ENERGY EFFECIENCY AND OPERATIONAL PERFORMANCE OF MANUFACTURING FIRMS IN KENYA.

BY:

PERIS KASAE

D61/72428/2011

A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFULLMENT OF THE MASTER OF BUSINESS ADMINISTRATION, SCHOOL OF BUSINESS, UNIVERSITY OF NAIROBI.

2014

DECLARATION

I declare that this project is my original work and has never been submitted for a degree in any university or college for examination/academic purposes.

Signature..... Date: …….

Peris Wanjiru Kasae

D61/72428/2011

This project proposal has been submitted for examination with my approval as the university supervisor.

Signature..... Date: ……

Dr.XN Iraki

DEDICATION

To my family for the love, understanding, and support in the entire period of pursuing my studies.

ACKNOWLEDGEMENT

I would wish to thank the Almighty God for His guidance, grace, strength and protection He gave me throughout my study. I sincerely want to acknowledge the University of Nairobi for the ample time and resources to successfully accomplish my study. My sincere gratitude goes to my Supervisor Dr XN Iraki for his support and dedication.

I truly acknowledge the efforts of all the lecturers who contributed in expanding my knowledge and skills during my study. Special appreciation goes my classmates; especially Naomi, Gitau and Ann for being part of the team that gave us support to see us through with our work in good time.

Special appreciation also goes to the Kenya Association of manufacturers CEEC team for their invaluable cooperation and willingness to provide information on the energy efficiency program me.

I would also wish to express my greatest appreciation to all my family members and friends for their support and encouragement throughout my study time.

God bless you all.

Table of Contents

ABBREVATIONS

EE Energy Efficiency Measures

CEEC Centre for Energy Efficiency and Conservation

KAM Kenya Association of manufacturers

SEEI Specific Electrical Energy intensity

LIST OF TABLES

ABSTRACT

Energy is a critical input to the social economic development of anynation as well as to the protection of the nation's environment. It fuels to industry, commerce, Transportation, agriculture and other economic activities.

Energy is an essential component for the industrialization process. For a country to industrialize, adequate and affordable energy supply is a pre-requisite. The energy sector mainly comprises of electricity, petroleum and renewable energy (geothermal, wind, solar, biomass).

The purpose of this study was to investigate the relationship between energy efficiency and operation performance in manufacturing firms in Kenya. The target population was 70 manufacturing firms out of 735 manufacturing firms as listed by Kenya Association of Manufacturers with a bias to firms that had conducted energy Audits. Three Key performance indicators to measure operation performance were used namely: Production, Electrical energy consumption and Specific electrical energy intensity (SEEI). Data was analyzed in terms of the baseline data and the current data. The baseline data been the data before implementation of EEMs by the companies while the current data been the data collected in after implementation of EEMs.

The data was analyzed using regression model. To test the relevance of the linear best-fit curve for energy consumption, production and SEEI, the Pearson correlation coefficient for both baseline and current data were examined.

The study established a considerable use of EEMs by manufacturing firms in Kenya with 92% of the targeted firms having implemented EEMS. The study also established a positive relationship between the use of EEMs and operation performance. However, this observation was not conclusive since some companies displayed weak correction coefficients of the variables both at baseline and current level suggesting a need for further analysis.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Energy Efficiency (EE) is broadly defined as decreasing the amount of energy consumed per energy service without substantially affecting the level of these services or simply reducing the amount of energy used to accomplish exactly the same task. (Kenya Association of Manufacturers (KAM), 2006).

Energy efficiency is a key instrument to the social economic development of any nation. The main reasons of energy efficiency includes among others: Saving money through buying energy-efficient appliances, making energy-efficient home improvements, and taking energy-efficient actions every day. Energy efficiency improves the economy through saving money as a result of use of energy efficiency measures, creation of jobs through energy efficient projects e.g. building improvement and infrastructure repairs; it also spurs innovation where industry leaders come up with energy efficient innovations and policies that lead to breakthroughs among manufacturers. E.g. Creation of energy efficient standards. (Abrahamse & Talib, 1998)

Operations performance on the other hand as defined by the business dictionary is Firm's performance measured against standard or prescribed indicators of effectiveness, efficiency, and environmental responsibility such as, cycle time, productivity, waste reduction, and regulatory compliance. (http://www.businessdictionary.com)

Operational performance has become widely accepted as a critical success factor for companies across many industries. It is best described as the level at which all business units in an organization work together to achieve core business goals. From Key to unlocking operational performance, (Greene, 2014) asserts that, unlocking operational performance requires businesses to transform the way they are managed, governed and leveraged throughout the enterprise with the end result being a business with the agility, efficiency and precision to consistently outperform the competition(Greene, 2014)

Energy efficiency through reduction of wastage in terms of electricity and fuel consumption, material usage, use of efficient machinery among others have been seen as key indicators of firms operation performance.

1.1.1 Energy Efficiency and the manufacturing Sector in Kenya

Energy efficiency is a growing policy priority for many countries around the world. It is widely recognized as the most cost-effective and readily available means to address numerous energy-related issues, including energy security, the social and economic impacts of high energy prices and concerns about climate change. At the same time, energy efficiency increases competitiveness and promotes consumer welfare. (International Energy Agency, (ITA), 2014)

Kenya currently generates about 1,762MW of electricity with over 60% of generated energy into the national grid being used by manufacturing enterprise. Energy has been a critical issue to the manufacturers for a long time driving up the costs of production and driving down Kenya's competitiveness. The cost of energy is comparatively high in relation to other countries in the region. For instance in Ethiopia, Egypt and Uganda electricity costs are US cents 3/KWh, 5/KWh and 18.6/KWh respectively. Tanzania had their tariff reviewed recently to US cents 4/KWh from 9/ KWh compared to Kenya's current cost of US cents 18.7/KWh. (KAM, 2014)

The government has shown its commitment to increase the power generation in the country and has promised a total generation of 5000MW by year 2017. The 2014-2015 budget has provided for Ksh. 10 billion for Geothermal power generation development. Energy efficient usage will be a key instrument in the social-economic development of Kenya through improving economic competitiveness, reducing the country's import bill, improving the balance of trade, creation of job, improving security of energy supply among others.

The manufacturing sector in Kenya constitutes70 per cent of the industrial sector contribution to GDP with building, construction and quarrying cumulatively contributing to the remaining 30% per cent. Kenya Vision 2030 identifies the manufacturing sector as one of the key drivers' for realizing a sustained annual GDP growth of 10per cent. However, the sector's contribution to GDP has been on the decline worsening from 9.6 per cent in 2011 to 9.2 percent in 2012, while the growth rate deteriorated from 3.4 per cent in 2011 to 3.1 per cent in 2012.These adverse changes are attributed to among other

things high costs of production, (Kenya Institute for public policy and analysis (KIPPRA) 2013).

The manufacturing sector has high, yet untapped potential to contribute to employment and GDP growth. For example, compared to the agriculture sector, which is greatly limited by land size, the manufacturing sector has high potential in employment creation and poverty alleviation since it is less affected by land size (Bigsten et al., 2010). However, the contribution of the manufacturing sector to GDP has continued to stagnate at about 10 per cent, with contribution to wage employment on a declining trend as depicted in the Kenya economic report (KIPRA, 2013)

A study conducted by CSIRO and Griffith University, (2007) on energy efficiency opportunities revealed that manufacturers are investing in more energy efficient designs for their products. Designing and manufacturing new energy efficient product solutions offers a strategy to gain greater market share while improving brand recognition and customer loyalty. This study revealed that Japan was one of the first governments to help its national corporations gain increased global market share through phasing in higher energy efficiency standards. Japanese Energy Conservation Laws enacted in 1979 set demanding energy efficiency standards for refrigerators, air-conditioning and automobiles, stimulating product improvements that strengthened the international position of Japanese firms in these markets.

This study identified among others the following energy saving opportunities that can be used by the Kenyan manufacturing industries: Improving efficiency of industrial processes, designing more effective catalysts and finding lower energy pathways in industrial processes, using recycled plastics as energy source, recycling of waste in paper and pulp manufacturing, recovering waste heat and using it to generate electricity and through re- manufacturing and recycling products. Re-manufacturing products provides a significant way for the manufacturing sector to reduce its carbon footprint. This is because significantly less energy is required to remanufacture and recycle products and materials than if a new product had to be created from scratch using virgin materials. (CSIRO &Griffith University, 2007)

In Kenya organizations' such as The Kenya Association of Manufacturers (KAM) through its Centre for Energy Efficiency and Conservation (CEEC) have tried to address the issue of high cost of energy in the manufacturing sector by developing energy efficiency measures that manufacturers can adopt to lower their energy consumption. Energy Audit is one tool that is being used by the organization whereby the current consumption of a particular company is assessed, potential areas of energy saving identified and energy saving implementation strategies identified.

