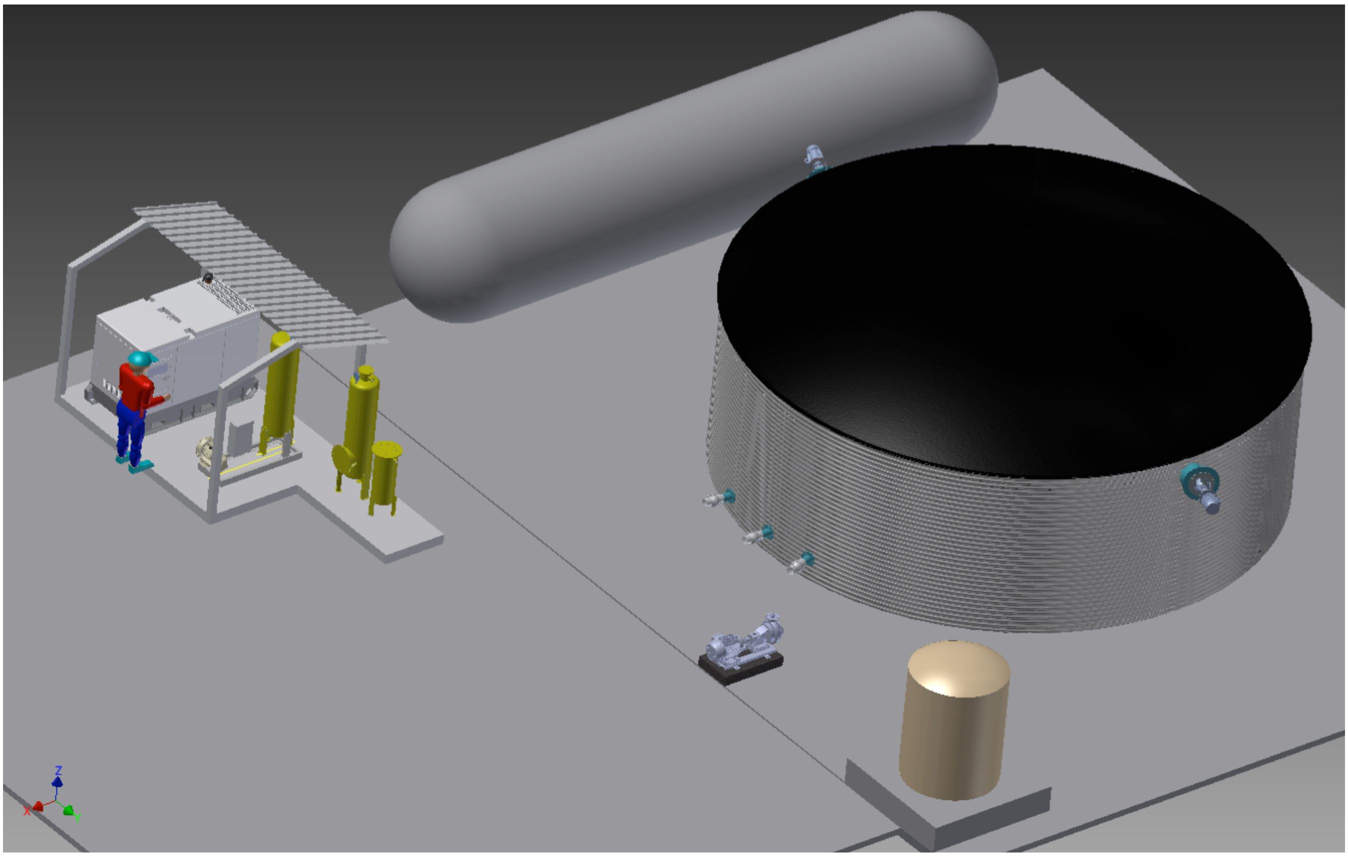
17 August 2015

PROJECT PROPOSAL

Turn-key solution for

80,000 - Chicken Broilers

Biogas Plant



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Executive Summary

Project description	Turn-key Biogas Facility with Electric Generation
Plant Model	STR 170.1 – Stirred Tank Reactor Digester
Packages	Manure Bunkers: Push-floor automatic feeding bunker system Feed Preparation: Mixing tank, Mixers, and Pump Digestion: 1 X Stirred tank anaerobic digesters (Incl. Mixing & Heating systems) Discharge Handling: Post Store Biogas Handling: Gas treatment, pressure boosting system, and 3 hours of storage Generation: 1 X Electric generator sets 25 kW 3-Phase + CHP Boiler Plant Controls: Electricity distribution, connection and Manual Control Panel Gas Heaters: Big Dutchman – Guardian 250 heaters & piping for internal house heating

