Identifying and Managing the Market Barriers to Renewable Energy in Kenya

Tampere University of Applied Sciences

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ABSTRACT

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ABSTRACT

The topic came to mind after thinking of the challenges in Kenyan energy sector we are facing today and which are likely to get more challenging with time. As the population grows some of the resources we have will be strained further; these includes energy, water resources, forestry, transport systems and more wastes will be generated. How to provide the population with adequate supplies of energy, cleanly, safely and sustainably? This is the question which will be of interest to policy makers. Our world today is been run by energy mainly from fossil fuels which are not sustainable and the resources is to diminish further due to the increasing energy demands and the ever growing population not forgetting the developing nations in the world which are in high demand for energy.

The study analyses different barriers to RE in Kenya and for comparison also elsewhere. The study is based on available literature and goes further to give solutions on ways to mitigate RE barriers in Kenya. The current energy situation and RE potential in Kenya is presented. The aim of the study is to give ideas on how to have more RE as the source of energy in Kenya.The largest barrier is policies and regulatory framework. Conventional energy sources getting tax reduction and R& D funds. The barriers to RE are not technological , but they are more political, financial, educational and all related to the- infrastructure.

Keywords: energy, renewable energy, barrier, potential

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Kilonzo David Muthami

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ABBREVIATIONS AND TERMS

RE- renewable energy

RED-renewable energy development

RET-renewable energy technology

NGO-nongovernmental organization

R&D-research and development

RD&D –research development and dissemination

MOE-ministry of energy Kenya

LCA-life cycle assessment

GHGs-green house gases

SMEs-small micro enterprises

ERC-energy regulatory commission Kenya

REA-renewable energy authority

KETRACO-Kenya electricity Transmission Company

GoK-government of Kenya

VAT-value added tax

KPLC- Kenya Power and Lighting Company

IPPs-independent power producers

GDC-Geothermal Development Company

KENGEN – Kenya electricity generating company

UNFCC-united nation framework convention on climate change

IPCC-international panel on climate change

Km- kilometre

KES-Kenya shilling

Ksh- Kenya shilling

IEA-international energy Agency

SREP- scaling up renewable energy program

UN-united nations

UNEP-united nation environmental program

CDM-clean development mechanism

PURPA-public utility regulatory policies act

KWh-kilowatt hour

MW-megawatt

GWh-gigawatt hour

FiT-feed in Tariff

LPG-liquefied petroleum gas

TAMK-Tampereen Ammattikorkeakoulu / Tampere University of applied science

EU-European union

dB- decibels

SO_2-sulphur dioxide

CO_2-carbon dioxide

NO_x-nitrogen oxides

CH_4-methane

IAP-indoor air pollution

WTP-willingness to pay

REP-renewable energy program

PV-photovoltaic

PGR-partial risk guarantees

PPAs-power purchase agreements

CURRENCY EQUIVALENTS

As of 21.11.12[i]

1 US$=Ksh 85.7198

1 euro=109.369Ksh

ENERGY UNITS

The energy contents of fuels and electricity in different units around the world are shown below;

Quad (quadrillion Btu) =1.055 exajoules

Ton of oil equivalent (toe) =41.9Gj=39.7Million Btu

Barrel of oil (bbl) =6.1Gj=5.8Million Btu

Ton of coal equivalent (tce) =29.3Gj=27.8Million Btu

Kilowatt hour (kWh) =3.6Mj=3.412Btu

Watt=1J/s=3.412Btu/hour

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1. INTRODUCTION

Renewable energy (RE) is defined as any naturally occurring, theoretically inexhaustible source of energy, as biomass, solar, wind, tidal, wave and hydroelectric power, which is not got from fossil or nuclear fuel (Goli ,2013) . Energy is derived from a Greek word en (in) and ergon (work). Energy is the capacity labiality to do work (moving something against a force (Boyle 1990).

In 1990s there was an outburst of energy policy changes around the world. Driven by economic, ecological, security and social concerns, energy regulation has been in great - flux. The world population is growing and is to reach 10 Billion people in 2050 according to Boyle, 1990 and also by end of 21st century UN projection is that the population would be between 10 and 12Billion people.

According to Kenya institute of public policy research and analysis study and analysis ,2010 of energy consumption in Kenya most of households (52%) in Kenya use kerosene for lighting and 60% of households use biomass for cooking. The connectivity to electricity also varies from region to region; Nairobi 53.47%, Central 42.4%, North Eastern 14.5% and western 14.7%[ii](ERC, 2010).

In Kenya only a small percentage of the 1500 rural health clinics were using solar refrigerators until in 1991 when there was severe gas shortage that disrupted fuel supply and shut down immunization services in seven districts an indication that efficient and trustworthy source of energy is of great need (Ricardo 2002).

Carbon dioxide concentration had increased to over 390Pmm above industrial levels by the end of 2010. Demand for energy and associated services are on increase. Various types of RE can supply electricity, thermal energy and mechanical or produce fuels. The cost of most RE technologies has declined and technical advances will see more declines in costs. The life cycle assessment (LCA) of green house gases (GHGs) emissions for RE median value is 4-46g CO2 eq/kwh while that of fossil fuel is 469-1001gCO2eq/kwh. This shows the contribution RE can help in fighting climate change which is associated with GHGs like CO_2. RE increase worldwide in 2009 was wind 32% increase 38GW added, hydropower 3% 31GW added, grid connected PV 53% 75GW added, geothermal 4% 0,4GW added, solar hot water 21% 31GW(IPCC, 2012).

In 2030 if no new policy to change poverty is introduced 1.3Billion people (16% of world population) will have no electricity access mostly in Asia and Africa(Niez, 2010).This shows the big attention required in order to ensure people have descent life and access to electricity. 30GW the entire generation of 47 countries of sub-Saharan excluding South Africa equals that of Argentina despite the big population in Africa. Africa has a population of 820M and it's expected to reach 1,5B in 2030 according to Abeeku Brew (Hammond et al 2008). Energy is a key player to economic growth and according to UNEP 7000MW/yr needed to meet increasing demand and support economic growth.

2. KENYA BASIC DATA

Total area: 582,650 km^2 (almost size of France)

Boundaries: Ethiopia(861km), Somalia (682km), Sudan(232km), Tanzania(769km), Uganda(933km). The distances in kilometres indicate the length of the bounder line.

Length of coastline: 536km of Indian Ocean

GDP 2012 (PPP)-US$71.427billiom

GDP nominal 2011-US$34.796billion

Population- a little over 43,013,341million 2012

Water percentage-2.3%

Energy: oil 55000 barrels/day-2004

Fiscal year: July 1 through June 30

Independence: December 12, 1963 from the United Kingdom

Currency-Kenyan shilling (KES) / Ksh

Map of Kenya

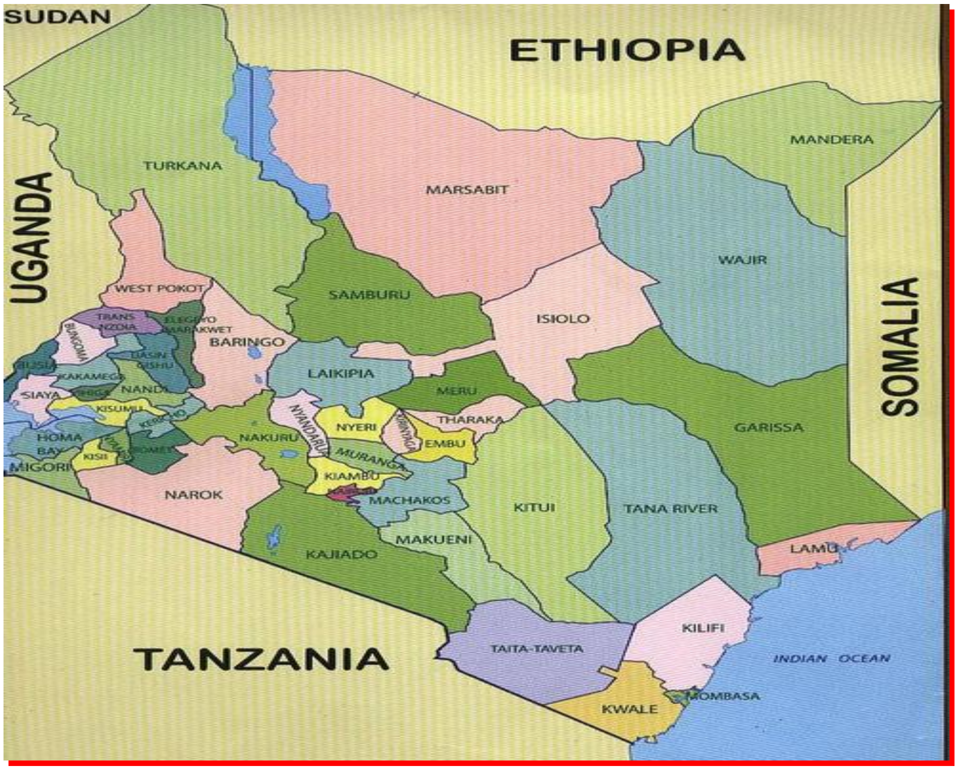

Figure 1.1Map of Kenya (Reproduced from Albert, 2009)

3. AIM OF THE STUDY.

The aim of the study is to list and analyse the barriers to renewable energy sources and use in Kenya and make recommendations on how to promote it.

Fossil fuels lead to acid rains; SO_2 and NO_2 when they react with water to form sulphuric acid and nitric acid respectively which affect plant life and erode buildings and other environmental problems. Though renewable energies provide a good alternative to fossil fuels as they are sustainable they have not been exploited a lot for example solar thermal amount per year incident on the earth is 160times the energy stored of fossil fuel which is 173,000TW (Boyle 1990). This led to me to choose the topic on why this is so and what can be done to avoid hard times in the future by utilizing the RE resources we have.

According to Kinner, 2010 the overall lack of REs is an indication that there may be barriers that countries share in common. The aim of the study is to examine the obstacle to something that is almost universally seen as beneficial and to help other scholars and policy makers. Though this thesis is about helping how to improve investing in renewable energies in Kenya still the country is doing some efforts this is according to a article published on the star newspaper Kenya on 15.10.2012 indicating that Kenya is ranked first out of nine African countries (Ethiopia, Rwanda, Tanzania, Burkina Faso, Senegal, Benin and Cameroon) in the implementation of the biogas programme after farmers embraced the energy technology. According to the article about 300 farmers are taking up the technology every month and close to 6000 have built biogas units in their farms in the last three years. According to Kenya national farmers federation 2,557 units have been built in 2012 alone compared to Uganda with 1.511 units (the Star, 2012).

4. INTERNATIONAL ENERGY AGENCY STATISTICS ABOUT KENYA

Table1.1 2009 Kenya energy sector overview (IEA, 2009)

Commercial energy use	514.5MW
Electrical power consumption	4,684,000,000 kWh
Electrical outages>days	83.6days
Fossil fuels Hydro power Nuclear power Wind ,solar and import	71% 17.7% 0 11.3%

4.1 Kenya electricity institutional framework

Kenya institutional framework comprises of nine main players as shown in figure 1.2 below. This may confuse investors as it becomes challenging to know which department to visit as they are all related to electricity which calls for a need of one stop shop. According to SREP, 2011 the institutional arrangement in Kenya in the electricity sub sector has many institutions; Ministry of energy, ERC, KENGEN, REA, Kenya electricity transmission company (KETRACO), geothermal development company (GDC) and IPPs. The many institutions may lead to long time in making decisions if consultations are to be made by all institutions which may discourage investors.

