BIOGAS IN GHANA

Sub-Sector Analysis of Potential and Framework Conditions

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Currency

1 USD	=	GHS 2.3718 (January 2014)
1 €	=	GHS 3.2335 (January 2014)

Measurement

W	Watt	Wh	Watt hour
kW	Kilowatt	kWh	Kilowatt hour
MW	Megawatt	MWh	Megawatt hour
GW	Gigawatt	GWh	Gigawatt hour

List of Acronyms

Acronym	Text (Standard)
ABL	Accra Brewery Ltd
AD	Anaerobic digestion
ASCO	Ayensu Starch Company
CER	Carbon Emission Reduction
CHP	Combined Heat and Power
EC	Energy Commission
ECG	Electricity Company of Ghana
EFB	Empty fruit bunches
EPA	Environmental Protection Agency
EPC	Engineering, Procurement and Construction
FFB	Fresh fruit bunches
FiT	Feed-in Tariff
GGBL	Guinness Ghana Breweries Limited
GridCo	Ghana Grid Company Limited.
LFG	Landfill gas
LPG	Liquefied Petroleum Gas
MOE	Ministry of Energy
MoFA	Ministry of Food and Agriculture
MSW	Municipal solid waste
NED	Northern Electricity Department
PKS	Palm kernel shells
POME	Palm oil mill effluent
PPA	Power Purchase Agreement
PURC	Public Utility Regulatory Commission
RE	Renewable Energy
RFO	Residual fuel oil

1 Executive Summary

Biogas, a sustainable renewable energy form, is at a starting point of market development in Ghana. Due to its economic growth and development of the regulatory environment, the Ghanaian renewable energy sector is attractive for foreign companies from the sector interested in investing in Sub-Saharan Africa. As a result of the present day energy situation, characterized by grid instabilities and increasing power prices, commercial and industrial producers from the agricultural industries look for alternative solutions to secure constant energy supply to avoid production loss and to reduce energy costs. The installation of biogas plants on production sites is one of the most attractive solutions. It enables producers to dispose agricultural waste, generate electricity for self-consumption, use residues as fertilizer and feed-in energetic surpluses to the grid at the same time.

This paper will provide information about frameworks, potentials and business opportunities in the Ghanaian biogas sector. A gross estimation of biogas potential of different sectors is shown, as well as specific project opportunities for energy utilization of biogas and landfill gas as representatives are identified.

In general, agricultural industries show the greatest potential in biogas in Ghana with a relevant potential due to significant feedstock available for biogas generation, in particular, agro-industrial residues but also animal and agricultural residues. Very little biogas installations are implemented so far compared to the given biogas potentials in the agricultural sector. Most of the biomass remains unused.

Potential clients for biogas implementation are big food processing companies that have a need to find cost-effective solutions to bio-degradable waste disposal, such as oil palm mills, cocoa processing companies, fruit processors, starch production companies, breweries and abattoirs.

Agricultural residues can be an additional material to assist the biological processes due to the supply of missing nutrients by the co-substrate or simply to increase the biogas yield. The utilization of agricultural residues as a base load for biogas projects is not recommended. Due to smallholder farming, the material is mostly available only on small scale and thus needs to be collected and transported to a centralized biogas facility, which will make such projects economically unfeasible.

Metropolitan Assemblies with engineered big landfills should have a strong interest to establish landfill gas plants and not miss the opportunities to generate additional revenues by landfill gas capture and energy recovery.

Regulatory framework is being developed in Ghana and basic guidelines are already regulating the licensing of renewable power plants with grid access and the sale of power fed into the grid. With the feed-in tariff scheme, Ghana is hoping for stronger promotion of the renewable energy sector, especially the biogas sector.

However, there are barriers that limit the biogas sector. So far no suitable financing is available for biogas projects. Furthermore the lack of biogas specific technical, operational and management expertise is delaying the implementation and demonstration of successful biomass utilization for biogas plants on a large scale.

More projects are planned, in particular by big food processing companies. The need and interest for economically feasible biogas projects offers interesting business opportunities for plant design and engineering companies, suppliers of power plants and process equipment, EPC contractors but also maintenance service providers, consultants and especially project developers.

2 General Biogas Sector Overview

2.1 Assumptions behind the Calculations

The theoretical biogas potential was calculated according to

- total annual amounts of available organic material (feedstock in t/a) based on production figures of industry or official material statistics from the Ghanaian Ministry of Food and Agriculture (MoFA)
- biogas potential for the substrate (m^3/t VS) based on dry matter (DM) content of the residue (% fresh matter, FM) and volatile solids (VS) content (% DM)
- methane content in the biogas (%)
- if there is no fermentation analysis available for organic material, figures from literature are used to estimate the biogas potential

Neither of the energy potentials calculated considers the fact that future biogas plants use part of the energy produced.
The energy potentials are given as total energy producible by conversion of produced methane taking into account the energy content of methane. Thus, one cubic meter of methane equals 10 kWh of energy. The further conversion efficiency from methane into heat and electricity is depending on the technical specifications of the CHP generation plant:

	Total energy [kWh/ m^3 methane]	Efficiency of electricity production [%]	Full load hours CHP [h/year]
Min	10	32	7,500
Max		39	

Table 1 Conversion factors for calculation of energy potential from biogas

2.2 Feedstock for Anaerobic Digestion in Ghana

Ghana is well endowed with a great variety of organic material that can be used in anaerobic digesters as a feedstock for generating biogas. Ghana's economy is strongly oriented toward agriculture, made up of five major subsectors – food crops (59.9 %), livestock (7.1%), fisheries (7.6 %), cocoa (14.3 %) and forestry (11.1%). [1]

There are two main categories of biomass in Ghana which can be used as feedstock in a biogas plant. The first category includes farm based products such as animal manure, agricultural by-products and farm based wastes. The second category consists of a broad range of suitable organic wastes from the food and feed industries as well as municipal solid waste etc.

The suitability of all feedstock types must be analysed regarding their methane potential, digestibility and possible contamination with chemical, biological or physical contaminants. The most crucial parameters are feedstock availability and economics (e.g. gate fees, collection and transportation costs, and seasonality).

Common feedstock types that are available in Ghana and can be used for anaerobic digestion are:

- agricultural residues and food-processing residues,
- livestock manures,
- slaughterhouse wastes,
- municipal solid waste (organic fraction) and municipal sewage sludge.

Some of the before named possible feedstock types are technically challenging and need a special pre-treatment.

2.2.1 Food processing

Oil palm processing

Ghana currently has a total of 305,758 ha of oil palm of which more than 80% is cultivated by private small-scale farmers. The oil palm tree yield is distributed over the entire year. It is estimated that 243,852 tons of palm oil are being produced per year. [2] The mills process the fresh fruit bunches (FFB) into crude palm oil and other useful by-products. During the processing of the FFB, a significant amount of wastewater with high organic loads is produced, known as Palm Oil Mill Effluent (POME). The ratio of POME produced is approximately 0.6 tons per ton FFB processed. [3] Furthermore, empty fruit bunches (EFB) and palm kernel shell (PKS) is waste generated by the milling process at the rate of 23% and 7% respectively from processed FFB.

On the basis of the information available from other projects using POME for biogas generation in Malaysia a bio-methane potential could be estimated up to 15 m³ CH_4 per ton FFB. [4] PKS generated during the palm oil milling is usually used as a boiler fuel while EFB are left to decay naturally in the plantation or used for composting. One sample of each, EFB and PKS from JUABIN OIL MILLS, has been analysed in 2011 via a fermentation test and show a methane yield of 155 m³ CH_4 per Mt EFB and 254.2 m³ CH_4 per Mt PKS.

Company	Milling Capacity [MT FFB /hour]	POME (estimated) [MT/hour]	EFB (estimated) MT/hour	PKS (estimated) MT/hour	Estimated methane potential [m³ CH4/h]	Electric capacity [kW installed] Min -	Max
GOPDC - Ghana Oil Palm Development Company Ltd.	60	36	13,8	4,2	4,101	13120	15993
TOPP - Twifo Oil Palm Plantations Ltd.	30	18	6,9	2,1	2,050	6560	8000
BOPP - Benso Oil Palm Plantations Ltd.	27	16.2	6,21	1,89	1,845	5905	7200
NORPALM GH. LTD.	30	18	6,9	2,1	2,050	6560	8000
JUABIN OIL MILLS	15	9	3,45	1,05	1,025	3280	4000
AYIEM OIL MILLS	10	6	2,3	0,7	6,83	2187	2670
TOTAL	172	103.2	39.56	12.04	11,755	37.617	45.846

Table 2: Energy potential from biogas of Oil Palm Processors
[5]

Fruit processing

Ghana is a major producer of fruit and vegetables. Currently up to 15,000 Mt of mango and up to 525,000 Mt [6] of pineapple are produced. As most other agricultural products, fruit and vegetables are mainly cultivated by private small-scale farmers with the major commercial production areas located in the southern part of the country where closeness to the ports enhances the export trade. At the coastal areas commercial activities are concentrated in the Accra Plains and southern Central Region.

