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EXPANDING ACCESS TO CLEANER AND MODERN ENERGY OPTIONS FOR THE RURAL POOR IN EAST AFRICA

PRIORITY TECHNICAL AND POLICY OPTIONS FOR EAST AFRICAN CSO'S

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Table of Contents

EXPANDING ACCESS TO CLEANER AND MODERN ENERGY OPTIONS FOR THE RURAL POOR IN EAST AFRICA

PRIORITY TECHNICAL AND POLICY OPTIONS FOR EAST AFRICAN CSO'S

1. Energy for Development – An Introduction

Energy is considered an essential ingredient in economic growth and social development in East Africa. The growth of energy demand is often driven by several factors: population growth, economic growth, urbanisation, rural electrification/energisation programmes, increasing penetration of energy-intensive appliances, and industrialisation. Energy is consumed by all sectors of the economy and therefore growth in the economies of East African countries leads to a concomitant rise in the consumption of energy. While the region is experiencing significant growth in energy demand, energy supply appears to have stagnated or dwindled. The security of energy supply – especially electricity generation – in East Africa seems to be threatened by climate change-induced phenomena,[1] chief among which is drought (Karekezi and Kithyoma, 2005; GoK 2004; GoK 2005; GoK 2006; GoK 2007; GoK 2008).

East African economies have recorded improved growth over the past few years. Leading economists of East Africa predict improved economic performance in the coming years, but the recent global financial crisis is expected to lower economic growth rates. In addition, all the countries in the region are experiencing rapid population growth, accompanied by even more rapid urbanisation. For example, it is estimated that in Kenya 40% of the population is urban, and that nearly half of the entire population will be urban by the year 2020 (GoK, 2007; GoK, 2008). Rapid growth of the country's urban population has led to growing demand for energy services, especially electricity and refined petroleum products.

2. Key energy challenges facing East Africa

East Africa is characterised by very low access to cleaner and modern energy services, which is both a symptom of and contributor to rural poverty. Access to modern energy options such as electricity can be used to increase incomes, enhance skills, and improve health and education services – the principal pre-requisites for escaping poverty. It is interesting to note that the urban and peri-urban poor face similar energy challenges despite close proximity to better-developed energy service infrastructure.

a. Rural poor have no access to cleaner energy services

East Africa is one of the least electrified sub-regions of the world, with rural electrification levels below 6% for all East African countries. Table 1 confirms that a large portion of the East African population (particularly in rural areas) has no access to electricity.

Table 1: Electrification Levels in East Africa (2008)

Countries	Electrification Levels (%)			Population without access (millions)	Per capita electricity consumption (kWh)
	Total	Urban	Rural		
Eritrea	32.0	86.0	5.0	3.4	48
Ethiopia	15.3	80.0	2.0	68.7	42
Kenya	18.1*	51.3	5.0	33.2*	156
Tanzania	11.5	39.0	2.0	36.8	84
Uganda	9.0	42.5	4.0	29.1	68

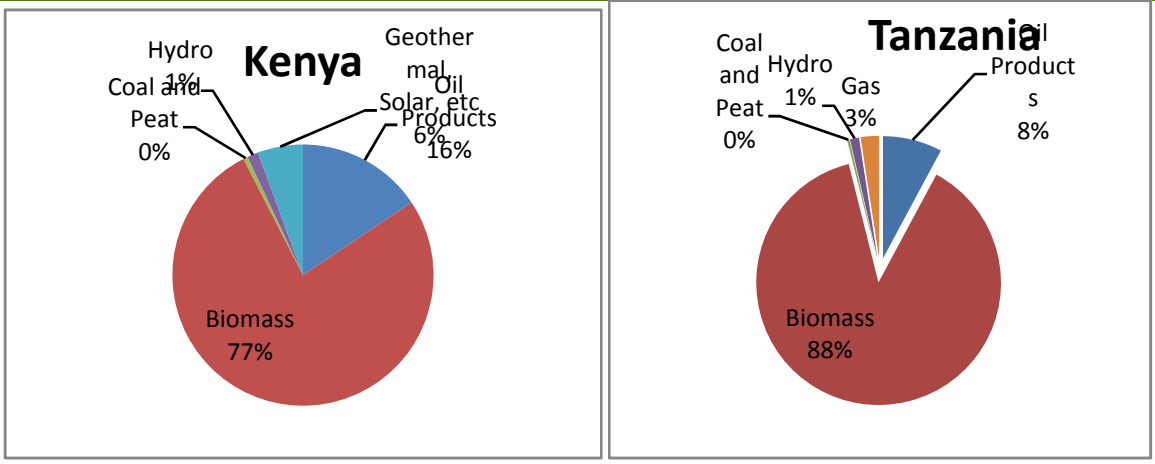
Note * Data for 2010
Source: IEA, 2011; KPLC 2010; Nation Master.com, 2011; World Bank, 2011

