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CRITICAL FACTORS IN BIOENERGY IMPLEMENTATION IN GHANA

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Lähi vuosina huoli bioenergia-teknologian toteutumisesta on alkanut vaivata monia. Tutkimukset tästä osoittavat että tekijät jotka myötävaikuttavat bioenergianteknologia-kauppaan, joko myönteisesti tai kielteisesti, vaikuttavat Afrikan myötä myös Ghanaan.

Tutkimus kertoo myös eri bioenergia systeemien kasvusta eri instituutioiden ja hallintolaitosten avun ottoon päätöstenteoissa. Tutkimuksessa tarkasteltiin seuraavia kriittisiä tekijöitä: Taloudellisten toimien yhdistyminen käytäntöön, institutionaaliset valmiudet, toimitusketjun koordinointi, kilpailu maan sisällä ja taloudelliset kannustimet jotka estävät bioenergian laajenemisen Ghanassa.

Tutkimus paljasti neljä asiaa mahdollisista vastustavista asianhaaroista. Ensinnäkin, ei ole mitään voittamattomia esteitä jotka pystyisivät kieltämään bioenergian potentiaaliset mahdollisuudet Ghanassa. Toiseksi, ei-tekniset ongelmat estävät kasvua enemmän kuin tekniset ongelmat. Kolmanneksi, bionenergian haasteet ovat dynaamisia riippuen asianyhteydestä ja neljänneksi, johdonmukainen ponnistelu esteiden poistamiseksi eritapauksissa tuottaa tuloksia.

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ABSTRACT

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The implementation of Bioenergy technology has become the concern of many in recent years. This research contributes to the identification and analysis of factors that facilitate the implementation of Bioenergy technology including barriers and drivers behind Bioenergy market growth in Africa and for that matter Ghana.

The paper talks also about the growth of different Bioenergy systems available for decision making within the various institutions and industry for administrative purposes. The following critical factors are identified, know-how in the various Bioenergy companies, economic conditions and supply chain coordination. They are affecting the Bioenergy industry in Ghana positively and negatively.

The case studies reveal the four main points about barriers. Firstly, there are no absolute barriers when it comes to the realization of the potentials of Bioenergy in Ghana. Secondly, technical issues rather do not hinder the growth of Bioenergy like non-technical challenges. Thirdly, Bioenergy barriers are dynamic depending on the context and fourthly, efforts are being made consistently to intervene and overcome barriers in various case studies.

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1 INTRODUCTION

Investigating barriers to utilize Bioenergy in Ghana is justified by the importance and relevance of energy security to the Ghanaian society as a whole and in combination with the limitations on conventional energy sources (mainly fossil) in Ghana. Crude oil reserves are not enough to meet the energy demands of the country and hence there is the need to make other sources of energy viable to meet the energy needs of the country.

The development of the Ghanaian energy system in the context of energy security and climate change will rely on improved energy efficiency and expanded renewable energy. Ghana has been divided geographically into ten (10) regions but the present pattern of Bioenergy utilization varies across the regions. Bioenergy is the only sizeable option in the energy supply of some regions in Ghana including Western, Ashanti, and Central where forests and agricultural resources promote the use of Bioenergy.

The Bioenergy resources in Ghana in addition to the continuing development of conversion technologies show that Bioenergy will play a significant role in the future of Ghanaian energy system. One of the major problems facing Bioenergy in Ghana is how to accelerate the implementation of Bioenergy systems to meet targets for renewable energy and Bioenergy,

The implementation chain, that's where most of the critical problems appear, especially at the later stages where technically well performing systems have to compete with other forms in the energy market. Those problems are referred to as ''Nontechnical Barriers'' to Bioenergy implementation. Non-technical barriers have been identified by a number of projects and conferences. For example, non-technical barriers were identified during the AFB-Nett project which was financed by the European Union (EU) (Roos;Graham;Bo;& Rakos, 1999).

As of now, there are no structured frameworks that have been delivered to point out the important barriers that hinder the development of the Bioenergy market in general but this study presents a framework as to how barriers should be understood. Dynamic forces are also focused within the Bioenergy market rather than separate single projects.

Living standard is one of the important factors in determining the importance of wood a source of energy. It is estimated that about 80% of harvested primary round wood is used by the forest industry, and what is used from logging in energy production is usually small and instead, the use of wood in energy production is based on industrial by-products. About 80% of wood from logging is used directly for energy production in the developing world. (Toivonen;Tahvanainen;Pelkonen;& Magar, 2008)

1.1 Objective of the research

The objective of this research is to identify factors that facilitate the implementation of Bioenergy technology including barriers and drivers behind the Bioenergy market growth in Ghana. The study applies theories and concepts from economic theory. The main focus is to analyze the problems associated with the implementation of Bioenergy in the perspectives of production and market structure.

1.2 The research questions

This paper will look critically into the following questions with respect to implementation of Bioenergy technology in Ghana whiles considering factors that lead to barriers and drivers behind the Bioenergy growth.

- What is the potential feedstock in Ghana?
- What are the barriers in Bioenergy implementation?

1.3 Limitations of the research

The limitations of this research include the fact that the time allocated for research trip to Ghana was very limited and because it was within the Christmas festivities

so managers were not always by their desks to answer questionnaires which made it difficult to obtain certain critical information.

1.4 Structure of the research

The theoretical framework for the research is presented in chapter 2 as a literature review, where information on the subject is gathered by mainly on-site information and interviews of key personnel concern during the visit to all the organizations and institutions mentioned in this work and information gathered from already existing books and articles. Moreover, theoretical framework talks about the critical factors that can affect the Bioenergy technology implementation negatively or positively.

2 LITERATURE REVIEW

This is a critical and in depth evaluation of why this particular research is being pursued. It expands and explains the reason behind the selection of this particular topic as the title of the research.

