Barriers to the development and deployment of Renewable Energy Technologies in Kenya.

The role of social capital in overcoming these barriers.

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Responsibility for any errors is entirely my own.

Table of Contents

List of Acronyms and Abbreviations

AFREPREN	African Energy Policy Research Network
BOT	Build-Operate-Transfer
CDF	Constitutional Development Fund
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CIA	Central Intelligence Agency
CSD	United Nations Commission on Sustainable Development
DDC	District Development Committee
EC	European Commission
EST	Environmental Sound Technologies
FIT	Feed-In-Tariff
GDP	Growth Development Product
GHG	Greenhouse Gas Emissions
IEA	International Energy Agency
IFIs	International Finance Institutions
IPPs	Independent Power Producers
JBIC	Japan Bank for International Cooperation
KBDA	Kenya Biodiesel Development Association
KenGen	Kenya Electricity Generating Company
KIPPRA	Kenya Institute for Public Policy research and Analysis
KPLC	Kenya Power and Lighting Company
KPRL	Kenya Petroleum Refinery Limited
MNCs	Multinational Corporations
NGOs	Non Governmental Organizations

NORAD	The Norwegian agency for Development and Cooperation
NSSD	National Strategies for Sustainable Development
OECD	Organization for Economic Cooperation and Development
PV	Photovoltaic
R&D	Research and Development
R, D&D	Research, Development and Demonstration
REA	Rural Electrification Authority
REP	Rural Electrification Programme
RES	Renewable Energy Sources
RET(s)	Renewable Energy Technologies
SED	Sustainable Energy Development
SHS	Solar Home Systems
SMEs	Small Medium Enterprises
SMHPP	Sondu Miriu Hydro power project
TOE	Tonnes of Oil Equivalent
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention for Climate Change
VAT	Value-added Tax
WP	Watt peak

List of Graphic Elements

1 Introduction

Renewable energy is energy that replaces itself within a human lifetime. It is therefore inexhaustible. Renewable energy has been considered as one of the strongest contenders to improve the plight of over seven hundred million people, mostly living in the rural areas of Africa, that are without access to conventional forms of energy(Statham 2009:16). A case study of renewable energy deployment in Kenya reveals various progress and obstacles in the efforts towards energy poverty alleviation in the rural places (Abdalla, 2007). The most rapidly growing population in Kenya, and Africa at large, is from the rural regions and this poses a serious challenge concerning the need to provide more energy to the growing populations and economies, while at the same time avoiding more harmful emissions to the atmosphere (South Centre, 2008:15). Delivering on this premise demands a swift transition from conventional energy sources to renewable sources of energy[1].

Several technologies have been developed to harness energy from renewable sources, and these are collectively referred to as Renewable Energy Technologies (RETs) (Edjekumhene et.al. 2001:4). Some RETs include wind power, solar power, hydropower, geothermal energy and biomass. With proper management, the negative impact of RETs on the environment is minimal (and in some cases nil), with little or no emissions of Greenhouse gas (GHG) (ibid: 2). However, it is ironic that the use of RETs in Kenya is on an even lower scale, despite her endowment with the many of the world's renewable energy resources.

It is against this backdrop that I conducted a case study of renewable energy deployment in Kenya, in order to identify the main barriers to increased utilization of RETs. Despite technological developments and economic viability for several RETs in Kenya, this technology has so far only tapped a small fraction of its potential. This is due to the existence of several types of barriers to the utilization of renewable energy

[1] A conventional source of energy relies on burning of fossil fuels which emits dangerous gases to the atmosphere while renewable sources of energy are environmentally benign (UNEP 2009).

sources. This thesis focuses on the identification of these barriers and possible ways to overcome them, with special reference to RETs in Kenya.

1.1 Research Question

Many developing countries possess excellent conditions for utilizing renewable energy, not least solar energy, but have generally little industry or expertise in this field. Presently, much research has been done in Europe within the field of renewable and the adjustment capability of RETs to the institutional structure in European countries. However, little research has considered RETs and its potential for adjustment to the African context and energy demand conditions. The prospects of RETs exploration in Africa are quite promising, but unfortunately, implementation is, more often than not, wholly based on the domestic policies and experiences of the country exporting the technology (technology and capital intensive countries). Since these policies are more often tailored to suit the domestic energy policies of the technology exporting country, successful implementation has often not been realised. In most cases implementation has been delayed as a result of several barriers at the home to the technology importing country. Some of these barriers may be specific to a particular technology, while others may be specific to a country or region. Wilkins (2002:50) notes that the classic image of RETs transfer to developing countries is large-scale public investment based on foreign technology and soft loans, with minimal knowledge transfer and domestic capacity building. Little attention has been given to Research, Development and Demonstration(R, D & D) at the local level, such as, training local people to maintain the facilities or investing in locally manufactured equipment.

A quick study of RETs in Kenya reveals that, in order to maximize the benefits of this technology to the locals, renewable energy needs to be an integral part of national strategies for sustainable development(NSSD) and other poverty reduction strategies and plans(Karekezi and Kithyoma, 2003). From this, we can obviously see that there exists a knowledge gap concerning how Kenya can successfully integrate and

implement RETs within the local/national context. This thesis contributes to filling this gap by addressing the following research questions:

1. What barriers exist for the adoption of renewable energy technologies in Kenya?
2. What can be done to overcome these barriers?

1.2 Literature Review

This section draws on an extensive review of academic articles, reports, speeches and interviews with policy makers and experts within the energy sector in Kenya and the international community[2]. Most of the literature mainly revolves around four perspectives of RETs, for the most part reflecting on agenda 21 of the UN program on sustainable development[3]. The first strand of literature focuses on barriers and opportunities involved in RETs transfer from developed countries of the North to developing countries of the South (Lall 1993; Painuly 2001; Martinot and et.al 2000). However, existing literature on South to South transfer of RETs is limited (Karekezi and Kithyoma 2002; Mshana and Ischebeck 1999; Sampa and Sichone 1995; Wilkins 2002). Technology transfer to the south has evolved around discussions on sustainability development and poverty alleviation through the promotion of Environmental Sound Technologies(EST) in developing countries, and public – private partnership as an effective way of financing the transfer of these technologies (UNEP reports 2009 and 2002; Karekezi and Ranja 1997; Enos 1989; Kumar 1993; Mshana and Ischebeck 1999; Painuly 2001; Salih 2001;).

[2] Special reports from the United Nations Environmental Programme (UNEP), Intergovernmental Panel for Climate Change (IPCC), EU-Africa Energy Partnership, African Energy Policy Research Network (AFREPREN), International Energy Agency (IEA) and workshop proceedings on Renewable Energy.

[3] Agenda 21 was revealed at the United Nations Conference on Environment and Development, held in Rio De Janeiro in 1992, which became the first major event to highlight the fact that business and industry play a crucial role in bringing about sustainable development (Wilkins, 2002).

The second strand of literature focuses on designing cost-effective RETS approaches to reduce CO^2 emissions and to tackle other environmental problems through initiatives such as Clean Development Mechanism (CDM). (Jacobson 2004; UNEP Risøe report 2009; UNEP Project CD4CDM 2009). In addition, this strand of literature also covers the debate on the social, economical and environmental impacts of environmental friendly renewable sources of energy like biofuels (Barbir an Ulgiat 2007; Clements, 2008; Sims 2002; Mariita 2002; Muok 2008). The third strand of literature focuses on identification of these barriers and prescriptive measures to be put in place in order to ensure successful development and dissemination of the technologies (Mwangi 2003; Muok 2008; Strelneck and Linquiti; Ministry of Energy Strategy Report 2008). This strand of literature emphasises the importance of choosing "appropriate renewable energy technologies" for developing countries (Wilkins 2002; Moyi and Njiraini 2005).

Developing countries have sometimes criticised cooperation projects that they felt were mainly designed to test advanced technologies which had not found applications in their countries of origin and which, in some cases, proved to be too complicated, unsuitable or uneconomic(UNGASS Report, 1999:50). This critique contains an element of truth in those cases where insufficient attention was paid to the adaptation of technologies to the actual conditions of the country, site, or context of application (UNGASS, 1999, Jacobson 2004). Therefore, transfer of advanced technology should focus on the adaptation of the technology to the particular needs and conditions of receiving country. UNGASS (1999) report, argues that adaptation must be carried out largely by the receiving country itself, and the technology must fulfil an identified need, that is to say, it must be the result of a "market pull", not a "technology push[4].

Karekezi (2002) points out that a successful dissemination of RETs and maximizing the benefits of such technology to the local community demands that the technology is integrated within the national development strategies. The absence of a well

[4] Technology push implies that a new invention is pushed through R & D, production and sales function on to the market without proper consideration of whether or not it satisfies users need. In contrast, an innovation based upon market pull has been developed by R&D function in response to an identified market need. (Martin, 1994).

coordinated government activities within the renewable energy sector in Kenya, has resulted in a vacuum of authority in decision making on RETs (Karekezi 2002:34).This has meant that the majority of RETs dissemination efforts have not only been *ad hoc*, but have operated largely as informal sector activities outside the framework of government machinery, thus failing to mobilize the fiscal support of the central government and its major donors (Karekezi 2003, 2008, Munasinghe 1995; BW' Obuya 2002). In addition, much of the literature refers to the negligence of Small Medium Enterprises (SMEs) by the governments of developing countries, despite the huge role this industry plays in their respective economies, something that could explain the slow process in the embracement of RETs in Kenya (Ibid; Moi and Njiriani 2005; Kenya Standard Bureau of Statistics; 2009).

The fourth strand of literature focuses on the interplay between social capital and the identified barriers to RETs in Kenya. Technology innovation and adaptation involves a set of long term, radical and mutually-reinforcing changes in the economic, technological, institutional and socio-environmental domains of a system that serves a societal function (Adler and Kwon, 2002). In Kenya, the interplay between the above domains is finely embedded in interpersonal networks and relationships between government actors, private actors and the civil society. This type of social network may act both as positive or negative catalyser to RETs development in Kenya. Negative, in that the embedded social networks may lead to non-transparency and non-accountability, hence slowing down the policy implementation process of RETs. Positive, in that the network bounds stakeholders within this sector together and acts as an attractive magnet to investors. The gender perspective of RETs is also given attention under this strand (Mbuthi et.al 2007; Muchiri 2008; and Cecelski 2002).The literature on social capital is therefore relevant in theorizing the development and deployment of these RETs in Kenya (Putnam 2000, Statham 2009; Boutilier 2009; Adler and Kwon 2002; Nawaz 2008).

1.3 Research Design

In this section, I start by presenting the method I used to address the research question presented in section **1.1**, and proceed to discuss my theoretical framework and my sources of data.

1.3.1 Method

The objective of this thesis is to identify the barriers that hinder the adoption and implementation of RETs in Kenya, and to stipulate measures that can be put in place, to either, remove the barriers or create conditions that lead to indirect elimination of these barriers. Inorder to generate enough knowledge of existing barriers, it is important to first identify RETs that have investment potential in the region and their feasibility. My criteria for selection of RETs to be studied were based partly, on a personal qualitative assessment of renewables through site visits, interaction with the stakeholders and other experts within this field, and through available literature on RET analysis[5]. This method of preparation for the empirical study provided me with a basis to conduct a case study with the aim of theory testing (Cooper, 1984 cited in Yin, 2009:35,). I have conducted an embedded type single case design that involves the study of four types of renewable sources of energy in Kenya, namely: geothermal, hydropower, solar power and biomass based on a two level unit of analysis that looks at government engagement and cooperation with other stakeholders in the deployment of RETs (Yin, 2009:50). Nevertheless, I'm very much aware that single –case designs are vulnerable, because of the risk of putting "all my eggs in one basket". However, the validity of this research design is justified by the analytical benefit of having " multiple sources of evidence" in the development of my inquiry, and cross-checking findings, a process also referred to as triangulation(Bryman 2004:275).

The United Nations Environmental Programme, (special report, 2002) suggests a framework for the analysis of barriers that uses the top-down and bottom-up approach. The top-down approach identifies a broad category of barriers at the top level and then proceeds downwards to other levels by identifying the components of each category

[5] Interaction with stakeholders is based on semi structured interviews and discussions with experts and policy makers, investors within the RET industry, the civil society and the consumers of this technology.

(Ibid). The bottom up approach begin by identifying barriers from the end users and ascends to other stakeholders like RETs developers and policy makers. This thesis applies the same framework of barrier identification and groups the barriers under four main categories namely: (a) Financial; b) technical; c) social and environmental; d) and institutional. Last but not least, measures to address the identified category of barriers to RETs are discussed consecutively, under each of the four types of RETs. Technological leapfrogging[6], Research and Development (R &D), institutional capacity building, government incentives and efficient policies are some of the measures highlighted to ensure successful RETs dissemination (UNEP Report 2002; Karekezi & Ranja 1997; Muok 2008).

1.3.2 Theory

The theoretical framework of this thesis study is based on how social capital can be deployed in the advancement of RETs. In analysing the challenges facing the renewable energy policy scenario in Kenya, I base my arguments on the level of government involvement and cooperation with other stakeholders within the RETs sector. Munasinghe (1995) proposes an integrated approach to Sustainable Energy Development (SED) which encompasses the interests of multiple actors, for example, international institutions, public and private institutions and the civil society, in policy formulation. I use the theory of social capital to explain the structure and content of the multiple actors' social relations and their impacts on the country's institutions, economy, technological and social capacity [7](Statham, 2009, Boutilier, 2009:5, Putnam, 2000:19, and World energy council report, 2009). The concept of social

[6] The rationale behind technological leapfrogging is that companies holding monopolies based on incumbent technologies have less incentive to innovate than potential rivals, and therefore they eventually lose their technological leadership role when new radical technological innovations are adopted by new firms which are ready to take the risks. When the radical innovations eventually become the new technological paradigm, the newcomer companies leapfrog ahead of former leading firms (UNEP 2002:117, Wilkins 2002).

[7]Remember that these issues being analyzed are also identified as the major barriers to RET diffusion, (see chapter 3).

capital specifies what it is about relationships that confer various advantages upon those with different configurations of relationships in networks (Adler and Kwon 2002:23). The basic assumption is that social capital will facilitate cooperation as well as the creation and sharing of knowledge across all the levels of actors involved.

Gerring (2007:72) points out that, usually, a hypothesis arises from an open-ended conversation between a researcher and his evidence. Thorough analysis of my case study database makes me suspect that two issues are central to the barriers hindering the successful implementation of RETs in Kenya. These issues are (a) the extent to which the government engage in the deployment of RETs and (b) the extent to which the civil society and other stakeholders cooperate within the RETs industry. The above assumptions lead to the development of two hypotheses:

H1: Successful development and deployment of RETs in Kenya, demands high level of cooperation between the government, civil society and other stakeholders within the energy sector.

H2: Non involvement of civil society and other stakeholders in RETs in Kenya slows down the development and deployment of these technologies.

Using the above mentioned hypotheses as a point of departure, my study attempts to analyze findings in order to provide enough evidence to test my theoretical assumption (Yin, 2009:36, Gerring 2007:72).

1.3.3 Data

The requisite data were obtained from diverse sources including relevant strategic government documents, power utilities' periodical reports and other public reports, journals and relevant books. The thesis is widely supplemented by interviews with local and international experts and other stakeholders within the field of RETs. Outcomes from field surveys and group discussions with end-users of RETs also contributed a lot to the empirical content of this thesis. Personal experience as a consultant in the field of renewable energy, and access to strategic documents of

stakeholders within this field, provided me with an insight into several components of barriers that later helped me to structure my questions. Nevertheless, my background as a Kenyan has provided me with enough experience and knowledge of the field, and this is one issue that played a major role in the choice of my case study. I conducted 19 interviews and the interviewees included: high ranking officials from the ministry of Energy, Agriculture and Foreign Affairs in Kenya, and several experts from NGOs and research institutions.

Initial contact with the above interviewees made it easy for me to identify other relevant interviewees through the snowball sampling[8] method (Bryman 2004:334) .The first step of Data collection was based on convenient discussions and consultation with stakeholders within RETs who helped me identify the four potential RETs in Kenya under study. The criteria for identification of the RETs to be studied were based on the technology's relative potential for energy contribution within the country and other factors such as: adequate resource base for the RETs, commercial viability, environmental and socio-economic impacts and benefits (Painuly, 2000, Karekezi 2003). The interviews conducted included both face-to- face interviews and telephone conversations. The interviews were semi-structured, that is to say, questions were organized around broad topics.

I conducted field surveys of RET projects in Kenya which included: a survey of the geothermal electricity plant in Olkaria; Sondu/Miriu hydropower station in Sondu, and a survey of smallholder farmers' biofuel feedstock plantations in Vihiga district. In addition, I also conducted a visit to three rural homes installed with solar home systems. Even though the case study lasted for just 3 weeks, I was advantaged since I had developed good relationships over time with some of the interviewees during the previous visits to Kenya. The in-depth interview which took place over an extended period of time, and not just a single sitting led to a gradual development of the interviewees role to that of an "informant" rather than a respondent (Yin, 2009:107). However, due to interpersonal influence and the former status client-consultant

[8] Snowball sampling implies that I first made a contact with knowledgeable persons who recommended the interviewees and helped me establish contacts (Bryman 2004:334).

relationship I had with most of the experts interviewed, I could not wholly depend on information provided by my informants. A reasonable way of dealing with this pitfall, and hence minimizing the errors and biases in this study, was to rely on other sources of evidence to corroborate for any insight by such informants and to search for contrary evidence in other secondary sources of data (Ibid).