The bulk of the East Africa population continues to rely on traditional biofuels used in inefficient and unhealthy cookstoves to meet their cooking and heating needs - an important indicator of poverty. For example, in Kenya, biomass energy accounts for close to 77% of the total energy consumed. Much higher

[1] The primary cause of global warming is known to be the high concentration of greenhouse gases trapped within the atmosphere. There have been studies showing that the gases trap the heat from the sun thereby preventing them from escaping through the ozone layer. The subsequent result is the creation of the greenhouse effect, which in the process, increases the earth's temperature.

consumption levels of biomass are registered in Tanzania as shown in the Figure 1. Indoor air pollution arising from use of traditional biofuels in inefficient cookstoves contributes to respiratory illnesses – a key cause of death among children and contributor to long-term respiratory diseases in adults.

Figure 1: Energy Supply by source in Kenya and Tanzania (2008)



Source: IEA, 2011

b. Unreliable energy supply

The few rural households with access to electricity and cleaner fuels face another important challenge of security of supply. As shown in Table 2, frequent load shedding, blackouts, and brownouts are the norm in East Africa. Tanzania and Uganda experience close to three power interruptions per week, nearly 12 a month. Recent press reports indicate that power interruptions and load shedding have increased in both Tanzania and Uganda. Power interruptions and brownouts are more frequent in rural areas, in part due to being at the outer, weaker edge of the national grid system.

Table 2: Power Outages in Business in a typical month (number)

Country	Number of interruptions	Year of data
Tanzania	12	2006
Uganda	11	2006
Kenya	6.9	2007
Ethiopia	5.01	2006
Eritrea	2.97	2009
Source: World Bank, 2011		

In addition, rural and urban business firms interviewed by World Bank highlighted unreliable electricity supply as one of the major constrains to doing business in the region. For example, over 60% of firms in Tanzania and Uganda indicated that power shortages constitute a major constraint to business (see following table). Again, it is enterprises in rural areas reliant on the weaker out end of the grid system that face the most serious power problems.

Table 3: Electricity as a business Environment constrains for Firms

Country (Year)	Tanzania (2006)	Uganda (2006)	Kenya (2007)
Firms (%)	73	64.	1
Source: World Bank, 2011			

In Uganda, prolonged and severe droughts have led to low water levels in rivers and underground aquifers and reservoirs, affecting hydrology, biodiversity, and water supply. The most severe effects were experienced during the drought of 2004−2005, which led to a reduction of water levels in Lake Victoria and the Nile, drastically reducing hydropower generation, and adversely affecting Uganda's economy (GoU, 2007). More frequent droughts in East Africa translates into recurrent dramatic reduction in hydropower generation which, in turn, leads to drastic power load shedding with huge negative effects on national economies.

East African countries also faced regular supply disruptions of LPG and kerosene, widely used as cooking and lighting fuels. Shortages of LPG are particularly common (see Box 1), and often compounded by escalating cost, as discussed in the next section.

Box 1: Cooking gas shortage and Power Interruptions at KPRL

An LPG-cooking gas shortage has gripped the market following technical failure at the country's sole refinery and delays in the shipments of imports. This shortage has affected consumer-end prices. At the retail level, prices have already gone up 20%, with the 13-kilogramme container retailing at Sh2,200 (up from an average of Sh1,800) in the few unbranded outlets with stocks, while a six-kilogramme cylinder is retailing for Sh1,100 (up from Sh900).