2.1 Renewable energy

Renewable energy is defined as the type of energy that is obtained mostly from natural resources such as sunlight, wind, rain, tides and heat from the ground (geothermal) and they are all renewable, meaning they are naturally replenished. Almost sixteen percent 16% of energy consumed globally comes from renewable resources. Traditional biomass also gives ten percent 10% of the global energy which is also used for heating and electricity generation (Dictionary.com, 2012). Some examples of renewable energy are as follows:

- Solar energy
- Wind energy
- Bioenergy
- Hydro power

This research concentrates on Bioenergy which is one of the sources of renewable energy made available from materials derived from biological sources. Biomass is any organic material which has stored sunlight in the form of chemical energy. As a fuel it may include wood, wood waste, straw, manure, sugarcane, palm kennel shell and many other byproducts from a variety of agricultural processes (Roos, Graham, Bo, & Rakos, 1999).

Biomass has been grouped into two categories namely primary and secondary products. The primary products come from direct photosynthetic exploitation of solar energy which includes the entire phytoplankton, e.g. agricultural and forestry products such as fast- growing trees, energy grass, vegetable residues, waste from agricultural including straw and residual wood from forest and industry (Kaltschmitt M, 2007). The secondary products of biomass are formed by decom-

position of organic matter and other organisms like animals, e.g. manure, solid waste, kitchen waste and garbage.

2.2 The research model

The research model was based on three key components for Bioenergy in Europe (McCormick & Kåberger, 2007) which are as follows:

- Know-how
- Economic condition
- Supply chain co-ordination

These components were critically looked into and analyzed in the three case companies in Ghana during the research period.

2.2.1 Supply chain

Supply chain is the process of fulfilling a customer request which does not only include the manufacturer and suppliers. It also includes the transporters, warehouse, retailers and the customers. In every organization, for instance a manufacturer, the supply chain which includes all the functions that comes into play during the receiving and fulfillment of a customer request. Some of those functions are product development, operations, marketing, distribution, and finance and customer service (Chopra, S., & and Meindl, 2004).

Every supply chain must be dynamic and must have a constant flow of information including the availability of funds between the various stages, in other words, the primary purpose of a supply chain is to satisfy the needs of the customer and at the same time making profits. It always starts with the order a customer places and ends when the services done a customer is fully paid for.

The term supply chain comes into mind when products are moving from suppliers to manufacturers to distributors to retailers to customers along a chain. The movement of the chain should always move together with products, information and funds. The supply chain can also be in such a way that only one player is in-

volved at each stage. In other words, a manufacturer can receive materials from many suppliers and then delivers to several distributors.

A supply model can have several stages. Some of these stages include the following.

- Customers
- Retailers.
- Wholesalers/Distributors.
- Manufacturers.
- Raw material suppliers.

The forms of energy that are derived from fossil fuel and nuclear power have received considerable amount of subsidies over the years and they continue to receive such subsidies which has made the competition in the energy market to be distorted. Energy subsidy has no formal definition but it is resulted from different estimates and confusing debates. In other for renewable energy to shift towards sustainable energy efficiency, sustained support is needed for the renewable energy technologies.

It is very important to consider external costs which are most often than not exclude from calculations in energy markets in order to expand renewable energy. For renewable energy to compete with fossil fuels and nuclear power, it is important that external costs are internalized in energy markets. In contrast, Bioenergy often produces positive impacts that are not compensated by energy markets, including energy security, combating climate change and promoting regional development (McCormick & Kåberger, 2007)

The benefits derived from the positive impacts of Bioenergy are often described and documented. However, it is not common for these positive impacts to support entrepreneurs who want to invest in Bioenergy technology. There are some benefits associated with the development of a Bioenergy system and the construction of a biomass gasifier according to various case studies. The benefits being referred

to here are however not able to be incorporated into evaluations by entrepreneurs and they not recognized by the general society.

The introduction of Bioenergy systems can only be made possible by overcoming the related barriers to economic conditions. Investment grants were critical to establishing Bioenergy systems, according to a research carried out in the Swedish town of Enkönping and an Austrian town of Mureck (McCormick & Kåberger, 2007). The Swedish case realized at the end of the day that investment cost was about 40% percent whiles investment cost grants and all other costs were between 30 and 75% percent in the Austrian case study which was connected to several Bioenergy technology systems. The several benefits that are derived from Bioenergy technology are not compensated by the energy markets. To promote sustainable energy technology, investment grants must be introduced. Since the carbon tax was introduced in Sweden, it imparted on the economic conditions making it possible for the Bioenergy technologies to be competitive with the fossil fuels.

In Finland, there is research and development, energy taxation, and investment grants, that are dedicated to the expansion of renewable, especially Bioenergy (McCormick & Kåberger, 2007) Many researchers have also established that most of the barriers obstructing Bioenergy can be overcome through national policy.

In Ghana, the cost of electricity and the energy demand of the country which is not being met by the Volta River Authority which has made the country to resort to load shedding at some points in time, has made it possible for energy experts to expand their interests in renewable energy technologies like what is happening at Samartex Timber and Plywood Company Limited and Twifo Oil Palm Plantations (Gridco to begin load shedding, GBC., 2010).

2.3 Components of the research model

This section discusses the three components of the research model into details. It talks about what happens in the companies considering the companies one after the other.

2.3.1 Know-how and institutional capacity

Bioenergy technology systems include biomass resources, supply chain, conversion technologies, and those energy related services. For a Bioenergy technology to be setup there is the need to combine knowledge and skills to institutional framework or capacity so that plans and dreams can be brought to reality. An institution can become a barrier when members of staff of that institution do not understand the mission and the goal of that institution, for example inexperienced maintenance staff of a firm and also lack of understanding by bank staff.

