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Presented by

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ASSESSING IMPLEMENTATION OF ENERGY EFFICIENCY PRACTICES AND INDUSTRIAL ENERGY MANAGEMENT: A CASE STUDY OF KENYAN INDUSTRIES

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DECLARATION

I, Jacinta Akoth Okwako, declare this as my original work and to the best of my knowledge, no part of this report has been presented elsewhere for the Master's Degree award.

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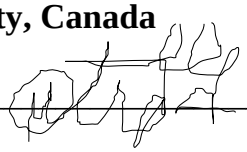
Signature:  Date: September 14 2018

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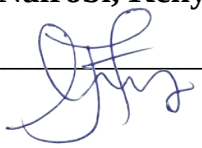
Signature:  Date: September 14 2018

DEDICATION

To my lovely daughters Shirlene Stacy and Happiness Hawi, you are my ray of hope, source of inspiration and pillar of strength.

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LIST OF ABBREVIATIONS

AAPOR	American Association for Public Opinion Research
CEEC	Centre for Energy Efficiency and Conservation
CFLs	Compact fluorescent
CO_2	Oxygen
COP	Conference of the Parties
EMA	Energy Management Awards
ERC	Energy Regulatory Commission
GDP	Gross Domestic Product
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IEEP	Institute for European Environmental Policy
INDCs	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organizations for Standardization
KAM	Kenya Association of Manufacturers
KIPPRA	Kenya Institute of Public Policy and Research Analysis
KITP	Kenya Industrial Transformation Programme
KNBS	Kenya National Bureau of Standards
KPLC	Kenya Power and Lighting Company
KSh	Kenyan shillings
MJ	Mega Joules
KWh	Kilo Watt Hour
MPA	Manufacturing Priority Agenda
OECD	Organization for Economic Co-operation and Development

REN21	Renewable Energy Policy Network for 21st Century
SEZ	Special Economic Zones
SPSS	Statistical Package for the Social Science
UNICEF	United Nations International Children's Emergency Funds
UNIDO	United Nations Industrial Development Organizations
US	United States
USD	United States Dollars

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ABSTRACT

The government of Kenya in Vision 2030 aims to turn the nation into a higher middle-income economy which is driven by industrial transformation. In abide to achieve this, a number of programmes have been initiated with the recent one known as The Kenya Industrial Transformation Programme. The Kenya Industrial Transformation Programme has its foundations in Vison 2030 but its main focus is on the manufacturing sector. It provides a roadmap which can be used to enhance manufacturing and value addition, stimulation of exports and subsequently transform the Kenyan economy. To achieve this, there is greater need for the nation to generated more electricity since most industries are energy intensive. In a country like Kenya where sometimes generated electricity is never due to issues like drought which occurs almost on yearly basis and the electricity tariff is very expensive (USD cents 15/KWH), the best solution in this case is for the industries to invest in the adoption of energy efficiency measure in order to reduce the cost of energy use. Adoption of energy efficiency and management will also help the industries to reduce the greenhouse gases emitted to the environment hence helps to take care of climate change issues. As way of helping the industries to use their energy efficiently, the government of Kenya has been sensitizing the high energy consumers to adopt energy efficiency and management measures and the benefits associated with the uptake of energy efficient technologies in their facilities. To show their commitment in the journey of energy efficiency, the government through ERC passed a regulation known as The Energy Management Regulation of 2012. This regulation requires the industries to integrate energy management measures into their system as well as undertake an energy audit once in three years then consider to implement at least 50% of the recommendations provided by the auditors.

This explorative and quantitative study was conducted with an aim of assessing the implementation of energy efficiency and management in industries with main focus on the Kenya manufacturing industries. The study specifically focused on the industries' energy management systems, their sources of information, currently adopted energy efficient measures, driving forces for improving energy efficiency and barriers encountered while implementing energy efficiency. In order to gain an understanding on these issues, structured questionnaires were administered to the industries physically and face to face interviews was also conducted in some industries where the concerned people dealing with energy issues were available. The study was conducted in major towns of Kenya namely Nairobi, Mombasa, Thika and Kisumu in order to get a broader understanding and a true picture regarding the implementation of energy efficiency in Kenyan manufacturing industries. Out of the 50 questionnaires which were administered, a total of 31 were received. The surveyed industries were from 8 different categories namely food and

beverage (33%), leather and foot (9%), paper and board (10), chemical and allied (5), plastic and rubber (5%), building, mining and construction which were mainly cement companies (14%), metal and allied (14%) and pharmaceutical and medical equipment (10%).

The results revealed that there exist energy efficiency opportunities in the surveyed industries and out of the 31 industries surveyed, only 3 of these industries had not complied to the Energy Management Regulation of 2012. Most industries under survey had metered their electricity to the whole site and building level. Energy audit reports was considered to be the most effective source of information on energy efficiency among the others. The main driving force was found to be cost reduction by lowered cost of energy which is considered to be a market related; it was seen as a way of increasing their profit margins. The highly ranked energy barrier from the study was high initial cost of adopting energy efficient technology. A number of recommendations were drawn from the study including introduction of industries' in-house awards to recognize their staff who have helped in improving energy efficiency and management.

RESUME

Le gouvernement du Kenya, dans Vision 2030, vise à faire de la nation une économie à revenu moyen supérieur, tirée par la transformation industrielle. Pour y parvenir, un certain nombre de programmes ont été lancés avec le programme connu sous le nom de Programme de transformation industrielle du Kenya. Le programme de transformation industrielle du Kenya a ses fondements à Vison 2030, mais il se concentre principalement sur le secteur manufacturier. Il fournit une feuille de route qui peut être utilisée pour améliorer la fabrication et la valeur ajoutée, stimuler les exportations et par la suite transformer l'économie kenyane. Pour y parvenir, le pays a davantage besoin de produire plus d'électricité, car la plupart des industries consomment beaucoup d'énergie. Dans un pays comme le Kenya où l'électricité produite n'est jamais due à des problèmes comme la sécheresse qui se produit presque tous les ans et le prix de l'électricité très cher (15 cents / KWH), la meilleure solution dans ce cas est d'investir dans l'adoption de mesures d'efficacité énergétique afin de réduire le coût de la consommation d'énergie. L'adoption de l'efficacité et de la gestion de l'énergie aidera également les industries à réduire les émissions de gaz à effet de serre dans l'environnement, contribuant ainsi à résoudre les problèmes de changement climatique. Pour aider les industries à utiliser efficacement leur énergie, le gouvernement du Kenya a sensibilisé les grands consommateurs d'énergie à adopter des mesures d'efficacité énergétique et de gestion ainsi que les avantages associés à l'adoption de technologies écoénergétiques dans leurs installations. Pour montrer leur engagement dans le cheminement de l'efficacité énergétique, le gouvernement a adopté, par le biais de l'ERC, un règlement intitulé Le règlement de gestion de l'énergie de 2012. Ce règlement exige que les industries intègrent des mesures de gestion de l'énergie dans leur système et effectuent un audit énergétique une fois sur trois. Années alors envisager de mettre en œuvre au moins 50% des recommandations fournies par les auditeurs.

Cette étude exploratoire et quantitative a été menée dans le but d'évaluer la mise en œuvre de l'efficacité énergétique et la gestion dans les industries avec un accent particulier sur les industries manufacturières du Kenya. L'étude portait spécifiquement sur les systèmes de gestion de l'énergie des industries, leurs sources d'information, les mesures d'efficacité énergétique actuellement adoptées, les forces motrices pour améliorer l'efficacité énergétique et les obstacles rencontrés lors de la mise en œuvre de l'efficacité énergétique. Afin de mieux comprendre ces questions, des questionnaires structurés ont été administrés aux industries et des entretiens en face à face ont également été menés dans certaines industries où les personnes concernées par les questions d'énergie étaient disponibles. L'étude a été menée dans les principales villes du Kenya, à savoir Nairobi, Mombasa, Thika et Kisumu, afin d'obtenir une compréhension plus large

et une image réelle de la mise en œuvre de l'efficacité énergétique dans les industries manufacturières du Kenya. Sur les 50 questionnaires administrés, 31 ont été reçus. Les industries étudiées provenaient de 8 catégories différentes : aliments et boissons (33%), cuir et pied (9%), papier et carton (10), chimique et allié (5), plastique et caoutchouc (5%), bâtiment, exploitation minière et la construction qui était principalement composée de cimenteries (14%), de métaux et alliés (14%) et d'équipements pharmaceutiques et médicaux (10%).

Les résultats ont révélé qu'il existe des opportunités d'efficacité énergétique dans les industries étudiées et sur les 31 industries étudiées, seulement 3 de ces industries ne se sont pas conformées au règlement de gestion de l'énergie de 2012. La plupart des industries étudiées ont mesuré leur électricité sur l'ensemble du site. Niveau de construction. Les rapports d'audit énergétique ont été considérés comme la source d'information la plus efficace sur l'efficacité énergétique parmi les autres. La principale force motrice a été la réduction des coûts par la réduction du coût de l'énergie considérée comme liée au marché ; il a été vu comme un moyen d'augmenter leurs marges bénéficiaires. La barrière énergétique de haut rang de l'étude était le coût initial élevé de l'adoption d'une technologie écoénergétique. Un certain nombre de recommandations ont été tirées de l'étude, y compris l'introduction des prix internes des industries pour reconnaître leur personnel qui a contribué à améliorer l'efficacité énergétique et la gestion.

CHAPTER ONE: INTRODUCTION

1.1: Background

Globally, energy is a fundamental ingredient for economic development as well as for the improvement of social welfare. Moreover, is always necessary for a country to provide adequate and reliable supply of energy in order to ensure sustainable development. However, it has always been noted that energy conversion and usage has resulted to social problems as well as emissions of harmful pollutants to the environment such as carbon dioxide (CO_2) which in turn results to climate change. The increasing rate of environmental threats as a result of energy usage has led to great concerns from different parties on issues related to sustainable development which in turn has led to a challenge of trying to separate economic growth and energy use. In order to solve this challenge, there is need to put in place appropriate usage of resources, technology, incentives and strategic policy planning both at the regional and national levels. There will also be need to monitor the impact of selected policies on regular basis in order to determine if they are working or need to be reviewed (International Atomic Energy Agency (IAEA), 2005).

The judicious use of energy resources and technology in order to reduce their negative impact is strongly related to two concepts namely energy efficiency and energy management. Energy efficiency refers to an activity which generally contributes to greater performance in the use of energy sources. It is guided by a range of policy imperatives and specific decision-making drivers across the world (Rosenberg and Winkler, 2011). A concept closely related to energy efficiency is known as "*energy efficiency improvement*" which refers to the reduction of energy input for a given service, good or output. On the other hand, energy management refers to the "strategy of adjusting and optimizing energy, using systems and procedures in order to reduce the amount of energy required per unit of output while holding constant or reducing total costs of producing the output from these systems" (Chakarvarti, 2011). It is evident that these two concepts advocate for the use of energy resources in a way that will result to savings and ensure minimal wastage while promoting social welfare and environmental sustainability.

In response to the aforementioned challenge, more so to the one resulting to climate change, international bodies such as Intergovernmental Panel on Climate Change (IPCC) proposed a number of strategies, one of them being rolling out of energy efficiency programs in order to reduce the emissions per unit energy used (IPCC, 2007). In 2015, countries concerned with climate change issue met in Paris in order to find a way of dealing with climate change menace which has become a threat globally. In a bid to deal with this issue, majority of the countries committed to scaling up energy efficiency programs and renewable energy through Intended Nationally Determined Contributions (INDCs) as a way to limit global warming to below 2^{O} C.

It is reported that a total of 167 countries committed to energy efficiency while 147 countries were committed to renewable energy and other policy reforms in non-renewable energy (REN21, 2016). Kenya is one of the states that ratified the Paris agreement on Climate Change during COP 22 gathering in Marrakech, Morocco. The president assured of Kenya's commitment to ratify the agreement through the submitted INDCs using energy efficiency programs (Kenya Ministry of Environment & Natural Resources, 2017).

Apart from international bodies providing strategies, a number of countries around the world have also adopted the energy efficiency and management measures which has led to reduction of energy used and improved production. By adopting these strategies, industries have managed to improve on the environmental protection, economic growth and social welfare.

1.2: Overview of Manufacturing sector in Kenya

Kenya's manufacturing sector is among the key productive sectors identified for economic growth and development because of its immense potential for wealth, employment creation and poverty alleviation. Kenya's Vision 2030 aims to transform the country into "a newly industrialized, middle-income country providing a high quality of life to all its citizens in a clean and secure environment." Manufacturing sector was identified as one of the priority sectors under the economic pillar of Kenya's vision 2030 and it has been earmarked to spur the country's socio-economic progress (Wangare, 2015; Kenya Vision 2030; Deloitte, 2016.). As a way to achieve the vision, a rapid growth in the manufacturing sector is foreseen and this growth will directly impact on Kenya's energy demand.

According to a report by Kenya National Bureau of Standards (KNBS) (2017), the manufacturing sector's contribution to Gross Domestic Product (GDP) has been stagnant over the years ranging around 10% and by 2016 it had reached 9.2% while the growth rate has been deteriorating from 5.8% in 2010 to 3.5% in 2016 (Kenya Association of Manufacturers (KAM), 2018). The drop in GDP to 9.2% was as result of a number of issues such as double taxation, delayed payments, multiple levies and fees brought on by devolution and the plastic bag ban among others. Due to these issues, the overall competitiveness of the manufacturing sector was affected (KAM, 2017). These adverse changes can majorly be attributed to high cost of energy which in the long run results to high cost of production (Kenya Institute for public policy and analysis (KIPPRA) 2013). However, the government of Kenya has come up with an initiative known as Kenya Industrial Transformation Programme (KITP) which aims at growing the manufacturing sector from 9.2% to 15% by the year 2022 through exploitation of the already existing opportunities. KITP initiative has its foundation in Vision 2030 but it mainly focuses on the manufacturing sector (KITP, 2015).

In order to improve on the growth of sector, KAM launched the Manufacturing Priority Agenda (MPA) in 2017 under the theme "Driving industrial transformation for job creation and inclusive economic growth". The document was based on five pillars namely Policy, Legal and Regulatory Reforms, Level playing field for manufacturing in Kenya, Competitive Local Manufacturing Sector, Make Kenya a manufacturing hub for Exports and Securing the future of Industry. With the aim of accelerating Kenya's industrialization, the government of Kenya came up with "The Big Four" agenda and manufacturing sector was identified as one of the big fours. Under manufacturing sector, the agenda targets to support value addition and raise the manufacturing sector share to GDP to 15% by 2022 (KIPPRA, 2018).

The manufacturing sector is grouped into 14 sectors with food and beverage sector being the biggest contributor to the GDP of about 43% of the total contribution from the manufacturing sector. By July, 2017, there were 960 firms registered by Kenya Association of Manufacturers (KAM, 2018). This is a low number registered to the organization compared to existence of about 3700 firms which are registered with the manufacturing sector (KAM, 2017). Kenya Association of Manufacturers is an organization which falls under the umbrella of Centre for Energy Efficiency and Conservation (CEEC) and it was formed with an aim to address issues of high energy cost in the manufacturing industries. They tackle this issue by developing energy efficiency measures that manufacturers can adopt in order to lower their energy consumption. One of the tools employed by this organization is undertaking of energy audit exercise whereby the industry's electricity consumption is assessed, potential areas where energy can be saved is identified then the energy savings measures to be implemented is advised accordingly.

