III. Anaerobic digestion (Biogas plants) [i]

Introduction

The anaerobic digestion is decomposition of biodegradable material by micro-organisms in the absence of oxygen. Anaerobic digestion is often used for industrial or domestic purposes to manage waste streams. Three principal products are produced through the process of anaerobic digestion. First, the process produces a biogas, consisting mainly of CH_4 and CO_2, which can be used for energy production. Second, the process results in a nutrient-rich digestate. Finally, the process results in liquid liquor that can be used as a fertilizer.

Technology Characteristics

As illustrated in Figure 8, a biogas facility with an anaerobic digester has four main components:

1. A manure (or waste-water) collection system.
2. The anaerobic digester: The production of the biogas consisting of methane and CO_2 occurs here.
3. A biogas handling system: A device that puts the biogas to use such as a combined heat and power plant.

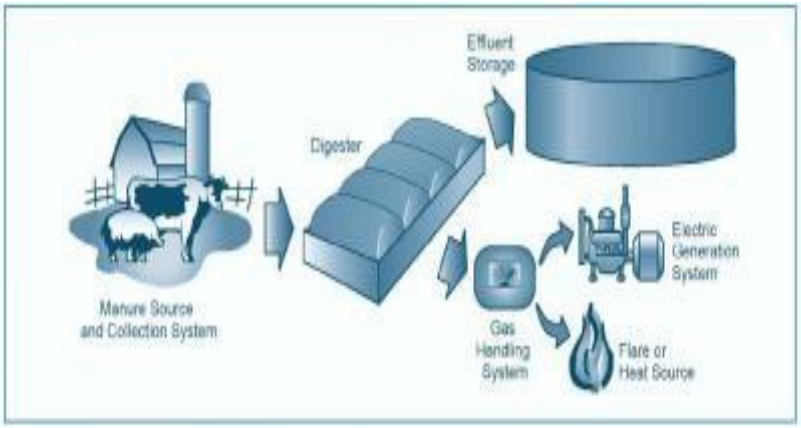

Figure 8: Main components of anaerobic digester facility

SOURCE: EPA, 2002

There are two basic types of digesters: batch and continuous.

Batch-type digesters are the simplest to build. Their operation consists of loading the digester with organic materials and allowing it to digest. The retention time depends on temperature and other factors. Once the digestion is complete, the effluent is removed and the process is repeated. In a continuous digester, organic material is constantly or regularly fed into the digester. The material moves through the digester either mechanically or by the force of the new feed pushing out digested material.

Continuous digesters produce biogas without the interruption of loading material and unloading effluent. They may be better suited for large-scale operations. Proper design, operation, and maintenance of continuous digesters produce a steady and predictable supply of usable biogas.

Many different variations of anaerobic digesters exist. The three most common variations are: the covered lagoon, the completely mixed reactor, the plug flow anaerobic digester and the induced blanket reactor.

Country specific applicability and potential

The recovery of biogas through anaerobic digestion systems is a proven technology. Both in the United States and the European Union the anaerobic digestion of animal waste streams has been used extensively. The technology has great potential in Bhutan too.

Status of technology in country[10]

The Bhutan Biogas Project was launched in 2011 with the aim of building capacity in the public and private sectors to construct and operate 1,600 biogas plants in four project areas Dzongkhags namely, Tsirang, Sarpang, Samtse and Chukha from March 2011 to February 2014 on a pilot basis.

Benefits to economic, social and environmental development

The sector in which the technology is mainly applied is the agriculture sector, which is the mainstay of Bhutanese economy. Projects using anaerobic digestion technology improve the viability of these rural enterprises. The technology is therefore capable of strengthening the backbone of the economy and subsequently improves social development.

The current waste stabilization technique most often used at farms and industrial locations is the open anaerobic lagoon. Next to emitting methane directly into the atmosphere, this technique has several disadvantages that would be solved by the introduction of anaerobic digester facility. The workplace at an open lagoon system is unhealthy and unpleasant to work at. Local air quality at such facilities is poor and strong odour is produced by the open lagoon. The implementation of an anaerobic digester facility makes the workplace safer and healthier. Local air quality is significantly improved.

Several economic development benefits arise from the energy production of the technology.

National energy self sufficiency is increased due to the local energy production. This also would reduce Bhutan's dependency on other countries for fossil fuel imports, which in turn would lead to an improved economic balance sheet of the country and a higher level of energy security.

Large amounts of animal waste can create serious environmental concerns. When animal manure enters rivers, streams or groundwater supplies it can have environmentally detrimental effects. In addition, decomposing manure causes air quality concerns associated with ammonia emissions, and the contribution of methane emissions to global climate change. The implementation of an anaerobic digestion offers a number of air and water quality benefits.

Digester systems isolate and destroy disease causing organisms that might otherwise enter surface waters and pose a risk to animal and human health. Moreover, anaerobic digesters help protect ground water. Synthetic liners provide a high level of groundwater protection for manure management systems (EPA, 2002). The concrete or steel in plug flow and complete mix digesters also effectively prevent untreated manure from reaching the ground water.

Biological treatment of waste, such as composting and anaerobic digestion reduces volume of waste and therefore the lowers landfill requirements. Recycling of the residual solids as fertilizer further reduces waste volume.

Climate change mitigation benefits

The main climate related benefit of this technology is the prevention of methane emissions associated with conventional manure management practices. In addition, the energy produced by the biogas facility offsets energy derived from fossil fuels. Therefore, anaerobic digesters with a biogas recovery system can help reduce overall quantities of CO_2. For example, the Colorado based pork farm with an anaerobic digester was able to reduce fossil fuel derived CO_2 emissions by 409 tons per year and methane emissions on a CO_2eq basis by at least 3022 tons per year[11].

Costs

[10] http://bio-gas-plant.blogspot.in/2011/07/bhutan-biogas-project.html, accessed on 18 June 2012

[11] ERG, 2003. An assessment of the Colorado Pork, LCC. Anaerobic digestion and biogas utilization system. Eastern Research Group submission to AgSTAR programme of the United States Environmental Protection Agency. Retrieved 25th October from: http://www.epa.gov/agstar/anaerobic/evaluation.html, cited in http://climatetechwiki.org/technology/jiqweb-anbt, accessed on 4 May 2012.

system constructed in the U.S. can have average costs of US$ 470 per cow. More generally, anaerobic systems for digestion, solids processing, and generation are expected to cost US$ 500 to US$ 800 per cow in the U.S.[12]

Table 28 illustrates the capital and operating costs of European digestion systems.

Table 28: Operating and capital costs of European Digester Systems

	Large 1 MW 5000 Cow Facility	**Small 25 kW 125 Cow farm**
Capital Cost	US $ 9.113.000,-	US $ 500.000,-
Annual Operating Cost	US $ 643.000,-	US $ 8.800,-
Power Sale Rate $/kW	US $ 0.06	US $ 0.06
Heat Sale $/kW	US $ 0.01	US $ 0.01
Solids Sales	US $ 700.000,-	US $ 20.000

[i] **This fact sheet has been extracted from TNA Report – Technology Needs Assessment and Technology Action Plans For Climate Change Mitigation– Bhutan. You can access the complete report from the TNA project website http://tech-action.org/**