General Information

Feedstock (Averaged Daily availability)

80000 X Chicken Breeding Brioler [Chickens]

Total = 2.2 ton/day Fresh matter feed (wet) ~ 74 ton/ 33 day cycle X 8.3 cycles/year ~ 632 ton/annum

Plant Output Capacity

Peak Electrical Power Generation Potential This number expresses the amount of Electrical energy that could be generated if all the Biogas produced was utilised for electricity production. If gas is redirected for alternative uses such as heating then the electrical production figure should be adjusted.	400	kWh/day
Peak Monthly Electrical Power Generation Potential	12,000	kWh/month
Nominal Annual Electrical Power Generation@ 90% availability	130,000	kWh/annum
Peak Monthly Electrical Account at annualised average electrical price of R0.9118/kWh	11,000	R/month
Generation: 1 X Electric generator sets 25 kW 3-Phase + CHP Boiler	25	kW
Genset Heat Recovery CHP Hot Water @ 85°C	1 ~ 26 ~ 13000	m^3/h kW (Heat) Litres/day
Generator Daily Operating Hours	24	hours/day
LPG Equivalents of Biogas Produced This number expresses the amount of Biogas energy produced equivalent to LPG kilograms. It is the total amount of gas energy from the plant, if a portion of this quantity is used for alternative heating the electrical production figures above should be reduced. Price Calculated at R13.27/kg	2,100 27,867	kg/month R/month eq. LPG Value

Plant Footprint Size		44 X 20	m
Organic Fertiliser Discharge	Compost Fibres: 1 ton/day @ R 20/ton	6,000	R/annum
	Liquid (dissolved Nutrients)	1,300	Litres/day
	N : 9026kg @ R6.4 /kg	58,000	R/annum
	P : 5416kg @ R19.2 /kg	104,000	R/annum
	K : 5777kg @ R6.4 /kg	37,000	R/annum
	Total Organic Fertiliser Value	205,000	R/annum

Project Basic Cost Estimate (+- 15%) Accurate

Feed Preparation: Mixing tank, Mixers, Macerator, Pump and Piping	R	75,578
Digestion: 1 X Stirred tank anaerobic digesters (Incl. Mixing & Heating systems)	R	218,206
Biogas Handling: Gas treatment, storage and pressure boosting system	R	65,707
Generation: 1 X Electric generator sets 25 kW 3-Phase + CHP Boiler	R	120,000
Plant Controls: Electricity distribution, connection and Manual Control Panel	R	66,250
Construction: Civil Works & Construction Manpower	R	190,000
Gas Heaters: 2 X Guardian 250 kBTU converted gas heaters for (285kW worth of heating power installed internally to the house) + Piping	R	45,000
Total Project Cost (exl. VAT)	**R**	**780,741**

Payment Terms: 50% Deposit, 20%/20%/10% progress payments

Execution Timeframe: 5 Months, (2 Months on site)

* Costs indicated above are estimates at present costs if the complete project is executed concurrently and are thus subject to escalation due to inflation and exchange rate fluctuations if the execution is significantly staggered in time. All imported equipment will be re-quoted upon receiving letter of intent and final selling price to be specified within 30 days of letter of intent. Selling price for phases executed at a later stage will need to be re-calculated at the date of re-commencement of the project

Plant design life and discount period of 20 years. Maintenance on rotating machinery will be required on years 5, 10, 15 and 20. Expected maintenance expenses are 1% every year and 6% every 5th year respectively of the total plant cost. Generator Maintenance interval is every 400/2000/8000 hours for general/medium/major services with expected life 40 000 hours = 10 years for 12h/day operation, re-conditioning overhaul required on 40 000 hours.

1. Scope of Work

The objective of the project is to provide financially viable renewable energy solutions for the biogas plant. The following baseline data has been used for the design and proposal.

Below the general scope of works for the biogas components are described, while the detailed technical solutions are described in the appropriate annexes.

The **scope of work for the 25 kW biogas system** include the following:

- Design, manufacture, supply and installation on site of the complete biogas power plant including manure stockpile bunker system.
- Detailed planning and smooth execution of the project
- Performance testing of the complete system
- After sales service, directly or through local contractual arrangement
- Training of persons to be nominated by client of the various aspects of operation and maintenance of the biogas system.