As a strategy of achieving part of Vision 2030 which is meant to turn Kenya to a "newly industrialized, middle income country", the government of Kenya is planning to establish three special economic zones (SEZ) which will help in boosting manufacturing sector by allowing for lower tax levels and fewer regulatory hurdles. A report by Oxford Business Group (2016), reveals that the SEZs will have a capability of boosting the manufacturing sector which in turn will result to 1.5 million jobs created in a year and 10 million jobs in the next 30 years. The primary industry which is foreseen to benefit from this great plan will be the textile production (Oxford Business Group, 2016). Most industries are based in Nairobi with the largest number hosted at a place known as Industrial Area which is at the southeast end of the central business district sandwiched by the city center and the railway station to the west. The industries located within this area mainly are food and beverage processing firms, oil processing firms, cable manufacturing firms, motor vehicle assembly firm, chemical processing firms, engineering works and mass printing firms. The common thing among these industries is that they are all energy intensive (Studio, n.d.).

1.3: Energy Efficiency in Kenya

Globally, energy efficiency has been recognized as a very important energy policy and it has been a growing policy priority in many countries worldwide. It has been identified as most cost-effective means which can be employed in addressing the issues related to energy such as energy security, high energy cost and climate change. Energy efficiency has also been seen as a way which can help to increase competitiveness and promote the welfare of the consumers (International Energy Agency, (ITA), 2014).

According to a report by Energy Regulatory Commission (ERC) (2015), Kenya had an installed capacity of 2,299MW in 2015 and the generated electricity was about 1,762MW. The industries (manufacturing industries included), consumes almost 60% of the generated electricity which is fed into the national grid. Figure 1.0 below reveals that in 2015, Kenya Power (the national electricity distribution company) recorded the highest sales in the commercial and industrial sector with 57% (ERC, 2015).

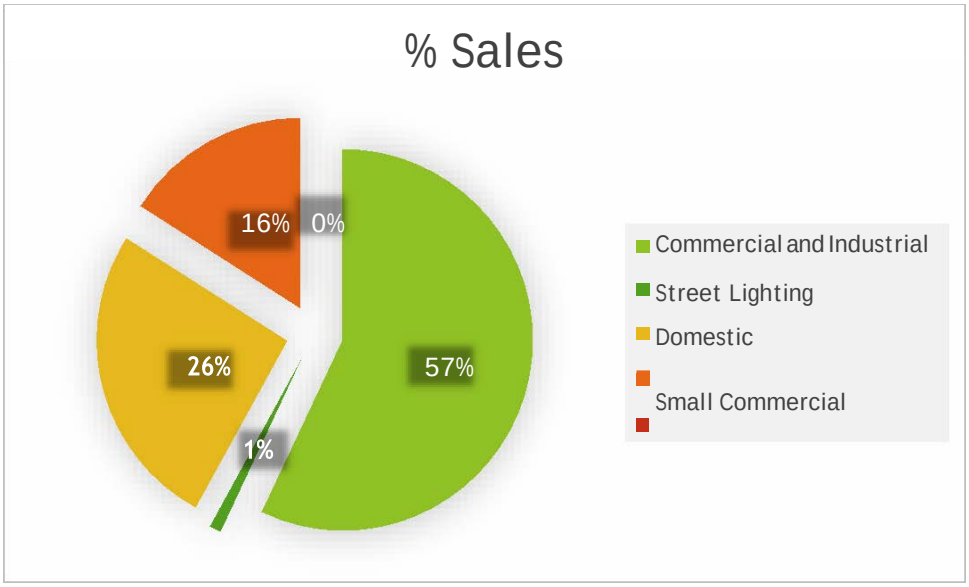

Figure1.0 : Kenya Power Sales by Customer Category (Source: ERC, 2015)

Comparing the cost of electricity between Kenya and the other countries, it can be noted that Kenya's electricity is relatively expensive. For instance, currently the price of electricity in Ethiopia, South Africa and Botswana is USD cents 0.4/KWh, 0.738/KWh and 0.739/KWh respectively compared to Kenya's price of 15/KWh. Due to the high cost of energy, the cost of production for the manufactured goods has been high resulting to inability for Kenya to compete with the other countries in the economic market favorably (KAM, 2017). As a way of dealing with high cost of electricity issue, the government of Kenya had shown its commitment to increase the amount of power to be generated to 5000MW which was to be accomplished by 2017 though this did not happen. The government had even allocated KSh

10 Billion in its budget which was to be used in the development of Geothermal power generation within the period of 2014-2015.

The campaign for the industries to implement energy efficient technology is seen as a promising instrument which will help in the socio-economic development of the country by improving energy security, deal with climate change menace, improving economic competitiveness, reducing the country's import bill, improving the balance of trade, creation of more job among other benefits (KAM, 2014). There exists a number of organizations and institutions such as KAM and ERC which have been trying to address the issue of energy efficiency and management in industries. The ERC has shown its commitment to address the high energy costs incurred by the industries through the energy efficiency strategies which are demonstrated in the document known as The Energy Management Regulations 2012. One of the measures outlined in the Energy Management Regulations 2012 requires that every company should carry out an energy audit once in every three years and they should be able to implement at least 50% of the recommendations outlined in the audit report. Complying to this strategy put across by the ERC as per the Energy Management Regulation of 2012, it will help the industries to identify real projects which can be implemented (ERC, 2014). However, failure for industries to comply to this regulation will result to the industry's top management to either a fine of Ksh 1,000,000 (USD 10,000) or imprisonment for one year or even both for neglect or misrepresentation. Furthermore, there will also be a fine of Ksh 30,000 per day for non-compliance on the submission of the documentation which includes an audit and implementation plan within six months of the end of the financial year after the audit and an implementation report 12 and 24 months after. The audit should be carried out by the competent energy auditors licensed by ERC (ERC, 2017).

Therefore, energy is a very vital component in the production of the manufactured goods and the manufacturing industries need to embrace energy efficiency measures in order to enhance their cost savings since an increase in the industry's production will automatically result to an increase in the energy consumption. This measure also will help the manufactured industries to reduce carbon emissions, material wastage as well as Improve their productivity as a result of using more efficient technology and finally the overall performance of the industries will be improved.

1.4: Problem Statement

The demand for energy is increasing at an alarming rate as a result of increased industrialization globally. This has led to some energy related challenges witnessed such as increase in energy prices, rapid depletion of energy resources, climate change due to emissions of CO_2 and other pollutants to the environments among others. In order to respond

to the increasing concerns related to these challenges, several industries around the globe have already adopted energy efficient and management initiatives in order to reduce their energy intensities. By adopting these initiatives, these industries have contributed in enhancing environmental protection as well as increased their economic competitiveness. Kenya being one of the most industrialized country in East Africa, plans are underway to increase its power generation by constructing new power plants using both renewable and non-renewable technologies in order to meet the industries' growing demand. The construction of new power plant using non-renewable technologies such as coal plant in Lamu may results to environmental and socially disastrous effects if not utilized in a sustainable way. However, most of these effects can be reduced only if the growing demand is controlled by implementing energy efficiency and management initiatives in industries. These initiatives will also help the Kenyan industries gain greater savings. Unfortunately, like any other industries in the developing world, Kenyan industries are still lagging behind in the implementation and adoption of energy efficiency and management initiatives hence missing out the benefits of implementing these initiatives. This is because these industries face a number of challenges related with the implementation of these initiatives which mainly could be emanating from a combination of market failure, organizational failures and irrational human behavior.

1.5: Justification

This research aims at assessing the implementation of energy efficiency and management in Kenyan manufacturing industries in order to determine the initiatives adopted by these industries as well as the benefits realized and challenges encountered while adopting these initiatives. This will in turn enable the government to reduce the generation capacity of the new plants to be constructed hence resulting to a reduction in the construction cost while still meeting the growing demand. This study will also enable the industries to gain greater savings and improve the industries' competitiveness economically.

1.6: Objectives

The main aim of this research is to assess the energy efficiency and energy management measures adopted by Kenyan industries in the manufacturing sector.

1.6.1: Specific objectives

(i) To study the on-going energy efficiency and management measures undertaken by Kenyan industries.

(ii) To study major benefits realized by Kenyan Industries by adopting energy efficiency and management measures

(iii) To study major driving force for the adoption of energy efficiency and management in Kenyan Industries

(iv) To assess major energy efficiency barriers that hinder adoption of energy efficiency and management by the Kenyan industries

(v) To identify mitigation measures that can help to improve energy efficiency and management in Kenyan industries.

1.7: Research Questions

In order to achieve the objectives of this research, the under listed research questions will be addressed:

(i) What are the adopted energy efficiency and management measures in Kenyan Industries?

(ii) What are the benefits of implementing energy efficiency practices and management measures by Kenyan industries?

(iii) What barriers hinder the implementation of energy efficiency in Kenyan industries?

(iv) What are the driving forces for the adoption of energy efficiency and management in Kenyan industries?

(v) What role can the government play to help in the improvement of energy efficiency and management in Kenyan industries?

1.8: Scope of the study

This research was conducted in major industrial towns of Kenya namely Nairobi, Thika, Mombasa, Kisumu and Kitale. It was limited to the research of manufacturing industrial plants which was randomly selected. The survey involved the study of on-going energy efficiency and management measures adopted by Kenyan industries in the manufacturing sector, their driving forces and barriers they face in adopting energy efficiency initiatives.

1.9: Limitations of the Study

Most of the participants were reluctant to provide some important information such as the total amount of money spent on the energy used annually and the company's turnover resulting to some aspects of the questionnaires left blank. This is because they were afraid of being victimized for providing such vital information. The participants were assured that the study was only meant for the academic purpose and it will not be used for any other reason.

CHAPTER TWO: LITERATURE REVIEW

2.1: Initiatives adopted by Industries to enhance Energy Efficiency

Several studies that have been carried out before indicated that there is existence of energy saving potential that can be achieved through adoption of effective energy efficiency initiatives. Adoption of these initiatives is seen as one way of attaining global energy supply security, economic competitiveness, improvement in livelihood and environmental sustainability. These initiatives when adopted will really help the industries improve on their economic output with less energy input (Taylor *et al*., 2008).

In the developed world like Europe, a number of initiatives have already been adopted by industries in order to reduce energy intensity and improve energy efficiency. These initiatives are energy audit, energy efficiency networks, benchmarking and voluntary agreements and industrial waste heat recovery among others. Energy audits undertaken by these companies has proved to be very effective since it provides individual companies with valuable feedback on their energy consumption. It has also been noted that energy efficiency networks are extremely effective multiplier of energy efficiency best practices because they engage industries in energy saving efforts (European Union, 2006).

In a research study which was carried out by United Nation Industrial Development Organizations (UNIDO), it was revealed that an investment of 90 Billion USD when implemented between 2008 to 2020 would result to an annual energy savings of about 600 Billion USD (UNIDO, 2011). The same study by UNIDO also showed that the already existing energy efficiency technologies and solutions in industries required appropriate diffusion into the industrial processes with some proper modification and customization fit into the process through capacity building (UNIDO, 2011).

Kemp *et al*, 2015 carried out a study in Nigeria and Kenya on the adoption of energy efficiency measures by firms in Africa. They found out that several companies had already adopted energy efficiency measures. From their results, the energy efficiency measures which had been adopted by these companies comprised of good housekeeping, better process control, equipment modification among others as shown in figure 2.1 below (Kemp *et al*, 2015).

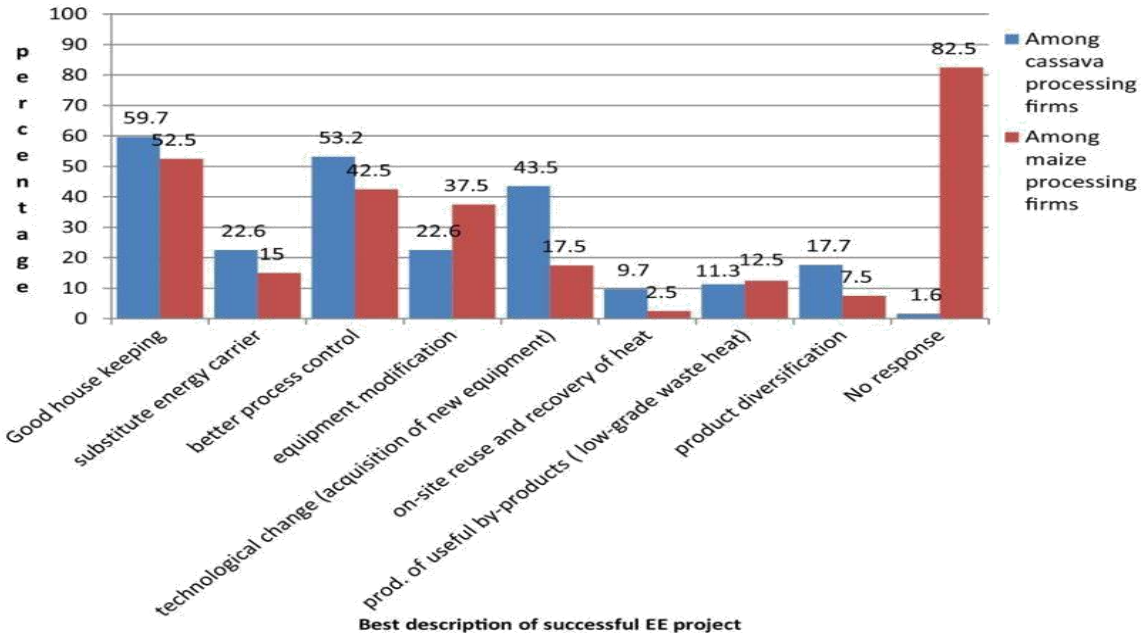

Figure 2.1: Overview of energy efficiency measures adopted. Sources of technologies. Source: (Kemp et al., 2015)

In another study, Apeaning & Thollander carried out an explorative and qualitative study in Ghana with an aim to investigate the barriers to and driving forces for the implementation of energy efficiency measures in Ghana's largest industrial area. This study was carried out in Ghana's largest industrial area called Tema. The team found out that the industries within Tema had adopted a number of energy efficiency measures such as the metering of electricity either at site and building level or at equipment level providing a proper baseline for the energy data assessment. The results also revealed that only five companies out of 34 firms which were studied had carried out energy audits which provided them with proper energy usage analysis while four of the companies had conducted benchmarks in order to compare their energy usage against. Other industries had even put in place a monitoring and targeted scheme in their electricity usage (Apeaning & Thollander, 2013). According to the findings, majority of the firms studied had no standardized energy policy and management system while only five of the studied companies had subscribed to ISO Standards (ISO 22000, ISO 9001 and ISO 14001) of which two of these companies had adopted an energy policy which formed part of their ISO 14001 they had subscribed to. Notably, the respondents from the two companies which had an energy policy in place indicated that policy was not being extensively implemented due to inconsideration of energy as an environmental hotspot in Ghana (Apeaning & Thollander, 2013).

The Table 2.1 below shows that the findings on the energy efficient technologies and measure adopted by the firms studied mostly relied on electricity use such as power factor correction. It was noted that an implementation of power factor correction helped steel

smelting company to reduce their annual electricity bill by 5-10% (Apeaning & Thollander, 2013).

Table 2.1: The main implemented energy efficiency measures and their corresponding average score (Apeaning & Thollander, 2013).

	Main energy efficiency measures	Average score
Electrical	Power factor correction	0.39
	Use of energy efficient computers, photocopiers & other office equipment	
Lighting	Replacement of 38 mm fluorescents with 26 mm	0.36
	Replacement of tungsten filament lamps with compact fluorescents	
	Use of high frequency fluorescents in new & replacement fittings	
	Optimize the use of natural light	
Compressor and pump	Use of centrifuge pumps and throttle controls	0.33
	Use of appropriate and efficient motors (or variable speed motors)	
Heat processing and boiler plant	Proper Insulation of distribution pipes, valves and boiler.	0.17
	Accurate control of furnace temperature, pressure and air/fuel ratio	
	Use of boiler refractory	
	Installation of thermostatic radiator valves	

Energy conservation measures like avoidance of idle running of electrical machinery e.g. pumps and fans (through employee sensitization using posters and labels), helped in cost reduction. The use of appropriate and efficient motors was done as a way of reducing energy costs. In other firms the rigorous inspection and sealing of compressed air leaks was taken up but not so seriously due to the lack of a proper maintenance culture (Apeaning & Thollander, 2013). Furthermore, lighting energy efficiency measures taken up by industrial plants in Ghana to reduce their lighting costs included the replacement of tungsten lamps with compact fluorescent lamps (CFLs). In other firms, the maximization of daylight through retrofitting of the buildings was taken up to reduce lighting electricity costs (Apeaning & Thollander, 2013). Other energy efficiency measures done were in thermal applications. These measures included regulating the boiler temperature, pressure, and air-fuel ratio. The use of boiler refractory, to reduce on thermal heat loss, helped in reducing fuel consumption. Heat recovery systems and complete sealing of steam leaks were also put in place to reduce boiler fuel consumption and reduce loss of steam in distribution, thereby improving on the overall steam system efficiency (Apeaning & Thollander, 2013).