The needed know-how can be developed by actors which are already in existence through the process of learning and also by bringing in new ones concerning the learning the process, energy companies can have some experience with Bioenergy because of the 1970s. In Ghana, there is confidence in the reliability of conversion technologies and availability of biomass resources, which are being used to exploit Bioenergy but the confidence in investing in renewable energy, is very low. Some food crops are expected to play a very important role in expanding Bioenergy in Ghana. However, there is competition between food and energy in the sense that most food crops serve as energy crops making it difficult to forget about food and produce energy. There is the possibility for expanding Bioenergy in Ghana but for this to take place successfully, farmers should be supported in the production of food/energy crops for biomass production.

The production of Bioenergy has many challenges which include the perceptions of the general public and especially the political leaders about how biomass can be useful for our energy purposes. They consider Bioenergy as fuel for the past generation rather than energy source for the present and future so the understanding of our politicians and the general public of what biomass is capable of can help mobilize the necessary support for expansion of Bioenergy in Ghana.

Bioenergy was at a point opposed in Ghana because waste was scattered all over the country. In Ghana, biomass resources are categorized as waste so it makes it somehow difficult to exploit Bioenergy. People started welcoming the idea of investing in Bioenergy in Ghana when there was the realization that the country's

most dependent energy source (Akosombo Hydro Power Dam) could not meet the energy demands of the country anymore.

2.3.2 Economic Condition

The forms of energy that are derived from fossil fuel and nuclear power have received considerable amount of subsidies over the years and they continue to receive such subsidies which has made the competition in the energy market to be distorted. Energy subsidy has no formal definition but it is resulted from different estimates and confusing debates. In other for renewable energy to shift towards sustainable energy efficiency, sustained support is needed for the renewable energy technologies.

2.3.3 Supply chain co-ordination

The functionality of any Bioenergy system requires an efficient supply chain management to meet the needs of all departments. Energy companies and suppliers of Bioenergy are the most important players in the Bioenergy industry. To invest in Bioenergy requires energy companies to buy biomass resources, and also for conversion technologies to be established, it requires suppliers of Bioenergy resources. Technologies are needed to carry out the activities within the processes of making Bioenergy available to the masses, e.g. harvesting, refining and transportation. The Supply chain is very important in the implementation of Bioenergy in Ghana.

A well-established Bioenergy system must provide electricity, heat, and fuels for transport. The cooperation between the players in the Bioenergy industry is very paramount in the success of the Bioenergy industry to be expanded, there must be the formation of partnerships among the Bioenergy companies and another development, and it is always difficult to establish collaboration between Bioenergy companies and governmental institutions.

3 RESEARCH METHODOLOGY

The study was conducted through a qualitative type of research which was made possible by interviews in the case companies and also managers of the companies were made to answer questionnaires which were delivered later through e-mail. The case companies are as follows;

- Samartex ltd.
- Benso oil palm ltd.
- Twifo oil palm ltd.

There are other institutions which were also visited for the purpose of policy making and their contributions to the Bioenergy industry in Ghana. They were the ministry of Energy, Ghana Energy Commission, Ghana Grid Company and each institution is described in more detail below.

3.1 The Ministry of Energy

The directorate of the Renewable Energy was established in December 2010 under the Ministry of Energy to take care of the development and promotion of renewable energy for accelerated sustainability to energy services in the country. Renewable energy resources in Ghana include wood fuel, hydro, solar, wind, biofuels, waste-to-energy and animal traction (Togobo, 2011)
The Directorate is currently made up of three professional and four support staffs. It also has two National Service Personnel and three temporary staffs on attachment. So in all, there are twelve members of staff working with the Renewable Energy Directorate under the Ministry of Energy (Ministry of Energy, Ghana, 2010).

According to the Ministry of Energy, Ghana has a considerable amount of Bioenergy potential with biomass energy which is also in the form of wood fuel and charcoal consumption contributing for about 72 percent of total energy consumption. Two-thirds of the country or 18.3 Mha is under tree cover. The climatic and soil conditions in Ghana are very suitable for large scale agriculture, energy crops,

food crops and sustainable wood fuel productions. It is estimated that with annual rainfall of Ghana which is between 1,300 – 2,200mm, approximately 243PJ/yr or 65,000GWh/yr of wood fuel could be obtained from the tropical forests in the country (Ministry of Energy, Ghana, 2010).

3.2 Ghana Energy Commission

The Volta River Authority (VRA) has the primary responsibility to generate and supply electrical energy to the Electricity Company of Ghana (ECG) and Ghana Grid Company (GRIDCO) also has responsibility for the transmission of electricity in the country. VRA supplies electrical power in bulk to the ECG and Northern Electricity Department (NED) for distribution to consumers through the transmission line which are owned by GRIDCO. These are the three major players within the power sector who are responsible for the generation, transmission and distribution of power in Ghana. The total installed generating capacity of electric power in Ghana is about 1650 MW, comprising of 1100 MW of hydro generation (Akosombo and Kpong stations) and 550 MW from Takoradi Thermal Power Station (Ghana Energy Commission, 2012).

Ghana is endowed with several renewable energy resources. These include solar radiation, small hydro, biomass and wind. Technologies to harness most of these resources have been demonstrated in Ghana (Otu-Danquah, 2011).

The Energy policy of the Ghana government is included in its Strategic National Energy Plan 2006-2020. Some of the aims and objectives of policy to develop a sound energy market that would provide sufficient, reliable and sustainable energy services for Ghana's economic development through the implementation of a comprehensive plan that will outline the development, utilization and efficient management of energy resources available to the country (Ghana Energy Commission, 2012).

