EVALUATION OF THE CLEAN DEVELOPMENT MECHANISM IN REDUCING CARBON DIOXIDE LEVELS IN THE ATMOSPHERE AND ACHIEVING ECONOMIC DEVELOPMENT: A CASE STUDY OF THE BAGASSE PROJECT AT MUMIAS SUGAR COMPANY LIMITED.

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A project paper submitted in partial fulfillment of the degree of Masters of Arts in Environmental planning and Management in the Department of Geography and Environmental studies at the University of Nairobi.

DECLARATION

This project is my original work and has not been presented for a degree in any other university.

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DEDICATION

I dedicate this work to my loving parents who have been my constant support base. Their encouragements have contributed to my determination throughout the course of this project. I also dedicate it to my loving uncle Dr. Justus Inyega without whom this journey would have not have commenced.

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LIST OF ABBREVIATIONS.

CDM- Clean Development Mechanism

CER- Certified Emissions Reduction

ET- Emissions Trading

ER- Emissions Reduction

GHGs- Green House Gases.

IPCC- Intergovernmental Panel on Climate Change

JCF- Japan Carbon Fund

JI- Joint Implementation

KPLC- Kenya Power and Lighting Company

MoE- Ministry of Energy

MSCL- Mumias Sugar Company Limited

MW- Mega Watts

RETs- Renewable Energy Technologies

SPSS- Statistical Package for the Social Sciences (SPSS)

UN- United Nations.

UNFCCC- United Nations Framework on Climate Change Convention.

UK- United Kingdom

ABSTRACT

Issues of climate change have become an integral part of our development plans and therefore how to respond to them while ensuring sustainable development has become an integral part in most of the world`s nations including Kenya. One mechanism, the Kyoto protocol, can play a very important role in reducing global warming and ensuring that countries are able to achieve sustainable development at their own national levels (UNFCCC, 2002). The Clean Development Mechanism (CDM) under the Kyoto protocol permits projects reducing emissions in the developing countries to earn certified emissions reduction credits for the developed countries.

The bagasse project at Mumias Sugar Company Limited is one of the CDM projects in Kenya whose aim since its inception in 2009 was to ensure that by avoiding dumping bagasse CO2 levels would reduce and grid electricity would be displaced with GHG-neutral biomass electricity generation. The overall GHG emission reductions expected from the project is 129,5914t CO_2e over the period (2008-2018).

This study`s main objective was to evaluate if the bagasse project has reduced carbon dioxide ($CO_{2)}$ emissions through the use of electricity a renewable source of energy and avoiding bagasse decomposition as a result of accumulation. The specific objectives were; to determine the effect of the bagasse project on the levels of CO_2 emitted, to examine how the company and the surrounding community have benefited economically from the project and to assess what challenges the bagasse project has experienced.

The study used longitudinal study design to collect primary data from cluster random samples of 45 respondents drawn from three groups of people working and living around Mumias Sugar Company Limited. Actual data was collected using a semi-structured questionnaire to get information on carbon dioxide levels and economic development enhanced by the project. Key informant interviews were applied to obtain first-hand data from selected respondents and to complement questionnaire data. Secondary data was collected from the company records and publications on the project by UNFCCC. Questionnaire data was entered and analyzed with the aid of the Statistical Package for the Social Sciences (SPSS) while data from interviews was analyzed using content analysis method.

The results showed that the project reduced CO_2 emissions through the use of the increased renewable energy (electricity) produced and lack of accumulation of bagasse as it was all being used in the project. Initially before the project the company was able to export 2MW of electricity for 16 hours per day to the national grid (UNFCCC, 2010) but this increased to between 24MW and 28MW over the years (MSCL, 2017). In a monitoring study done by UNFCCC from 01/10/2008 to 30/06/2011 the project had generated 140,544.8 tCO_2 and the plant had achieved a maximum of 30 MW power export to the grid although not on a continuous basis.

The project has improved economic development in the area by increasing supply of electricity thus accommodating for energy deficits, providing employment directly and indirectly, providing cattle feed and organic fertilizer and improving the environment. The results further indicated the project had also led the growth of other sectors such as agriculture, transport, industry and infrastructure.

The major challenges facing the project were inadequate raw materials, Ineffectual technology, and high transportation cost of cane, corruption and poor agricultural practices. The study established that corruption enhanced mismanagement of the company so that farmers were not paid in time making it hard for them to continuously supply cane on time stalling project activities due to lack of raw materials. The poor agricultural practices also led to reduced cane yield further contributing to reduced amount of raw materials.

The study concludes that the project was able to reduce level of carbon dioxide emitted and enhance economic development in the area. However the challenges the project has experienced have affected the achievement of the set goals in the given time. The study therefore recommends that these challenges be addressed and systems be put in place to make certain there is accountability and transparency in management of the project to prevent avoidable mishaps Further, development priorities of the local communities should be considered before commencement of any project to ensure project aims are compatible and able to address actual issues on the ground as a result ensure success.

CHAPTER ONE

1.1 INTRODUCTION

This chapter gives a background view of the study and the importance of looking into the performance of the Clean Development mechanisms in achieving their set goals. It covers the objectives of the study and justifies why it is important to undertake this study. It also looks at the scope of the

1.2. Background of Study

The State of the Environment report 2006/2007 states that climate change is a permanent shift outside the normal range of natural climate variability in the traditional patterns of climate. There are many variables responsible for these changes; however a report by the IPCC in 2014 indicates that scientists were 95% sure that human (anthropogenic) activities were largely responsible for global warming being effected by , majorly the rise in concentration of greenhouse gases such as methane and carbon dioxide.

The impacts of global warming are far reaching and greatly affect people and their development. Model studies by the Hadely centre UK (2006) show that the risk of increased flooding as a result of many parts of the world experiencing great rainfall had increased by10 times more while risk of droughts in areas such as sub-Saharan Africa had increased up to 5 times more. Between 1975 and 2002 more than 200,000 people died as a result of flooding while 2.2 billion people were affected while 500,000 died as a result of drought and 1.3 billion people were affected (Jonkman, 2005).

Such issues of climate change make populations vulnerable affecting their ability to achieve sustainable development. According to the definition by Van-der-Merwe and Van-der-Marwe (1999) it requires a redefinition of the economic development process , ensuring quality of life for people while also protecting the environment and the community in order to acquire sustainable development (as cited in Ogujiuba, Stiegler, &Fadila, 2012). As developing countries we have to make a choice of either mimicking the developed countries or going through a development phase that is wasteful and full of pollution or leap frog some of their steps and

incorporate efficient technologies (UN, 1998) which will enhance ability to develop despite of challenges.

The need to come up with sure ways of dealing with global warming has led to the coming together of nations across the globe in bi and multi-lateral agreements. One of such agreements is the Kyoto protocol connected to the United Nations Framework Convention on Climate Change (UNFCC, 2002). It came into effect on February 16, 2005, after about eight years of consultations between many countries. Member parties are committed by being part of internationally binding emission reduction targets facilitating development and the transfer of clean technologies therefore increasing resilience to climate change impacts. One of its programs, the Clean Development Mechanism (CDM) is an emissions reduction program that can play a very important role in reducing global warming and ensuring that countries are able to achieve sustainable development at their own national levels (UNFCCC, 2002). The CDM permits projects which reduce emissions in the developing countries in order to acquire certified emissions reduction credits for the developed countries in order to allow parties to achieve their emission targets.

Clean Development Mechanism can work in many ways and one is through enhancing the use of renewable energy. Electricity is one form of renewable energy that is mostly acknowledged to be the most suitable for industry and daily life (Song, 2002). Electricity is being expansively used as a source of clean energy, however in parts of East Africa there have been constant shortages due to droughts leading to a drop in water levels of hydro power projects. There is a steady increase in demand, despite the shortages, for electrical energy in the Kenya where; 74.5% of generation is from renewable resources, and 25.5% from fossil fuels (GoK, 2008). A survey carried out by the Ministry of Energy (MoE) in 2007 indicates potential by the Kenya sugar industry to generate about 200MW of electricity from biomass cogeneration for export, while at the same time helping push down the cost of sugar production.

The Mumias Sugar Company bagasse project where they use bagasse in the production of electricity is a CDM project in Kenya sponsored by Japan Carbon Fund (JCF). It involves the use of steam obtained during combustion of bagasse in the processes of the sugar plant and equipment. At the same time power is generated for use both internally by the company while the rest (25MW) is exported to the national grid (UNFCCC, 2006). It is important to note that the

fibrous matter that remains after in this case sugarcane stalks are crushed to extract their juice is bagasse. Typically it is waste which when allowed accumulating results in production of carbon dioxide (CO_2), a very dangerous greenhouse gas.

Initially before the project; MSCL had only been able to export 2 MW for 16 hours a day to the national grid after meeting the company's internal electricity demand (UNFCC, 2010). The project would therefore be very important in achieving economic development by accommodating for energy deficits. It would help meet the requirements of the current population by supplying clean energy while at the same time reducing the unintended outcomes resulting from a rise in concentrations of greenhouse gases in atmosphere due to rapid industrialization in the region (Song, 2002).

The project would also enhance economic development of the rural community living around the company by providing sustainable benefits through the diversification of revenue streams where the farmer will be producing cane for sugar production and getting compensation while also getting electricity and CERs which will be able to ensure good compensation for the farmer (UNFCCC, 2006).Construction of the project was completed and it was commissioned in February 2009. Power export to the grid started on eleventh of May 2009, when the system was synchronized with the Kenya Power and Lighting Company (KPLC) grid (UNFCCC, 2010).

This project report intends to find out if the project has helped reduce the amount of carbon dioxide (CO_2) released to the environment through electrical power produced and accumulation of bagasse. It also aims to find out if economic development has been achieved and finally what challenges the project may have experienced since inception in 2009.

1.3 Statement of the study problem

Issues of climate change have become an integral part of our development plans. How to respond to these challenges while ensuring development is sustainable is at the moment high on most of the leading countries` political agenda. The Clean Development Mechanism (CDM) associated with the Kyoto protocol is an emissions reduction program that can play a crucial role in reducing global warming and ensuring that countries are able to achieve sustainable development at their own national levels (UNFCCC, 2002).

CDM has to a large extent been accepted as being able to help emerging and developing Countries to achieve a development path that is sustainable, with improved energy security supply and reduced greenhouse gas emissions (Flamos et al. 2008). The CDM has the role of helping industrialized countries have cheaper emission reduction abatement (UN, 1997) and investing in renewable energy sources in the developing nations has become one of the ways of achieving this. It is important to further emphasize that the growth and use of renewable energy resources has become an essential component of a sustainable global energy plan and is one of the most efficient ways of achieving sustainable development (Goldenmberg, 2007).