The Energy Regulatory Commission (ERC) is committed to addressing the high energy costs by industries through energy efficiency measures as demonstrated by The Energy Management Regulations, 2012 that require among other things that companies carry out energy audit once every three years and implement at least 50% of recommendations (Energy Regulatory Commission (ERC), 2013)

Energy thus is a key factor of production of all manufactured goods. All other parameters being equal, an increase in industry production (output) will generally lead to an increase in energy consumption; one way the manufacturers can reduce this cost is by embracing energy efficiency measures that will not only enhance their cost saving in terms of energy but also through reduced material wastage, reduce carbon emissions, enhanced productivity due to use efficient machinery and improved overall performance of a firm.

1.2 Statement of the problem

Demand for energy worldwide is rising at a fast rate due to increased industrialization worldwide. This has led to energy crisis as well as the rapid depletion of energy resources in many countries. Numerous Empirical studies have been conducted on productive and efficient energy usage especially in developing countries. Nicola (2011) in her contribution to United Nations Industrial Development Organization (UNIDO) 2011 report conducted a study on energy efficiency in developing countries where she studied the firm-level data in 24 developing countries to examine among others the determinants of energy efficiency in the developing countries and the link between energy efficiency and profitability in developing countries. (Nicola, 2011)

Recent research contributions focus on the benefits derived from energy efficiency, especially from a macroeconomic perspective. Research contribution by Taylor et al

(2008), Semboya (1994), United Nations Development Program me (UNDP) 2006), McKaneet (2007), and International Energy Agency,(IEA), 2009) recognizes that energy efficiency would lead to among other things : More economic output without requiring additional energy supply at both firm and national level, economic competitiveness (through lower prices) at national and firm-level, Creation of jobs, improvement of livelihoods, energy supply and price security and reduced uncertainty, environmental sustainability and reduced import bill nationally . (Nicola, 2011)

KAM has also conducted a study on lowering energy cost in Kenya where Energy Efficiency technologies such as high Efficiency lighting, high efficiency motors, co-generation, high efficient boilers and use of recycled materials were identified as available to manufacturers. Studies have been conducted relating to alternative sources of energy in Kenya E.g. Biomass Energy use in Kenya 2010 (Practical Action) Low carbon competitiveness in Kenya 2013 (Karen et al), Lowering Energy costs 2006 (GEF-KAM Energy efficiency project) and Energy Consumption patterns in Kenya (KIPPRA, 2010) .

This study will build on other studies that have been conducted to determine the impact of energy efficiency technologies on electrical energy consumption and on production and will also assess the challenges the Kenyan manufacturing sector is facing while trying to embrace energy efficiency.

This study will seek to answer the following questions.

1. Are there any energy efficiency measures (EEMs) being adopted by the manufacturing industries in Kenya?

2. Has the use of EEMs if any led to any operation performance improvements in terms reduced electrical consumption and increased production of selected manufacturing firms Kenya?

1.3 Objective of the study

The objectives of the study are:

1. To establish the extent of the use of energy efficiency technologies in manufacturing firms in Kenya

2. To establish the relationship between energy efficiency and operational performance in the manufacturing firms in Kenya.

1.4 Value of the study.

The study will strengthen the manufacturing firms by providing information on energy efficiency models and how they can embrace them to gain a competitive edge both at a local and global level.

The study will also provide information that can be used by the government of Kenya and other stakeholders in knowing areas that they can support the manufacturers in embracing energy efficiency. The study will also help scholars to improve their literature on Energy efficiency in manufacturing sector and provide further guidance in filling in the gaps on further studies.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter summarizes the studies from other researchers on the same field of study. The specific areas covered here are energy efficiency in developing countries, energy efficiency in manufacturing industries, energy efficiency opportunities in manufacturing industries, an overview of energy efficiency and operations and a chapter summary.

2.2 Energy Efficiency in Developing Countries

Generally, energy efficiency is a concern to all countries since energy is a major component of both domestic and international budgets.

(U.S. Congress, Office of Technology Assessment, (OTA), 1991) asserts that, energy use in developing countries has risen more than fourfold over the past three decades and is expected to continue increasing rapidly in the future. The rising energy demand has contributed to the upward pressures on world oil prices and also partly to the high levels of indebtedness in the developing countries. This study also concludes that, the rapid increases in fossil fuel use in these countries represent a growing contribution to the increase in local and regional air pollution a well as atmospheric concentrations of greenhouse gases such as carbon dioxide. (OTA, 1991).

The IEA's 2008 World Energy Outlook reference scenario estimates world primary energy demand to grow by 1.6 percent per year on average between 2006 and 2030 for an overall increase of 45 percent. The majority of this growth will be in developing countries, 87 percent of the projected increase in demand will take place in non-OECD countries, 50 percent of total demand will come from China and India. (UNIDO), 2011).

The McKinsey Global Institute finds that 65 percent of all available positive return opportunities for investment in energy efficiency are located in developing regions (Farrell & Remes, 2009). An estimated investment of US$ 90 billion in the next twelve years could save these developing countries $600 billion annually by 2020 in energy savings. This $90 billion is projected to be only half of the required investment to keep up with energy demand growth. (Diana, & Jaana , 2008).

After studying different reports and studies of different research and international organizations, UNIDO through their study on energy efficiency in developing countries found that energy efficiency leads to a decreasing intensity in energy overtime but this result widely differ among countries. They found a negative trend was identified in Europe, North America and China while this is not the case in Africa, Latin America, India and Middle East. This shows that, it's not clear whether there's a positive or a negative relationship on the level of energy intensity on country's economic growth. This study will try to address this lack of consensus. (UNIDO, 2011)

2.3 Energy Efficiency in the manufacturing Sector

The manufacturing sector in many countries is in a state of transition. Growing in emerging economies, shrinking but becoming more productive in advanced economies. Some manufacturers compete on cost while others prefer to compete on technology and innovation. Lean manufacturing techniques which control costs and improve quality are pervasive. (Chartered Institute of management Accountant, CIMA, (2010).

(Susan et al, 2011) in their study on the demand for energy in the manufacturing sector revealed that, the Kenyan manufacturing sector is the third largest energy end user in the economy. It's the second largest user of petroleum products, after the transport sector, and the largest consumer of electricity. According to their study, most manufacturing activity is concentrated around the three major urban centers in Kenya: Nairobi, Mombasa, and Kisumu. The major sub-sectors within the manufacturing sector include food processing, paper production, textile and apparels, pharmaceutical and medical equipment, building construction and mining, and chemical and chemical-related industries. (Susan et al, 2011)

The authors also indicate that, most of the above manufacturing processes use industrial diesel oil and fuel oil for their thermal energy requirements. Electricity is also widely used for drying, grading, and packing while a significant fraction mostly in food processing relies on wood fuel. The supply of electricity to the sector is commonly rationed, especially during the dry season since most of the country's electricity is hydro-based. Leading to losses in terms of production, sales and damaged equipments (Susan et al, 2011)

The cost of this electricity is high and volatile depending on changes in international oil prices. (Susan et al, 2011). This highly contributes to the high cost of doing business in Kenya making the country uncompetitive in the global market. There is therefore, need to mitigate costs of production through reduced energy costs as well as enhanced investments in alternative energy sources, including geothermal, wind and solar energy.

2.4 Opportunities for Energy Efficiency in manufacturing industries.

This part reviews areas which other researchers have identified as energy saving opportunities for manufacturing industries.