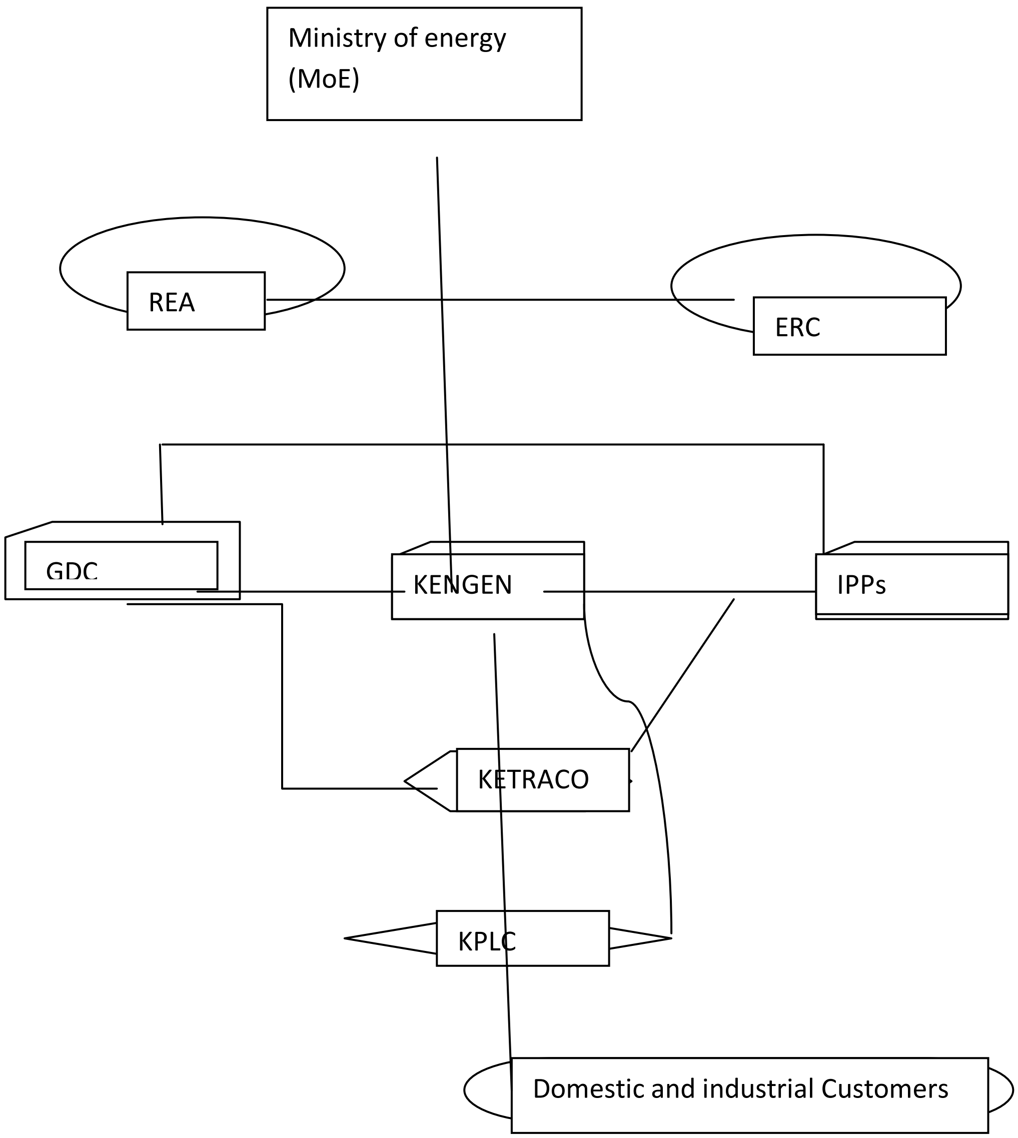

Figure 1.2 Kenya electricity institutional framework stakeholders. Reproduced from Reinkenya, 2011 available online at http://reinkenya.blogspot.fi/2011/01/kenya-energy-sector-institutional.html)

Kenya with a population of over 41million has a poor electricity supply with a supply of 1500MW compared to Finland with a population of roughly around 5.5M but with energy supply of 70.4TWh. 83% of the rural population has no electricity and the people who are connected experience power cut now and then due to reliance on hydro power which is affected by climate according to Kenya national energy policy 2012 as seen in table 1.1. Despite the challenges facing energy sector, Kenya is situated in a region which experiences strong winds of up to 11m/s and about six hours of sunshine. These potentials have not been utilized to the maximum despite the technologies been available (National energy policy Kenya, 2012).

The government in 2011 incurred losses amounting to US$17M due to transmission losses. In the year 2002 to 2008 the government lost ksh 2.414B due to vandalism on transmission network. The electricity connection charges range from 17000ksh to 35000ksh (150-320euros) which is still a lot of money taking into account a primary school teacher earns around 100euros per month (National energy policy Kenya, 2012).

KENGEN is the government entity producing 80% of electricity consumed in the country. Hydro power contributes 64.9% from 14 stations; geothermal produces a total of 45MW in Olkaria 1(1981, 1982, and 1985) and 70MW in Olkaria 2(2010). In regards to wind power there is power plants in Ngong with the first one been established in 1993 through a Belgium donation but is now not in operation, the second wind plant in Ngong established in 2009 produces 5.1MW and has a potential of 14.9GWh/yr. Plans are underway to increase the capacity to 25.5MW (National energy policy Kenya, 2012).

From thermal energy power is generated at Kipevu 3 station in Mombasa. The contract was signed in November 2009 with Wärtsilä Oy Finland and there was an oil spill in 2012. The plant went into operation in March 2011 with 7 diesel engines generating 74.5MW at an efficiency of 42.5%. Some off grid stations are in Lamu 2,4MW and Garissa 3.4MW all running on diesel oil. Combustion engine technologies have adverse effects which are well known such as noise, exhaust fumes and oil leakage dangers but governments prefer them as their have short lead times and they have been there for long so the negative impacts are known (Ricardo 2002).With the opening of Kipevu 3 the national grid is now 115MW richer which cost the government Ksh 11billion according to an article on daily nation on 4.12.12[iii]. This raised the country's installed capacity to 1,232MW (Agutu, 2012). Though thermal generation is the most expensive to run due to prices of oil but the government seems ok with it with the anticipation of oil to be produced in the country. In 2011 the price for electricity was ksh15/kwh and the average domestic user needs 3kwh/day which translates to around 90kWh/month at a cost of ksh1350 (National energy policy Kenya, 2012).

4.2 Firewood, fossil fuels and kerosene use effects due to lack of RE.

Some of effects associated with lack of clean energy include health problems due to indoor air pollution, high opportunity costs related to time spend gathering fuel(wood) and lack of media information due to lack of information facilities like radio or television. Outdoor air pollution is causing 5% of deaths in urban areas in developing countries. Smoke exposure in wood fuel in cooking leads to respiratory and eye infections (sayigh 2011). According to Susanne Schwan, 2011 indoor air pollution contributes to 1.9 million deaths/year and 1.5 Billion people in developing nations have no access to electricity. There has been an increase of 31% rise in CO_2 and 151% CH_4 levels since pre industrial times due to dependence on fossil fuels rather than RE (Howard, 2002).

4.3 Renewable energy potential.

Modern RE sources account for only 1/3 of RE total. The energy demand is likely to increase by 54% 1997 levels by 2020 according to IEA, 2009. RE sources could provide all the energy consumed in the world for example wind power has a potential of 20-50trillion KWh/yr which is 1.5-4 times current world wide electricity production (Howard, 2002).

Kenya has a potential of 7000-10000MW of geothermal energy. Geothermal energy has an advantage over hydro as it not affected by climate change, its reliable, has no fuel costs, long plant life and it's green and available but also it should be noted that energy is needed to pump the heat up from the soil. The government has puts lot of effort to tap this potential and government commitment was indicated by the establishment of Geothermal Development Company (GDC) to undertake initial project activities through which the government absorbs the attendant risks associated with geothermal development (Howard, 2002).

According to the national energy policy of 2012 the energy sector is to be the key enabler for vision 2030. Vision 2030 is a long term development blue print aiming at transforming the country into a globally competitive, newly industrialized, middle income and prosperous country with clean and secure environment. Government targets are geothermal energy 5,110MW, hydro power 1,039MW, wind energy 2036MW, thermal energy (diesel engines) 3,615MW, coal 2420MW and import 2000MW. The government plans to replace electrical water system heaters with solar water heating systems. Approximately 20,000 institutions in Kenya approximately consume 270tonnnes of wood/year. In the whole of Africa biomass contributes 47% of total energy consumed, oil 24.8%, coal 16.5%, and gas 10.4% and RE 1.3% (Howard, 2002).

5 RURAL ELECTRIFICATION IN KENYA

The section 66 of the energy act no.12 of 2006 provided for the establishment of Rural Electrification Authority (Kenya national energy policy 2012).Worldwide 1,456B people have no access to electricity of which 83% are in rural areas. This is no exception in Kenya where majority of people in rural areas have no access to electricity and rely heavily on wood for cooking which has adverse effects on indoor pollution leading to health complications as indicated earlier. Collecting firewood too takes a lot of time which mainly affects girl education as girls are the one who usually collect firewood. In Sub Saharan Africa 12% of rural population have electricity which is far less to the 35.4% average access of developing countries worldwide (Kenya national energy policy 2012).

6 KENYA ENERGY SECTOR

6.1 Policy history

The energy policy in Kenya has evolved through the sessional papers, regulations and acts of parliament[iv]. The first policy was on sessional paper No. 10 of 1965 also referred to as the electric power act (CAP 314) which was used to regulate the electricity sector. The second sessional paper was No. 1 of 1986 which called for establishment of department of price and monopoly control within the finance ministry to enforce pricing. In 1981 National oil Corporation of Kenya Limited was established through companies act (CAP 486) to coordinate oil exploration. Act No.22 of 1997 allowed IPPs to enter into power purchase agreement with

KPLC, it also called for KPLC to be divided into three sectors: KPLC, KENGEN and electricity regulatory board to regulate power sector.

The sessional paper No. 4, 2004 came into force to ensure enough, quality, cost friendly and affordable supply of energy to meet development while protecting the environment. The Energy ACT No.12, 2006 called for energy regulatory board to be changed to Energy Regulatory Commission (ERC) in 2007 to offer regulatory stewardship to electricity, petroleum and new renewable sub sector. This act also saw the establishment of rural electrification authority and energy tribunal.

The Kenyan government has established an energy policy. The mission of the policy is to facilitate provision of clean, sustainable, reasonably priced, reliable and secure energy service at least cost while protecting the environment. The policy is important to the country as Kenya tries to achieve its 2008 vision 2030(Kenya national energy policy 2012).

The sessional paper no. 4 of 2004 and the energy act no. 12 of 2006 restructured the energy sector in a bid to facilitate high level performance; the sessional paper and the energy act were made to transform the energy sector and provide for more people to have access to power. The policy has enabled increased private participation in the development of the sector whilst focusing on improved management and delivery of energy services. This was intended to enable the sector address its mission of proving clean, sustainable, affordable, reliable and secure energy services at least cost while protecting the environment. The involvement of private sector eliminates monopoly which is enjoyed by government owned companies (Kenya national energy policy, 2012)

The ministry of energy (MoE) is responsible for formulation and implementation of energy policies through which it provides an enabling environment for all parties. The Energy regulatory commission (ERC) was established as an energy sector regulator under energy act, 2006, for economic and technical regulation of electric power, renewable energy and petroleum sub sectors. Its responsibilities include setting tariff, re-evaluate, licensing, enforcement dispute settlement and authorization of power purchase and network contracts. Kenya Power and lighting company limited (KPLC) is a state corporation with GoK shareholding of 30% as at

December 2011. It’s responsible for electric power generation and produces the bulk of electricity used in Kenya (hydro, geothermal, thermal and wind) (Kenya national energy policy, 2012)

6.2 Challenges in Kenya energy sector

Some of the challenges facing the energy sector in Kenya is quantity, quality and reliability of energy supply, high initial capital outlay, and long lead times from feasibility studies to development of energy infrastructure, mobilizing adequate financial resources to undertake investment in the power sector and high cost of energy, low per capita incomes and the low level of industrialization. Challenges of institutional arrangements; governance issues, lack of research institute, funding constraints and inadequate human resources capacity, overlap of mandate of various institutions (Kenya national energy policy 2012).