2.2: Benefits of Industrial Energy Efficiency

A series of research which have been carried out before revealed that energy efficiency improvements in industries can result to lots of benefits across a wide range of sectors which can be broadly categorized into environmental benefits, economic benefits and social benefits. In the study carried out by Ryan and Campbell (2012), they acknowledge that improvements of energy efficiency in industries can results to much more benefits in addition to the well-known benefits of energy savings and emission reductions with some being non-energy related. Some of the non-energy related benefits include reduced environmental compliance costs, enhanced productivity and competitiveness, decreased maintenance costs, extended equipment life-time, reduced waste disposal costs, improved process and product quality, and improved work conditions and decreased liability (International Energy Agency (IEA), 2014). In addition to these benefits, it has been noted that the implementation of energy efficiency measures can help in the generation of business opportunities and new market access (Mundaca *et al*, 2010). According to International Energy Agency (IEA) (2014), implementation of energy efficiency in industries also has a potential to reduce local and global pollution, create employment, stimulate new business sectors and enhance energy security. Figure 2.2 below gives an illustration of multiple benefits of energy efficiency in industries according to IEA (2014). As seen from the figure, it can be noted that the impact of energy efficiency measures can go far beyond energy savings and energy efficiency improvements resulting economic growth and social development. Therefore, it is evident that energy savings that is realized as a result of improvement of energy efficiency should also be considered to be a means to pursue a range of practical improvements for various levels of society (Ryan and Campbell, 2012).

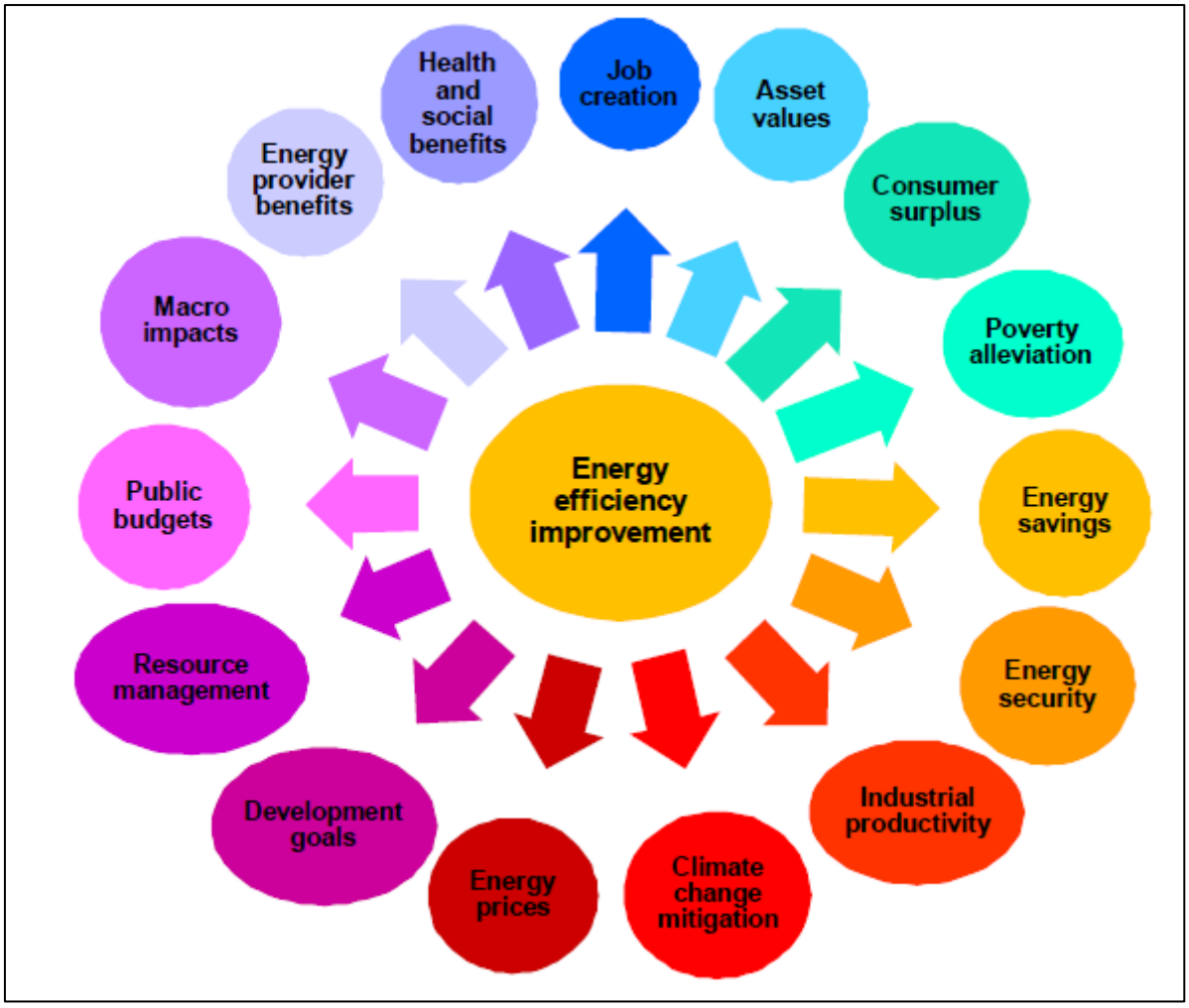

Figure 2.2: The multiple benefits of energy efficiency (IEA, 2014)

In a study which was carried out by UNIDO on industrial energy efficiency in developing countries, findings revealed that industries which have managed to implement energy efficiency measures and strategies have in return improved their productivity. An improvement in their productivity has in turn translated into huge profit margins which could have been redistributed to increased salaries and wages as well as an investment in the output expansion, hence being beneficial to both the suppliers and consumers (UNIDO,2011). Improved productivity due to adoption of energy efficiency measures has been noted that it can result to development of new innovations which in turn results to creation of new job opportunities as well as increased employment. Consequently, energy efficiency adoption can also improve the working conditions of the firms and the quality of life in the communities where the workers come from. In a case study review which was carried out by Worrell (2001) to review the relationship between energy efficiency improvement measures and productivity in industry on the basis of 70 industrial case studies, he noted that energy efficiency investments can provide “a significant boost to overall productivity within industry”. A report by

Institute for European Environmental Policy (IEEP) suggested that there exists a strong link between energy efficiency in industry and competitiveness. It went ahead to explain that energy efficiency can contribute towards reduction of overall company expenses, increment in productivity, competitiveness and the trade balance in an economy (Sauter and Volkery (2013).

2.3: Industrial energy management

Energy management has been identified as one of the ways which can be used to overcome the factors which limits the adoption of energy efficiency measures. According to research, adoption of energy management practices in industries will help the industry owners to reduce up to 40% of their total energy consumption (Thollander *et al*, 2013). According to Scheihing (2009), since 2002 Toyota North American Energy Management Organization was able to reduce its energy use per unit by 23% when they applied energy management system. In another research which was carried out by Caffal in 1996 showed that industrial energy management when applied within an industry, it can help to reduce amount of energy used by 40% (Caffal,1996). However, according to OTA (1993), it can be noted that the opportunities to save the energy used in industries depends on a number of factors such as technical, economical, institutional and political.

For an industry to succeed in the journey of adopting energy efficiency measures, it is paramount for the top management to develop an energy management program and they remain committed to it. According to Thollander *et al*, (2013), top management support is very important when it comes to the creation of an in-house energy management program. Additionally, the adoption of energy management program should be complemented with conduction of an energy audit. Energy audit helps the industry identify the key areas where energy is used which in turn will guide the management on the right measures to be implemented in order to reduce on the energy use and enhance energy savings (Thollander *et al*, 2013).

2.4: Features of Effective Energy Management Systems

The management system is based on a cyclic “plan-do-check-act” approach (Figure 2.3) which is majorly used in all management systems that aims at continued improvements.

Figure 2.3: Cyclic approach of an energy management system aiming at continued improvements.

2.4.1: Plan Phase

The main step in the development of energy management standard of any firm is to establish an energy policy which is the management's top official statement of the firm and the performance of the work which is related to the firm's activity. The developed energy policy should include the firm's energy plan, set goals, commitments, targets and top management's procedures. This phase entails conducting an energy review and establishment of the baseline, benchmarking against similar sites, setting up firm's objectives and targets, development of necessary resources and action plans with an aim to deliver required outcomes in accordance with the firm's energy policy. This helps the firm to overcome energy efficiency barriers and improve energy efficiency.

2.4.2: Do Phase

This phase deals with the implementation of the energy management programs undertaken by the firm. This is done by aligning the operation and activities carried out by the firm in order to reduce energy consumed by equipment systems and processes. Worrell, (2009) states that for an energy management program to be successful, there should be existence of strong

organizational commitment tin dealing with continuous improvement of energy efficiency. Therefore, this means that an energy management program should involve allocation of management responsibilities and the creation of energy committee which comprise of experts with different functionalities in the plan phase. The main duty of this particular committee should be to steer and monitor the program as well as ensure the set goals are improved. In order for the energy management programs to be successful, both the committee members and the workers within the firms should be trained. This training helps to equip them with the necessary energy management competence. It is also of great importance for the firms to develop an energy manual which can be used to educate the workers on the firm's energy management programs.

2.4.3: Check Phase

Check phase helps to monitor and measure the performance in terms of energy savings which is always done by carrying out energy audits. This phase also aims at comparing the organization's objectives as well as set targets related to energy. When it is noticed that there exists a deficit in energy, it is deemed fit to identify the causes and analyse them. This helps to correct the problem in order to achieve the already set goals. Therefore, it is necessary that the set goals should be quantifiable in order to facilitate the process of assessing the progress and improvements.

2.4.4: Act Phase

This phase mostly deals with the review of audits, internal and external reports related to the performance of the energy management programs which is carried out by the management. These reports are very important to the running of the firms since it helps in the identification of shortfalls and any other organizational needs which should be acted upon in order to ensure continued improvement hence increased benefits to the organization.

2.5: Energy Efficiency Gap

Currently, countries across the globe are faced with challenges which are redefining global energy consumption. A number of crucial issues such as higher energy prices, increased environmental consciousness and strict policy instruments and regulations have been deemed vital in improving energy efficiency. Despite the great need to increase energy efficiency across boards, studies indicate that cost- efficient energy saving measures are not always implemented and this implies there exists an efficiency gap (Rohdin *et al*., 2007). Energy efficiency gap as mostly used in energy efficiency literature refers to the difference

between the levels of investment in energy efficiency which are cost effective and the lower levels actually occurring (Golove and Eto, 1997). According to engineers and technologists, they strongly believed that an improvement in technology is the best option in improving energy efficiency. However, lots of questions comes up as to why the energy efficiency gap has not been bridged by the existence of these cost-effective technologies. A more viable answer can be obtained from an economist perspective in that the main reason is attributed to market barriers that impede the diffusion of optimal technologies (The Allen Consulting Group, 2004).

In a research study carried out by Jaffe and Stavins (1994) on energy efficiency gap, they outlined five levels of energy efficiency gap or energy efficiency potentials namely the economists' economic potential, the technologists' economic potential, hypothetical potential, the narrow social optimum and the true social optimum as shown in the figure 2.4 below. According to the authors, each level in the figure represents different optimal scenarios. From the figure, the term economic potential indicates the degree of energy efficiency that could be achieved upon removal of the economic barriers. The economists' economic barriers and technologists' economic barriers indicates both the market and non-market barriers hence indicating that a higher estimated potential can be achieved if both barriers are eliminated.

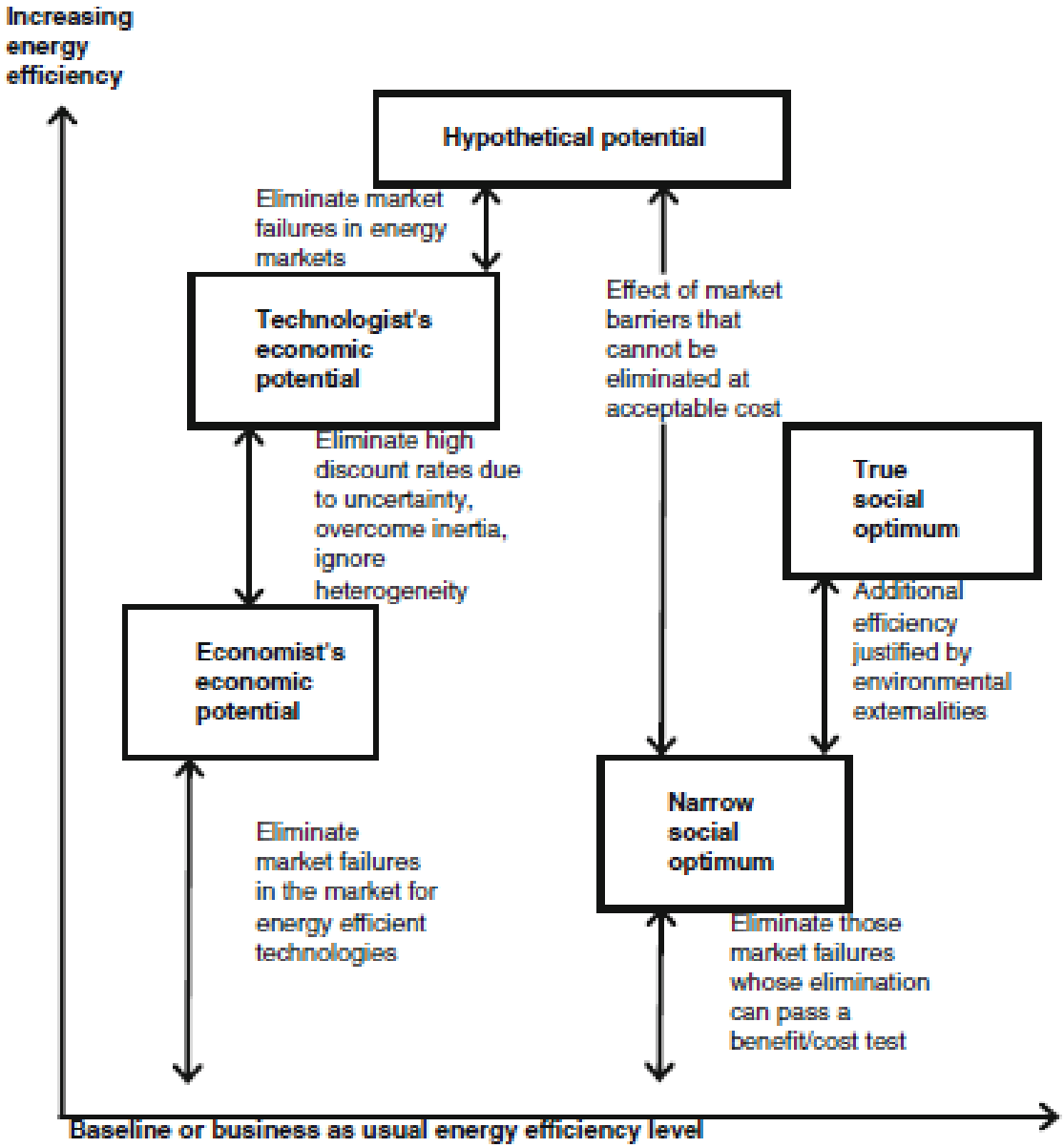

Figure 2.4: Various levels of energy efficiency potential (Jaffe and Stavins 1994)

2.6: Drivers for Energy Efficiency and Management improvements in Industries

A driver for industrial energy efficiency and management refers to any factor which helps to promote the uptake of a cost-effective energy efficient investments (Thollander & Ottosson, 2008). According to Thollander and Ottosson (2008), a firm's reason to adopt or improve their energy efficient technology implementation can be influenced by either internal or external forces or a combination of both. These drivers to implementation of industrial energy efficiency can be grouped into market-related, energy policies related, organizational and behavioral factors (Thollander and Ottosson, 2008).