3.3 Ghana Grid Company.

GRIDco was incorporated on 15th December, 2006 as a private limited liability company under the Companies Code, and granted a Certificate to Commence Business on 18th December, 2006. The Company became operational on August 1, 2008 following the transfer of the core staff and power transmission assets from VRA to GRIDco (Ghana Grid Company, 2009).

The main purpose of the Ghana Grid Company includes the following;

- To undertake dispatch and transmission of electricity from wholesale suppliers to bulk customers or the end user. See Figure 1, below.
- To provide fair and non-discriminatory transmission services to all power market participants in the country.
- To acquire, own and manage assets, facilities and systems needed to transmit electrical energy.
- To carry out transmission system planning and implement necessary investments to provide the capacity to reliably transmit electric power
- To undertake expansion and maintenance of the transmission network.
- To manage the wholesale power market.

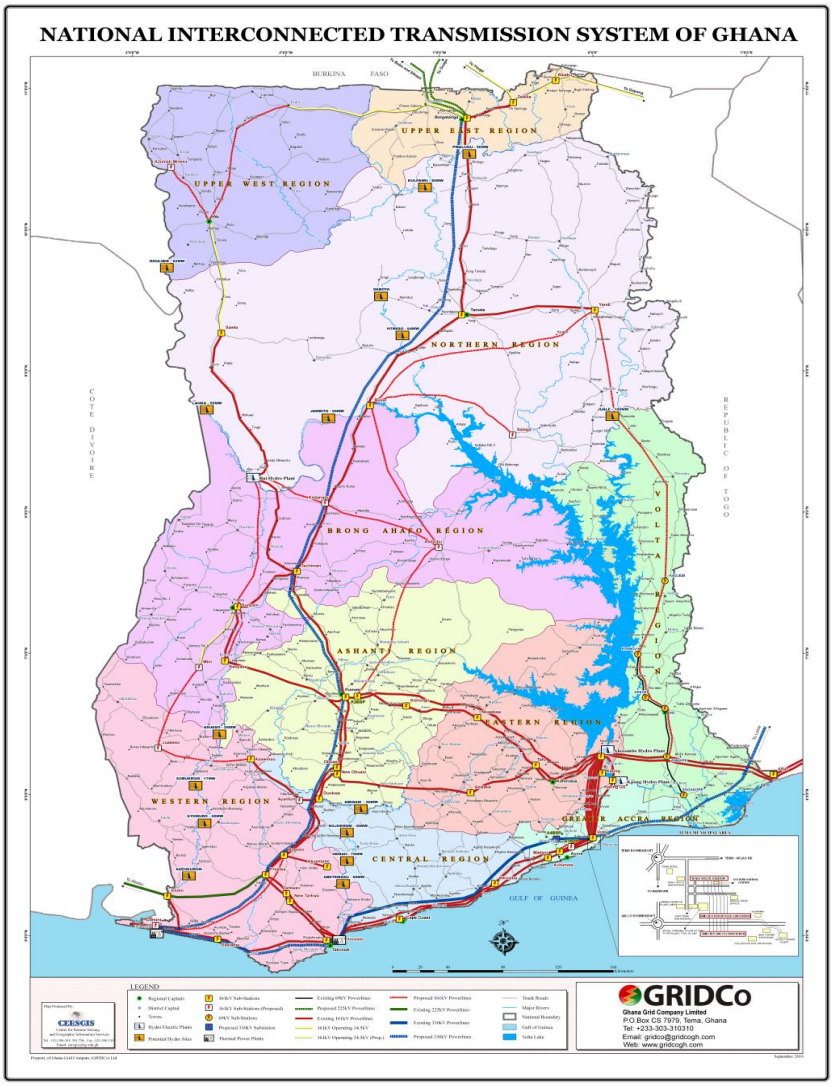

Figure 1. The transmission network of Ghana (Ghana Grid Company, 2009)

3.4 Public Utilities Regulatory Commission

The Public Utilities Regulatory Commission (PURC) was established by an act of Parliament in 1997. The functions of the Commission are as follows

- To provide guidelines on rates chargeable for provision of utility services.
- To examine and approve rates chargeable for provision of utility services.
- To protect the interest of consumers and providers of utility services.

- To monitor the standards of performance for provision of services.
- To initiate and conduct investigations into standards of quality of service given to consumers.
- To promote fair competition among public utilities.
- To conduct studies relating to the economy and efficiency of public utilities.
- To make such valuation of property of public utilities as it considers necessary for the purposes of the Commission.
- To collect and compile such data on public utilities as it considers for the performance of its function.
- To advice any person or authority in respect of any public utility.
- To maintain a register of public utilities (Ghana Legal, 2012).

4 CASE COMPANIES

The case companies in this study are three Bioenergy companies in Ghana which were visited during the research period to access their input and output including the type of technology being used. The companies are Samartex Plywood & Timber Company, Benso oil palm plantation ltd, Twifo oil palm plantation ltd.

4.1 Samartex Plywood & Timber Company

Samartex Timber & Plywood Company Limited was established in 1995, but before then, the company operated under a different name known as African Timber & Plywood Company Limited (AT&P) which had been in existence since 1947 under the UAC group of companies. Samartex Timber & Plywood Company Limited took over AT&P during when the company was saddled with a lot of problems including mismanagement and a serious fire outbreak, which had left the company's facilities in chaos (Samartex Limited, 2006).

From 1995 till date, the company has gone through a massive transformation program of rehabilitation and some kind of investment to become the leading sustainable and socially responsible timber company in Ghana. Apart from wood processing, the company is into the regeneration of the natural resources at its disposal through the establishment of plantation and agro-forestry schemes. Samartex has gone through the development of value-added products with non-timber forest products (NTFPs) and downstream processing of wood pieces that would have otherwise been considered waste into carvings (Samartex Limited, 2006).

