Clarke Energy®
A KOHLER COMPANY

Engineer - Install - Maintain

Agricultural Biogas

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Clarke Energy, a Kohler company, is a multinational specialist in distributed power generation technology. Our scope ranges from the supply of a gas or diesel fuelled power generation engine, through to the turnkey installation of a multi-engine power plant. Clarke Energy is an authorised distributor and service provider for INNIO's Jenbacher gas engines. The business has a strong focus on aftersales support; developing in-country resources to service and maintain our facilities, along with original equipment manufacturer approved spare parts. Our aim is to provide high quality products and installations supported by a reliable, accountable and localised after-sales service. Integrity is a core company value and Clarke Energy operates to the highest international standards of compliance.

Benefits of working with Clarke Energy

— Quality products, balance of plant and installations products mean high technical and environmental performance hence maximum returns for our customers.
— Our installations are backed up by the highest levels of localised aftersales support, meaning maximum reliability of the power generation assets we supply.
— Extensive engineering experience across a range of gases and applications, meaning tailored, optimal power generation solutions for our customers

Agricultural Biogas

The farming industry offers a range of potential applications for agricultural biogas systems. Arable land can be used to grow crops which are fed into dedicated digestion systems. Alternatively waste products from the farm can be harnessed to provide renewable energy. Agricultural digestion systems are typically sized between 0.5 and 3.0MW electrical output. The heat produced by the engines is typically used in a cogeneration/ combined heat and power (CHP) configuration with heat from the engine cooling systems used to warm the digesters and pasteurise input materials. Additional heat is available from the engines to be used for local heat users such as grain driers or for district heating.

Benefits of Agricultural Biogas

— Production of renewable power
— Avoidance of greenhouse gas emissions
— Disposal of waste
— Economical onsite power and reduced transmission losses
— Production of soil improver
— Cost effective, proven technology
— Helps isolate farmer from crop price fluctuations

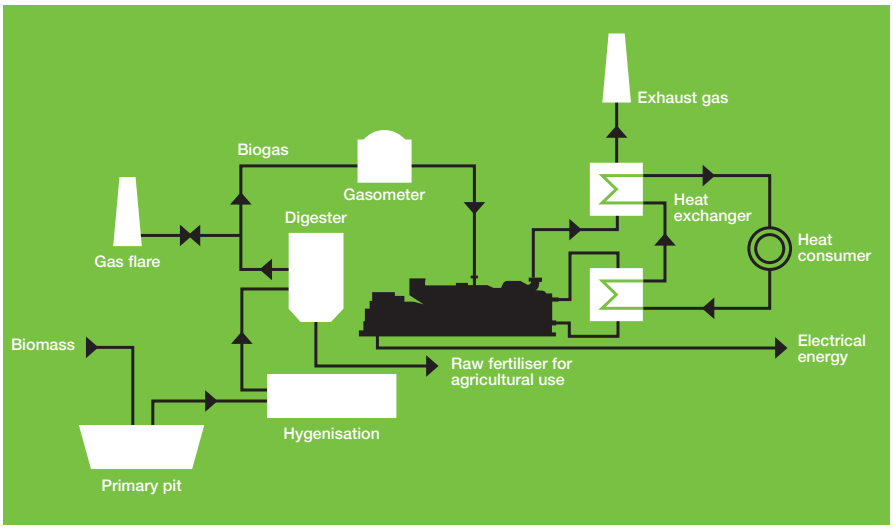
Biogas Creation

Biogas is a renewable fuel that is created by the anaerobic decomposition of biodegradable organic materials. As a metabolic product of the participating methanogens and acidogenic bacteria, the prerequisites for its production are a lack of oxygen, a pH value from 6.5 to 7.5 and a constant temperature of 35-45 °C (mesophillic) or 45-55 °C (thermophilic). The digestion period or retention time is typically between 10 and 30 days depending upon the type of digestion employed. The anaerobic digestion systems of today operate largely within the mesophilic temperature range.