According to Kenya national energy policy 2012 with the use of renewable energy there would be available energy for all Kenyans and the government would avoid the use of taxation to discourage wasteful consumption of energy. The government also has exemption of VAT for domestic users with a bill of 200KWhrs/month (Kenya national energy policy 2012). In 2011 fossil fuel produced 22% of total energy consumed while coal contributed 1%. With recent discoveries of oil in Ngamia 1 in Turkana country by Tullow oil n January 2012 the contribution of fossil fuel is to increase at the expense of other sources. The government is putting more efforts towards discovery of oil due to rising world crude oil prices (Kenya national energy policy 2012).

According to economy survey report 2011 Kenya fuel consumption was 2.9million tons of oil equivalent in 2004 and it increased to 3.6milion tons of oil equivalent in 2009 showing a increasing demand of energy of around 17%. In 2009-2010 financial year there was 3.95million metric tonnes of import of crude oil which is 25.3 % of country’s total annual import bill. The demand is likely to increase by 3.1%/year between 2009 and 2030. In 2020 oil prices were US$ 73 to 86/barrel and this changed in December 2010 to US$91.85/barrel (economy survey report 2011).

According to the national energy policy 2012 the peak load in Kenya is to grow to 2511MW by 2015 and later to 15026Mw by 2030. As on 30.6.2011 only 28.9% of Kenya's total population was connected to electricity this was an increase from 15% on 30.4.2004. This shows a growing population and not growing energy provision (Kenya national energy policy 2012).

By 2030 the government projections according to economy survey report 2011 Kenya is to produce nuclear energy 19%, geothermal 26%,coal 13%,hydro 5%, , thermal 9%, gas turbine (LPG) 11% ,wind 9% and import 8% and this should help to generate the 15026 which will be required by 2030 as shown in table 1.2 below.

Table 1.2 Energy source productions in 2011 and expected production in 2030 (Kenya national energy policy 2012).

	2011	2030
Geothermal	12.4%	26%
Nuclear	0	19%
Fossil	37%	0
Coal	---	13%
Wind	9%	0,3%
solar	--	--
hydro	47.6%	5%
LPG	2.4%(bagasse)	11%

6.3 Renewable energy in Kenya

According to the economic survey 2011 renewable energies account for 69% of the Kenya's overall energy mix while petroleum accounts for about 22% and electricity 9%.Though the percentage seems high for RE but the majority come from hydro power which is unreliable due to its dependence on climate. Kenya deployed one million improved household stoves, 200,000 solar PVs, 1000 biogas units to meet cooking, heating and lighting needs of undeserved communities

According to a study by Sabah Abdullah and Anil Markandya, 2007 on rural electrification programmes (REP) in Kenya it indicates that the program has faced set back due to high connection costs. The willingness to pay (WTP) to be connected to the grid and photovoltaic services is less due to the high cost which the government should deal by reforming the energy sector by giving subsidies.

The Kenya overall electrification rate in rural area is 14% which far below the sub Saharan Africa level of 23 % (Abdullah, 2007). Lack of enough capital in rural areas has led to poor electrification as the cost increases with distance from the grid, this makes connection cost in urban areas cheaper than in rural areas. The low consumption of electricity in rural areas and low income makes extension of grid to those areas uneconomical. In Kenya wood fuel provide up to 70% of the energy sector except for transport and commercial purposes. This has led to high indoor air pollution (IAP) (Abdullah, 2007).

The REP in Kenya gets its fund from rural electrification levy fund which is 5% levies charged from all electricity users nationwide. The 'umeme' program (Swahili) which is electricity together was introduced to help households to come together to save cost and pay for extension of grid. There is also less WTP for solar photovoltaic system due to awareness of the limitation of the service (Abdullah 2007).

6.3.1 EU comparison with Kenya

Most countries in the world are aiming to reduce their emissions by choosing cleaner energy sources. European Union for example aims to reduce emissions by 20% from 1990 levels according to the 20-20-20 targets binding legislation. The union also wants to have 20% of gross final energy from RE sources by 2020, 10% of transport from RE. The progress in EU can be seen in the table below. This is an indication that with good and operating legislations RE can be of success (Lowe, 2012).

Table 1.3 EU energy production percentages by fuel in 1990 and 2009 (Lowe, 2012)

Energy source	1990(total 943Mtoe)	2009(total 818Mtoe)
Renewable energy	7%	18%
nuclear	22%	28%
gas	17%	19%
oil	14%	13%
coal	39%	20%

Source: http://ec.europa.eu/energy/energy2020/energy2020_en.htm

In Finland renewable accounted for 33% of the total energy produced(70.4TWh); hydro 17%, wind 1%, peat 7%, biomass 7% and black liquor 7%[v]. The progress can be seen in table 1.4 below.

Table 1.4 Electricity generations with renewable 2000–2011(Reproduced from Niininen 2011)

	2000	2008	2011
Hydropower in TWh	14TWh	17TWh	12TWh
Black liquor	5TWh	5TWh	5TWh
Other wood fuel	3TWh	4TWh	5TWh
Wind power and other Renewable	0.5TWh	1TWh	1TWh

Source: http://stat.fi/til/salatuo/2011/salatuo_2011_2012-10-16_kuv_004_en.html

There are differences between EU countries as compared to Kenya, for example the population of EU as of 2012 was 503,663,601 while in Kenya is around 42million. The climate varies greatly with EU climate ranging from temperate, continental in nature, maritime climate to Mediterranean in the south while in Kenya though it varies with a location but it is characterized by tropical climate with rainy and dry seasons in a year. EU has some countries which experience extreme cold winters like Finland which can have an impact on solar energy during winter season unlike in Kenya where sun is available almost every day of the year (Ecorys, 2010).

Renewable energy barriers in EU as indicated by Ecorys, 2010 include planning delays and restrictions, lack of coordination between different authorities, long lead times to obtain authorization, costs of obtaining permissions and lack of a one stop shop to cater for all RE issues. To get RE permits in EU varies greatly within EU countries and ranges from 1-2 months in Denmark to 40months in Greece. The lead time in grid connection which is a also a barrier to RE varies to with country from 6months in Finland to 3 years in Spain (Ecorys, 2010)

A one stop shop helps avoid dozens of authorizing institutions and has been effective for example in Germany. In EU the barriers facing RE also varies according to the size of the project whether on large scale or small scale. Large scale projects barriers to RE include long time of planning, strict Environment impact assessment requirements and legal suits. For small scale projects the barriers to RE may involve the costs of permits. For example in Italy a 5kW solar panel installation on a roof permit costs 40% of the total cost (Ecorys, 2010).

6.3.2 Geothermal Energy in Kenya

Geothermal energy is caused due to high temperature at earth centre which is around $7000^{o}c$ this is attributed to when the earth forming process was taking place and tiny quantities of long lived radioactive isotopes e.g. thorium 232 which release heat as they decay. The total thermodynamic heat content of a system is called enthalpy. The Environmental impacts include noise(during preparation), disposal of drilling fluids, accidents e.g. santiaguito volcano in Guatemala in 1991, CO_2, H_2S, SO_2, H_2, CH_4, N_2 emissions , metals disposal, NaCl, KCl, $CO^{2-}{}_3$ releases depending on nature of water rock interaction at reservoir depth (Boyle 1990).

According to an article published in standard newspaper on 21.11.12 by Macharia Kamau geothermal development company (GDC) will next year name four companies to generate electricity (400MW) from geothermal well in Menengai 2 project. This shows the enormous potential available in Kenya of up to 7000MW still remains achievable with good plans and committed government.

According to Kalei, 2010 with right policies and private sector partnership, Kenya can harness much geothermal energy to even export to her neighbouring countries. The heat produced from the ground is used to heat water which turns into steam. The steam is then directed towards turbines under high pressure which turn to generate electricity.

In order to encourage private companies to verger into partnership with GDC, GDC plans to drill the wells and develop basic structures which it will operate with the four firms in a public private partnership. GDC will also provide 20-40% of the capital. Each investor however will need to raise at least ksh17B (around 15M Euros) to be short listed. According to the article the capital intensive nature of the business and the risks of drilling wells which turn out dry are some of the reasons private sector has shield away from investing.GDC advices on insuring against dry wells (Kamau, 2012).

6.3.3 Biomass Energy in Kenya

Biomass is organic matter that can be used to give heat, produce fuel and generate electricity. Wood, plant residues from agriculture, forestry and organic components of municipal and industrial wastes and landfill gas are the products which can be used to get biomass. In Kenya firewood and charcoal contributed to 68% of primary energy consumption (Githui 2010). According to Githui, 2010 in 2000, 34.3 million tonnes of biomass was used for fuel of which half of it was in form of fuel wood while the rest was charcoal processed in kilns with 10% efficiency.

It is agreeable to some level that biomass energy will be the main and for some the only source of energy in developing countries for some years to come (quoted from O'Keefe et al., 1984 by Githui, 2010). In Kenya biomass is provided mainly from fuel wood and charcoal (89%), farm residues used by only 21% of households, nationally about 2% of households use animal dung for energy along with other sources like wood. Other source of biomass is wood waste from wood shaving, saw dust and wood rejects which is used by 2.5% of households in 2010 compared to 5.1% in 1980(Githui, 2010).

According to Githui, 2010, the charcoal industry employs an estimated 700,000 people and supports 2.8million people and has estimated market values of US$427miilion as of 2005.

According to Abeeku, 2008 Kenya ceramic jiko (KJC) shown in figure 1.3 below is one of the most successful projects in Africa. It saves 600kg of charcoal/yr, US$60/yr for a family. The cost of jiko is around US$82 and 1.6million jikos were sold between 1997 and 2001.

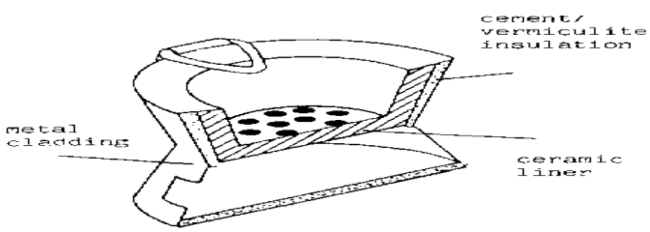

Figure 1.3 Kenya ceramic jiko (picture from Greenstone, 2007)

Though biomass is a renewable energy source if used unsustainably for example in case of using wood without reforestation can have effects on climate change. This is due to the fact that plants help absorb some of the carbon dioxide gas in the air ensuring carbon balance. Limited awareness of the FiTs aimed at encouraging investments in renewable energies has led to poor investment for example on biomass. Biomass can be processed either by gasification or by pyrolysis. Biomass gasification is where solid fuels reacted with hot steam and O_2 is used to produce gaseous fuels under hundreds thousands degree Celsius operating temperature. Conventional pyrolysis involves heating biomass in absence of O_2 at 300-500^{o}c until volatile materials is driven off. The residue is char and has high energy density (Boyle 1990).

By using 30% of the agriculture residues and 10% of wood processing industry residues 15000MW can be generated from biomass (UNEP 2012). Biomass is currently the most important RE source on a global scale which can be used for heat, electricity, liquid fuels and chemicals (Veena 2009). Baggasse from sugar cane has also been used to produce power mainly from sugar factories. It has a significant potential as a biomass fuel since it mainly arise at sugar factories where flow of materials and energy are already well organized (Boyle 1990).

6.3.4 Biofuels from Biomass in Kenya

It's the conversion of biomass into liquid fuel (ethanol and biodiesel) to meet transport need. It helps reduce emission and save on foreign currency for importing crude oil. Sugarcane and sorghum may be used to produce ethanol, coconut, and croton and cotton seed can be used to produce biodiesel.

Challenges facing biofuels include lack of sufficient research, insufficient legal and institutional framework to support sustainable generation, lack of public knowledge on the viability of growing crops for Biofuels as a business. Some of the policies available include tax holiday, duty waivers for biofuels production projects, plants and equipments.