4.1.1 Forest development division

Samartex has a plan that if they can secure future resources, they must do something about the widely recognized traditional slash and burn (S&B) agriculture that has destroyed much of the forest resource of Ghana. Samartex decided to reduce these pressures by keeping local farmers on the same piece of land for longer

so that the process could be slowed. The timber trees were also seen as long-term viable cash crops so a Forest Department Division (FDD) was set up under the Department of Forestry within the company for the company to be able to meet its future timber supply so the following strategies were adopted for them to achieve their goal (Samartex Limited, 2006).

- To facilitate the development of agro-forestry systems and plantations through collaboration with communities and out grower farmers.

- Establishment of plantations on degraded lands.

- The promotion of NTFPs such as Thaumatoccocus daniellii. Under the first strategy, a pilot project known as Oda-Kotoamanso Community Agro-forestry Project (OCAP) was initiated by Samartex in the year 1997 in a nearby village called Oda-Kotoamanso. The German Development Agencies has support-ed them the company to replicate them in other areas.

- Artificial regeneration through enrichment planting and direct plantation is being carried to rehabilitate degraded Samartex concession area. The enrichment planting is a post-harvest management operation in logged forest while the direct plantation is to re-establish failed Cedrella which were planted in the 1970s.

- One of the Non Timber Forest Products known as Thaumatoccocus daniellii which was added to the agro-forestry models is now being processed into a high value product and its development is being promoted.

- The forestry division is undertaking a whole lot of activities that will im-prove the supply chain of the company including the following:

- Tree Ownership and Land Registration Project

- Nursery Development.

4.1.2 Power generation process at Samartex

Boilers were first installed at Samartex in the year 1947 when the company was operating under the name, African Timber & Plywood Company Limited (AT&P). A German company called Backcock & Wilcos did the installation at the time (Adams, 2011).

The company now has a work force of over 1700 employees including management, senior staff, junior staff and expatriate. They also have a system where graduate students are drawn from the universities trained as Management trainees. Among all these employees, the management staff and the senior staff are occupying 65 residential bungalows on the on the company's premises. The company generates its own electrical power and water. This has been made possible by the installation two big water pumps in a nearby river called (Tano river) where water is drawn to the premises of the company into an overhead tank. The water is then treated to get rid of all the impurities. After the water has been treated to the level that can be used for domestic chores and part of the water goes through the boiler to produce the necessary steam capable of turning the turbines for the 1400kW capacity generator to generate power for wood processing and domestic use.

The fuel used by this plant is wood waste and sawdust but since the company's primary business is wood processing, there is no problem with the availability of fuel. The fuel intake facility is far away from the boiler, where the thick wood waste is mixed sawdust and then passes through a conveyor belt to the boiler for burning to produce the needed steam to turn the turbine.

To prevent inefficiency and power outages in the premises, the company has secured a standby diesel generator which has almost the same capacitor as the installed generator of 1400kW. The company has about 65 management and senior staff bungalows on the premises that are also using treated water from the Tano River and also their electricity generated on their premises. None of their electricity supply is coming from the national grid (Adams, 2011).

4.2 Benso Oil Palm Plantations Ltd.

Benso Oil Palm Plantations Limited (BOPP) was established on January 22, 1976 as a limited liability company. The company was formed jointly by the Government of Ghana and Unilever Plc. The main business of the company is the processing and production of crude palm oil.

BOPP got listed on the Ghana Stock Exchange officially on 30th August, 2004. Unilever Ghana Limited owned about 58.45% of equities in BOPP until February 2, 2010 when it was sold to Wilmar Africa Limited (Wilmar, 2012). BOPP was converted into the public limited liability in 2004. The business of the company as authorized was to carryout includes: the growing of oil palm and other agricultural products, processing of oil palm fruits to produce palm oil and palm kennel shells. They are also dealers and traders in palm oil, palm kennel shells and other agricultural products. BOPP is located in the Mpohor Wassa East District of the Western Region of Ghana which is about 42 km from Takoradi.

Figure 2. Fresh palm fruits at Benso

Besides the company's plantations, it operates a smallholder and an out grower project where the company, which is wholly private or the government provides a technical assistance and inputs of seed stock, fertilizers and pesticides on loan basis, sometimes partially subsidized by government. There may also be a written contract delineating the agreement and possibly including guarantees of sales and calculating the mill price. Currently, there are different types of smallholder arrangements which include supported smallholders, independent smallholders and collective landowners.

4.3 Twifo Oil Palm Plantations Ltd.

Twifo Oil Palm Plantation Ltd. (TOPP) was an agricultural project initiated by the Government of Ghana in 1977. It was undertaken from a loan financing from the Government of Netherlands and others like the EU, CDC AND FMO. The Work on the project begun in August 1978. The type of business they were authorized to carry out include: the growing & processing of oil palm into palm oil and other agricultural products (Bloomberg Businessweek, 2012). The back view of the plant area at TOPP. See Figure 3 below.

Figure 3. Back view of Plant area at TOPP.

The major shareholders of the company were the Government of Ghana and Unilever Ghana Ltd. until recently when Unilever became the total shareholders of the company. The estate of the company is situated at Twifo Ntafrewaso/Twifo Mampong area. TOPP is one of the largest producers of palm oil in Ghana, and the company. The company has an office in Accra that handles other businesses like shipping, supplies and so on.

Table 1 below shows the three Bioenergy companies and their operational activities.

Table 1. Biomass-fired co-generation plants in Ghana (Ghana Energy Commission, 2012)

Name	Type	Input	Technology	Output
Samartex Ltd.	Operational	Forest resources	CHP Plant, Biomass	Heat and Electricity

			boiler	
Benso oil palm	Operational	Agricultural re-sources	CHP Plant, Biogas	Heat and Electricity
Twifo oil palm	Operational	Agricultural re-sources	CHP Plant, Biogas	Heat and Electricity

5 BARRIERS IN CASE COMPANIES

This chapter talks about challenges confronting the Bioenergy industry in Ghana. It also contributes to the identification, analysis and discussion of the barriers identified in the case companies.