In the design of the biogas plant, the following principles are adhered to in order to ensure compliance with best practices and client performance expectations:

- Selection of a packaged system that meets client's needs. A criteria for the system include reduction in monthly electricity bills, replacement of bedding costs through recycling the digested fibre, carbon reduction and environmental benefits
- Ensuring the selected area is capable of handling the desired system
- Designing the system in compliance with all applicable building and electrical codes
- Ensuring the design meets local utility interconnection requirements
- Plant capacity calculations and electrical generation efficiencies are calculated on very conservative figures in order to ensure a low-stressed system design that will easily achieve the specified performance data.

Technical description[1]: The biogas plant

Biogas plants, where residuals from industries or manure are digested and the gas it utilized for local production of electricity and heat, are today commercially viable installations. During the last 30 years extensive experiences have been made worldwide on digestion of almost all types of biomasses and the gas yield as well as the process conditions are today known resulting in precise planning and budgeting of biogas plants.

The biogas plant shall be seen in context with the wider increased utilization of biogas. There are several reasons for the worldwide increased application of biogas power plants. These include:

- Biogas plants combine energy, environment and agriculture
- Biogas plants is an integrated business producing CO2 neutral energy, re-use of organic residuals from agriculture and industry, provide efficient utilization of energy crops and produce fertilizers
- Biogas plants produce no waste but only energy and clean fertilizer
- Biogas plants produce CO2 neutral energy from resources that cannot be used in other type of energy producing plants
- Biogas produces high quality energy (gas) that easily can be utilized for decentralized electricity and heat production. For a more extensive utilization of manure and agricultural waste into biogas, agriculture becomes a supplier not only of food but also of power to the people
- The digestate is a high quality and environmental friendly fertilizer that can substitute chemical fertilizer. The digestion will improve the fertilizer quality of manure and kills all major pathogens such as E-coli and Salmonella making it more suitable for application on any arable land and saves money in the farming sector.
- Biogas plant can utilize residuals from the food industry such as slaughter- houses, dairies, ready-food-production etc. for energy production and the nutrients can be recycled back to agriculture in a safe way
- Biogas plants improve the health standard in agriculture

1. Layout and process flow

The overall layout, components and process flow for the biogas plant is provided in figure below. The figure shows the key components in the biogas plant, including (1) intake mixing tank, (2) digestion

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tank, (3) digester heating, (4) gas treatment and distribution system, (5) generator engine as well as an optional (6) effluent storing and handling.

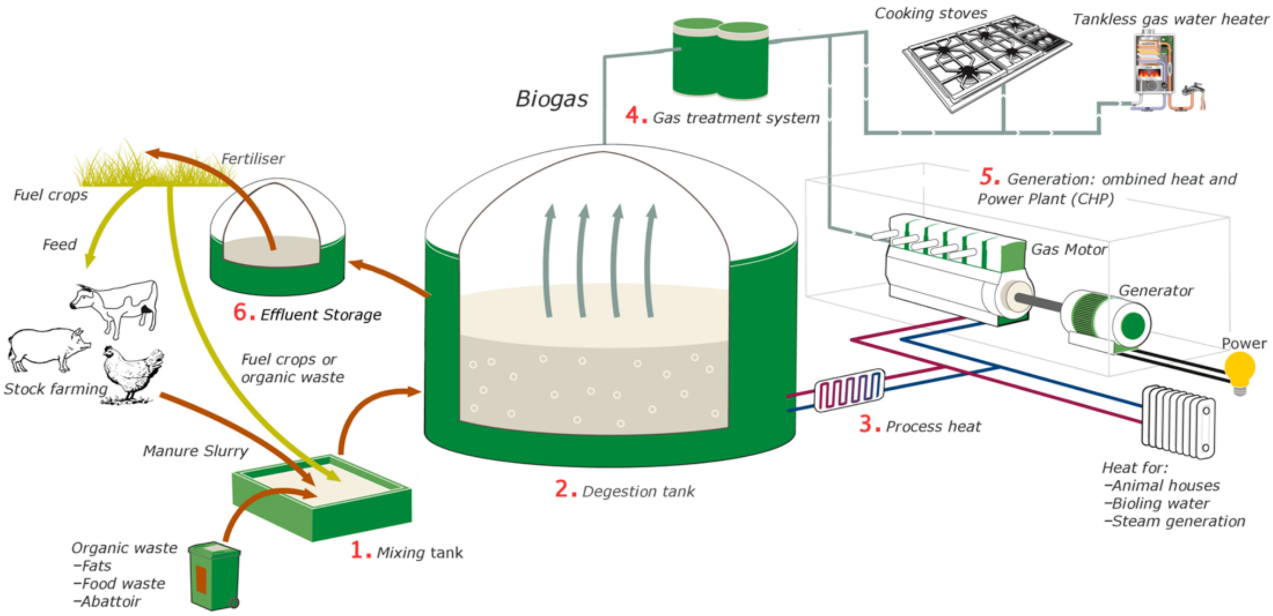


Figure Diagram for the biogas production system

The material flow includes biomass and organic waste by-product as input and electricity, organic fertilizer and heat / hot water as outputs. The biogas plant will produce methane gas, which through an engine will be converted into electricity and heat or hot water. Around 90 % of the organic input will come out as enriched liquid fertilizer.