1.4 Organization of the thesis

The remaining parts of this thesis cover 6 chapters and are organized as follows. Chapter 2 offers a brief account of the development and role of renewable energy technologies in Kenya as a tool to sustainable development and poverty alleviation with specific reference to solar energy, geothermal, hydropower and bioenergy. The chapter also gives a brief presentation of the category of barriers but detailed discussion is however done in the presiding chapters. Chapter 3 present the theoretical framework of social capital and its relevance to the four categories of barriers namely; financial, institutional, social/environmental and technological. Chapter 4, 5, 6, contains detailed analysis of the selected RETs namely; solar energy, geothermal and hydropower and bioenergy respectively. These chapters analyses barriers to the development and deployment of these RETs and advances strategies to overcome them. Finally, Chapter 7 gives a summary of the main findings and concludes the thesis.

2 Background

The main objective of this chapter is to highlight the role played by RET in fighting energy poverty in Kenya through rural electrification. The first section of the chapter presents the United Nations' plan on fighting energy poverty as spelled in Agenda 21. It also presents Kenya's implementation of this plan through its rural electrification programme to fight energy poverty. The second section of the chapter gives a general presentation of four categories of barriers to RETs development and dissemination in developing countries.

2.1 Energy Poverty

Now and over the next decades, developing countries are and will most likely disproportionately affected by climate change negative impacts and suffer higher costs because of their greater vulnerability to natural hazards[9]. One major explanation for developing countries' vulnerability is to be found in energy poverty. Energy poverty is the lack of equitable distribution of energy resources and services which is a strong causal factor of economic poverty and underdevelopment(South Centre, 2008:11).The energy poor are therefore not surprisingly more exposed and sensitive to external pressures because of higher incidence of extreme poverty, malnutrition, diseases, mortality, lack of access to education and gender inequality. Therefore, the improvement of living situations of the energy poor in developing countries is premised, among other things, on the enhancement of access to energy resources and services – in particular renewable energy (South Centre, 2008:10). Agenda 21 of the UN which led to the establishment of the UN Commission on Sustainable Development (CSD) set out a plan on how to fight energy poverty, especially in developing countries, through Sustainable Energy Development (SED) (Ibid). In the light of agenda 21, many developing countries launched a Rural Electrification Program (REP) as part of the implementation strategy of SED (Chasek 2000:378). The

[9] This is a statement made by the Norwegian minister for environment during the United Nations Climate Conference in Copenhagen (COP15) (Eide, 2009).

CSD's mandate is to monitor and review progress on the implementation of agenda 21 at local, national and international level; to develop policy recommendations; and to promote dialogue and build partnerships for sustainable development among governments, the international community, and major groups (Chasek 2000:379).

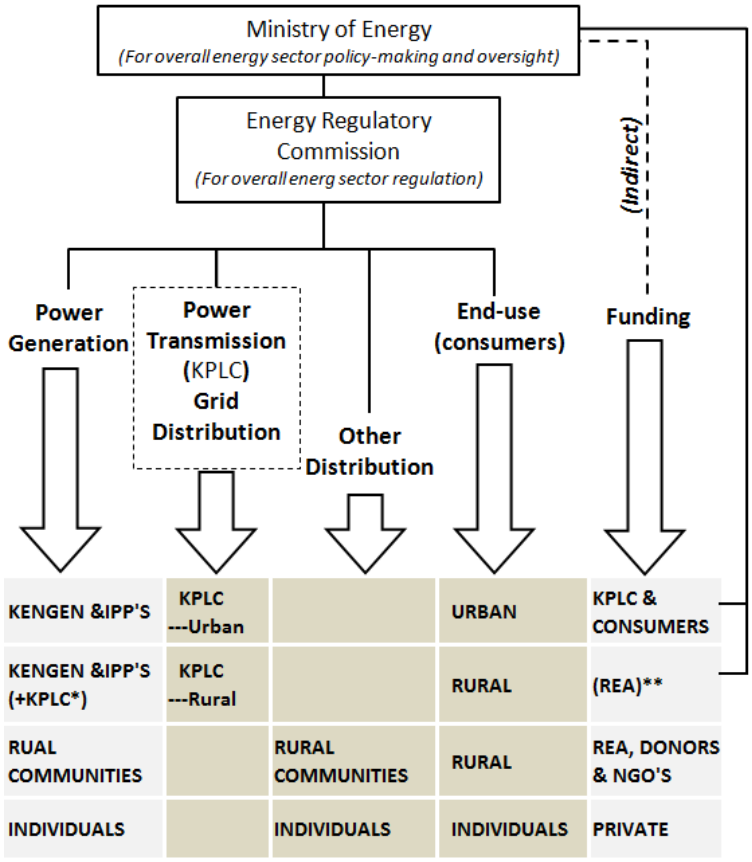
2.2 Reforming the Energy Sector in Kenya.

The development of energy policy in Kenya to officially recognize the role of renewable energy technologies in rural and urban electrification was initiated in 1987, but momentum picked up in the power sub-sector, when unbundling was done in 1997 to create a separate national electricity generation, transmission and distribution utilities (Abdalla et.al 2009:12, Ikiara et.al, 2007:19). This policy affecting the whole energy sector was tabled in parliament as Sessional Paper Number 4 of 2004, which led to the enactment of the Energy Act, 2006 giving legal force to the policy (Ibid). Below is a summary of measures contained in the Sessional paper Number 4 of 2004 which is still under implementation.

1. The conversion of Energy Regulatory Board (ERB) into the Energy Regulatory Commission (ERC) so that the body now regulates the whole energy sector. ERC is responsible for licensing, tariff setting and approval and protection of rights and privileges of energy providers, and consumers. Under the ERC, are the Kenya Power and Lighting Company (KPLC) and Kenya Electricity Generating Company (KenGen). KenGen manages and operates all public power electricity generating facilities and sells electricity in bulk to KPLC who owns all transmission and distribution assets, and buys electricity in bulk from generating companies for transmission, distribution and retail to customers.
2. Independent Power Producers (IPPs) build, own and operate power stations and sell the power in bulk to KPLC.
3. Rural Electrification which started in the 1980s is given a new impetus, by the formation of a Rural Electrification Authority (REA), to provide specific funding for REP and promote its development through the active involvement of various actors such as private sector developers and NGOs.

4. The establishment of a renewable energy department that aims at accelerating the adoption of renewable energy as a means of improving energy security and access to modern energy.
5. Promoting private or community-owned vertically integrated entities either operating renewable energy power plants or hybrid systems to coexist with licensed distributors.

Figure 1:Institutional setup in the Kenyan Energy Sector



Source:Self elaboration based on Abdalla (2009) and UNEP (2002).

2.2.1 The Rural Electrification Programme (REP)

Over 70% of Kenya's population which stand at approximately 38 million, lives in rural areas, with only 5% of the rural population having access to electricity (CIA world fact book, 2009). The remaining 95% of the rural population relies heavily on traditional biomass energy supplies, which have serious environmental drawbacks

arising from cutting of trees for fuel, wood and burning of charcoal (Mshana and Ischebeck, 1999:87, Karekezi, 2002). The Kenya government, through its REP that is still under implementation, hopes to provide cost effective and affordable energy services to the rural poor, especially through the use of RETs such as solar photovoltaic, bioenergy, hydro and geothermal power (AFREPREN, 2008). Electricity generation in Kenya is done by the public generating company, KenGen and other independent power producers (IPP). Table 2 below shows Kenya's current total electricity consumption at 1245.65MW, with Hydropower having the highest installed capacity at 57.6%, thermal (29.1%), geothermal (10.3%) while the rest stands for (3%).The total share of renewable energy in total electricity consumption is estimated to be 70.3%.

Figure 2:Kenya's sources of electric power in Megawatts.

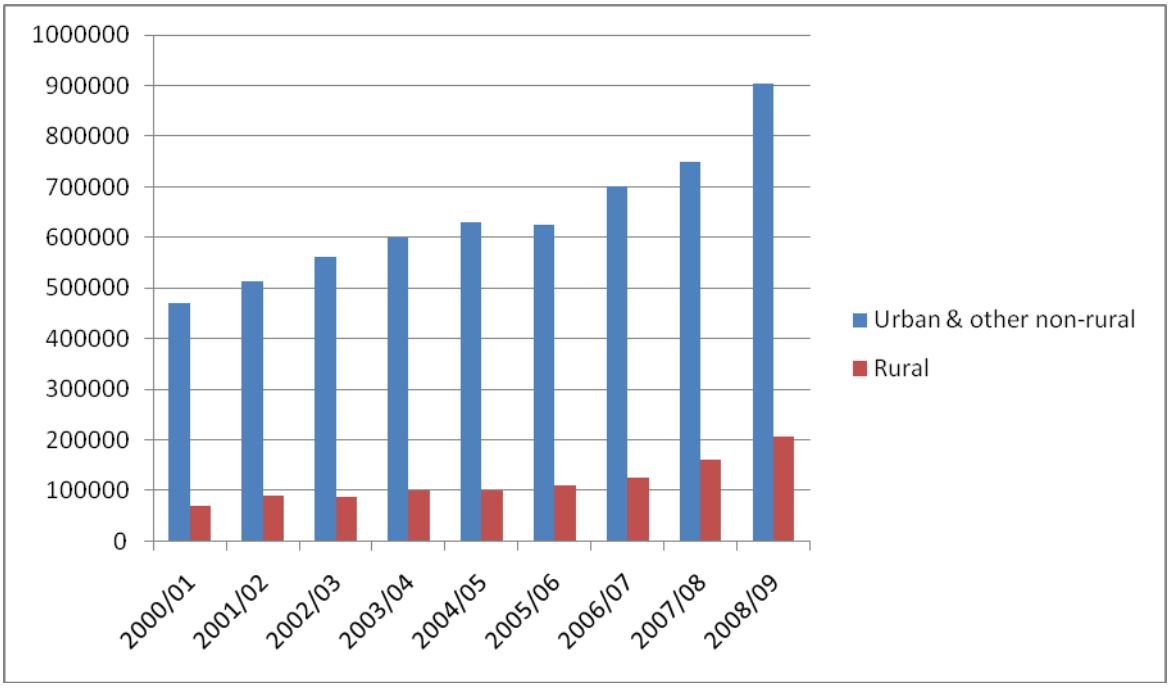
	Thermal	Hydro	Geothermal	Wind	Biomass	Solar	Total production
KenGen	363,12	677	115	0.55	36		
IPPs	5.1	unknown	13	unknown	2		
Totals	368.22	677	128	0.55	36	4*	1245.65
(%) of total electricity production	29.15	60	57.6%	0.55		0.32	
Potential		2033MW	3000MW	3-10m/s(wind speeds		4-6kWh/m2	

Source: Self elaboration based on data from KPLC 2010 and Ikiara (2009).

Since the establishment of the REP, its implementation was done by KPLC with power supply under the programme, primarily provided by the company's large hydro-dominated national grid and diesel powered isolated grids. However, rural electrification under the implementation of KPLC proved to be a very slow process that only managed to electrify slightly over hundred thousand rural homes in a couple

of decades, a figure that is less than 1% of the rural population (KPLC, 2007, AFREPREN, 2008). Another reason for this low level of electricity supply stems from the neglect of rural areas as a result of excessive centralization of development activities with very minimal decentralization (Abdallah, 2007:82). In addition, electricity supply through grid extension to the rural areas proved to be very costly and inefficient due to the large distances of the rural areas from the main grids[10] (Ibid). Figure 3 below shows KPLC electricity supply rate to urban and non-rural places as compared to rural places. The figure shows very slow pace of rural electrification as compared to the electrification of urban and other non-rural areas.

Figure 3:KPLC (public) electricity consumers.



Source: Self elaboration based on data from KenGen and KPLC Statistical Data base (2000-2009).

In order to enhance rural electrification and development through other cheap RETs sources, the Kenyan government transferred the mandate to run REP to the 'newly' created REA, effective as from the year 2009(Ibid). The government quickly realized that the role of private actors and other non-state actors have to be recognized if the

[10] Installation costs were estimated at ksh 180,000(Approximately US$2225) per consumer in the rural areas which is almost ten times the price of rural electrification through solar house panels(Mwakubo et.al, 2007:43)

goal of bringing energy to the rural areas is to be achieved. The government therefore, relinquished some aspects of its role in rural electrification, making it easier for the community to join forces with other actors in public-private partnerships, with a view to undertaking rural electrification projects (UNEP Risøe, 2009:3). Even though the government recognized the important role played by private actors and other non-state actors in rural electrification through RETs; this task has met several barriers. A brief presentation of the barriers follows below.

2.3 Barriers

The term barrier is used in this thesis to refer to factors impeding the deployment of RETs. These barriers tend to be interrelated; hence it may be difficult to isolate the impact of any one barrier in particular. Wilkins (2002:121) points out that in many cases, barriers to technology transfer are similar in industrialized and developing countries, although specific national characteristics play a role in determining the type of barrier within each country. This implies that some of the barriers in developing countries result from insufficient development, while others result from weak policies and lack of government targets and plans. I hereby consider four categories of barriers: financial, institutional, social/environmental; and technological.

2.3.1 Financial barriers

These barriers are related to the costs and benefits of investing in RETs. Installers and end users of RETs need access to capital in order to purchase, install and use renewable energy systems. For installers, the main barriers are regulations and conditions imposed by lenders before approving a loan. There is need for policy makers to initiate appropriate economic instruments, which offers the producers and consumers of energy services incentives to alter their production and consumption decisions. Specific economic instruments include taxes, subsidies, tariffs and favorable financial schemes (Edjekumhene 2001:8). An energy tax is simply a compulsory levy imposed by a government or a public agency on an energy source (Ibid). Different levels of tax on different fuels and sources of energy will have a significant effect on

energy supply and demand patterns. These taxes can be used to harness market forces to produce desired policy outcomes[11].

Lack of investment also results from lack of understanding of the investment profiles and life-cycle costs for renewable energy systems, which are characterized by higher up-front cost but with longer-term benefits (Wilkins, 2002:132). Capital costs may also go up due to increased risk perception, as a result of political and economic instability and corruption. In such cases of investment uncertainty, subsidies can be used to encourage private investment. Subsidies open up the possibility of granting selective support for certain objectives such as developing new energy technologies or providing energy to the urban or rural poor. Subsidies can be direct or indirect. Indirect subsidies come in the form of tax reductions and exemptions ((Edjekumhene 2001:9). Opportunities provided by other potential finance mechanisms like the CDM have not yielded much fruit due to the strict rules and requirements that projects have to meet before they can qualify as CDM projects. In short, there are different barriers related to the financing of RETs. Barnes et.al 1998(quoted in Edjekumhene 2001:10) have stated that, "there is no magic fix for the challenge of renewable energy finance, and that responding to the challenge involves patiently cultivating the right mix of supporting institutions, reforms, policies, market, and infrastructure, based on the country and circumstances".

2.3.2 Institutional barriers

The implementation of RET is affected by policy and regulations on the national level that relate to rural electrification and poverty eradication goals. The institutional structure of the energy sector in many developing countries is still under government monopoly, with responsibility for energy generation and distribution divided among several government departments and the electricity utility, hence locking out other

[11] Taxes can be formulated as volume taxes where rates of taxation are per unit of volume of the different fossil fuels or as value tax- which sets the tax as a percentage of the value of the different fuels. Energy taxes can also be constructed as 'environmental taxes' where fuels are taxed according to the degree of pollution they cause ((Edjekumhene 2001:8).

stakeholders (Ikiara et.al 2007:55, Painuly, 2001.80, Wilkins, 2002:126). This type of monopoly creates an unstable macro-economic environment which increases risks and discourages investments. Lack of a strong legal regulatory framework governing intellectual property rights, other fiscal policy and support mechanisms is a key requirement for RETs development. Without this government commitment, investors, suppliers and developers are apprehensive that adequate support may not be made available, and are less likely to invest time and money in developing a market for RETs in Kenya (Zambrano and Ofstad, 2010:21).

2.3.3 Social and Environmental barriers

Social acceptance of RET is very important and decisive for the dissemination of these technologies. For example, gas from urban waste for cooking may not be acceptable to some segments of the society. Women both gather and use most of the energy used in households in rural communities; therefore, it is important that suppliers of RET understand the relationship between gender technology (Wilkins, 2002:135) The local culture, religion and superstitions of the community need to be understood when projects are planned in order to avoid problems later in the development stage of the technology. In addition, the social fabric of the community, the hierarchy and decision making process need to be given due consideration when planning RETs. Resistance to RETs may also arise in cases where neighboring communities are displaced from their ancestral land or denied access to grazing land due to the development of large RETs like hydropower and geothermal plants. Other barriers are connected to lack of valuation of environmental externalities.

2.3.4 Technological barriers

Discussion of technological barrier evolves around the type of technology in use and inadequate access to R&D capabilities. Some technologies are developed locally while some are acquired from other developing countries, or from the developed countries. One of the fundamental barriers related to technology transfer to developing

countries is that the technology being transferred is not appropriate to the local context and demand or not adapted to the local environment (Wilkins, 2002:122).

It is important to understand the local situation of developing countries and meet their required energy demands with appropriate technology identified for each situation. Doing this, demands local capacity building through the transfer of knowledge and investments in research, development and demonstration of the new technology.

2.4 Summary.

This first section of this chapter has provided an insight on the Kenyan government's efforts in enhancing access to renewable energy resources. It presents the reforms made within the energy sector that saw the amendment of the energy policy in Kenya to officially recognize the role of RETs in rural and urban electrification. The second section gives a brief understanding of the barriers to RETs. The framework of barrier analysis is composed of four categories of barriers namely: financial, institutional, social and environmental and finally technological barriers.