5.1 Know-how in the case companies

When it comes to the establishment of Bioenergy technology, a combination of knowledge and skills is needed to move from a dream to actualization and this include educational qualification and on the job experience.

5.1.1 Know-how at Samartex

Because of the process of employing new graduates from the various universities in Ghana, and also training them during internships, the issue about know-how is well dealt with, and as it has already been described above that know-how is the combination of knowledge and skills. Having put in place a system that ensures the continuous development and education of their human resource base, and one of the most advanced forest management techniques which makes the employees of Samartex have the know-how about the company's business (Samartex Limited, 2006).

5.1.2 Know-how at Benso

Benso oil palm plantations are into the manufacturing of oil palm, that is the production and processing of it. They produce oil such as Refined Bleached and deodorized oil (RBDO) and after fractionation of the (RBDO), you will get Olein which is pure vegetable oil and stearin.

Figure 4. Fibre mixed with shells at Benso

BOPP is also into vegetable oil mills and they control a large part of the market in West Africa. The refinery of fats and oils including blending has been part of BOPP's business. The company owns a patented technology to convert wasted food into nutritious food.

5.1.3 Know-how at TOPP

Twifo Oil Palm Plantation (TOPP) installed two stoker boilers with a steam generating capacity of 15T/HR per boiler but one is operated at a time and 80% of the total steam produced is used for power generation while the biomass feedstock consumption of the plant per hour is 5.53T/H.

The total size of land required for the installation of the whole plant, i.e. the boiler, turbine, feedstock storage facility, moisture reduction equipment and the conveyor belt is 1,071 cubic meters. The volumetric capacity and cost of the feedstock storage facility is 675 cubic meter. The wet palm kennel shell is separated from the dry ones. See Figure 7.

Figure 5. Separating the wet shells from dry ones

The feedstock moisture reduction equipment and the quantity of feedstock processed per minute/hour by this equipment is 10.5T/H and the moisture content of the feedstock after going through the moisture reduction process is 6.03 percent. The calorific value of the feedstock depends on the material available. Palm kennel shell is 19.055kcal/kg and that of palm kennel shell is 18,884kcal/kg. The estimate cost of a ton of biomass feedstock is $45.00 if TOPP were to buy from other supplier, which means $45.00 is the price per ton. The feedstock available at TOPP is from fibre and shell produced as waste products from the process of palm oil production (Owusu, 2012).

Figure 6. Palm Kennel shell heaped at TOPP

About 23,000 tons of fuel (fibre and dried palm kennel shell) are produced as waste annually and about 80-85% is used for power generation. See Figure 8 below. An additional quantity of (wet) palm kennel shell from palm kennel production which is approximately 4,500 tons is produced annually and sold out for export to Europe. After using 80-85% of the by-product, i.e. the feedstock for power generation, the remaining 15-20% is used for land filling and mulching of young palm seedlings. Empty fruit bunch of an average of 2,200 tons annually which is also a by-product is used for mulching and fertilization of the soil.

Figure 7. Fibre heaped at TOPP as fuel

Due to feedstock constraints, maintenance and unexpected faults, the plant is shut down for about 430 hours in a year. The company has decided that future power expansion and extension to the national grid will require the running of all the two 15T/H boilers which will also require additional 21 personnel for a 3-shift system for power generation.

5.2 Supply chain in case companies

Bioenergy companies need functioning and well organized supply chain that is able to meet the need of all relevant partners within the setup.

5.2.1 Supply chain coordination at Samartex

Samartex is sourcing the raw materials from their own forests which is made up of a big concession and are known for centuries to provide the best quality of Khaya ivorensis. Samartex forests were audited in November 2008 by the Rainforest Alliance 'Smart wood initiative to the FSC controlled wood standard. Smart wood is the worldwide leading auditor for FSC (Samartex Limited, 2006). The sustainability of the forest is assured through selective cutting and re-forestation.

After cutting down the timber in the forest, which is done through selective felling, it is then taken to the company premises where it is processed into either plywood or lumber and other wood products like curl veneer. The waste wood that comes out of the production process in addition to the sawdust is used for heating the boiler to produce the steam which turns the turbine. See Figure 8 below

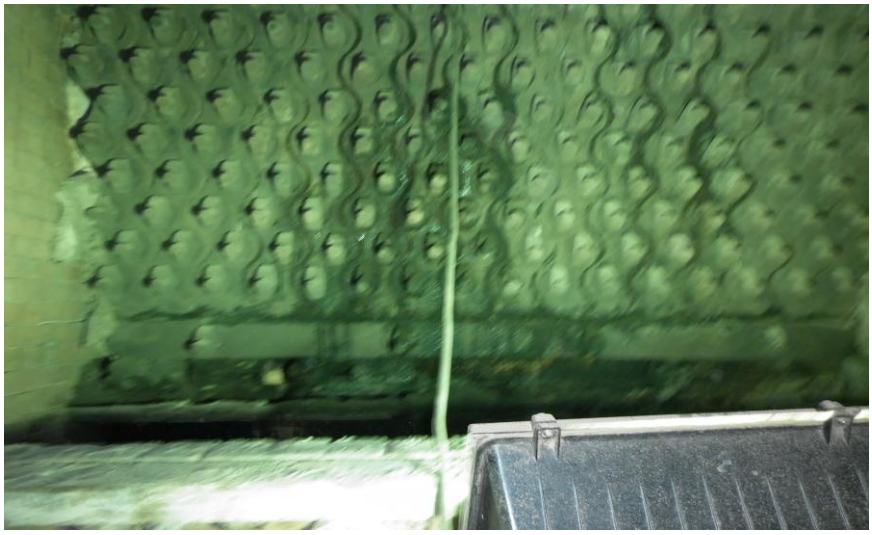

Figure 8. Water holes of the boiler at Samartex

The water in the boiler which boils to produce the steam is pumped from the Tano River which is some few kilometers away from the premises through pipes and with the help of pumps. The water is then stored in an overhead tank which is situated on the company premises, together with the impurities. The water in the overhead tank is then treated by the addition of chemicals to the extent that, it is used for domestic purposes and even drinkable. (See Figure 9 below). The electrical power that is generated by Samartex internally is 2MW (Adams, 2011).