The biogas process. Biogas is a mixture of Methane (CH_4) and Carbon Dioxide (CO_2) that is produced through a natural occurring decomposing and fermentation process of any organic matter, by bacteria that functions in the absence of oxygen. In order to create a suitable living environment for the bacteria that is producing the gasses by their natural living processes, an airtight tank or holder is built that will hold the water and organic matter mixture (the bacteria's food). The tank will partially be heated by the sun to allow optimal living conditions for the bacteria and will be supplemented by internal heating elements for winter months. This tank is called the digester. The bacterial digestion process that takes place on the inside of the digester tank produces the methane and carbon dioxide gasses that are released as evaporating gas from the liquid. This gas is collected from the top of the tank and treated in order to allow it to be used as a fuel source in various ways. First the sulphurous (H_2S) component in the gas is removed and then any excess moisture is taken out of the gas stream. These components must be removed to protect the generator and other gas burning equipment from corrosion.

Input to the process: Organic matter that can be fed into the tank as feedstock can be chicken litter, pig manure, cow manure, all components of slaughterhouse waste from all animals, any plants (except too much wood), food waste, fat, oil and human sewage. Each type of feedstock need to be processed in a suitable way to allow maximum efficiency of the bacterial digestion process inside the tank. Each type of feedstock has different digestion characteristics thus requiring different tank sizes and generates different gas yields per ton. When a very low moisture content feedstock is fed into the digester the addition of fresh water in equal quantities to the feed volume will be required.

Output of the process (biogas to electricity and heat (gas or hot water)): The gas produced by the anaerobic digesters is extracted on a continual basis into the gas handling system. Once the gas is cleaned it can be used as fuel for a standard internal combustion engine driven generator to produce electricity. Biogas can also be used for gas cooking stoves, gas heater equipment, hot water boilers and geysers. When a generator is used, the excess heat from the generator exhaust gasses can be harvested by a heat exchanger to produce steam or hot water for general heating purposes. For electrical generation the correct generator size is selected in order to maximize the utilization of the generator and to be able to serve the maximum power demand of the operation. Operating the generator at a constant output of 90% of the peak power ensures maximum fuel efficiency and energy production. Operating multiple smaller generators is also possible which ensures redundancy in the event of a generator being out of service for maintenance or breakdown.

A heat recovery system (CHP) is integrated into the generator in order to recover all the waste heat from the generator jacket cooling and exhaust gas into usable hot water that can be distributed via hot water pipes for heating applications elsewhere on the operation. The total heat energy contained in the hot water is up to 130% of the total electrical energy produced by the generator. The hot water is thus a valuable asset and energy source that should be applied in order to further increase the energy savings potential provided by the biogas plant. Apart from electricity generation the gas can also be used for direct heating applications to replace LPG usage. All LPG equipment's burner jets need to be changed out for Natural-gas jets in order to obtain the same energy output. In the event of the gas being used directly for heating applications, naturally the electrical energy generation potential will have to be reviewed as the fuel supply is now being divided between the two applications.

Output of the process (fertiliser): The anaerobic conditions in the digestion tank ensures the destruction of all major pathogens such as E-coli, Salmonella and Campylobacter making the slurry safe for any form of agricultural land application. The discharge from the digester tank is in the form of a liquid mixture of dissolved and spent food particles and fibres. The liquid, a thin mud-like slurry, can be applied onto farmland through an application system as a faint fertiliser. The same quantity of material that is fed into the digester is also taken out of the tank at the same frequency as the loading rate. The discharge from the digester can immediately be pumped to the irrigation system or it can be stored in the pond for later distribution.

The typical analysis of the digested slurry is as per the table below.

	Dry matter, %	N-total, kg per tonne	NH_4-N, kg per tonne	P, kg per tonne	K, kg per tonne	pH
Digested slurry	16	25	19	15	28	7,6

The discharged slurry is de-watered by a screw press in order to separate the fibrous particles (bedding material and maize husks that cannot digest) and a liquid. The fibres can be put through a wood chip drier in order to effectively re-cycle the bedding material for re use. During the drying process at temperatures above 220°C the fibres are sterilised, ensuring a clean inert fibre is produced for safe usage as bedding material. Alternatively the fibres can be land-applied as composting medium without drying. The liquid is the nutrient rich part of the discharge where all the dissolved N, P and K reside.