Reducing energy usage through energy efficiency offers an economic bonanza for business because saving fossil fuel is a lot cheaper than buying it. Since the early 1990s, The Climate group's reports have shown that major manufacturers like Dupont, IBM, Alcan, and Bayer have collectively saved billions of dollars while reducing their carbon emissions by more than 60 percent. (Michael & David, 2005)

A study conducted by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) & Griffith University,(2007) on energy efficiency opportunities revealed that manufacturers are investing in more energy efficient designs for their products. Designing and manufacturing new energy efficient product solutions offers a strategy to gain greater market share while improving brand recognition and customer loyalty. This study revealed that Japan was one of the first governments to help its national corporations gain increased global market share through phasing in higher energy efficiency standards. Japanese Energy Conservation Laws enacted in 1979 set demanding energy efficiency standards for refrigerators, air-conditioning and automobiles, stimulating product improvements that strengthened the international position of Japanese firms in these markets. (CSIRO & Griffith University, 2007)

The KAM study on lowering energy cost revealed a number of technologies that firms can adopt to save energy cost as stipulated in table 1.0 below:

Energy Using System	Energy Efficiency opportunities Available
Electrical Systems	High efficiency lighting
	High efficiency motors
	Power factor correction
	Correct Choice of motor size
	Correct wiring to keep internal distribution losses low
	Electrical power demand regulation
	Variable speed drives
	High internal power quality maintained through control of harmonics
	Automation

Source KAM, Lowering Energy Cost, 2006

Other technologies that are available to firms to reducing their energy costs include use of Biomass, solar, wind, hydro and geothermal energy.

2.2.4 Operation Performance

Healthy revenue and profit margin are crucial to any company's success and sustainability. It's therefore important that companies determine the factors in their operations that are critical to the overall success of their business. e.g the efficiency of the supply chains, the labour productivity, efficiency of machinery, energy usage etc. They should be able to measure those metrics and put in place a system for continually improving performance.

Performance indicators in an energy using unit includes: Electrical consumption, energy intensity, and productivity and carbon emission. (Nicola, 2011)

Electrical consumption is the amount of the amount of electrical power usage as measured by kwh, electrical energy intensity is level ratio of electrical consumption per unit production while productivity can be referred to as the level of output.

Electrical energy cost may be reduced by either reducing the energy consumption (kWh) while maintaining the same production or maintaining same consumption while increasing the production or changing both production and consumption in unequal proportions. In each scenario, the resulting electrical energy intensity (SEEI) should be lower than the original. (Nicola, 2011)

2.2.5 Energy Efficiency and Operation performance

Energy is one of the key factors of production especially in manufacturing industries and is seen to be among the top cost pressures in these industries. Energy prices are also on the rise and its supply is restrained in most countries globally. Manufacturers' response to this tightened energy market will determine their business performance and profitability.

ARC advisory Group (2009) in their review of Sustainable Energy Management and Energy Efficiency for Industrial, Commercial, Municipal and Manufacturing Operations asserts that, manufacturing and infrastructure operations are highly dependent upon today's low energy costs in order to remain profitable. Energy conservation and energy independence are also regarded among the foremost leading business strategies for creating a competitive advantage. Many companies are realizing that a corporate focus on energy management is essential to address social, economic, environmental concerns as well as minimizing risk. This study by ARC advisory group points that energy efficiency programs are among the most economical options to increase profitability. (ARC advisory Group , 2009)

2.3 Empirical Review

The UNIDO (2011) report on energy efficiency in the developing countries manufacturing industries, Nicola Cantore concluded that in 23 out of the 24 firms investigated, there was a strong negative correlation between energy intensity and total factor of productivity, meaning that most innovative firms were those showing the lowest level of energy intensity. The study also revealed that 27 countries that lowered level of energy intensity experienced increased profitability and in 13 countries the relationship was significant at 0.05 significance level .Only for 2 countries the study found a positive but not significant coefficient expressing the relationship between energy intensity and

profitability. This study also observed that management and organization factors especially matter in explaining future choices of firms in developing countries to invest in energy efficiency rather macroeconomic factors. Moreover firms that already invested in energy efficiency are more likely to do it again in the future. (Nicola, 2011)

Studies have also been conducted to analyze the cost effectiveness of utility energy efficiency programs such as rebates, tax incentives, and low-cost loans. Arimura et al. (2012), Auffhammer, et al (2008) and Loughran & Kulick ,(2004) generally find that the cost per kilowatt hour saved is greater than the low cost estimates by utilities and advocates. However, Auffhammer, et al (2008) and Arimura (2012) find that the differences between their estimates of cost effectiveness and those reported by utilities are not statistically significant. Rivers & Jaccard (2011) find that energy efficiency program spending had no effect on electricity demand growth in Canada. (Kenneth et al 2009)

The McKinsey Global Institute finds that 65 percent of all available positive return opportunities for investment in energy efficiency are located in developing regions (Farrell & Remes, 2009). An estimated investment of US$ 90 billion in the next twelve years could save these developing countries $600 billion annually by 2020 in energy savings. This investment of $90 billion is projected to be only half of the required investment to keep up with energy demand growth without improved efficiency measures. Industrial efficiency improvements to produce more economic output with less energy input is essential for reasons of energy supply security, economic competitiveness through improved industry profitability, improvement in livelihoods, and environmental sustainability (Taylor et al, 2008).

2.4 Summary of Literature review.

The literature review shows that, energy has become a major concern for both industrialized and developing countries. The rising demand of energy as a result of industrialization has brought forth other concerns such as increasing price of energy prices globally, environmental degradation such as air pollution a well as atmospheric concentrations of greenhouse gases such as carbon dioxide (CO2). The high levels of energy costs have increased cost of production in industries and even seeing

manufacturers shy away from investing in countries with relatively higher energy costs.

To address these concerns, the manufacturing sector being one of the main energy users must embrace energy efficient opportunities that would enhance their operational performance through reducing overall energy wastage, reducing production cost, reduce material wastage, reducing carbon footprint among others.

2.5 Knowledge gap.

Most of the studies conducted take a broad view on energy efficiency technologies worldwide.

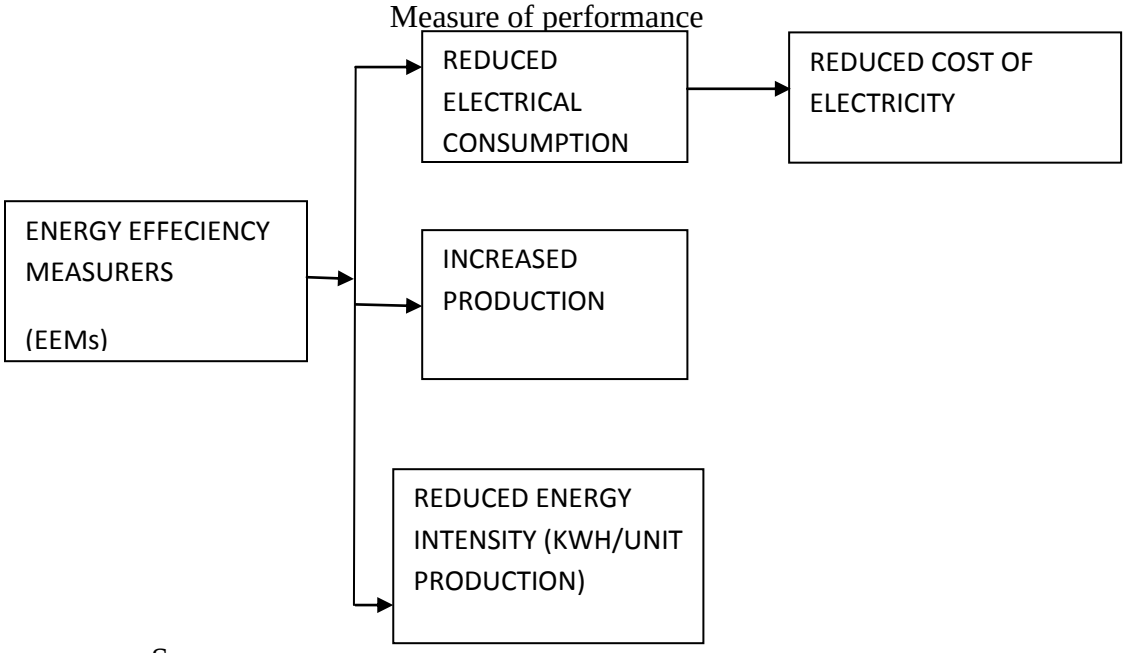
The UNIDO report study however is very instrumental as it has a specific focus on energy efficiency developing countries and the specific parameters measured will be used in this study.

The study conducted by KAM in developing a guide to energy efficiency is specific to the Kenyan energy efficiency scenario. However, it looks at the broader view of energy efficiency such as energy efficient technologies available to commercial enterprises, energy efficiency improvement processes, accessing viability of energy efficiency technology and financing of viable technologies, implementation of an energy efficiency project and training on energy efficiency.