According to the study done concerning CDMs by Flamos in (2010), before choosing which technologies are to be transferred to and implemented in a country it is vital to begin with an assessment with stakeholders, of the country's energy service needs and priorities. Vision 2030 which is Kenya's development plan expects that there is to be a high increase in the demand for energy as a result of both social and economic activities to be tackled (Vision 2030, 2008).There are many possibilities for bioenergy to provide greatly in meeting this demands (Mugenya, 2014). A survey carried out by the Ministry of Energy (MoE) in 2007 indicates potential by the Kenya sugar industry to generate about 200MW of electricity from biomass cogeneration for export, while at the same time helping push down the cost of sugar production.

The Japan Carbon Fund came in under the CDM and has funded all the project transaction costs in the 35 MW Bagasse Cogeneration Project at Mumias Sugar Company Limited. It is a project requiring the generation of electricity using sugarcane bagasse for power production expansion. Apart from improving the development opportunities for the company and neighboring community the project aimed to reduce GHG emissions from dumping of bagasse by up to 82,352.40 tons of CO_2 emitted (UNFCCC, 2006) while the displacing of grid electricity with biomass that is GHG-neutral electricity generation was expected to reduce emissions by 1,295,914 tons of CO_2emitted over the period between 2008 and 2018 (UNFCCC, 2008).

A study by Sutter and Parreñoin in (2007) indicated there being no UNFCCC registered CDM projects likely to fulfill both of the Kyoto Protocol's objectives of simultaneously delivering greenhouse gas (GHG) emission reduction and contributing to development that is sustainable. This study aimed to find out if the bagasse project has been able to achieve both these goals by

improving the local air quality through reduced levels of CO2 and enhancing economic development in the area. Further, Flamos in (2010) states that there are barriers which can limit the success of the CDM projects in the developing nations. The study also purposed to find out if any such barriers exist, their influence on the project and if indeed they have hindered the success of the project.

1.4. Research Questions

1. Has the project influenced the levels of carbon dioxide (CO2) being released into the environment?
2. How have the Company and the surrounding community benefited from the project?
3. What challenges has the bagasse project faced since inception?

1.5. Study objectives

i. To assess the effect of the bagasse project on levels of carbon dioxide (CO_2) emitted.

ii. To examine how the company and the surrounding community have benefited from the project.

iii. To assess the challenges the bagasse project has experienced.

1.6. Justification of the Study

Climate change has been documented to be the most urgent environmental problem of the 21st century (Okonski, 2003). Deep concerns from multidisciplinary sectors have laid out climate change as important in global development campaigns. According to IPCC (2001), over more than the last century, the earth's temperature has increased from 0.4^{o} to $0.8\ ^{o}$C, possibly because of anthropogenic activities. Over this period, many climate sensitive environmental indicators or sectors of the economy have changed some for the better, however, most of which, have been for the worst.

This topic of research is important because how to respond to these climatic encounters while ensuring sustainable development have become a major challenge and are presently on most of the leading countries` key agendas. Many stakeholders have claimed that the schemes for immediately mitigating greenhouse gas (GHG) emissions, Kyoto Protocol included, are acceptable as human-induced global warming is the superseding environmental challenge facing the world at the moment. The Clean Development Mechanism (CDM) connected with the Kyoto protocol is an emissions reduction program that can play a very vital role in reducing global warming and ensuring that countries are able to achieve sustainable development at their own national levels (UNFCCC, 2002).

The impact of climate change should be regulated; otherwise it will trounce both natural and human systems by growing the widespread presence of climate-sensitive diseases, raising sea levels, lessening agricultural fertility in developing countries, and changing ecosystems, forests, and biodiversity worldwide (Smit & Pilifosova, 2003). The need for policies that prevent hazardous and perilous human induced interference with climate while simultaneously addressing the energy requirements of underprivileged people is a fundamental challenge of the current era (Haines & Smith, 2007).

This project a study of the clean development mechanism in reducing carbon dioxide levels in the atmosphere and achieving economic development is a case study of Mumias Sugar Company Limited bagasse project one of the CDM projects currently active in Africa. It is important to evaluate its progress to determine if indeed it has been able to achieve the goals it set out to and

what challenges it has faced and how these can be addressed to enhance success of similar projects in the future.

This information will be very helpful for solving some of the problems facing generation of renewable energy in many of the local sugar companies. It can be used to enable them to get a boost to enable them to run their activities more efficiently and get more revenue which would in turn result in better prices for farmers resulting in constant supply of cane. This is more so important at such a time in our country when many of the sugar companies are shutting down due to shortage and lack of enough cane for processing.

The research is also important in determining how viable such projects are in the developing countries for solving their energy needs and still being able to achieve development. With the current issue of exploitation of coal for our energy needs in Kenya it is important to establish if all other alternative cleaner renewable sources of energy have indeed been fully exploited. As an agricultural country climate change is indeed an issue that hits home hard, this information will help to determine if such a project is able to reduce global warming and even improve agriculture at that local level. With the recent hailstorm in Laikipia, which was so severe the roads were impassable, we are at a point where reducing global warming is not a choice but the ultimate.

1.7. Scope of Study

Mumias Sugar Company Limited (MSCL) is one of the major sugar manufacturing companies in Kenya. The company is situated in Mumias town, Kakamega County and it is surrounded by its sugar plantations and the factory itself. Mumias lies approximately 395 kilometers using road transport, northwest of Nairobi (Globefeed, 2015). MSCL was chosen for this study because it is a CDM project involved in the generation of electricity from bagasse otherwise considered waste. It has the capacity to produce 34MW of electricity of which about 26MW is able to be transmitted to the national grid (MSCL, 2015).

For this study the bagasse project was considered to see how it is impacting the amount of CO_2 emitted by supply of electricity to the company and the national grid and ultimately how it influences development in the area. The bagasse project at Mumias Sugar Company Limited is one of the active CDM projects in Kenya and it's crucial to study it as this is important in the

sugar manufacturing sector that is gradually fluctuating and in the production of renewable energy especially for a country like Kenya which is industrializing.

Primary data and secondary data were used in this study. Primary data consisted of questionnaires which were issued to the employees of the Mumias sugar company and the company adjacent business owners. Based on the questionnaires, the benefits that the project has presented to the surrounding area were discerned. Information about how much production of electricity had increased was obtained from secondary data from Mumias Sugar Company. The data was cleaned, coded and analyzed and the results discussed.

CHAPTER TWO

2.1. LITERATRE REVIEW

The chapter deals with the literature on issues to do with global warming and how this is influenced by increased levels of greenhouse gases. It deals with mechanisms put in place to reduce these gases, how effective they are and how these mechanisms can also help in achieving sustainable development. Literature gaps on the same are identified and how this study can address those gaps is put into perspective.

2.2. Climate Change and Global warming

Climate change and global warming have been used mutually and their significance in our lives is as great as ever. According to the State of the Environment report 2006/2007; climate change is a permanent shift outside the normal range of natural climate variability in the traditional patterns of climate. Climate change is caused by varied factors but the significance of human activities has increased over time and became a major contributor.

Human activities cause greenhouse gases such as carbon dioxide (Co_2), Methane (CH_4), Nitrous Oxide (N_2O), Halocarbons, Ozone (O_3), Water Vapor and aerosols to increase in the atmosphere which in turn results in global warming. The IPCC reported in 2014 that scientist were 95% sure that the increasing concentration of greenhouse gases such as methane and carbon dioxide was mainly responsible for global warming and it is majorly being caused by human (anthropogenic) activities.

Global warming is the rise in the average temperatures of the earth`s surface because of the effects of greenhouse gases that trapping heat that would otherwise be escaping from earth. According to Peter U, Clark et al;, (2016) the climate system has a large “inertia” and as such greenhouse gases will stay in the atmosphere for a long time and many of the effect from this will be persistent for decades or centuries up to tens of thousands of years. Models by the Hadley center in UK (2006) indicate that the risk of floods as a consequence of extreme rainfall in many parts of the world rose up to a factor of more than 10; while the risk of droughts in some areas, sub Saharan Africa included, increased by factors of more than 5 due to global warming.

The concern over climate change has been ongoing for years and one of the mechanisms to deal with it has been multilateral agreements. The long process towards building international and

domestic measures to deal with Greenhouse gas emissions in response to the rising assertions of global warming and its effects began internationally. The process began in 1992 in Rio, where 160 countries agreed on the United Nations Framework Convention on Climate Change (Boswall and Lee, 2002). This was a framework while the necessary details were left to be addressed by the subsequent Conference of parties.

One important agreement is the Kyoto protocol connected to the United Nations Framework Convention on Climate Change (UNFCC, 2002). It was effected on February 16, 2005, after about eight years of consultations between many countries. Parties are committed by the setting of internationally binding emission reduction goals, which facilitate the development and deployment of clean technologies increasing resilience to the changing climate`s impacts. The protocol recognizes that with more than 150 years of industrial activities the developed countries are the primary contributors to high volumes of GHG emissions in the atmosphere hence placing more responsibility on them accommodated by the principle of "common but differentiated responsibilities". As stated by the UNFCCC in 1992, developed countries need to take leading action in dealing with the changing climate and its detrimental effects

The first commitment period for the protocol started in 2008 ending in 2012, where members committed to reducing GHG emissions by 5% of the 1990 levels. We are now on the second commitment period where members have committed to reducing emissions by 18% from the 1990 levels in the period of eight years starting from 2013 to 2020 and countries are supposed to meet their targets primarily through national measures. Furthermore members are provided with more ways to meet their objectives by way of three market-based mechanisms which assist to grow green investment while helping Parties to realize their emission goals in a cost-effective way.

The three mechanisms are the clean development mechanism (CDM), the joint implementation (JI) and the emissions trading (ET).Their goal is to help to restore development that is sustainable by ensuring the transfer of technology and investments; while assisting countries under the protocol to meet goals of reducing carbon from the atmosphere in other countries in a way that is cost effective. They also in their emission reduction efforts encourage the participation of the private sector and developing countries.

The Clean Development Mechanism (CDM) is a flexible program with the dual objectives of providing cheaper emissions abatement options to developed countries while at the same time assisting in the achievement of national development that is sustainable by the developing countries (UN 1997; UNFCCC, 2002). According to the definition by Van-der-Merwe and Van-der-Marwe (1999) it requires a redefinition of the economic development process , ensuring quality of life for people while also protecting the environment and the community in order to acquire sustainable development (as cited in Ogujiuba, Stiegler, &Fadila, 2012)

The CDM has the role of helping industrialized countries have cheaper emission reduction abatement (UN, 1997) and one way for them to do this under the CDM is by investing in green and renewable energy projects in developing countries (Burkett, 2008). It is important to further emphasize that the growth and use of renewable energy resources has become an integral component of a sustainable global energy strategy and is one of the most efficient ways of achieving sustainable development (Goldenberg, 2007).