3 Social Capital

This chapter of the thesis will discuss the relevance of social capital to institutions, finance, technology and the environment as factors which influence the development and dissemination of renewable energy technology. The main aim of this chapter is to show how the theory of social capital is intertwined with the four factors which also represent the barriers to rural electrification through RETs. The discussion takes into account both negative and positive impacts of social capital on the four barriers. In addition to an increased role of civil society participation, the role played by the government in RETs dissemination will be emphasized in the last section of this chapter. The chapter concludes with a brief summary.

3.1 Definition of Social Capital.

Over the last 10 years, reviewers of social capital research and theories have observed no emerging agreement on a precise definition of social capital (Nahapiet and Ghoshal, 1998, Schuller, Baron and Field 2000, Nahapiet, 2008). The debates revolve around the notion of social capital and whether social capital is social, and more commonly, whether it is capital, and, if it is, what this implies for how it enters the production function. My definitional approach of social capital will borrow from several authors basing my judgment on their specific contributions relevance to the barriers of RETs under study.

Adler and Kwon(2002:17) gives a more embracing definition of social capital by suggesting that social capital might be seen as an umbrella concept, broadly understood as " *the goodwill engendered by the fabric of social relations, and that can be mobilized to facilitate action*". Even though social capital can be a difficult term to pin down, most definitions include (at least one of) the degree of trust, co-operative norms and associational memberships or networks within a society.

There would seem to be reasonable agreement that social bonding, cohesion, integration, identification between individuals, trust, obligations and mutual expectations, developed through networks and interaction, would constitute the essential facets of social capital as a resource (Baron et.al., 2000). And further, that such resources may- to the extent that they are appropriable- constitute capital in the sense of facilitating the achievement of goals (Coleman 1990). The goal to be achieved in the context of this thesis is to understand the barriers to RETs and ways of overcoming them.

Social capital is intrinsically embedded in a variety of social relationships with several variables; hence it is of great importance to conceptualize social capital. I take the view that the "social" in social capital refers to social relationships: aspects of social networks that have the potential for yielding profits. It is therefore not a single entity but a variety of different entities, with two elements in common: they all consist of some aspects of social structures, and they facilitate certain actions of actors- whether persons or corporate actors within the structure (Coleman, 1988:98). This relationship of social capital is further divided between government social capital and civil social capital. Government social capital refers to institutions[12] that influence peoples' ability to cooperate for mutual benefit while civil social capital encompasses common values, norms, informal networks, and associational memberships that affect the ability of individuals to work together to achieve common goals (Knack, 2002:42). The two types of social capital envisage the extent of the engagement or interaction of both the government and the civil society in RETS and how this interaction can accelerate the rate of RETs development and dissemination. The discussion that follows presents the relationship between social capital and identified barriers to RETs development and dissemination.

[12] The most commonly analyzed institutions include those responsible for the enforceability of contracts, the rule of law, and the extent of civil liberties permitted by the state.

3.2 Level of Analysis

It is necessary to clarify the assumptions one operates with in regards to the relationship between that of the social and the individual, and more generally: how phenomena's on the social macro level emerges from the interaction and relatedness at the individual micro level.

The discussion rests on the two hypotheses about the need for government engagement in RETs and the need for stakeholder cooperation drawing from government and civil society types of social capital respectively. Operationalization of social capital demands identification of the different elements of social capital that have the potential of stimulating RETs dissemination. Nahapiet and Ghoshal (1998:244) identify elements of social capital which they then integrate into an operationalization of the concept as follows below.

The Structural dimension of social capital is to do with the overall pattern of connections between actors which implies resources inherent in a social structure on a macro level relative to individuals, and a micro level relative to the level of the firm(Ibid:252). For example, the structural dimension of social capital in the Kenyan society will help us understand the institutional, legal and political framework within the energy sector and how this framework relates to private and non-state actors in facilitating the development and dissemination of RETs.

The Cognitive dimension deals with the shared culture, codes and language and shared narratives. It is considered as discourse which is characteristic of a collective, which is also present at the macro level relative to individuals, either on the level of the firm or the level of sub-units. This dimension makes a notable attempt to tackle the link between culture and economic performance on empirical basis, i.e., the role of social inequality and authority within the society, the position of the individual vis-a-vis the collective, the relative emphasis on gender relations and how to cope with uncertainty and conflict(Baud and Post, 2002:47). For instance, the cognitive dimension of social capital will help one understand the social fabric of the society, which may include

cultures and superstitions, taboos and rituals, languages etc, all these being important elements of the social/environmental barrier to RETs.

The relational dimension refers to "assets created and leveraged through relationships" (Ibid: 244). In other words, it deals with trust, norms, obligations and identification. This simply implies the social interaction between stakeholders and all other actors involved within the renewable energy sector.

3.2.1 The interaction between social capital and institutions

The prevailing discussion in this part is based on North's definition of institutions as being 'the rules of the game in a society or, more formally, the humanly devised constraints that shape human interaction' e.g. laws and regulations enacted by the government (North 1990:3). He further points out that these humanly devised constraints are the informal codes, conducts and conventions of behavior, what he also refers to as informal institutions(Ibid:4).North uses the analogy of rules in sport to make the distinction clear. The written rules of a sport are analogous to formal institutions, whereas unwritten codes of conduct, such as an acceptance that it is unacceptable to kick an opponent in the head, are analogous to informal institutions (Ibid). He goes on to argue that 'underlying these informal constraints/institutions are formal rules, but these are seldom the obvious and immediate source of choice in daily interactions (Ibid: 36). The implication here suggests that informal institutions are actually more important than formal institutions (Knowles, cited in Mavrotas and Sharrocks, 2007:200). A key theme of North (ibid: 201) is that good institutions will encourage co-operation and reduce transaction costs, notions that also feature prominently in the social capital literature. The arguments rest upon the power of trust in increasing the number of mutually beneficial trade, solving collective action problems and solving principal-agent conflicts. Fukuyama (1995:10) asserts that trust is a crucial variable in economic success and the glue that makes social capital possible.

The role of government in solving collective action problems through the enforcement of property rights and rules is vital in the presence of formal institutions. However, in cases where these institutions are weak or totally absent, social capital may make it easier to resolve collective action problems (Knowles, cited in Mavrotas and Sharrocks, 2007:204). For example, community based institutions, that represent a decentralized, bottom-up form of government have evolved in many parts of the developing world to take over the management of common property resources. As much as these community-based institutions play an important role, it may be difficult to determine whether these institutions should be classified as formal or informal institutions[13].

3.2.2 Interaction between Social Capital and Information flow.

The more people interact with each other, be this in choral societies, sports groups, religious or educational organizations, the better the flow of information. Social capital theory and research point clearly to the importance of networks, relationships, trust, norms and identity as potential explananda for the creation and sharing of knowledge, which is a key component of technology(Rønning 2008:3). The flow of information may include knowledge about best practice techniques which make the introduction of new technologies more likely, hence increasing the level of production (Ibid). The scope for technological learning within local economies depends in part on their networking characteristics. In addition, Baud and Post (2002:50) asserts that the capacity for innovation in part depends on tacit knowledge embodied in people and local institutions, it follows that local factors play a key role in the ability of firms (especially small) to embark upon a technological upgrading strategy. Knowledge itself or human capital as a qualitative production factor is assumed to exhibit increasing returns. The basic assumption is that social capital will facilitate

[13]Institutions can sometimes be difficult to categorize into formal and informal, so it can be useful to think of institutions forming a continuum, with written constitutions at one end and taboos, customs and traditions at the other, while towards the middle comes the community based institutions that exist in many parts of the world to manage common property resources (Mavrotas and Shorrocks, 2007:217).

cooperation as well as the creation and sharing of knowledge between and within employees and firms at the micro and macro levels respectively (Rønning, 2008:4, Staveren, 2000:18). However, the type of network of social capital employed in the transfer of knowledge or technology is also vital for the successful implementation of the transferred technology. All societies; modern, authoritarian, democratic, feudal or capitalist- are characterized by both formal and informal networks of communication and exchange. Putnam (1994:173) points out that some of these networks are primarily "horizontal," bringing together agents of equivalent status and powers while others are primarily "vertical," linking unequal agents in asymmetric relations of hierarchy and dependence. These networks of communication determine the effectiveness of knowledge and technology transfer between South-South or North-South countries. Putnam (1994) further argues that vertical network, no matter how important it is, to its participants, cannot sustain social trust and cooperation. This owes to the fact that vertical flows of information are often less reliable than horizontal flows, in part because the subordinate may husband information as a hedge against exploitation, or the master may deliberately choose to withhold some information from his/her client. Note that this is possible in all types of knowledge transfers. Below is a distinction of the two types of transfers.

Interaction between Social Capital and Technology transfer.

With intensifying globalization which brings about competitive pressures on firms and local economies, learning of new technology is no longer a matter of individual firms alone, but assumes collective features(Baud and Post, 2002:50).Technology transfer can be defined as the diffusion and adoption of new technical equipment, practices and know-how between actors (e.g. private sector, government sector, finance institutions, NGOs, research bodies, etc) within a region or from one region to the other (Wilkins, 2002:43). In general, 'transfer' should therefore be regarded as putting the technical concepts into practice locally in a sustainable framework so that local people can understand the technology, use it in a sustainable manner and replicate projects to speed up successful implementation(Ibid). This type of technological transfer is referred to as horizontal transfer, which describes the long-term process of embedding

technology within local populations and economy, including technical and business training and financial management. In horizontal transfer scenarios, foreign companies always establish a joint venture with local companies, an approach that makes it more difficult for the foreign companies to protect their technical designs and control the quality of their products, since the local company is an embedded partner in the manufacturing process. This scenario leads to a more sustainable situation as skills and knowledge are built up in the developing country that can help in the installation, operation and maintenance of the new technology(Ibid:45). The direct opposite of horizontal transfer, is the vertical technological transfer. In the latter, the international or multinational company(MNCs), might set up a factory to manufacture its technology in developing countries due to the low cost of operation, but the factory would be wholly owned and operated by the company(Ibid:44). This implies that the management and technical staff might be expatriates while the general work force would be provided by cheap local labour. This structure allows the MNC to protect its technical designs against potential competitors and hence control the quality of production.

So far only the positive effects of social capital on information flow and technology have been discussed. It is also possible that some customs or norms may hinder the introduction of new techniques. It is also quite possible that some networks or associations may hamper the adoption of new technology or collude to avoid the introduction of a new technology, due to the fear of competition or extinction of the old ineffective technology. Ogilivie (2004) notes that social networks such as guilds, cartels, mafias, political organizations and lobbying groups may provide benefits for members, but this can often come at the expense of non members.

3.2.3 Interaction between Social Capital and Economic Performance

The notion that economic activity is embedded in specific social settings that are likely to influence its performance is not new. For economists, embeddedness stands for the fact that economic (market) relations coexist with a set of social attributes. In other words, economic decisions are not solely based on market forces, such as prices and

quantities, but are also influenced by social attributes, such as cultural values, personal relationships, etc. i.e., who you are, what you know, and-not least who you know (Baud and Post, 2002:44).Virtually all transactions require an element of trust, meaning that an absence of trust reduces the number of mutually beneficial trades. Arrow (1972) suggests that a lack of trust explains much of the economic backwardness observed in the world (Cited in Mavrotas and Sharrocks, 2007:200). In the case of developing countries, where access to formal credit is not always easy or well developed, informal credit schemes may often provide a solution to capital access. However, the success of these credit schemes requires that members do not free ride. But, in a world governed by self interest, some members may be tempted to borrow money from the scheme, and then refuse to continue to make contributions (Co-operate). The non-cooperation can easily be shown with a prisoner's dilemma bargaining game, where the absence of an enforceable contract will provide the incentive for each self-interested party to defect on her part of the bargain, hence the likelihood of generating pareto-optimal solutions or scenarios is rather small if not nil. Dissemination of solar panels in rural Kenya has highly benefitted from these financial schemes, though operations of these schemes have been threatened by untrustworthy debtors.

The renewable energy sector in Kenya is still new and not yet much developed, hence requiring greater private and government collaboration in order to reduce monitoring and transaction costs. The issue of monitoring workers may act as a constraint on a firm size in low-trust economies or environments. Once a firm reaches a certain size, the owner operator has to delegate a degree of managerial decision making to others but this may be a challenge in situations of low trust. Employers may respond by employing people already known to them, rather than employing the person best qualified to do the job. In a society that is divided along ethnic lines like Kenya, preference may be given to hiring people from the same ethnic group as the employer, in the belief that they can be trusted more. This lack of social capital (trust) is one reason that prevents small firms from growing into large firms in many parts of Africa (Ibid: 202). Apart from trust, responsibility, loyalty and intrinsic motivation are other

social capabilities inherent in social capital spill-over effects to the market and state. Without the spill over of these social capabilities to the market and the state, economic actors will not be able to make rational decisions (Staveren, 2000:22). “Trust leads to lower transaction costs in markets and to higher collective contribution to public goods (Taxes). Responsibility decreases negative externalities from market exchange and reduces free-riding and rent seeking in the public sector. Loyalty reduces adjustment costs in dynamic market processes, where it supports the continuation of public goods supply. Intrinsic motivation increases labor productivity in both the market and the public sector” (Ibid).

3.2.4 Relation between Government and Civil Society Capital

The overwhelmingly positive association attached to social capital reflects the nature of its relationship to neo-liberalism. If laissez-faire involves leaving everything to the market, social capital suggests that the market does need to be complemented by a healthy civil society (Fine, 2010:48). Networks of personal relationships embedded between the government and the civil society inspire loyalties as well as communality of purpose and understanding. Membership of such networks makes cooperation easier, thus enhancing economic efficiency beyond the level reached by the atomic actors of neo-classical economies (Baud and Pos, 2002:45). Munasinghe (1995:21) stresses the need for more decentralization and greater private participation, which would hopefully loosen the grip of government on the energy market, and hence lead to an increased civil sector participation and cooperation with the government. Engagement of the private sector and other non-state actors in developing countries’ electric power provision is a fairly recent phenomenon, and started with the wave of energy sector reforms at the close of the 20th century(UNEP, Risøe 2009:8). As part of this transformation process, rural electrification, which has traditionally been viewed as a government responsibility, has also been devolved to sub-national and private actors. The decentralization of the electricity sector has had both positive and negative effects. Positive in that it has opened up for private sector and civil society involvement in RETs, and negative in that decentralization has led to increased

corruption and patronage as a result of the benefits embedded in the newly created networks at the local level. At this backdrop, the thesis examines the influence of social capital on RETs development and dissemination in developing countries.

3.3 Summary.

This chapter has argued that social capital (informal institutions) and formal institutions can either be substitutes or compliments. The theory of social capital tends to suggest that social capital will affect the accumulation of other factors of production through its spill-over effects on the market and the state. I have elaborated on how social capital: can increase efficiency through helping resolve collective action problems; lead to the introduction and adoption of new technologies and facilitate the transfer of knowledge; by reducing transaction and monitoring costs, and facilitating cooperation and interaction between the state, market and the civil society. It is important to take note that these spill- over effects of social capital on the market, state and the civil society are envisaged upon trust, responsibility, loyalty and intrinsic motivation as the core components of social capital.

4 Solar Energy

This chapter presents the use of solar energy in rural electrification starting by giving a description of the development of this technology, which was largely pioneered by the civil society with very minimal government involvement. The second section will provide an analysis of how financial, institutional, social/environmental and technological barriers have hampered effective development and dissemination of solar energy systems. These sections will also discuss the role played by the civil society and other stakeholders in overcoming these barriers.

4.1 Brief history

Kenya receives a plentiful supply of solar radiation, averaging between 4 and 6 kWh/m²/day which translates to approximately 1.54 billion Tonnes of Oil Equivalent (TOE). However, only a small proportion of this resource has been harnessed (Mutinda, 2007). Direct solar energy can broadly be categorized into solar photovoltaic (PV) technologies, which converts the sun's energy into electrical energy, and solar thermal technologies; which use the suns energy directly for heating cooking and drying (Karekezi and Ranja, 1997). Solar energy poses the most meaningful option of renewable energy for the rural sector, particular in terms of lighting, refrigeration, energizing small appliances and provision of hot water to households and institutions (Acker and Kammen, 1994, Karekezi 2002). Kenya has emerged as one of the global leaders, per capita, in the use of solar energy technology and this attributes largely to a growing market of solar PV systems among rural households, with current annual sales topping 30,000 units (Kenya Standard Bureau of Statistics, 2009). The Kenyan solar market has emerged as a key alternative to grid-based rural electrification, with minimal direct government support and only very moderate inputs from international donor aid groups (Jacobson, 2004). This makes Kenya an important example to a growing international trend towards market- based approaches to rural energy service delivery. While there is little doubt about the size and growth of the local market, there is an ongoing debate about the growing role of the private sector

and the relative quality of service delivery (Karekezi and Kithyoma, 2003). Under normal circumstances, the private sector creates an environment of competition that lowers commodity prices but can lead to quality problems in service delivery if their activities are not properly monitored and coordinated (Karekezi and Ranja, 1997:143).

The growing role of the private sector is as a result of the increase in donor support for solar energy technology, which is widely associated with concerns about the environment as well as the technology's role in rural poverty reduction. The latter, was an initiative of the World Bank under its structural adjustment program of the 1970s aimed at supporting liberalization, reforms and private sector participation through the financing of REP in developing countries (Ibid). In Kenya, the World Bank initiated a project in July 2000 through the department of Energy, to design standards for PV systems and components. Recommendations from the study, led to the provision of quality standards like labeling and certification of PV modules with provision of warranties such that consumers are better protected as well as better aware of what they are buying (Munasinghe, 1995).