This study will attempt to establish the energy efficiency technologies available to manufacturing industries in Kenya and also the relationship between energy efficiency and operational performance in these manufacturing industries in both at firm level and National level.

2.6 Conceptual Framework.

Measure of performance



Source, own

Electrical energy cost may be reduced by either reducing the energy consumption (kWh) while maintaining the same production or maintaining same consumption while increasing the production or changing both production and consumption in unequal proportions. In each scenario, the resulting electrical energy intensity (SEEI) should be lower than the original.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research design. It discusses the population of the study, sample and sampling techniques, data collection method as well as data analysis and data presentation methods employed in the study.

3.2 Research Design

The study was descriptive in nature as it tried to demonstrate the relationship between the variables been tested. Bickman and Rog (1998) assert that descriptive studies are usually the best methods for collecting information that will demonstrate relationships and describe the world as it exists. These types of studies are often done before an experiment to know what specific things to manipulate and include in an experiment. (Bickman and Rog ,1998)

This design has also been widely used in similar studies E.g Nicola (2011), in her research on energy efficiency in developing countries and the U.S (National Association of Manufacturers (NAM), 2002) in their study on Efficiency and Innovation In U.S. Manufacturing industries.

3.3 Population

In line with the subject matter of the study, the target population of the study was all the manufacturing firms in Kenya as listed in the KAM directory 2013.There are 735 companies listed under KAM 2013 directory grouped into 14 different sectors.

3.4 Sampling Design

The study used a purposive non- probabilistic sampling design since the sample consisted of a predefined group of firms that have conducted energy audit. Data was collected from 70 firms out of the 735 in the selected population.

Questionnaires were given to the technical person in charge of energy in each firm.

3.5 Data Collection

The study used mostly secondary data sources that have been documented by KAM and from financial reports of the studied manufacturing firms. Secondary sources are more cost effective provides more detailed data suitable for this study. Data on energy efficiency conservation measures, energy consumption pattern and energy savings by the

different firms were collected from different reports by KAM including their Energy management Awards Assessment tools.

Primary data was collected using structured questionnaires .These questionnaires were then directed to the factory managers or operation managers or their representatives for each target entity. The questionnaires were administered through email and drop-and-pick later method. The questionnaires were adequately prepared to provide for both open and closed ended questions in order to capture the objectives of the study

3.6 Data Analysis.

To determine energy efficiency technologies opportunities being adopted manufacturers, the data collected on energy efficiency measures implemented by the sampled companies was analyzed, interpreted and broken down into various categories sing the guide below.

Energy Efficiency Measure (EEM)	Number of Companies implementing
High efficiency lighting	
High efficiency motors	
Power factor correction	
Correct Choice of motor size	
Correct wiring to keep internal distribution losses low	
Electrical power demand regulation	
Variable speed drives	
High internal power quality maintained through control of harmonics	
Automation	
Others (Specify)	

To determine the impact of energy efficiency on performance, electrical consumption, production and specific electrical energy intensity (SEEI) were used as key performance indicators. The year in which a company was audited before implementation of EEMs was used as the base while the current year was the year of review after implementation

of EEMs.

s/no	organization	Baseline Year			Current Year		
		Production (ton)	Electricity consumption (kwh)	Average annual specific electric energy (kwh/production)	Production (ton)	Electricity consumption (kwh	Average annual specific electric energy

It was assumed that there would be a linear relationship between electrical energy consumption and production i.e. energy consumption would increase linearly with production as depicted in fig 1 and Fig 2 below. Linear regression was used to test this relationship where the Pearson correlation coefficient was determined for both the base year and the current year. Positive correlation coefficient was expected. The same test was conducted for electrical energy intensity vs production.

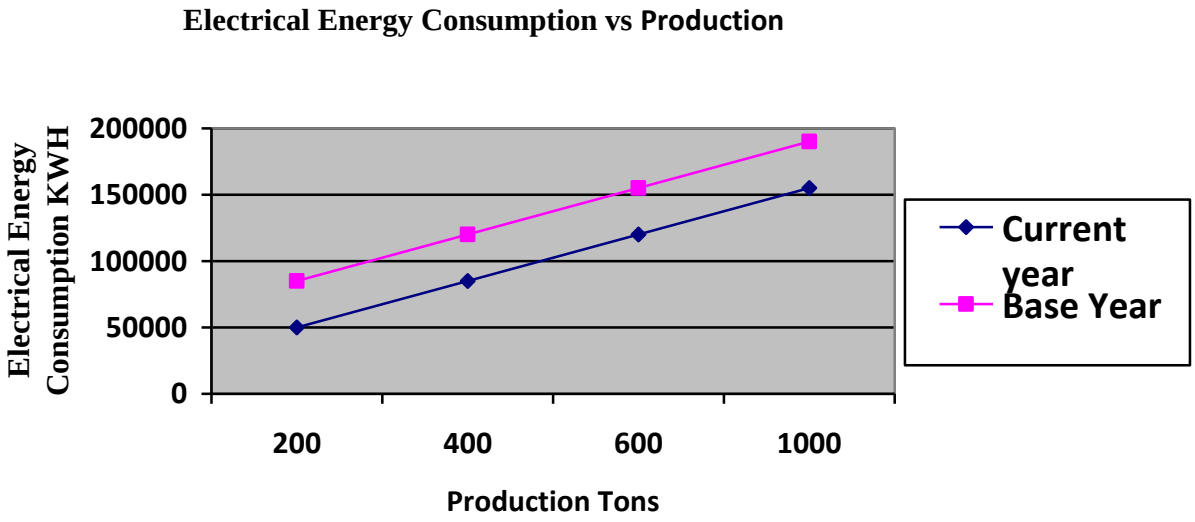


Fig 1

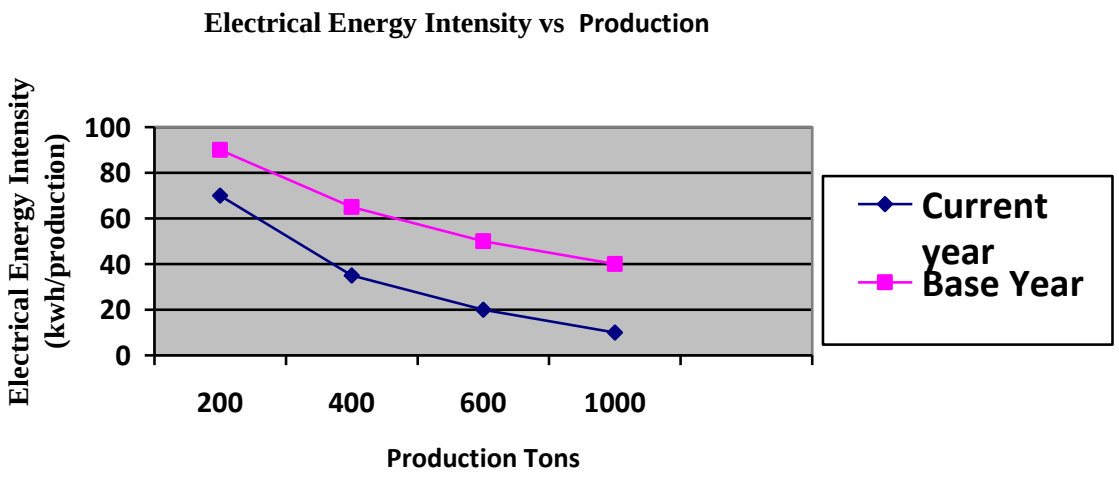


Fig 2

The correlation coefficient r will then be determined using the formulae

$$r = \frac{\sum_i (x_i - \overline{x})(y_i - \overline{y})}{\sqrt{\sum_i (x_i - \overline{x})^2} \sqrt{\sum_i (y_i - \overline{y})^2}}$$

Where r was 0.7 or higher, it signified a strong correlation and that the data is reliable, if it was between 0.5-0.7, it meant there was need to improve the data quality and if r is below 0.5, the correlation is weak and the credibility of the daba is in doubt.

To determine the extent of electrical energy cost savings, a comparison between the base year and the current year was be done.

Cost savings= Baseline cost (kes) - Current Cost (kes)

CHAPTER FOUR: DATA ANALYSIS, FINDINGS AND DISCUSSION

4.1 Introduction.

This chapter presents the research findings and discussions. The findings were analyzed in accordance with the objectives of the study which is to:

To establish the use of energy efficiency technologies in manufacturing firms in Kenya

To establish the relationship between energy efficiency and operational performance in the manufacturing firms in Kenya.