Choosing the most suitable energy technology that is sustainable to implement through the CDM is an issue that those making development decisions are faced with more often than not and in which various conflicting goals or standard have to be contemplated (Adhikari et al., 2008). In most countries, Kenya included, the governments do not have much influence in the programs which are put in place. In deed according to CDM rules each CDM project is voluntary, hence, governments cannot influence the type of projects to be developed (UNFCC, 2002). This brings in the problem of projects which do not actually help in achieving development that is sustainable in host countries as described in the CDM plan (Karakosta et al., 2009). In this study we will try to see if the bagasse project has actually been able to address energy needs of Kenya and the company.

A study done concerning CDMs by Flamos in (2010) indicates that the choosing of which technologies are to be transferred to and implemented in a country need to begin with an assessment with stakeholders of the country's energy service needs and priorities. This study intended to find out if the technologies transferred to Mumias Sugar Company Limited (MSCL) were able to actually serve the energy needs of the company and the area. What priorities were considered when choosing the technologies, were they also the priorities of MSCL and the area in terms of development.

A study by Sutter and Parreñoin in (2007) indicated there being no UNFCCC registered CDM projects likely to fulfill both of the Kyoto Protocol's objectives of simultaneously delivering greenhouse gas (GHG) emission reduction and contributing to development that is sustainable. This study aimed to find out if the bagasse project has been able to achieve both these goals by improving the local air quality through reduced levels of CO2 and enhancing economic development in the area. Further, Flamos (2010) in his study states that there are barriers which can limit the success of the CDM projects in the developing nations. The study also purposed to find out if any such barriers exist, their influence on the project and if indeed they have hindered the success of the project.

2.3. Background on Africa`s Energy needs.

Africa's energy sector can be classified into three distinct regions. The region greatly dependent on oil and gas North Africa, that which significantly relies on coal South Africa, and the rest of Sub-Saharan Africa, which is markedly reliant on biomass (Karekezi, 2002a). Serious environmental issues have been attributed to traditional biomass energy use and as a result respiratory illnesses in highland areas of sub-Saharan Africa have majorly been attributed to the indoor air pollution. Further, reliance on biomass (especially in the form of charcoal) stimulates land degradation.

The typical energy sector, singularly the electricity sector is majorly marked by undependable power supply, availability factor, low capacity utilization , low access levels availability factor; wanting maintenance; insufficient procurement of spare parts; and high transmission and distribution losses among other issues (Karekezi and Kimani, 2002). From studies done, Projects, specifically renewable energy ones are being faced with challenges such as economic, organizational and infrastructural barriers to implementation (Pain and Fenhann, 2002, Beck and Martinot, 2004). In particular lack of technical capacity, limited awareness, and lack of access to credit, weak maintenance services and the high initial capital cost are common problems to implementation of renewable energy projects.

The renewable energy resources` potential in Africa has not been fully utilized and this is majorly because of little policy interest and investment degrees. Furthermore there have been low levels of adoption of the RETs in the region because of technical and financial (Karekezi and

Ranja, 1997). In recent years though, this has changed by the recurrent crises faced by most power utilities in the region

2.4. Renewable energy in Kenya

Kenya has three main sources of energy including: biomass, petroleum, and electricity making up for 74.6%, 19.1% and5.9%, respectively (GoK, 2002).

In Kenya`s energy supply, noncommercial biomass has a vital role especially to the domestic/residential sector just like in many other developing countries. The transport, agriculture, commercial and industrial sectors greatly depend on commercial energy, more so petroleum fuels and electricity.

2.4.1. Electricity

Grid electricity is the main source of modern energy in Kenya with major sources being hydropower, thermal and geothermal. The electric power generation capacity totally installed as of September 2008 was 1345 MW; comprising of a mix of hydropower, oil thermal, geothermal, cogeneration from sugarcane bagasse and wind generation.

The country` demand for electrical energy is steadily rising. Generation from renewable sources makes up for 74.5% of with fossil fuels taking up the remaining of 25.5%. Vision 2030 which is Kenya's development plan projects a swift rise in the demand for energy resulting from economic & social activities to take place. The highest demand for electricity is expected to rise from 1,350MW in 2013, to 3,400MW by 2015 and 5,359MW by 2017 (GoK, 2010).

There is a big opportunity for bioenergy to contribute significantly towards meeting these energy demands (Mugenya, 2014).). A survey carried out by the Ministry of Energy (MoE) in 2007 indicates potential by the Kenya sugar industry to generate about 200MW of electricity from biomass cogeneration for export, while at the same time helping push down the cost of sugar production.

Due to inadequate rainfall experienced in the catchment areas for the water used in electricity generation n the recent past, there has been a rise in dependence on thermal generation. However, thermal plants rely on expensive imported petroleum fuel, leading to high cost of electricity which has a negative impact on economic activities in agriculture, manufacturing and

transport sectors (GoK, 2008). This further supports the importance of increasing electricity generation from everyday less expensive resources which would otherwise be termed as waste.

2.4.2. Generation of electricity from bagasse (biomass)

Energy from biomass and waste in local areas is a big source of renewable energy. At least 10% of the world`s total energy needs could be met from from agricultural and forestry waste (IEA, 2006). Waste is considered as one of the seven key sectors contributing to climate change (IPCC, 2007) yet it can be used to enhance our clean energy needs.

When sugarcane stalks are crushed to extract their juice there is the fibrous matter that remains after, and this is bagasse (Britannica Online Encyclopedia, 2016). The industry comprises seven sugar companies producing an average of 1.8 million tons of bagasse with fiber contents of about 18% by weight annually. 56% of this is used in co-generation using an installed capacity of 25 MW and the balance disposed at cost.

Bagasse as a primary source of energy when burned produces sufficient energy to supply the needs of a typical sugar mill. Further it can be used in co-generation to produce both heat energy and electricity to be used in the mill, excess electricity can then be sold to the consumer electricity grid; helping in meeting the country`s clean energy needs. Power generation from the process provides for renewable energy options which boost development that is actually sustainable, it takes advantage of domestic resources, increases profitability and competition in the industry, and cost-effectively addresses climate mitigation and other environmental objectives (Rainey and Thomas, 2009).

The 35 MW Bagasse Based Cogeneration Project by Mumias Sugar Company Limited), is a power capacity expansion project involving the generation of electricity using sugarcane bagasse. It is one of the CDM programs whose aiming is bring about a rise in the production of electricity from steam obtained during combustion of bagasse in a broiler. Some of the steam generated is used in the sugar plant processes and equipment, while the power generated is used internally by the company and the excess (25 MW) exported to the national grid (UNFCCC, 2006). The expansion of the project will ensure that all the bagasse produced in the company is used instead of the initial situation where the available boiler was only able to use a fraction with the remaining being dumped in company nucleus estate.

After decommissioning all the current steam turbine drives in the factory were to be replaced by electric motors and the old retained steam boilers refurbished and economizers to ensure energy efficiency improvement. Another 20 MW export of power to the national grid was expected as a result of this (UNFCC, 2006).The project anticipated to operate for at least the same number of days as the sugar mill but could run for a longer time, depending on bagasse availability after the sugar factory shutdown therefore. During the dry season when the proportion of the fossil fuel-based thermal power in the grid generally decreases this would be important for complementing the existing renewable component of the grid. All bagasse generated was to be used to produce steam and generate power, even when the sugar factory is down.

Bagasse is one of the main polluters in the environment around the sugar companies. When left to accumulate it results in the formation of carbon dioxide. The project would ensure that by avoiding dumping the bagasse GHG emissions would be reduced by up to 82,352.40t CO2e (UNFCCC, 2006). The project would prevent this and also ensure displacing of grid electricity with biomass that is GHG-neutral electricity generation. The overall GHG emission reductions expected from the project is 1,295,914t CO2e over the period (2008-2018).

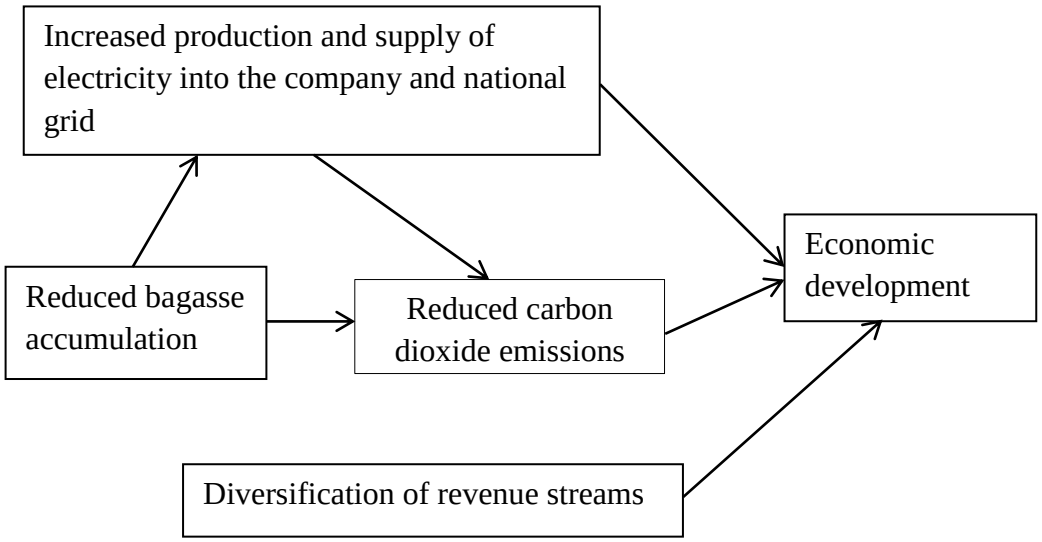
The project would therefore play a vital role in economic development by accommodating for energy deficits. The project would also enhance economic development of the rural community living around the company by providing sustainable benefits through the diversification of revenue streams where the farmer will be producing cane for sugar production and getting compensation while also getting electricity and CERs which will be able to ensure good compensation for the farmer (UNFCCC, 2006).

Mumias Sugar Company Limited (MSCL) is the project sponsor and operator while the Japan Carbon Fund (JCF) is purchasing the Emission Reductions (ERs) arising from the Project Activity and is also a project participant (focal point). All the CDM project transaction costs have been funded by Japan Carbon Finance (UNFCCC, 2008). Some of the problems facing generation of renewable energy such as; technological, economic, institutional and political, common practice, cultural, and investment barriers have been narrowed by the project. The most important in this case being the economic barrier, where the company is able to get a boost to

enable it to run its activities more efficiently and get more revenue which should in turn result in better prices for farmers resulting in a constant supply of cane.