Figure 9. Water storage facilities at Samartex

The company is not connected to the national grid; they rely on their own generated power and water which is about 4000 liters annually. They also supply electricity and filtered treated water free of charge to Samreboi and Tigarikrom communities (Adams, 2011). The waste wood and the sawdust are moved into the boiler, via the overhead conveyor belt, (See Figure 3).

Figure 10. Overhead conveyor belt at Samartex

5.2.2 Supply chain coordination at BOPP

Benso oil palm plantation is currently producing over 17,500 metric tons of palm oil and about 4,500 metric tons of palm kennel shells, fruits are obtained from more than 6,000 small private farmers in the Western and Central Regions stretching from their own backyard, (Adum Banso) through Beposo to Mankessim and even as far west to Elubo (Edward Amankrah, 2011).

The oil palm mill which was commissioned in November 1981 has since been upgraded from 16 to 20 metric tonne per hour milling capacity. The company has plans to upgrade the 625kVA steam turbine power generating plant to 1300kVA. This source of power using fibre and shell generated from the milling process as fuel for the boilers is considered to be a cheap source because it is a clear example of sustainable Agriculture by using waste products for power generation.

The oil mill is capable of handling 137,500 metric tons FFB per annum. The distribution of the total annual FFB ranges from 5.3% in the through month to 12.8% in the peak month. According to (Oteng, 2011), the high quality of their palm oil is achieved by early harvesting and sterilization of the fruit soon after cutting. To

make this very efficient, a network of 317km road has been constructed within the estate. In order for the high quality of their oil to be maintained after several months of production, they make sure a strict quality standard is certain before dispatch (Oteng, 2011).

About 1650 hectare smallholder scheme funded with Government aid money through the Agence Francaise De Development (AFD) started in 1995. Each farmer is allocated a 4 hectare plot and money in the form of loan for inputs. The ADB is the facilitator whilst BOPP provides all extension services and grants in the form of money. The scheme is in four phases (from 1995 – 1998). Farmers have been selected from the local communities and the scheme has been successful and popular within the communities. Harvesting has been very successful with the smallholder scheme and since onwards, more than 17,000tonnes is harvested every year (Arthur, 2011).

The company embarked on a replanting program since 1998 at a rate of approximately 250 ha per year. A total of 568 ha (1420 acres) representing the 2005, 2006 and 2007 replants which are in the immature phase. The entire plantation would have been replanted by 2016.

5.2.3 Supply chain coordination at TOPP

Supply chain is the process of fulfilling a customer request which does not only include the manufacturer and suppliers. It also includes the transporters, warehouse, retailers and the customers. In every organization, for instance a manufacturer, the supply chain which include all the functions that comes into play during the receiving and fulfillment of a customer request. Some of those functions are product development, operations, marketing, distribution, and finance and customer service (Owusu, 2012).

Figure 11. Packaged Palm Kennel

Every supply chain must be dynamic and must have a constant flow of information including the availability of funds between the various stages, in other words, the primary purpose of a supply chain is to satisfy the needs of the customer and at the same time making profits. It always starts with the order a customer places and ends when the services done a customer is fully paid for.

The term supply chain comes into mind when products are moving from suppliers to manufacturers to distributors to retailers to customers along a chain. The movement of the chain should always move together with products, information and funds. The supply chain can also be in such a way that only one player is involved at each stage. In other words, a manufacturer can receive materials from many suppliers and then delivers to several distributors (Chopra, S., & and Meindl, 2004)

What usually happens at TOPP to ensure a smooth supply chain is that, the company has a total of (4,234) hectare of oil palm plantation and individual farmers who are into the smallholder project supply the mail with their products. The out grower project team which also see to it that new farmers who want to engage in oil palm business are helped out with seedlings, fertilizers and other inputs.

5.3 Economic conditions in case companies

For some decades now, fossil fuel and nuclear power have received considerable amounts of subsidies which have made the competition in the energy market to have some distortions.

5.3.1 Economic conditions at Samartex

For Bioenergy to be initiated, barriers that are related to economic conditions must be overcome by the introduction of financial incentives that serve as interventions to recognize benefits and promote sustainable energy systems. Some of this incentives are, green certificate, tender schemes, blending requirements, differential taxation, feed-in tariffs, carbon tax etc.

According to the Energy Commission of Ghana, the incentive that is available in the country or what they consider in their operation for individuals and investors in the Bioenergy industry in Ghana is the feed-in tariffs (Otu-Danquah, 2011)

5.3.2 Economic condition at BOPP

BOPP has had some expansion programs over the years to enable them one of the vibrant palm oil producing companies in Ghana. The oil palm business has become one of the major contributors to export revenue and rural development, with the growing demand for palm oil as the raw material for the manufacturing of soap and other detergents in commercial quantities for the sub-region by Unilever Plc. Palm oil is the most affordable as quality cooking oil especially in Ghana because of its cholesterol free state.