KPRL's production of gas in August 2011 was not able to meet the predicted monthly output. During the month of August, KPRL delivered some 2,300 tonnes against the programmed quantity of 2,500 tonnes. The lower production is due to power outages at the refinery.

The refinery is forced to shut down every time the electric power is cut off or interrupted for short periods exceeding two seconds. The number of power interruptions has been increasing steadily in the last 10 years, reaching the current peak of 60 interruptions in 2008, and over 50 between January and October 2011.

In addition, direct imports of LPG cannot adequately serve the growing market; very small volumes of LPG are brought into the country, making the cost of imported gas much higher than locally produced gas —an estimated 50% more.

Source: Adapted from Business Daily, 11th October 2011

c. The rural poor pay more for the limited and insecure modern energy services

Largely driven by international market prices, the cost of LPG and kerosene has been increasing in the last few years. In the case of kerosene, which is often sold in small quantities to the rural poor, the large number of intermediaries in the kerosene supply chain increases costs as well as supply insecurity arising from incidences of local level hoarding of kerosene supplies. The retail prices of kerosene per litre in Kenya had increased by over 50% as compared to January 2006 (see table 4) .

Table 4: Average Retail Prices of Kerosine in Kenya (January 2006 compared to June 2011)

Period	January-2006	June-2011
Price of Kerosene in (Kshs)	57.04	86.66

Source: KNBS, 2011

d. Growth in rural electrification and access to clean fuels is too slow

Progress in rural electrification in East Africa is still below expectations. In Tanzania and neighbouring Ethiopia, the rate of rural electrification is outpaced by population growth, implying that every year the proportion of people with no electricity increases. In Kenya, Eritrea, and Uganda new, invigorated approaches to rural electrification through dedicated rural electrification agencies/programmes (see

Appendix 8) have begun to reduce the proportion of un-electrified people relative to the national population, but very slowly.

Table 5: comparing population growth and rural electrification rate (2008)		
Country	**Population growth (annual %)**	**Rural electrification rate (%)**
Eritrea	3.1	5
Ethiopia	2.2	2
Kenya	2.6	5
Tanzania	2.9	2
Uganda	3.2	4
Source: IEA, 2011; World Bank, 2011		

e. Bulk of modern energy services to the poor are not renewable

Inadequate access to modern and cleaner energy services in East Africa is particularly jarring for a region blessed with abundant local renewable energy resources (Tables 6–9).

Being near the equator, all the countries in the East Africa region enjoy long sunshine hours and have a daily average solar insolation of about 4.5–6.5 kWh/m^2 (Kiva, 2008; Baanabe, 2008; Mwihava, 2008). There has nevertheless been little effort by key financiers, including private-sector partners, to invest in large-scale diffusion of solar PV and solar thermal installations to harness this freely available source of energy.

Table 6: Solar Insolation and systems Dissemination in Eastern African Countries			
Country	**(kWh/m^2)**	**Estimated number of systems**	**Estimated capacity (kWp)**
Eritrea	4.0-7.0	2,000	-
Ethiopia	5.0-6.0	5,000	-
Tanzania	4.0-6.0	2,000	300
Uganda	4.5-6.5	3,000	152
Kenya	4.0-5.0	200,000	3,600
Source: Karekezi et al, 2009			

The region is also well endowed with large geothermal resources that could be used for both power-generation and heat applications. Although Kenya has the largest geothermal resources in the region, it has only managed to install 150MW out of an estimated geothermal power potential of 10,000MW (GDC, 2010; KPLC, 2010). To date, no East African country has utilised, on a significant scale, the enormous potential of geothermal and ground-source heat pumps for heat applications that could benefit the rural poor.

Biogas also has a huge potential in the region but is currently underutilised.

Table 7: Geothermal and Technical Biogas Potential in Africa		
Country	**Geothermal Potential (MW)**	**Biogas Technical potential (000 Units)**
Ethiopia	5,000	
Kenya	10,000	1,259
Tanzania	150	1,781
Uganda	450	1,314
Source: Karekezi, Kithyoma, Oruta and Muzee, 2009; WEC, 2010; GDC, 2010, Winrock, 2007; Dube, 2008		

Kenya, Tanzania, and Uganda also have enormous small-hydro resources that are still largely unexploited.