Construction of the project was completed and it was commissioned in February 2009. Power export to the grid started on 11/05/2009, when the system was synchronized with the Kenya Power and Lighting Company (KPLC) grid. The plant has been operational since then, but went through some teething problems until 09/08/2009 when steady export to the KPLC grid system was achieved. By 2010, the plant had achieved a maximum of 30 MW power export to the grid although not on a continuous basis (UNFCCC/ CCNUCC, 2010).This research aims to find out if the project has been able to reduce levels of CO_2 in the environment while achieving economic development in the area and if it has faced any challenges and how they have affected the success of the project.

2.5. Conceptual framework



Adapted from, Patrick A., 2012.

Figure 2.2: Factors influencing carbon dioxide emission and achievement of economic development.

With the commissioning of the project it was expected that there would be no more accumulation of bagasse in the compound premises and this would in turn result in there being less carbon dioxide levels in the atmosphere. The generation of electricity which would be used in the company and some exported to the national grid would also reduce CO2 levels in the environment as it will assist to remove an equivalent amount of carbon dioxide emissions which would have been otherwise generated due to power generation at grid.

The increased production and supply of electricity would also enhance economic development as it would cater for energy deficits. The community around the company would benefit through the diversification of revenue streams where the farmer will be producing cane for sugar production and getting compensation while also getting electricity and CERs which will be able to ensure good compensation for the farmer (UNFCCC, 2006).

CHAPTER THREE

3.1. METHODOLOGY

This chapter deals with the whole process of data collection in order to get the information needed for the study. It includes which study design was used to carry out the study, the population from which data was collected, the sampling techniques and how data was collected and analyzed.

Study Area

The area under study as shown in figure 3.1 and 3.2 was Mumias Sugar Company Limited. The company is located in Butere-Mumias District along the Kakamega Bungoma Road on plot No. FR/257/12 with a total area of 4,295 hectares.

The exact location of the sugar factory is 0021.792'N 34030.25'E.

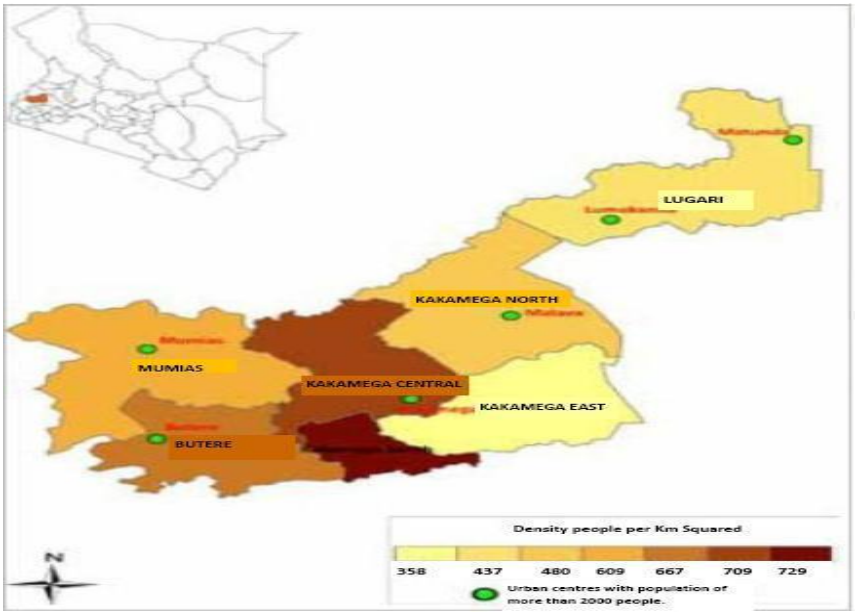


Figure 3.1: Map of Kakamega county

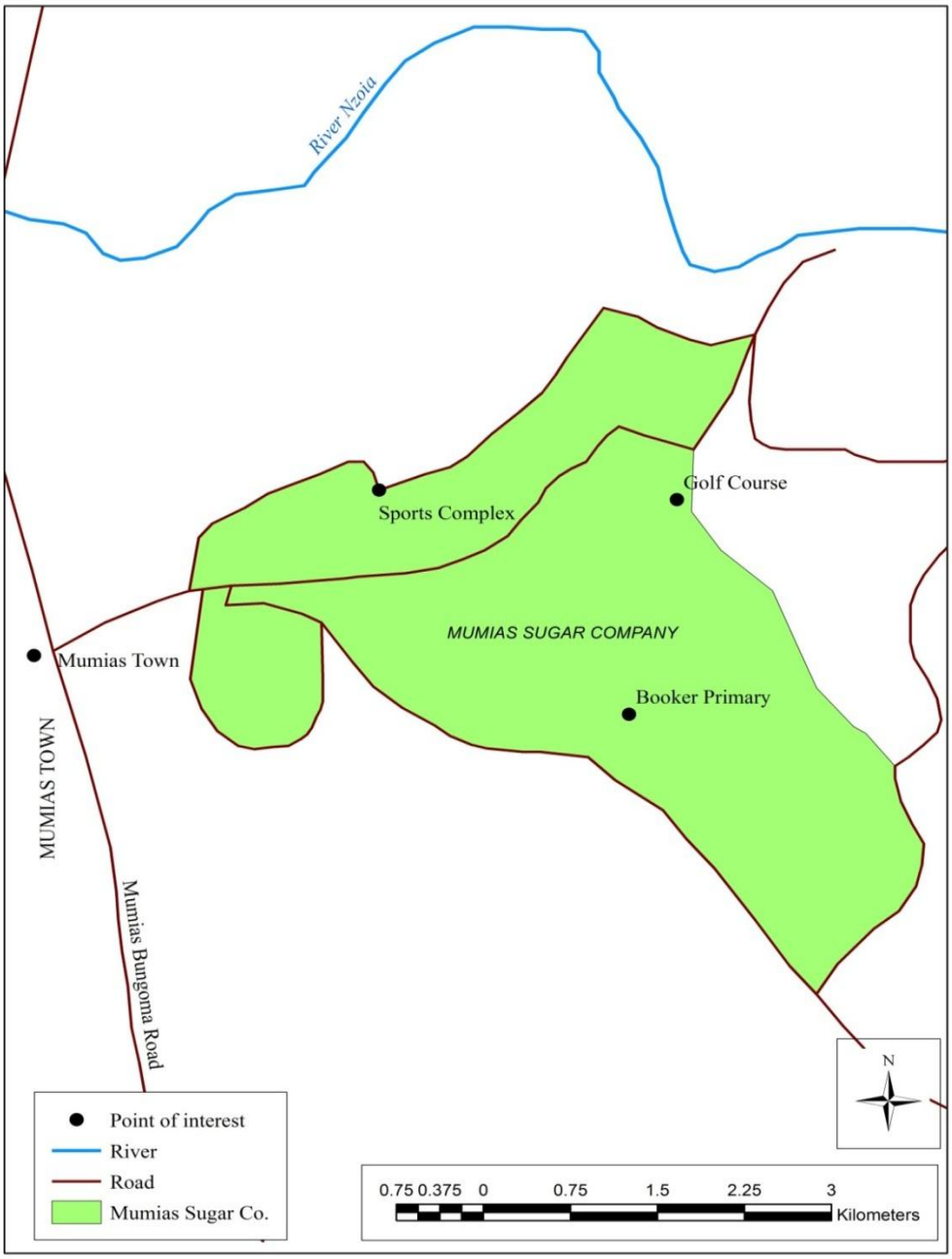


Figure 3.2: Map of Mumias sugar company Limited and the surrounding area.

3.3 Study Design

For the study longitudinal study design was used to find out the changes in amount of carbon dioxide (CO_2), electrical megawatts produced and exported to the grid and development achieved over time since the project commencement in late February 2009 (UNFCCC, 2010) to date. It enabled me to establish over this period if the project activities had brought about changes and what those changes were. It was important not to stay focused on the smaller variations over time but rather the general trend. This is because sometimes some issues such as management, political interference or even delayed and poor payment of farmers altered the trend but once dealt with it generally flowed in a given direction. The variations could also be due to sampling era.

3.4 Study Population

The population under study included 100 business operators in the company and at Shibuli center next to MSCL and 25 workers in MSCL present at the time of the study. Some of the business operators in and around the company had also been suppliers of cane. From this it was possible to get opinions of people who have been a part of the project and business owners who also had the perspective of being cane farmers.

3.5 Sources of Data

For this study both primary and secondary sources of data were used.

Primary sources of data included interviews done within and outside the company. Interviews were done by means of questionnaires administered to individuals working within the company and business owners within and outside the company. Two expert interviews were done with the manager for maintenance of boilers and operations manager respectively.

Secondary sources of data included reviews of books and articles on the topic. Review of UNFCCC data on the project was instrumental as it is a project that is evaluated under their mandate. Information from Mumias Sugar Company limited was also used.

3.6 Sample Size and Sampling Techniques

3.6.1 Sample Size

Before choosing the sampling technique to use, the sample size was determined. According to the thumb for determining the sample size; an appropriate sample size should be larger than 30

and less than 500 (can be more depending on the target population) and the minimum size of the sample should be 30 % of the population (Sekaran, 1975).

In this study, fifteen people working directly in the bagasse project, ten business owners in and twenty business owners outside the company were interviewed making it a total of 45.

3.6.2 Sampling Techniques

In this study cluster random sampling was used in choosing the participants to be interviewed. This ensured the sample was not biased and that every member of the different clusters was able to get a fair chance of being chosen. I grouped the target population into three clusters; workers working directly in the bagasse project, business owners within the company compound and business owners at Shibuli center next to the company.

From each cluster, the study randomly picked individuals to participate in the study by answering administered questionnaires. There were 25 workers working directly in the project during the study and 15 agreed to participate and questionnaires were administered to them. From the business owners within the compound all those that were operational participated and these were 10 while for those business owners at Shibuli centre next to MSCL 20 agreed to participate.

Two key informant interviews were carried out with one person in charge of maintenance and operations in the boilers section and the manager in charge of operations in the project.

3.7 Methods of data collection

3.7.1 Individual interviews

Two interviews with an expert in the operation of the boilers and the overall manager of operations in the bagasse project were carried out. This was very useful as it helped get critical information especially as the boiler`s manager had been with the company since the commencement of the project and he could shed light on a lot of things.

3.7.2 Questionnaires

The study used semi-structured questionnaires and they helped to guide the answers to meet the objectives of the study without restriction, such that interesting issues were easily explored in

more depth. This was important as it helped acquire more insight helping to understand the responses.

3.8 Methods of Data Analysis

From the administered questionnaires statistical package for the social sciences (SPSS) was used to analyze the data. The study further used percentages to describe the findings. With illustrations such as pie charts, column and bar graphs the respondent`s views were presented.

3.9 Study Limitations

These are influences or short comings which cannot be controlled that can place restrictions on the bagasse project methodology and conclusions.