2. Biomass inputs

The biogas production on site will be based on residuals from broiler chicken operations. The following biomasses is expected to be included:

- Chicken litter and bedding

The plant is designed primary to utilize chicken litter from the broiler operation. Besides the above biomasses, the design is made for utilising a wide variety of other potential organic waste products. As can be seen from the table, the following inputs are preliminary used for planning and calculations:

Feedstock – Averaged daily availability		
Chicken Manure from 80,000 chickens per cycle	74	ton/ cycle
Total daily feed	fresh matter feed (wet) 2.2	ton/day

3. Energy, heat / hot water and fertilizer outputs

The above feedstock is calculated to produce the outputs shown in the table below. The table summarizes the projected plant capabilities.

Plant Output Capacity			
Peak Electrical Power Generation Potential This number expresses the amount of Electrical energy that could be generated if all the Biogas produced was utilised for electricity production. If gas is redirected for alternative uses such as heating then the electrical production figure should be adjusted.		400	kWh/day
Peak Monthly Electrical Power Generation Potential		12,000	kWh/month
Nominal Annual Electrical Power Generation@ 90% availability		130,000	kWh/annum
Peak Monthly Electrical Account at annualised average electrical price of R0.9118/kWh		11,000	R/month
Generation: 1 X Electric generator sets 25 kW 3-Phase + CHP Boiler		25	kW
Genset Heat Recovery CHP Hot Water @ 60°C		1 ~ 26 ~ 13000	m³/h kW (Heat) Litres/day
Generator Daily Operating Hours		24	hours/day
LPG Equivalents of Biogas Produced		2,100	kg/month
This number expresses the amount of Biogas energy produced equivalent to LPG kilograms. It is the total amount of gas energy from the plant, if a portion of this quantity is used for alternative heating the electrical production figures above should be reduced. Price Calculated at R13.27/kg		27,867	R/month eq. LPG Value
Plant Footprint Size		44 X 20	m
Organic Fertiliser Discharge	Compost Fibres: 1 ton/day @ R20/ton	6,000	R/annum
	Liquid (dissolved Nutrients)	1,300	Litres/day
	N : 9026kg @ R6.4 /kg	58,000	R/annum
	P : 5416kg @ R19.2 / kg	104,000	R/annum
	K : 5777kg @ R6.4 /kg	37,000	R/annum
	Total Organic Fertiliser Value	205,000	R/annum

Energy output: The electricity generated by the biogas plant will be 130,000 kWh/year, which could be utilized at the chicken operations.

Heat / hot water output: The plant will produce hot water that can be circulated at a flow rate of 1 m³/hour of hot water at 60°C which is equivalent to 26kW of heating power from the generator CHP boilers. The generator heat recovery boiler is placed in series before the main coal fired boiler in order to effectively provide a pre-heat to the cold returning water from the broiler houses. That will be sufficient to provide about a 10% saving on heating requirements of the facility. Integration of the hot water system into the broiler houses is not included in the current project plan.

Fertilizer output: The fertiliser output is extracted on a daily basis. The liquid can be distributed as is in the form of a mud-like fluid or can be dewatered in order to further improve its saleable qualities. The dewatered liquid can be stored for spreading at later times and the Fibres can be stockpiled for drying as recycled bedding material or sold as compost. 1 tons of fibre will be extracted per day as well as a minimum of 1,300 litre of liquid fertiliser per day. The liquid fertiliser will be stored in a temporary storage pond which can accumulate 6 months worth of digested liquid before having to be emptied.

The calculations are based on standard input figures and database results and may be adjusted, when detailed figures for the available products and composition of the actual inputs are known.

The output of the 40 kW biogas plant will result in around 226 tons of CO2 being displaced annually based on Eskom's CO2 emissions factor 1.2 kg/kWh.

5. Technical component specifications

The Biogas plant will consist of 1 x 170 m^3 digester of 8.5 m diameter x 3 m tall each. It will be possible to fit the biogas plant site into 44 x 20 m but more space would be convenient.

The plant will be equipped with 1 x 40 kW generators with a synchronisation cabinet that allows the chicken houses to draw electricity primarily from the generators and in those events when the peak load on the chicken house exceeds that of the generators then the additional energy will be drawn from the Eskom grid.