The kind of subsidies and supports that are enjoyed by the agricultural industry in Ghana from the government like technical support and fertilizer and pesticides subsidy helps the palm oil industry to get more expanded with the smallholder and out grower projects.

5.3.3 Economic conditions at TOPP

There is always competition in the energy markets due to the fact that fossil fuel and nuclear power have received a considerable amount of subsidies for many years and continue to receive a lot of support. There is no agreed definition for energy subsidies, which results in different estimates and confusing debates, however, fossil fuels and nuclear power continue to benefit from energy subsidies as has earlier been said and that sustained support is needed for renewable energy to shift towards sustainable energy system (Roos;Graham;Bo;& Rakos, 1999).

This study investigates the many barriers that are related to economic conditions at TOPP including investment grants and governmental subsidies for individuals involved in the small holder and out grower projects. Investment grants are interventions to recognize benefits and promote sustainable energy systems. It is introduced to alter the economic conditions making Bioenergy sufficiently competitive with fossil fuel for energy production. In Ghana, there is a research and development on feed-in-tariffs and investment subsidies like the free zone board which allows an investor in renewable energy not to pay import duties on some selected items which are meant to promote the growth of renewable energy in the country according to the Ghana energy commission (Energy Commission, Ghana., 2010)

6 ANALYSIS

The analysis describes the activities that were taken into under the various barriers in the case companies.

6.1 Analysis of implementation of Bioenergy

The analyses of barriers include the three case companies from Ghana located at Samreboi, Benso and Twifo Mampong/Ntafrewaso area. The case companies use a range of inputs such as forest resources, agricultural resources like palm kennel shell and the fibre.

Their outputs are mostly heat and electricity where the heat is used to produce vapour to run the turbine of generators to produce power and they provide more information about the following:

- Barriers and drivers for Bioenergy.
- Strategies and interventions to overcome barriers.
- The key barriers including the development and diffusion of Bioenergy systems in Ghana.

A well-established Bioenergy system must provide electricity, heat and fuels for transport. The cooperation between the players in the Bioenergy industry is very paramount in the success of the Bioenergy industry. For the Bioenergy industry to be expanded there must be the formation of partnerships among the Bioenergy companies and in another development, it is always difficult to establish a collaboration between Bioenergy companies and governmental institutions.

The analysis of activities in the various case companies were chosen from educational qualification, on the job experience, availability of supply chain resources and among others as shown in Table 2 below.

Table 2. Analysis of activities in case companies

Barrier	Activity	Samartex	BOPP	TOPP
Know-how	Education	√	√	√
	Experience	√	√	√
	Learning environment	√	√	√
	Equipment maintenance	√	√	√
Supply chain coordination	Feedstock available	√	√	√
	Self power generated	√	√	√
	Supply chain resources	√	√	√
	Raw material availability	√	√	√
Economic Conditions	Subsidy from Government	√	√	√
	Subsidy to	√	√	√

	farmers			
	Sustained support	√	√	√
	Investment grants	√	√	√
	CSR	√	√	√

7 CONCLUSION AND RECOMMENDATIONS

This then examined and discussed the means and how Bioenergy implementation in Ghana will be without the usual stress currently being encountered by investors and industry experts. Due to that, some recommendations have been made which include the following;

- For small-scale actions that will not be selling power to the grid like what is currently going on in Ghana, the legislative reform required is less but entrepreneurial training becomes very important and also well qualified NGO is needed to look for international funding:
- Financial performance in Bioenergy projects should be monitored including the following, legislative complications, maintenance, community support, international energy market price per period and the availability of feedstock must be given a high priority. All these can change with time and politics and long term success will depend on them.

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APPENDIX

QUESTIONNAIRE ON BIOMASS COMBUSTORS FOR BENSO AND TWIFO OIL PALM PLANTATIONS LTD.

1. Is your plant a stoker boiler or fluidized bed boiler?
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2. What is the total installed cost of your plant (purchase price and installation cost for the boiler and turbine)? What is the total steam generating capacity of the plant?

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3. What proportion of the steam output of the plant is used for power generation?

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4. What is the biomass feedstock consumption of the plant per hour?

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5. What is the size of land required for the installation of your plant, i.e., boiler, turbine, feedstock storage facility, moisture reduction equipment and conveyor belt?

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6. What is the volumetric capacity and cost of your feedstock storage facility?

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7. What is the cost of your feedstock moisture reduction equipment and the quantity of feedstock processed per minute / hour by this equipment? What is usually the moisture content of your feedstock before and after it goes through the moisture reduction process?

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8. What is the calorific value of your feedstock? What is the heat rate of the plant?

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9. What is the annual operation and maintenance cost of your plant? What is the fixed operating cost of the plant per year? What is the estimated cost of a ton of biomass feedstock, assuming you were buying it from another producer?

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10. What are the academic / professional qualification levels of your plant manager, mechanics, attendants and laborers? What is the number of each category of staff? How sustainable is the feedstock supply? What is the useful lifespan of your plant according to the manufacturer? And how long has it been in operation? What are the by – products of the biomass – to – electricity processes, and what do you use these by – products for? – i.e. the economic value.

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11. What proportion of the feedstock do you return to the land for environmental requirements, such as soil fertility maintenance etc? How many hours in a year is your plant down due to maintenance, faults, and feedstock supply constraints?

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12. If you were operating at 24/7 and 365 days a year, and feeding into the national electricity grid, what do you think your capacity factor would be?; that is, what percentage of the time would you not be operating due to faults, maintenance and feedstock supply problems?

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13. If, in future you begin feeding your energy output into the national grid what additional plants, equipment, facilities and human resources do you envisage would be required to enable you meet voltage, frequency and overall grid system stability requirements. What price in GH¢/kWh/ or US cents/kWh would your electricity attract if you begin feeding into the national grid?

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