For this study it was difficult to find many people who have been there from the beginning of the bagasse project up to date; however the participants were still able to provide valuable information on the project based on the time they had been there. This problem was solved by ensuring that the questionnaires established the time the respondent has been affected by the bagasse project.

There was an issue with communication when talking about the bagasse project. Many did not know what bagasse is and therefore it had to be constantly explained to them what it meant. There was also the issue of language barrier where some of the respondents and especially those not working directly in the project wanted me to translate bagasse to their local dialect, of which I am not a native speaker of the local language. This was solved by having one assistant from the local area to assist in translation.

3.10 Ethical Issues.

Ethical issues have become an integral part of research as they determine how valuable your work is and if it is able to make any difference.

First and foremost when carrying out research it is important to seek the permission of the person you are interviewing. Only those who accepted to participate were explained to what the research was about, what it aimed to achieve and how it could help enhance the participant`s life.

It was clearly pointed out to respondents that it was an academic exercise and that any information they disclosed to was confidential and their identity would not be shared with

anyone else. It was ensured that the participants understood that the information they gave would be in this case used for learning purposes only.

CHAPTER FOUR

4.1. RESULTS AND DISCUSSIONS

This chapter is about the results and findings from the data collected. It also looks at how the findings addressed the objectives of the study.

4.2. Response rate

The findings were based on the following : to assess the effect of the bagasse project on the amount of carbon dioxide being emitted, to examine how the company and the surrounding community have benefited from the project and to assess what challenges the bagasse project has experienced.

The study targeted 50 respondents of which, 45 respondents participated and returned their questionnaires contributing to a response rate of 90%. This response rate was adequate and illustrative and conforms to Mugenda and Mugenda (2003) stipulation that a response rate of 50% is sufficient for analysis and reporting; a rate of 60% is good while a response rate of 70% and over is excellent.

Quantitative and Qualitative data from questionnaires was entered using Microsoft Excel. The data was then sorted and analyzed using Statistical Package for the Social Sciences (SPSS) based on the study objectives. Descriptive statistics, percentages were used to describe the sample. The outcomes were then presented in charts and graphs. Ethical integrity was upheld in data analysis and presentation.

4.3. Background of the respondents.

4.3.1 Gender and age of respondent.

About 78% of the respondents were male while 22% were female. This shows that most of the people working around the company and most business owners in the area are male.

As shown in figure 4.1 below, most of the respondents 48% were in the age bracket of between 35 and 44. Those who were interviewed from the age bracket 45-54 were 20% and 15-24 were 8%, while 4% were above 55 years of age. This indicated that most of the respondents were of an age where they could easily remember when the project started and its effects on the environment and the community since its commissioning.

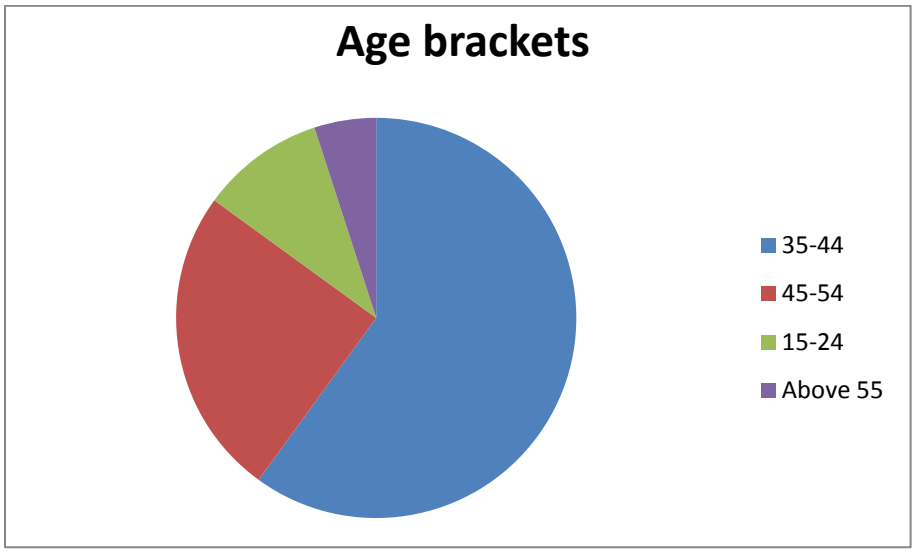


Figure 4.1: Age bracket of respondents.

Source, Field data 2017

4.3.2. Education level.

As illustrated in figure 4.2 below, about 75% of the respondents had a tertiary education, 13% had primary education, 10%, had secondary education, while 2% (1) had no formal education all. This was important as it ensured that majority of the respondents understood the questionnaires.

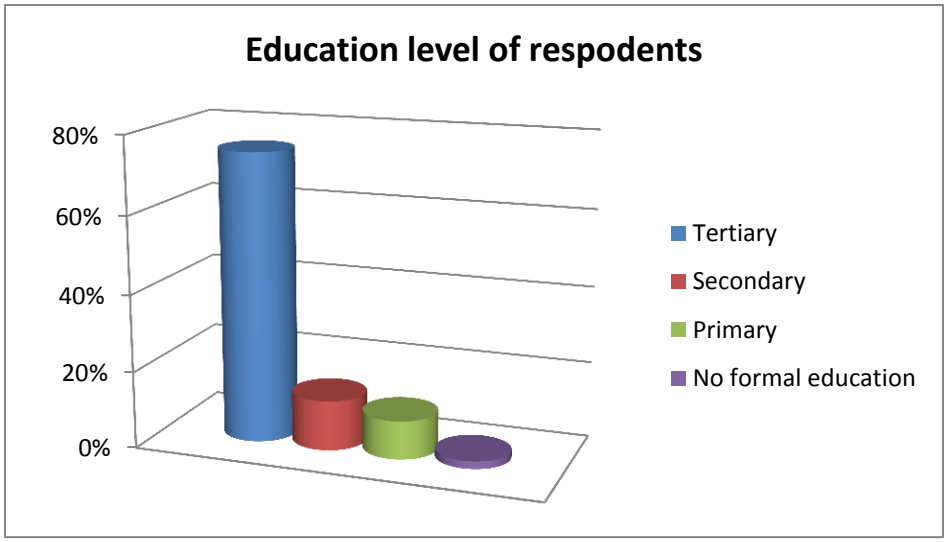


Figure 4.2: Education levels of respondents.

Source, Field data 2017

4.4. Effects of the bagasse project on the carbon dioxide being emitted.

In terms of accumulation of bagasse which was resulting in release of carbon dioxide to the environment, there was no more heaping of the same as the bagasse was now all being used in the project. The company was even getting more bagasse from other factories in the region such as west Kenya Sugar Company and Butali sugar mills (MSCL, 2015)

In a monitoring study done by UNFCCC from 01/10/2008 to 30/06/2011 the project had generated 140,544.8t CO_2 and the plant had achieved a maximum of 30 MW power export to the national grid from 2MW before its commencement, although not on a continuous basis. An interview with an expert in the maintenance and operations of boilers department revealed that in the first six years of the project the company was able to produce between 24 and 28 megawatts per day of which the company was able to consume about 6 megawatts. The rest was then transferred to the national grid. The generation of clean power from the project activities assisted to remove an equivalent amount of carbon dioxide emissions which would have been otherwise generated due to power generation at grid.

The project has also improved the local air quality as particulate matter from the flowing gases was being cleaned by an electrostatic precipitator.

As shown in figure 4.3 below, the respondents also felt that the project was important in reducing CO2 levels in the area.

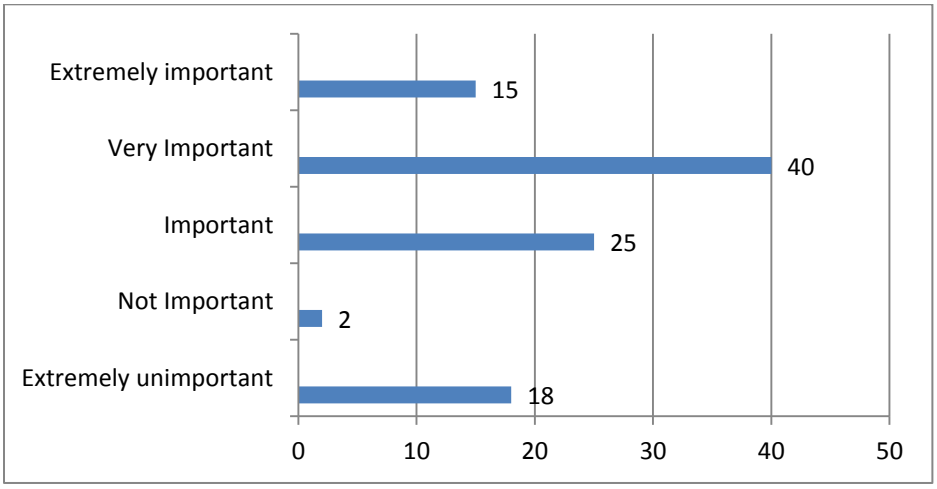


Figure 4.3: Level of importance of the bagasse project in reduction of CO2 at MSCL.

Source, Field data 2017.

4.5. Benefits of the project to the company and the surrounding community.

The bagasse project in Mumias Sugar Company has come with a number of benefits, not only to the company but also to the surrounding community. The project supplied power, organic fertilizer, feed to cattle, created employment opportunities, minimized the production cost, and improved environmental conservation. The increased supply of power lowered the cost of production in Mumias Sugar Company as they did not need to pay for power and they were getting some income from the electricity supplied to the national grid. The supply to the national grid made up for energy deficits in the area and country. As indicated in figurer 4.4, 44% of respondents said that the project improved supply of organic fertilizer as the company supplied fertilizer to farmers which would later be deducted from their pay from supply of cane making access easier. Molasses from the project was also useful in providing feed for cattle in the area. The project activity created employment opportunities for the local people, both during construction (not less than 1,000 workers, inclusive of contractors) and operation (11 new permanent positions) (UNFCCC, 2010). The number of workers in the project currently is 40 (MSCL, 2017).

Initially before the project the company was able to export 2MW of electricity for 16 hours per day to the national grid (UNFCCC, 2010) but this increased to between 24MW and 28MW over the years (MSCL, 2017). In a monitoring study done by UNFCCC from 01/10/2008 to 30/06/2011 the project had generated 140,544.8 tCO_2 and the plant had achieved a maximum of 30 MW power export to the grid although not on a continuous basis.

An interview with an expert in the maintenance and operations of boilers department revealed that the project had indeed been useful in boosting the company energy needs. In the first six years of the project the company was able to produce between 24 and 28 megawatts per day of which the company was able to consume about 6 megawatts. The rest was then transferred to the national grid.