An application can be made to Eskom in order to install a back-feed system in order to take advantage of the newly announced Eskom electricity banking system which is generally used by Solar power installations to bank electrical credits on the Eskom network that can be deducted from one's overall account at the end of an annual period. There are additional costs involved in requesting the necessary equipment to be installed by Eskom to take advantage of the banking system. Those costs can only be determined after Eskom has received a formal request from a line customer and a cost-estimate had been done.

The following biogas plant system is proposed

Plant Model	STR 170.1 – Stirred Tank Reactor Digester
Packages	Manure Bunkers: Push-floor automatic feeding bunker system Feed Preparation: Mixing tank, Mixers, Macerator and Pump Digestion: 1 X Stirred tank anaerobic digesters (Incl. Mixing & Heating systems) Discharge Handling: Digestate de-watering screw press & Post Store Biogas Handling: Gas treatment, pressure boosting system, and 3 hours of storage Generation: 1 X Electric generator sets 25 kW 3-Phase + CHP Boiler Plant Controls: Electricity distribution, connection and Manual Control Panel

The Botala biogas plant system consists of the following key components.

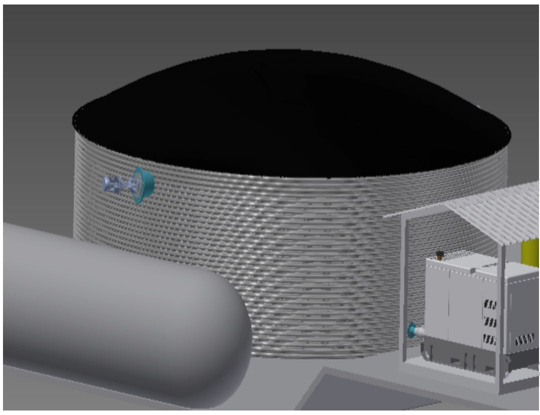
5.1. Mixing tank

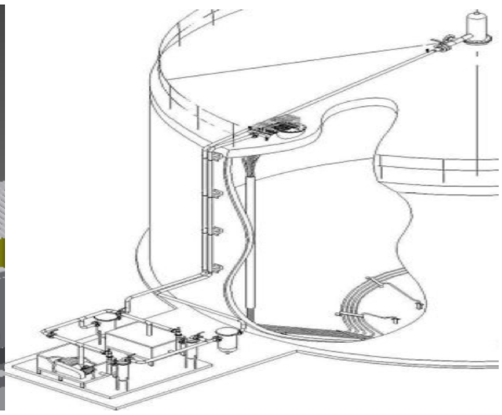
The mixing tank is a concrete sump at the corner of the bunker. The chicken litter will be washed down the trench into the mixing tank with digestate extracted from the digester. Solids will be kept in suspension in the mixing tank by a small mixer. At increments determined by the controller system a slurry pump will empty the mixing tank, pumping the feed into the digester.

- Mixing tank: 5m^3 mixing pit
- Mixers: 1 X 0.35 kW submersible mixers
- Pump: 1 X 30m^3/h slurry pump.

5.2. Digestion tank

- Stirred tank fermenters: 1 x 170 m^3 dam-type tanks; diameter 8.5 m, height 3 m
- Internal proprietary gas mixing system
- Heating systems: Internal drum-type heat exchangers
- Protection: Pressure relief & vacuum protection valves.





5.3. Heat / hot water generation

The hot water generation system is used to heat up the digester at start up as well as any other time when heat is not available from the generator.

- 1 x 6 kW standby boiler
- 1 x hot water circulation pump 10 m^3/h
- 3 x internal drum type heat exchangers per digester - 2 kW each
- Hot water piping.

5.4. Gas treatment system

The gas treatment system conditions the gas to remove moisture and hydrogen sulphide (H2S) which can cause corrosion to gas burning equipment and the generator.

- Gas treatment: De-watering & biological H_2S treatment vessels
- Air-dosing compressor 9 *l*/min
- Pressure boosting system: 1 x 60 m^3/h blower with pressure controller
- 6 hours of gas storage: 1 x 100 m^3 gas storage balloon mounted on top of the liquid post store pond

5.5. Electricity generation and plant controls

- Electricity generation: 1 x electric generator sets 25 kW 3-Phase
- 1 x heat recovery CHP boilers, mounted onto each generator
- 1 x hot water circulation pump 5m^3/h
- 1 x heat-dump external air radiator 20kW(heat)
- Electricity distribution: 3-phase cabling on plant & plugs
- Connection: Generator to site connection switches and generator paralleling unit.
- 50m cabling allowed for connection to chicken house distribution board
- Manual control panel: Plant control circuit breakers and switches
- 1 x 3 kVA UPS standby power supply for black generator start up.