While most Ghanaian fruit is exported unprocessed, there are some companies processing mango, pineapple, papaya or oranges locally. This sector is an important avenue for employment and private sector initiative.
The main different product groups are:

- Fresh fruit
- Fresh cut fruits
- Dried slices or fruit chips
- Fruit concentrates or juices

There are few large fruit-processing companies in Ghana. The processing industries generate significant quantities of waste product. This material can quickly become spoiled, giving rise to decayed material with a bad odour which therefore needs proper treatment and also qualifies as feedstock for biogas generation:

Companies	Products	Fruit residues [Mt/year]	Estimated methane potential [m^3 CH_4/ year]	Electric capacity [kW installed] Min -	Max
Blue Skies Ghana Ltd.	fresh cut-products for export and juice for the local market	8,000 MT of fresh cut residues and fruit waste from juice production	374,000 - 572,000	160	298
Pinora Ltd.	juice concentrate for export from pineapples and oranges	40,000 Mt of fruit waste	1,600,000 - 2,134,000	680	1,110
Fruittiland Ltd.	juice and concentrate for export from pineapples and oranges	45,000 Mt of fruit waste	3,200,000 – 4,800,000	766	1,249
Peelco Ltd.	fresh cut-products for export	2,000 Mt of fresh cut residues	150,000 – 250,000	33	68
Total				1,639	2,725

Table 3: Energy potential from biogas of selected fruit processing companies

Cocoa processing

Ghana is the second largest producer of cocoa in the world. Currently there are six cocoa growing areas namely Ashanti, Brong Ahafo, Eastern, Volta, Central and Western regions. These growing areas amount to 1.6 million ha of cocoa farming land with a production of about 870,000 Mt cocoa beans as a key product. [7]

The cocoa fruit comprises of the pod husk, beans, pulp and placenta. The cocoa pod produced after the removal of the cocoa beans from the fruit, is one residue that could be a potential feedstock for biogas plants. The pod forms about 66 - 70% of the weight of the fruit [8], and from estimates of cocoa production in Ghana, about 2 to 3 million tonnes of dried pod could be available annually on Ghanaian cocoa plantations.
The average calorific value of cocoa pods is estimated to 23.4MJ/kg was estimated when used for thermal energy generation. [9]

However, utilizing pod husks as a substrate for biogas has yet to be investigated. Besides, the widespread nature of cocoa-processing sites and smallholder farming make it difficult and expensive to collect and transport the cocoa-pods to sites of utilisation. The utilization will also depend on logistical and economic factors.

Once cocoa beans have been harvested, fermented, dried, and transported, cocoa processing is the next key step in preparation for commercial consumption. While most of the cocoa beans are exported to processors in Europe, Asia or America; there are some cocoa processing companies in Ghana.
Cocoa bean shells are the main by-product of cocoa bean processing and in some cases are already used for generating heat energy (steam) through combustion in boilers. The remaining amounts of shells are usually dumped/landfilled or further processed from buyers outside of Ghana, i.e. in China or India.
Table 4 shows the main processing companies in Ghana of which the cocoa shell capacity is known and might be a source for energy generation through biogas.

Companies	Production Location	Cocoa bean shells in Mt/year	Estimated methane potential [m³CH4/year]	Electric capacity [kW installed] Min -	Max
Barry Callebaut Ghana Limited	Tema	up to 3,000	500,000	213	260
Cargill Ghana Ltd.	Tema	up to 6,000	1,000,000	427	520
Cocoa Processing Co. Ltd	Tema	up to 3,000	500,000	213	260
Niche Cocoa Industry Ltd.	Tema	up to 3,000	500,000	213	260
ADM Cocoa (Ghana) Ltd.	Kumasi	up to 3,000	500,000	213	260
Plot Enterprise Ghana Ltd.	Takoradi	up to 5,500	900,000	384	468
West African Mills Co. Ltd.	Takoradi	up to 5,000	820,000	350	426
Total				2,013	2,454

Table 4: Energy potential from biogas of cocoa processing companies

The volumes of cocoa bean shells of other big processing companies, such as Nestlé Ghana Limited, Cadbury Ghana Limited, is not known but could be in the same range of between 3,000 and 6,000 MT per year.

Starch production

Ghana is the third-largest producer of cassava in Africa after Nigeria and the Democratic Republic of Congo with a production capacity of 14,240 Mt in 2011.
The crop can grow all over the country and apart from its utilization for local food; cassava is used for starch production for industrial application for glue, biscuits, pharmaceutical products, paper-cartons, animal feed etc. Most recently, the brewery industry is also using cassava for local production of root beer.

The Ayensu Starch Company (ASCO) was established in 2003 by government in an attempt to commercialise the cassava. ASCO at Bawjiase in the Central Region is by now the only starch production factory in the country. The factory has a capacity to process 22,000 tonnes of cassava starch every year to feed local (multi-national) industries in Ghana.
The production process generates wastewater including a pulp, which needs adequate treatment but is more likely to be discharged uncontrolled.
According to factory's technical manager, per ton of cassava starch approximately 15.6 m³ wastewater and 5.6 tons pulp is generated, which can be used as feedstock for biogas plants:

	Residues [Mt/year]	Estimated methane potential [m³CH4/year]	Electric capacity [kW installed] Min -	Max
Pulp (from wastewater)	123,200	6,133,000	2,620	3,190

Table 5: Energy potential from biogas at starch production at ASCO

Unfortunately, ASCO was saddled with political, technical and financial problems and is currently trying to rehabilitate the plant to again reach the production capacity of 22,000 tonnes of cassava starch per year.

To meet the demand on starch for breweries in Ghana, meanwhile a mobile unit is also used to process the cassava plant to cassava cake at the point of harvest [10]. In one hour the mobile unit processes about 3,8 tons of roots into two tons of cassava cake on-site. The cake can further be processed to flour and cassava starch. The total output and residues of this mobile unit are not known.

Breweries

Ghana's alcoholic drinks industry is producing hard liquors such as whisky, brandy, schnapps, gin and rum, wines, ciders and other mild alcoholic beverages, as well as beers and stout.

The largest companies in the industry are Guinness Ghana Breweries Limited and Accra Brewery Limited.
Guinness Ghana Breweries Limited (GGBL) produces about 1.7 million hl beverages from the two breweries in Ghana, in Kumasi, at Kaasi and in Accra, at Achimota.
Accra Brewery Ltd (ABL) is the oldest brewing company in West Africa and now a subsidiary of SABMiller. ABL produces both alcoholic and non-alcoholic beverages, in total 1,872 million hl. [11]

Brewery wastes contain spent grains, yeast biomass but also liquid waste/ effluents. Up to 6 hl of wastewater is produced per hectolitre produced beer.
GGBL has waste water treatment facilities installed in Kumasi and Accra and is already producing biogas this way.

The following table gives an indication on the waste volume streams of a typical brewing process of one of the local breweries and their corresponding biogas potential:

Type of residue	Volume [m^3/year]	Estimated methane potential [m^3CH_4/year]	Electric capacity [kW installed] Min -	Max
Wastewater /effluent	300,000 m^3	360,000	256	312
Sludge from wastewater treatment	4,000 m^3	104,727	45	54
Spent grains	1,500 t	155,870	24	29
Spent yeast	120 t	unknown		
Total			325	395

Table 6: Energy potential from biogas of brewery with 500 khl production capacity per year

Cashew processing

Cashew production in Ghana is mostly carried out by smallholder farmers (90%), with an average farm size of around 2.5 ha; the largest farm size is up to 52ha. Approximately 40,000 farmers are engaged in cashew cultivation, producing up to 20,000 MT of raw cashew nuts in 2012. Most of them are located in the two major cashew growing regions, Brong Ahafo Region, Northern Region and the north part of Volta Region. The season for cashew is from February to June in Ghana.

Most of Ghana's cashews are exported raw and processed abroad. However there are few domestic processing facilities, but they are also taking advantage of the diverse cashew by-products, using the cashew shells as fuel for steam-powered machines and the cashew apples are processed into a wide variety of products, such as cashew wine, brandy, juice or bakery products. 5-6 Mt of cashew apple are produced per ton produced cashew nuts. So at least 100,000 Mt of cashew apples are available every year in Ghana.

Usually smallholder farmers neither have knowledge about how to properly collect, store and transport the rapidly decomposing apples nor funds to establish processing units. [12]

Nevertheless, the cashew shells as well as the cashew apples could be used as feedstock for AD. Unfortunately no literature information is available and no lab-scale tests of the biogas yield are available. So it is impossible to estimate the biogas potential of the available material from cashew production and processing in Ghana.

2.2.2 Livestock Farming

Taking into account the population of the five main livestock groups in Ghana and the estimated dung per head, the volume of manure produced would be the following:

Type of Livestock	2010 ('000)	2011 ('000)	Estimates of dung per head [kg]	Dung produced daily in 2011 [Mt/d]	Estimated methane potential [m³ CH4 /year]	Electric capacity [kW installed] Min -	Max
Cattle	1,454	1,498	12	17,976	119,086,506	50,810	61,925
Sheep	3,759	3,887	1.2	4,664	54.305.284	23,170	28,239
Goats	4,855	5,137	1.5	7,706	89.724.811	38,283	46,657
Pigs	536	568	3.6	2,045	24.632.025	10,510	12,809
Poultry	47,752	52,575	0.02	1,052	17.509.488	7,471	9,105

Table 7: Energy potential from biogas of manure produced by livestock in Ghana
[13; 14]

Smallholding is by far the most practiced form of livestock farming in Ghana; there are hardly any commercial farms. The major production of livestock is concentrated in the Northern, Upper East and Upper West regions of Ghana. Manure from livestock is therefore only available in small scale. Its utilization as feedstock for large scale biogas systems will be challenging and could need extensive pre-treatment:

- poor quality of the manure – lots of sand and feathers (poultry)
- unsteady availability -irregular cleaning of cages and stabling
- difficulties in manure collection due to poor infrastructure and long distances between farms

Manure is a source material whose dry matter and energy content is relatively low, which means that processing of a weak source material requires a relatively large tank fleet and the investment requirement per energy unit produced is higher than in the case of a plant which operates with a more energy-efficient source material. However, livestock manure could be an additional feedstock for co-digestion and a source of nitrogen, which is very important for the micro organisms in the biological process.

