CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems
LED BY: IWMI International Water Management Institute

Generating Power from Manure

Business characteristics

Geography	Rural regions with livestock farming and large livestock industry
Scale of production	16 KW up to 5 MW of electricity 22,000 to 700,000 tons of carbon dioxide (CO_2) equivalent/year in carbon credits
Type of organization	Food companies, livestock processing factories, farms and/or communities with livestock
Investment cost range	USD 500-5,000/KW for capacities ranging between 1 MW and 3 MW
Key costs	Investment costs (engineering, construction, equipment, commissioning), costs for training farmers, and operational and data management costs (labor and maintenance costs)
Revenue stream	Trade of carbon credits, savings from avoided electricity costs, and potential sale of electricity or biogas and bio-slurry (fertilizer)

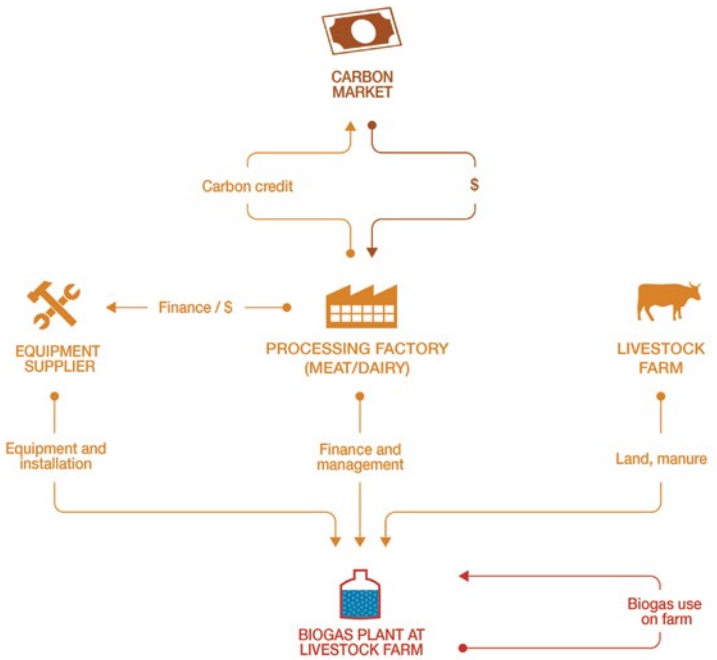
Business model

The business model processes livestock manure to produce power and/or thermal energy to be used internally by an enterprise, or sold to the grid or households and businesses. Using anaerobic technology, manure is fed into a bio-digester to produce biogas for electricity generation. Additional revenue can be earned from the sale of carbon credits and bio-fertilizer (a by-product of the process).

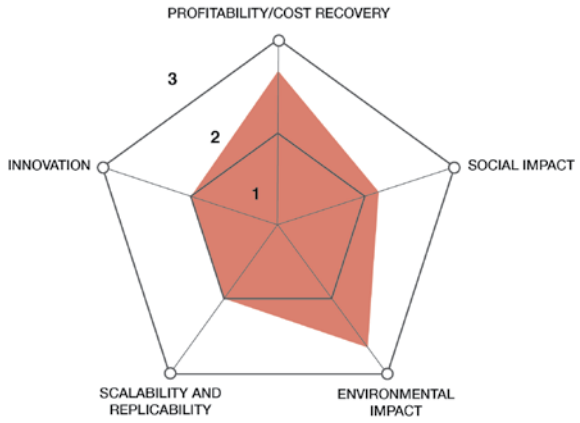
The business can be set up by either a livestock processing factory, a farm or a remote community with personal livestock. In the first instance, the factory owner installs bio-digesters on the farms within its supply chain in order to ensure sustainability throughout the value chain and gain additional revenue from carbon credits. The factory finances the installation of the biogas plant by an equipment supplier on one of its farms. The farm then operates and maintains the plant, and gradually pays back the factory by transferring its carbon credits until it gains ownership of the plant. The energy produced from livestock waste is used within the farms.

For a remote community with livestock, the regional government can install bio-digesters as part of a rural electrification program.

BUSINESS MODEL VALUE CHAIN FOR A LIVESTOCK PROCESSING FACTORY



Business performance



The business model performs particularly well in terms of profitability and environmental impact, with high cost savings from internal electricity generation and potential for electricity/gas and carbon credit sales, and significant reduction in greenhouse gas (GHG) emissions (up to 700,000 tons of CO_2 equivalent per year).

Main risks

Market risks: Risks exist for the carbon credits as the market is volatile, which can put the financial viability of the reuse business at risk. Therefore, the business has to diversify its revenue streams to include the sale of power/thermal energy and bio-fertilizers to mitigate market risks.

Technological risks: Although the technology used is well established and mature, it requires skilled labor to operate, which may not be available to farmers.

Safety, environmental and health risks: Processing livestock waste and operating bio-digesters can pose risks for environmental pollution and human health, if appropriate measures are not taken. These include possible methane leakages, and health and safety risk for workers.

Case study: Brazil

In 2003, Sadia, a Brazilian food company, implemented the Sustainable Swine Production (3S) program. It provides swine producers with bio-digesters and is designed to reduce GHG emissions from more than 3,500 producers in Sadia's supply chain, as well as qualifying the emission reductions as a Clean Development Mechanism (CDM) project.

The program came about through Sadia recognizing the increasing influence of social and environmental issues associated with the swine production systems in its supply chain and wanting to implement sustainability within it. The company runs the model through its non-profit entity on a build and transfer basis, with it owning all the equipment and managing the trade of carbon credits. The amount obtained from carbon trading is shared with farmers, according to each farm's potential emission reduction, and after deduction of the investment made in the bio-digesters, program implementation and operation costs.

The program contributes to improving the local environmental condition by improving quality of water and reducing soil pollution and foul odors. It is also expected to help disseminate environmental education among swine producers and the surrounding community.

Key performance indicators (as of 2012)

Capital investment:	USD 28 million for the whole program
Labor:	Provided by the individual swine farms
Operation and maintenance cost:	Paid by the individual swine farms
Output:	290,000 tons of CO_2 equivalent of carbon credit sold in 2006 and 2.5 million tons of CO_2 equivalent under agreement
Social and environmental impact:	CO_2 offset, improved working conditions of swine farms, improvement in local environmental condition, improvements in water quality, and reduction of soil pollution
Payback period:	5-10 years

For more information on the business model and related cases, see Chapter 5 of **Otoo, M.; Drechsel, P. (Eds.). 2017.** ***Resource recovery from waste: Business models for energy, nutrient and water reuse in low- and middle-income countries.*** **London: Earthscan/Routledge. In press.** The book has been produced by the Resource Recovery and Reuse subprogram of the International Water Management Institute (IWMI), under the CGIAR Research Program on Water, Land and Ecosystems (WLE) and its Rural-Urban Linkages Research Theme. The support of the Swiss Agency for Development and Cooperation (SDC), the International Fund for Agricultural Development (IFAD), and CGIAR Fund Donors (www.cgiar.org/about-us/our-funders/) is gratefully acknowledged.