4.1.1 Solar Power- Technology options.

A variety of technological options exist for rural electrification by solar power, ranging from small applications such as solar lanterns to large community power plants and solar home systems suited to serve public institutions such as schools and community health centers. The two commonly applied PV solar systems in Kenya are solar lanterns and Solar Home Systems (SHS). Community Systems are quite new in the market and is therefore not given attention in this thesis.

4.1.2 Solar Home Systems in Kenya (SHS),

A solar home system (SHS) is an independent off-grid domestic installation, normally consisting of a 10-50 watt peak(Wp) photovoltaic module and a battery sometimes coupled with a charge controller, wiring, and connections to small appliances that provides power to a household (Jacobson, 2004). SHS presents the least-cost option for electrifying homes in many rural areas especially within sparsely populated arid

and semi-arid lands. This sector has experienced minimal government involvement, and the little government intervention was restricted to specific projects, for example, PV power supplies for schools and rural clinics, rural water supply systems, high frequency radio and telecommunication relays and railway signaling amongst others (Wilkins, 2002:193). There is a strong rural demand for SHS in Kenya, and the market continues to grow at around 15-20% per year, with many more installations in rural Kenya(well over 3% of rural household that stands at approximately 26 million) than there are connections under the KPLC subsidized REP(Kenya National Bureau of Statistics 2007:32).

The PV market in Kenya has developed primarily along commercial lines with the first phase of installation championed by upper-middle class rural innovators and community based NGO projects that marketed the technology at the grassroots level and created high demand. The cost-effectiveness of PV systems, appealed to the over 3 million people outside the reach of primary grid electricity, hence, large numbers of the rural poor bought small PV panels and batteries primarily to power lights and small appliances like television sets, radio and communication devices (Wilkins, 2002:193). Purchase of the SHS was made easier by the high-purchase and community financing schemes which offered small credit advances with well tailored payment agreements to suit the income profile of the rural poor. In addition, field surveys shows that the cheap Chinese 12V television sets and radios that have been widely available in the markets, increased the demand for these gadgets in the rural areas and hence the need for cheap electricity to power them. Nevertheless, a big event like the upcoming football world cup has increased the demand for SHS to power their television sets(Nyambega 2009[Interview].

4.1.3 Solar lanterns

A solar lantern is one of the simpler PV applications used in rural electrification. The lantern consists of three main components; a mini solar PV panel, a storage battery and a light. The lantern charges in the sun during the day, and will give light in the evening for about 4-6 hours (Gambacorta et.al, 2008:24). A commonly used lantern in most

rural homes in Kenya is a simple one with no integrated solar panel and the battery is recharged by simply carrying them to a solar or diesel generator powered station "battery charging shop, where they are left overnight (or sometimes for several days) for charging (Karekezi, 2010[Interview).The lantern is easy to handle, it is also cheap and can therefore, be rented on a daily basis, and the low unit cost guarantees good returns for the local entrepreneurs engaged in the rental business.

4.2 Financial Barriers

One of the main obvious reasons why the potential PV market has not yet been reached in Kenya is the lack of sufficient capital to purchase the equipments. Access to credits for households has been a problem as there have been few suitable micro-financing schemes available in the rural areas that match the income profile of the larger population(Jacobson 2004:15) However, there has been an upsurge in membership confined savings and credit schemes at the grass root level which serve the members' savings and credit needs. The credit function of savings and credit schemes is accommodative of the economic and social status of the poor who lack capacity to meet the terms demanded by commercial banks, and are useful institutions for providing credit for all round development (Mshana and Ischebeck, 1999:60). The accommodative role of these institutions is captured by a statement from one of the interviewees who owns a SHS:

> The heavy rains just before the harvest season totally destroyed my crops and I'm therefore left with nothing to sell or fend my family. I had just acquired a solar panel on higher purchase with support from a local bank but since I didn't have money to service the monthly charges, the panel was repossessed by the bank. However, thanks to Nyamgolo women group's finance scheme that bailed me out with a loan enough to complete my solar debt and also pay the semester's school fees for my children who had to discontinue their studies because of lack of school fees (Nyambega, 2010[Interview]).

Most of the households in rural Kenya do not have regular cash incomes, as their cash incomes may depend on the harvesting and selling of crops and handicrafts, or remittances from family members working away from home in urban areas or overseas. Fortunately, there is a rise in informal lending schemes in Kenya, the so called “maendeleo ya wanawake” or “merry-go-rounds” , micro-credit schemes that allow the consumers access to small loans that are repayable by farm products and other means[14]. Access to credit for other players such as developers, installers and local technology manufacturers can also be difficult, as banks are not used to assessing project finance for renewable energy systems which have a relatively high up-front costs (Wilkins, 2002:140). In order to stimulate the development of these technologies, the private sector has facilitated access to the technology, through loan guarantee by technology suppliers in the form of buyback of the equipment at a depreciated value over time (Karekezi, 2010[Interview]).

A survey undertaken by AFREPREN (2008), disclosed how unfavorable requirements of banking institutions affected dissemination. The study noted that banking institutions laid down strict conditions for RETs investors who as part of their application requirement had to include a feasibility study conducted at the applicant’s expense, land titles and other property ownership documentation as collateral. Furnishing this information is a herculean task for small-scale- entrepreneurs’ enterprises that do not keep such detailed records, and in most cases have not yet developed a sound track record, and still do not have enough financial securities to prove their creditworthiness (Martinot et.al 2000). And in cases where loans were provided, lending organizations and development banks charged extremely higher interest rates. The co-owner of a newly started solar company in Kenya elaborates this point:

[14] Maendeleo ya wanawake is a Swahili phrase which simply means women empowerment while Merry-go-rounds”, which means a revolving fund arrangement for assistance of members. Responding to the need for gender-specific programmes, women lawyers, bankers, entrepreneurs and trainers set up the Kenya Women Finance Trust in 1981. It is the only micro-finance institution in the country exclusively for women, and it has more than 100,000 members. It grants cheap credit to low-income earners to start small businesses.(Mutume 2006:6)

> Using land titles as bank security presented difficulties because people often do not have land titles - and, if they do, the land was not owned by a single individual or company but by a family.(Nyambega, 2010[Interview]).

Surveys of the cost of various solar models in the rural regions are relatively high as compared to per capita incomes in the region, and this has resulted into a consumer group basically composed of the middle income group with an annual income of about US$2500 and above (Kenya National Bureau of Statistics, 2009). In addition, poverty in the rural regions of Kenya has increased exorbitantly in recent years and at current exchange rate, the national poverty line for rural areas is lower than the international poverty line of US$1 per day [15](KIPPRA economic report, 2009:22).

Nevertheless, high import duty and value added tax(VAT) on SHS components as compared to the subsidies provided on alternative energy, like kerosene and paraffin has been one of the major reasons for high prices on SHS(Wilkins, 2002:141). Solar sales in Kenya have long been (and continue to be) driven largely by unsubsidized over- the -counter cash purchases of SHS. However, in 2009, as an initiative to promote renewable energy, the government implemented a zero-rated (0% import duty) on solar PV panels, solar water heaters and solar pumps, though still imposing a 16% Value Added Tax (VAT); there was a remarkable increase on demand and supply of these appliances (Wahome, 2009, Ikiara, 2009).

Price distortions in the solar Market and inconsistencies in fee setting from village to village make people unwilling to pay for the SHS. In addition, some villages could be lucky to benefit from free or very cheap solar energy technologies from demonstration projects by NGOs', and this may leave the users with the impression that they need to pay very little or will be given the service for free, hence reneging on making payments (Okwemba 2010[Interview]).With access to loans and fee-for-service arrangements, estimate suggest that the SHS markets could reach 50% or more of unelectrified rural homes (Ikiara, 2009:7).

[15] National surveys set the rural and urban poverty line at Ksh 1,560(App. US$19) and 2,648(App.US$32.7) per month (National Bureau of Statistics, 2009:37).

4.3 Institutional Barriers

Even though, the development and dissemination of SHS has experienced minimal government intervention, imperfections and distortions in the market, coupled with unfavorable financial and regulatory environments imply that government intervention is not only desirable but also necessary to promote the development of the solar energy market. Without clear policies of government backing,through incentives, for the development of PV technology, then other key players particularly the private sector are not encouraged to invest in the technology or participate in market development. The establishment of an extensive retailer/installer/ maintenance network to support the solar market, is crucial and requires users to have frequent access to spare parts and maintenance services (Wilkins, 2002:197). Unfortunately, many advanced solar PV modules are not being produced locally yet, due to the high technology and raw materials required (Ikiara, 2009:8). The solar energy market is largely dominated by the informal sectors who indulge, to a wide extent, in the manufacture of spare parts and other PV module components.

Ironically, the informal sector actors are never consulted when the government draws up its national strategic plan on rural electrification through solar energy, and are only consulted for comments when the draft document is complete (Ikiara, 2009:5). Consultation with the private sector would save the government a lot of money on rural electrification planning and execution. One of the experts elaborates on this barrier:

> In order for developers to estimate the potential market for stand alone renewable energy systems, or mini-grids, it is important to know which areas are to receive grid electrification within the next 5-10 years, as this knowledge will help us plan strategically on which areas are to receive pre-electrification systems. The government ought to include private developers in drawing up the

rural electrification plans in order to avoid overlapping plans [16](Okumu, 2010[Interview]).

It is therefore important to wholly integrate this sector in the overall national economic planning in order to tap benefits accruing from public- private partnership in the dissemination of solar energy technologies. Meanwhile, to help create a market for locally manufactured solar components, a normative measure should be instituted by the government, which will stipulate that all government funded and donor-funded projects should use local components where available (Edjekumhene et.al. 2001:117). Furthermore, the extremely low level of feed-in-Tariff (FIT)[17] at $0.20kWh has locked out potential investors in this technology, as there is no assurance that the government would buy electricity generated by the IPP (Ministry of Energy, 2008). The lack of inadequate standard policies for SHS design, manufacture and procurement procedures, to guide companies in the purchase and design of PV technologies has destabilized the SHS market, especially in the rural areas. This has reduced the customers trust in this technology and at the same time scared away potential investors in the technology (Karekezi and Kithyoma, 2002). This simply means that if poor-quality technology is used or systems not maintained regularly, then technical failure will occur resulting in lack of confidence in the technology. This in turn prevents financiers' from providing funds and the market collapses in the long run.

[16] Pre-electrification systems are designed to give access to electric power for a few years only while the area is waiting for grid connection. Once the grid arrives, the systems can then be moved on to another village (Wilkins, 2002:124).

[17] A Feed-in-Tariff is an instrument for promoting generation of electricity from Renewable Energy Sources (RES). The FIT allows power producers to sell and obligates the distributors to buy on a priority basis all RES at a pre-determined fixed tariff for a given period of time. Its objectives are to: a) facilitate resource mobilization by providing investment security and market stability for investors in RES electricity generation) reduce transaction and administrative costs by eliminating the conventional bidding processes; c) encourage private investors to operate the power plant prudently and efficiently so as to maximize its returns(ministry of energy, 2008:1). In March, 2008, the Ministry of Energy formulated a feed-in-tariffs policy for wind, small hydros and biomass resource generated electricity with the exemption of solar energy from the list. A mid term review of the FIT policy in January, 2010 led to the inclusion of solar energy in a bid to facilitate accelerated investment in this sector (Ibid).

4.3.1 Small Medium Enterprises in Kenya(SMEs)

SMEs wield huge economical power in Kenya and are estimated to contribute over 18% of the national growth domestic product(GDP), and currently employing over 72% of the labor force(Government of Kenya, 2003). This sector has for a long time been considered as" informal" despite its economic prowess and has been subsequently excluded from the overall national economic strategy. While Kenya expects SMEs to play a central role in employment, industrial transformation and poverty reduction, the competitiveness and growth prospects of SMEs falls below the level required to meet challenges posed by these expectations (Moyi and Njiraini, 2005:8). The sector acts as the seedbed for entrepreneurial pursuits and complements the process of adjustment in large enterprises, by emerging as competent suppliers of products and services previously not available in the market. Despite his huge contribution, SMEs have operated in an environment lacking a coherent and comprehensive technology and innovation policy framework.

During discussions with experts, many admitted that the scope of SMEs is very wide and there is no doubt that if organized more effectively and professionally, they can improve the communities' livelihood substantially. Some of the recommendations emerging from discussions with experts on how to improve the role of SMES in RETs include: Capacity building and training; coordination, monitoring and evaluation of SMEs activities and their empowerment. In addition, SMEs stand a good chance of being sustainable, as they are initiated by the people and have a high degree of community commitment and ownership. The government has drawn up adequate policies to uplift this sector and integrate it in the national economy[18]. These policies aim at strengthening enterprise skills and market linkages through facilitating easy access to finance, marketing and technology (Ibid)

[18] The Economic Recovery Strategy for Wealth and Employment Creation acknowledges the role of the SMEs sector in generating growth, creating jobs and reducing poverty (Government of Kenya Strategy Report, 2003:1). The strategy paper expects over 88% of the 500,000 new jobs target to be created in this sector (Ibid).

4.4 Social and Environmental Barriers

Poor matching of individual and national development objectives pose a big challenge to the social acceptance and the environmental role played by solar technology. RET projects in developing countries are based on two assumptions: that rural communities need alternative energy to displace fuelwood, and that they could do well with renewable energy sources because they are cleaner and help protect the environment(UNEP, 2002)**.** Because of this assumption, some solar projects initiated by NGOs, without assessing the energy needs of the Siaya community were rejected in protest (Okumu, 2010[Interview]).

A number of businessmen involved in the sale of Kerosene and power from diesel generators have experienced a tough competition from the environmental friendly solar panels and hence making them loose a lot of profits (Ibid). In response, they have become serious critics of solar energy, calling for the poor sector of the community to boycott solar panels with the claim that the panels are too expensive compared to kerosene and diesel generated power (Ibid). This critique has made the use of solar panels for electrification to be viewed as something for the rich.

Some skeptics also argue that the environmental benefits of solar electrification are minimal, and its economical productive uses are few and far between, and that, in the absence of subsidies, solar sales are primarily to the rural middleclass elite rather than the rural poor (Karekezi and Kithyoma, 2002, Leach, 2001). Thus, the argument of skeptics goes that, the fact that benefits accrue primarily to the rural middle class, challenges the characterization of solar PV as a tool for poverty alleviation. On the other hand, this argument can be challenged by viewing the benefits accruing from the economic activities initiated by the middle class as a result of access to solar electrification, which in turn provides employment to the rural poor. Poverty alleviation through RETs is the main concern of developing countries and this can be justified by the statement below:

> Concerns for the environment is just mentioned in passing, in the rural electrification master plan, with the intention of attracting international funding

but our main focus as a government, is provision of electricity at the rural areas to help boost economic development and job creation" (Onyonka, 2010[Interview]).

The above statement made by the assistant minister for foreign affairs in Kenya, is quite representative for many developing countries. Many developing countries interest in renewable energy is not driven by the technology's cleanliness as a matter of priority but the technology's suitability to fight energy poverty.

Figure 4: Income-work and household related use of solar electricity in rural Kenya.

Appliance	% reporting income uses(Total)	% reporting farming uses	% reporting other business/salary work uses	% Reporting household use.
Lighting	32	30	70	98
Television	30	10	5	60
Radio	22	16	30	95
Mobile phones	90	78	40	99
Refrigeration	72	60	70	14

Source: Own elaboration with figures borrowed from AFREPREN Energy Handbook (2008).

Figure 4 shows results of a 2008 survey conducted by AFREPREN on energy uses for 100 households in Siaya town in Kenya. A large number of households were reported using solar energy primarily for lighting, and powering television, radios and mobile phones. Refrigeration is for the most part used for income generating activities and by institutions such as dispensaries and schools. Most solar users reported productivity related benefits from solar like commercial mobile phone charging and their use in

receiving information valuable for farming or business related services. Evidence from the survey indicate that despite the critism that solar energy is popular among the rural middleclass, many benefits accrue to the rural poor too through solar electrification, in the provision of public services like schools and health institutions.

Understanding the social fabric of the society also poses a challenge to the SHS distributors, technicians and payment collectors (Pastor Ong'injo 2010[interview]). Social pressures on the payment collector or technician responsible for disconnecting or removing systems can be difficult if they are closely related to the households with the systems. In such cases, some support from the outside community or respected community members with social status can help to monitor the administration, help in the deployment and ensure enforcement of the technology. The introduction of SHS in Siaya town in the Western part of Kenya was done by an NGO who gave out free solar panels for testing and demonstration to a number of community members during the initial stages of the technology. However, when the technology spread to neighboring villages, payment for the technology became a problem since the neighboring community also demanded the service free of charge. It had to take the intervention of local Catholic Church priest to install discipline in the community and ensure monthly payment (Ibid 2010[Interview]).

4.5 Technological Barriers

Figure 5: Maintaining Solar Panes in Kenya.

Source: Panos/Crispin Hughes for African Renewal in Mutume (2006).

“A key challenge for reliable long-term solar energy development in African countries has been the lack of knowledge, maintenance capabilities and administrative systems related to solar power installations” (World Energy Council report, 2009:4). It is quite obvious that if potential users are not familiar with the PV technology due to inadequate skills and knowledge then, there will be no demand for the system and market of the technology. The government through the Kenya Bureau of Standards offers quality control and maintenance devices for PV modules, and training courses on installation, maintenance, manufacture and marketing of PV products (Ministry of, Energy 2010). Marketing of SHS is a key difficulty especially in rural areas where access to media such as TV and Radios are limited. Spreading awareness therefore demands a face-to-face encounter with the users and demonstration of the technology, which can be time-consuming and demand a large number of technicians, which is always limited in supply. This therefore calls for localizing technological know-how at various levels from supply of the technology to local maintenance, through building of a sufficient local capacity assessment matrix that includes financial, technical and social criteria for technology acceptance (UNEP Risøe report, 2002).