Biofuels are seen as potential source of economic growth and as an alternative source of 'clean' energy. Agriculture provided jobs for 1.3B small holders and landless workers in 2007 worldwide. In Ghana larger areas of land have been outsourced by traditional land owners for biofuel production (Matondi et al 2011)

6.3.5 Biogas Energy in Kenya

Biogas is the gas produced due to anaerobic fermentation of different materials for example cow dung. It can be either from slaughter house, municipal waste, some of the projects which have been successful includes bio power limited in Kilifi which use sisal waste and cowdung to produce 150Kw. Flower farms (cut flower waste) can generate 87GWh/yr which is equivalent to 20MW this is due to large flower farms in Kenya. According to Abeeku Brew Hammond biogas was introduced in Kenya in mind 1950's by European farmers, by 1958 tunnel technology limited had constructed about 150 plants in some parts of the country. Most of them were however abandoned 5years later (Abeeku, 2008).

The government is involved in 'biogas for better life' a business opportunity to provide two million households with biogas digesters by 2020. A feasibility study in Kenya has shown a potential of 6,500 digesters every five years. Out of 300units built between 1980 and1990 only 25% were operation by 2002. This has been attributed to poor designs and construction of digesters, lack of maintenance, poor dissemination strategy, and lack of follow up by promoters, lack of government support through a focused energy policy. In rural Kenya 80% of people own livestock (quoted by Abeeku, 2008 from Njoroge, 2002, B4BL initiative, 2007) showing the enormous potential available in rural areas which are poorly connected to the grid.

Biogas for better life programme in Rwanda Cyangungu prison; a 150m^3 fixed dome biogas digester uses human waste generated by 1500 prisoners and contributes 50% of cooking needs of 6000 inmate prisons (Abeeku, 2008). This is an indication of how with good planning biogas can contribute to save energy by providing all the required or some energy to institutions. Ghana has a potential of 278000 biogas plant which can create massive employment but there is need for project monitoring and follow up (Abeeku, 2008).

6.3.6 Solar power in Kenya

Solar energy is derived from the sun by use of solar panels which have a life span of 20-30yrs. Photovoltaic (PV) were discovered by a French physician Becquerel in 1839. PV cells prices have reduced due to use of solar grade silicon which is manufactured cheaply unlike the previous mono crystalline silicon PV modules which were expensive (Boyle 1990). Solar thermal energy can either be active solar heating (discreate solar collector/domestic water heating) or passive solar heating (reduce energy needed for heating/low energy building design) or solar thermal engines (extension of active solar heating can drive steam turbines) (Boyle 1990).

PV provides electricity in developing nations to an estimated 500,000-1million people in rural areas. Solar home systems (SHS) can be used for lights, TV, radio and fans. Solar energy can be used for lighting bulbs, heating houses and water, drying and generating electricity. Kenya location astride the equator gives it a unique opportunity to invest in solar energy as it experiences solar radiations of 4-6kwh/m2/day and around 6hours of strong sunlight (National energy policy, 2012). To get the amount of energy or the number of solar panels one would need the calculation below can be used;

In Kenya where there is 5.6hours of sun/day

A 80W solar panel would produce=450Wh/day

No. of solar panels one would need if 10200Wh is the power requirement in a house/institution for lighting and other electrical appliances;

Total power usage=10200Wh

Charge hours=5.5hrs

Inefficiency-20%

10200Wh/5.5hrs=1854.54W

20%=2225.45W

2225.4W/75W panels=30 panels each 75W will be needed in this scenario.

Some of the barriers facing solar energy include lack of trained technicians cause market spoiling leading to erosion of consumer confidence due to faulty installation, lack of political will (lack of vision, no policies, and corruption), regulations, infrastructure, raw materials, awareness, exploitation from experts, expensive solar home systems. Policies strategy which can be used should involve promoting wide use, incentives for local production, frame work for connection of solar energy to national grid through direct sale or net metering, and enforce minimum standards for technologies, financiers for credits, tax rebates, zero tax and duties (National energy policy, 2012).

6.3.7 Wind power in Kenya

Wind was first used to propel sailing boats, windmills used for about 4000yrs. Kenya has a potential of 346w/m^2 as it experiences wind speeds of up to 11m/s. According to Ricardo, 2002 wind is a form of energy which is caused by uneven heating of the atmosphere by the sun, the earth's rough surface and the rotation of the earth. Wind energy is used to generate mechanical power to electricity. Most of the wind pumps in Kenya are manufactured locally for example by Kijito wind pumps (Abeeku, 2008). Winds pumps have a life span of Wind 10-20 yrs.

Wind turbine suppliers globally and their respective percentage in terms of the number wind pumps they supply include vestas from Denmark 34%, Gamesa from Spain 18%, enercon from Germany 15%, GE from USA 11%, Siemens 6%, suzlon from India 4%, Repower 3%, Mitsubishi 2%, ecotecuia 2% and nordex 1%. Wind pumps can either be horizontal axis wind turbines (blades) or vertical axis wind turbines (vertical axis of rotation can harness wind from any direction). The total installed capacity in the leading countries in the world is US 25,170MW in 2008, Germany 23,903MW, Egypt 365MW (Veena 2009) showing the great potential and thousands of megawatt of energy wind can supply to the grid.

Lake Turkana wind project source which is one project the government intends to build will supply 300MW by late 2014. It will cover an area of 162km^2 with 365 turbines each 850kW making it the largest wind power project in Africa at a cost of 800m dollars/582m Pounds/ksh75B. The project is expected to earn 260mUS$ from trading carbon under UNFCC carbon trade program[vi]. Other projects include Aeolus 100MW and Gitson energy 300MW.

Challenges acting as barriers to wind energy include high upfront costs, potential areas far from the grid and load centres, inadequate wind regime data, inadequate wind energy industry standards, competing land interests and lack of R&D (National energy policy, 2012).

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figure 1.4. Kijitowind pump, manufactured in Kenya in use in Turkana to pump water .Source: http://www.appropedia.org/Windpumps

According to an article published in Capital fm newspaper on 3.12.12 by Margaret Wahito the proposed Lake Turkana wind project (330MW:40,000acres of land) is now is to be financed with a guarantee from African Development Bank. This was after World Bank which was the main financiers pulled out over fears that the power plant was too big for Kenya’s power grid and may produce huge amounts of electricity which may go to waste hurting its position to pay creditors[vii] (Wahito, 2012).

Wind is an interruptible source as it requires reserve backup. It changes the dynamic of grid behaviour and system study would be required to assess the impact in the grid and the need for reinforcement. According to a report by the ministry of energy Kenya wind changes the dispatch regime and the capability of KPLC to operate it need to be augmented this to some extend acts as a barrier[viii] . Evecon E-126 is the biggest wind pump generating 7.58MW with a height of 198m and a diameter of 126m.Some of the calculation which need to be done before starting a project on wind power are shown below;

Power output=kCp1/2ρAV^3

K=0, 000133(a constant to yield power in KW)

Cp=maximum power coefficient (0, 25-0, 45)

P=air density

A=rotor swept area (ft^2) ∏D2/4

V=wind speed (mph)

Annual energy output (Kwh/yr) =0.01328D2V3

D=rotor diameter

V=annual average wind speed (mph)

The power output of wind is generator is proportional to the area swept by the rotor i.e. swept area doubles the power output doubles

Example

D=126m A=12470m2   ρ=1.23kg/m3   energy=5MW V=14m/s

P=0, 5*12470m^2*1.123kg/m^3*(14m/s*14m/s*14m/s) =19213277W

A wind pump with an efficiency of 10% the generated power would be 1921317.7W

Annual electricity production=Kv_mA_kT

Where K=2.5 factor based on typical turbine performance characteristics

Vm=annual mean wind speed (m/s)

At=swept area of the turbine in square metres

T=no of turbines

Wind negative impacts include noise, electromagnetic interference for example radio and TV and visual impact. Figure 1.4 below shows the noise effect by wind pumps at different distances from the pump.

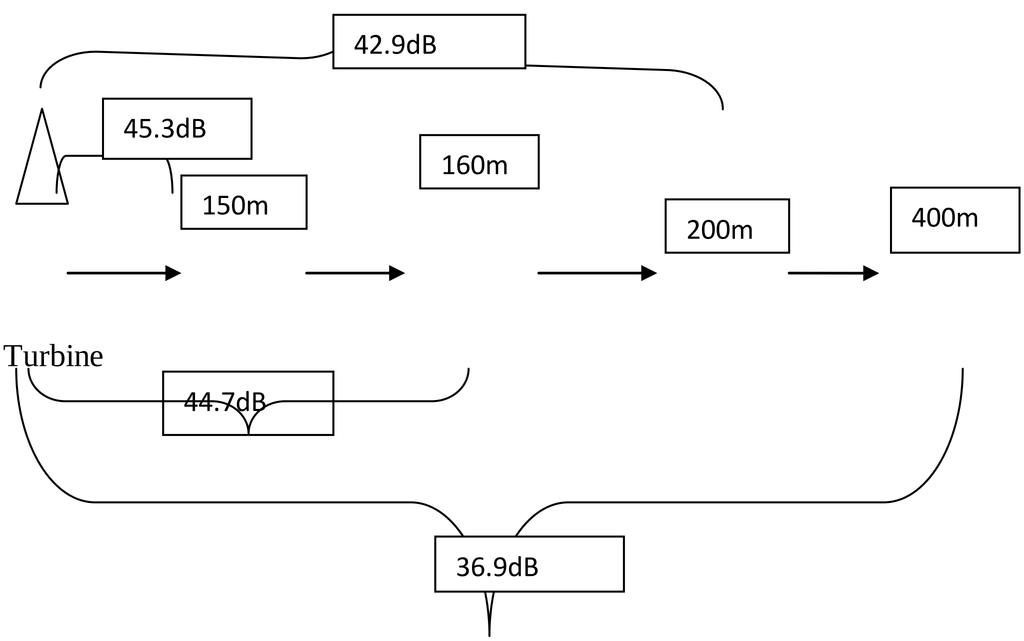

Figure1.4. The noise levels at different distances from a wind pump. Reproduced from http://www.planningni.gov.uk 2009

6.3.8 Hydro power in Kenya

The current generation of hydro power in Kenya is around 750MW (national energy policy report, 2012). Kenya has a potential of 1450MW from plants with generation of 10MW or more each and a potential of 31000mw of small hydro powers plants(less than 10MW). Mini hydros have a life span of 30-50yrs. Some of the calculations to be taken into consideration when starting a project on hydropower are;

Power (kW) =10*Q*h

Q=amount of water/second (m^3/sec)

H=water fall height (m)

Some of the barriers facing hydro energy include the destruction of catchment areas it can cause, inadequate financial resources&techical personnel for carrying out feasibility studies, inadeqaute hydrological data and land and water competing interests, displacement of people and wildlife Submersion of extensive areas upstream, destroying ecologically rich and productive land, riverine valley forest, marshlands and grasslands (National energy policy, 2012)

6.3.9 Municipal wastes in Kenya

Municipal waste consists of solid wastes including durable and non durable goods,containers,food scraps, yard wastes,inorganice wastes, manufacturing wastes,agriculture,mining and constrtuction,demolition debris, sludge and liquid water from water and waste water treatment facilities, septic tanks, slaughter houses and sewerage systems(National energy policy, 2012)

The waste can be used to produce energy in form of biogas for example where food left over can be used. Nairobi has over 2million people so the waste generated is a lot and can produce energy with good planning where people separate waste from their households before they throw it away. 1,530 tonnes of waste are generated every day. Dandora dumpsite had 1.3million cubic metre of waste as of 2002(National energy policy, 2012).All legislature and policies on solid waste management have been for local councils through local government act cap 265 (Muniafu et al, 2010)

6.3.10 Energy Cogeneration in Kenya

Cogeneration is simultaneous production of heat and power from one single fuel source. Mumias sugar company one of the largest sugars producing company cogenerates 38MW and sends to the grid 26MW through a power purchase agreement. Cogeneration is possible where steam is generated for process requirement in factories. Excess steam used for electricity generation for example to turn turbines under pressure (National energy policy, 2012).