2.6.1: Market Related Drivers

Market related drivers refers to factors which the firm requires in order to remain competitive by reducing their energy use and in return helps them to reduce their internal energy costs and be able to deal with the threats of rising energy prices which happens almost on the daily basis. The cost reduction helps the firms to secure position in energy use since it takes care of dealing with the risk of rising cost of energy prices. The market related factors help the firms to secure their future dividends by reducing their energy use and behavior (Apeaning &Thollander, 2013). According to the study which was carried out by Apeaning &Thollander in 2013, the results reveal that the industries in Ghana ranks the cost reduction by reduction in energy use and the treats of rising cost of energy as being the main market related driving forces which motivates the industries to adopt energy efficiency measures in their firms. According to the study which was carried out by Kemp *et al*. (2015) in Nigeria and Kenya, the results showed that the main driving force was the desire to save cost which prompted the cassava and maize milling firms in these two countries to adopt energy efficiency measures. In a study which was carried out by UNIDO (2011) showed that the adoption of energy efficiency measures by the industries is mainly due to reduced cost of energy because it results to these forms reducing the cost of their production which makes them compete favorably with other industries economically both at the national and international levels (UNIDO,2011)

2.6.2: Energy Policies Related Drivers

Energy policies related drivers are those factors which are associated with government energy efficiency requirements and policy instruments such as voluntary agreements, energy saving certificates, emission trading schemes, energy and emissions taxes, information dissemination, investment subsidies and tax exemptions among others. These factors are very effective motivators when it comes to implementation of energy efficiency and management in industries. The above-mentioned policy instruments play a vital role in capacity building in energy service markets as well as promotion of efficient use of energy (McKane *et al*., 2008; UNIDO, 2011). According to a study which was carried out in Nigeria and Kenya by Kemp *et al*. (2015) revealed that the support provided by the government and donor countries was the main driving force which aids in accelerating the rate at which the energy efficiency measures are being adopted. It was noted that the government incentives of Energy Efficiency measures such as removal of taxes on all renewable energy technologies and support of government institutions like ERC, development partners, and campaigns by environmental NGO's in Kenya and Nigeria played a major role in the policy

support for the interviewed companies' fast adoption of energy efficiency measures. The presence of local technical expertise from the local institutions such as. universities and technical colleges in both countries played also enhanced the fast adoption of energy efficiency technologies (Kemp *et al*, 2015). According to a study which was carried out in Ghana by Apeaning & Thollander (2013), the requirements which was put in place by the Government in regards to energy efficiency by introducing the standards and labeling of air conditioners, refrigerators and lamps was identifies as the main promoter of the fast adoption of energy efficiency measures by the industries. In a study by UNIDO, it was noted that the government supports the energy efficiency drive due to the fact that it directly and indirectly benefits from the measures. It benefits in that there is more economic output without requiring additional , constrained energy supply, jobs of technical local human resources increase due to the installation, repair and maintenance of the energy efficiency technologies, there are improvements of livelihoods of people through reduction in poverty due to increased jobs, there is a reduction in import bills of energy imports like oil and gas, there is a reduction in energy insecurity due to over dependence of import of energy like oil and gas and finally there is environmental sustainability due to less contamination of environment while in transportation, generation and utilization of the energy especially in conventional energy such as oil (UNIDO, 2011).

2.6.3: Organisational and Behavioral Drivers

These factors are mainly the internal factors which depicts the way in which energy is viewed or taken up within a firm. It majorly requires full commitment in approaching the way energy is being used in a firm and trying to find a way in which it can be conserved with the help of the employees in order to improve the image of the firm. This can only be driven mainly by people with real ambitions or even the managers who possess self-drive when it comes to environmental conservation and implementation of energy management systems (Thollander & Rohdin, 2006). According to a study which was carried out in Nigeria and Kenya, it was found that it was mandatory for the many parent companies to adopt energy efficiency measures in order to save energy. The parent companies ensured their commitment through the commitment of top managers and they also ensured that there was an in-house sensitization about energy efficiency through trainings and putting up of posters and labels in the company premises which was done in order to ensure that the energy efficiency drive did cut across the organization (Kemp *et al*., 2015). According to a study which was carried out in Ghana, it was found that the information dissemination on energy efficiency within the firms was low among the top management despite the importance of top management commitment to adoption of energy efficiency related

measures. The study also showed that the public campaigns on energy efficiency were mainly done during the energy crisis in the country (Apeaning & Thollander, 2013).

According to the above literature on the energy efficiency drivers, it is evident that firms' need to promote energy efficiency is pegged on a number of drivers and not just one with the need to reduce cost of energy use in order to enhance profit margin has been identified as being the main driver. Nevertheless, it is important to note that each and every company have their own reasons to adopt energy efficiency measures.

2.7: Barriers to Energy Efficiency Implementation in Industries

According to Sorrell *et al.* (2011), a barrier to energy efficiency refers to "a postulated mechanism that inhibits a decision or behavior that appears to be both energy efficient and economically efficient". According to (Thollander *et al.*, 2010) these barriers can be categorized as economic, organizational and behavioral. In 2000, a research study carried out by Sorrell and his team, they were able to come up with a barrier framework as indicated in the table below (Table 2.2)

Table 2.2: Barriers to energy efficiency

Economic (Non-market Failure)	❖ Heterogeneity ❖ Hidden costs ❖ Access to capital ❖ Risk ❖ Imperfect information
Economic (Market Failure)	❖ Split incentives ❖ Adverse selection ❖ Principle-agent relationships
Behavioral	❖ Bounded rationality ❖ Form of information ❖ Credibility and trust ❖ Inertia ❖ Values
Organizational	❖ Power ❖ Culture
Political/Policy	❖ Political instability ❖ Weak contracting institutions

	❖ Absence of a national energy efficiency policy ❖ In appropriate energy pricing and cross subsidies ❖ Skill-short government ❖ Government without adequate training facilities ❖ Government without access to necessary hardware and software

2.7.1: Economic barriers

Economic barriers can majorly be categorized into two groups namely market failure related and non-market failure related.

2.7.1.1: Non-market Failure related

Heterogeneity: While a particular or measure may be cost effective on average, it may not be so in all cases. This may explain technology the non-adoption of some technologies at some of the institutions (Schleich, 2009).

Hidden costs: Engineering-economic analyses fail to account for either the reduction in benefits associated with energy efficient technologies, or the additional costs associated with them. As a consequence, the studies tend to overestimate efficiency potential. Examples of hidden costs include overhead costs for management, disruption, inconvenience, staff replacement and training, and the costs associated with gathering, analyzing and applying information (Schleich, 2009)

Access to Capital: If an organization has insufficient capital through either internal funds or borrowing, energy efficient investments may be prevented from going ahead (Schleich, 2009). In the public sector, additional borrowing may be inhibited by public sector rules. In the private sector, companies may be reluctant borrow due to concerns about the risk of increased gearing. Where internal funds are available, other priorities may take precedence, thereby also preventing the energy efficient investment.

Risk: The short paybacks required for energy efficiency investments may represent a rational response to risk (Schleich, 2009). This could be because efficiency investments represent a higher technical or financial risk than other types of investment, or that business and market uncertainty encourage short time horizons

2.7.1.2: Economic Market failure Related

The general types of market failures are incomplete markets, imperfect competition, imperfect information and asymmetric information. The most discussed market failures in energy service markets centers on the imperfect and asymmetric information. Incomplete markets and imperfect competition are important but are less relevant to explaining the efficiency gap. Environmental externalities are a form of incomplete markets, but fail to explain the adopt technologies at current prices. Similarly, monopoly energy suppliers may depart from marginal cost pricing, but this again doesn't explain the gap (Schleich, 2009; Trianni and Cagno 2012).

Imperfect information: Lack of information may lead to cost effective energy efficiency opportunities being missed. This may be considered a market failure in that information has public good aspects, which make it likely that it will be under supplied by markets. Furthermore, unlike energy supply, energy efficiency consists of a wide range of complex technologies and services, which are purchased infrequently and for which it is difficult to determine their quality either before or after purchase. As a consequence, the transaction costs for obtaining and processing information on energy efficiency are higher than for energy supply. Overconsumption of energy may be the result (Schleich, 2009; Trianni and Cagno 2012).

Split Incentives: Energy efficiency opportunities are likely to be foregone if the party cannot appropriate the benefits of that investment. For example, individual departments in an organization may not be accountable for their energy use and therefore have no incentive to improve efficiency (Schleich, 2009; Trianni and Cagno 2012).

Adverse Selection: Suppliers know more about the energy performance of a good than purchasers. The latter face difficulties in both obtaining information prior to purchase and verifying performance subsequent to purchase. As a result, purchasers will tend to select goods on the basis of visible aspects such as price, and be reluctant to pay the price premium for high efficiency products. In some cases, inefficient products will drive efficient products out of the market

Principal agent Relationships: Principal-agent relationships occur when the interests of one party (the principal) depend on the actions of another (the agent). This type of relationship is pervasive in hierarchical firms. It is characterized by information asymmetry, since the principal lacks detailed information about the activities and performance of the agent - and in particular about the merits of individual investment projects proposed by the agent. Such monitoring and control problems can lead principals to require stringent investment criteria to ensure that only unambiguously high value projects are undertaken

2.7.2: Behavioral Barriers

Bounded rationality: Actors do not make optimizing decisions in the manner assumed in standard economic models. Instead, constraints on time, attention, and the ability to process information leads to reliance on imprecise routines and rules of thumb (Ellison, 2006; Trianni and Cagno 2012). These economies on scarce cognitive resources. A consequence of this type of decision-making is that that actors may not maximize utility, even when given good information and appropriate incentives. Hence, bounded rationality may be considered as an additional barrier that does not fit into conventional economic models.

Form of information: The cost of acquiring information is only one aspect of decision-making. Research demonstrates that the form of information is critical. To be effective, information must be specific, personalized, vivid, simple and available close in time to the relevant decision. (Sorrell *et al*., 2000)

Credibility and trust: Also, critical is the credibility of the source and the trust placed in the source. Trust is particularly encouraged through interpersonal contacts. If these factors are absent from information on energy efficiency, inefficient choices will be made

Inertia: Agents resist change because they are committed to what they are doing and justify inertia by downgrading contrary information. Individuals also treat gains differently from losses, thereby undervaluing opportunity costs; give greater weighting to certain outcomes than uncertain; and have a strong desire to minimize regret. All these factors cause individuals to favor the status quo. Inertia creates a bias against energy efficiency since (unlike energy purchasing) this involves investing in hardware with uncertain outcomes and represents a departure from the status quo.

Values: Energy efficiency has clear environmental benefits. Individuals motivated by environmental values may therefore give a higher priority to efficiency improvements than those that are not. Efficiency improvements are most likely to be successful if 'championed' by a key individual within top management. Hence, the environmental values of key individuals are relevant variable in explaining organisational performance on energy efficiency.

2.7.3: Organizational Barriers

Power: Organizations can be viewed as political systems, characterized by conflicts between groups with divergent interests. The influence of a particular group depends upon its formal authority, the control it has of scarce resources (particularly finance) and its access to information. It is commonly the case that energy management has a relatively low status and is viewed as a peripheral issue by top management. Lacking power, funds and management

support, the scope for effective action may be circumscribed. This may constitute an organisational barrier to efficiency improvement

Culture: Organizations may encourage efficiency investment by developing a culture (values, norms and routines) that emphasizes environmental improvement. This is more likely to be successful if 'championed' by a key individual within top management. Hence, organisational culture is a relevant variable in explaining organizational performance on energy efficiency.

In generally, it can be noted that energy efficiency barrier is multi-faceted and this means the industry management should approach them in different ways in order to improve energy efficiency in their firms. For instance, if the barrier belongs to economic (market related) then the policy options which can be used to over come this barrier should be formulated and worked on. If it is a barrier associated with behavioral factors, then more information on the existing measures could be used as possible solution to this barrier. Therefore, it is important for the management to define and redefine the existing barriers within their firms in order to help them identify solutions tailored to their company.

`CHAPTER THREE: RESEARCH METHODOLOGY

3.1: Introduction

This Chapter explains the methodology that was used to carry out this research. It includes the research design, population target, sampling design, sampling techniques data collection and instrumentation, research procedure and data analysis.

3.2: Research Design

The study used explorative research design. The choice of this research design was due to the fact that it is flexible and provides the initial groundwork for future research. According to Burns and Bush (2006), the explorative research designs are always the best designs for collecting data on issues which has not been extensively researched on. It is not limited to one specific paradigm but may use either qualitative or quantitative approaches.

3.3: Population Target

In this study, the target population of the study consisted of 50 companies from different sectors which are listed in the KAM directory. There are 960 manufacturing companies listed under KAM 2016 directory which are grouped into 14 different sectors.

3.4: Sampling Design

The research made use of non-probabilistic technique (Etikan and Bala, 2017). From the existing non-probabilistic sampling techniques, purposive sampling was used to select the managers and technical representatives who were targeted due to their perceived knowledge arising out of known experience that they have regarding implementation of energy efficiency measures. This technique was employed following the postulate that if sampling has to be done from smaller groups of key informants, there is need to collect very informative data, and thus the research will result to the need to select the sample purposively at one's own discretion (Sekaran, 2003).

3.5: Data Collection

The study mostly relied on primary data. The field visit to the respective identified industries was arranged to study the initiatives and measures which have been put in place for efficient energy usage, as well as to search for in-depth knowledge regarding the benefits and challenges encountered while implementing energy efficiency and management initiatives. The primary data was drawn from the questionnaires which were filled by the representatives of the industries as well as from the structured questionnaires which were directed to the industry managers or technical experts dealing with energy issues to the targeted industries. The questionnaires were administered through drop and pick later method and through interview for the respondents who were both willing and available. The questionnaires were adequately prepared using knowledge from the literature review in chapter two in order to

cater for both the open and closed ended questions in order to capture the objective of the study. The questionnaires contained questions from the following topics as illustrated in the table below. The table also contains the reference against each question topic indicating where the idea which was used to develop the question was obtained. The first three topics were meant to help in obtaining information on the company's profile such as the category of manufacturing sector under which the company falls on, number of employees and annual turnover as well as the overview on energy use, annual spending on energy used and energy management systems. The fourth, fifth and sixth -researched on the energy efficiency opportunities, sources of information deemed relevant on energy efficiency and the extent to which the energy efficient technologies have been implemented in industries.

Table 3.1: Questionnaire's main topics used for data collection

No.	Question topic	Reference
1	Profile of the industry	Sorrell *et al*., (2000)
2	Energy used annually	Sorrell *et al*., (2000)
3	Information on energy management systems	Sorrell *et al*., (2000)
4	Energy efficiency opportunities	Sorrell *et al*., (2000)
5	Source of information on energy efficiency	Sorrell *et al*., (2000)
6	Currently implemented energy efficient technologies	Cagno and Trianni, (2014); Sorrell *et al*., (2011). Sustainable energy regulation and policy making training manual
7	Barrier to energy efficiency improvement	Sorrell *et al*., (2011); Apeaning & Thollander (2013); Brunke *et al*., (2014); Mallett *et al*., (2011).
8	Driving forces for energy efficiency improvement	Apeaning & Thollander, (2013).