The researcher obtained data provided by KAM on energy consumption patterns and energy saving technologies of the selected companies which had been gathered during follow ups on companies in which have done energy Audits. The researcher also issued 70 questionnaires each to the respective companies in order to verify the accuracy of the documented information. However only 36 were fully completed and returned for analysis. The response rate was 51%

The following are presentations of data collected their analysis and discussions arising thereof.

4.2 Electrical Energy Efficiency Measures being employed by the firms.

The following EEM were found to be implemented by most of the firms

Energy Efficiency Measure	Percentage
Installation of translucent roofing sheets	28%
Replacement of 250 W high pressure sodium lamps with 125 W	36%
Replacement of HPMV (400 W) lamps with CFL (200 W) energy saving lamps	36%
Replacement of high pressure mercury vapour lamps with mercury halide lamps	19%

Replacement of electromagnetic ballasts with electronic ballasts	14%
Use of CFLs and LED lamps in offices and other areas	78%
De-lamping	56%
Lighting switch separation - zone lights switching	83%
Regular cleaning of light diffusers and reflectors to improve illumination	69%
Installed auto control; photo sensors and/or timer switches for security lighting	14%
Task lighting	56%
Staff sensitization to switch off unnecessary lights	92%
Energy saving advocacy through memos/posters posted on notice boards informing staff members on how to save energy. Some highlight the benefits and how they affect the reader.	56%

Table 1.1 Energy Efficiency Measures adapted

The table shows that 92% of the companies that had implemented EEMS had their staff sensitized to switch off the lights while not in use and 83% of the companies having lighting switch separation so that light can only be switched on in the zones where it's been used to avoid wastage. It also shows that the use of electronic ballasts as opposed to electromagnetic ballasts and the use of auto control switches for security lighting were not widely adapted with only 14% of the companies adapting the same these technologies.

Savings in electrical energy consumption should be evidenced by decrease in specific energy intensity. This intensity is not constant but varies with production. Therefore to

assess the impact of implementation of energy efficiency measures, the monthly average baseline and current energy intensities were compared.

4.4 Comparison of Baseline And Current

S/n	Organization	Baseline (Audit)				Current Year		
		Average Monthly				Average Monthly		
		Production	Electricity	Average Annual SEE (Kwh/unit production)		Production	Electricity	Average Annual SEE (Kwh/unit production)
1	ASP	861 ton	210,000	274		85 ton	63,786	747
2	ARM, Kaloleni	21,3051 ton	901,667	113		26,621.2 ton	2,518,675	95
3	Corn Products	4,144 ton	860,833	208		3,385 ton	804,999	238
4	Dawa Ltd	45.5 ton	35,991	791		97 ton	42,378	436
5	Eveready EA	9,888,076 pcs	349,293	353		4,923,083 pcs	4,923	39
6	Friendship Container4	156 ton	136,667	875		184 ton	144,236	784
7	Glaxo SK	815 ton	248,250	302		479 ton	279,188	583
8	MRM, Nairobi	2,121 ton	139,846	66		2,596 ton	162,786	63
9	Pwani Oil Products	9,994 ton	578,750	58		7,972 ton	594,444	75
10	PZ Cussons EA	655 ton	194,359	297		626 ton	133,660	220
11	Sarova Stanley	60% occupancy	164,710	48		80% occupancy	177,307	35
12	Sarova Whitesands	65% occupancy	275,975	44		84% occupancy	367,495	42
13	Sony Sugar5	5,402 ton	1,949,545	340		5,304 ton	2,002,671	378
14	Dodhia Packaging	1,125 ton	117,600	91		1,441 ton	115,483	80
15	Insteel	1,859 ton	228,035	121		2,033 ton	228,443	112
16	KimFay E.A Ltd7	293 ton	20,448	70		255 ton	56,350	221

17	Saj Ceramics	198,673 m2	477,500	2.3		226,596 m2	512,463	2.3
28	Sarova Panafric	68 % occupancy	96,892	28		75 % occupancy	99,069	26
19	Thika Cloth Mills	366,092 m	488,196	1.3		424,730 m	462,872	1.2
20	Metsec	317,500 km	115,049	0.03		Incomplete data8	97,828	ND
21	ARM, Nairobi	ND	583,000	ND		11,0379 ton	558,392	51
22	Kenafric Confectionaries	ND	ND	ND		2,022 ton	335,346	168
23	Kenafric - Footwear	ND	468,073	ND		1,509,000 pairs	569,308	3863
24	Ombi Rubber Rollers	ND	4,346	ND		2,091 ton	5,073	2.4
25	Tarpo Industries	ND	9,847	ND		759 pcs	4,471	6
26	Banbros	26 buses	19,990	784		ND	ND	ND
27	Blowplast12	ND	ND	ND		63 ton	748,987	15
28	Brookside Dairy	ND	ND	ND		8,118 ton	711,830	88
29	C&P Shoe Industries	296 ton	344,454	1,170		ND	ND	ND
30	Dune Packaging	104 ton	112,250	1,079		ND	ND	ND
31	KVM	ND	53,417	ND		71 vehicles	52,661	684
32	Nairobi Plastics	412 ton	381,295	924		ND	439,962	ND
33	Rodwell13	3,437,000 impressions	16,167	4.83		ND	41,915	ND
34	Allpack	1,604 ton	254,747	172		ND	284,153	ND
35	Crown Berger	449,804 l	56,394	0.13		1,144,317 l	61,041	0.05
36	Kapa Oil Ref	11,640 ton	1,619,167	139		18,863 ton	1,989,630	105

Table 2.1

The last three organizations did not implement EEMs. The baseline and the current data above on the KPI were then analyzed in Table 2.2 in terms of percentage change.

Table 2.2 shows the percentage changes in the KPI. The baseline being the reference value. Where there are dashes, either the baseline, the current data or both were not available. Negative signs with respect to electrical consumption and production shows decrease to the annual average values while negative signs with respect to SEEI indicates an increase in the annual average value.

Percentage change in electrical KPI

S/no.	Organization	Percentage (%) increase in average monthly		
		Production	Electricity consumption	Percentage (%) decrease in annual average SEEI
1	ASP	-90	-70	-173
2	Athi River Mining – Kaloleni	25	179	16
3	Corn Products Kenya Ltd	-18	-6	-14
4	Dawa Ltd	114	18	45
5	Eveready East Africa	-50	-99	-11
6	Friendship Container Manufacturers	18	6	10
7	Glaxo Smithkline	-41	12	-93
8	Metsec	-99	-15	-
9	Mabati Rolling Mills – Nairobi	22	16	5
10	Pwani Oil Products	-20	3	-29
11	PZ Cussons EA Ltd	-4	-31	26
12	Sarova Stanley Hotel	33	8	27
13	Sarova Whitesands Beach Resort	29	33	4
14	Sony Sugar	-2	3	-11
15	Dodhia Packaging	28	-2	12
16	Insteel Ltd	9	0	7
17	KimFay E.A Ltd	-13	176	-216
18	Saj Ceramics	14	7	3
19	Sarova Panafric Hotel	10	2	6
20	Thika Cloth Mills	16	-5	8

21	Athi River Mining – Nairobi	-	-4	-
22	Kenafric Industries – Confectionaries	-	-	-
23	Kenafric Industries – Footwear	-	22	-
24	Ombi Rubber Rollers	-	17	-
25	Tarpo Industries	-	-55	-
26	Banbros	-	-	-
27	Blowplast	-	-	-
28	Brookside Dairy	0	-	-
29	C&P Shoe Industries Ltd	-	-	-
30	Dune Packaging	-	-	-
31	KVM	-	-1	-
32	Nairobi Plastics Ltd	-	15	-
33	Rodwell	-	159	-
34	Allpack Industries	-	12	-
35	Crown Berger	154	8	26
36	Kapa Oil Refineries	62	23	24

Table 2.2 % change in KPI

It can be noted that, Crown Berger and Dawa limited recorded the largest increase in production at 154% and 114% respectively. The increase in average monthly electricity consumption is however moderate at 8% and 18% respectively. This could be highly attributed to the use of EMS. Athi River- Kaloleni recorded the largest increase in average monthly electricity consumption followed closely by Kimfay and Rodwell press. However, Kimfay and Rodwell Press metered jointly with their sister companies Count on Us and Interlabels respectively. The production data for these sister companies was not available and this could explain why the electrical consumption was high relative to production. 64% of the companies whose all the data was available showed electrical consumption increased at a lower proportion with increase in production or reduced at a higher proportion with reduction in production, This demonstrates that the use of EEMs enhanced electrical consumption saving.