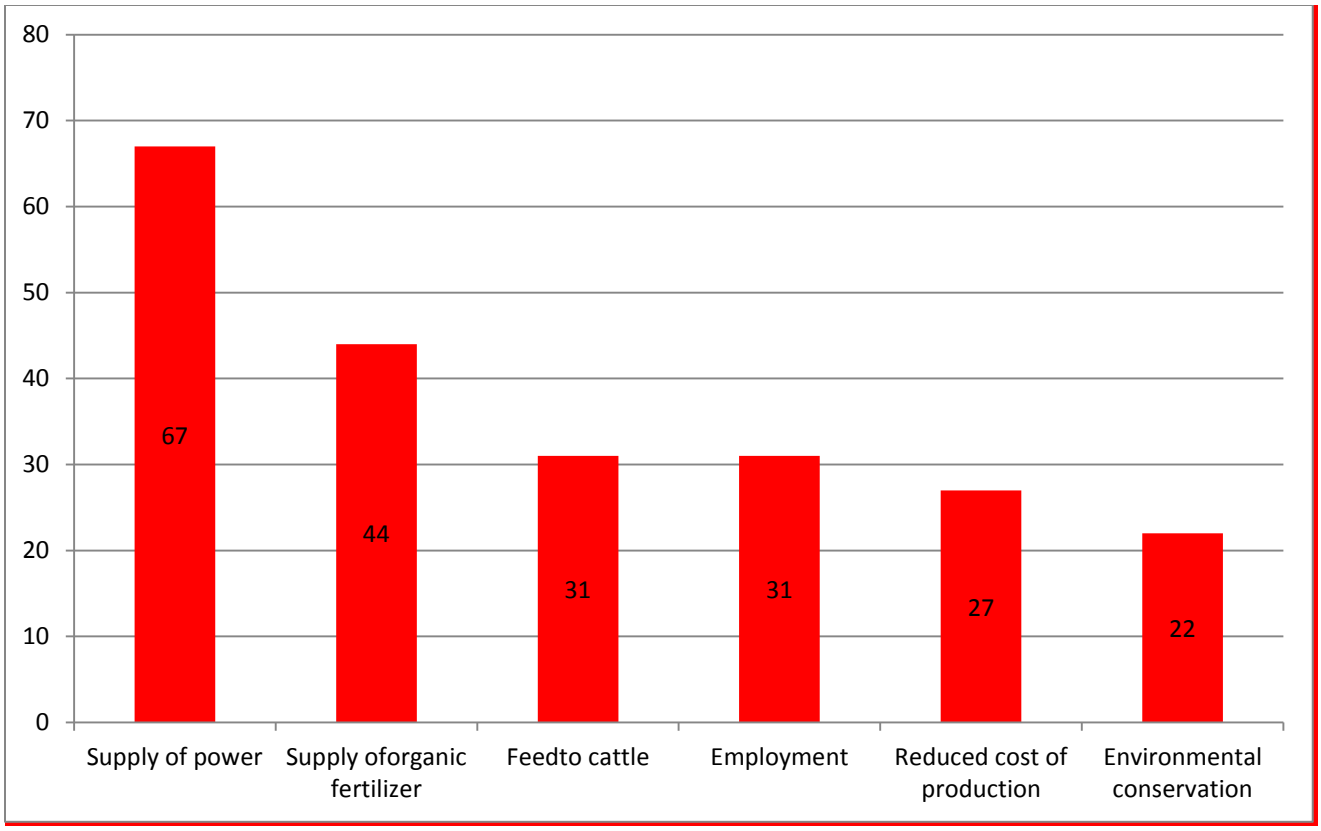


Figure 4.4: The benefits the project has brought to the company and surrounding communities

Source, field data 2017

The project improved the company electricity bank. According to MSCL the best year in the production of electricity from the bagasse project was between 2013 and 2014.Indicated in figure 4.1 below is the revenue generated from sale of electrical megawatts to KPLC for year 2013/2014.

Month and Year	**Revenue (Kshs)**
Jul 2013	**28,102**
Aug 2013	**20,646**
Sep 2013	**11,483**
Oct 2013	**7,168**
Nov 2013	**9,189**
Dec 2013	**11,214**
Jan 2014	**20,880**
Feb 2014	**35,814**
Mar 2014	**33,377**
Apr 2014	**15,231**
May 2014	**21,581**
Jun 2014	**16,188**

4.1; Data on revenue generated at MSCL year 2013/2014.

Source, MSCL, 2017

A foundation formed as a CSR program by the company, Mumias Foundation, helps to cater to needy children as it gives bursaries enhancing primary school education. MSCL had three schools within its compound; Complex primary school and Central primary school which are both public schools and Booker Academy a private school. The company offered land for the public schools to be built and continues to support them with amenities such as water; it also assists in repair work of structures.

The project has also influenced indirect employment such as in the hospitality industry; Mumias town benefited so that the standard price for a room was about Ksh.700 and at the same time even finding the accommodation was difficult. Hardware stores as far as Kisumu were benefitting as farmers sought to buy wares to manage their farms. The project resulted in an economic chain benefiting employees, farmers, business owners not only in the area but beyond into the western region of the country.

4.5.1 Activities enhanced by the bagasse project

From the questionnaires there were activities which were enhanced as a result of the bagasse project activities. As shown in figure 4.5, 65% of the respondents said that agriculture was the most enhanced. Sugar cane farming in the region improved as farmers had market for their crop at the company and ready supply of fertilizer from the company improved production. Another sector that has benefited is transport; a lot of feeder roads to the cane farms were improved by the company to enable farmers to transport their produce. The infrastructure of the area improved as people set up shops, hotels, filling stations even as services provision improved to meet the requirements of the influx of people living within and doing business in and around the company. This enhanced economic growth in the area. Shibuli center next to MSCL gate was one of the centers to grow as a result of the project activities. On top of that systems such as banking, communication, legal, accounting and professional consultants have gotten business (UNFCCC, 2010)

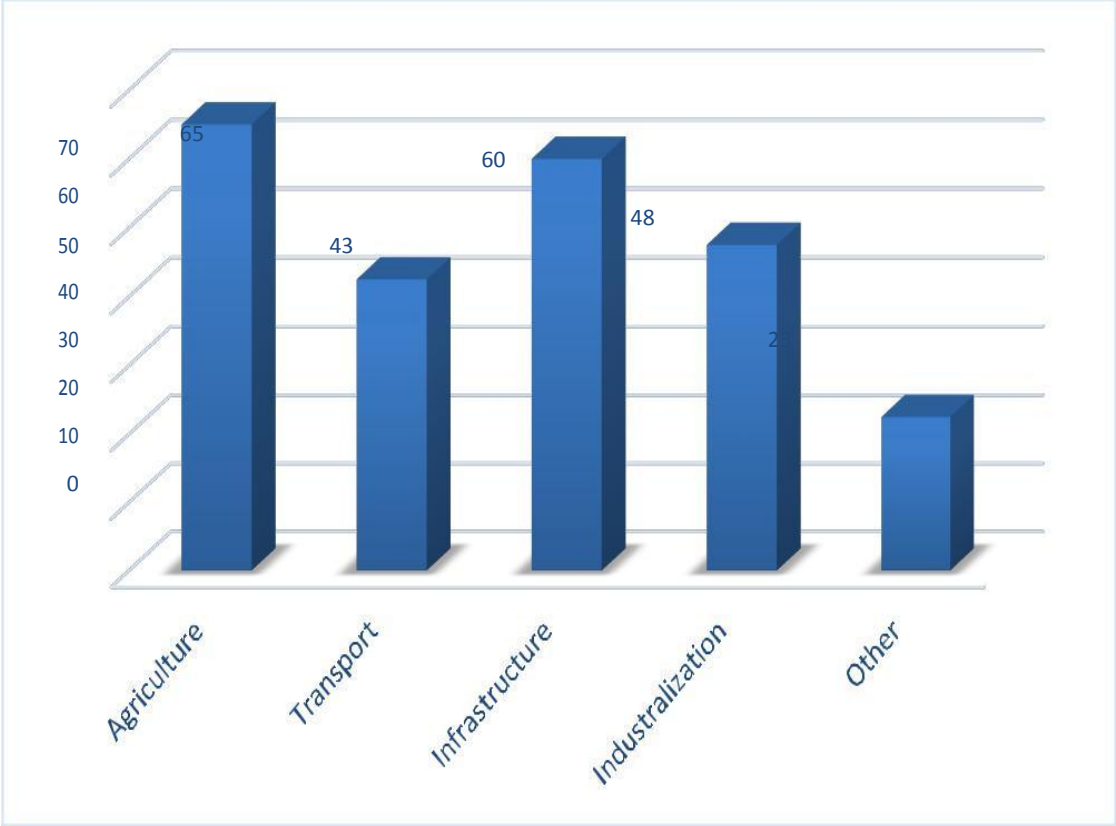


Figure 4.5 Activities enhanced by the bagasse project

Source, field data 2017.

As illustrated in figure 4.6 below, 88% of the respondents felt the project was important in achieving economic development in the area

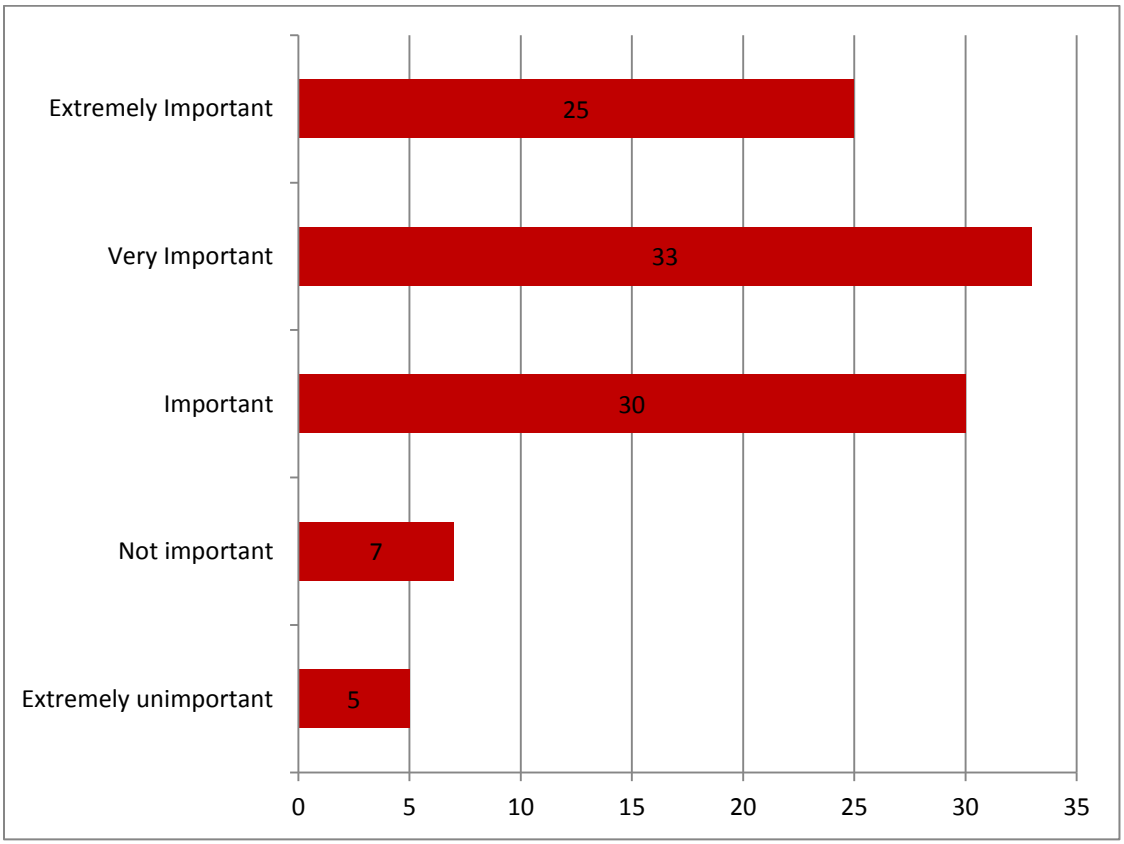


Figure 4.6: The level of importance of the bagasse project in achieving economic development.