The study also made use of secondary data sources that have been documented by KAM. Data on energy efficiency initiatives, energy consumption and energy savings by different firms was collected from different reports by KAM which also included their energy management awards Assessment Tools.

3.6: Data Analysis

After the completion of data collection process, the questionnaires which were returned after being completely filled were edited, coded then entries made into Statistical Package for Social

Sciences (SPSS version 25.1). Coding consists of technical procedures where symbols which are normally numerals are given to the raw data in order to transform it into an easily tabulated and counted format, (Churchill & Iacobucci, 2002). It assists in reducing the replies to a few categories containing information required for analysis. Thus, codes were given to each individual response.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1: Background of the survey

The research was carried out with an aim of determining how the current practices of energy efficiency and management are being implemented in the manufacturing industries in Kenya. This was done by investigating the extent at which energy efficiency measures have been adopted, the driving forces that promote their adoption and the barriers which at some point hinder the adoption of these particular measures.

The researcher administered a total of 50 questionnaires to 50 different industries located in Nairobi, Mombasa, Thika and Kisumu out of which 31 questionnaires were dully filled and returned. The surveyed industries fall under 8 different categories namely food and beverage (33%), leather and footwear (9%), paper and board (10), chemical and allied (5), plastic and rubber (5%), building, mining and construction which were mainly cement companies (14%), metal and allied (14%) and pharmaceutical and medical equipment (10%).

The questionnaires were distributed physically and the returned questionnaires represented 58% as shown in the figure 4.2. American Association for Public Opinion Research (AAPOR, 2010) defined the response rate as being the end results or outcome for surveys. Babbie (2004) argues that a return rates of 50% is acceptable to analyse and publish, while 60% is good and above 70% is very good. According to Mugenda and Mugenda (2003), in their argument they indicate that a return rate of 50% is acceptable. According to Awino (2011), in her argument she states that a response of above 65 percent is acceptable. According to Baruch (1999), a response rate of above 55.6% is acceptable. Therefore, according to the argument outlined by these authors in regards to response rate, a feedback rate of 58% was good for the study.

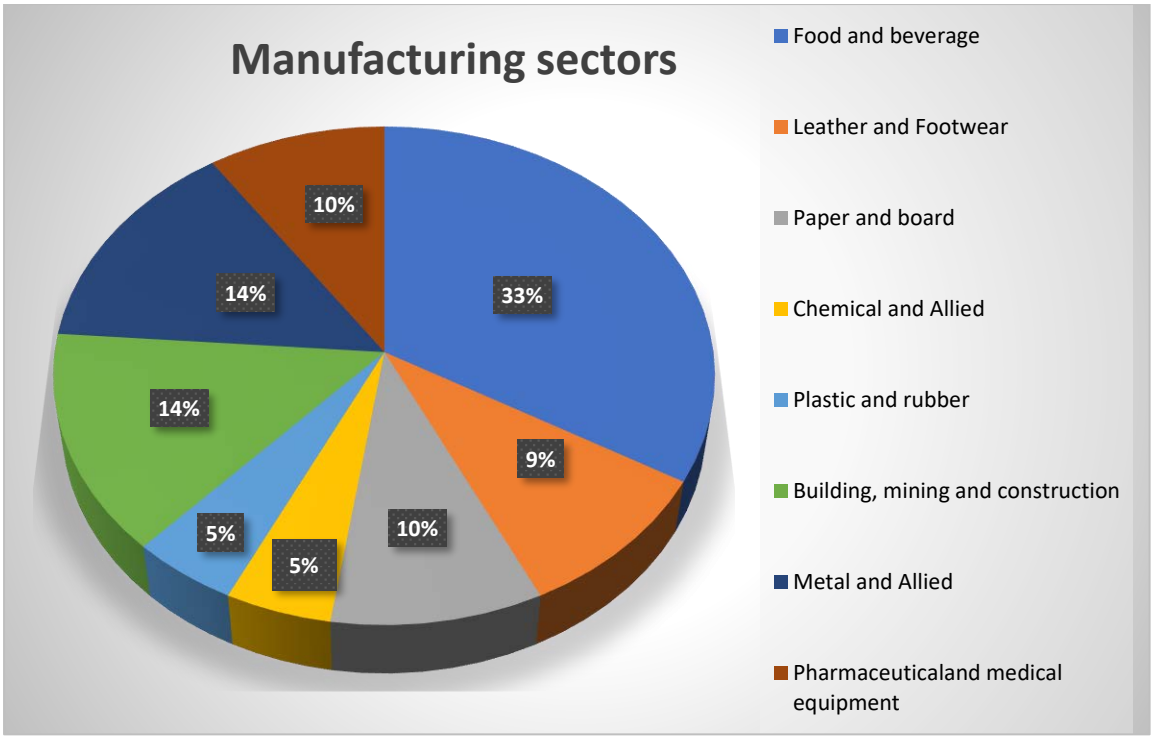

Figure 4.1: Participating industrial sectors

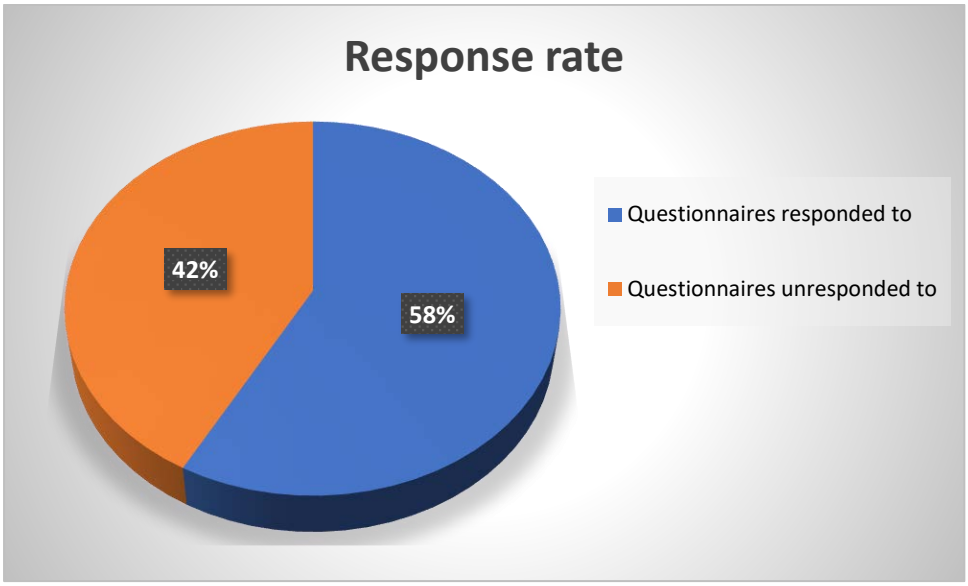

Figure 4.2: Response rate

The findings from the surveyed industries on the number of employees revealed that 38.7% of the manufacturing industries have more than 1000 employees, 25.8% of these industries showed that the number of employees was between 751-1000, 9.7% of the industries under survey showed that they had between 501-750 employees, 12.9% had employees between 251-500, 6.5% of the industries indicated that the number of their employees was between 100-250 and the industries who had employees less than 100 was represented by 6.5%. The

findings from the study showed that human capital is a very important component when it comes to production and survival of the industries (Kibas, 2012). According to (Kings & MacGrath, 2002), an under or over employment in a firm can not only result to lowered production but also closure of the industry. A large number of employees as depicted by the findings from the study is a clear indication that these industries consume lots of energy in their line of production and therefore the industries have a responsibility to create awareness in regards to energy efficiency and management among their employees in order to cut down cost on energy used.

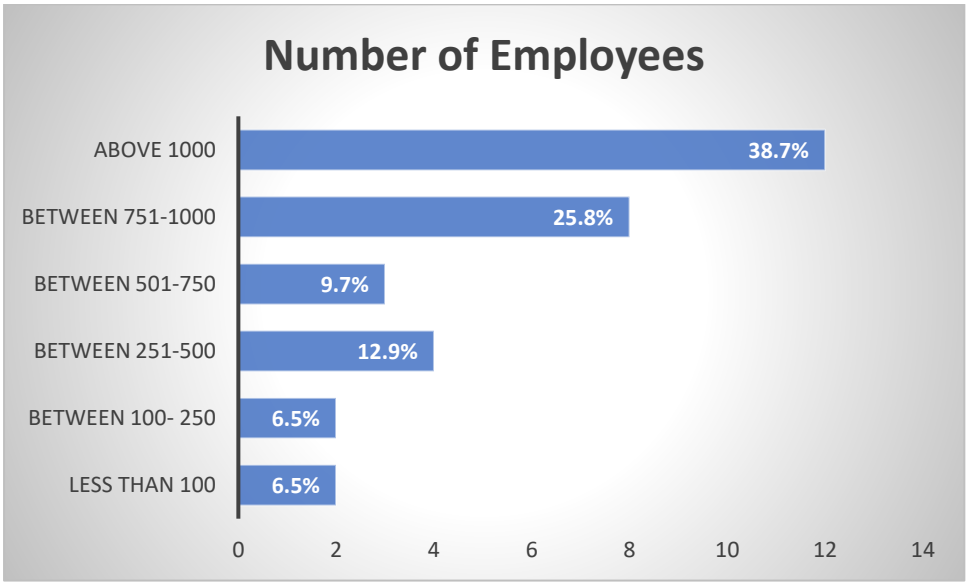

Figure 4.3: The number of employees per industry

The findings also revealed that twenty-eight of the surveyed industries had energy officers who were in-charge of the energy issues in their industries while the other industries had company managers and engineers specialized in energy to whom the questionnaires were administered to.

4.2: Energy Efficiency and Management practices in Kenyan Industries

The findings revealed that all the industries surveyed were using both thermal and electricity in their manufacturing production with very high amount of electricity consumed annually. This clearly shows that these industries spend a lot of money in electricity alone which in turn will mean that they spend even more in the total amount of energy used in the industries when the other types of energy such as thermal and fuels are included. Hence there is greater need for the industries to embrace adoption of energy efficiency and management.

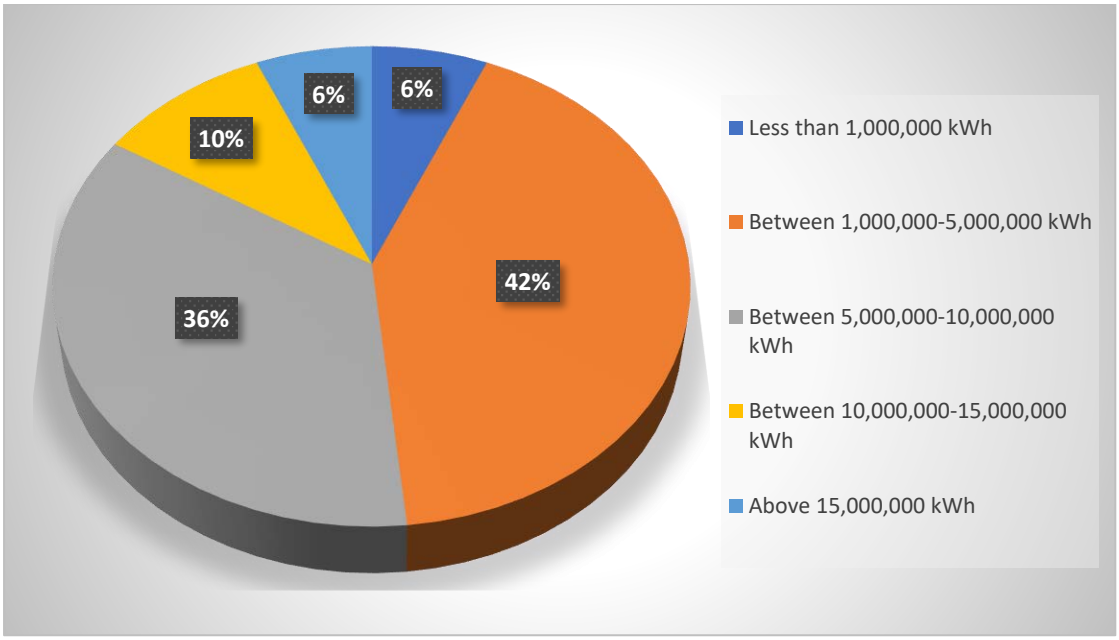

Figure 4.4: Amount of electricity used per industry

To assess the existence of an energy efficiency gap in manufacturing industries, the respondents were requested to assess if there exist some cost-effective energy efficiency opportunities in their industries. The findings showed that six (6) of the respondents strongly affirmed that there exists opportunities on energy saving, twenty four (24) of the respondents merely affirmed the existence of energy efficiency opportunities while one respondent was neutral about the existence of the opportunities (Figure 4.5). The findings indicate that there is existence of energy efficiency opportunities in the surveyed industries and the people in charge are very much aware of the existence hence it can be exploited to narrow down the energy efficiency gap in industries.

In order to determine energy management levels undertaken by the industries, the respondents were requested to answer questions on their energy information systems. The findings reveal that 90% of the industries that were surveyed had installed meter electricity both at the site and building levels while the other 10% had their electricity meters installed on the equipment lines. All the respondents confirmed that they take their electricity use recordings every month as well as monitor their energy use trends. Notably, about 38% of the respondents indicated that they make use of monitoring and targeting schemes as a way of managing their electricity consumption. Approximately 7% of the respondents affirmed that they had benchmarks in order to compare their energy consumption with. The findings from the research also revealed that 10% of the total industries which was surveyed had not carried out the energy audit despite it being a regulation in the Kenyan government under the regulation on The Energy Management Regulation of 2012 (Figure 4.6). This regulation requires that the industries to carry out energy audit once in three years or face

either an imprisonment of one year or pay a fine of Ksh 1,000,000 (USD 10,000). Therefore, from the findings, it is evident that the respondents assess the energy efficiency gap in their industries using empirical data (audit data) since most of them had carried out energy audits. According to Allcott & Greenstone, (2012), using empirical data on energy used to determine the average returns on the investments made by the industries is very instrumental in the determination of energy efficiency gap.

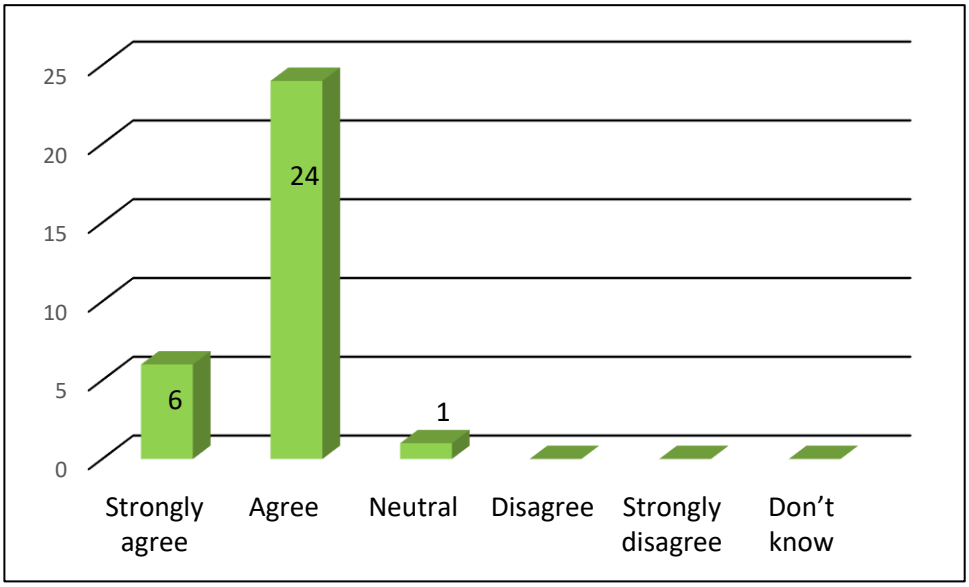

Figure 4.5: Energy Efficiency Opportunities

In order to determine if the industries had any energy management system in place, the respondents were requested to answer a question related to the same. The findings revealed that only three of the surveyed industries had an energy policy in place which the management was so much committed to. The commitment by the management was evident in that they made their staff to be highly aware of it by integrating it into their companies' operations. None of the industries had subscribed to ISO 50001:2012 despite its importance in energy management in organizations and institutions. ISO 50001:2012 is a strategic tool which is meant to help the organizations put in place an energy management system and use their energy more efficiently. However, 27 industries had subscribed to different ISO standards such as ISO 9000:2001, ISO 22000:2005 (food safety certification), ISO 14001:2015 (environmental management certification), ISO 18001:2007 (Occupational Health and Safety Management System Specification certification), ISO 9002/1(Quality Management Systems certification) among others. All the respondents apart from two indicated that their industries do not have standardized energy management scheme but twenty-eight of the companies had

an energy officer in place who dealt with management issues as required by the energy management regulations of 2012.