Of the 21 organizations where SEEI could be determined, only 8 companies recorded a significant decrease in SEEI of 10% and above while 6 companies recorded 10 % and less. In total, about 67% of the companies recorded a decrease in SEEI while the rest

recorded an increase. This demonstrates that SEEI which the proportion of electrical consumption in kwh in relation to production decreases with the use of EEMs.

4.5 Comparison of baseline And Current Monthly SEEI

A decrease in annual SEEI does not necessarily mean improvement in energy consumption. Therefore there's need to compare the monthly average specific electrical energy intensity for baseline and current year to deduce the impact of EEMs.

To test the relevance of the linear best-fit curve for energy consumption-production, the Pearson correlation coefficient for both the baseline and current data were examined. A positive linear relationship between electrical energy consumption and production was assumed i.e. energy consumption increases linearly with production and therefore positive correlation coefficients are expected. If the correlation coefficient is 0.7 or higher, it signifies strong correlation and the data is reliable. If correlation is between 0.5-0.7, it means that there is need to improve energy monitoring (data quality) and product definition, and improve consumption by operational control to attain and sustain the standard energy performance. For coefficients below 0.5, the correlation is weak and the credibility of the data is in doubt.

Figure 3,4 and 5 shows the variation of monthly average SEEI with production for organizations whose specific intensity improved for all levels of production. The Pearson correlation coefficients for the best-fit curves for current and baseline data samples rC and rB, respectively are also given.

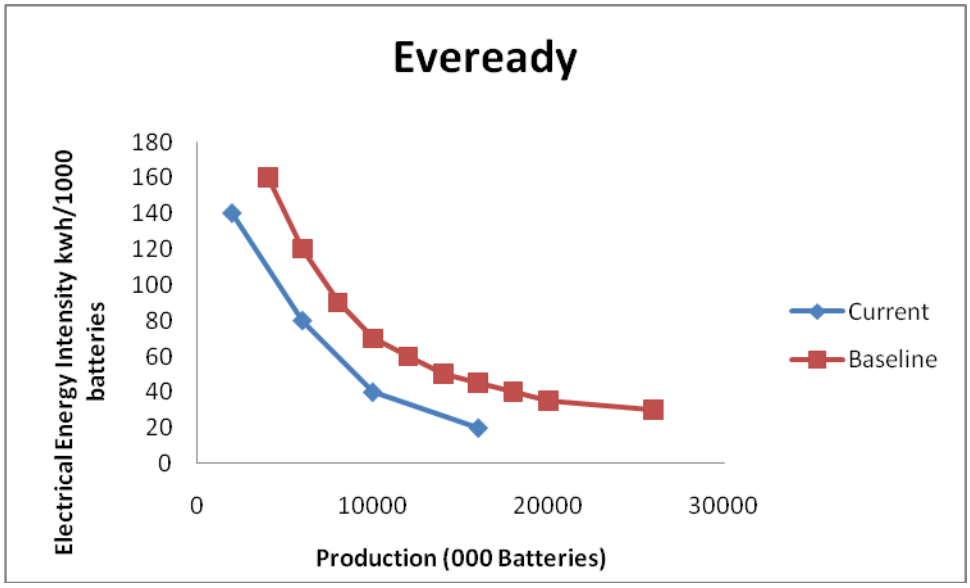


Fig 3

(a) Eveready East Africa Ltd yB = 5701.4x-0.5551, yC = 7989.1x-0.6239
(rC = 0.92; rB = 0.69)

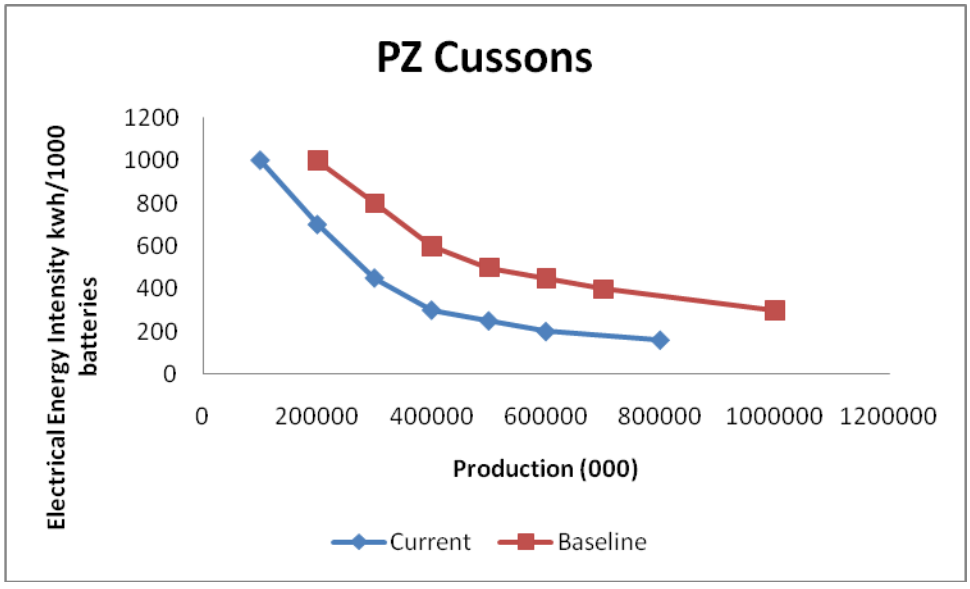


Fig 4
(b) PZ Cussons East Africa Ltd. yB = 4298.7x-0.4111, yC = 3273x-0.4229
(rC = 0.96; rB = 0.83)

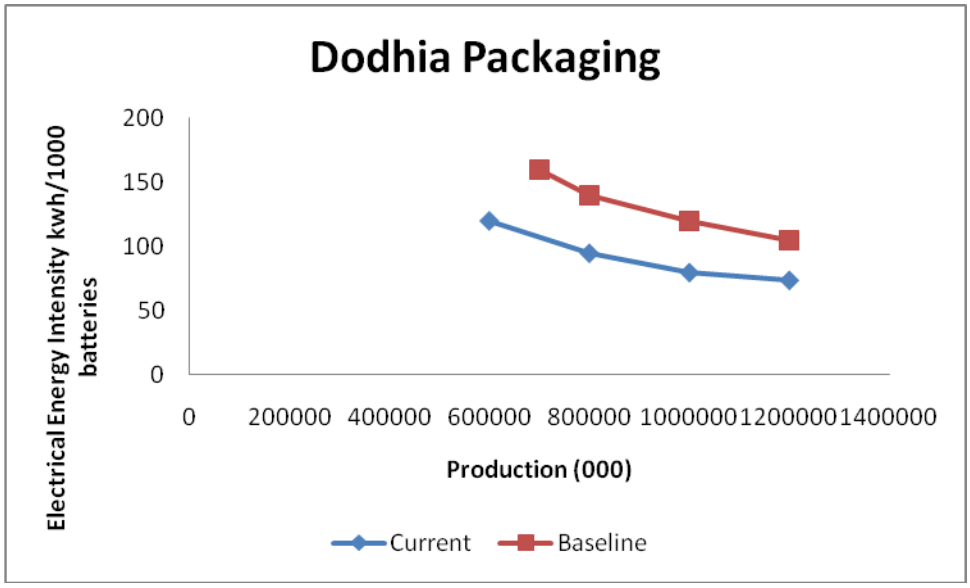


Fig 5

(c) Dodhia Packing Ltd. yB = 12108x--0.6824, yC = 6846.4x--0.6122,
(rC = 0.24; rB = 0.55),

It can be observed from the above that whatever lever of production, the specific electrical intensity is lower than the baseline SEEI. This signifies a reduction in electrical consumption. For Dodhia packaging, the correlation between production and electricity consumption is very weak and thus the accuracy of the data is in doubt.