Close to 30% of Kenya's population is directly or indirectly dependant on sugar and tea subsectors. According to a study by MoE in 2007 Kenya has a potential of 120MW of electricity for export to grid. The planned generation from all sugar companies is to reach 90MW this year of which 38MW is currently been generated by Mumias sugar company (National energy policy, 2012).

In Mauritius though there has been an exception with around 5.5million tonnes of bagasse cane been use to produce 318GWh contributing to 40% of total amount generated. Policy guidelines, legal framework and incentives from government saw a rise from 242MW in 1995 to 318GWh in 2004. The government intends to undertake capacity building programmes in available technologies on this form of energy, carry out study on its potential, provide incentives to promote cogeneration from biomass and undertake RD&D in cogeneration technologies National energy policy, 2012).

6.3.11 Nuclear power in Kenya

A nuclear power plant is a facility at which energy released by fission of atoms is converted to electrical energy under strict regulated operating conditions. Nuclear fuel cycle starts from mining of uranium to disposal of nuclear waste (National energy policy, 2012).

As of September 2011 there were a total of 434 nuclear power plants in the world, 28 under construction and 222 were in planning stage. The advantage of nuclear to solar and wind is that less land is required for example to generate 1000MW from a power plant nuclear plant will require 333,000m^2, solar 332,000,000m^2 while wind 165,000,000m^2. Kenya so far has no nuclear energy just like many other developing nations though the government plans to have nuclear plants running to be able to meet the increasing energy demand by 2030 (national energy policy, 2012).

7 ENERGY POLICY TOOLS

7.1 Policies and strategies

Policies and strategies are tools used to encourage investors to invest on RE. There are different forms of polices which can be used and may vary from eliminating taxes to subsidies. In Kenya there is 15yrs income tax holiday for hydroelectric projects whose installed capacity is not less than 50MW, 10yrs for between 20MW-49MW, 7yrs for less than 20MW but more than 1MW. The government also has 15yr tax holiday for geothermal plants, 10yrs holiday for fossil fuel plants of at least 50MW, 7yr-30MW-49MW, 5yrs-10MW-29MW 10yrs tax holiday for RE including biomass (National energy policy, 2012).

7.2 Feed in Tariffs

Feed in tariff is a policy instrument that makes it mandatory for energy companies or utilities responsible for operating the national grid to purchase electricity from RE sources at a pre-determined price that is sufficiently attractive to stimulate investments in the RE sector[ix] (UNEP, 2012).

A FiT is an instrument for promoting electricity generation from renewable energy sources. In Kenya the FiT policy was launched in April 2008 and applied to wind, small hydro and biomass (municipal waste and cane bagasse). To attract private sector investment, a realistic review of the tariff has to be undertaken to include other energy sources like biogas (national energy policy, 2012).

Its objectives are;

- Encourage resource mobilization by providing investment security and stable market for investors in electricity generation from RE sources.
- Minimize transaction and administrative costs and time wasted by eliminating the conventional bidding process.

- Encourage private sectors to operate their plants prudently and efficiently to maximize returns.

The challenges facing FiT include insufficient data to inform the level of tariff in different technologies, lack of awareness on FIT among investors, no clear guidelines on PPA negotiation results in lengthy negotiation and inadequate technical and financial capacity of some community base projects. For Fit to be of greater attraction to investors it should include operation and maintenance escalation components of electricity industry value chain which includes fuel, generation, transmission, distribution and also delivery(national energy policy, 2012).

8 BARRIERS

According to Ricardo Forcano, 2002 lack of knowledge, costs and people preferring extension of grid other than use of micro grids can act as a barriers to development on RE. This is due to most people perception that when connected to the major grid they trust it more than small scale projects like biogas plant. With lack of economic development in rural areas it leads to alleviation of poverty levels in urban areas as more people migrate to urban areas constraining more the available energy resources (Ricardo 2002).

According on an article by Matt McGrath on Desertec project on 19.11.2012 on BBC (British broadcasting corporation), Desertec project was set up in 2009 with a budget plan of 400B Euros to invest on solar energy mainly from North Africa. Major companies were Siemens and Bosch as industrial partners but they have since pulled out of the imitative. The Spanish government also declined to sign a declaration of intent citing difficulties finding subsidies. Unstable political situation in North Africa has also brought concerns to investors and governments.

In Kenya in regard to IPPs power transformers, electrical switch gear with metering and an adequate power line linking to the grid needed and producers should have them. The electric power act Kenya requires IPP operators to have resources and experience that is unlikely to be found in indigenous people. Cogeneration has been less successful due to low pressure boilers in sugar producing factories (Abeeku, 2008 pg 16).

Barriers which limit the supply or investing on RE include limited supply infrastructure which mainly involves poor connection of the grid with some areas been unreached. Quality standards issues lead to people losing trust on some RE sources. For example solar power if the panels are installed wrongly with low standards they may not work efficiently leading to poor supply. In case of wind accurate data is needed for example wind speed in the area. In case there is no data then it becomes a barrier as investors need the data to be publicly available (Margolis et al, 2006).

Lack of information in potential customers for example on biogas may lead to people preferring the major grid to be extended to their facilities to micro grids. The most frequently identified barriers as indicated by R. Margolis and J. Zuboy ,2006 in the report on non technical barriers include ; Lack of government policy supporting renewable energy, Lack of information dissemination and consumer awareness about energy and renewable energy, High cost of renewable energy technologies compared with conventional energy, Inadequate financing options, Failure to account for all costs and benefits of energy choices, Inadequate workforce skills and training, Poor perception by public of renewable energy systems aesthetics, Lack of stakeholder/community participation in renewable energy projects. Lack of institutional familiarity with the technology can act as a barrier for example if builders and architects are not comfortable enough with the technologies to suggest or offer it in new building designs (Margolis et al., 2006).

Kenya spends more than half of its export for importing energy; this can lead to even poor economic growth as the money can be used for other infrastructural benefits. Kenya has poor financing options according to IPCC with rural population using rotating saving and community based financing methods. According to IPCC a country which majority of people use saving and credit cooperatives is termed to have poor financing option unlike in a place where banks and insurance companies are used (IPCC report, 2012).

8.1 Costs and pricing barrier

Cost of renewable energy has been the greatest barrier to renewable energy due to the costs incurred before one can generate energy from the plant. This has faced more sets backs due to governments reducing subsidies for fossil fuels and nuclear power rather than increasing subsidies for renewable energy (Beck, 2004).The world bank and IEA put global annual subsidies for fossil fuels in the range of US$100-200B (Beck,2004). IEA put global subsidies for fossil fuels at US$312B/yr in 2009, RE at US$57B/yr in 2011. Subsidies for oil include tax incentives, RD, insurance, leases, waste disposal, fuel prices risk guarantees political risks-war, civil disturbance, critical for foreign investors and financing institutions (Beck, 2004).

The high initial cost discourages investors which is made worse by high lending rates by financial institutions due to low pay back time of RE. There is also the location value factor which occurs where most RE are located near the consumer and far from the grid making it hard to connect to the grid. The time factor is created and may build a barrier due to the additional time required in permitting finances due to lack of information about the technologies on RE. Though majority of people may argue that RE is expensive compared to fossil fuels but most of the calculation on cost does not include environmental externalities which is the money spend due to fossil fuels for example health care costs (Beck, 2004).

8.2 Legal and regulatory barrier

In Kenya there is monopoly in power utilities both in electricity production and distribution. But off late the sector has seen the entry of independent power producers (IPP) selling some amount of electricity to grid. Though for IPP to be operational according to Beck, 2004 a legal frame work is needed for them to invest, this leads to creation of power purchase agreements. The failure to have a legal framework to encourage private sector to invest on the grid is a barrier.

Other restrictions which affect RE are restrictions on buildings upon height, noise and safety or in urban areas (TAMK wind turbines certain height due to Tays hospital landing helicopters). Wind turbines may also be restricted in places with migratory bird paths (Beck et al, 2004). New transmission lines been built to access remote RE sites may be blocked by transmission access rulings. In Kenya this is experienced in case people are to be resettled and they go to court blocking the resettlement which delays construction works. The long court cases discourage investors who want to invest and get profits from the projects they want to start.

Another form of legal and regulatory barrier according to Beck, 2004 is on transaction costs of hiring legal and technical experts to understand and comply with the interconnection requirements as stipulated in different regulatory frameworks. This can be avoided by creating policies that create uniform and sound interconnection standards to reduce interconnection hurdles and costs.

Legally binding national targets forcing the government to have a certain percentage of RE providing power to the grid can be of great boost to RE. In European Union for example the legally binding target to increase the amount of RE has helped the countries to increase RE amounts and at the same time reduce emissions from fossil fuels. Several countries have adopted RE targets for example EU 22% by 2012, Japan 3% by 2010, US 10% by 2020. India and china became the first developing countries to have RE targets, India 10% 2012 and china 5% 2010. Kenya has a policy on what she intends to have as source of energy by 2030 but the targets are not legally binding which can cause poor RE performance at the expense of fossil fuels.

8.3 Market performance

Lack of access to credit by potential investors is a barrier as any project needs money to start. Most of the big projects need a substantial amount of capital which one cannot be able to finance unless there is credit or loans from financial institutions. Market barriers include inconsistent pricing structure, institutional, political and regulatory, though these barriers differ between developing and developed nations. Traditional energies benefit from a long history of government intervention unlike RE. Regulatory framework enabling policies and subsidies that favour conventional energy should be removed. Conventional energy companies are extremely wealthy and powerful and can influence political decisions or they bring about a political challenge (Kinner 2010).

New technologies may be perceived as risks if new in a region in case people have no confidence in it .This is normal in every part of the world as new products are not trusted due to lack of information about the technology. This creates the need for government to set up experimental centres where people can learn and see the technology work (Kinner, 2010).

Dispersed population can bring a challenge for example on extension of the grid. The economical value will be none as the cost will be high yet the people to be covered are few. This can be avoided by use of micro grids instead of grid extension. For example using solar panels or wind power can act as a good solution. People in dispersed population should be a great opportunity for RE to succeed with the use of micro grid (Kinner, 2010).

9 GENERAL PROMOTION POLICIES

General promotion policy to RE include Price setting and quantity forcing policies, Investment cost reduction policies and incentives and Public investments and market facilitation activities. They are made to reduce market barriers and facilitates RE markets.

9.1 Price setting and quantity forcing policies

These policies are set to reduce costs and pricing related barriers (beck et al, 2004). They set favourable pricing regimes which are aimed at attracting investors to verger into RE related investments. The quantity under such regimes is unknown but the price is known in advance. Quantity forcing do the opposite, they mandate a certain percentage quantity of generation to be supplied from RE at unspecified prices. These policies can attract investors and create RE boom if the government is committed to having RE (Beck et al, 2004).

They provide a good playing field for investors as the price is already set and they are favourable. The quantity forcing policies requires the government to commit to have a certain percentage of its energy from RE. This attract investors as they have government support as the target are been aimed at. To get a certain quantity of energy from RE the government will be forced to create favourable conditions to investors by reducing taxes to encourage investors (Beck et al, 2004).

9.2 Cost reduction policies

These policies are made to reduce capital costs upfront(subsidies and rebates), reduce capital after purchase(tax relief), offset cost though a stream of payments based on power production(production tax credits), provide concessionary loans and financial assistances and reduce capital and installation costs through economies of bulk procurement(Beck et al,2004).

Some of examples where the above policies have been used include Germany where in 1991, only 1000 solar roofs in individual households, the government gave 60% off in 1999 leading to a rise to 100,000 roof households amounting to 300MW peak. In US there are investment tax credits where businesses get 10% tax credits for purchase of solar and geothermal RE property. Other forms of tax reliefs include accelerated depreciation tax benefits to recover investment, production tax credits, personal income tax incentives, sale tax incentives, pollution tax exemptions, grants and loans (Beck et al, 2004).