The efforts of the government and other stakeholders like the Greenpeace Solar Generation Movement, in localizing the knowledge on solar energy was quite evident in a visit to one of the local schools in Kogelo, where President Barack Obama’s grandmother hails from. The young trainees from the local area attached to the Greenpeace Solar Movement were responsible for the installation of solar panels at Senator Barack Obama School in Kogelo and five different homes that I visited. The grandmother, Mama Sarah, who got considerable international attention during the 2008 presidential election in the US, was quoted in an article saying:

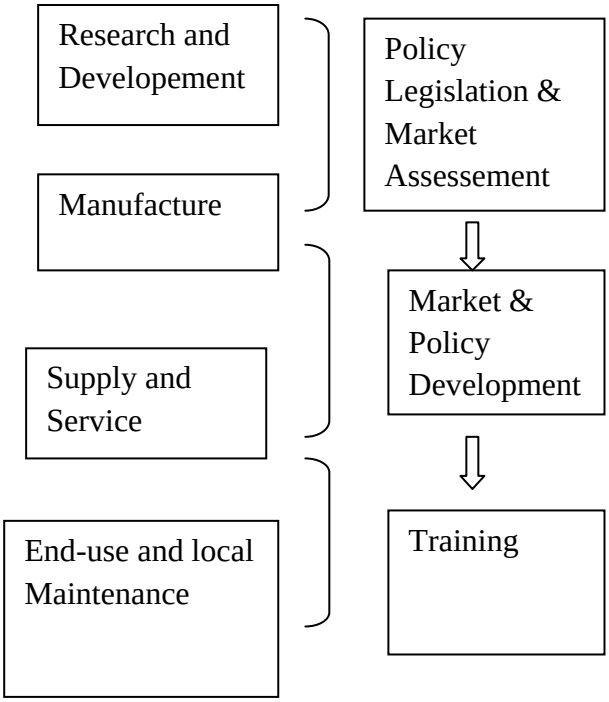
> I am very pleased that my home has been improved, thanks to solar energy and I'll make sure my grandson hears about it. Solar power is clean, reliable and affordable, unlike paraffin that is widely used in the area. Also, we now have qualified youth in the village who can help with the upkeep of the systems (MCkinnon blog, 2009).

Figure 6: Picture showing President Barack Obama's grandmother and the local school in Kogelo have solar panels installed.

Source: McKinnon blog (2009).

Nonetheless, successful technology delivery is envisaged on an intertwined cooperation between private entrepreneurs, civil society (end-users) and the government. As can be seen on the figure 7 below, the boundaries are not clear which simply means all the sectors have to be integrated in a common national plan incase any success in delivering the technology will be realized.

Figure 7: Steps in Technology delivery.



Source: Adapted from Wilkins (2002).

4.6 Summary

In order to hasten rural electrification through solar energy, the issue of equity and finance needs to be addressed in the context rural areas. Access to credit micro-financing schemes need to be made available, taking into account seasonality of income and the need for non-cash method of payments. The civil society organizations and other components of social capital are seen as organizations through which pooling of resources from large numbers of people could be achieved, with the hope of accelerating rural electrification through the utilization of solar energy

The government has also realized the major role played by SMEs in the solar energy market, and made efforts to integrate the sector in the overall national economic plan. Besides providing other supportive services to the private sector, the government ought to raise the feed-in-tariffs to attract private sector investment in solar energy.

The role of technology transfer with the aim of reinforcing local capacity building at both the private and public level has also been emphasized.

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5 Geothermal and hydropower electricity

The main sources of grid electricity production in Kenya through RETs are hydro-power and geothermal (Kenya atlas. 2005:16). This section considers the case of rural electrification by grid based electricity produced from geothermal and hydropower generation from Olkaria and Sondu Miriu Hydro power project (SMHPP) respectively. The field study I conducted have examined the role played by the civil society communities and the private sector, Vis-a- Vis that of the government in grid electrification. It is essential to note that this chapter deals with large-scale RETs that require substantial upfront investment unlike the two other cases of RETs considered in this thesis.

Having mentioned that, I start by giving a brief introduction of both hydropower and geothermal electricity generation in Kenya with specific reference to the two field studies conducted. I then proceed to the second section that presents the four categories of barriers: financial; institutional; social and environmental and technological respectively. In the last section of the chapter, I give a summary of the barriers and a brief discussion of measures to overcome these barriers basing my analysis on the various stakeholders' responses and considerations.

5.1 Hydropower

The official hydropower potential in Kenya stands at 2,033 MW, of which 677 MW (about 33%) is put in use (Otieno and Awange, 2006). Hydropower electricity stands for over 60% of electricity consumed in Kenya, but its adequate exploitation has not yet been fully achieved. The present generation of hydropower electricity in Kenya is concentrated to one main river, the Tana River, which has seven installed hydropower stations (Otieno and Owange, 2006). This heavy dependence of hydropower generation on a single river has led to high vulnerability to electricity shortages. Electricity shortages are more rampant especially in cases of droughts or when the

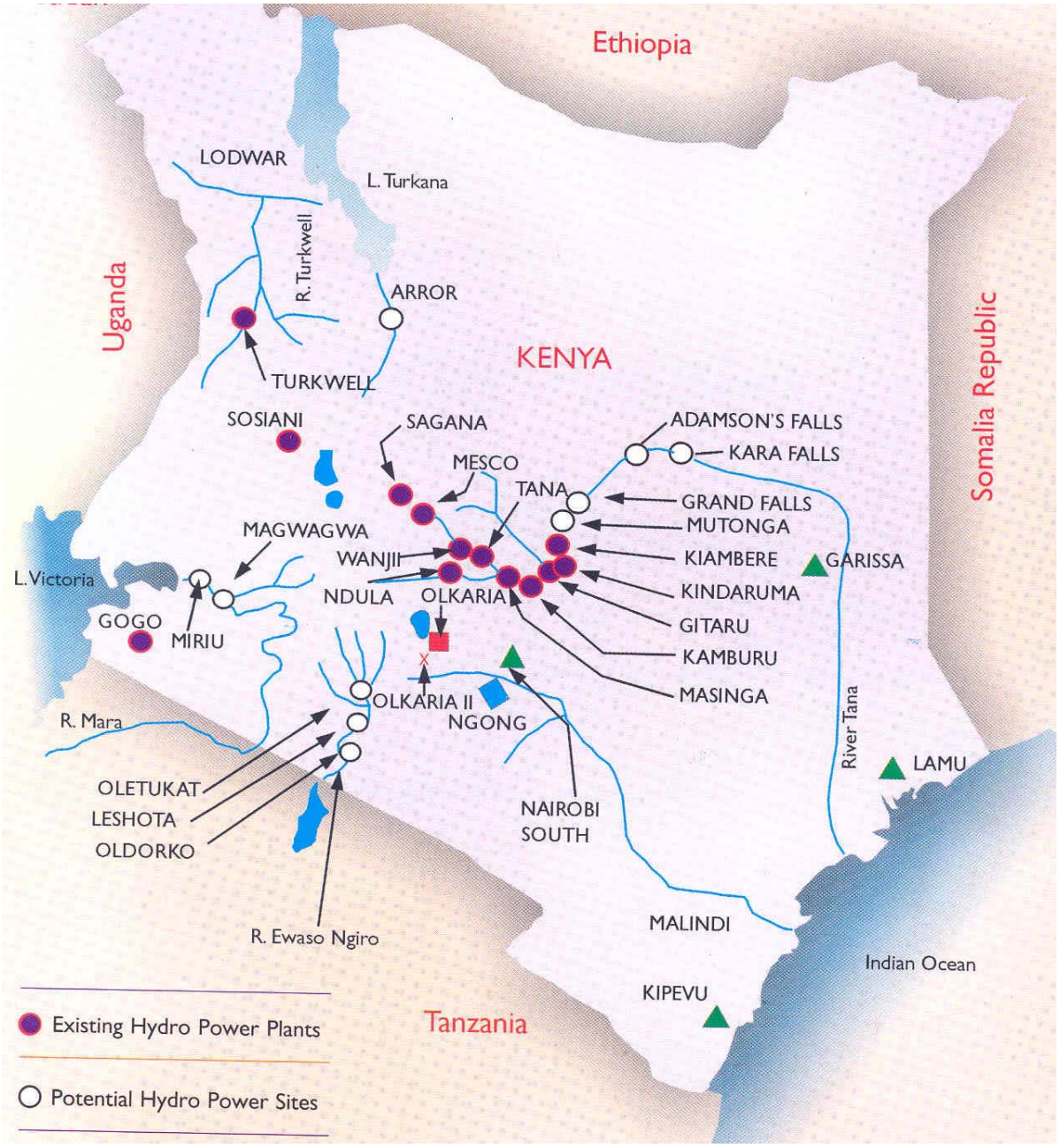
river and its catchment areas experience dry spells. In order to reduce the risks of power shortages nationally and at the same time stimulate rural electrification, the government initiated the Sondu Miriu hydropower project.

I conducted a site survey and study of Sondu/Miriu hydroelectric power project located in Nyakach, 30 km southeast of Kisumu, about 300km northwest of Nairobi[19]. The project utilizes water from the Sondu River flowing into Lake Victoria to generate 60 MW of power (KenGen, 2004). The Sondu/Miriu project implementation is executed by the government owned company KenGen which has further contracted the building of the power plant to private contractors[20]. Even though hydropower is a dominant renewable source of energy in Kenya, its full integration into the national rural electrification plan has met several barriers.

[19] See the allocation of Sondu/Miriu on the figure 8 below.

[20] The tender for civil works is executed by three companies: Konoike Construction from Japan, Viedekke heavy construction company of Norway and Murray and Roberts Contractors International of South Africa. Consultancy work is done by Nippon Koei Company of Japan (KenGen, 2009).

Figure 8: Map of Kenya showing existing and potential hydropower plants in Kenya.



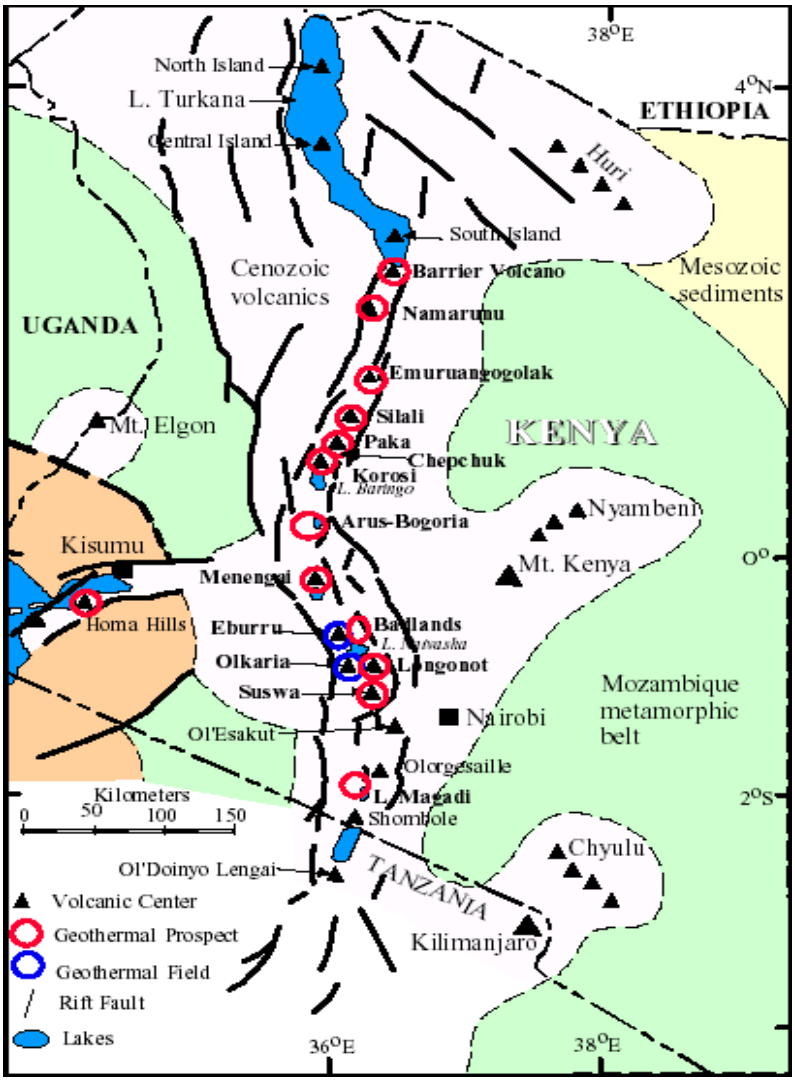
Source: KenGen (2009).

5.2 Geothermal Energy

Geothermal energy is the natural heat from the earth's interior stored in rocks and water within the earth's crust (Bw'Obuya, 2002:1). This energy can be extracted by drilling wells to tap the steam at high pressures which is then led through pipes to drive electricity (Ibid). In Africa, Kenya is the first country to tap geothermal for

energy (Mutinda, 2005:26). The Olkaria geothermal field is located on the southern part of Kenya's Rift Valley about 120 kilometers from Nairobi and has an estimated potential of over 2000 MW of geothermal power (Ibid). Electricity in olkaria fields is being tapped by Kenya Electricity Generating Company (KenGen), which is a public utility and Orpower4 which is an independent power producer (IPP) (Mutinda, 2005:27).Geothermal electricity exploration in Kenya started as early as 1956 but real electricity generation did not commence until the earlier 1980s as a result of several barriers that have slowed down the process (BW' Obuya, 2002:32).

Figure 9:Simplified geological map of Central and Western Kenya showing the location of geothermal fields and prospects



Source: Adapted from BW' Obuya (2002:10)

There are currently four plants in Olkaria that generate geothermal electricity: Olkaria I, II and III with a capacity of 45MW, 65MW and 48MW respectively. Consequently, the fourth project named Olkaria IV and an extension of Olkaria I are under construction, and both have a capacity of 140MW each (KenGen, 2009). However, despite the large investments in geothermal energy, financing of these geothermal projects still poses a big challenge to realizing the full potential of geothermal energy.

Figure 10: Map showing the location of Olkaria 1, 11 and 111.

Source: KenGen (2009).

5.3 Financial Barriers

Geothermal and hydropower investments often require colossal investments of money and this is one of the major barriers to the development of this form of RET. For instance, about US$ 2 million are required to put up a hydropower plant to produce 1MW of electric power (KPLC, 2008). In addition, the government charges extremely high tariffs in order to repay long-term loans and raise funds to undertake resource assessment and generation[21]. The high tariffs charged further make it difficult for the poor to access this electricity. The slow pace of geothermal power development in Olkaria is due to the high initial capital of drilling wells. One has to invest in drilling of a number of wells in order to assess the economic geothermal power potential for a particular prospect (Mbuthi and Andambi, 2004:21). Wells to develop the second phase of geothermal plant in Olkaria II were built between 1986 and 1993 but construction of the power plant was delayed until 2003 when funds became available [22](Mwakubo, 2007).

The high initial capital costs and associated risks of exploration and development are highly attributed to a mild cooperation between the various stakeholders within the government owned KenGen and the private sector (Mbuthi and Andambi, 2004). The sort of investment required in rural electrification is not a profit maximizing type of investment and this therefore demands good terms of investment to attract private sector participation and smart subsidies that benefit the local end users[23]. On the other hand , the government of Kenya seems to have ignored the ability of community

[21] Kenya electricity tariff is among the highest in Africa and about five times higher than that of South Africa and Egypt. For instance, for high voltage industrial customers, the tariff is US cents 9.7 per Kwh compared to South Africa 2.4 per Kwh (KPLC Annual Report 2008:19).

[22] Drilling one test well is estimated at a cost of over US$5 million (KPLC annual report, 2008:20).

[23] The use of subsidies as a tool for energy policy however, has recently come under harsh critism. Some argue that subsidies stultify innovation, distort markets and support the already rich rather than the poor. However because subsidies are in certain cases essential and do have some benefits, a new tool called the smart subsidy has been coined to put some distance between the current forms of subsidies and the earlier forms(Edjekumhene et.al, 2001:9)

electricity cooperatives to solicit the large up front costs required in grid extension and hence concentrated on foreign financing(Karekezi 2010, [Interview]. Community financing has been largely associated to electricity cooperatives offering micro-credit forms of financing that is not sufficient enough to finance large-scale RETs. Consequently, the government has therefore been very instrumental in encouraging International Finance Institutions (IFIs) to invest in the large-scale RET sector. The presence of international financial institutions within the energy market in Kenya offers a conducive environment for the development of partnerships between industrialized and developing countries. For example, the presence of IFIs within the RET sector has encouraged the bundling of small RETs, by putting lots of projects in one package hence reducing transaction costs and making them bankable(Mwangi, 2003:30).