4.6. Comparison between Electrical Energy Consumption and Production

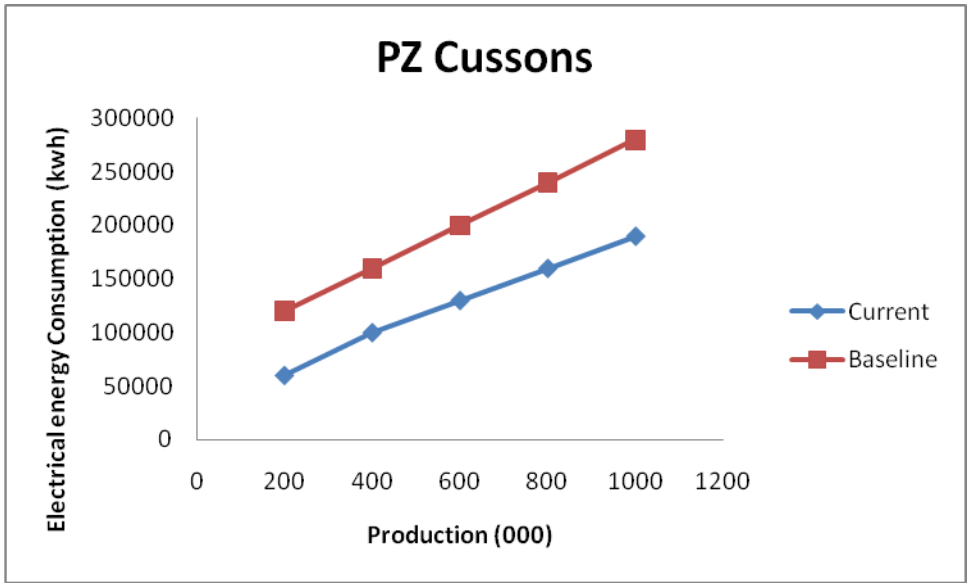


Fig 6

yB = 166.79x + 85193, yC = 126.65x + 54292

It can be seen from the figure that both the current base load (y-intercept), which is an indication of energy consumption by processes that do not contribute to production, and the incremental consumption (gradient) are lower than those recorded for the baseline. Eveready and Dodhia Packaging displayed a similar scenario.

For Eveready and PZ Cussons, the production and electricity consumption decreased. However, the annual average SEEI for Eveready increased whereas that for PZ Cussons decreased. This discrepancy is due to the fact that Eveready reduced production thus, operating on the high end of the intensity curve whereas PZ Cussons marginally reduced (4%) her production. Hence, spread of production remained very nearly the same as baseline, but at a lower specific intensity.

Figure 9.0 shows the variation of average monthly SEEI with production, for organizations whose specific intensity improved for high production levels only.

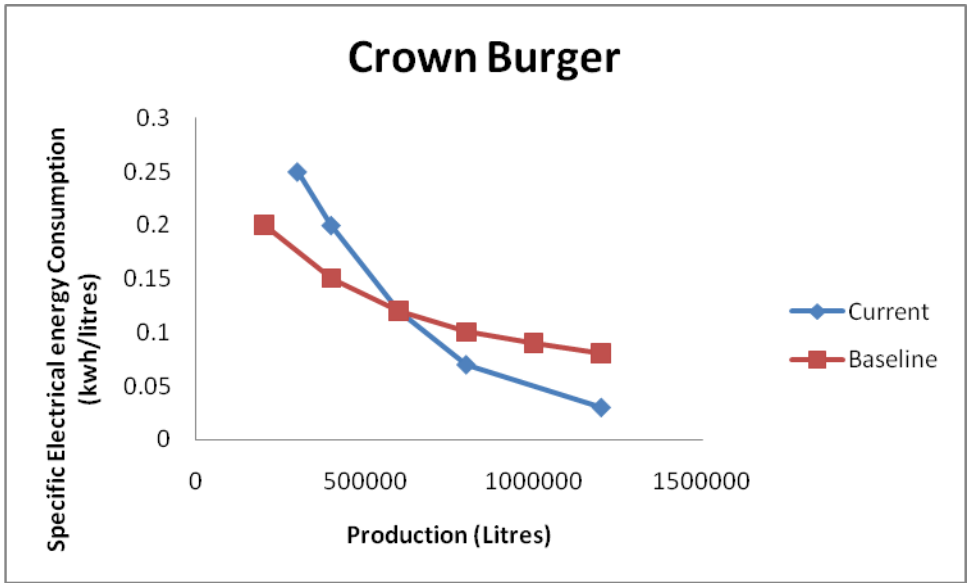


Fig 7

yB = 330.04x-0.608, yC = 196667x-1.0857

(a) Crown Berger (rC = -0.005; rB = 0.71)

Fig 8

yB = 3.8697x-0.0831, yC = 89387x-0.8648

(c) Thika Cloth Mill (rC = 0.16; rB = 0.96)

The specific intensities for these organizations improved for high production but for low production, the baseline operation gave better intensities. This may result if the base load increases but the incremental consumption decreases.

It is notable that the correlation between production and electricity consumption for the

current data is very weak in both cases. The correlation coefficient for Crown Berger indicates that the two variables are almost independent of each other. This is contrary to common knowledge that consumption increases with increase in production

4.7 Electrical Energy And Cost Savings

Below is a Summary of electrical energy savings and investment costs

S/n	Orgarnization	Electrical Energy saved annually (kwh)	Energy Cost savings (ksh)	Total investments cost (ksh)	Simple payback (years)
1	ASP	18,615.00	182,702.00	204,890.00	1.12
2	Athi River Mining - Kaloleni	1,305,520.00	17,019,977.00	1,935,000.00	0.11
3	Corn Products Kenya Ltd	-	-	187,140,014.00	-
4	Dawa Ltd	120,000.00	2,620,000.00	11,500,000.00	4.39
5	Eveready East Africa	238,410.00	7,855,120.00	16,054,985.00	2.04
6	Friendship Container Manufacturers	6,717.00	105,952.00	55,000.00	0.52
7	Glaxo Smithkline	380,812.00	10,212,113.00	35,450,000.00	3.47
8	Metsec	153,534.00	2,423,438.00	257,788.00	0.11
9	Mabati Rolling Mills - Nairobi	546,696.00	8,076,940.00	74,532,800.00	9.23
10	Pwani Oil Products	93,260.00	1,146,869.00	3,008,000.00	2.62
11	PZ Cussons EA Ltd	260,638.00	3,107,404.00	12,150,000.00	3.91
12	Sarova Stanley Hotel	200,000.00	3,055,035.00	1,320,000.00	0.43
13	Sarova Whitesands Beach Resort	735,100.00	9,581,029.00	8,415,000.00	0.88

14	Sony Sugar	180,096.00	2,832,281.00	3,542,569.00	1.25
15	Dodhia Packaging	ND	-	380,000.00	-
16	Insteel Ltd	18,647.00	273,862.00	ND	-
17	KimFay E.A Ltd	ND	-	ND	-
18	Saj Ceramics	ND	-	ND	-
19	Sarova Panafric Hotel	ND	-	1,010,000.00	-
20	Thika Cloth Mills	1,220,608.00	15,854,066.00	ND	-
21	Athi River Mining – Nairobi	2,500.00	35,581.00	45,000.00	1.26
22	Kenafric Industries - Confectionaries	503,256.00	6,522,134.00	28,000,000.00	4.29
23	Kenafric Industries - Footwea	1,956,048.00	25,600,331.00	3,675,720.00	0.14
24	Ombi Rubber Rollers	6,384.00	107,677.00	31,650.00	0.29
25	Tarpo Industries	16,354.00	268,513.00	232,000.00	0.86
26	Banbros	ND	-	ND	-
27	Blowplast	ND	-	ND	-
28	Brookside Dairy	ND	-	ND	-
29	C&P Shoe Industries Ltd	ND	-	ND	-
30	Dune Packaging	ND	-	ND	-
31	KVM	No records	-	1,362,634.00	-
32	Nairobi Plastics Ltd	ND	-	11,000,000.00	-
33	Rodwell	189,187.00	3,007,286.00	3,258,700.00	1.08
34	Allpack Industries	-	-	-	-
35	Crown Berger	-	-	-	-
36	Kapa Oil Refineries	-	-	-	-
	Totals	**6,913,127.00**	**103,760,382.00**	**205,540,502**	

Table 3.1: Electrical energy cost and cost savings

From the table, it can be seen that the collective investment in energy efficiency projects for 19 organizations is about Ksh.205.5 million, yielding annual energy savings of nearly 7 million kWh, with a corresponding savings in energy costs total nearly Ksh.104 million. It can be observed that for most organizations (63%), the energy efficiency projects have a payback period less than two years. The ones with long payback periods involve technology change e.g. Kenafric Industries Confectionaries Division replaced two kneader machines with equivalent production capacity mixers at a cost of Ksh.28 million.