9.3 Public investment and market facilitation activities

This may involve setting up a Public benefit fund or state clean energy fund. The funds from the system can be used to encourage RE investing. For example the funds can be used to establish experimental facilities where people can learn more about RE (Beck et al 2004).

This kind of activities can work and in Kenya the rural electrification program gets its fund from a levy collected from electricity payments by each individual. With proper planning the government can get funds to facilitate RE activities in the country (National energy policy, 2012).

9.4 Infrastructure policies/market Infrastructure

These policies are made to create a good infrastructure for RE projects to start and run on. Construction design policies require buildings to have RE or a design that encourages RE. Other tools which can be used are site prospecting where areas with potentials are studied and the information made ready for access by investors, review and permitting-assessment programs to enable investors to get required permits to invest in RE in a easy way and zoning to identify best sites to invest. India for example has 600 stations where one can acquire information on sites, equipment standards and contractor certification (Beck et al, 2004).

For market infrastructure industrial recruitment for example giving credits, grants to attract RE equipment manufacturers, direct equipment sales where consumers buy and lease RE systems can also encourage investors (Beck, 2004). In case where people have no confidence in a certain RE systems they can lease and use it for some time instead of buying. In Kenya where majority of people have less capital leasing RE systems like solar panels can see major use of it.

Transport Biofuels policies mandate requires a certain percentage of all liquefied transport fuels be derived from RE for example the ‘proAlcool’ program of Brazil since 1980’s which mandated the use of ethanol to be blended with all gasoline. In 2000 40% of all automobile fuel consumption in Brazil was ethanol (Beck, 2004). In another example in Germany biodiesel consumption shot to 750Mgallons in 2002 from 200M gallons on 1991 due to tax incentives. Kenya has no transport policy which can attract investing in RE fuels for example use of Biofuels in vehicles (Beck, 2004).

Emission reduction policies; these are policies to reduce power plant emissions (NO_x, SO_2 and CO_2). Through RE sets aside can reduce emissions by companies buying credits from RE power producers. Green house mitigation policies can be achieved by low interest rates for development of biomass and methane energy resources. By having policies to reduce emissions may create market for RE which is clean with no emissions. This is a challenge to developing countries for example Kenya which want to be middle income country. Reducing emissions by using RE which are seen as expensive is seen to hinder development in developing nations which will need a lot of energy so they can run industries (Beck, 2004).

Power sector restricting policies; these policies have an effect on electric power technologies, costs, prices, institution and regulatory framework. Competitive wholesale power markets and removal of price regulations on generation in power markets according to Fred Beck, 2004 power contract are signed between buyers and sellers in wholesale to avoid advantages monopolies have had due to presence of IPP. RE has difficulty competing on the basis on price alone as short term contracts favour fossil fuels. Green power can be used to increase the competitiveness of RE in retail markets, for example in Netherlands high tax on fossil fuels has created more interest on RE.

10 KENYA RE BARRIERS

RE incentives and policies are needed in Kenya since IPPs and private sector can end up investing in fossil fuels (IEA, 2007) which have short lead time and the risks associated with fossil fuels are known since the fuel has been used for long time.

In Kenya there has been a over reliance on hydropower and low investment in power sector by private sector, high cost or rural electrification and low countrywide electricity access(SREP, 2011). According to a report by Kenya electricity transmission limited company (KETLC) January 2012 a 428km transmission line (suswa transmission line) will affect 1,250 land titled parcels. This will cost around 140M Euros and 184 residential have to be relocated and compensated. The process of relocating people increases the cost of projects and the time before the project can start can become many years.

Traditional fuel remain dominant resulting in slow market development and poor commitment to science and technology education and low budgetary allocation to research and development and demonstration. In Africa according to Abeeku, 2008 there are 78 researchers for one million inhabitants and 1% of total global gross expenditure in R&D (Abeeku, 2008 pg. 37). Absence of mandatory standards and enforcement leads to poor designs, competition of energy crops with arable land, inadequate access to high quality planting materials, media passes non essential information materials mostly about politics (Abeeku pg 1-52).

Geothermal Kenya has mainly been operated by government and has seen little progress. With a potential of around 7000MW only hundreds megawatts have been exploited. The government should move from use of parastatals to private sector. The private sector if given a good business environment can exploit and start many projects which can lead to more power been generated from Geothermal (Abeeku, 2008).

Large investment used for maintaining the existing power infrastructure especially hydro power plants has led lack of starting of new projects. Most of the power plants are old and needs a lot of money to maintain them. According to a report by UNEP, 2012 the use of Private sector is a key will be play key role to opening up of new RE projects. The average generation cost in sub Saharan Africa is US$0.181/kwh while in Asia US$0.04/kwh. With 80% of the population living on US$2.5 the choice of electricity source will be cost motivated (UNEP, 2012).

RE projects requires some data e.g. wind, sun radiation, precipitation history which is not or may not be available in developing nations (UNEP, 2012) .Unfamiliarity with RE mean long process assessment, sitting, permitting, planning ,development, proposals, assembling financing packages and negotiating power purchase contract with utilities (UNEP, 2012). The government should collect all the data and make it available to investors. Geothermal sector has been characterized by long gestation period due to various constraints which include financial and geothermal resource risks.

According to engineer Henry Gichungi, 2012, 51% of earth's sunlight is in Africa though the continent has the smallest amount of electricity supply. In Kenya 13 micro grids are operated by KPLC and additional 9 microgrid financed by REA are under construction all of which are diesel powered. The use of diesel powered micro grid projects by REA is an indication of lack of capital to start RE projects which are termed as costly.

The current electricity demand in the country is 1,191MW and the effective installed capacity is 1,429MW. By 2015 it is projected that the peak load will reach 2,500MW and in 2030 it will reach 15,000MW, the installed capacity by 2030 should be 19,200MW as per the government plans. It costs KES 35,000(US$422) to get connected to the grid and UScents15 equivalent/kWh of electricity service. The high cost is brought about by the investment needed to build new generation utilities, transmission lines and distribution facilities due to the weak distribution and transmission network. The increasing demand may force the government to invest on fossil fuels at the expense of RE if there is no policy and legal framework committing the government to have some percentage of its total energy production from RE.

According to Dario Yuko, 2004 modern energy supports the three pillars of sustainable progress namely social equality, economic growth and preserving environment. Most of the new projects in areas perceived as new or untested have failed due to decision makers sticking to 'business as usual' policies. KPLC was ordered to buy all available power from sugar companies (cogeneration plants) in an effort to encourage sugar companies to produce power. For RE to experience robust growth an appropriate mix of public and private partnership will be needed.

Least cost power development plant(LCPD) is a twenty year forward plant which is a tool used by the ministry of energy to identify power resources and to assess their financial viability before power projects are commissioned(prepared in 1986 and updated annually). This is an example of tools which can be used to encourage investors as they have information on areas which can be of importance in RE (National energy policy, 2012).

According to SREP report, 2011 wind energy experiences high capital costs and lack of sufficient wind regime data. The potential areas are also far away from the grid. In 2003 the first Wind Atlas was developed to help guide investors to invest in wind energy. The solar energy in Kenya also experiences some barriers which include high initial costs, low awareness of potential opportunities and economic benefits and lack of adherence to system standards by suppliers. The government has zero rated import duties, removed VAT and RE equipments and accessories. Hydro power though common in Kenya also has its own barriers which include high installation cost(US$2,500/kw), inadequate hydrological data, effects of climate change, limited capacity to manufacture small hydro power components as the government has to import them making them costly.

According to Peter Kahare, 2012, in Kenya one wind installed MW costs between US$2-2.4M while one hydropower installed MW costs between US$2-3.1M. The 300MW wind power project in Turkana in Northern Kenya is expected to cost US$1B. Easily available information on the internet can help attract investors[x]. Empowering rural areas to produce power can help develop rural electrification program. Lack of framework to promote RE investment at the lowest level has contributed to poor rural electricity supply (Kahare, 2012). The use of small hydro off grid may be more beneficial to remote areas which are far away from the main grid as it will save cost on grid extension which may be uneconomical. In Kenya only 5.1MW is generated from wind power, there is a potential of 7000-10000MW of which only 2% has been exploited. The budget allocation to ministry of energy was US$753m of which 30% was used for geothermal.

The urban population is growing at 6% growth per year which means more electricity demand[xi]. According to an article published on 28/10/2012 on daily nation Kenya, Kenya acquired 100,000 acres of land in Marsabit County to generate wind of 300MW at a cost of US$1B; the cost may be reduced if the land is leased instead of buying. The large acres of land required for example for wind power is a barrier due to competing land interests by farmers. Most of the population practices agriculture and more land is needed to feed the nation as the population grows.

The government seems to be putting lots of effort on thermal energy due to its short lead time, predictable risks and cheaper price. Solar power is viewed as expensive and unpotential. This was proved in the feed in tariff of 2008 which excluded solar but was later included in 2010 but only for 100MW plants which can provide 500KW to the grids. To generate 500KW it is estimated that an investor needs US$1,25M. The 500kw to provide to the grid is too high and should be reduced to 3kw which is the maximum demand for ordinary consumers in the country if investors are to be encouraged to exploit this sector. Though Kenya receives good amount of sun due to its geographical location around the equator the energy has remained fully unexploited. For example a 1KW of solar installation can generate 2000KWh in Kenya as compared to Germany where it will generate 1000Kwh (National energy policy, 2012).

According to a report by national climate change response strategy in April 2010 the effects of climate change on hydro power are likely to increase in the future due to lack of rains (pg 55). In Kenya the emissions from energy sector increased by 50% in the period 1990-2010 (pg 59). This can be attributed to thermal energy especially diesel engines. The cogeneration from tea and coffee husks has a potential of 300MW as Kenya is a major tea and coffee producer.

11 DISCUSSION

To analyse on the facts provided previously it is worthy to say that RE can be managed with proper policies to provide a substantial amount of energy in Kenya. Currently RE provides over 60% of the total energy but this though RE it is not sustainable anymore. This is due to the fact the energy is coming from old hydro power plants which are costly to maintain making it hard for government to start new power projects in the country.

RE is likely to face more competition in Kenya for the next few years after the discovery of commercially viable oil deposits in the country. This will provide a worrying trend as the government will be keen to get oil deposits in the country at the expense of other sources of energy in the country affecting RE. The government currently spends 23% of its import capital annually to import crude oil so it will be critical for them to get oil deposits in the country to save on that.

Kenya been a developing country with growing energy demand day by day due to the growing population and setting up of new factories it can be noted that it will be hard for the energy sector to grow towards RE due to the long lead times. In the near future more thermal energy will be used as it has short lead times which can provide energy after the installation of generators running on fossil fuels.

The government has some targets which it intends to achieve by 2030 for example improving the current geothermal generation from around 200MW to 5,110MW. Though this is achievable it will need commitment and big incentives to attract investors who are more likely to invest on thermal energy. Another challenge is the cost factor; to generate 115MW thermal energy it cost the government 11Billion Ksh while to generate 300MW of wind for example the Lake Turkana project will cost 75Billion Ksh which could generate over 700MW from thermal in a shorter lead time.

The peak load in Kenya currently is 1500MW and is to rise to 2511MW is 2015 and later to 15026 in 2030. If the predictions are right and 15026MW will be required by 2030 then it provides the government with an enormous challenge on how to generate this energy in less than 20 years time. This can be a good time for RE like wind and solar to flourish if the government is to plan and acquire all the regime data required by investors. If the government does not pass legally binding targets in the next five years then it will be impossible to get substantial amount of energy from RE by this time. This will in turn open investment opportunities for thermal energy using fossil fuels to try to get enough energy for the economy.

Some of the initiatives that the government started before for example the ‘umeme pamoja’ can be effective especially in poor rural areas. In these areas most people struggle to get money for food and fees to educate their children. It is almost impossible for them to get loans to pay for grid extension. Another issue is that the cost of grid extension depends on how far a house is located from the grid, this provides another challenge where people are scarcely populated and they have less income. The government needs to extend the grid to every rural area so the distance to grid is less. The other best scenario is the use of micro grids for example use of solar panels of wind power to serve a certain region.