2.2.3 Abattoirs and slaughterhouses

The Accra and Kumasi Abattoirs are the largest in Ghana and have been equipped with modern facilities. Both are supposed to have a maximum capacity to slaughter 450-480 cattle per day, 450-480 sheep and goats per day and 200 pigs per day. .

City / area	Type of animal	Average per month	Content per animal		Estimated methane potential [m^3CH_4/ year]	Electric capacity [kW installed]	
			Paunch kg	Blood kg		Min -	Max
Kumasi Abattoir	Cattle	7,000	12	15.8	62,730	27	33
	Sheep	1,600	1.6	2.1	1,910	0.8	1
	Goats	1,900	1.6	2.1	2,270	1	1.2
	Pigs	475	4.4	5.8	1,560	0.7	0.8
	Total				68,470	29	36
Accra Abattoir	Cattle	1900	12	15.8	17,030	7.3	8.8
	Sheep	275	1.6	2.1	330	0.14	0.2
	Goats	475	1.6	2.1	570	0.24	0.3
	Total				17,930	8	9

Table 8: Energy potential from biogas at abattoirs in Kumasi and Accra [5; 13; 16]

In contrast to European habits, in Ghana slaughtering is done daily. Therefore biomass would be available daily and throughout the year on a relatively constant level with little peaks on holidays. Average data for biogas yields are defined as 60 m^3 per Mt paunch content with 55% methane and 37 m^3 per Mt blood with 60% methane

But apart from those two large facilities in Kumasi and Accra, there are only small to medium scale slaughterhouses or slabs in Ghana with low number of animals slaughtered: less than 200 large animals (cattle) per month or less than 1000 goats and sheep per month.

The slaughterhouse in Accra is significantly less frequented than the one in Kumasi, accordingly the waste streams are lower. Since there is hardly any livestock farming in this region, this slaughterhouse remains significantly under-used in the long-term. This is due to the fact that all small animals, up to the size of a goat, sheep or pig will be slaughtered at home and due to the location of the slaughtering houses and slabs mainly right in the centres of the cities, which makes them not well accessible for cattle transportation.

2.2.4 Agricultural products

Different kinds of tropical crops are cultivated in Ghana and residues such as maize cobs, rice husks or palm shells are major potential fuel used in many parts of the country. On one side, they are popular fuels that are usually used in relatively small quantities in addition to the main fuel forest wood or charcoal. On the other side they are also used exclusively for heating purposes such as in traditional palm oil processing, fish smoking or small scale palm kernel oil processing. Table 9 below shows the production of some major crops and their residue in Ghana.
Anaerobic digestion is one way to harness the energy potential of such crop residues. However, the main problem is that most of the agricultural residues are lignocelluloses with low nitrogen content. To improve the digestibility of crop residues, pre-treatment methods like size reduction, heat treatment, chemical or enzymatic decomposition etc are necessary.

Crop	2011 (‘000 Mt)	Type of residues	Ratio of residues to crop volume [t/t]	Estimated methane potential [m³ CH4/ year	Electric capacity [kW installed] Min	Max
Maize	1,683	Cobs and stalks	1.5	353,430,000	150.797	183.784
Millet	183	Millet straw	1.2	34,696,.800	14.804	18.042
Rice (paddy)	463	Rice straw	0.25	186,126,000	79.414	96.786
Sorghum	287	Sorghum stalks	1	17,908,800	7.641	9.313
Cocoyam	1299	Yam Straw	0.5	120,157,500	51.267	62.482
Yam	5,855	Yam Straw	0.5	541,587,500	231.077	281.626
Total				1,253,906,600	535.000	652.031

Table 9: Energy potential per kg DM from selected food crops
[13, 5, 16, 30, 31]

The co-digestion of crop residues together with animal manure or sewage sludge could be possible but only on a small to medium scale. Due to smallholding livestock farming and crop cultivation, collection and transport of the material is challenging and from an economic point of view mostly not feasible.
Nevertheless, co-digestion offers a good opportunity to farmers to treat their own waste properly and produce biogas for cooking.

2.2.5 Municipal solid and liquid waste

Organic material is one of the largest constituent of municipal solid waste streams. Currently, waste management in Ghana does not provide for full segregation of organic wastes due to a lack of financing or organisation or awareness of people.
As most of the municipal solid waste (MSW) is being dumped without diversion, another way to make use of the energy potential of the organic components is landfill gas capture and utilization.
Although anaerobic digestion of sewage sludge in wastewater treatment facilities is a common practice worldwide; in Ghana currently, raw faecal and sewage sludge is hardly treated at sewage treatment plants but rather dumped at landfills or poured into the ocean.

Regional Capitals	Solid Waste per month (tons)	Liquid Waste per month (m^3)
Accra	60.000	24.000
Tema	41.600	3.281
Sekondi-Takoradi	4.792	1.638
Kumasi	45.000	6.500
Tamale	5.600	5.504
Cape Coast	3.195	341
Ho	850	3.236
Sunyani	3.600	165
Koforidua	4.500	690
Wa	2.636	117
Bolgatanga	2.819	880

Table 10: Solid and liquid waste from various Metropolitan and Municipal capitals [5]

Biogas production from municipal liquid waste has been carried out in Africa over recent decades. However most of these plants are very small and are used to produce cooking fuel or to power domestic lighting but none of these plants has been built for producing electricity and none on a large scale.

2.3 Potential Clients and Structure

2.3.1 Potential client structure and critical mass

Potential clients for investments into biogas systems can be found by considering the perspective of actors that have waste that needs treatment.
The following are the most likely categories of potential clients for biogas installations:

- Food processors that have a need to find cost-effective solutions to bio-degradable waste disposal. They may, or may not, take in other feedstock either to assist the biological processes or simply to increase income.
- Land-owners/farmers who wish to treat their farm waste and add value to it. The waste coming from their farms can form a basic load for the plant. They may or may not take in material or waste products (e.g. source-segregated food waste) from other farmers or sources.
- Waste management companies that could establish landfill gas plants *or* in future install biogas plants close to landfill sites, if the bio-degradable waste is separated and pre-treated before final disposal.

However, one of the most important factors to the successful implementation of large-scale biogas is the collection of the feedstock. Thus irregular amounts and irregular quality of feedstock is problematic. The collection of small volumes will create traffic movement and enormous costs.

But apart from that, there are other critical factors for biogas installations:

- High initial invest: Potential clients such as food processors may have difficulties to finance the high initial investment that renewable energy projects require as a result of challenging market situations and intermediate weak financial situations.
- Limited access to financing: in Ghana financing biogas projects becomes often uneconomical due to astronomically high interest rates and the lack of long-term loans.

- Unfamiliarity with biogas technology: potential clients are generally unfamiliar with renewables and have institutional barriers to develop renewable energy concepts. Technical managers of food processors are focussing on their key competence – the production process itself. In terms of energy, managers are likely to concentrate on low-cost solutions and are not aware how renewable resources could fit into their systems. Only few environmental managers may consider pollution associated with their electricity demand.
- Lack of expertise for operation and maintenance: Workers must be trained to install, operate, and maintain renewable technologies. Biogas plants need special operating experience; the biological process needs to be controlled and monitored regularly to secure stable biogas generation. Education, training, and instructions to local managers, engineers and technicians are required and will also have a positive effect on the attitude to new technology in the long-term.
- Lack of maintenance practice: Lack of knowledge and skills as well as awareness to regularly and properly maintain technology is considered to be a major risk in Ghana and will cause additional costs and funding for rehabilitation.

Although Ghana mainly houses small scale plantations and farming and small scale urban based agro-processing as well, there are few food processing companies with large and stable production volumes and organic residues available on-site. Apart from adding value to organic waste streams, these companies have further motivation to invest in biogas systems:

- Provision of energy to be used in the industry on-site or feed into the nation grid
- Security of supply of electricity – need for stable energy supply (electricity, heat, cooling, steam)
- More cost-effective energy supply - utilization of own by-products/residues as for energy generation and supply
- Generation of valuable biological fertiliser as a by-product – replacing mineral fertilizer
- Interest to change energy system – energy efficiency and renewable energy
- Interest to change sanitation system – solving environmental problems caused by discharged effluents and organic waste

2.3.2 Electricity prices for potential clients

The biggest driver for biogas installation next to sanitation aspects however is the energy recovery from biogas systems. The biogas can be used to generate different forms of energy as heat, cooling and power.
At present, energy consumption at industries is a big part of the production cost. This is because there are usually significantly high consumption of fossil fuels such as Diesel, Residual Fuel Oil (RFO) or even LPG due to the operation of a mainly old, inefficient steam boiler, generators or high consumption of power from the grid.

Fuel	**RFO**	**Diesel**	**LPG**	**Power** Load Tariff Medium Voltage			**Power** Non-residential Tariff			
in GHS	per liter	per liter	per kg	Capacity Charge (kVA/month)	Energy Charge (/kWh)	Service Charge (/ month)	1-300 units	301-600 units	601 + units	Service Charge (/ month)
2011	0.84	1.77	1.36	13.2252	0.2039	15.4294	0.2527	0.2689	0.4243	2.760
2013 (October)	1.1	2.2	2.30	23.6598	0.3648	27.6032	0.4521	0.4811	0.7591	4.929

Table 11: Fuel prices in GHS
[17; 18; 19]

In October 2013 the Public Utility Regulatory Commission (PURC), as the body mandated to set the tariffs for electricity and water has approved adjustments in water and electricity tariffs. The current electricity tariffs amount to an increase of up to 80%.