These findings clearly demonstrate that Energy efficiency leads to significance energy savings both in terms of usage and cost. The energy savings can be realized in the short term or in the long term mainly depending on the technology adapted.

The study was therefore able to demonstrate that manufacturing firms have adapted energy efficiency measures and that the use of energy efficiency has lead improved operational performance.

CHAPTER FIVE:SUMMARY,CONCULSIONS AND RECOMMENDATIONS.

5.1 Introduction.

This chapter presents a summary of the research findings, a conclusion of the research findings and draws recommendations based on the research findings. The chapter is sub divided into five main sections namely summary of research findings, conclusion, recommendations, and suggestions for further study and contribution to the body of knowledge.

5.2 Summary of the findings

This section presents a summary of the research findings as grouped according to the objectives of the as outlined in chapter one which are:

To establish the use of energy efficiency technologies in manufacturing firms in Kenya

To establish the relationship between energy efficiency and operational performance in the manufacturing firms in Kenya.

The study established that most of the manufacturing firms have adopted energy efficiency measures. With 33 out of 36 companies who were studied had implemented EEMs.

The study also established that for organizations whose SEEI improved for all levels of production, the SEEI for the current year is lower than the baseline year. This signifies a reduction in electrical consumption. Most of these firms showed a strong correlation coefficient between SEEI and production. For some organizations specific intensity improved for high production levels but not for low production, the baseline operation for these firms gave better intensities. This may result if the base load increases but the incremental consumption decreases. However, the correlation coefficient between production and electrical consumption for some of these organizations was very weak e.g. for Crown Berger it was -0.005 indicates that the two variables are almost independent of each other. This is contrary to common knowledge that consumption increases with increase in production.

In all the 36 firms, Increase in production lead to an increase in electrical consumption but at varying levels. Cost savings were experienced for most firms who had implemented energy efficiency measures. For 21 organizations who provided energy

savings data, the total energy savings amounted to 8,152,382kwh. For 19 companies who had all the data on energy savings, cost savings and investment amount, the total cost savings was established to ksh 103,760,382 with an investment of ksh 205,540,502. It was also established that 63% of energy efficiency projects had a payback period of less than 2 years. These study findings clearly demonstrated enhanced operational performance in terms cost savings and efficiency in energy usage.

5.5 Conclusions

The study established that different organizations have implemented energy efficiency measures at different levels which are assumed to have led to energy savings. Most of the EE projects implemented have a payback period of less than 2 years with that for projects involving technology transfer being longer.

From the study, it was evidence that, electrical energy intensity reduces with the use of EEMs thus improved operational performance however, for some organizations, the intensity only improves at high production levels only. This analysis was however not conclusive since some firms showed very weak correlation between electrical energy consumption and production both at the baseline and current level

5.5 Recommendations

The study recommends continued adaption of energy efficiency measures by the manufacturing firms so as to continue gaining for cost savings.

The study also recommends more awareness by the government and other stakeholders on the use of EE among manufacturing firms. Capacity building should be done by the government and other stakeholders to the executives of the manufacturing firms especially on the determination of the energy savings as it was established that many firms could not give data on the amount of savings.

5.6 limitations of the study

The main limitation of the study was time since the researcher was not able to analyze all the firms whom data was available.

Another limitation was that some firms had incomplete information. E.g some had data on only the investment but not the energy savings and some had energy savings data but no investments data and others had no data at all.

5.7 Suggestions for further study

The study suggests that a similar study should be conducted in future as a follow up or a longitudinal study, probably after 3 years so as to assess whether there is improvement in the energy and cost savings.

The study recommends that a similar study should be conducted in another type of energy e.g thermal, solar, wind and Biogas usage.

REFERENCES.

Abrahamse, W. & Talib, V. (2005): *A Review of Intervention Studies Aimed at Household Energy Consumption*. Journal of Environmental Psychology 25:273-291.

Abrahamse, W. & Talib, V. (1998): Creation of Energy Efficiency Standards

Allcott, H, & Michael G. (2012): *Is There an Energy Efficiency Gap?* Journal of Economic Perspectives 26 (1):3-28.

Anderson, S,& Richard, N.(2004). Information Programs for Technology Adoption:The Case of Energy-Efficiency Audits. -Resource and Energy Economics 26 (1):27-50.

ARC Advisory Group (2009). Sustainable Energy management and Energy Efficiency for Industrial, Commercial, Municipal and Manufacturing Operations.

Austin, D, & Terry, D. (2005). Clearing the air: The costs and consequences of higher CAFE standards and increased gasoline taxes. Journal of Environmental Economics and Management 50 (3):562-582.

Chartered Institute of Management Accountant, CIMA, (2010).The global manufacturing sector issues.

CSIRP & Griffith University,(2007) Energy Efficiency Opportunities.

Diana,F., & Jaana , E. (2008). Promoting energy efficiency in the developing world.

Energy Digest, (2013) June-July 1st issue, Integral Media publications.

Energy Regulatory Commission (2014), Draft National Energy Policy

Golove, W, & Joseph. E.(1996). Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy Efficiency

International Energy Agency (ITA), 2014.Energy Efficiency Indicators.

Karen Kabere (2011), Impact of CEEC activities in selected organizations.

Kenneth et al, 2009. Energy Efficiency Economics and Policy.

Kenya Association of Manufacturers (2006), Lowering Energy Costs

Kenya Association of Manufacturers (KAM), 2014. Powering The Economy Energy Policy Brief.

Kenya Institute for public policy and analysis (KIPPRA), 2013), Kenya Economic Report.

Michael, N., & David, S. (2005) The mythology of economic peril. Environment Finance journal

Ministry of Industrialization,(2010). Kenya National Industrialization Policy Framework.

Nicola et al (2011), United Nations Industrial Development Organization (UNIDO) report.

National Association of manufacturers (2002), Effeciency and Innovation in U.s manufacturing industries.

Susan et al, (2011)' *Demand for Energy in Kenyan Manufacturing Sector'* A journey of Energy and Development.

U.S. Congress, Office of Technology Assessment, (OTA), (1990), Energy in Developing Countries.

APPENDICES

Appendix I: manufacturing Firms in Kenya by sector.

	SECTOR	**MEMBERS**	**%**
1	Service & Consultancy- Support to Manufacturers	75	10.2
2	Building, mining & Construction	23	3.12
3	Chemical & Allied Sector	70	9.52
4	Energy, Electrical & Electronics	39	5.33
5.	Food & Beverages	172	23.43
6	Leather & Footwear	10	1.36
7	Metal & Allied Sector	71	9.65
8	Motor vehicle & Accessories	40	5.44
9	Paper & Board Sector	64	8.7
10.	Pharmaceutical & Medical Equipment	24	3.26
11	Plastic & Rubber	64	8.7
12	Fresh produce	2	0.27
13	Textile & Apparels	60	8.16
15	Timber, Wood & Furniture	17	2.31
	TOTAL	**735**	**100**

Fig.6

Source (KAM Directory 2013)

Appendix I1: Questionnaire

Kindly answer the following questions by filling the spaces provided.

1. COMPANY PROFILE

Company Name:

.....……. Postal Address: **.....** Postal Code:

.....……..... Physical Location:

..... Telephone Nos.: .....… Fax No.:

.....

E-mail Address: **.....**

Website:

……..…….....

Nature of Business: **.....**

Contact Person: ……..……

Title: ……..

Year of general energy audit: ……..……

Month: ……..

2. ENERGY EFFECIENCY MEASURES (EEMS)

Please tick against the energy efficiency and conservation measures that you have implemented

Energy Efficiency Measure (EEM)	Tick appropriately
High efficiency lighting	
High efficiency motors	
Power factor correction	

Correct Choice of motor size	
Correct wiring to keep internal distribution losses low	
Electrical power demand regulation	
Variable speed drives	
High internal power quality maintained through control of harmonics	
Automation	
Others (Specify)	

Please list the ways in which your company identifies energy efficiency and conservation opportunities.

3. COMMENTS / SUGGESTIONS

Please suggest what incentives you believe can encourage your organization to further implement energy efficiency and conservation measures?

……..……

……

Any other comments or suggestions.

……..……

……..……

……..……

……...……

Thank you for your cooperation in completing this questionnaire