Public-Private partnership

The aim of public-private partnership is to leverage public resources, mobilize private capital and harness market forces(Wilkins, 2002:101).This type of partnership has proved an efficient vehicle for attracting financing of geothermal and hydropower investments in Kenya where the private sector stands for over 80% of financing [24](Oyuke 2010, Lxrichter 2010). The government support of private investment together with backing from credit guarantee facilities have effectively unlocked private capital and technology transfer from developed countries. Aspelund et.al(quoted in Ibeh and Davies 2009:148) points out that the initiation of public-private partner structures are often the result of structural social capital, and their credibility is often reinforced by internationally recognized links. Ensuring the credibility of public-private partnership in joint ventures often calls for an external reinforcement often found in export credit agencies (KPLC, 2008). The reason is simply related to the fact that in joint venture

[24] The Olkaria geothermal power project has benefitted from public-private financing over the last four decades totaling to ksh 330 billion(US$ 4089m) from Japan, and approximately ksh 400 billion(US$4957) from EU and US (Lxrichter, 2010)

investment; lending banks demand an external international guarantee rather than guarantee from the local government that is not always certain. The significance of export credit agencies is captured in the statement below from the vice president of Scatec solar renewable energy Investment Company in Europe:

> Securing a loan to finance huge renewable energy projects in developing countries demands not only a risk guarantee from the developing country's government in question, but also the back up of a third party which in this case is international export credit agencies like the World bank. The Norwegian agency for Development and Cooperation (NORAD) has in many cases acted as a risk guarantee for Scatec solar investments abroad (India and South Africa). This is a necessary fall back position incase the government of the developing country in question renege on its promise of financing the loan (Osmundsen 2010[Interview]).

Private sector involvement in the development of geothermal and hydropower plants in Olkaria and sondu/Miriu has also been evident through the so called build-operate-Transfer (BOT) strategy. BOT is an alternative to foreign borrowing or public financing where the private sector is responsible for financing, building and operating the project for some time before it is transferred to the public utility (UNGASS, 1998). Operating the project for some time enables the private company to recover its investment and maintenance expenses all depending on the terms of concession agreement (Ibid). The BOT strategy could be an effective tool in the acceleration of RETs development in Kenya. However, the monopoly on supply and distribution of electricity held by KPLC often lead to price distortions in the market hence hindering independent power producers from fully recovering their investment costs (Mutinda, 2005:26, Karekezi, 2008:21).

5.4 Institutional Barriers

Geothermal and hydropower energy account for the highest percentage of electricity installation capacity in Kenya and power is provided by KPLC's national grids and

isolated diesel powered grids (Mwakubo et.al, 2007:19). Wilkins (2002:125) emphasizes the important role of policy and regulations relating to rural electrification and planning as a key successful implementation of RETs in developing countries. Unfortunately, the REP in Kenya which has practically concentrated on off-grid electricity connection fails to provide a clear cut policy on how electricity supply through geothermal and hydropower energies will benefit the non-grid connected rural areas of Kenya (African Energy Handbook, 2008:22). The scattered urban centers and rural villages in the country make it difficult to connect to the national grid hence derailing the process of providing power directly to rural consumers [25](Mwakubo et.al, 2007:45). Even though the policy on REP provides for IPPs[26] to supply power directly to consumers through setting up commercial renewable generation and mini grids in remote areas, its implementation has been barred by several institutional problems resulting from political and elite capture.

For example, the issue of licenses' and concessions to independent power producers within geothermal and hydro energy sector has either been dictated by business clienteles (based on personal connections) or on a condition that IPPs sell their power to the national grid. This is an act that makes it economically expensive to establish mini-grids far away from the national grids and that continues to deny the rural poor off-the grid access to electricity (Kituyi 2009[Interview])

The patron-client nature of social and political order in Kenya where the patrons, who are the politicians and respective heads of the energy parastatals , secure the loyalty and support of their clients in the private sector by bestowing benefits such as concessions to them often from the state resources. Nawaz (2008:6) refers to this particular network of social capital as neopatrimonialism, a type of governance where the formal- rational legal state apparatus coexists and is supplanted by informal

[25] For example, the 2006 losses for KPLC are estimated to be 18.2% which are high compared to the average world losses in transmission and distribution of about 10 percent (Mwakubo et.al, 2007:45).

[26] Currently, there are three large Independent Power producers; Iberafrica, Tsavo power and Orpower Inc accounting for a total of about 18 per cent of electricity generated in Kenya(Ibid)

clienteles networks of governance that exists outside the state structure. Furthermore, this patron-client type of relationship is accompanied by weak legal institutions, which is a serious barrier to technology transfer. Wilkins (2002:128) points out the correlation between weak institutions and unstable macro-economic environment. For example, the nature of contracts and concessions procurements is a deterring element to investors because of the fear of not being able to enforce contracts or recover costs through the courts if problems occur[27].The uncertainty of contracts is inevitable in huge renewable energy investments like geothermal and one of the investors interviewed pointed to this as a major potential threat to investment.

> With over 20 years experience as an investor in this field, my major fear is the property risk involved when one looses a contract as a result of corrupt patron-client networks. These people are always highly connected with strong bonds running from the ground messenger at the power plant sight to the top management of electricity utilities. I've witnessed cases where a single concession is signed by several investment companies and the process of getting approval to invest may be a long drawn-out costly process in courts that may last for years. The property risk involved have probed several investors to avoid transferring technology or transfer only older technologies that put less of their capital stock at risk(De Bruyne, 2010[Interview]).

Another critical weakness is the lack of a systematic holistic national plan for the electricity sector that integrates the views of the private sector and the community. The process has always been presumed to be the sole responsibility of the government, with stakeholders appearing at the end, either as critics or as commentators who have no role in contributing to the realization of the vision of national development and growth (Mwakubo et.al, 2007). Non uniformity in planning has also led to non standardized data collection where data needed for planning is scattered between several actors. Since the government lacks an overall overview it sometimes ends up

[27] KenGen could have openly flouted procument rules when it was awarded a ksh3.75 billion($50million) contract to a Chinese company, shengli oilfields highland petroleum and Equipment company to supply two electric land rigs for drilling of geothermal wells at Olkaria I and IV(Njiraini and Anyanzwa, 2010)

using old non-updated data in the electricity planning process (Mbuthi and Andambi, 2004).

My survey of the REP at Sondu/Miriu revealed that responsibility for rural electrification was divided among several government departments and KPLC, leading to inadequate management and overlapping of duties[28]. Munasinghe (1995:33) points out that decentralization of policy implementation to several departments can result in a lack of commitment to push forward the revised policy and planning regulations needed to aid technology transfer and rural electrification. Nevertheless, my field surveys show that representation of the private sector and the civil society at the Rural Electrification Fund(REF) of the government at Sondu/Miriu, was very limited ,with only one representative each from the private and the local cooperative society against 15 representatives from KPLC which is owned by the government (Onyando, 2010[Interview).

Painuly (2001:80) warns that inadequate representation of local community in rural electrification decision making process has the potential of resulting in misplaced priorities and powerful lobbies against rural electrification through RETs. The proclaimed decentralization process of rural electrification to empower the local community has been a top-down exercise with limited support at the local level. Abdalla (2007:92) shares a similar opinion on decentralization, claiming that the process has led to lack of transparency and accountability which has further marginalized the rural places off the grid.

For instance, due to limited rural electrification funds, priority criteria are applied in selecting beneficiaries of the programme through its District Development Committee (DDC)[29]. However, judging from the nature and spread of the electrification that has

[28]The task of rural electrification is no longer the responsibility of KPLC but that of the Rural Electrification Authority (REA).However, KPLC had not yet fully relinquished the task of rural electrification at Sondu/Miriu at the time my field work was conducted.

[29] The District Development Committee (DDC) fund is now attached to the Constitutional Development Fund (CDF).Proposals from the DDC concerning electricity are forwarded to a special committee of the Ministry of

taken place in the rural areas around Sondu/Muriu, there is lack of equitability in the selection of REP beneficiaries and there are indications that political power based on resource appropriation for the benefit of a few leaders has been influencing the selection. This view is captured by the frustration of one of the private investors from Orpower4.

The Constitutional Development Fund (CDF)[30] is controlled by the local area member of parliament and his cronies who divert funds (set aside for off-grid and grid electricity extensions) to their own pockets and those of their supporters. If these funds were publicly accounted for and grid extension plans well articulated, then we, the private sector would be more than willing to pursue a joint investment plan with the REP for the purpose of grid extension or establishing a mini-grid(Kituyi, 2009[Interview]).

Unfortunately, it is the community that stands to bear the brunt of the ills resulting from this lack of stakeholder cooperation[31] .

5.5 Social and Environmental barriers

Energy, known as the Electricity Development Committee. This is a team of government officers, civil society representatives, and leaders appointed and given the responsibility of filtering the proposals from districts and other sources. Their output is supposed to be a list of rural electrification projects for implementation, taking into account the need for equitable balancing of socio-economic development nationwide. Rural electrification master plans are prepared on the basis of the committee's decisions (Abdalla, 2007:35).

[30] The Kenya government has been setting aside some money for each constituency in the country, to be used for development projects selected by a constituency committee. The fund so created is known as the Constituency Development Fund (CDF), and the chairman of the CDF committee is normally the area member of parliament (Ibid).

[31] A study conducted on 'Rural Cooperatives in Kenya with Community Cooperatives Engagement', exposes how these community organizations despite their quest for participation in rural electrification ,have fallen prey to government manipulators as a result of their minimal level of education and awareness hence leading to excessive control by government (Abdallah, 2007).

The assessed potential environmental impacts of the two power generation stations are the resettlement of families affecting mostly children and women. Correspondence with the locals in Sondu/Miriu revealed that the project forcefully displaced over 2000 households without any adequate resettlement plan. Additionally local communities have denounced that KenGen has not kept its promise of providing them electricity and irrigation facilities, as stated in the initial project documents hence prompting a heated resistance to the project (Onyando, 2010[Interview]). A visit to the site showed that the diversion of river Nyando into the dam has provoked a shortage in the supply of water, hence leading to persistent droughts. Similarly, the construction of a geothermal plant in the middle of one of rift valley's major world life parks was accompanied with a major resettlement of the nomadic Maasai community. Despite loosing large tracks of land, the Maasai community did not show a heated resistance to geothermal as the community around Sondu Miriu[32]. This is because the Maasai are allowed access to social and economical amenities like health centers, schools and other infrastructure provided by KenGen(Cheruto, 2010[Interview]). Karekezi (2008) points at the noble access to social and economic benefits by the community, as being paramount to cubing resistance to RET.

My observation of the neighboring communities around Olkaria and Sondu/Muriu reveals a similar energy demand and supply to that of other rural communities in Kenya. Fuel wood and charcoal are the main sources of energy used for cooking and warming the house. This can be clearly seen from the large tracks of bushes that have been cleared near the homesteads. For example, both communities are not yet electrified through the REP, in spite of being very close to the Olkaria power station and the hydropower plant respectively. When asked why they have never considered electrification from the main grid that is a stone throw away, one of the discussants from the Maasai community said:

[32] Similar studies on environmental and socio-economic impacts of geothermal power plant on the rural community of the Maasai have been conducted and findings reveal a general positive attitude towards the project even from those who were relocated or moved without compensation (Mariita 2000).

> Electrification is something for the rich and accessing connection demands a well connected individual who can mobilize the community behind such a project. Furthermore, our area member of parliament has not yet initiated such a project. As for me alone, connection costs would imply selling my entire 20 herd of cattle which is my only source of wealth and income (Ole Kipto, 2010[Interview]).

From this answer, it would appear that the high cost of electrification, cultural attitudes and lack of political leadership were some of the main bottlenecks in bringing electricity to the neighboring communities of the Maasai. On the other hand, the informant also acknowledges the significance of joint community initiative and the relevance of social capital in the promotion of rural electrification, with the leadership of people with status and societal connections. Nevertheless, the government has made efforts to fund RET projects through the Constitutional Development Fund (CDF) kitty that is mentioned by the informant. However, due to corruption, only a few people connected to the elites have benefitted from this kitty.

5.6 Technological barriers

A visual inspection of Sondu/Muriu hydropower plant and Olkaria geothermal plant revealed an overwhelming number of foreign technicians, with the support of a few local consultants mostly from KenGen. This could partly point to the fact that the government of Kenya has not yet developed an adequate technology capacity at home to meet all the necessary demands of this sector and therefore depends on the wiring of technology from abroad. One of the experts responsible for recruitment of local engineers explains that KenGen recruits scientists and engineers from the local markets who are then taken to oversee universities for special training. This owes to the fact that local universities where the recruits come from do not offer geothermal technology at degree level (Njoroge 2010[Interview]). However, over the years, KenGen has demonstrated a successful technology transfer with a well orchestrated model of building local capacity to manage its geothermal facility and slowly replacing foreign consultants with locals. This has been facilitated through the

introduction of specially tailored courses in geothermal training and management at the university of Nairobi and Moi in Kenya (Mwangi, 2003:5).

Notably, the private sector has been very instrumental in the quest of geothermal and hydropower technology and the adaptation of this technology at home. One of the experts reveals:

> Networking between IPPs and energy cooperatives through joint ventures has been very instrumental in attracting skilled professionals in drilling technology and reservoir management at the power plants. The private sector has been very instrumental in utilizing the potential of local cooperatives in Sondu Miriu through their involvement in simple operation and maintenance services at the plant and at a later stage transferring them to KenGen for educational assistance(Njoroge, 2010[Interview])

The statement clearly shows the role of social capital through networking with the private sector in promoting technology adaptation and laying the basis for self sustaining paths. Nevertheless, Wilkins (2002:45) points out that technology is owned by companies rather than governments and therefore its successful transfer will not happen without the involvement of private companies. Even though, geothermal technology adaptation and capacity building in Kenya has been very successful to the point where Kenyans now serve as geothermal consultants to other African countries, there is still inefficient technological capacity within the country (Kozloff, 1995:31).

Field surveys at Olkaria geothermal power plant and Sondu/Muriu hydropower showed an overpopulated environment, with foreign experts which could be a possible indicator of shortage of local capacity. One obvious explanation could be attributed to the fact that KenGen has largely relinquished control to foreign contractors and expatriates as a result of procurement contracts which are often based on conditional finance agreements [33](Ibid). This has led to successive stages of the project

[33]Over 85% of the total costs of financing Sondu/Muriu hydropower station accrued from soft loans and grants from Japan Bank for International Cooperation (JBIC). However, the grant was attached to certain

development tapping less and less of the local expertise. Discussions with community members around Olkaria and Sondu Miriu revealed that locals were not wholly satisfied with the level of their involvement in the operation and maintenance of power plants with allegations of foreigners invading their resources. Green (1999) points out that socially accepted technology is that which promotes the assimilation of technology by the community, enhancing equal participation by the stakeholders with the aim of facilitating the devolution of power to the people rather than its concentration in the hands of the elite. The solution to these allegations therefore lies in equipping the communities with required technology in order to avoid the outflow of resources to expatriates.

Overcoming the barriers

Suggestions to overcome the barriers are based on the analysis of various stakeholders' considerations. There is need for long-term renewable energy programmes designed to develop a critical mass of locally trained manpower with the requisite technical, economic and social-environmental knowledge. This demands integrating analytical expertise of independent actors within the energy sector like NGOs and research institutions with that of other key actors in the development process - such as expertise within the banking, social/community development and public sectors(Karekezi, 2010[Interview]). This would enhance an increased understanding and cooperation amongst the actors involved in the RETs sector. Secondly, many of the engineering and technical courses that are currently taught at universities and colleges in Kenya still provide little exposure to large-scale RETs. Modest changes in the curricula of existing colleges and universities could significantly increase the supply of skilled geothermal and hydropower energy engineers and policy analysts.

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conditionalities like tender of executing the project being awarded to only Japanese companies and its associates (Okoth, 2009).

Thirdly, a revitalized REP is needed which will leverage other funding from donors, the private sector and the community. These calls for a new energy policy that removes the legal and regulatory barriers facing decentralized energy systems and an appropriate framework that makes it easy for these actors to invest in electricity. Fourthly, a review of the monopoly on supply and electricity distribution held by KPLC is also necessary in order to attract investors. The review should provide a mechanism that guarantees recovery of operation and maintenance costs by independent power producers. Strengthening the autonomy of rural electrification fund and protecting it from patron-client forms of networking that derails the process of rural electrification. Finally, priority should be given to the establishment of innovative and sustainable financing programmes. For example, the establishment of a national fund for renewable energy projects financed by a modest tax on fossil fuels.

5.7 Summary

This chapter has identified four major elements of barriers and suggestions to overcome these barriers. Firstly, geothermal and hydropower utility has largely relinquished control to foreign companies hence making minimal utilization of the available local capacity. To correct this, I have pointed out the efforts made by the government and the private sector to establish training institutions that will boost technology adaptation and capacity building at home. Secondly, imperfections and distortions in the market coupled with unfavorable concession procurement anomalies have acted as a barrier to potential investors. Correcting these anomalies calls for transparent criteria for allocating concessions and build opportunities to potential investors. Thirdly, enhancement of rural electrification through grid electricity is largely dependable on the role played by other social actors like the private sector and the civil society. This task of soliciting for the large upfront costs in large-scale RETs is demanding and calls for a type of joint venture investment, also referred to as public-private partnership.

Fourthly, government steered rural electrification has done little to provide power to the rural population. Political manipulation and client-patron type of networks has

contributed to the low rural electrification coverage hence watering the perceived positive effect of decentralization. Overcoming this barrier calls for a review of the monopoly of electricity supply and distribution possessed by state owned enterprises.

6 Bioenergy

This chapter consists of four parts. The first part presents the production of biomass in Kenya and the efforts to modernize biomass fuel to an efficient small-scale renewable energy technology. The second part discusses the gender perspective of bioenergy and its role as a potential barrier to the development and dissemination of bioenergy technology. The third part discusses the viability of biodiesel feedstock production in current Kenya by examining the role played by small-scale farm holders. Finally, the last section presents an analysis of barriers to bioenergy with specific attention given to biofuels feedstock production.