5.8. Technical building

- One building divided in combined pumping and gas treatment, and generator rooms
- The standard technical building consists of a steel structure covered with IBR sheeting on all sides**.**

5.9. Gas heaters

- 2 X Guardian 250 kBTU (95kW each = 285 kW) has heaters
- 400m x 50mm HDPE Class 6 gas pipe.

5.10.Construction, civil works and infrastructure

- Concrete work for digester foundations, pump station and technical building foundations based on geotechnical survey
- Scaffolds and lifts in the construction period
- Placement and mounting and erection of all equipment
- Fencing off the biogas plant perimeter with standard galvanised diamond mesh fence
- Water and electricity during the construction period (supplied by client).

Appendix 2:

Project implementation, Operation and Maintenance

The project execution will span over 5 months from date of order. Construction on site will start after month 3. Long lead time items such as equipment imports will require 3-4 months delivery and will arrive on a Just-In-Time basis for inclusion in the installation program.

The client shall provide for a manure stockpiling area by his own means.

The construction activities includes the following main works:

- Earthwork preparations to establish a terrace for the construction site of the plant; specification of ground conditions on site for the ring-beam foundations for the water silos
- Installation of the watertight geo-membrane lining for dug-in mixing pond and installation of mixer
- Simple steel shed with IBR sheeting for wall and roof covering for generator and gas treatment equipment housing and control panel
- Silo-type digester vessels complete with water and gas-tight lining, insulation, inlet outlet gas and slurry piping and Gas-injection mixing system. Internally mounted drum-type heat exchangers together with temperature and level gauges
- Single slurry handling pump. Slurry handling piping system internally to the plant. Slurry discharge piping to point 20 m from digesters. Gas piping, treatment and storage up to 20m away from digesters
- Installation of gas storage holder, gas purification vessels and all interconnecting gas piping and pressure boosting system
- Generator installation and connection to the local electrical network (first fills included)
- Electrical and controls wiring and connection to control panel including integration of UPS power supply for control system.
- Construction of the manure stockpile bunker.

1. Plant Start up and Commissioning

Plant start-up and commissioning will commence as soon as the various elements of the plant become available. After equipment had been dry-tested the client will sign over responsibility for the equipment and will take full ownership and liability for the equipment from thereon. From the time of digester filling and inoculation to the start of flammable gas production would require 40 days. A further 40 days is required before the plant will reach full production capacity. During this start-up period the appointed site manager will make weekly visits to the facility in order to judge the progress and make any necessary final adjustment to equipment as the plant is prepared for full capacity operation.

Training of client technical staff in the routine operation, maintenance and safety of the biogas system will be conducted on-site and during workshops where all aspects of the system will be covered. Training materials will be provided which will include a maintenance schedule to follow as well as a troubleshooting list with possible causes and remedies.

Operation and Maintenance

2. Daily operation

The operation of the biogas plant will require an operator to perform the daily inspections. The Chicken litter will be stored in a stockpile bunker with walking floor reclamation system. The floor extraction system will on a timer-based operation extract the set amount of manure from the bunker and discharge into a mixing channel from where it will be pumped into the digesters. The feeding of mortalities have not been allowed for as a separate feeding system that will make use of a grinder that will grind the carcasses and deposit the remains into the feed mix is necessary for this and would add unnecessary costs to the system at this stage. The digester's feed can also be supplemented by additional organic material available on the farm such as grass, wasted food crops and waste from neighbouring farms. In the case that additional feedstock are considered additional alternative feeding systems should be designed into the plant in order to correctly prepare and introduce the material into the digester. When feeding dry materials the addition of some water to dry material volume per day will be required. The feeding pumps will gradually feed the pre-mixed feed from the mixing pond into the digester on a semi-continuous basis.

Once a day the equivalent amount of material that was pumped into the digester will have to be extracted from the tank into the discharge pond from where it can be distributed to irrigation systems or to be collected by buyers as fertiliser replacement. For the extraction task the digester normally has a set overflow, so as the fresh material is pumped in surplus material will over- flow into the slurry drainage canals. Alternatively if the operator desires to better control the outflow of the digester the operator only needs to open the waste valves and run the pump until the required operating level on the thanks level indicator has been reached. The digester generates gas at a constant rate equivalent to the amount of average daily feed. The gas flows from the digester into an accumulation holding bag mounted on top of the liquid post storage tank from where a pressurisation blower will distribute it to equipment that consumes the gas.