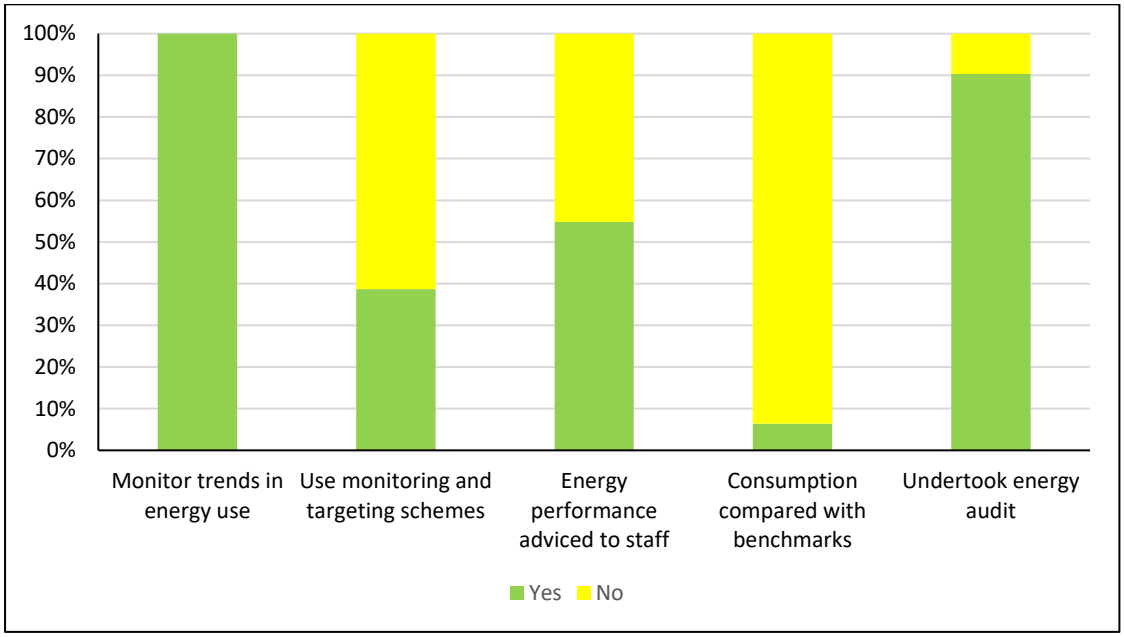

Figure 4.6: Energy management information

4.3: Source of Information on Energy Efficiency in Kenya

For proper implementation of energy efficiency and management in industries, acquisition of information in regards to this plays a very important role not only to the management but also to the staff within the industry. There are numerous avenues where the industries can acquire information about energy efficiency and management, its benefits and how they can implement them in order to increase their savings. The most important thing when it comes to the usefulness of the accessed information not only lies on the source but also on the credibility of that particular information. In Kenya, there are particular bodies and organizations which are officially responsible in the dissemination of information related to energy efficiency and management. These organizations are Energy Regulation Commission (ERC), Centre for Energy Efficiency and Conservation (CEEC), Kenya Association of Manufacturers (KAM) and Kenya Power and Lighting Company (KPLC). There are other sources of information which are not official such as conferences, seminars, energy consultants, colleagues within the company and the sectors, equipment manufacturers and written sources such as journals and manuals.

The findings from the research reveals that energy audit reports are the best source of information on energy efficiency and management implementation in industries as shown in the figure 4.7 below. This is because energy audits are conducted with experts with required

knowledge and they have been licensed to carry out the audit. Therefore, the recommendations provided by the auditors are reasonable and will be helpful in reducing energy cost when implemented.

Information from the manufacturers of the energy efficient equipment was ranked as the second-best source of information. This is because, the manufacturers of the equipment are the ones who has the knowledge on how the equipment was developed and how efficiently it can work hence they are well positioned to provide the necessary information on how effectively it can work. However, the management of the industries should be cautious with this kind of information because sometimes an energy efficient equipment manufactured in developed countries may not necessarily work efficiently in developing countries.

The information from the sector organizations such as Kenya Associations of Manufacturers (KAM), Kenya Power and Lighting Company (KPLC) and Energy Regulation Commission (ERC) were ranked as third, fourth and fifth respectively as the best sources of information. This could be due to the efforts that the government has lately been trying to support the industries to reduce their cost of energy by encouraging them to embrace energy efficiency and management. This is more evident with the introduction of Energy Management Regulation of 2012 which encourages industry owners to carry out energy audit. However, the respondents acknowledged that more support was still required in the dissemination of the information by the ERC. The respondents pointed out that their service was a bit slow when it comes to giving back the feedback on the energy audit reports submitted which plays a very crucial role in the acquisition of the required information by the industries.

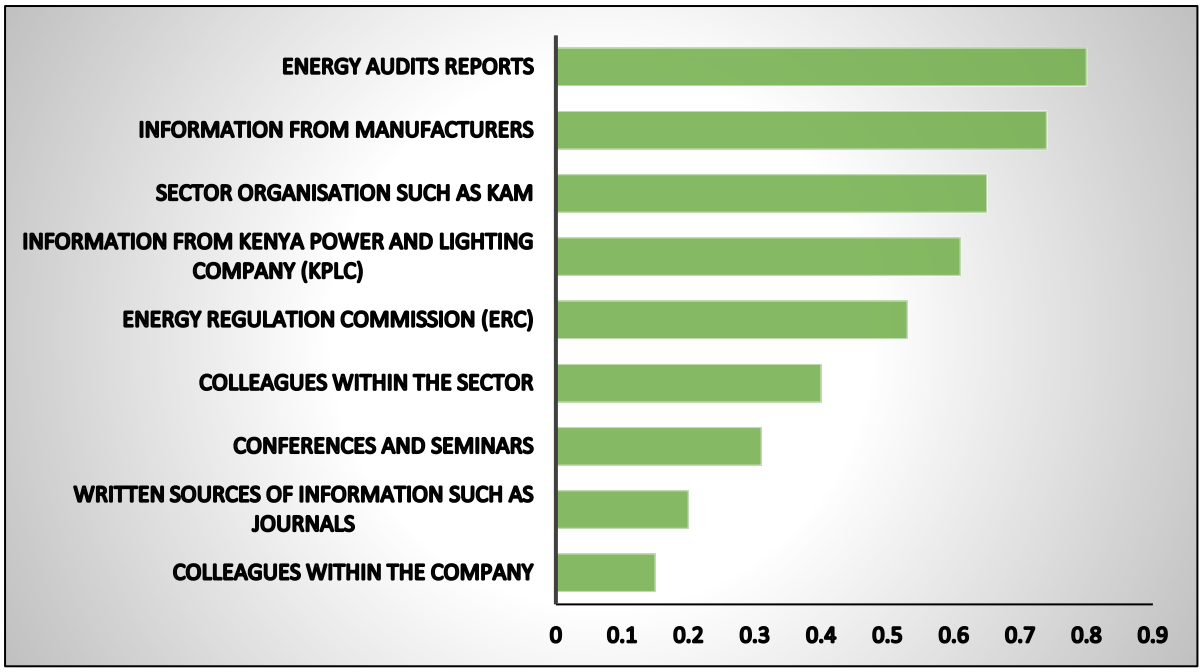

Figure 4.7: Sources of information

4.4: Energy Efficient Technology adoptions in Kenyan industries

To determine the baseline for assessing the extent to which the industries had implemented energy efficiency measures, the respondents were provided with a list of four broad categories of energy efficient measures and they were asked to rank them between 0 to 1 with 0 being least implemented and 1 being extensively implemented. The scores from the collected data were added then average as shown in the figure 4.8 below.

Findings revealed that housekeeping is the most implemented measure of energy efficiency. The respondents acknowledged that most measures which falls under housekeeping category were easier to implement since some of them required either small amount of money to be spent or even in some cases nothing was required for spending. Good example of such measures are retrofitting, replacement of incandescent lamps with LED lamps, making use of daylight among others.

System optimization was ranked 2nd position while adoption of energy management systems and staff capacity building were rand third and fourth positions respectively. Some respondents indicated that they had a centralized air compressor in place and this has helped them to reduce on the numbers of compressors running in a given time. They confirmed that this move has really helped them to effectively maintain the compressed air system since it is more convenient for the technician to service the centralized system.

Adoption of energy management systems came third position. Fifteen respondents confirmed that they had an energy management system in place and only two out of these fifteen respondents indicated to have installed online energy management monitoring systems. According to Ershaid *et al*. (2014), online energy monitoring system helps in auditing and monitoring key components like equipment efficiencies and energy saving costs as well as validating data.

On the fourth place was staff capacity and training. About 50% of the respondents acknowledged that their management have been organizing for energy efficiency awareness among its staff and they were committed to it. However, they pointed out that sometimes it becomes difficult to reach every employee because of the huge numbers. For those who had extensively carried out staff building capacity and training on energy efficiency and management confirmed that there were lots of improvement on energy use in their companies. According to UNIDO (2008), the capacity building is one of the key avenues in the creation of system optimization experts who can advance the practice of energy management practices both now and in the near future.

The respondents mostly from the companies which had implemented some energy efficiency measures after undertaking energy audit acknowledged that they have managed to accrue

some savings as a result of cutting down on energy use. For example, one respondent stated that their industry has been saving about USD 30,000 per month on fuel. Another respondent indicated that they did manage to reduce their steam consumption from 5247 tons to 3728 tons between 2016 and 2017 as a result of installing steam traps and Pressure Reducing Valves.

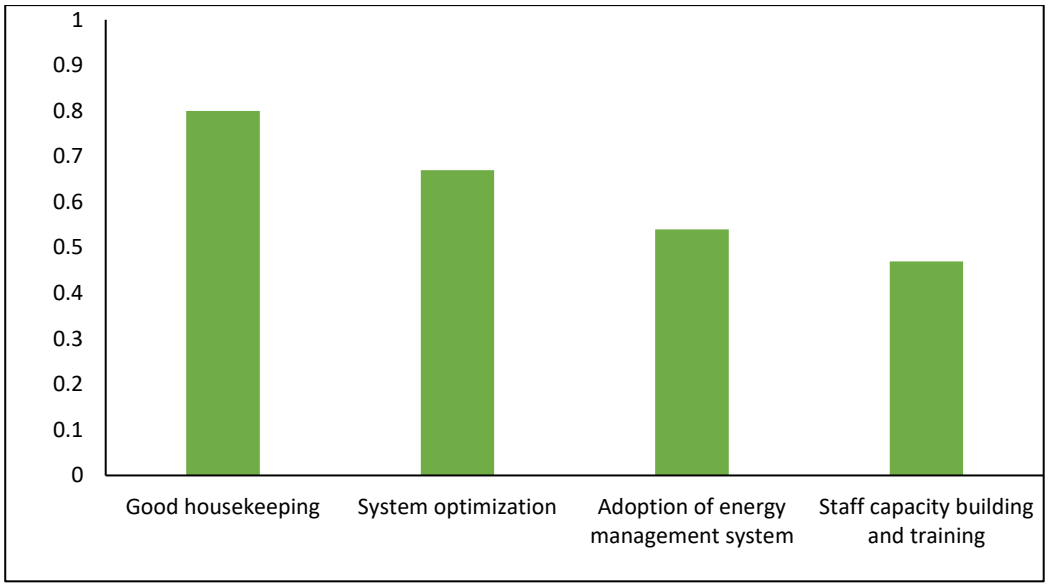

Figure 4.8: Adopted energy efficient measures

4.5: Driving force for Improving Energy Efficiency in Kenyan Industries

The need to adopt or improve on energy efficiency and management in a company can be due to either internal or external factors. To understand the reasons as to why the industries adopted an energy efficiency measure, the respondents were provided with a list of eleven driving forces for industrial energy efficiency and they were requested to rate the importance of these driving forces using a scale of 0 to 1 with 0 being least important and 1 being most important. In order to determine the least to the most important driving forces, the points were summed up then averaged. The rankings are shown in figure 4.9.

From the findings, the cost reduction due to lowered energy use was ranked as the most important driver when adopting an energy efficiency measure. This was closely followed by the need to increase their production. These two driving forces are considered as market related because they have a role of increasing the industries' profit margins. The institution requirements were ranked as the 3rd best by the respondents. The institution requirement refers to policy related issues such as energy management regulation of 2012 which compels the industries to carry out an energy audit once in three years hence encouraging the industries to adopt energy efficiency and management measures. This is considered as a

policy related. In the 4th position was the desire for the industry to be recognized as green company. The best example is the energy efficiency awards which are organized on the yearly basis by the Kenya Association of Manufacturers (KAM). The awards help to encourage industries to adopt energy efficiency measures to be recognized by KAM as being an outstanding industry in energy use reduction. This particular driving force is considered to be an organizational and behavioral factor. Threat of rising energy prices and investor's interest in energy efficiency were ranked at 5th and 6th positions respectively. Both are considered to be market related. While the threat to energy prices helps the industries to secure their profits, investor's interest in energy efficiency ensures that their products are price competitive within the market hence resulting to sustainable energy consumption within their companies.

Operation reliability and control, avoidance of capital expenditure, government incentives such as Energy tax, international competition and general energy advice obtained from the seminars, journals and books were ranked at 7th, 8th, 9th, 10th and 11th positions respectively. Government incentives is known to be a very important driving force in energy efficiency worldwide but surprisingly, it was ranked the ninth position by the respondents. The respondents didn't find the general advice from the seminars and written documents such as journal and booklets to be very important. This could be attributed to the fact that maybe the authors could be writing for the purpose of research or alternatively, the advice provide may work better in the developed world than in the developing countries like Kenya.