RE requires some capital to start the projects and get them running. In a country which is still struggling with poverty, hunger and security issues the cost burden increases. In this scenario to be realistic the government will spend a substantial amount of its budget to buy food, provide security and improve the welfare of the people. Though energy is a key to improving the welfare of the people but it will be outcompeted by other factors like providing descent houses for example to people leaving in slums. Energy from RE is still attainable but it will cost the government to have legally binding targets and polices which have to be enforced if RE is to compete with other interests in the country.

Since Kenya has Kijito wind Pump Company which can manufacture wind pumps locally the government should take that opportunity and channel funds to this company so people or institutions can have winds pumps at a cheaper price. The presence of this company is the country indicates that the expertise is there in the country. The presence of good governance polices and regulations can help a lot in attracting investors. Kenya is crippled by corruption in government institutions which can make investing in the country or having policies implemented hard. The presence or a good road map on government plans can help to avoid scenarios like was with the case with Lake Turkana wind project where the World Bank pulled out citing issues that the energy to be generated is a lot for the country and will go to waste.

Most of the municipal wastes for example in Nairobi end up in landfill. The councils are the one given the work to collect waste but there is no legislation requiring them to generate energy from the waste. If the councils were to generate energy and sell to the grid they can get more income to run the councils but it will need a legally binding legislation to enforce the same. Creation and enforcement of waste management policies as well as ways to do it, incentives, community involvement, education and awareness will be of great importance.

Most people are happier if given the chance to have the main grid extended to their place than having solar panels as they trust it more. This is also strange taking into account that Kenya experiences 83days in a year of power cuts. The government can set experimental centres for example utilizing schools which can improve the confidence of local people. This is the only way to have majority of people have RE in their homes since the reality of it is that before the main grid gets to every house in the country it will take tens of years.

The political situations in the country especially when nearing the general election is so tense that the economy is at stand still and most investors hold on their finances and wait after the election when they can invest. General elections are held after every five years and the campaigns take almost 6 months before the Election Day. This translates to one year in every ten years when the country is in tense mood and investors shy away in fear of losing their capital. The government has to set up strong legislation to ensure politics do not interfere with investors who can invest for example in RE boosting the energy situation in the country.

RE sector though sustainable it will need government intervention for it to be a success. This is due to many barriers which face the sector and the preferred fossil fuel because of their long history in the world. To create market the affecting factors need to be taken into account to improve the market. In Kenya most consumers have the willingness to pay for energy they use. Willingness to pay is the maximum amount of money that may be contributed by an individual to equalize a utility charge. This indicates with good energy supply the market will be there.

In Chile rural electrification is at 80% due to government subsidies. The Kenyan government should commit itself to see the success of rural electrification by giving subsidies and also allowing the private sector to supply energy to rural areas within agreed terms. In Kenya KPLC is the only entity who owns the markets in electricity transmission and distribution. As of 2002, 200,000 households had solar panels (Abdullah 2007)[xii]. This is a big success showing how RE can help provide energy. With tax reliefs and reduced prices the number of people who will use solar panels can increase to millions.

To make RE to be of a success by removing the existing market barriers several measures have to be undertaken. The measures could only be taken after knowing the barriers we face so we can break the barriers and achieve our goals on RE. The measure should be made to eliminate cost barriers, information barriers and policies and regulatory frame work will be the key measures to be used.

The use of cooperatives which involves people coming together with the same goal can be of great contribution in the breaking of barrier on high costs and access to credit. Cooperatives can share the burden of cost making it cheaper to individual people. The cooperatives can also easily access credits from banks or financial institutions as they have more guarantees/trustee which the financial institutions can trust. The use of cooperatives has been in Kenya for a while and would end achieving much if the government encouraged their formation and allowed easy access to credit from financial institutions. Micro financing also can be of great help to breaking the barrier on cost. Local communities wind turbines in Denmark where group of people buying wind turbine (cooperatives) have been a success where 50% of all wind turbines are owned this way (Boyle 1990).

For private sector to invest in energy to supply to the grid real time pricing and interconnection regulation legal access laws need to be passed. This will help avoid time wastage in interconnection issues. In Kenya full grid extension is costly and unrealistic as people spend less electricity mainly for lighting and electrical appliances. The government should encourage private sectors to invest and supply rural areas with electricity or the government can use energy service concession where the government selects on company to serve an area; the government regulates fees and provide subsidies.

Democracy and security is a key to economic development and energy development. Lack of security may force the government to spend much capital on providing security at the expense of development. The 2007/2008 post election violence in Kenya cost the government billions of Kenya shillings settling the displaced people. The money could have been used to invests a lot of energy from RE. The little progress by Desertec project due to political tension in North Africa is also an indication how political stability is important in energy sector. Democracy will also be needed and it is needed to pass key bills and polices to encourage investing in RE. Political tensions also discourage investors as in case of government failure their businesses may collapse incurring losses (McGrath, 2012).

Education campaigns, available information to investors and people, working regulatory framework, subsidies, utilizing CDM facilities, involvement of local personnel, technology transfer both horizontal(technical and management) and vertical(skills) will play a key role in breaking RE market barriers. Government should plan and coordinate RE projects. Low budgetary allocation to the ministry of energy or to R&D leads to little progress towards a sustainable energy system. The capital should be made available and the government should commit itself to supporting energy related institutions. Financial institutions should be sensitized to make provision for special packages to promote RE according to Abeeku, 2008.

IPP should be for RE not fossil fuels this can only be achieved by providing tax reliefs, subsidies and good interconnection to grid terms. Fossil fuels provide a fast and cheap way to generate energy creating a challenge to investing in RE. The government should start training programs on the use of RE, have agreements with financial institutions to provide low cost long term financing for RE projects and create awareness for existing financing mechanisms. Potential investors also should be trained on how to identify and manage RE projects and commercializing IPPs to electricity utilities.

Lack of government policy in acquisition of new technology and equipments have been recommended by Alexandra Niez, March 2010. In Kenya there exists monopoly in the energy utility with only government owned companies providing for generation and distribution of electricity. Opening up for private sector may create room for more investing and competition leading to more projects opening up.

In USA they have PURPA (public utility regulatory policies act) which was set up in 1978 to reduce dependence of fossil oil. In California they set up a standard offer in 1980 of 6cents/kwh which spurred many investments but failed in 1990's. The electricity feed in laws in EU in 1990's set up a fixed price for utility package of RE, for example Germany in 1991, RE producers could sell power at 90% of retail market prices(Beck et al,2004). Utilities were also obliged to purchase power, this led to 8500MW of wind power in 2001 making Germany RE leader. In UK they have non fossil fuel obligation of 1990 policy. This led to wind power contracts been reduced from 10pounds/kwh in 1990 t0 4.5pounds/kwh in 1997 though this did not lead to projects. All this success is a good indication that with good government plans and policies RE can achieve a lot.

RE green certificates can also be used to encourage investment in RE. It's a way for utilities and customers to trade RE production and consumption credits in order to meet obligations under RE portfolio standards (RPS) and similar policies. In this situation according to Beck, 2004 one can buy and sell certificates from those who have met set standards in case you have not. This has been tried in EU between 2001 and 2002 where 40 companies in seven countries had opened trading accounts.

To replace 1000MW power station by wind farms it would require 667km^2 of protected space. Wind alone cannot support all energy needs but can contribute something. Ethanol use in Brazil has led to Amazon deforestation (Pimentel, 2008). The large land areas required by some RE sources require government good planning to avoid human conflict with these RE sources. Displaced people also should be well compensated.

The tariff rates should be lowered as the rates have gone high due to thermal generations in the country. In 2011 SREP (scaling up RE program) allocated to Kenya US$50M to invest in RE. Kenya is more ambitious to geothermal than other renewable. There is need to lower feed in tariff so as to scale up investment but this would require regulations. In Kenya there is need for an incentive regime. The sector experiences regulatory constraints, high initial costs, limited pool of trained technicians for operation and maintenance, insufficient public awareness and less transmissions network.

Globally some 300,000 people are employed in wind power, 170,000 in solar photovoltaic 600,000 in solar thermal, 1.2M in biomass and 2.3 M people overall(UNEP, 2009). This is an indication of enormous benefits got from RE apart from it been sustainable. Global oversupply of solar energy goods lead to decreased price. Though it's good for prices to go low but the issue of manufacturers closing due to low prices has be taken care of by policies (closure of component manufactures ought to be thought of). Kenya exported solar panels worth US$1M in 2007 and imported solar panels worth US$10.3M (IEA, 2007).

To stimulate RE, laws requiring utilities to purchase all electricity generated from RE or law requiring RE to be a certain percentage of all power generated need to be passed to ensure investors have market for the power they produce from RE. Subsidies for investment in component manufacturers, reduction in taxed for component manufacturers and tariff for electricity from RE (Veena 2009). Though technology transfer is good it should be regulated to avoid crowding out local innovation according to Veena which could be of greater significant.

Building codes are been reviewed and should be analysed further to incorporate measures that will encourage climate proofing and the construction of energy efficient buildings. Regulations to provide framework for the solar PV value chain and facilitate good design, installation and proper use of solar PV systems; this will help avoid supply of substandard components and installation. Another challenge is on geothermal resources located in underdeveloped areas. This can be solved by use of micro grids to provide energy to the surrounding population in case in it uneconomical to extend the major grid. The first 45MW in Olkaria drilling started in 1955 but it was commissioned in 1985, 30years later. GDC aims to make the process shorter to 5yrs from drilling to commissioning. The government budget allocation to GDC rose from US$85M in 2009/2010 to US$188M in 2012 financial year. Private sector has key role in boosting the exploration of geothermal energy use.

Wind power in good location can deliver power at a cost below US$69/mwh compared to coal at US$67/MWh (unep 2012). Private sector needs a level playing field which can be created by public incentive mechanism, ease of market access by eliminating monopoly as in the case in Kenya and mitigating political and regulatory investment risks (UNEP 2012). Most countries have RE targets but no support policies to achieve the targets according to UNEP making it impossible to achieve the targets. This is the case in Kenya where they have the targets but no legal framework on how to achieve them.

According to a report by the MOE on guide for investors 2012 , in March 2008 the MOE formulated and published FiT for wind, small hydro, biomass, geothermal, biogas and solar. FiT allows power producers to sell and obligates the distributors to buy in priority basis all REs generated electricity at a pre determined fixed tariff for a given period of time. FiT levels are technology specific and depend on investment costs of the plant, operation and management costs, fuels costs where applicable, financing costs and return on the invested capital, estimated lifetime of the plant and amount of electricity generated.

Wind atlas in Kenya provides broad national information which may be of little help in case an investor needs data of a specific area thus a detailed feasibility study is required. The government should undertake feasibility study in areas with potential for wind power and make the data available if needed by investors

The most successful states are the states that have intervened on the part of RE markets. Countries with intervention policies still struggle with Renewable energy development (RED). Kinner notes that government intervention should not go very far but policies and regulatory frame work is good for RED. One such good example is in Albania where the government intervenes on financial institutions.

In the case of developing countries the market perspective can be shaped by outside sources, honesty of government and capacity of government to intervene effectively. Energy sector plays a role on basic health and nutritional needs and in developing countries it takes a sizable share on total house expenditure (Kinner 2010). Countries doing well in producing oil perform poorly in RE for example Saudi Arabia and the Kenyan government has to pass supporting polices and legal framework on RE with recent discovery of oil which may shift government attention from other sources of energy to fossil fuels. R&D important as RET is an emerging sector, demonstration centres need to be established so to enlighten the population on the greater potential available from RE. NGOs have a role to play as they are the link between the government and the people. NGOs can plan and implement government facilities like demonstration centres to educate people.

