

Introduction

In December 2008, the Energy Efficiency and Conservation Authority (EECA) agreed to part-fund a coordinated programme of biogas feasibility studies and dissemination activities within the NZ pork industry. The project was scoped as part of a three-way collaboration between industry (NZPork and producers), EECA and MAF designed to support the assessment and uptake of farm biogas systems to deliver on climate change and renewable energy objectives.

Project Selection

Fourteen applications were received and assessed against selection criteria designed to achieve a representative spread across regions, system types, scale of operation, and sector/community linkages. The final selection of projects comprised:

- North Island: three projects at a range of scales (small, medium, large), two of which were mixed pig and dairy farms
- South Island: a large pork production farm, and the Canterbury “Hub” project (sponsored by a consortium of five producers and the Corrlands farm).

The feasibility studies canvassed three system options:

- Covered pond systems
- Independent tank digester
- Multi-stakeholder, mixed feedstock system.

Feasibility Studies

The feasibility studies describe the technical and financial feasibility of biogas recovery systems specific to the farm/project. Core data includes:

- Manure analysis (especially volatile solids (VS), i.e. the “digestible” material)
- Sizing the digestion facility (pond or tank capacity)
- Methane production and energy potential matched to farm/facility usage
- Capital costs of digestion chambers (pond or tank)
- Options and costs for recovery of heat energy or conversion to electricity
- Estimates of payback periods

Canterbury “Hub” Feasibility Study Results

The Canterbury “Hub” project was an industry partnership to explore the feasibility of a centralised biogas facility:

- Sourcing pig manure and other “waste” products from a radius around a large farm in close proximity to Christchurch
- Supplying energy for heat, and fertiliser for farm and horticulture operations.

The feasibility study analysed feedstock, developed a concept design and presented rough order costs and returns. The results of the feedstock analysis are shown below:

Pig Farms	Flowrate t/day	VS t/day	VS	Biogas m³/day
1M (fresh, thick)	45	4	9%	2,200
3R (fresh)	17	1	7%	600
4T (reasonably fresh)	13	1.7	13%	900
5C (thickened 200%)	12	1	9%	600
2 (pull-plug, 70 days old)	Not incl.			

The volatile solids (VS) in these samples are reasonably concentrated but pig slurry is still a relatively high volume, dilute feedstock. The proposed feedstock recipe supplements pig slurry with selected high protein/high fat “waste” materials as follows:

Feedstock	Flowrate t/day	VS t/day	VS	Biogas m³/day
Pigs x4	88	8	9%	4,300
Other x5	12	4	33%	2,700

The high fat loading in the feedstock recipe (over 30%) can potentially inhibit the digestion process. The concept design provides for conservative sizing/retention time to ensure a stable digestion process; and all key steps are designed with redundancy (safety factor of 2). The increased capital costs (summarised below) are intended to be balanced against increased gate fees (for receipt of incoming industrial waste), and increased biogas production.

Canterbury “Hub” concept design	Rough order costs (+20%, -10%)
Planning & consent fees	Not included
Design & project management	\$1.2m
Feedstock reception & pasteurisation	\$1.3m
Digester tanks x2	\$1.2m
Digestate storage (slurry form)	\$0.4k
Biogas boiler, gas connects, misc.	\$0.9k
Total capital	\$5 million

Operating costs and revenues are structured to deliver a win to each participating party:

- Pig manure: paid for at a rate based on the nutrient content (less transport costs)
- Industrial waste: charged gate fees (set at 80% of current disposal costs)
- Sale of biogas for heating (at rate less than cost of diesel)

Canterbury “Hub” operating revenue/costs	
Annual income (gate fees, sale of biogas, fertiliser)	\$1.5m
Annual expenditure (transport, manure payments, labour)	\$0.6m
Earnings before interest, tax, depreciation	\$0.9m
Simple payback	5.8 years

Farm Study Results

The results of the four farm projects are summarised below (numbers rounded off):

	450 sows farrow to wean	500 sows farrow to finish	1000 sows farrow to finish	1000 sows farrow to finish
Daily effluent	50m ³	100m ³	300m ³	200m ³
Volatile solids	0.8%	1.0%	0.5%	1.0%
Pond or Tank	New Pond	Pond Cover	New Pond	Tank
Capital Cost	\$50k	\$75k	\$170k	\$1.2m
Daily Power Use	600kwh	1100kwh	2000kwh	
Annual Power	200,000kwh	400,000kwh	800,000kwh	
Annual Cost	\$40k	\$100k	\$130k	\$130k
Daily Methane Production	80m ³	150m ³	350m ³	
Methane Use	Boiler	CHP	Genset Recon.	CHP & assoc.
Capital Cost	\$30k	\$60k	\$20k	\$800k
Daily Energy Potential	800kwh heat	400kwh elec (+700 heat)	1000kwh elec (+ 1700 heat)	
Total Capital	\$80,000	\$135,000	\$150,000	\$2m
Net earnings pa	\$13,000	\$20,000	\$30,000	Not comparable
Payback	3.8 years	3.5 years	3.8 years	Not comparable

Discussion of Results

A key factor driving the capital costs of digestion chambers (pond or tank) is the dilute nature of slurry from flush-down housing systems, requiring increased capacity to achieve reasonable retention times (for digestion of the solids). An alternate approach to boost biogas production from a given digestion capacity is to introduce other more concentrated feedstock materials (as in the “Hub” project). This option was assessed in two of the farm feasibility studies, but in both cases was discounted due to a concern to focus on core business and protect farm bio-security.