This development together with unstable line-side power supply has adverse repercussions on businesses and is challenging Ghana as a whole.
Every energy-intensive industry is facing severe problems in terms of energy costs and fears the shutdown of production. The power demand currently relies on the national power grid and diesel fired generators as well as on RFO or LPG for heat and steam production. Most of the companies will look for options to replace this high-cost energy forms and to become more independent by using renewable energy technologies.
Biogas systems can offer an optimized interplay of all energy forms through an integrated concept by combined generation of electrical power, heat and cooling.

2.3.3 Sanitation and environmental requirements

With anaerobic digestion, a renewable source of energy is captured, which has an important climatic effect. The use of renewable energy reduces the CO_2-emissions through a reduction of the demand for fossil fuels and at the same time, by capturing uncontrolled methane emissions from organic waste and wastewater, the second most important greenhouse gas is reduced.
Besides, when industrial or municipal wastewater is being treated with anaerobic digestion, surface waters and ground and drinking water resources are being protected. Often the purified wastewater can be reused, e.g. as process water in industry or as irrigation water in agriculture.

Another driver for medium to large scale biogas installation is the improvement of environmental performance in accordance with environmental standards set by Environmental Protection Agency (EPA). Environmental indicators such as energy and water use, solid waste management and effluent treatment but also public complaints are monitored regularly. Especially parameters including effluent discharges, water and air quality are collected and controlled and violating the EPA guidelines is cause for a strong warning and potential closure of production plants.
Nevertheless, the current AKOBEN program, the environmental performance rating and disclosure initiative of EPA Ghana, confirms that only few food processing companies are showing signs of good environmental performances. Most companies, among others abattoirs, palm oil mills, distilleries or cocoa processing companies are rated with unsatisfactory or poor environmental performance. Despite the detection of non-compliance (violations) of laws, there is hardly strict punishment by EPA for deviators.

Generally, the international food processing companies have a stronger interest to increase their environmental accountability before their retailers and consumers. Improving their production process by using their own by-products and effluents for energetic purposes is an ideal opportunity to reach this goal.

2.4 Potential Business opportunities

The renewable energy market in Ghana is at the beginning of its development; experience, equipment and know-how for the use of production of biogas from abroad is very much in demand. Business opportunities for German companies exist in different areas that are connected with biogas technology and projects.

Before this background, Ghana is a market with many supply opportunities for plant manufacturers or installers as well as providers for plant equipment:

- Technologies, motors and components of biogas plants from organic waste and wastewater
- Technologies, motors and components for CHPs and exhaust gas systems
- Technology and components for refrigeration from exhaust heat or steam generation

Engineering know-how and technological advice is of interest, but the majority of potential clients for biogas installations are mainly looking for turn-key projects plus full service afterwards to overcome the challenges of biogas projects and to ensure economic plant operation in the long-term. Especially international investors prefer experienced partners for developing, installing and operating biogas projects in Ghana:

- Biogas EPC contractors: full responsibility for engineering, procurement and construction works on medium to large scale and complex energy generation projects
- Technical and biological support service: regular onsite service and analysis of feedstock in the digesters as well as constant remote monitoring and in order to prevent equipment stoppages and breakdowns and ensure optimum efficiency biogas production
- Maintenance and service providers for biogas technology: Expertise for preventive and corrective maintenance of CHPs and biogas process components, providing necessary range of consumables and spare parts, carrying out maintenance levels
- Logistic providers for biomass transportation: adapted transportation systems to ensure consistency of delivery and volume of feedstock supply, making agro-residues available for energy generation at medium to large-scale commercial, municipal and industrial biogas plants.
- Consultants for permit and licensing procedures: e.g. technical datasheets for biogas technology, Environmental and Social Impact Assessment and final documentations for the environmental permit.
- Companies specialized in environmental management: e.g. developing sustainable waste and wastewater management concepts in line with GHG reduction and improvement of energy performance of manufacturing industries.
- Organic fertilizer manufacturers and suppliers: whereas biogas digestions residues are mainly applied as liquid fertilizer on the surrounding agricultural land, there is also the possibility to treat the residues and offer different solid and liquid fertilizer products to agricultural producers across the country.

Although German companies will face extremely budget-conscious business partners, German companies and German products enjoy a high reputation in Ghana. Besides this, there is room for joint research and innovation programs, training and qualification of Ghanaian employees.

2.5 Framework Conditions

2.5.1 Policies and regulation

It is important to note that legislation and policy surrounding AD in Ghana is still under development and thus some of the information in this report could quickly become out-of-date.

Renewable Energy Act, 2011 (Act 832)

The first legal framework condition for renewable energies has been established, when the Parliament of Ghana has enacted the Renewable Energy Act in December 2011. Its goal is to increase the share of renewable energy technologies in the total energy mix and achieve 10% contribution in electricity generation by 2020. The objective of the Act is to support the participation of private sector in the electricity sub-sector and to allow independent power producers access to the grid. [20]

Key provisions of this RE Act:

- Feed-In Tariff Scheme for Renewable Energies to guarantee the purchase of grid electricity from independent power producers. The Feed-In Tariff rate has been determined and gazetted by PURC in August 2013:

Renewable Energy Technology	FIT effective 1st September 2013 GHp/ kWh
Wind	32.1085
Solar	40.2100
Hydro ≤ 10 MW	26.5574
Hydro 10 MW > ≤ 100 MW	22.7436
Landfill Gas, Sewage Gas and Biomass	31.4696

Table 12: Feed-In Tariffs for Electricity generated from renewable energy sources; [21]

- Obligation to purchase power from IPPs by the two state utilities and distributors of electricity to consumers, Electricity Company of Ghana (ECG) in the southern region and Northern Electricity Department (NED) in the northern region,
- Right of connection to distribution systems, to be provided by ECG or NED. Generators wishing to be connected to the transmission system must enter into an electrical connection agreement with Ghana Grid Company Limited (GridCo)
- Renewable Energy (RE) Fund to be established and managed by the Energy Commission (EC). The fund will be used to pay for the promotion and development of renewable energy sources as well as to fund the feed-in tariff. The fund will provide financial resources for capacity building in the renewable energy sector, grid expansion and the development of technology and pilot projects. The government is looking to pay for the RE Fund through a mixture of a levy on bio energy exports, government money and European Union funding.

Licence Procedure under Energy Commission

By the provisions of the RE act, any person that wishes to engage in a commercial activity in the renewable energy industry must obtain a licence from the Energy Commission before doing so. The Act defines the activities that require acquisition of a license, among others:

- the production and supply of electricity from renewable energy sources for supply to distribution utilities and bulk customers - Wholesale Electricity Supply Licence granted for 20 years
- the installation and maintenance of renewable energy systems – Installation and Maintenance License granted for 10 years

A licence may only be granted to a citizen of Ghana; or a body corporate registered under the Companies Code, 1963 (Act 179) or under any other law of Ghana; or a partnership registered under the Incorporated Private Partnership Act, 1962 (Act 152).
The different manuals for licences and application forms and licence fees shall be available at the Energy Commission’s website

→ www.energycom.gov.gh

The acquisition of the Wholesale Electricity Supply Licence consists of three stages [22]:

Stage 1: Acquisition of Provisional Licence
Stage 2 A: Acquisition of Siting Clearance (Siting Permit)

Stage 2 B: Acquisition of Construction Work Permit (Authorisation to Construct)
Stage 3: Acquisition of Operational Licence (Authorisation to Operate)

- At stage 1 the applicant has to submit the Feasibility Report and a Business Plan but would also need to demonstrate its financial capability as well as its operational experience and expertise.
- During Stage 2A an Environmental Assessment permit or certificate granted by EPA will have to be submitted.
- EPA has set guidelines for preparing of Environmental Impact Assessment for new energy investments as well as guidelines for the preparing Environmental Management Plan for existing energy companies and general guidelines for monitoring environmental performance and indicators and de-commissioning of all energy investments. The full procedure is described in Appendix 2.
- During Stage 2 B an approved FiT from PURC has to be provided as well as a signed Power Purchase Agreement (PPA) with an electricity distribution utility or a bulk consumer.

ECG has developed a procedure for engaging IPPs that is presented in Appendix 3.
A template for a standardized form of a PPA is currently developed by EC and will soon be available.

2.5.2 Financing mechanisms and donor programmes

A major barrier to rapid development of renewable energy projects is the lack of adequate financing mechanisms in Ghana. Although there is a strong interest by international and local financial institutions to promote RE projects, in Ghana, the financing becomes uneconomical due to astronomically high interest rates and a shortage of long-term loans.
However, financing is one of the key elements in order to ensure project viability. Low interest long-term loans are the most suitable means for financing the renewable energy projects. This type of loan should meet the demands for long maturity, low interest and low initial instalments.

Some local and international financial institutions have identified this lack and are in the process to develop instruments to make financing for renewable energy projects available under reasonable conditions.

- Establishment of Renewable Energy Desks by local banks to offer mainly micro to medium scale financing (i.e. by ProCredit)
- Raising of Renewable Investment funds (i.e. by JCS Investment) to provide small to medium scale financing (GHS 500,000 to 3 million)

The limited access to financing is also derived from lack of knowledge about suitable national and international available financing mechanisms and programs. Here just to name two special funds that could be suitable for certain biogas projects:

- Ghanaian Export Development and Investment Fund (EDIF) : Under this scheme, companies with export programs can borrow up to $500,000 over a five-year period at a subsidized cedi interest rate of 15%..
- UNEP Renewable Energy Enterprise Development (REED) is providing seed capital to small and medium enterprises operating in the clean energy sector in certain developing countries, among others in Ghana.

However, financing institutions or investors lack experience and knowledge in the sector. They are unfamiliar with the evaluation and calculation of biogas projects and only show interest in short payback period and high return on invest.