Table 8: Small Hydropower Utilisation in East Africa		
Country	**Potential (MW)**	**Harnessed (MW)**
Kenya	3,000*	44.7
Tanzania	250	10.8
Uganda	200	17.0
Note: The higher figure of 3,000MW for Kenya includes somewhat larger small hydro sites that can be classified in medium-sized hydro power plant category. *Source: Karekezi, Kithyoma, Oruta and Muzee, 2009, Energy Regulatory Authority, 2006, Karekezi, Kimani and Onguru, 2007.*		

Wind resources sufficient for water pumping can also be found in East Africa. Kenya and Tanzania show great potential for wind power generation. Available wind resources have not been widely exploited, but it is estimated that wind speeds in East Africa are sufficient, and could provide the basis for installing well over 100,000 wind pumps in the region. The following table shows the number of wind pumps installed in East Africa.

Table 9: Wind Pump Installations in Eastern Africa	
Region	**Number of Wind Pumps Installed**
Kenya	300-350
Tanzania	58
Eritrea	8
Uganda	7
Source: Karekezi et al, 2009.	

f. Limited high-level policy attention to sustainable energy-based access solutions for the poor

Although, the budgetary allocation to the energy sector in Kenya and Tanzania has increased, in local currency terms, in the last few years, the proportion of the energy budget allocated to pro-poor small scale sustainable renewables continues to be miniscule (table 5). For the financial year 2009/2010, the Government of Tanzania allocated Tshs 2,825,431 million compared to Tshs 2,201,095 million in 2007/2008, an increase of slightly over 27%. During the same fiscal period, the Government of Kenya allocated Kshs 33,118 million in 2009/2010 compared to Kshs 21,075 million for 2007/2008 - an increase of over 50% (GoK, 2011). However, the allocation to renewable energy development continues to be miniscule (as shown in table 5). In Tanzania and Ethiopia, this tiny allocation to renewables has decreased able the last few years.

Table 10: Energy Budget Allocation to Renewable Energy Devlopment (%) in Ethiopia, Kenya and Tanzaniain								
Country	**R.E %**	***Year***	**R.E %**	***Year***	**R.E %**	***Year***	**R.E %**	***Year***
Ethiopia	0.05	*2000*	0.03	*1999*	0.08	*1998*	0.06	*1997*
Tanzania	0.03	*09/10*	0.05	*08/09*	0.04	*07/08*	0.05	*06/07*
Kenya*	1.67	*10/11*	0.01	*2002*	0.02	*2001*	0.00	*2000*
Uganda	0.10	*10/11*	0.05	*09/10*	0.08	*08/09*	0.07	*07/08*
Kenya * - small-scale renewable development Source: *Brown, 2000; Gashie, 2005; GOK, 1994; 1995; 1996; 1997; 1998; 1998; 1999; 2000; 2001; 2002; 2003 ; Karekezi et al, 2008*								

g. National level investments in energy is primarily focused on conventional and fossil-fuel based centralised generation systems

A closer examination of energy financing patterns in the region reveals that the bulk of public financing is channelled towards centralised generation systems and national electrification programmes which use conventional and fossil fuel-based sources. Kenya's energy finance requirement in the fiscal year 2010/2011 amounted to Kshs 34,571 million (approximately US$ 346 million at the October 2011 exchange rate) for national electrification that is largely based on conventional and fossil-fuel sources compared to a paltry Kshs 605 million (approximately US$ 6 million at the October 2011 exchange rate) allocated to renewable energy technology programmes (GoK, 2011). Similarly, in 2009/2010, the Tanzania government allocated Tshs 1,200 million to renewable energy compared to investments in conventional centralised utility-based power generation and electrification projects which total Tshs 76,646 million.

During dry seasons, water levels drop and hydropower generation is reduced. East African governments regularly resort to high-cost emergency thermal generation, which relies on expensive, imported fossil fuel. Emergency thermal generation plants contribute to the high cost of power in the region. The cost per Kwh of some emergency thermal power generation installation is above US$ cent 20/Kwh – an astronomical figure, making it costlier than a wide range of renewable energy options, including wind, small hydro, and biomass cogeneration.

h. Limited national level investments and policy interest in decentralised energy options and renewables

Renewable energy programmes in the region are unlikely to register significant development and dissemination without supportive government policies backed by the requisite budgetary allocations. While most renewable energy-based systems are now technically mature and proven, they are sometimes still regarded as risky, complicated, expensive – the legacy of unsuccessful past pilot initiatives.