Energy saving cook stoves and solar PV systems has seen some success in Kenya. According to Abeeku RE sector needs planning, resource assessment, rebate, industry development and public awareness programs. The institutions mandated with RE should be well staffed and resourced. Market studies, LCA studies, policy studies will be needed. According to Abeeku primary player in energy markets include public utilities, large energy companies, SMEs, community based organizations, micro enterprises, consumers and energy services and product Media engagement, active public and private sector and empowered consumers. According to Abeeku Re projects which have failed it has occurred when projects are donor funded, pursed by research and development institutions and focused on training alone. The writer recommends learning by doing more it's more effective than seminars and workshops. Political commitment is needed together with engaged NGOs that RETs initiatives founded on industry and private enterprises. Capacity development efforts to focus in primary players, R&D institutions to support local industry/private sector and work more on real life projects, energy policy research institutions to undertake studies of both successful and failed experience in RE technology and publish them.

Abeeku also notes that donor funded projects have largely been unsustainable after project funding is exhausted and also curtailed by the absence of enabling policies and support to stimulate technological process and market scale up. This has been the case with Turkana wind project where the World Bank pulled out. High subsidies and donor driven programs can also lead to end users to expect free and heavily subsidized systems undermine market. Voluntary agreements between governments and private sector can also work for the benefit of RE as each party will sign voluntarily.

RD&D and policies such as financial incentives/regulations can be powerful force for technology innovation and deployment. Partnering between developed and developing nations can be valuable driving force to have technology transfer. India 10 yr loan with low interest by PV dealers US$20 but dealer retains ownership and provide maintenance has proven to be successful in developing nations where people do not have much capital.

RE is the least cost option if all environmental and social costs are included in the comparison option therefore incentives are justified to make RE affordable. Germany banks offered low interest rates for RE. Spain wind power and RE fixed price to the average price saw a boost from (50MW) in 1993 to 2700MW in 2000.

Home grown technologies with government support for example ethanol use in Brazil. This is an indication that with support to RD by local people can be of great success. Since these innovations will be home made the population will embrace them as their won boosting RE. This was the case with Kenyan Jiko which was a great success. Taxing fossil fuels and using part of tax to subsidy RE can also help reduce cost. Though this may a challenge as majority of people use fossil fuels for example to run vehicles and some industries which could lead to demonstrations and protests.

According to a report by IEA about Finland the energy supply was 35M tones of oil equivalent in 2005. The emissions levels to be stabilized to 1990’s level according to Kyoto protocol. Solar and wind energies rose from 80ktoe in 2005 to 173ktoe in 2005. The country also has a Policy to have 40%RE by 2025. In Finland hydro has a potential of 9.7TWh more though some is in protected areas or uneconomic to develop areas. The potential in unprotected areas is 1TWh/yr. wind has high potential of 6TWh/yr though freezing seas makes offshore projects challenging Hydro contributes 3% and this has attributed to the flat terrain of the country and lack of mountains limiting unlike in Kenya where the terrain is good for hydro .In EU renewable energy rose from 4% in 1990 to 9% in 2009 while the use of oil declined from 38% in 1990 to 37% in 2009.This is an indication that with good strategies and policies energy sector can be operated for the better part of the nature.

Developing countries have some features that could enable them to be leaders in the transition to a clean energy future; plenty of RE resources, energy efficient opportunities, transport, building and high growth rates. Article 12 of Kyoto protocol provide for CDM which developing countries can use to get money through establishing RE projects. RE can provide all the energy needs Kenya needs as long as the government is committed to achieve energy from RE. By providing polices and working regulatory framework RE can be of great success.

Challenges facing biogas production include lack of information on the benefits and potentials of biogas technology, lack of research on emerging technologies, high upfront costs of domestic and commercial biogas plant and equipment; a $10m^3$ biogas plant costs US$2800-4200(Sayigh 2011) which is expensive for farmers and even middle income people which are the majority in the country, inadequate skilled installers, lack of post installation operation and maintenance service for plant, equipment and appliances, lack of clear registration and regulation guidelines for biogas installation contractors.

Policies and strategies which can be adopted are to create awareness, promote research, introduce rebates and waivers and promote local manufactures of biogas plant and equipments, registers technicians, zero VAT and reduce custom duty on biogas plants and equipment, training programs, develop guidelines for registration and regulation of biogas technicians.

12 CONCLUSION

In conclusion the market barriers which are currently and are likely to continue hindering RE unless the solutions given in this thesis are taken include poor policies and regulatory framework, lack of R&D funding, tax reduction on fossil fuels, high costs of RE installations and projects, long lead times of RE projects, less human resource power and lack or poor awareness on RE potential within the population and FiT. Other market barriers include the government over reliance on hydro power over other RE sources, over reliance on wood fuel by majority of the population and poor involvement of private sector in the energy sector.

The solutions to deal with RE market barriers which can be used include offering tax reliefs and subsidies to reduce on RE projects costs, having one stop shop to cater for all RE activities including licensing and permit issuance for RE projects to reduce lead times, strengthening FiT, setting prices for RE so that the prices are known before hand by investors, educating the public on RE potential and benefits associated with it and having improved infrastructure like good grid connection.

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14 TABLES AND APPENDIXES

Table 1.5 summaries of renewable energy policies and barriers

policies	description	Key barriers addressed
Renewable energy promotion polices		
Price setting and quantity forcing policies	Mandate prices to be paid for RE/fixed amount of shares of generation to be renewable	High costs,unfavorable power pricing rules, expected risks
Cost reduction polices	Reduce investments costs through subsidies, rebates, tax relief, loans and grants.	High costs, perceived risks
Power grid access policies	Gives RE equal treatment to access to power grids and transmission systems	Independent power producer frameworks, transmission access, interconnection requirements.
Transport biofuels policies		
Biofuels mandates	Mandates specific shares of transport fuel consumption from biofuels	Lack of fuel production or delivery infrastructure
Biofuel tax policies	Provides tax reliefs for	High costs

	biofuels	
Emissions reduction policies		
Renewable energy set asides	Allocates, or sets aside, a percentage of mandated environmental emissions reduction to be met by RE	Environmental externalities
Emissions cap and trade	Allows renewable to receive monetary credit for local pollutant emission reductions	Environmental externalities
Green house gas mitigation policies	Allows renewable to receive monetary credit for local pollutant emission reductions	Environmental externalities
Power sector restructuring policies		
Competitive wholesale power markets	Allows competition in supplying wholesale generation to the utility network and eliminates wholesale pricing restrictions	May heighten barriers of high costs, lack of fuel prices , risk assessment, unfavourable power pricing rules
Self generation by end users	Allows end users to generate their own electricity and either sell surplus power back to the	Reduces barriers on interconnection requirements, but heighten barriers of high capital costs, lack of fuel price

	grid	assessment
Privatization or commercialization of utilities	Changes government owned and operated utilities into private or commercial entities	Reduce barriers of subsidies but heightens barriers of high capital costs and perceived risks
Unbundling of generation, transmission and distribution	Eliminates monopolies so that separate entities provide, generation, transmission and distribution	May provide a greater incentives to self generate, including with RE
Competitive retail power markets	Provide competition at the retail level for power sales, including green power sales	Reduce barriers of high costs, lack on of information, transaction costs
Distributed generation policies		
Net metering	Values renewable energy production at the point of end use and allow utility networks to provide energy storage for small users	Unfavourable power pricing rules
Real time pricing	Vales renewable energy production at the actual cost of avoided fossil fuel generation at the any given time of the day	Unfavourable power pricing rules

Capacity credit	Provides credit of the value of standing renewable energy capacity, not just energy production	Unfavourable power pricing rules
Interconnection regulation	Creates consistent and transparent rules, norms and standards for interconnection	Interconnection requirements and transaction costs incurred
Rural electrification policies		
Rural electrification policy and energy service concession	Makes RE part of rural electrification policy and planning and creates regulated business to serve rural customers	Subsidies for competing fuels, lack of skills and information, high costs, lack of access to credit
Rural business development and microcredit	Supports private entrepreneurs to provide RE products and services to end users and offer consumer credit for purchases	Lack of skills and lack of access to credit
Comparative line extension analyses	Analyzes the relative costs of RE with conventional fuels and power delivery	Subsidies for competing fuels, lack of information

Table 1.6 the barriers affecting the exploitation of renewable energy resources and the government mitigation efforts

Barriers/affected resource	mitigation
High capital cost-wind, solar small hydro, geothermal	Designed incentive packages to promote private sector investments by zero rating import duties and taxes on equipment and accessories Annual budget allocation Partner with development partners Green energy facility
Inadequate data-wind, small hydro,biomass,geothermal	Installation of wind masts and data loggers Undertake feasibility studies
Renewable energy resource distribution relative to existing grid-wind, geothermal	Strategic expansion of the transmission lines taking into consideration new areas with potentials to generate electricity
Challenges in reaching financial closure-wind, solar ,geothermal	Green energy facility introduction FiT policy and periodic review Partner with development partners to provide guarantees to private sector
Lack of appropriate and affordable credit and	Green energy facility introduction

financing mechanism-solar, biomass	
Low awareness of the potential opportunities and economic benefits-solar, wind, biomass	Awareness creating though sensitization and demonstrations Promote planting of fast growing tree species Introduction of green energy facility
Lack of adherence to system standards and poor after sale service-solar	Development of standards by KBS and regulation by ERC
High cost of resources assessment and feasibility studies-small hydro, geothermal, wind	Undertake feasibility studies and avail the report to potential investors
Climate change impact-small hydro	Re-afforestation
Limited capacity for equipment and human resources-solar, small hydro,biomass,geothermal	Procurement of drilling rigs Train human resource Encourage manufacture of equipment by Kenyans.
High resource risk-geothermal	GDC taking up the initial project preparations activities which have been deterred for geothermal development e.g. infrastructure development and purchase of drilling rigs.

Table 1.7 feed in tariff structure in Kenya

Technology type	Plant capacity(MW)	Maximum tariff US cents/kWh	
		Firm power	non firm power
geothermal	Up to 75	8,5	-
wind	0,5-100	12	12
biomass	0,5-100	8	6
Small hydro	0,5-0,99	12	10
	1-5	10	8
	5,1-100	8	6
biogas	0,5-100	8	6
solar	0,5-100	20	10

Source: MOE FiT 2010 policy

Table 1.8 Electric power generation sources and energy generated in FY 2012/11

Source of electric power generation		Installed capacity		Annual generation	
		MW	%	GW Hrs	%
Renewable energy	hydro	762	47,8	3,427	46,9
	geothermal	198	12,4	1,453	19,9
	wind	5	0,3	18	0,2
	cogeneration	38	2,4	87	1,2
	imports			30	0,4
	total	1.003	63,0	5.015	68,7
Fossil fuels	MSD	452	28,4	1.976	27,1
	Gas turbines	60	3,8	1	0
	HSD	18	1,1	44	0,6

	Emergence power plants	60	3,8	267	3,7
	total	590	37,0	2.288	31,3
Installed capacity and units generated		1.593MW		7.303 MWhs	

Table 1.9 demand and consumer statistics

	2004/5	2005/6	2006/7	2007/8	2008/9
Energy generated GWh	5.347	5.697	6.169	6.385	6.489
Energy sold GWh	4.379	4.580	5.065	5.322	5.432
Peak demand MW	899	920	987	1.044	1.072
Number of consumers	735.144	802.249	924.329	1.060.383	1.267.198

Source: KPLC annual report and financial statement 2011

Table 1.10 Ongoing energy related projects in Kenya

Source(total MW)	region	MW	completion
Wind(206,8MW)	Ngong	6.8	April 2013
	Isiolo	50	July 2013
	Marsabit	150	Feasibility study ongoing
Geothermal(452,5MW)	Eburru	2.5	December 2011
	Olkaria	140	December 2013
	olkaria	140	June 2016
	olkaria	170	June 2016
Thermal(900MW)	Kilifi	600	July 2016
	LNG	300	Feasibility study ongoing
Hydro		53	2013

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[ii] www.erc.go.ke accessed 10.11.12
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