Table 4.1. Drives for Energy Efficiency

No.	Driving forces	Category	Average score
1	Cost reduction by lowering energy use	Market related	0.92
2	Increase production	Market related	0.9
3	Institution requirements such as audits, energy management regulation,2012	Policy related	0.87
4	Recognition as green company such as Energy Efficiency awards	Organizational and behavioral	0.84
5	Threat of rising energy prices	Market related	0.8
6	Investor's interest in Energy Efficiency	Market related	0.75
7	Operation reliability and control	Market related	0.7
8	Avoidance of capital expenditure		0.52
9	Government incentives	Policy related	0.4
10	International competition	Market related	0.32

11	General energy advices through seminars, journals, booklets etc	Organizational and behavioral	0.2

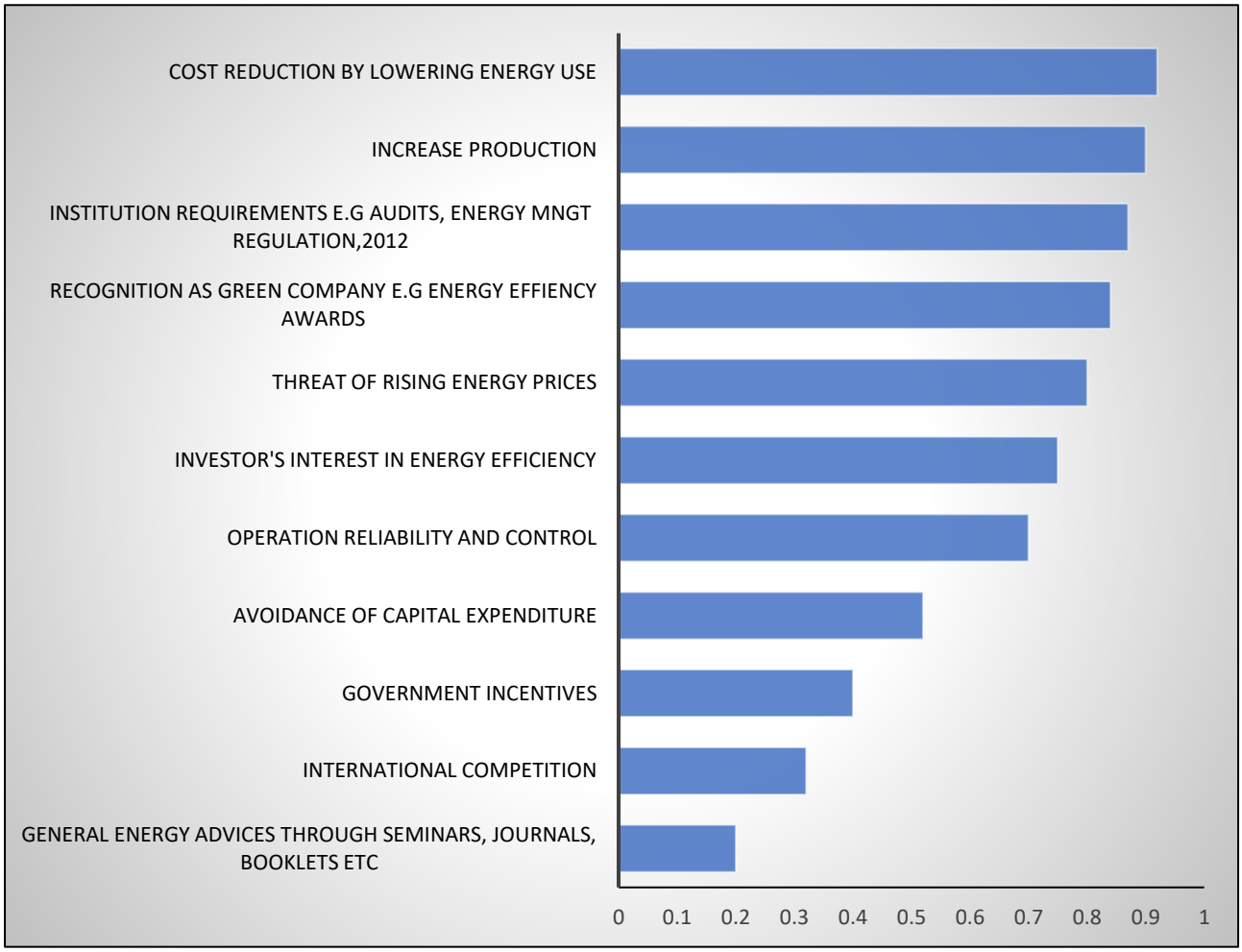

Figure 4.9: Driving forces for energy efficiency adoption

4.6: Barriers to Energy efficiency improvement in Kenyan industries

The respondents were provided with a list of 9 barriers to energy efficiency of which they were asked to rank them from 0 to 1 with 0 being least important and 1 being most important. By doing this, it would help in understanding the hurdles encountered by the industries while trying to implement the recommended energy efficiency projects. The questions were developed with the help of literature review of the related articles as outlined in chapter three. The points were then summed up and average in order to determine the least to most important barriers to energy efficiency in industries. The figure below shows the obtained rankings.

High initial cost was considered as the most important barrier which was closely followed by inadequate budget funding in the second position and in third position came in other priorities on the expenditure. Theoretically, these barriers are considered to be associated with lack of access to funds and they can be categorized as economic and non-market failure. The respondents acknowledged that some energy efficient equipment or technology requires large

amount of money (capital) in order to implement it making it a times next to impossible to acquire them. This is because access to capital a times is a horrible nightmare or even if the capital is accessed, some managers considers other projects worthwhile investing the capital in as compared to energy efficiency projects. Production based priorities was ranked the fourth position by the respondents. On the other hand, other priorities on the expenditure are considered as hidden costs according to (Thollander & Rohdin, 2006). The respondents ranked production-based priorities in the 4th position. This barrier is closely related to other priorities on the expenditure whereby the managers of the firm may be more interested in the production increase compared to energy efficiency management. This barrier is categorized as economic (non-market failure). According to UNIDO (2011), when the industries are unable to appropriate all the benefits of an investment, they are less likely to invest which can end up resulting to a conflict between those who stand a chance to gain more from the implementation of energy efficiency measures and those who may gain less from it.

Table 4.2. Barriers to energy Efficiency

No.	Barriers to Energy Efficiency	Category	Average scores
1	High initial cost	Economic (non-market failure) barrier	0.92
2	Inadequate budget funding	Economic (non-market failure) barrier	0.89
3	Other priorities on expenditure	Economic (non-market failure) barrier	0.85
4	Production based priorities	Economic (non-market failure) barrier	0.8
5	Inadequate technical skills	Organisational barrier	0.7
6	Beauracracy	Organisational barrier	0.6
7	Inadequate staff capacity building & training	Behavioral barrier	0.5
8	Inadequate information on energy efficiency opportunities	Economic (market failure) barrier	0.42
9	Lack of submetering	Economic (non-market failure) barrier	0.3

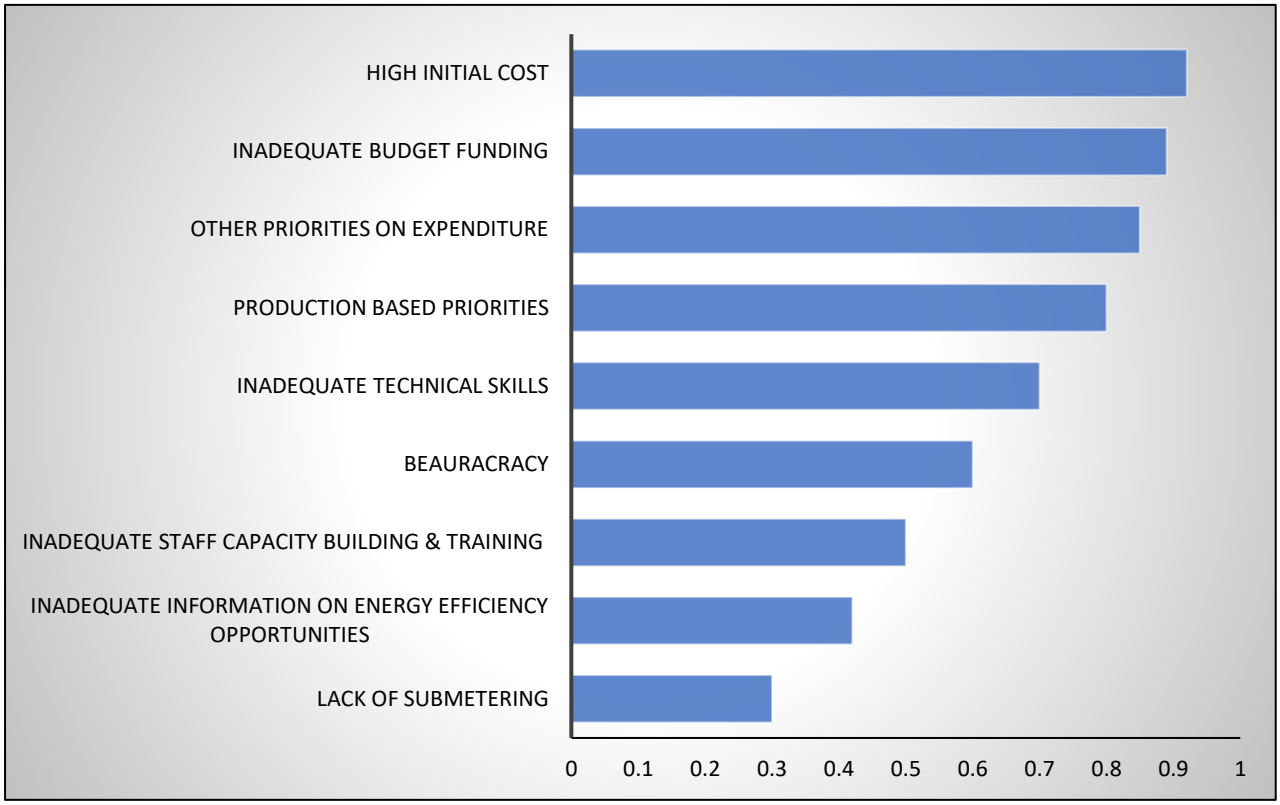

Figure 4.10: Barriers to the adoption of energy efficiency

Inadequate technical skills were ranked in the fifth position and it is considered to be an organizational barrier. The respondents explained that some energy efficiency projects require specialized skills to implement them and therefore absence of these technical experts or skills limits the ability of a company to take up the technology.

Beauracracy was ranked sixth position and it is categories as an organizational barrier. This can be as a result of conflict between those who wish to invest in energy efficiency project and those who feel that energy efficiency projects are not worth invested in and instead wish to invest in other projects such as increasing production. This can result to managers taking longer to decide on where to make an investment.

Inadequate staff capacity building and training was ranked in the seventh position and this is categorized as behavioral barrier. Seven of the respondents acknowledged that staff capacity and training had been organized in their industries with an aim to create awareness on energy efficiency and management. However, they did point out that it's been a bit difficult to reach every member of the staff solely because of their large number. In the eighth and ninth position was the inadequate information about energy efficiency and lack of submetering respectively. Lack of submetering is considered as an economic (non- market) barrier. This indicate that these two barriers were considered as least important barriers hence its still possible to

implement energy efficiency projects without much difficulties even when these barriers are present.

CHAPTER FIVE: DISCUSSION

5.1: Energy Efficiency and Management practices in Kenya Industries

The government of Kenya through Energy Regulation Commission passed a regulation known as The Energy Management Regulation, 2012 of Legal notice 102 dated 28th September 2012 which required all industrial, commercial and institutional users of energy consuming more than 180,001 KWh annually (equivalent to 648,004 MJ annually) to carry out an energy audit once in three years and further implement at least 50% of the recommendations provided in the audit report. The energy audit to be carried out by an energy auditor who is licensed by ERC to do so and the report is supposed to be submitted to the ERC within six months to the end of the financial year. The implementation is supposed to be overseen by an energy officer appointed by the audited company in case there is none in place yet. Due to this regulation, lots of changes have been experienced in the energy sector because it has helped to ensure that the industries, commercial and institutional facilities used energy efficiently. If any facility refuses to comply to this regulation, the top management of the facility is supposed to either be jailed for one year or pay a fine of Ksh 30,000 per day (USD 300 per day). An annual implementation report is supposed to be generated and then submitted to ERC; failure to do so calls for a penalty charge of about Ksh 30,000 (USD 300) per day. From the results of the surveyed industries, 28 companies had complied to the Energy Management Regulation of 2012 while the other three industries were yet to comply since they had not even carried out an energy audit. The finding also revealed that only 2 industries out of the twenty-eight industries which had carried out an energy audit had not yet received their compliance certificate from ERC although they had already submitted their energy audit report to them.

The findings also revealed that the surveyed industries were energy intensive meaning that they consumed large amount of both electricity and other forms of fuels. On July 30th, 2018, ERC made an announcement on the new revised electricity tariffs by Kenya Power and Lighting Company. The new tariffs as clearly depicted in figure 5.1 reveals that the industries will even pay more for the amount electricity consumed compared to the old tariff. Therefore, the top management needs to embrace energy efficient measurements now more than ever to help them cut down on the amount of money used on electricity consumed. All the respondents apart from one confirmed the existence of energy efficiency opportunities in their industries. This is a clear indication that there is still room for these industries to save even more by cutting down on their energy use. For instance, as seen from the results some of the industries consume huge amount of electricity and implementing on some more energy efficiency measures such as retrofitting, centralization of air compressors among others will help them reduce on their electricity bills

The industrial tariffs BO, B1, B2, B3, C1, C2, C3, C4 and C5 have been merged into the Commercial / Industrial tariff as shown in the tables below.

OLD TARIFFS - COMMERCIAL/INDUSTRIAL CUSTOMERS									
Tariff/ Charges	BO	BI	B2	B3	C1	C2	C3	C4	C5
Fixed Charge	800.00	600.00	2,000.00	7,500.00	600.00	2,000.00	7,500.00	7,500.00	7,500.00
Voltage	415 V	240/415 V	11 kV	66/132 kV	415 V	11/33 kV	66/132 kV	66/132 kV	66/132 kV
Charge Per unit (kWh)	6.40	5.16	4.60	4.40	5.10	4.40	4.17	4.07	4.00
Demand (KShs. Per KVA)	-	300.00	200.00	100.00	300.00	200.00	100.00	80.00	80.00
Units Consumed	7,000 - 100,000	7,000 - 100,000	7,000 - 100,000	7,000 - 100,000	100,001 - 5,000,000	100,001 - 5,000,000	100,001 - 5,000,000	5,000,001 - 7,5000,000	> 7,5000,000

NEW TARIFFS - COMMERCIAL/INDUSTRIAL CUSTOMERS					
Tariff/ Charges	CI	CI2	CI3	CI4	CI5
Fixed Charge	800.00	2,500.00	2,900.00	4,200.00	11,000.00
Voltage	415 V	11 kV	33/40 kV	66 kV	132 kV
Charge Per unit (kWh)	5.75	4.73	4.49	4.25	4.10
Demand (KShs. Per KVA)	600.00	400.00	200.00	170.00	170.00
Units Consumed	> 15,000	> 15,000	> 15,000	> 15,000	> 15,000

Figure 5.2: New power tariffs (KPLC, 2018)

5.2: Driving force for Improving Energy Efficiency in Kenyan Industries

The most highly ranked driving forces were those that belonged to the category of market related driving forces. The other driving forces which were ranked by the respondents were organizational and behavioral factors. The respondents ranked cost reduction by lowering energy use as being the most important driving force in the implementation of energy efficient measures and this is considered as being a market related driving force. According to Apeaning & Thollander (2013), the market related forces helps the industry to remain competitive by reducing their energy consumption and they end up reducing the amount of money spent on energy consumed. Cost reduction is also seen as a way of securing the industry's position in energy consumption in order to deal with the rising cost of energy prices. The respondents acknowledged that this particular driving force provided them with an opportunity to lower their operation costs which in turn helped them to increase their profits. The increased profits will help the managers to invest in production increment in order to improve the company's turnover.

Some respondents who had previously implemented some measures which were recommended by the energy auditor after conducting an audit in their companies revealed that a reduction in their operation costs due to cost reduction in energy used helped their products remain competitive in the market due to constant prices. Pricing of produced items is a very important element in a developing country like Kenya where a bigger number of its citizen live below the poverty line. According to UNICEF (2017), forty two percent of the forty-four million citizens live below the poverty line. This clearly indicate that the industry owners' main goal should be to produce a product of lower prices if they want them to be consumed by every citizen. Therefore, the owners have a bigger chance of getting more profits when the price of the product is lower hence the need to embrace improvement of energy efficiency and management in industries. According to Rekettye (2011), it is more logical for the firm management and owners to consider customer's interest, commodity's value, price and the cost first before thinking about the profits if they want their products to remain competitive.