Source, field data 2017.

4.6. The challenges the bagasse project has experienced.

The bagasse project has faced a number of challenges since its conception. According the respondents, the challenges include, inadequate raw materials, Ineffectual technology, high transportation cost for raw materials, increased demand for cane in the region, incidences of corruption and poor agricultural practices from the farmers. As indicated in figure 4.7, Most of the respondents 71% who said that limited availability of raw materials, in this case, sugar cane, from which bagasse is extracted, was the most significant challenge to the bagasse project.

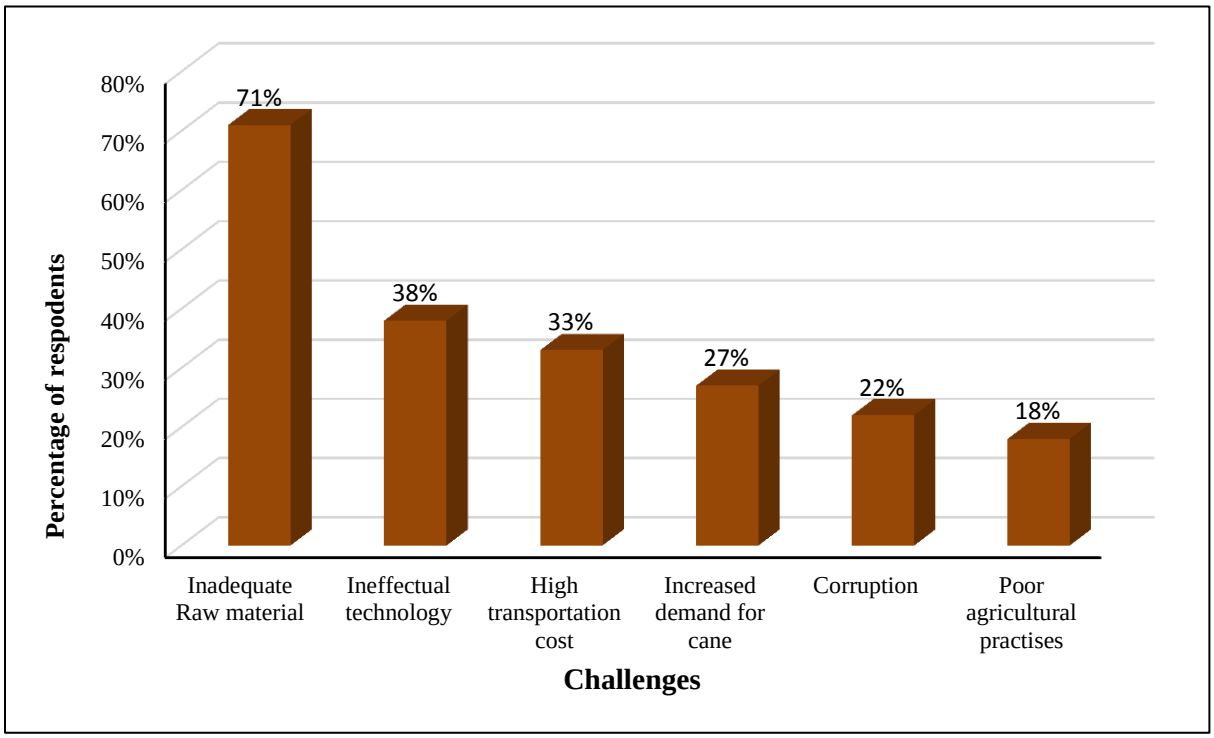


Figure 4.7: Challenges facing the bagasse project at Mumias Sugar Company

Source, Field data 2017

From the interviews carried out with experts one of the major challenges in the company was mismanagement. This affected the project activities in that the farmers were not given their dues on time and as such they instead preferred to take their cane to other sugar companies in the region. It's important to note the other sugar companies in the region have the a capacity of about 2500tonnes in their boilers while MSCL has a capacity of 7500 tonnes; this therefore means that for it to make economic sense for MSCL to crush cane it needs much more cane than the other companies. Competition from the other companies for the cane and the fact that they are able to

pay on time has contributed to the raw material shortage at the company and this in turn means there`s less bagasse to enhance generation of electricity.

Another issue contributing to a shortage in raw materials is poor agricultural practices such that instead of the cane being able to be harvested for up to 4 seasons they end up being harvested twice before they have to be uprooted. The high transportation costs have also affected availability of raw materials as some farmers have to deliver cane to the company from farms far way and this increases costs in terms of investment in the trade making some prefer to stop production completely.

From the expert interviews it was established that during commissioning of the project an electrostatic precipitator (ESP) was installed to help in cleaning gas produced from the project activities. An electrostatic precipitator removes fine particles like dust and smoke from gas that is flowing (IUPAC, 2006). However the technology was not appropriate for the raw materials being used in the project. The reason for this setback was that the sugarcane which was being fed into the crashers had too much ash for the ESP to work effectively. First of all the manner of harvesting, loading and transporting the cane left it relatively dirty. According to MSCL, in the rainy season the ash levels were up to 10% of the total weight of cane transported into the factory. Further the cane was not being washed before being fed into the crusher making it difficult for the ESP device to work.

In this instance the technology adapted was not appropriate for the raw materials as they were being used. Opting to wash the sugarcane before feeding it to the crushers was not an option as that would have made the cost of production too high. The levels of ash in the cane were not taken into consideration before deciding which device to use to clean gas produced from the project activities.

Another challenge from the interviews was that the transfer of electricity to the national grid came to a stop in 2015 due to hefty penalties attached to the contract between MSCL and KPLC. KPLC gave the company targets which if they were not met high penalties were issued despite of the company still supplying the less than stipulated target. This resulted in a lot of accumulated penalties which resulted in the ending of the contract in early 2015.The main issue hindering the

company was the lack of enough raw materials so as to continuously supply the amount of electrical megawatts stipulated in the contract with KPLC.

CHAPTER FIVE

5.1. SUMMARY OF KEY FINDINGS AND RECCOMENDATIONS

This chapter deals with summarizing the key findings of the project, making conclusions and giving recommendations for the same.

5.2. Summary

From the study findings levels of carbon dioxide in the environment have gone down because of the project activities. The generation of clean power from the project has assisted to remove an equivalent amount of carbon dioxide emissions which would have been otherwise generated due to power generation at grid. Generation of electricity improved from 2MW generated before the project to 30MW between 2008 and 2011 (UNFCCC, 2011) and between 24MW and 34MW over the years. Emission of carbon dioxide from accumulation of bagasse was reduced as all the bagasse is being used in the project.

The project has also enhanced economic development through the export of electricity to the national grid as it reduces overdependence of Kenya`s energy needs on fossil fuels .It has also enhanced other areas of the economy of the area. Shibuli center and others in the region have grown and expanded as a result of providing goods and services to workers in the company compound and those visiting and doing business there. Systems such as banking, communication, legal, accounting and professional consultants have also grown to accommodate for the needs arising from the project activities.

One of the big challenges facing the project is inadequate raw materials. This has been precipitated by various mishaps, one major one being mismanagement at the company. This affected the project activities in that the farmers were not given their dues on time and as such they instead preferred to take their cane to other sugar companies in the region. Competition from the other companies for the cane and the fact that they are able to pay on time has contributed to the raw material shortage at the company and this in turn means there`s less bagasse to enhance generation of electricity. Other elements such as ineffectual technology, high transport cost and poor agricultural practices have also affected the success of the project.

5.3. Conclusion

Despite the project facing some challenges which have affected the project activities, it has been able to achieve the goals it set out to achieve to some extent. It has been able to reduce the levels of carbon dioxide in the environment and enhance economic activities in the area and region. It is important therefore to come up with ways in which the challenges being faced can be eliminated or reduced so as to enhance the project success.

5.4. Recommendations

It is important to ensure that before there is any technological transfer in the CDM program that the nature of raw materials to be used in a project are taken into consideration to ensure the it is effective. Systems should also be put in place to make certain there is accountability and transparency in management of the project to prevent avoidable mishaps. Another crucial factor to take into account is the economic priorities of the local economies before commencement of any project to ensure the project aims are compatible to enhance relevance and success.

5.5. Policy recommendation.

It is very important that before embarking on any development and in our case any CDM projects, the policies prevailing in the local economies should be taken into consideration. The local development priorities should be considered so that the project objectives are in synch with the needs of the affected community. This will enhance the projects` success as they will be solving actual issues on the ground while achieving their own goals.

One way of doing this is by holding consultations with governments of host countries so as to know the prevailing conditions on the ground in order to come up with programs that have a high chance of success. This will also help to anticipate which challenges are likely to come up and how best to deal with them; it will also enhance the monitoring process to ensure attainment of goals.

5.6 Recommendation for further study

Further studies should be done on the challenges facing CDMs in the developing countries and how they can be reduced and prevented in order to enhance the success of such projects.

References

Adhikari, S., Mithulananthan N., Dutta A., Mathias AJ. (2008).Potential of sustainable energy technologies under CDMs in Thailand: opportunities and barriers. *Renewable Energy33 (9),* (21–33.)

Asmerom, M. G., Robert,V. B., Mitchelle, J.S., (2009).*Enabling optimal energy options under the clean development mechanism.* Carnegie Mellon University, Civil & Environmental Engineering and Engineering & Public Policy, 5000 Forbes Avenue, Pittsburgh, PA 15213.