Typical Component Composition (by volume)	
Methane (CH_4)	50-65%
Carbon dioxide (CO_2)	50-35%
Water vapour	saturated

Barfoots of Botley, Bognor Regis, UK, 1 x JGMC320

Agricultural Biogas Schematic



Digester Feedstock

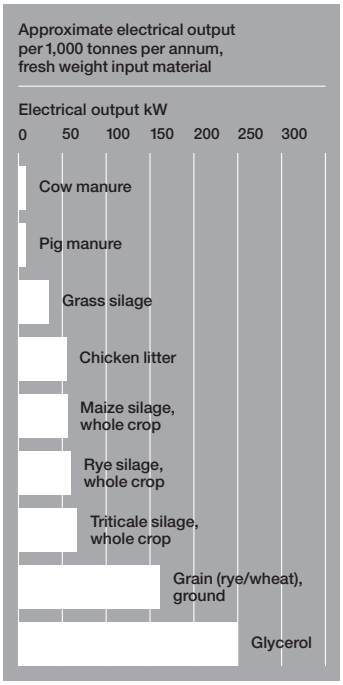
Agricultural biogas plants utilise organic materials found on farms to generate biogas, a source of renewable energy. The plant may be designed to accept energy crops that have been grown specifically to input into the digestion facility. These crops are typically ensilaged and stored in clamps or hoppers and are continuously fed into the digester throughout the year. Energy crops for biogas production can include:

— Maize
— Grass
— Wheat
— Rye
— Triticale

An approximate rule of thumb is that for 1 acre (0.405 hectares) of whole crop maize will produce enough gas to generate 1kW of electrical power.

Alternatively other organic materials such as waste products may be used including:

— Slurry
— Manure
— Vegetable waste
— Glycerol – from biodiesel manufacture



Conversion Steps from Feedstock to Power

The process of biogas generation is divided into for steps:

1. Preparation of the input material including removal of physical contaminants, practical size reduction & pasteurisation of wastes
2. Digestion (fermentation), consisting of hydrolysis, acetogenesis, acidogenesis and methanogenesis
3. Conversion of the biogas to renewable electricity and useful heat
4. Post treatment of the digestate

Initially the feedstock to the digesters is received in a primary pit or liquid storage tank. From here it is loaded into the digester by various different means depending upon the constitution of input materials.

In the digestion tanks a series of biological processes are harnessed in order to produce biogas. Hydrolysis is the process where the organic material is solubilised into the digestion liquid. It then undergoes the intermediate steps of acidogenesis and acetogenesis which create the precursor molecules for methanogenesis. Methanogens feed off these precursors and produce methane as a cellular waste product.

The biogas containing this biologically-derived methane is contained and captured in a gas storage tank which is located separately to the main digester, or alternatively can form its roof. The gas storage tank acts as a buffer in order to balance fluctuations in the production of gas in the digesters.

Typically an agricultural biogas plant will consist of two or more tanks topped with a twin-skinned gas-holding roof. The majority of biogas will be produced by the first digestion tank with a lower gas yield being attained in the secondary digestate storage tank.

Jenbacher and Agricultural Biogas

The broad range of Jenbacher biogas engines are specifically designed to run at full load with high efficiency and high availability, despite a low heating value and fluctuating gas quality and pressure. The high quality and specially designed engine parts resist the impurities that usually appear in biogas and similar types of fuel.

Before the biogas can be fed into the gas engines, it needs to be dried and compressed. Severe contaminants such as sulphur should be removed if exceeding guideline concentrations. Not only will these measures considerably increase the availability of the generator, but they will also reduce the costs associated with operation.

Please request a fuel gas quality specification to understand operational limits for gas contaminants in the generator's fuel.

Agricultural biogas plants typically generate returns via the sale of electricity alone, gate fees as a charge for the acceptance of waste materials may be low or non-existent. This means that the gas engine is of particular importance for the success of the plant. If the farmer grows energy crops to feed into the plant then there is a cost associated with producing the feedstock. These two factors make it essential for the farmer to have an engine with the maximum levels of availability (running time per year) and the highest levels of electrical efficiency, in order to convert the gas to the maximum level of electrical output and hence financial return.

Our Competence

Clarke Energy has extensive multi-national experience in the engineering, installation and maintenance of generation facilities operating on gas derived from biological sources.

Jenbacher engines are known for having the highest levels of electrical efficiency on the market. When coupled with a contractual maintenance agreement with Clarke Energy, it will give peace of mind to the customer that they will achieve the highest levels availability and hence consistent returns from their biogas plant.

Stoke Bardolf, UK, 2 x JGMC320