2.5.3 Investment conditions

The new Ghana Investment Promotions Centre (GIPC) Act 2013 (Act 865), which repeals the GIPC Act 1994 (Act 478), is introducing changes to the country's investment laws and institutions and contains provisions that may curtail foreign direct investment into Ghana. The Act requires Ghanaian citizens who partner with foreign investors to have at least 10% equity participation in the joint enterprise and capital requirements of the foreign investors of not less than US$50,000 in cash or goods relevant to the investment or a combination of both by way of equity capital.

In the case of an enterprise that is fully controlled by a foreign investor, the capital requirement is not less than US$200,000. The Act also expands the investment activities reserved for Ghanaians and Ghanaian owned enterprises: Trading enterprise that is principally engaged in the purchase or sale of goods shall not be wholly owned by non-Ghanaian but shall operate by way of a joint venture with a Ghanaian partner. The capital requirement for the foreign investor is not less than US$1,000,000 and such joint ventures employ at least ten skilled Ghanaians.

The GIPC ACT seeks to empower Ghanaian owned businesses whilst restricting foreigners into the retail sector. However, these changes are still new and their effects uncertain.

3 Major Potential Market Segments

3.1 Agricultural Industry and other Food Processing Industries

3.1.1 Fruit processing

The big fruit processing companies are potential clients for biogas installation. They are compliant to specific standards in terms of farming, production and transport since their clients require such certification.

The energy consumption is a big part of the production cost, due to:

- cooling, freezing to secure an unbroken cold chain for their chilled product – mainly electrically powered cooling units
- heat demand for drying the products or
- steam demand for juice

Although all of them process regular and big volumes of organic waste, there is just one biogas plant installed so far, but further installations a planned and considered.

<u>HPW Fresh and Dry Ltd.</u>

HPW is one of the largest factories for dried fruits in West Africa and has a capacity of 250 Mt dried fruits per year. The factory is situated in Adeiso, Ghana, approximately 60 km northwest of Accra. HPW is processing mango, pineapple, coconut and banana, mainly for export.

Figure 1: Biogas Plant at HPW Fresh and Dry Ltd in Adeiso 2011

HPW has invested in a medium scale biogas generator. Waste from the companies operation together with fruit deemed to be substandard is collected and passed into two digesters.

The system has been built to provide for 1/3 of the energy needed. The biogas is used to fuel the 200 kW_{heat} boiler providing heat for drying the finished product. The 120 $kW_{electric}$ generator that also has been installed is not working because of irregular biogas production (24 –59 m^3/h) with unstable methane content (40 -60 %).

Function, stability and performance of the biogas plant have been under review and different improvement measures have been initiated. Regular feeding with a balanced feeding of also nitrogen rich feedstock as well as regular measurements and control of gas parameters, pH and alkalinity has resulted in a stable biological process allowing stable biogas generation.

The use of the digestion residues as a fertilizer has not been possible so far because of the farmer's scepticism. This will further be investigated to improve environmental benefits and economics of the plant.
But apart from HPW, other fruit processors have shown interest into AD treatment due to lack of environmentally sound treatment of waste and effluents and due to rising electricity costs and need for alternative energy sources.

<u>Blue Skies Ghana Limited</u>
In Ghana Blue Skies is a major processor and exporter of fresh cut fruit which it exports by air to Europe. Blue Skies factories produce fresh-cut fruit and juice products and employ over 1,500 people and sources fruit from over 100 small to medium sized farms. Currently the majority of stationary energy consumption on the production facility is electrical and used for refrigeration. The power demand currently relies on the national power grid and stand-by diesel generators and sums up to 400 $kW_{electric}$. The biggest part, 80% of this energy, is used for the cooling system. Since the factories have to be chilled 24 hours daily, steady electricity consumption has been identified throughout the year.

In 2012 a feasibility study was conducted for the anaerobic digestion of the 7,300 – 8,000 Mt of fruit waste per year, which is mainly made up of pineapple and mango waste; however there is also some useable waste from papaya, passion-fruit, coconut and pomegranate. Currently part of this waste is being composted. Some additional materials have also been identified to be fed to the biogas plant, such as cocoa shells and pineapple mother plants.

Expected Output:

- 1.4 million m^3 biogas produced every year, used to fuel combined heat and power units (CHP)
- 400kW electric capacity to cover the energy demand for electricity
- 420 kW thermal capacity will not only cover own heat demand of biogas operation (digester heating) but also be used to produce warm water for the factory and feed the cooling system of the factory by absorption refrigeration.
- By using the released heat and the electric power of the CHP the total annual energy demand of Blue Skies Factory can be covered to 100%
- 2,000 Mt of digestion residues annually to be used as fertilizer

Financial Analysis:

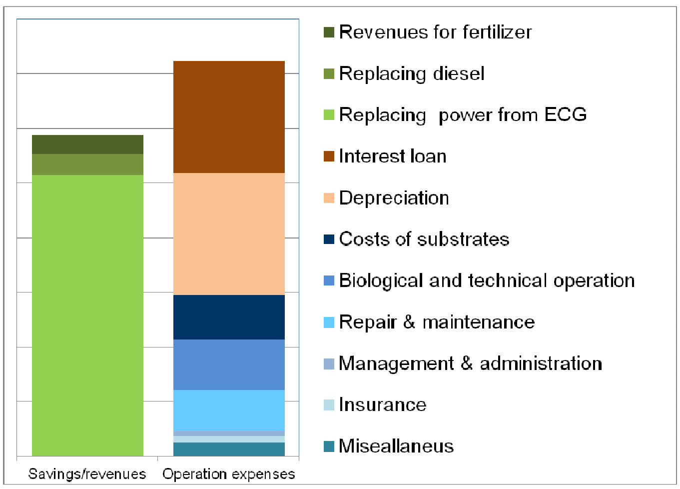

Figure 2: Annual costs and savings for a biogas plant project at Blue Skies Ghana

The total cost for the project has been estimated at GHS 5 million.
Revenues are primarily derived from the replacement of electricity and diesel (savings).
Furthermore, revenues for the sale of digestion residues as fertilizer are assumed. Currently mineral NPK fertilizer is GHS 50 per 50 kg fertilizer
Annual operating costs mainly consist of capital costs (60%), technical and biological operation (13%), feedstock supply (11%) and maintenance/ service (10%).

The capital costs are derived by the debt financing of 70% of the project costs with 12% interest rate and 10 year credit period. The equity, 30% of the project costs, will be financed by the project operator.

The cost-benefit analysis of the project has shown that the project is financially viable and economically sustainable if the initial investment of GHS 5 million will partly be funded by a grant. The scenario shown in Diagram 1 indicates that without any grant funding the capital costs incurred by the initial invest will result in annual expenses that are higher than the annual savings.
Status of the project:
The implementation of the project has been delayed due to the lack of grant funding for the project.
Currently Blue Skies is planning a pilot plant for the new factory building that is going to be installed in 2014. Once the pilot project has been successfully completed with proof of concept as regards technology and business model, the implementation of a large scale biogas plant may follow.

3.1.2 Oil palm processing

The traditional system used in Ghana's Oil Palm industry for effluent treatment consists of a set of anaerobic open-lagoon systems. The uncovered ponds generate biogas which is currently being discharged into the atmosphere.

One way to optimize these treatment systems and ensuring energy recovery at the same time is through covered anaerobic lagoons (digesters) and biogas capturing. The biogas can be captured and used for energy generation replacing the fossil fuels (diesel and bunker oil) that is utilized for heat generation in the Palm Oil Mill or the biogas can be used to run a CHP plant producing electricity and heat for the Palm Oil Extraction Plant.

<u>Ghana Oil Palm Development Company GOPDC</u>
The company has had plans for the construction of biogas plant with POME treatment at the mill at Kwae in the Eastern Region. The captured gas should be used to generate electricity and as a fuel for the GOPDC's refinery plant, which currently consumes 511 metric tons of diesel annually. Currently the POME is treated through the open anaerobic lagoon system without methane capture.
The expected output of the project was 126 kW of clean electricity for three communities, 1,000 Mt equivalent of diesel (in the form of 1.95 million m³ of biogas annually), 2,000 Mt of organic fertilizer annually as well as bio-oil and charcoal for domestic cooking
The total cost for the project has been estimated at €3.5 million, incurring an annual operating cost of €75,000. The cost-benefit analysis of the project has shown that the project is financially viable and economically sustainable.
The project implementation has been delayed as a result of the global financial meltdown in 2008 that causes challenges for GOPDC to secure the project's financing.
Other Palm Oil Mills do show interest in on-site biogas installations, e.g. Norpalm Ghana Ltd. has carried out a pre-feasibility study for a biogas project with its POME in 2010 and now plans to analyze EFB and PKS as additional feedstock for a future biogas plant.

3.1.3 Starch production

<u>Ayensu Starch Company Ghana Ltd</u>
Ayensu Starch Co Ltd. (ASCO) in the Central Region was established in 2003 by government. It is so far operating the only starch factory in Ghana with a production capacity of 22,000 metric tonnes of cassava starch every year. The company is considering the installation of a combined wastewater treatment and biogas generation. The effluent from the starch factory will be anaerobically digested to produce a high-quality biogas. The biogas can either fuel a generator for electricity production, or to fuel a boiler for steam production.

During full stable production with a capacity of 22,000 tons of starch, the proposed biogas energy plant will digest more than 123,000 tons of pulp per year, generating 12,000,000 m³ biogas per year.

Energy output <u>per ton of produced starch</u>:

- 545 m³ biogas generating an energy output of 11,740 MJ of energy - this could be converted to roughly 1150 kWh of electrical energy
- Per ton produced starch 63 L of RFO are used to fire the boiler for steam production (2,400 MJ)
- Per ton produced starch also 300 kWh of electricity (grid or diesel generator) are necessary

The starch company can fully cover its energy demand by using biogas produced by anaerobic digestion.