6.1 Biomass

Bbiomass is the most popular source of energy in Kenya meeting over 70% of the country's total energy consumption needs (UNEP, 2002). The traditional form of biomass energy involves the use of feedstocks; mainly firewood, charcoal and agricultural residues for direct combustion (Salih, 2001, UNEP Risøe 2006). Biomass largely springs from Communal forests and woodlands, government plantations, trees around fields, along roadsides and homesteads, and from private smallholder farms (Ibid). Collection of biomass feedstock, especially firewood, is widely known to be part of women and children workload. The women and children daily spend several hours searching for fuel wood hence causing long term damages to forest soils and water resources. Their activities have had a tremendous impact on Kenya's forest resources which cover only around 6% of the country's 58.2 million hectares and are estimated to be decreasing by 2% annually (practical Action Consulting, 2009:14). In 2008, woodfuel demand and supply in Kenya was estimated to be 32 million tones and 16 million tones respectively. This is a 50% deficit, drawn from standing woodstocks, which further leads to deforestation and environmental degradation (Population Census report, 2009).

6.1.1 Charcoal

Charcoal is an important household fuel and, to a lesser extent, industrial fuel. Its major consumers include urban and rural households, as well as institutions like schools and hospitals (Salih, 2001:164). It is mainly used in the urban areas where its ease of storage, high-energy content and lower levels of smoke emissions, make it more attractive than woodfuel. In the last 20 years, Kenya has directed substantial effort towards the modernization of small-scale biomass energy technology.

The Ministry of Energy, through the support of several NGOs, pioneered the development and dissemination of improved charcoal cook stoves that is more energy-saving, efficient and environmental friendly (Karekezi, 2003:13). The charcoal cookstoves have with time become very popular in Kenya, and hence led to an accelerated production of charcoal as its main feedstock.

Despite charcoal being the major source of fuel in urban areas, its production has been for along time considered semi-illegal and therefore those involved in the business have to overcome several social barriers (Practical Action Consulting, 2009:14). Previously, many market actors did not operate openly in the business, but the situation is slowly changing. The business has now attracted a high level of collaboration between several groups of social actors with permits for charcoal transportation and sale issued by the local authorities under the ministry of trade (Ibid, Mwakubo et.al, 2007:50). Even though women are the major users of charcoal, most of the actors within this field are men. This could be possible attributed to the historic nature of the business being semi-illegal. As a result of this, many women have been locked out of the commercial aspect of charcoal production. One of the informants explains why women are few in this sector:

> Charcoal business is quite tedious and involves rubbing shoulders now and then with the local authorities who are often out to exploit us through unnecessary tax increases. It requires a strong will in order to meddle up with these people and I don’t think our wives have what it takes to avoid being exploited. We therefore often sign business contracts with our sons or other men instead of our wives (Kamau, 2010[Interview]).

The above statement also reveals the endemic nature of the widespread corruption in this sector which leads to the exploitation of those involved in the business by the local authorities. The sector has no developed standards and policy regulatory systems to govern the production, transportation and marketing of contracts of charcoal, an issue that contributes to locking out majority of other interested stakeholders (Practical Action Consulting, 2009:79).Unfortunately; the exclusion of women in the commercialization of small-scale renewable biomass technologies is not just limited to charcoal production. Women in Kenya have not been fully integrated in the implementation of RET programmes and projects in the country, and this is an issue that poses great challenge to the general social acceptance of RETs in the society (Mshana and Ischebeck, 1999:235). This means that, if the renewable energy sector wishes to contribute to development, then it has to take a more holistic view of the social structures of the society, and a good starting point would be to use gender analysis to gain an understanding of energy needs and the context of their operations. The section below is devoted to the discussion of lack of a gender perspective as a barrier to bioenergy development.

6.2 The Gender Perspective of bioenergy

Decision -making has mainly remained the prerogative of men and the household authority model is such that the wife has to ask for permission from the husband before undertaking any economic venture (KIPPRA, 2002:51). The statement below further highlights the exclusion of women from the economical process:

> In the traditional society set-up, collection and use of biomass is the responsibility of women and children, and men only get involved when these activities get commercialized (Pond, 2010[Interview]).

In addition, despite the fact that women, especially in rural areas, spend several hours of their time fending for the family energy needs, their economic contribution is more often than not unpaid, unrecognized and undervalued (Muchiri 2008, Cecelski, 2002:). Nevertheless, most of the other domestic chores performed by poor women,

especially in the rural areas, are not monetized and rewarded accordingly, a situation that further aggravates the economic and social deprivation of women.

As a result of this "invisible" economic contribution of women, little attention is given to investing in energy- efficient technology to help address the energy problems of women. The exclusion of women from the commercialization process of renewable sources of energy could be a possible reason why women are very skeptical in rallying behind RET projects, initiated by men. Moreover, in a patriarchal society like Kenya, the property rights system is discriminatory to women, especially the land tenure system that gave exclusive rights to men as the sole inheritors and owners of land [34](Mbuthi, et al, 2007). For instance, while traditional societies "expect" women to fetch energy for household cooking, drying and heating, women have no control over energy resources such as firewood and charcoal because land "belongs" to men.

The implication of this rudimental traditional society set up is revealed in a focus group discussion with women from a rural village of Vihiga district. These women did not dare fetch firewood from the family farm without permission from their husbands. More often than not, they had to move long distances to fetch firewood in the absence of their husbands who had to grant permission for the use of firewood from the family farm. In addition, most of the women from the same focus group were involved in biofuel feedstock production at the farm level but not in the commercialization process (Wahome, 2010[Interview]). They complained of doing the major workload of producing feedstocks but not reaping the fruits of their labor.

Decisions about access to energy supply are dominated by men even though women are the major users of biomass energy. For example, the pricing policy of wood fuel, states that when licensing commences, license fees will reflect the environmental costs associated with wood fuel harvesting to ensure sustainable development and exploitation (Muchiri, 2008:18). It is however not indicated how this measure will take care of gender concerns of those involved in the harvesting of this wood. Women

[34] The land tenure system was amended in 2008, giving equal rights of property ownership and inheritance, to both women and men (Kenya Law Reports, 2008).

should therefore be naturally involved in the pricing process in order to give a valid quantification of the environmental costs and time associated with wood fuel harvesting.

The gender perspective of the RET recognizes that some issues and constraints related to project success are gender specific, and stem from the fact that men and women play different roles, have different needs, and face different constraints on a number of different levels (Cecelski, 2002:31). Therefore, in order to realize the full potential of RETs, then women's specific contribution in energy decision- making needs to be explicitly recognized.

6.3 Biofuels production in Kenya

Biodiesel production in Kenya involves the use of jatropha[35] as a feedstock, due to its adaptability to semi-arid lands and its perceived economic and ecological advantages (Ministry of Agriculture, 2009). From the perspective of private investors and farmers, it is a newly available energy crop that is expected to be less expensive than other energy crops like rapeseed and soya beans. Jatropha production has been promoted for its perceived ecological and economic advantages, considered as one of the cheapest feedstocks. However, farmers have very little, if any, experience growing this tree, which takes years to mature (Karekezi, 2010[Interview]).

The production of biofuel feedstocks in Kenya is mainly for exports and very little is being used locally as blending of fuel with ethanol was withdrawn shortly after its introduction in 1983[36] (Ibid,). The withdrawal was due to the high cost of ethanol

[35] Jatropha is a large shrub or small tree reaching a height up to 5 meters. Having been introduced to Africa centuries ago, it is now widely observed in semi-arid lands. In Kenya, it is naturalized in bush lands and along rivers in the western, central and coastal parts of the country in altitudes of 0-1,650 meters above sea level (Ministry of agriculture, 2008:13).

[36] Kenya has produced ethanol from sugarcane since the early 1980s through the government led gasohol program that required the blending of ethanol with petrol. The program was unfortunately laid down in the 1990s due to high income earnings from export of ethanol as compared to its domestic use (Republic of Kenya, Sessional Paper, No 4 of 2004:17).

relative to crude prices (Ibid). However, the gasohol program is not totally forgotten and the government is working on rules that would compel oil marketers and Kenya Petroleum Refinery Limited (KPRL) to blend ethanol and petrol (Mahamud, 2009[Interview]). Until this plan is due, the use of biofuels as a source of energy in the transportation sector in Kenya will still remain minimal. Despite the minimal use of biofuels in Kenya, the production of biofuel feedstocks like sugarcane and jatropha is on the rise.

6.3.1 The role of small-holder farmers in biofuels

The case study I conducted dwelt on biofuel feedstock production by small-scale farmers of Vihiga district, in Western Kenya. Due to the relatively high population and scarcity of arable land in Vihiga district, farms have had to be subdivided repeatedly. It is on the small pieces of land, measuring about 5 acres or less, that much of cash crop farming is intertwined with jatropha feedstocks, and sugarcane plantations. The farmers have joined together in cooperative organizations, for the purpose of achieving economies of scale in the commercialization product chain of jatropha feedstock and other cash crops. From the survey I conducted, it seems that barriers obstructing the developments of this RET are very much attached to the livelihoods of the farmers.

However, recent dialogue around biofuels has tended to focus on large -scale production to supply liquid transport fuels to the global market, and discussions of livelihoods implications have tended to take a backseat (Muok, 2010[interview]. Several studies on this field reveal that biofuel production stands to benefit the society in Kenya if production is concentrated at small-scale level with the aim of improving the local livelihoods (Tomomatsu and Swallow, 2007). One of the experts from the Ministry of Agriculture elaborates:

> Small-scale farmers in Kenya are considered the major contributors to the Kenyan food basket and therefore large-scale production of biofuel feedstocks

would naturally imply major displacements of local farmers from their lands in order to make room for lager scale plantations “(Ruto 2010[Telephone correspondence]).

The core argument is that large- scale plantations require an intensive use of land, capital and technology which has the potential of locking out smallholder farmers from participating in the commercial chain of production. While allowing the production of biofuels and other food crops on small farms can increase diversification and provide an additional revenue source. The major contrast in large -scale biofuel production is that producers sell feedstocks to consolidated processing facilities with the profits going to outside corporations (Muok 2010[Interview]). The fact that feedstocks are produced for export may hinder the development of bioenergy technology at home. Consequently, developing biofuel technology at the local level demands that these farmers are equipped with processing facilities and this demands a lot of investment capital.

During my field study in Vihiga, I visited a local processing centre that was equipped with simple oil extraction facilities. The facility was used to extract oil from the jatropha seeds delivered by farmers. The oil was then used as kerosene substitute for lamps and stoves in the rural areas. The oil is much less expensive than kerosene so its use could contribute to savings for local communities and poor urban households. Equipping the rural areas with small-scale extraction facilities has therefore a great potential of decreasing energy poverty in the rural areas and reducing their dependence on dirty, labor- intensive traditional biomass fuels. However, realizing the full potential of biofuel feedstock production to benefit the local producers faces several barriers.

6.4 Financial Barriers

Biofuels feedstock is the primary and most expensive ingredient for biofuels production. Land availability and sound agricultural practices are the main factors that determine the supply and price of biofuels feedstock. Large- scale production of

biofuels in Kenya requires long-term financing to develop large commercial jatropha plantations and this is a potential obstacle to this type of production. Traditional banks are unwilling to provide finance due to market uncertainties and perceived high risks, which is sometimes a result of their general lack of knowledge and familiarity with bioenergy technologies and feedstocks (UNEP Risøe, 2009:193). Bankers and financers should therefore be invited to become more involved during the project development process in order to fully understand the issues involved.

Another observation made is that small-scale farmers in feedstock production often apply for single investment which may be too small to attract the interest of major financial institutions. Therefore, bundling of investment opportunities in feedstocks by the small-scale farmers would facilitate negotiation of attractive and lower interest rates from the financial institutions. This is an effective way to realize the benefits of economies of scale (Karekezi, 2008).The economic feasibility of producing biofuels is further worsened by higher operating costs (especially transport costs of feedstocks) due to poor infrastructure (Karekezi, 2002). Most feedstock plantations that I visited are based in the far distances of the rural areas with only walking paths and bad roads.

Another obstacle to full realization of the benefits of biofuels lies in the absence of its use at home. Revival of ethanol fuel production in Kenya has widespread support from the stakeholders who were interviewed for this study, but, this can only have a domestic economical impact if the government provides incentives such as subsidies or tax waivers on biofuels production (Karekezi 2010[Interview]). Hidden subsidies provided in the use of electricity from fossil fuels, kerosene and petroleum gas are a hindrance to the development of an equally competitive bioenergy market (Mbuthi et.al 2007, Sims, 2002:300). Moreover, the fossil fuel industry enjoys other incentives offered by the government, like funding further exploration of fossil fuels and R&D investment. All this together make it more difficult for bioenergy to penetrate the market. The Kenyan government should instead put in place initiatives like carbon taxes and tax reductions on bioenergy in order to make bioenergy more competitive and attractive to investors.

The bioenergy sector's ability to compete effectively with the fossil fuel sector is further limited by the smuggling of energy sources like kerosene, paraffin and diesel across the borders which make investment in bioenergy sources economically uncompetitive (Mbuthi 2007). Wilkins (2002:147) points out that in order for the RETs market to grow in a sustainable way; the energy services must be affordable and cost-competitive with other energy sources. This is simply to say that using renewable energy saving technologies should not bear an extra cost to the end user as compared to other fossil fuels.

6.4.1 Clean Development Mechanism(CDM)

The Clean Development Mechanism(CDM) is an innovative cooperative mechanism under the Kyoto protocol, designed with the dual aim of assisting developing countries in achieving sustainable development and assisting industrialized countries in achieving compliance with their greenhouse gas(GHG) emission reduction commitments (UNEP Risøe report 2009:155).

The opportunity created by CDM has prompted many investors in feedstocks to ignore the documented benefits accruing from small-scale biofuel production. Commercial investors in large-scale production of biofuel feedstock have been aiming at attracting funding incentives through the Clean Development Mechanism. Even though recent analysis indicates that biomass cogeneration projects are good candidates for CDM, very few projects in Africa have been able to access CDM funding[37]. A trial to promote jatropha production as a CDM project has been developed in Kenya, but approval is still pending owing to the several conditions that have to be met (UNEP report, 2009:5) The low visibility of Africa in CDM pipeline has been blamed on the

[37] Only 3% of registered CDM projects are in Africa, mainly in North Africa and South Africa. In addition to the registered CDM projects in Africa, only 2 out of 25 have thus far actually been issued Certified Emission Reductions (CERs) (UNEP Report, 2009:154).

complexity of CDM requirements, resulting in transaction costs that are simply too high to overcome in Africa hence discouraging investment (UNEP report 2009:155).

The CDM is an important potential instrument to promote foreign investment in GHG emission reduction options while simultaneously addressing the issue of sustainable development (UNEP Project CD4CDM, 2009:17). As much as promotion of foreign investment is concerned, CDM can not thrive in an environment where the government, political and economic framework is not conducive or receptive to investment. It is therefore prudent to note that many African countries, including Kenya, have relatively poor investment climates with considerable risk of project implementation failure.

Karekezi, (2008:23) points out that attractive CDM projects in biofuels will be large-scale ones that generate big volumes of Certified Emission Reductions (CER)[38], preferably implemented by a single corporate entity, not by the bundle of smallholder farmers. However, it is uncertain which type of biofuel production will attract CDM investment given the consequences of large-scale biofuel feedstock production discussed above. In order for large-scale production of biofuel feedstocks to qualify for financing, it demands that it does not replace production of other useful food stuff or put in use "idle lands" which in many cases is preserved for grazing (Ibid). In addition, the project developers would need to demonstrate that the biofuel project would have otherwise not been implemented in the absence of CDM project activity (Hovi, 2010[Personal correspondence]).

6.5 Institutional Barriers

Government policy influences the returns that can be generated from different value chains of biofuel feedstocks, and thus the potential return to different types of actors

[38]The CDM emission reduction projects implemented in developing countries by governments or private entities in industrialized countries receive credit in the form of certified emission reductions" also referred to as CERs. This credit counts against their national reduction targets (UNEP CD4CDM Project report, 2009:4).

(Practical Action Consulting, 2009). For small-scale producers, a value chain that allows decentralized biofuel service delivery at the local level has the potential to rejuvenate accruing profits than the central value chain of delivery. Currently, the Kenyan government has no clear policy vision on the direction of jatropha biodiesel industry. The dilemma is whether to focus on improvement of local livelihood by setting up small-scale processing facilities, or supporting the large-scale production by large commercial enterprises (Tomomatsu and Shallow, 2007:23).

The government has formulated a policy on bioenergy that aims at setting up a value chain which is presumed to develop business linkages beneficial to the local livelihoods (Muok et.al. 2008:2). It is hoped that these linkages will provide new extension approaches between producers, suppliers, processors and a reachable market, but unfortunately, the policy does not mention anything on how this will be implemented (Ibid). Many of the small-scale farmers I consulted in Vihiga district complained of the existence of a non-transparent feedstock market chain that barely benefitted them as producers of feedstocks. One way of ensuring support for the development of bioenergy is by instituting appropriate revenue sharing mechanisms, such that the benefits of bioenergy, such as biomass cogeneration, trickle down to the small-scale farmers and their families who are involved in the growing of the feedstock (Karekezi, 2008, Ibid).

