Fact Sheet – Biogas Production

What is the product?

Anaerobic digestion of wastes is a process similar to that which occurs in the human gut. Organic materials are broken down, resulting in the production of solid wastes, liquid wastes, and gas. In this case the solid and liquid wastes are useful fertilisers, while the gas can be used in energy generation.

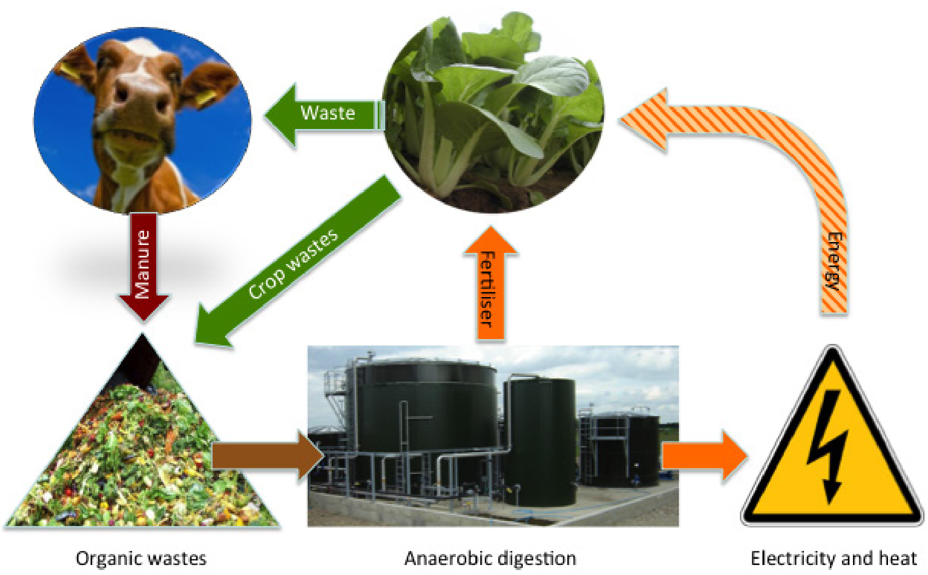
To generate biogas, organic materials are <5mm size pieces, seeded with bacteria and warmed under anaerobic conditions (without oxygen) in a large digester. The bacteria break down the carbohydrates, oils and fibre (referred to as “volatile solids” - VS) in the materials.

Digestion produces a range of breakdown products, including alcohols, organic acids and carbon dioxide. Specialized methanogen bacteria then break down these compounds further, producing methane gas.

Biogas generally contains around 50 – 70% methane, most of the remainder being CO_2. The biogas can be readily turned into electrical power using a generator. Heat produced by combusting biogas in a Combined Heat and Power (CHP) generator can be used to continue heating the digester.

Biogas production technology originally grew from the need to dispose of municipal wastes, manure and sewage. However, it is increasingly used in agriculture.

For example, there are already over 6,500 biogas plants in Germany alone, the majority of which are medium sized, farm-based systems which average 300kW of installed electrical generation capacity (ie 300kW per hour at full operation).



What is the benefit to vegetable growers?

Vegetable wastes are particularly suitable for anaerobic digestion as they have a high moisture content (75-90%), and are easily biodegradable.

Production of biogas from vegetable waste is up to 7x more than produced by pig or cow manure alone. Many studies have demonstrated that the technology is feasible.

Crop	Biogas (m^3 / kg VS)
Sugar beet	0.75
Fodder beet	0.78
Corn	0.61
Corn cobs and husks	0.67
Carrots, beans and eggplant	0.58
Mexico City produce market wastes	0.42

As well as gas, the process generates a mixture of solid and liquid waste referred to as digestate. The liquid part can be diluted and used as part of a hydroponic solution or applied through fertigation. Solids make a useful soil conditioner or mulch.

As nutrients such as N, P and K are preserved during anaerobic digestion, the composition of solid and liquid outputs from the system will strongly reflect the feedstock materials.

Materials and equipment required

Anaerobic digestion systems vary in complexity; there are single and multiple stage digesters and static and continuous processing systems. The main part of an anaerobic digestion system is basically a tank and pipes, with the more complex part involving how the gas is used and the scale of the operation.

The system requires continual inputs of organic materials to function well. It is likely that the minimum size system would require at least **10t / day** of raw materials, although it could be more if materials have a low VS content (lettuce, for example). Intake can vary so as to increase during peak periods.

One useful characteristic of biogas is that it can be accumulated in storage and used when needed. For example, if electricity use is highest during the day

due to packhouse / refrigeration requirements, then gas can be accumulated overnight and used to generate electricity to meet that demand. It is also possible to link the biogas generator with the refrigerant system used for coolstores so as to directly heat refrigerant materials and power compressors.

Alternatively, biogas could be accumulated during the day and used to heat greenhouses overnight.

Economic viability

Electricity costs are generally presented as the “levelised cost of energy” (LCOE). The LCOE takes into account the initial capital required as well as the costs of continuous operation, fuel, and maintenance over the lifetime of the equipment.

The current average retail electricity prices at the farm gate are typically in the range $200-300 / MWhr, with off-peak and peak rates usually around $150-350 / MWhr.

A reasonable average retail price for electricity is about $230 / MWh.

Energy produced by biogas costs $80-$160/MWh, well below the average price for electricity of $230/MWh

Electricity produced by biogas generally costs $80 - $160 / MWh, with farm wastes at the lower end due to their suitability for this process. It compares well with the cost of wind generation ($77 - $112 / MWh).

Unfortunately, electricity returned to the grid only earns $50 - $70 / MWh, below the cost of production using biogas. For this reason **biogas is only likely to be economically viable if all or most of the energy produced is used on-site**, rather than returned to the main grid.

A large vegetable farm would potentially produce 30t / day waste and organic materials during peak season, reducing to closer to 10t / day during winter.

In addition, it may be possible for farms to link with other operations so as to add manures, abattoir wastes or other organic materials into the digester (feedstock mix). Such additions have the potential to further improve the efficiency of the process and increase biogas production.

Biogas production therefore appears to be a viable option for large vegetable farms.

Case study – a continuous anaerobic digestion system

This table summarises indicative economics of biogas production system suitable for a large vegetable farm / processor (supplied by Utilitas)

Total project cost	$3,173,618
Vegetable waste treated (corn, broccoli & beans, 21% VS)	15 kt / pa
Commodities produced	
Biogas	1,800,000 m^3
Electricity generated by biogas	4,000 MWh
Digestate (fertiliser or soil conditioner)	30 kt / pa
Costs and Revenues	
Annual operating cost	$97,829
Annual savings on electricity (average price of $210/MWh)	$840,000
Potential value of digestate (@ $12 / t)	$360,000
Internal rate of return	
No value on digestate	26%
Value on digestate	38%
LCOE of biogas generator	$84 / MWh
Greenhouse gas emissions avoided	14 kt

This project (VG12046) has been funded by HAL using levy funds from the Australian vegetable industry and matched funds from the Australian Government…

Horticulture Australia