). • At least two case studies including feasibility (including CFI calculations), analytical, technical, financial, gas management, compliance and monitoring, which will draw on a Masters to be completed in connection with the project. • Sustainability and feasibility assessments of technology options and projects with cost benefit analysis for both conventional and deep litter systems. • Two training days for service and equipment suppliers and for producers. • A database containing technical assessment of service and equipment suppliers • Industry road shows/forums/presentations where invited and/or organised by Pork CRC/ APL. • At least two articles in industry communication channels ie pork it up, CRC newsletter, Australian Pork Newspaper. • Supervisory role for an engineering or agricultural Masters student. • Co-chair the Pork Biogas Group. • Biogas information sessions/training meetings in VIC, NSW, SA, QLD. One session in each state, each year of the two-year project. • Australian Pork Newspaper monthly biogas column • APSA paper • Capital grant funding for two piggery projects • Identification of opportunities and gaps for targeted research and applying for external funding to foster biogas technology in the Australian Pork Industry 	<ul style="list-style-type: none"> • As stated. Also developed the Code of Practice in collaboration with APL. • As stated. Analytical support included testing of methane potential for manure samples, testing of chemical composition and testing of biogas composition. • As stated. See Section 2 for details. • As stated. Also developed a feasibility calculation spreadsheet tool which was calibrated using demonstration piggery data and subsequently used to provide advice to other piggeries exploring/developing biogas projects. A cost benefit analysis for spent litter waste was carried out via spin-off research in Project 4C-111. • As stated, except that training of equipment suppliers primarily occurred via one-on-one contact and via presentations at Bioenergy Australia conferences. • As stated. Supplier details provided as a listing as/when requested by producer enquiries. • As stated and as detailed in Section 3. • As stated and as detailed in Section 3. • As stated. • As stated. • As stated and as detailed in Section 3. • As stated and as detailed in Section 3. • Two APSA papers, as detailed in Section 3. • Impact was via the Carbon Farming Initiative and by funding as sought/secured per Section 5. • As stated and as detailed in Section 5.
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<ul style="list-style-type: none"> • Regular updates to website, fact sheets or booklets addressing biogas topics • Updated/Amended CFI Methodology Determination for piggeries • One-on-one advice to producers on questions relating to biogas including pond management, gas utilisation, compliance, monitoring, design, construction, feasibilities and trouble shooting • Guideline for the design and operation of low-cost biogas cleaning systems - Masters Research Outcome • Four auditor training workshops <ul style="list-style-type: none"> • An updated database containing technical assessment of relevant service providers and equipment suppliers <ul style="list-style-type: none"> • Industry road shows/forums/presentations where invited and/or organised by Pork CRC/APL/other relevant • Web-based video training material • Live support to operational demonstration sites, including analysis of process monitoring data and troubleshooting, including analytical support • Extension of relevant research outcomes and findings on biogas to the pork industry 	<ul style="list-style-type: none"> • As stated and as detailed in Section 3. • As stated • As stated • As stated. Given in Talking Topic 4. • Did not proceed. This was discussed with the Pork CRC (Roger Campbell) and agreed to replace with extensive one-on-one training of producers and the presentation sessions detailed in Section 3. • As stated. Supplier details provided as a listing as/when requested by producer enquiries. • As stated and as detailed in Section 3. • As stated. • As stated. See also Section 2. • As stated. As detailed also in Section 3.
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7. Recommendations

It is recommended that a web-based platform of resources collated by the Bioenergy Support Program be regularly updated (at least annually) within the life of the Pork CRC, and then subsequently transferred to the Australasian Pork Research Institute Limited (APRIL) to be maintained as a web-based resource.

It is further recommended that the Pork CRC and subsequently APRIL maintain the technical support role of the BSP via Mr. Alan Skerman based at QLD DAF.

8. Acknowledgements

The following participating producers and contributors are thanked for their contributions of various types to the BSP; Tom Smith (Kia-Ora Piggery, Victoria), Don KRC Victoria, Scott Birchall (AgSystems Design), Edwina and Michael Beveridge (Blantyre Farms, NSW), Alan Skerman (DAF QLD), Janine Price (APL), Rob Wilson (Pork CRC, Westpork WA), Rivalea Australia (Mark Hogan/Ian Longfield), Hugh Payne (DAFWA, Medina Research Station).

9. References

Camp Scott Furphy Pty Ltd (1993). Danpork Australia Pty Ltd - Integrated Pork Processing, Marketing and Production Facility - Environmental Impact Statement, July 1993.

Federal Clean Energy Regulator (2016). <http://www.cleanenergyregulator.gov.au/ERF/project-and-contracts-registers/project-register>. Website accessed 06/12/2016.

Smith, R.J., Dalton, P. and DeBruyn, J. (1999). Assessment and Reduction of the Odour Impact of Piggeries - Final Report. Pig Research and Development Corporation, Canberra, Australian Capital Territory.

Skerman AG, Heubeck S, Batstone DJ and Tait S (2016). Low-cost filter media for removal of hydrogen sulphide from piggery biogas. *Process Safety and Environmental Protection Official journal of the European Federation of Chemical Engineering: Part B*. Accepted for publication.