3.1.4 Breweries

Guinness Ghana Breweries Limited in Kumasi
Guinness Ghana Breweries, is a subsidiary of Diageo Highlands BV, which is based in the Netherlands. GGBL is Ghana's largest beverage company and operates two plants in Ghana (Accra and Kumasi).
The Kaasi plant in Kumasi is one of the two Ghanaian breweries of GGBL. The brewery is producing up to 50% of the company's annual production including Guinness Extra Stout, Star Beer, Gulder and non-alcoholic liquor Malta Guinness and Amstel.
In 2005 an effluent treatment plant was installed at Kaasi. The plant produces large volumes of biogas and this gas was not utilised but rather flared for a long period. In 2012 GGBL announced the revamp of the treatment plant to improve the quality of waste-water discharged from the brewery.

Figure 3: Effluent Treatment Plant at GGBL in Kumasi (Kaasi)

However, the utilization of the biogas for energy generation should also be explored. On the average, 2,815m³ of biogas is produced daily with an average methane content of about 67% and an energy output of potentially 67,700 MJ per day. [23] The biogas can be burned directly in boilers to generate thermal energy for production at Guinness. The biogas can also fuel a CHP to produce, both electrical and thermal energy, potentially 280 $kW_{electric}$ and 300 kW_{heat}
The scenario to use the biogas in a boiler and partly replace the conventional boiler fuel has been considered. The result would be operational cost savings and the brewery will be a bit more independent from external fuel supply.

At GGBL Kumasi 12,000 litres of RFO is used to fire the boilers for steam production, this equals a daily energy output of roughly 41,000 MJ. Hence the RFO can be replaced with 2,815m³ biogas produced daily. Taking into account the present costs for RFO of about GHS 1.1 per litre, up to 4.8 million GHS of operational costs savings could be generated for the brewery annually.

3.1.5 Abattoirs

The Ministry of Food and Agriculture (MOFA) noted with concern that the health of the general public was in danger because of the poor sanitary conditions at some abattoirs and meat processing plants in Ghana.
The system concept and the design of the abattoirs in Kumasi and Accra are quite improved. Nevertheless, the state of both abattoirs is insufficient and due to lack of waste management and effluent treatment in unhygienic conditions. [24]
Furthermore the burden of extremely high energy costs is challenging the economical situation of abattoirs, making it impossible for them to generate profit. Hence, abattoirs do not have the financial strength to consider biogas projects with high initial investments. [25]

Kumasi Abattoir Company Limited

The mechanically relatively well equipped abattoir has been built in the beginning of the 1990's with Canadian and international funding and German technology. Switching to diesel generator in times of power interruptions as well as increasing price for LPG is causing financial constraints to the company.

Electricity generation from biogas from own wastes would create a basis for the abattoir both to generate its own energy, meet its own energy demand and sell with a profit the surplus electricity to the national grid. Using the by-product heat, hot water could be produced or, if needed, cooling capacity could be built up for cooling the meat (this option was not given up till now). At the same time, this would mean that the abattoir could increase its capacity.
To develop an economically viable concept for the abattoir based on its own organic waste, additional feedstock for anaerobic co-digestion needs to be identified, i.e activated sludge from the Guinness Brewery, cocoa been shells of ADM, biowaste from the central market.

In October 2013 the establishment of a pilot biogas project at the Kumasi Abattoir has been announced. The three-year project, which will be undertaken with a budget of GH₵3,815,469 (€1,280,000), is financed by Ministry of Trade, Industry and Energy (MOTIE) of Korea and Daewoo as well as by United Nations Industrial Development Organisation (UNIDO). The Ghanaian and Korean collaboration with the Energy Centre (TEC), Kwame Nkrumah University of Science and Technology (KNUST) as host is looking forward to providing a business case for industrial-scale biogas applications - demonstrated and promoted, ensuring an industry-led research on appropriate technologies and feedstock for optimum biogas production and raising public and political awareness and interest regarding the benefits of biogas. [26]

3.2 Landfill gas

3.2.1 Status quo of the market segment including project references

Presently there are only few intentions to capture landfill gas in Ghana. However, several investors have visited different locations and shown interest but so far, no landfill gas capturing and energy generation project has come to realization.
In 2011, Blue Sphere Corp, an Emission Reduction project integrator has signed a memorandum of understanding with the Kumasi Metropolitan Assembly for a landfill gas capturing and flaring project at the sanitary landfill in Kumasi. The project assumed an average Carbon Emission Reduction (CER) price of $13 per tonne summing up to approximately $988,000 earnings per year. This way Blue Sphere was planning to recoup its initial invest of approximately $1.8 million within two years. [27]
The CER price has fallen tremendously within the last years and currently reaches about €0,5 per ton in October 2013. [28] This means current prices are hardly able to cover transaction costs for project registration and issuance. Potential revenues have fallen below levels that provide an economic incentive for clean development projects.

Landfill gas projects comprising installation of landfill gas capturing systems and with power generation will be possible and the recently published feed-in tariffs for renewable energy are an incentive for such projects in Ghana.

3.2.2 Potential clients and areas

The technical circumstances allow landfill gas capturing and use in certain locations in Ghana. The organic content of the deposited waste is low, but there are sufficient gas building conditions – the water content in most of the landfills is sufficient for a stable anaerobic organic process.
The old dumpsites and dumpsites in rural areas are often unusable for degasification due to small deposited waste amounts, insufficient filling period, fires at the dumpsite as well as little organic content caused by a high sorting level. There are still shortfalls in the nature and structure of the deposited waste. There are few disposal sites with sufficient waste capacity and engineered filling area to be found.

Active Engineered Landfills in Ghana

	Daily dumping volumes in Mt	Maximum capacity (CHP) to be installed in $kW_{electric}$	Capacity (CHP) to be installed over a period of 4 years in $kW_{electric}$
Kumasi	1,000	2,400	1,200
Sekondi-Takoradi	320	700	600
Tamale	240	1200	800
Tema	2,200	7,000	6,000

Table 13: Energy potential of selected landfills
[29]

The following table presents the results of landfill gas prognosis: the potential maximum electricity output is calculated with respect to the medium gas production prognosis and specific parameters of a CHP plants (e.g. degree of efficiency 37%). Taking into consideration a minimum period of energy recovery of about 4 years, a plant capacity to be installed in CHP units is also assumed.

3.2.3 Promising business models, opportunities, trends and future development

Cooperation concept:
For developing business models on landfill gas projects, cooperation with the Waste Management Departments of the Metropolitan/Municipal Assemblies as well as with the landfill operators is necessary:
The Assemblies are the owners of the landfills and consequently also owners of the gas emitted by the landfills. Hence, the Assemblies may receive an adequate remuneration for the landfill gas based on the energy equivalent amount of produced electricity. On the other side, the landfill operator may use the heat energy produced by a combined heat and power plant for heating water for washing purposes (i.e. trucks and compactors).

Financial analysis:
Project costs of landfill gas capture and energy generation system could range between GHS 2,5 million for 800 kW plant and GHS 10 million for a 6 MW plant and include costs for power generation system (CHP aggregate including gas cooling device and gas cleaning device), gas capturing system and the power feed-in device (transformer and transmission stations).

The revenue sides of landfill gas projects are difficult to influence. There are hardly any industrial consumers for the power produced near to the landfills, so the major revenues will be generated by feeding the power into the national grid for GHp 31.46 per kWh.

Thus a potential landfill gas plant in Tema could generate revenues between GHS 14 and 15 million per year but will also have to bear the expenses for technical operation and management as well capital costs for the financing of the high initial investment.
Correct and reliable data about actually incurring costs with regard to the construction and operation of a landfill gas plant can only be given when commercial plants are realized:

- full service and maintenance
- personnel costs for plant operation
- electricity demand of CHP units
- management and administration also including insurance
- savings for the reinvest in new CHPs (replacement of engine) or general overhaul of the existing CHPs after 4.5 to 6 years
- remuneration of landfill gas

However, based on operational experience from other countries, the available feed-in tariff of GHp 31.46 per kWh might be sufficient to form economical viable landfill gas projects in Ghana.

3.3 Improvement of project's viability

3.3.1 Energy Efficiency

In Ghana Energy Efficiency is widely promoted, but mainly concentrated on adoption of energy efficient technology and practices. Efficient energy production is hardly practiced, i.e. the waste heat (exhaust and cooling fluid) from diesel generators is not used.

Biogas is a viable alternative to fossil fuel based energy. Although the installation of combined heat and power plants (CHP units) are usually related to higher investment, they will replace high-cost fossil energy forms through the optimized interplay of all energy forms: power, heat and cooling energy.
Thus, viable biogas projects are mainly derived from sustainable and efficient energy production concepts that take into account all energy demands: steam, heat, cooling and power and find ways for economic fossil fuel substitution and enable better return on investment.

3.3.2 Operation, maintenance and service

Operation and maintenance in the biogas sector involves a lot more than just continuous plant feeding and daily checks. Intelligent maintenance enables higher availability and lower maintenance costs in biogas plants. The daily work requires technical know-how and crisis management experience, among others expertise in:

- microbiology of biogas plant (controlling the fermentation process and monitoring of process stability in the digesters, feedstock characteristics and controlling and evaluation of process measurement data and crisis management)
- CHP technology (operation of CHP units, avoiding and remedying faults and impurities in the biogas, controlling and evaluation of CHP measurement data, identification of plant-specific maintenance intervals)
- Safety rules for biogas plants

Presently, there is hardly any expertise available in Ghana, especially on biogas driven CHP technologies. Some companies that provide service for diesel generators consider building up expertise on gas fueled CHP units to broaden their range of service.