Beck, F., Martinot, E. (2004). Renewable Energy Policies and Barriers. In Cutler J. Cleveland (Ed), *Forthcoming in Encyclopedia of Energy*. Academic Press/Elsevier science.

Burkett, M. (2008). Just Solutions to Climate Change: A Climate Change Justice Proposal For A Domestic Clean Development Mechanism. Colorado, USA: University of Colorado.

"Citi report: Slowing Global Warming would save tens of trillions of dollars." (2015). The Guardian. Retrieved 20 October 2016.

CLIMATE CHANGE, (2014). Synthesis Report. *Summary for policy makers*. Retrieved 24 October 2016.

Chunshan, S., (2002). Fuel processing for low-temperature and high-temperature fuel cells Challenges, and opportunities for sustainable development in the 21st century. *Clean Fuels and Catalysis Program, The Energy Institute, and Department of Energy &Geo-Environmental Engineering,* USA: The Pennsylvania State University: 209 Academic Projects Building, University Park, PA 16802 .

Gills, J. (2015). Short answers to hard questions about climate change. *The New York Times*. Retrieved on 22 October 2016.

Government of Kenya. (2008).*Economic survey: Ministry of planning and national development.* Nairobi, Kenya: Government printer.

Government of Kenya. (2008).*Least Cost Energy Development plan: 2009–2029. Ministry Of Energy.* Nairobi, Kenya: Government printer.

Edenhofer, O., et al. (2014). Technical summary in, *IPCC AR5 WG (3)* p.68.

Eichberger, S. (2006). *The Austrian JI/CDM Programme Characteristics, Experience and Expectations.* Moscow: Kommunalkredit Public Consulting GmbH.

Flamos, A., Gaast, W., Doukas, H., & Deng, G. (2008). EU and Asian Countries Policies &Programs for the Diffusion of Sustainable Energy Technologies. *Asia Europe Journal* International Co-operation on Environmental Issues: Asian and European Perspectives, *Springer*, ISSN: 1610–2932.

Flamos, A., Georgallis P.G., Psarras J. (2010). Bioenergy Options in the Industrialized and Developing world and Opportunities for the Clean Development Mechanism. *International Journal of Green Energy*. Vol 7(*6*).

Haites, E., (2004). Estimating the Market Potential for the Clean Development. Intergovernmental Panel on Climate Change (IPCC), 2001a. (2001). Climate Change. *The Scientific Basis*. New York: Cambridge University Press.

IPCC. (2007). *Synthesis report summary for policy makers, section 4: Adaptation and Mitigation Options,* In IPCCAR4 SYR.

IUPAC. (2006). *Compendium of chemical terminology*, 2nd ed. (the "gold book") (1997). Online corrected version.

John, H. (2008). *Global warming, a global emergency*. Belfast, spires conference Centre: CiS Ireland

Kiplagat, J. K., Wang, R.Z., Li T.X. (2002).*Renewable energy in Kenya: Resource potential and status of exploitation.* a. Shanghai Jiao Tong University, Shanghai 200240, China: Institute of Refrigeration and Cryogenics; b. Nairobi, Kenya: Energy Engineering Department, Kenyatta University, P.O. Box 43844-00100.

Karakosta, C., Doukas, H., Parris, J. (2008). RES technology transfer within the new climate regime: A "helicopter" view under the CDM. *Renewable and sustainable energy Reviews. 13(*1138-1143*).*Athens, Greece: National Technical University of Athens.

Kantai & Parselelo. (2002). 'Hot and Dirty*'. Eco Forum, 24(*4), Hot and Dirty. *Inside Kenya's 2 billion shilling charcoal industry*. Nairobi: Environment Liaison Centre International.

Karekezi, S., & Kimani, J. (2002). 'Status of Power Sector Reform on the Poor'. *Energy Policy, 30*(11-12), and Special Issue – *Africa: Improving Modern Energy Services for the Poor.* Oxford: Elsevier Science Limited.

Karekezi, S. (2002a). 'Renewables in Africa – Meeting the Energy Needs of the Poor', *Energy Policy, 30*(11-12), and Special Issue – *Africa: Improving Modern Energy Services for the Poor.* Oxford: Elsevier Science Limited.

Mark, Z.J. (2009). Review of solutions to global warming, air pollution, and energy security. *atmosphere/energy program*. California, USA: Department of Civil Engineering and Environmental Engineering, Stamford University, Electric auto association.

The World Bank PCF plus Report 19. (2008*). Mechanism: Review of Models and Lessons Learned.* Washington DC,USA.

Ogujiuba, K., Stiegler, N., &Fadila, J.(2012). Sustainable development in developing countries: Case studies of sustainable consumption and production in South Africa and India. *Journal of Economics and Behavioral Studies, 4*(9), 489-496.

Okosonki, K. (2003). "Adapt or Die", *The Science, Politics and Economics of climate change* (pp 56-74).

Pain, J. & Fenhann, J. (2002). Implementation of Renewable Energy Technologies – Opportunities and Barriers. *Summary of country studies*. Denmark: RisØNationalLaboratory,

Peter, U., Clark et al. (2016).Consequences of twenty first century policy for multi-millennial climate and as change. *Nature Climate Change 6*, 360-369, doi:10.1038/NLCLIMATE 2923.

The United Nations (UN). (1998). *The Human Development Report*. Oxford: Oxford University Press.

Rainey, Thomas J. (2009). *A study of the permeability and compressibility properties of bagasse pulp*. Brisbane, Australia: Queensland University of Technology.

Scott, S. (2013). Determining sample size: How to ensure you get the correct sample size. Accessed from https://www.qualtrics.com/blog/determining-sample-size/, accessed on 24th march 2017.

Sutter, C., Parreño, J.C. (2007). Does the current Clean Development Mechanism (CDM) deliver its sustainable development claim? An analysis of officially registered CDM projects, climate change, Vol 84(*1*) p.75-90. https://doi.org/10.1007/s10584-007-9269-9

Regoniel, P.A. (2012). Example of a Research Using Multiple Regression Analysis. *SimplyEducate.Me*. Retrieved from http://simplyeducate.me/2012/11/11/example-of-a-research-using-multiple-regression-analysis/.

Smit, B. and Pilifosova, O. (2003). Adaptation to climate change in the context of sustainable development and equity. *Sustainable Development*, *8*(9), p.9.

UNFCCC. (1998). *The Kyoto protocol to the United Nations framework convention on climate change*, http://unfccc.int/resource/docs/convkp/kpeng.pdf.

UNFCCC. (2001). *FCCC/CP/2001/13/Add.1*, *Decision 4/CP.7*, *Annex, Seventh Conference of the Parties to the UNFCCC*. UNFCCC, Marrakech, Morocco.

Van-der-Merwe, I., & Van-der-Merwe, J. (1999). Sustainable development at the local level. *An introduction to local agenda 21*.

Van der Gaast, W., Begg, K., &Flamos, A. (2008). Promoting sustainable energy technology transfers to developing countries through the CDM. *Applied Energy International Journal*, Elsevier, ISSN: 0306–2619.

APPENDICES

Appendix 1: Questionnaire.

Dear respondent.

I am Sally Tirimba, M.A Environmental planning and management student from the University of Nairobi. This study is part of my project aimed at evaluating how the bagasse project at Mumias Sugar Company has impacted levels of carbon dioxide in the environment and the community in the surrounding areas. The targeted respondents include those working/living in the company and the surrounding areas.

SITUATIONAL EVALUATION OF THE CLEAN DEVELOPMENT MECHANISM (CDM) IN REDUCING LEVELS OF CARBON DIOXIDE IN THE ATMOSPHERE AND ACHIEVING ECONOMIC DEVELOPMENT; A CASE STUDY OF THE BAGASSE PROJECT AT MUMIAS SUGAR COMPANY LIMITED

Questionnaire No_____Date of interview_____

Location of survey site

County_____Subcounty_____Division_____

___

Gender (tick): Male ☐ Female ☐

Age of respondent: 15-24 ☐ 25-34 ☐ 35-44 ☐ 45-54☐>55yrs ☐

Education level: None ☐ Primary ☐ Secondary ☐Tertiary ☐

Occupation: None ☐ Subsistence farmer ☐Public Service ☐ Self-Employees ☐ others ☐

Income level 10,000-30,000 ☐30,000-50,000 ☐50,000-70,000 ☐70,000 + ☐

1. How long have you lived around Mumias Sugar Company in terms of years?
   Less than 10☐ 10-20 ☐ 20-30☐ 30-40☐ 40-50☐ more than 50☐

2. How long have you worked at Mumias Sugar Company in terms of years?

   Never☐ 0-5☐ 5-10☐ 10-15☐ 15-20☐ 20-25☐ more than 25☐

3. Have you heard of the bagasse project at Mumias Sugar Company Limited?

   Yes ☐ No ☐

4. What do you know about the bagasse project at Mumias Sugar Company Limited?

   _____

5. Can you remember when it started?

Yes ☐ No ☐

6. If yes, how have you benefited from the bagasse Project?

   i. _____

   ii. _____

   iii. _____

   iv. _____

7. Since the time you started living/ working here do you think the bagasse project has contributed to increased carbon dioxide released to the environment?

   Yes ☐ No ☐

8. Has this problem continued to occur or has it been reducing over the years?

   _____

   Please explain _____

   _____

9. Can you remember when this problem was greatest (years(s))? _____

10. When did this problem begin to decrease? _____

11. In a scale of 1-5, to what level has the bagasse project reduced the amount of carbon dioxide produced at Mumias Sugar Company limited?

Extremely unimportant				**Extremely Important**
1☐	2☐	3☐	4☐	5☐

12. Which economic activities have been enhanced as a result of the bagasse project?
    Agriculture ☐ Transport ☐ Infrastructure ☐ Industrialization ☐ Other ☐
    Please specify _____

    _____

13. Please indicate the contribution of the bagasse project at Mumias Sugar Company Limited to the Economic development goals in a scale of 1 to 5?

Extremely unimportant				**Extremely Important**
1☐	2☐	3☐	4☐	5☐

Economic Development Goals

1. End poverty in all its forms everywhere.
2. End hunger, achieve food security and improve nutrition and promote sustainable agriculture.
3. Ensure healthy lives and promote well-being for all at all ages
4. Ensure access to affordable, reliable, sustainable and modern energy for all.
5. Promote sustainable, inclusive and sustainable economic growth, full and productive employment and decent work for all.
6. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
7. Take urgent action to combat climate change and its impacts.
8. Strengthen means of implementation and revitalize the global partnerships for sustainable development.

14. What are the challenges facing the bagasse project at Mumias Sugar Company Limited?

i. _____

ii. _____

iii. _____

iv. _____

v. _____

15. What is your opinion about the bagasse project at Mumias Sugar Company? Should it continue?

Yes☐ No ☐

If yes Why? _____

_____

If No, why? _____

_____