The Energy act of 2006 mandates the government of Kenya to pursue and facilitate the production of biofuels, but the government has not yet adopted a biofuel policy in response to this mandate (Strategy report of the Energy act, 2006a:12).The final draft of the biofuel Policy implementation report is further complicated by the fact that its regulation falls under several jurisdictions, hence leading to overlapping of responsibilities [39](Muok et.al 2008.4). Similarly, the current policy regulating the production and sale of charcoal causes confusion as it is split across many government departments creating conflict and unclear lines of responsibility on who does what. For

[39] Besides the ministry of Energy, the active actors in the biodiesel development activities include the ministries of Trade and industry , Water Development, Transport, Environment and Natural Resources, Vanilla Development Foundation and the Green Africa Foundation (Muok et.al , 2008:4).

instance, the development of biomass energy is handled by the Kenya Forest Service, who are pushing for a ban in charcoal production, while the Renewable Energy Division of the Ministry of Energy ignores the call for the ban, and is grappling with charcoal policy issues, while at the same time, the Ministry of Agriculture is promoting agro forestry for wood fuel (Mwakubo, 2007:50).

Therefore attracting sustainable biofuel production in Kenya calls for government consultation with all stakeholders within the bioenergy sector with the aim of integrating their interests and views in an overall energy planning strategy[40](Barbir and Ulgiati 2007:64). Doing this means that all the relevant information will be available at one place and all interested developers will be spared the menace of having to go through a full and costly consultation process each time. At the same time, establishing a one stop of handling and management of the bioenergy information will help solve the problem of overlapping of responsibilities within the various government authorities involved in this sector.

6.6 Social and environmental barriers.

The conflict between food and biofuels is a debate that dominates the development and dissemination of bioenergy in Kenya. The principal argument driving this debate is the assertion that biofuel production is impacting negatively on the availability of food and the debate evolves around two core arguments. Firstly, it is beyond dispute that food prices of major staples, which are also being used as feedstocks for biofuels production, have increased dramatically over the past several years as biofuels production has boomed (Muok, 2008, 2010:67). Secondly, demand for biofuels has increased competition for land and water resources which would otherwise be used for cultivating edible crops (Ibid). The competition is made worse with the behavior of international investors speculating the purchase of large tracks of land from indigenous farmers for commercial production of biofuels in developing countries (Eide, 2009).

[40] The stakeholders here involve key organizations, including municipal authorities, planning consultants, environmental groups, land owner associations and farmers, developers, researchers, equipment manufacturers and transport companies.

With respect to land rights and property ownership, many small-scale farmers base their ownership of land on ancestral inheritance, something that put them at the risk of loosing their land to potential biofuels investors and corrupt local government officials:

> We were offered a price we could not turn down, while at the same time land grabbing by local politicians and municipality employees is in the rise, we decided to take the money, lest we loose our plots sooner or later to grabbers(Okwemba, 2010([Interview]).

Buying land for biofuels production puts the already marginalized farmers in a dilemma, compelling them to dispose their land which is their only stable source of income generation. The result is a rise in the prices of basic staple food due to reduced production locally and unprecedented increase in imports of staple food like wheat, sugar and maize. Clements (2008:16) reveals that a well calculated strategy to increase imports of maize by high ranking officials within the ministry of agriculture in Kenya deliberately encouraged small-scale farmers in fertile highlands of Vihiga district, to lease their land to large-scale commercial producers of biofuel feedstocks. It was further revealed that revenues accruing from the increase of import tenders were channeled back to the pockets of these officials. This was made possible by making well- tailored requirements of import tenders to meet the contracting demands of companies associated with these corrupt leaders (Nyabuga, 2010). This action resulted to low yields of staple foods in Kenya for the last five years (Clements 2008:17). Generally, biofuel feedstock production has little support in Kenya. Barbir and Ulgiati (2007:63) have therefore a point to make when they argue that “large-scale biofuel production in developing countries is clearly a strategy supported by vested interests and only ‘biofools ‘ lobby behind the strategy which involves high costs and low benefits for the public good”(Barbir and Ulgiati 2007:63).

Currently, there is minimal data available on the perceived benefits of large-scale biodiesel feedstock production in Kenya given the fact that this RET is still at its infant stage. Sims (2002:299) emphasizes that the lack of information available to potential

bioenergy plant investors, leads to many of them relying on their own knowledge, which is often derived from magazines, from outdated publications or from word of mouth. Investors tend to rarely seek and pay for quality advice.

In addition, realizing the potential of bioenergy feedstocks on a large-scale level in Kenya, demand intensive, large-scale monoculture agriculture (Ministry of Energy Strategy Document 2008-2012:14). This will unfortunately be accompanied with land use that destroys local culture and biodiversity, without effectively solving the energy scarcity problem. For energy crops, monoculture production is deemed unacceptable by many environmental agencies and there could be public rejection of growing these feedstocks owing to their effects on landscape and changing biodiversity (Sims, 2002:299). Commercial investors highlight the fact that jatropha can be grown on "marginal" or "waste" land; this is a claim which must be tested for validity. While there may appear to be a great amount of underused marginal land in Kenya, where jatropha could be grown, most of these lands are currently used for communal livestock grazing (Tomomatsu and Swallow, 2007:18). For example, land that is not farmed, but instead used for grazing, may be considered "idle" by foreign investors since it produces little economic value. However, local small-scale farmers in Vihiga have evolved sound ecological strategies, like intercropping jatropha with other edible food stocks like maize to enable them live in harmony with the environment. By doing this, these small-scale farmers ensure steady food production, and at the same time, extra income generation through sale of biofuel feedstocks. In addition, planting a mix of species is not only for landscape benefits but for added resistance to the spread of pests and diseases. However, successful intercropping of different food species and feedstocks demands adequate technological knowledge which is discussed below.

6.7 Technological Barriers

Most farmers and project developers lack adequate knowledge in the production of biofuels feedstock and the respective use of available processing equipments. As a result, many unsuitable bioenergy plants have been sold to local bioenergy developers, by unscrupulous or poorly informed equipment suppliers. Bioenergy being relatively

new in the market, the ministry of energy has not yet developed a clear policy on human resource development and quality control mechanisms (Mbuthi et.al 2007:44). Fortunately, the Kenya Biodiesel Development Association (KBDA) has already designed a one stop shop for biofuels issues and aspires to collaborate with other relevant institutions in R&D, seed certification and product quality assurance and marketing (Muok et.al 2008:4)

6.8 Summary

This chapter has presented the use and production of biomass and biofuel feedstocks as the major sources of bioenergy in Kenya. The five major barriers to bioenergy have been analyzed and different suggestions to overcome them have also been discussed. The role of social capital in the gender perspective of the society is quite decisive in the deployment of RETs. This is very evident in the exclusion of women in the commercialization process of bioenergy, which poses a potential hindrance to the development and dissemination of this type of RET. I also argued that realizing the potential of biofuel feedstock lies in small-scale production rather than large-scale production. This is because large-scale production leads to increased competition for land and water resources which would otherwise be used for cultivating edible crops.

Economic risks of biomass and bioenergy in the energy market are high owing to competitive costs from fossil fuels and other large-scale RETs such as hydro and geothermal. Stimulation of investment in bioenergy therefore calls for incentives like tax breaks to project development, and strict measures to punish illegal activities like smuggling of kerosene. A lack of capital to finance bioenergy projects result from poor understanding by bank managers of the project risks, leading to poor ‘bankability’. Creating awareness and involvement of financers during the development process is one way of overcoming the barrier to financing. Even though CDM is viewed as a potential financing mechanism, it demands strict requirements that are unlikely to be met by bioenergy developers.

7 Conclusion

This concluding chapter is divided into three phases. I start by recapitulating the key findings arising from the study of each of the four types of renewable energy technologies and then compare and contrast these barriers. The second part constitutes the way forward and gives a summary of policy instruments and measures perceived as necessary for overcoming these barriers. I finally give a brief reflection on how this study could contribute to the effective implementation and dissemination of RETs in Kenya.

This thesis has revealed that Kenya is endowed with several renewable energy resources namely solar energy, geothermal and hydropower and bioenergy. Unfortunately, full utilization of these renewable energy resources is limited by several barriers, some of which are specific while other barriers apply to all the four RETs under study. Key findings of these categories of barriers are presented in the following order: financial, institutional; social and environmental and technological barriers respectively.

7.1 Summary and comparison of key findings on barriers

One of the main key financial barriers common to all the four RETs under study is the high start-up cost associated with the acquisition and development of these technologies. For example, solar technology in Kenya has emerged as one of the key alternatives to grid-based electricity, and hence it appeals to the rural population who are often far away from the grid. However, access to credits for the purchase of solar home systems by households and other developers is limited, as banks are not used to assess project finance for these RETs, which have a relatively high up-front cost. Similarly, geothermal, hydropower plants and bioenergy demand high-upfront costs in addition to high risks of investment, especially in the case of the former. This is primarily caused by the vast amounts of start-up capital required to initiate geothermal and hydropower projects. My analysis has shown how the role of social capital

envisaged in public-private partnership, has been paramount in leveraging public resources and mobilizing private capital financing of these RETs. This implies that the success of RETs in Kenya demands involvement from both the public and the private sector in their development and deployment.

Looking at the opportunities for investment, results of this study shows that geothermal and hydropower energy investment have primarily relied on joint venture investment by international finance institutions, while solar and bioenergy have mostly relied on financing by local banking institutions due to the manageable small-scale size of investments. High import duties and tariff charges on RETs are common barriers to all the four types of RETs. Subsidies on alternative fossil fuels like kerosene, paraffin and diesel generated electricity makes investment in RETs economically uncompetitive. On the other hand, the monopoly on supply and distribution held by KPLC, accompanied by low feed-in-tariffs leads to price distortions in the market, hence hindering independent power producers from investing in RET, due to the fear of not recovering their investments.

Key findings of institutional barriers are quite similar to the RETs. Inconsistent government policies and poor communication between the various governments departments involved in RETs have proved to be a common barrier affecting an effective development and deployment of these RETs. In addition, limited consultation with the private sector and the civil society in the development of national energy strategic plans has resulted in the overlapping of plans, hence derailing the process of RETs development. It is also notable that some institutional actions that involve policies and legislations are more politically sensitive than others, and hence difficult for certain actors to engage in. The sensitivity reflects the amount of investment required, the level of international cooperation needed and the potential impact on other actors. For example, geothermal and hydropower projects under study attracted high levels of vested interests and political capture hence restricting market access and locking out potential investors. In contrast, political capture and level of interest was quite limited in the case of solar energy investment. There is need to put in place or strengthen an appropriate framework to stimulate sector interest in geothermal energy

resource development. Tentatively, despite the huge economic prowess held by the small medium enterprises in Kenya, the sector is still considered as " informal" and has for along time, been excluded from the overall national economic strategy. This has in turn limited the sector's contribution to the development of RETs. There are opportunities for local community and the informal sector especially if RETs resource ownership and control is vested albeit partially with these groups.

My findings on social and environmental barriers are quite specific to the different RETs. However, the importance of matching individual energy needs to the type of RET to be introduced in the region is paramount to the success of solar energy, geothermal and hydropower development. The power of social capital bestowed upon the civil society is found to be very instrumental in driving the spread of solar technology. Resistance to this technology has been experienced in situations where developers ignore the social hierarchy of the society at hand and do not actively involve the decision makers of this hierarchy. Concurrently, geothermal and hydropower investments are large investments that require large resources of capital and land and in many cases families are displaced from their ancestral lands in order to create space for the development of the plants. This often results in heated resistance from the local communities around, especially in cases where access to social and economic amenities are denied to the locals. For example, the Maasai community around Olkaria region did not stage much resistance as compared to the Luo community around Sondu/Miriu. The former were promised access to the hydropower plant amenities and compensation for their lost land, an issue yet to be resolved.

Most of the key social barriers to bioenergy are very specific and do not apply to other RETs. The case of bioenergy is limited to the growing of feedstocks mainly for exports and very little is being used locally, since the withdrawal of the gasohol program in 1983. The main social barriers to biofuel feedstock production is its consequence of increased competition for land and water resources, which would otherwise be used for cultivating edible crops, hence resulting in increased food prices. The optimal way of realizing the potential of biofuels feedstock production in Kenya without hurting the production of food crops, is therefore, through small-scale

production. This is because small-scale farmers practice sound ecological practices like intercropping of jatropha with other crops, to ensure steady food production. Large-scale intensive production of biofuel feedstock, on the other hand demands large tracks of land leading to the loss of land by small-scale farm- holders to commercial investors.

Generally, there is a strong relationship between energy supply and the various gender roles in energy acquisition and end-use. Women are generally excluded from the commercialization process of RETs. For example, the discriminatory property rights system that gave exclusive land ownership rights to men is a major barrier to bioenergy development, which largely depends on land availability. In addition, it is recognized that men and women have different access and control over the resources, which they use to fulfill various tasks, and therefore effective planning interventions require an understanding of the different roles played by women and men in specific household or community structures.

Inadequate knowledge and lack of capabilities to develop and maintain the technologies stand out as a key technological barrier to RETs. However, there have been effective local capacity developments of technological know-how, accompanied with foreign technology transfer, especially in the case of geothermal and hydropower.

7.2 Way forward

Financial barriers related to the high start-up costs required in the studied RETs demand a right mix of economic incentives like subsidies and taxes with significant mobilization of private sector financing. Furthermore, to ensure private sector participation in the renewable energy industry, the government must provide a level playing field. This is because conventional energy is heavily subsidized and therefore similar subsidies must be provided for the renewable or premium feed-in-tariffs that allows power producers to sell and obligates the government distributor (KPLC) to buy, on a priority basis all renewable energy supply. In the same vein, power sector reforms that eliminate the monopoly on supply and electricity distribution by the

government owned KPLC would tremendously attract private investments. Nevertheless, the study shows that there exists minimal understanding by bank managers and financers, of the projects risks related to RETs, hence leading to poor financing. National banks and other financial institutions need training in best practice for renewable energy projects appraisal.

On the institutional front, the government should design clear- cut policies governing the renewable energy sector by consulting widely with the private and informal sector, in order to integrate their views in the overall national energy strategic plan. In addition, strong institutions free from political capture and that ensures transparency and accountability in the issue of contracts and concession procurements are called for.

My results reveal that the merger of small-scale manufacturers in RETs can help to improve technology and reduce manufacturing costs. However, it can also have the effect of putting SMEs out of business. So, in order to help SMEs survive, the government should focus on building their capacity, coordination and monitoring of their activities, and not least, the speed of processing project applications by SMES, can be reduced by streamlining and allowing one government department to deal with the procedure from beginning to end.

Overcoming technological barriers demands local capacity building through research and development. Developers of RETs should consider training local people to understand the technology and use it in a sustainable manner. Technological transfer for RETs should aim at embedding the technology within local populations and economy. In addition, involving the local population to a greater extent could help dismantle the social acceptance barrier that RETs tends to face. Programmes should as much as possible consider appointing local supervisors. This will not only increase the community's acceptance of the plant, but also enhance the sustainability of the plant once external support is removed.

How do these findings contribute to the existing literature on barriers to the development and deployment of RETs in Kenya? First, the thesis identifies and categorizes existing barriers in four categories which is easier to comprehend and

address. Second, minimal research has been done on the relevance of social capital in RETs development in Kenya. Existing research has primarily had the tendency to concentrate on the role played by the government in the dissemination of RETs in Kenya, with little attention given to other actors like the private sector and the civil society. This research has most importantly demonstrated that successful adaptation of RETs to the actual conditions of the receiving countries demands active involvement and cooperation between the civil societies the private sector and the government.

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Appendix

Research Questions

Prospects and Limits of RET in Kenya

Phase 1: Case study of Renewable energy implementation and exploitation in Kenya: Policy and Regulatory Frameworks.

Phase 1 will focus on the following:

- Objectives
- Policy description
- Barriers

Phase 11 will focus on the following

- Study objective
- Establishing the link between phase 1 and 11
- Approach
- Key issues
- Way forward.

1.0 Objectives

i. Identify factors which influence renewable energy development and the different framework conditions of Renewable Energy Policy in Kenya.
ii. Identify key domestic policies which are slow-moving, and would require international support and cooperation.
iii. Identify barriers affecting the implementation of Renewable Energy Technologies(RETs) in rural electrification
iv. Explore how regional and international cooperation and support can be used to increase the scale and scope of RETs and rural electrification.

2.0 Summary: Policy Description

a) Resource capacity development

i. Expand exploitation and development of RETs
ii. Achieve at least 10% RET in overall energy mix by year 2020

b)Energy efficiency in Energy intensive industries

i. Undertake energy audit projects
ii. Power factor enhancement projects for industries

c) Energy efficiency labelling and standards for equipment and appliances

d)Market development

Create and expand market for RETs service

Promote use of solar PV, solar water heaters

f) Renewable energy law

Establish conducive regulatory framework to promote:

Grid connected RE systems

Mini-grid connected systems

Stand-Alone systems

Operative questions related to institutional barriers

- How transparent is the criteria for allocating new investment opportunities to interested investors?
- What are the institutional responsibility and capacity for procuring tenders and whether transparent competitive bidding processes are practised
- What are the Procedures for dealing with unsolicited bidds?
- What is the governments approach to addressing energy equity?

- The ministry of energy's Sessional Paper 2004 had amongst other policies, to license charcoal trade in order to encourage sustainable development and efficient use of biofuels:

a)Why did charcoal business take such along time before it was licensed, when over 80% of Kenya's population use charcoal, as a source of energy?

b)What were the implications of lincensing charcoal?

Operative questions related to social barriers

- Is RET socially accepted by the local communities?
- Understanding the gender aspects of the technology: What are its effects to the society?
- What are the communities' priorities in terms of energy consumption?
- What is the hierarchy and decision making process in the community?
- Whose blessings in that hierarchy do we need in order to ensure approval of the projects?
- What are the contributions of the particular RETs to the rural population
- Was compensation or other provisions provided in case of displacements of families and native inhabitants, in order to provide room for large-scale RETs?
- What are the contributions of the said RETs to the community?