4 Conclusions and Recommendations

In general, the biogas potential in Ghana is clearly bound to the agro-industry and its future development.

It might be summarized as below:

- Current biomass utilization for biogas production is on low level in comparison to the given biogas potentials of organic residues from agricultural, agro-industrial and municipal sector.
- There is a high biogas potential within the food processing sector; however, this potential is currently not realized.
- Utilization of agro-and food industrial residues, especially from processors of oil palm fruit, cocoa beans, cassava, pineapple as well as oranges and mangos, could provide a solution to energy supply problems and contribute to environmental protection (e.g. water pollution, greenhouse gas reduction)
- The feed-in tariff for renewable energies is offering a slight incentive to implementation of biogas, although the major driver is rather the increase of energy costs (electricity tariff, LPG, diesel and RFO prices)

The most likely clients for biogas installations are big food processors because of their demand for:

- cost-effective solutions to organic waste disposal and wastewater treatment
- alternative energy (self) supply solution to become more independent from energy market and the price developments
- creation of cost savings regarding the energy supply
- strict compliance with environmental regulations

Main barriers referring to the implementation of biogas in Ghana are identified as:

- Lack of knowledge and experience in the field of biogas in general
- Lack of experience with implementation procedures for independent power producers licensing and permit procedures
- Lack of local biogas technology – need for import of high-priced equipment
- Lack of maintenance culture and maintenance service providers
- Low feed in tariffs for electricity from biogas plants
- Lack of financing mechanisms for biogas projects
- Lack of experience/ knowledge of financing institutions and investors of how to calculate and evaluate biogas projects

Need for further action could be identified for:

- Enforcement of Environmental Law

  In order to promote the further expansion of medium and large scale biogas plants, it is important to strengthen the enforcement of environmental protection law. In Ghana, despite regular inspections and monitoring activities (AKOBEN program), non-compliance (violation) with environmental regulations is hardly answered by any financial and/or penal consequences.
- Further incentives to motivate biogas investments
- Adaptation of foreign technology to country-specific conditions

The development of potential business opportunities is attached to the development and improvement of the specific biogas sector itself and thus the following stakeholders should show interest in the Ghanaian biogas sector:

- Biogas plant investor companies
- Biogas plant design and engineering companies
- Suppliers of power plants and process equipment
- Biogas EPC contractors
- Logistic providers for biomass transportation
- Maintenance and service providers for biogas technology
- Consultants for permit and licensing procedures
- Companies specialized in environmental management
- Organic fertilizer manufacturers

Generally, it is recommended to establish cooperation with local partners who can assist in overcoming the country specific conditions, laws and even cultural barriers. In the long term, the merger with a company that has been on the market for some time, could be a more effective solution than the establishment of an own subsidiary and the confrontation with all the peculiarities of the Ghanaian market.

In the end, there is one major issue that will positively affect the promotion of biogas projects: the acceptance of renewable energy systems largely depend on long-term successful projects. The present attitude towards biogas is positive, but can become negative if such biogas systems are neglected and not followed-up with maintenance activities which don’t show profitability because of bad business concept behind them.

References

1. MoFA, Statistics, Research and Information Directorate (SRID), Agriculture in Ghana – Facts and Figures 2011; August 2012
2. MoFA,; December 2013
3. Feasibility Study Report Malaysia
4. Biotec International S.C., http://www.bio-tec.net/; December 2013
5. REEEP, Renewable Energy Policy Framework for Climate Change Mitigation in Ghana; July 2010
6. UNIDO, Ghana's Mango and Pineapple Value Chains; July 2012
7. World Cocoa Fundation, Cocoa Market Update; March 2012
8. Adzimah, S.K., Asiam, E.K., Design of a Cocoa Pod Splitting Machine. Research Journal Applied Sciences, Engineering Technology, vol. 2, p. 622-634, 2010.
9. Bouafou Kouamé Guy Marcel, Konan Brou André, Dally Théodore, Kati-Coulibally Séraphin; Waste and by-products of cocoa in breeding: Research synthesis; Int. J. Agr. & Agri. R. 1(1): 9-19.
10. DADTCO; December 2013
11. SABMiller; December 2013
12. ACI, Byproduct Study Factsheet, December 2013
13. MoFA , Veterinary Services Directorate; December 2013
14. Larson Eric D. and Kartha Sivan, Bio Energy Primer: Modernised Biomass Energy for Sustainable Development, United Nations Development Programme (UNDP); 2000
15. The Journal of Physiology. (1943) December 31, 1943 102 (3) 290-305
16. MoFA, Statistics, Research and Information Directorate (SRID), Agriculture in Ghana – Facts and Figures 2010; May 2011
17. ECG, Approved tariff; October 2013
18. Finance News, Fuel Prices; December 2013
19. MoE; December 2013
20. Ministry of Energy , 2012
21. PURC, Publication of Feed-In Tariffs for electricity generated from renewable energy sources, 2013
22. EC, Wholesale electricity licence, December 2013
23. Elias Aklaku; 2011
24. MOFA; November 2013
25. Kumasi Metropolitan Assembly; November 2013
26. Daily Graphic; October 2013
27. Kumasi Metropolitan Assembly, Blue Sphere Corp; 2011
28. Weekly Carbon Report, October 2013
29. EnD-I AG, Landfill Gas and Biogas in Ghana, 2011
30. Biogasausbeuten Datenbank – lfl Bayern;.. http://www.lfl.bayern.de/iba/energie/049711/index.php; January 2014
31. Thomsen, S.T.; Kádár, Z. and Schmidt, J.E.; Estimating bioenergy potentials of common African agricultural residues; 2013

Appendix

Appendix 1 - Environmental Assessment Regulation 1999 (L.I.1652), Environmental Impact Assessment Requirements in Ghana

ENVIRONMENTAL ASSESSMENT REGULATIONS 1999 (L.I.1652)

It is an offence to start a project / development without an Environmental Permit

7. *VALIDITY OF ENVIRONMENTAL PERMIT (EP)*

When does my EP expire?

Environmental Permit is valid for 18 months from date of issue. Where the undertaking does not start within 18 months, the developer is required to re-apply.

8. *ENVIRONMENTAL MANAGEMENT PLAN (EMP)*

When do I have to submit an EMP?

Within 18 months of commencement of operations and thereafter every 3 years.

An Environmental Management Plan is a document that reports on the efforts that would be made to manage environmental impacts which will result from the operational phase of an undertaking.

9. *FUND FOR RECLAMATION*

What is Reclamation Bond?

Reclamation bond is a financial security or insurance which sets aside funds for the specific purpose of restoring any degraded area, if the proponent fails to do reclamation.

10. *ENVIRONMENTAL CERTIFICATE (EC)*

When do I have to obtain an EC?

Within 24 months of the start of operations, if the following conditions are met:

* evidence of acquisition of other permits and approvals where applicable
* compliance with all the commitments stated in the PER/EIS
* compliance with all the conditions of the environmental permit for the undertaking
* submission of an Annual Environmental Report and
* submission of an EMP

11. *ENV. PERMIT vs. ENV. CERTIFICATE*

What is the difference between the permit and certificate?

Environmental Permit must be obtained for proposed new undertakings. Environmental Certificate must be obtained for operating (ie. old or existing) undertakings.

12. *FEES*

Do I have to pay a fee for a permit or certificate?

Yes! A fee is required to be paid for each environmental permit or certificate issued.

13. *REVOCATION OF PERMIT OR CERTIFICATE*

Can my permit or certificate be withdrawn?

Yes! The Agency may suspend, cancel or revoke an Environmental Permit or Certificate if any of the conditions listed under Regulation 26 is breached.

14. *PROVISION FOR APPEAL*

Can a person complain when aggrieved by any decision or action?

A person aggrieved by any decision of the Agency may appeal to the Minister responsible for Environment. The complaint must be made within 30 days of becoming aware of the decision or action of the Agency.

For Further Information contact the:
Executive Director
Environmental Protection Agency
P. O. Box MB. 326, Accra
Tel.: (233-21) 664697/8; 663499; 671869
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Email: eia@epa.gov.gh/geacap@epaghana.org
Website: www.epa.gov.gh

1. *REGISTRATION OF UNDERTAKINGS*

1a. What is an undertaking?

"Undertaking" means any enterprise, activity, scheme of development, construction, project, structure, investment, plan, programme, demolition, rehabilitation or decommission, the implementation of which may have a significant impact.

1b. New undertakings

Do I need to register my proposed undertaking with EPA?

According to Regulation 1, all undertakings that could have a negative effect on the environment must be registered with the Environmental Protection Agency (the Agency)

1c. Existing undertakings

What about undertakings already in existence before June 24, 1999?

If an undertaking was already in existence before 24th June, 1999 and has or is likely to have adverse effect on the environment, that undertaking must also be registered and an environmental permit obtained, in line with Regulation 2.

1d. Process of registration

How do I register my undertaking?

An undertaking is registered by completing and submitting the appropriate registration form to the Agency (This also is the application for environmental permit).

2. *INITIAL ASSESSMENT (SCREENING)*

What happens after I register my undertaking?

After registration, the proposed undertaking is screened. The screening results in one of the following decisions:

(i) Approval for the undertaking (May proceed to develop)
(ii) Objection to the undertaking (Cannot proceed)
(iii) Preliminary Environmental Report (PER) Required
(iv) Environmental Impact Statement (EIS) Required

3. *PRELIMINARY ENVIRONMENTAL REPORT (PER)*

When is a PER submitted on an undertaking?

When the Agency considers that a proposed undertaking is likely to have some negative effects on the environment. Undertakings listed in Schedule 1 of the Regulations may require PER.