The Botala team will provide operational and technical backup for the first 6 months.

3. Maintenance required (redundancy / back up)

The plant's design life and discount period is 20 years. The main maintenance item of the plant is the generator engine. The engine installed inside the generator is a typical spark ignition engine comparable to a petrol engine. It will require the similar type of services as any other engine at regular intervals. The generator maintenance interval is every 400/2000/8000 hours for general/medium/major services with expected life of 40,000 operating hours or 10 years for 12h/day operation. After 40,000 hours of operation or 10 years it is expected that the engine will require a reconditioning overhaul.

The mixer in the mixing pond as well as the slurry pump will require major maintenance or replacement after 5 years of operation. Maintenance on rotating machinery will be required on year 5, 10, 15 and 20. Expected overall plant maintenance costs are 1% every year and 6% every 5th year respectively of the total plant cost.

On the gas handling system all the condensate traps should be checked and drained on a weekly basis. After a period of time when one can notice the sulphurous smell in the gas it will indicate that the H2S filter medium has to be replaced.

The biogas plant equipment requires few maintenance hours per year due to the few moving parts. A total of 300 hours per year of generator down-time is required for routine maintenance of the generator engine. During the generator servicing/maintenance, the plant does not produce electricity except if the plant was constructed with generators in parallel configuration, though the digester continues to produce methane gas from the anaerobic digestion. The excess biogas that is produced during maintenance and other generator down-time will be flared off.

Appendix 3:

Company presentation and references

1. Botala Energy Solutions

Botala Energy Solutions was established in 2012 out of a drive to make renewable energy work in Southern Africa. The company focuses on turn-key biogas digester plants to meet the pressing energy demands of farmers. Botala have constructed their own pilot 150 kWh/day biogas plant outside Heidelberg, Gauteng Province, as a demonstration of the biogas technology and enabling the company to proof-test equipment variants and different feed stock performances. Having an in-house operating plant provides Botala with the platform to install tried and tested solutions grown from own learning experiences.

Figure 1: 150 kWh plant at Caesarsvlei

Botala Energy Solutions is one of the first engineering companies in South Africa providing turnkey biogas power plants of all sizes. The head office of the company is located in Johannesburg, South Africa. The portfolio not only includes the feasibility design, engineering and construction of Waste-to-Energy plants such as Biogas and Syngas plants including technical services such as energy optimization and operational support. Whether utilizing gas directly for heating and cooking or converting it into electricity, Botala Energy Solutions offers a one-stop solution to suit the customer's specific needs. As the demand for renewable energy increases and the environmental awareness rises in Africa specifically southern African regions, Botala Energy Solutions is well positioned to provide the better alternative energy solution to this incredible continent.

Botala Energy Solutions specializes in the following technologies:

- Anaerobic Digestion (AD) is a naturally occurring process part of the decomposition cycle of all organic matter. By installing a plant that provides the ideal circumstances for anaerobic digestion to utilise the phenomenon to generate an energy rich gas called Biogas that can be used for all the same applications as Natural Gas or LPG. The gas consists typically of 60% Methane (CH4) and 40% Carbon Dioxide (CO2). Typical applications for biogas is for electric generation through generator engines, hot-water and steam boilers, direct-to-air gas heaters and gas distribution for stove-top cooking needs. AD is a great technology to be applied when a high moisture containing waste source is available. Usually the processing and disposal of these types of organic slurries are difficult and are mostly associated with generating bad odours, flies and create ground-water contamination problems. Anaerobic Digestion solves this problem by breaking down all the volatile organic compounds into Biogas. The process also kills all pathogens and reduces the Biological Oxygen Demand (BOD) of the slurry close to zero in order to safely spread on agricultural land or grass-land and lawns as a fertilizer without the problem of bad odours or groundwater contamination usually associated with slurry disposal

- Pyrolysis & Gasification (P&G) is a branch of the Biomass processing technologies that is well suited toward processing waste materials with bulk moisture values below 30% from practically any combustible material. The process generates a gas typically called Syngas, or wood-gas and can be applied in most applications where Natural Gas or LPG is used. The process entails heating the waste material to the required optimal vaporisation range in a controlled environment that regulates the oxygen consumption and heat input in order to control the quality of gas produced. Organic materials will vaporise, crack and react to reduce down to Hydrogen (H_2), Carbon Monoxide (CO), Methane (CH_4) and Carbon Dioxide (CO_2) + Nitrogen N_2 with varying percentage make-up dependent on the input waste source.

CVs for key team members will be forwarded on request.