Covered pond systems offer reasonably easy integration into existing farm systems (particularly in the North Island); reasonably attractive pay-back periods; and the decided advantage of “piggy-backing” on the experience of the early adopters within the pork industry (in Waikato and Taranaki). Farm-scale uptake in other regions (especially those subject to “deep-freeze” conditions) is likely to depend on a convergence of:

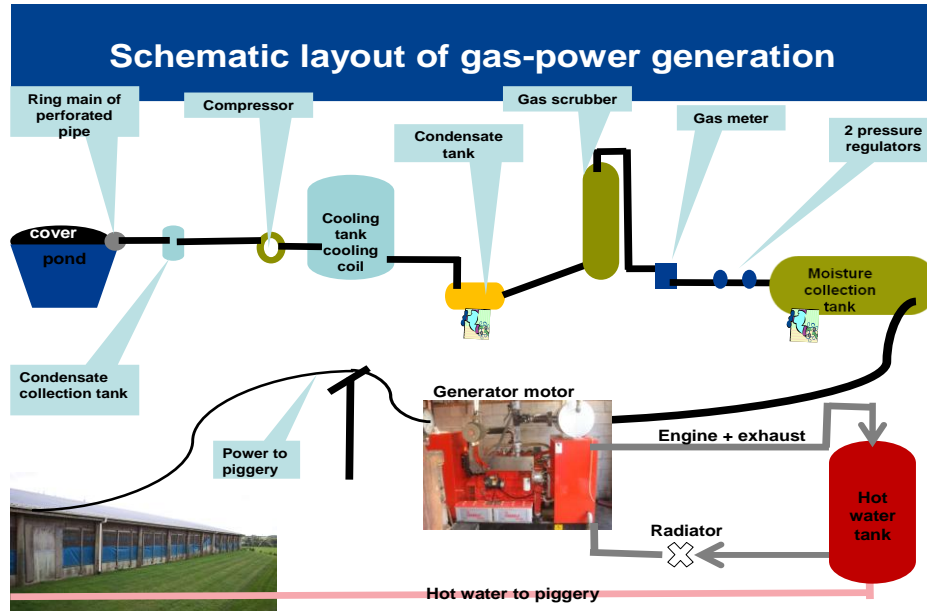
- Farm systems with more concentrated slurry (eg, scrape-down systems)
- Development of robust and cost-effective tank or pond solutions to maintain the integrity and performance of pipes and chambers under climatic extremes.

In all cases, the farm studies undertaken highlight the need for biogas recovery systems to be integrated into whole farm system planning, for example:

- Reducing water usage and storm-water infiltration to reduce digester sizing
- Analysing energy efficiencies and tariff schedules to optimise payback on biogas energy generated.

Operational Farm System

In parallel with undertaking the feasibility studies, an EECA Energy Intensive Business Grant was made to assist the establishment of a covered pond biogas recovery system on a Taranaki pig farm (400 sow farrow to finish). The system is recently operational, with the potential to supply a significant portion of farm power needs.



Waste heat is not currently being utilised (for every kw of electricity, approximately 2kw of waste heat is generated) but future plans include expanding the system to recover waste heat and reticulate hot water to partially replace electric heating units in the piggery. Details are summarised below: note figures presented for the new system are conservative – they are derived from the first months running which included commissioning and some venting of the pond.

400 Sows	Old System	New Biogas Use System	Add Heat Recovery
Annual Power Use	340,000kwh	240,000kwh	66,000kwh
Annual Cost	\$80,000	\$58,000	\$15,000
Total Capital		\$140,000	\$45,000
Payback		5.9 years	2.8 years

Further Information

Project details were presented at seminars convened in Taranaki (March 2010) and Canterbury (April 2010); with both seminars well-attended by farming, industry and government stakeholder groups.

Full copies of the five feasibility studies can be found at:

www.nzpork.co.nz/Environment/Biogas.aspx

The results of the Taranaki biogas recovery project will be available shortly at:

www.eecabusiness.govt.nz/case-studies

Further details of government/industry funding assistance can be found at:

www.eecabusiness.govt.nz/services-and-funding/technology-grants