The respondents stated that recognition of industries as a green company has really helped them to try and adopt energy efficiency measures in their facilities. Recognition of industries as a green company is considered to be an organizational and behavioral driving force. In Kenya, the recognition of companies which have adopted energy efficiency measures is done during the Energy Management Awards (EMA) which are held yearly. The Energy Management awards (EMA) are organized and managed by the Kenya Association of Manufacturers (KAM) through the Centre for Energy Efficiency and Conservation (CEEC). In the awards, the enterprises which have made greater and sustainable gains in energy efficiency by implementing modern energy management principles and practices and achieved significant energy and cost reduction in the process are recognized. The awards are divided into sixteen different categories namely Electricity Savings Award (Small Consumer), Electricity Savings Award (Medium Consumer), Electricity Savings Award (Large Consumer), Fuel Savings Award(Small Consumer), Fuel Savings Award (Larger Consumer), Best Energy Management Team Award, Best New Entrant, Technical Committee's Award-Best presentation, Best Energy Management –Tea Sector, Best Energy Management –Service Sector, Recognition in Water Efficiency, Overall Energy Management Award-Small Consumer, Overall Energy Management Award-Medium Consumer, Overall Energy Management Award-Large Consumer and Overall Energy Management Award. So far, KAM has organized 13 awards since Energy Management awards initiative was launched. Out of 31 respondents, 23 of them confirmed that they had participated in the energy management awards before and quite a number of them had won some awards too from different categories. The respondents confirmed that they will still

participate in the coming awards in future because winning the awards makes them feel their effort bore fruits and also appreciated.

The Energy Management Regulation of 2012 falls under the institution requirements and it is considered as a policy related driving force. Since this regulation was passed, tremendous changes have been witnessed in the energy sector because it has helped to motivate industries to improve on energy efficiency and management. The respondents who confirmed that they had carried out energy audit acknowledged that they did so as to comply with the regulation in order to avoid either being jailed or paying the penalty. Complying has helped them to realize some savings as a result of implementing the recommendations made in the audit report by the auditors.

5.3: Barriers to Energy efficiency improvement in Kenyan industries

From the findings, economic barriers were highly ranked indicating that they played a major role in impeding smooth adoption of energy efficient measures. The most highly ranked economic barrier was high initial cost. The other barriers such as behavioral and organizational scored a bit less compared to economic though most of the barriers which fell in this category were still considered to have some influence in the adoption and implementation of the energy efficiency measures in the industries surveyed.

In economic barrier category, the highly ranked barrier by the respondents was high initial cost. Some of the energy efficient equipment are quite expensive to acquire and install and implementing it will require the company to invest in a large amount of capital which can end up even interfering with other investments in some projects which are equally important to the company. Therefore, the management may end up taking longer to decide on whether to implement the measure or not as they try to weigh the options. The other economic barrier was inadequate budget funding. This can be attributed to inadequate access to capital for implementing energy efficiency measures due to other competing priorities. The top management at this point may decide to be reluctant when it comes to allocating budget for energy efficient projects as compared to making use of the same capital in investing in increasing the production. Another reason can be that the top management feels that they are not assured of the expected returns associated with the implementation of energy efficient measures hence ending up being quite expensive for the company to engage in it. The respondents echoed that due to unassured expected energy savings, taking a loan from the financial institutions which accrue high interests may later on push the company into a loss instead of increasing their profits. Therefore, the financial institutions need to have experienced technical experts who can help the company owners in evaluating their credit worthiness as well as the risks associated with the implementation of the energy efficient projects.

The inadequate technical skill had an average score of 0.7 indicating that it plays a major role in limiting the implementation of energy efficiency projects in industries. This can be associated with inadequate information when it comes to knowledge on current innovative energy efficient technology by the engineering expert. The management need to invest in their engineering staff to go for training on how to install and operate the newly innovated energy efficient technologies since most of these innovations comes from the developed world. The respondents confirmed that sometimes they are forced to seek for the help of an expert from the developed countries to help them install, operate and even repair the instrument in case of breakdown. By doing this, the implementation of that particular projects proves to be expensive on the side of the company owners and the management interfering with other investments in case the allocated share of the capital to this project end up being less as expected. According to Karekezi and Kithyoma (2005), there is greater need of technical knowledge which can be used to build a critical mass of policy analysts, economic managers and engineers who will be able to manage all the necessary aspects of efficient systems development. They also point out that there is need of trained manpower who are capable of developing and manufacturing energy efficient systems (Karekezi and Kithyoma, 2005). In his study, Karekezi and Kithyoma reveals that the inadequate technical experts is as a result of the available experts in the field of energy efficiency who tend to move to other sectors because of the embryonic nature of the renewable energy and energy efficiency industry and the limited business development training provided to trainees (Karekezi and Kithyoma, 2005). A report by the department of energy of United States (U.S) echoes on the lack of in-house technical experts. The report states that lack of in-house technical expertise or even the resource to source for an expert from outside to help in the development and operation of energy efficient projects can limit the implementation of the same projects (United States department of Energy, 2015).

In regards to inadequate information on energy efficiency opportunities as a barrier, the respondents said that it's not a major issue that can limit implementation of the energy efficiency projects. However, they emphasized that they still need lots of support from ERC since they noticed that the process of giving feedback from the submitted reports to the industries is a bit slow. The industries need to get the feedback from ERC in good time in order to implement the recommendations given by the energy auditors in good time and this needs proper planning on the side of industry's top management. Another reason for inadequate information is as result of some industries not having modern energy management systems in place hence they miss out on the information on the benefits of the same. Without the modern energy management system, the industry owners fail to capture the value of cost effective energy savings which can be achieved by having the system in place (United States (U.S) department of Energy, 2015). The top management also need to be aware of the

available incentives on energy efficiency measures given by government institutes such as ERC, sector organizations such as KAM and utility (KPLC) so as to benefit from them and improve the adoption of energy efficiency in their companies. Some company managers lack knowledge of these incentives either because they are not interest in energy efficiency projects or they are more focused on increasing the production leading to them missing out on the opportunities.

RECOMMENDATION AND CONCLUSION

The findings from the research revealed that the government of Kenya over the years has made tremendous efforts in a bid to transform Kenyan industries by encouraging them to adopt energy efficiency and management. The surveyed industries were found to be energy intensive and the respondents from these companies acknowledged that opportunities on energy efficiency existed in their facilities. Out of the 31 industries surveyed, 28 of them had carried out an energy audit as per the Energy Management Regulation of 2012 and more than half had already received their compliance certificate from ERC while the others are waiting for the approval of their audit reports which they submitted. Some of the industries which had carried out the energy audits acknowledged that they had even participated in the energy management awards which are always being organized annually and managed by KAM and quite a number of them have won some awards in different categories. The respondents from these industries also confirmed that they have realized some savings on the money spent in energy by reducing their energy consumption.

The study revealed that the energy audit reports was the main source of information on energy efficiency and management. It also showed that the manufacturers of the energy efficient equipment were very important when it comes to the information dissemination. This is because the manufacturers have the know-how on the functioning of the technology. However, it was noted that a times the information from the manufactures are not that effective since the equipment may work effectively in the developed countries as compared to the developing country like Kenya. The respondents indicated that getting information from ERC was not so effective due to the slow nature in giving the feedback on the audit reports submitted to them. The flow of information among the colleagues within the company was found to be least effective indicating there exist very minimal exchange of information among colleagues. Internally, the top management should encourage sharing information on how to use energy efficiently by organizing internal seminars and meeting. Externally, the government of Kenya through the ministry of energy and sector organizations such as KAM and ERC should work on planning for more seminars and conferences where colleagues from the same sectors can meet and share the information on energy efficiency and management. The company managers should consider benchmarking in other companies in order to learn on how best they are managing energy.

Almost all the industries under survey had implemented housekeeping measures extensively. Such housekeeping measures are retrofitting, using LED lamps instead of incandescent lamps and making use of daylight during the day. This is because most housekeeping measures cost less or even no cost at all to implement the measures. It was expected that staff building capacity and training to have been the most extensively implemented but on the contrary, it is

the least implemented measure of energy efficiency. The companies should strive to create awareness on energy efficiency and management among their employees if they expect to achieve more energy use reduction. The top management has to ensure that the staff are well motivated so that they can engage in energy efficiency and management for the best of the company without being reminded. Therefore, the top management should think of introducing in-house energy management awards in a bid to recognize those employees who have effectively helped the company to reduce the amount of energy consumed by observing the company's energy policy religiously and even those who have come up with an a very workable idea on how to manage energy effectively.

Findings from the study showed that the greatest barrier to improvement of energy efficiency in industries was high initial cost. This is because some items are very expensive to acquire and this means the management must source for the capital to invest. In an industry where increasing production is more important, the aspect of adopting an expensive technology is ignored and sometimes it's because the enterprise owners are not sure of its returns in future. Inadequate technical skill was also ranked highly (above 0.5) and this can be a limiting factor when the company wants to implement an energy efficient project. Therefore, the government should work on training more technical experts who not only learn the skills but experts who can develop and manufacture innovative technologies which will help in efficient use of energy. The government should strive to subsidies the expensive energy efficient equipment. The financial institute should consider hiring the right experts with the relevant experience when it comes to evaluating the benefits and risks associated with energy efficient projects so that the owners can be assured of the returns in cases whereby they need to take a loan for the purpose of implementing the project.

In order to improve the energy efficiency more, the manufacturing industries should adopt a day to day monitoring and analysis of energy consumption, continuous improvement of energy management practices, regular calibration of machines and equipment as well as communicating the expectations to the employees. The top management should ensure that they come up with the company's energy policy and get committed to the energy management. They should not wait for three years for them to carry out an energy audit as required by ERC but instead they should carry out internal audits. For the companies to thrive, they should consider reviewing their managements, compute annual trends not forgetting to make the identified opportunities a priority during the implementation of the industries' energy efficiency and management policies.

In-depth analysis of the industries' energy management systems is highly recommended. More research is needed to determine how the relevant sectors such as KPLC, ERC and

financial institution works to improves on the energy efficiency and management in order to assist Kenya as a nation achieve sustainable energy consumption. An in-depth explorative research on the existence of energy efficient opportunities in Kenyan industries is recommended.

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APPENDIX

QUESTIONNAIRE

Pan African University, Institute for Water and Energy Sciences (PAUWES) in Algeria

Questionnaire for thesis work on energy efficiency practices and industrial energy management– a case study of Kenyan industries.

Please, be assured that any information provided will be treated confidentially.

1. **Identification**

Name of the company …….

Category of manufacturing sector……..

Position/title……

2. **The company**

Number of employees (approximate)……

Annual turnover (approximation)…….

3. **Type of energy used**

Please tick the type of energy used in your company

Electricity……..

Thermal……

4. **Annual energy use**

Please indicate your company's approximate annual consumption of:

Fuel……

Electricity……...

(Please indicate units)

Please indicate your company's approximate annual expenditure on:

Fuel…….

Electricity……

5. Energy information systems

At what level is energy generally metered?

	Whole site	Building	Individual equipment
Electricity			
Steam/hot water			

How frequent is energy use generally recorded?

	Annually	Monthly	Weekly	Daily
Electricity				
Steam/hot water				

	Yes	No
Do you monitor trends in energy consumption?		
Are consumption records adjusted to energy price change?		
Is a monitoring and targeting scheme employed?		
Is energy performance advised to staff?		
Is consumption compared with benchmarks?		
Have you conducted energy audits?		

6. Energy management profile

i. Does your company have an explicit energy policy?

Yes [ ] No [ ]

ii. If yes, is the top management of your company committed to the energy policy?

Yes [ ] No [ ]

iii. If yes, is the energy policy fully integrated into your company's operation?

Yes [ ] No[ ]

iv. If yes, what is the level of the policy awareness among staff in the company?

High [ ] Low [ ]

v. Does your company have an implicit energy policy?

Yes [ ] No [ ]

vi. If yes, please state the related system or policy

……

……

vii. If yes, is the top management of your company fully committed to the energy policy?

Yes [ ] No [ ]

viii. If yes, is the energy policy fully integrated into your company's operation?

Yes [ ] No [ ]

ix. If yes, what is the level of awareness among staffs in the company?

High [ ] No [ ]

x. Does your company have an energy management system?

Yes [ ] No [ ]

xi. If yes, name and comment on the features of the energy management system

……

……

7. Energy efficiency opportunities

i. There exist cost-effective energy efficiency measures at my company, which can be implemented and considered profitable according to the company's investment criteria

Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know

ii. What is the estimated payback time for investing in the energy efficiency measures at the current energy price?

No idea	<1yr	<2yrs	<3yrs	>3yrs

8. Information sources

How useful do you consider the following sources to be as regards to information on energy efficiency measures?

	Excellent (1)	Good (0.75)	Average (0.5)	Poor (0.25)	Don't use (0)
Colleagues within the company					
Colleagues within the sector					
Sector organization					
Written sources of information such as journals					
Information from power companies					
Conferences and seminars					
Energy audit reports					
Energy commission (ERC)					
Equipment manufacturer					

9. The following table lists some common measures for reducing energy consumption. Please indicate the extent to which your company has implemented each measure by assigning it a number on a scale from 0 (not implemented) to 1 (extensively implemented).

Measures	0	0.25	0.5	0.75	1
Good house keeping					
System optimization					
Staff capacity building and training					
Adoption of energy management system					

Others

Please indicate any other major energy efficiency measures that you have implemented but which are not indicated above:

……

……

……
……

10. Barriers to energy efficiency improvement

Studies by researchers identify energy efficiency measures which are cost-efficient but which are not implemented. According to the aggregated experience in your company, how do you value the following factors impact on the implementation of cost-effective energy efficiency measures at your company?

	Often important (1)	Sometimes important (0.5)	Rarely important (0)
High initial cost			
Inadequate budget funding			
Other priorities on expenditure			
Production based priorities			
Inadequate technical skills			
Beauracracy			
Lack of submetering			
Inadequate staff capacity building & training			
Inadequate information on energy efficiency opportunities			

Do you have any further comments on barriers to energy efficiency improvement?

……
……

11. Driving forces for energy efficiency improvement

Successful industrial energy management is characterized by a number of factors, external as well as internal. According to the aggregated experience in your company, how do you value the following factors impact on the implementation of cost-effective energy efficiency measures at your company?

Barriers	Often important (1)	Sometimes important (0.5)	Rarely important (0)

Cost reduction by lowering energy use			
Increase production			
Institution requirements e.g audits, energy management regulation,2012			
Recognition as green company e.g Energy Efficiency awards			
Threat of rising energy prices			
Investor's interest in Energy Efficiency			
Operation reliability and control			
Avoidance of capital expenditure			
International competition			
Government incentives			
General energy advices through seminars, journals, booklets etc			

Do you have any further comments on driving forces for energy efficiency improvement?

……

……

Thank you very much for completing this questionnaire.

FINANCIAL REPORT

Nº	**Items**	No. of units	Cost per unit (USD)	Total cost (USD)
1	Return flight ticket from Algiers to Kenya	1	911.32	911.32
2	Return flight ticket from Nairobi to Mombasa	1	326.95	326.95
3	Return flight ticket from Nairobi to Kisumu	1	212.45	212.45
4	Taxi used for the purpose of data collection from the industres	-	-	890.52
5	Research permit from NACOSTI	1	10.42	10.42
6	Consultation at Kenya Association of Manufacturers		104. 12	104. 12
7	Data analysis training on SPSS software at Vision Institute		104. 12	104.12
8	Printing of 60 copies of questionnaires • Each copy had 6 pages and printing one page was Ksh 50	60	3.125	187.5
9	Printing of 7 copies of master thesis • Each master thesis has 84 pages and printing one was Ksh 50 • Binding of Master thesis: @ Ksh 200 a copy	7	45.83	320.83
10	Airtime for follow up and internet data bundles	11 Vouchers	10.42	114.58
	Total			**3,182.81**