4. *ENVIRONMENTAL IMPACT ASSESSMENT (EIA) REPORT*

(An EIA Report is also referred to as EIS)

4a. When is one required to submit an EIA Report?

(i) When the Agency after considering an application decides that the proposed undertaking is likely to have severe negative effects on the environment.
(ii) For Undertakings listed in Schedule 2 and
(iii) Those sited in areas that are considered to be environmentally sensitive (Schedule 5) EIA must be done.

4b. When is a Scoping Report Required?

Scoping is the first exercise to be carried out to determine the main issues to be addressed in EIA Study. The scoping exercise leads to the preparation of terms of reference (TOR) which serves as a guide for the EIA. The TOR must be agreed upon between the Agency and the proponent.

5. *REVIEW OF ENVIRONMENTAL REPORTS (PERs/EISs)*

5a. What happens to Environmental Reports submitted?

The PERs and EISs submitted are reviewed by the Agency in collaboration with relevant ministries and government agencies. For EISs, 21-day public notice (newspaper adverts) is served to invite contributions/comments.

Public Hearing is held as part of the review (Regulations 16 & 17) where:

* there are strong public concerns on the undertaking
* it involves resettlement/relocation of communities, utilities or diversion of river/stream
* the Agency considers that the undertaking could have extensive and far reaching consequences on the environment.

5b. When do I receive response to my submitted Application or Report

There are set time limits within which the Agency must complete its action on applications received.

* Screening application takes up to 25 working days.
* PER review takes up to 15 working days.
* Scoping Report takes up to 25 working days
* EIS review takes up to 25 working days.

These refer to the official period within which the Agency would make its decisions (except where Public Hearings are held)

6. *ENVIRONMENTAL PERMIT (EP)*

6a. When is an environmental permit (EP) issued?

Environmental Permit is issued to a developer when one of these conditions is met:

* An application is submitted and "no objection" is given;
* A PER submitted on an undertaking is accepted or
* An EIS submitted on an undertaking is accepted.

6b. Does my obligation under LI 1652 end with obtaining the Environmental Permit?

The requirements of the LI cover the entire life span (constructional & operational) of the undertaking. The EP gives clearance only to commence the undertaking.

EP is granted on a set of conditions including:

* submission of Annual Environmental Reports (Regulation 25),
* submission of Environmental Management Plans (Regulation 24),
* obtaining an Environmental Certificate for the operational phase and
* provision of financial security / insurance bond for reclamation (Where applicable).

Agriculture - *land for agric ≥40 hectares or affecting ≥20 families/irrigation and wetland cultivation/land and water based (aqua-) culture.*

General Construction and Service - *dam / impoundment/ reservoir / groundwater / land reclamation (coastal, etc.) / dredging / industrial and housing estates*

Health - *hospitals, health related-facilities / incineration, recovery, waste treatment, landfill facilities*

Mining - *mineral extraction/processing*

Energy - *oil and gas fields/oil refineries / pipelines / storage facilities / power generation / transmission*

Tourism - *hotel / recreational facilities ≥ 40 rooms or in national parks / reserves / hill tops / on islands*

Manufacturing Industry - *chemicals and petro-chemicals/ pulp and paper / food and beverages (abattoir, brewery, etc.)*

Forestry and Wildlife - *conversion to other land uses, conservation, management of wildlife, reserve areas, watershed, catchments / commercial exploitation of flora and fauna / introduction of (exotic) species, biological agents*

12.0 *Environmentally Sensitive Areas*

(i.e. EIA is required for undertakings within or near such areas)

- *National parks, reserves, sanctuaries, groves, watershed.*
- *Habitats of endangered / threatened / rare species*
- *Areas of unique cultural and tourist value.*
- *Areas prone to natural disasters, hilly areas with critical slopes, eroding coast, prime agricultural lands*
- *Recharge areas of aquifers / water bodies*

WHO BENEFITS FROM EIA AND HOW?

The Proponent and Society as a whole benefit.
EIA predicts likely problems, conflicts and constraints, and determines ways to minimize or avoid them; also offers opportunities and how to realise and enhance them.

EIA presents options to select from, makes projects more likely to be completed on time and resources relied upon are conserved.

EIA provides means for all parties to be consulted (public involvement), for agreement to be reached between stakeholders and proponent; and for the answers needed to make informed decisions for sustainable development.

ARE EIA REPORTS CONFIDENTIAL?

No!
EIA Reports (PERs and EISs) are documents in the public domain. They are required as much as possible to be non-technical, easy to understand and, their presentation must follow prescribed simple formats.

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Environmental Impact Assessment (EIA) Requirements in Ghana

EIA
the Pathfinder to Sustainable Development

1.0
What is Environmental Impact Assessment (EIA)?

EIA is a planning and a decision making tool, applied in Ghana to proposed "undertakings" (i.e any activity, project, structure, investment, plan, programme, etc., the implementation or development of which may have a significant impact).

2.0
What does EIA involve generally?

EIA involves the gathering and analysis of all relevant information on a proposed undertaking to determine the likely consequences if the undertaking is implemented in a given area; and if it should, what appropriate mitigations or alternatives must be considered, in order to ensure environmentally sound and sustainable implementation or development.

The main stages in the EIA process include screening, Scoping and the actual EIA. However in some cases a Preliminary Environmental Assessment (PEA) may be required (Section 6.0).

3.0
Who are the Key Actors in EIA of a Project Proposal?

The Proponent
Environmental Protection Agency (EPA)
Relevant Metropolitan / Municipal / District Assembly
Relevant Ministry and Departments
Other stakeholders (affected and interested parties)

All stakeholders must be effectively consulted/involved for their inputs and to address any concerns and requirements of theirs in the EIA.

4.0
Who conducts or carries out EIA of a Proposal?

EIA of a proposal is carried out by the proponent (i.e. The prospective developer or investor or owner of the undertaking). The proponent may conduct the study or commission an expert to do so.

Are you a prospective Investor?
Do you intend to start a project?

5.0
The Key Question to ask is:"

"Does my proposed project require EIA?"

5.1 (Yes) If project is included in the EIA Mandatory list (Section 11)
5.2 (No) If project is not listed in Section 11
5.3 If answer is YES continue from Section 7.0
5.4 If the answer is NO, fill in Proposal Registration - ***Form EA1 for screening advice***

5.5 The **advice** could be one of the following:
(i) Objection to proposal (i.e. cannot proceed)
(ii) No objection (i.e. Proposal may proceed)
(iii) PEA required (Section 6.0)
(iv) EIA required (Section 7.0)

6.0
Preliminary Environmental Assessment (PEA)

PEAs are required for moderately significant impact undertakings to provide adequate information on the undertaking as the basis for decision-making.

The findings of the PEA are compiled in a Preliminary Environmental Report (PER). Twelve (12) copies of the PER are submitted for review and decision-making on the undertaking. However if the findings indicate significant impacts, then EIA will be required.

7.0
Environmental Impact Assessment (EIA)

If the answer is YES in Section 5.1 fill in the Form EA2 to register your undertaking. You will be advised on receipt of the Form EA2 to carry out scoping for the EIA. (Scoping helps to focus the EIA on the major issues and concerns). The output of scoping is Draft Terms of Reference (TOR) for carrying out the EIA.

Ten copies of the scoping report (incorporating the TOR) must be submitted for **agreement** on the draft TOR, prior to commencing the actual EIA.

The findings of the EIA are compiled into a Draft Environmental Impact Statement (EIS). Twelve copies of the E.S are submitted for review and decision-making.

8.0
Environmental Permit

An Environmental Permit (EP) must be obtained in order to commence or implement an undertaking in Ghana. The three conditions to satisfy for EP issuance are:

i) If a "No objection" is given to an undertaking's form EA1 submitted

ii) If the PER submitted on an undertaking is considered acceptable

iii) If the EIS submitted on an undertaking is considered acceptable

An EP is an evidence of compliance with the Environmental Assessment Regulations, 1999 (LI 1652), the Ghana EIA Procedures and the Environmental Protection Agency Act, 1994 (Act 490). The EP validity period within which the proposal must commence is normally 18 months.

The EP for an undertaking must be regularised into an Environmental Certificate upon satisfactory commencement and compliance with relevant permit conditions within 24 months after commencement of operations.

9.0
Appeals

Any person(s) aggrieved or dissatisfied by any decision, action or omission of the Agency with respect to an Environmental Assessment of an undertaking has the right of appeal to the Minister responsible for Environment, who will appoint a Board to determine the case.

10.0
Fees

The Agency charges Environmental Assessment Permit and Processing Fees for its services.

11.0
EIA Mandatory List

(I.e. Undertakings for which EIA is required)

***Transportation** - airports, airstrips, roads, railways and Harbours*

Appendix 2 -ECG – Procedures for Engaging IPPs

ELECTRICITY COMPANY OF GHANA (ECG) PROCEDURES FOR ENGAGING IPPs

1. Letter of Intent and Report on Prefeasibility
2. ECG due diligence process commences (i.e. Legal, Financial & Technical diligence) Due diligence shall involve collection and validation of information from Investor
3. Signing of MOU
4. Stakeholder Consultation for both Investor & Off-Taker (i.e. MoEn, PURC, EC, Fuel Supplier, EPA, EPC, Contractors, etc.)
5. Inspections of licenses (i.e. Provisional license from EC & EPA Site Clearance)
6. Indicative pricing from PURC
7. Submission of final report on project feasibility
8. Discussion and Negotiations on technical feasibility, financial proposals and legal issues
9. PPA Negotiations
10. Initialing of draft PPA
11. ECG Board Approval
12. Signing of PPA
13. Distribution of signed PPAs to relevant stakeholders