Renewable energy systems are more affordable and can, depending on the circumstances, be lower in cost than conventional alternatives – for example, in remote rural areas that rely on small diesel-based electricity gene-sets. Renewable energy systems generate a wide range of social benefits (e.g., providing energy services for income-generating activities) as well as environmental benefits. Lack of awareness and understanding is often reflected right across the board from the local level (potential customers) to the national level (government departments which might otherwise implement activities or finance sustainable energy projects).

3. Growing Number of Embryonic Success Stories in Sustainable Energy Development

Small and medium-scale renewable energy technologies (RETs) can play an important role in poverty reduction, environmental sustainability and economic development as well as increase access to cleaner and affordable services. This is particularly true of those RETs that are locally manufactured and are thus a source of employment and enterprise creation.

A wide range of renewable energy technologies (RETs) have been introduced in East Africa. Although widespread success has not yet been realized in most renewables (with the exception of improve cookstoves that have been disseminated to millions of East African households – see table 11), an increasing number of RETs have registered encouraging results and include (Karekezi and Ranja, 1997):

1. Bio-energy technologies
2. Solar energy technologies
3. Wind energy technologies for water pumping
4. Small hydro-power technologies

One of the most successful charcoal stove projects in Eastern Africa is the Kenya Ceramic Jiko (KCJ) that is produced and marketed through the informal sector. The KCJ projects range from small-scale grassroots initiatives by community-based organizations to large-scale national programmes which are usually supported by donor agencies (Karekezi and Ranja, 1997). The KCJ initiative utilized the existing production and distribution system for the traditional stove to produce and market the KCJ.

Besides Kenya leading in dissemination of improved household stoves, the KCJ stove design has also been replicated successfully in Uganda, Tanzania, Rwanda, Sudan, Ethiopia and parts of Malawi (Karekezi and Ranja, 1997; Gashie, 2006). Table 11 provides the dissemination numbers of improved household stoves in the region.

Table 11: Improved Household Stoves Dissemination in Selected African Countries

Country	No. Disseminated
Eritrea	50,000
Ethiopia	125,000
Kenya	3,136,739
Tanzania	54,000
Uganda	52,000
Source: AFREPREN, 2004. Gashie, 2006	

Improved cookstoves are designed to reduce heat loss, decrease indoor air pollution, increase combustion efficiency, and attain a higher heat transfer (Karekezi and Ranja, 1997; Masera et al, 2000). This results in less fuel used, which translates to direct cash savings (see Appendices). In addition, it alleviates the burden placed on women and children in fuel collection, freeing up more time for women to engage in other activities, especially income-generating activities. Reduced fuel collection times can also mean increased time for education for rural children, especially girls (Karekezi et al, 2002).

With increased incomes, rural households have the option of using kerosene and LPG, which are considered modern forms of energy. LPG is not widely used, even among East Africa's urban or rural poor. Current trends indicate, however, that its use is steadily growing. In Kenya, for example, the growth in LPG use is due to government subsidies for LPG imports as well as innovative measures that have reduced the up-front cost of LPG cylinders, and cookstoves that have, for example, reduced the cylinder size and simplified the LPG cookstove to allow poor households to procure LPG equipment. The cost of refilling an LPG cylinder is affordable to a large number of rural and urban poor households once the up-front cost of LPG cylinders and cookstoves is reduced.

While kerosene and LPG are the most affordable near-term modern and cleaner cooking energy options for the poor, there is a school of thought in civil society that is not comfortable with promoting kerosene and

LPG in East Africa, as it would lock the region's energy system onto an energy path that is unsustainable in the long-term and potential costly, subject to unstable world oil prices and growing uncertainty about long-term supply.

Biogas, a clean and renewable form of energy, can be a competitive substitute for conventional sources of energy, especially in rural areas. Biogas technology has received considerable attention in East Africa over the last three decades, mainly in the promotion of domestic and institutional biogas digesters (industrial-sized biogas plants are not common in the region). The raw material is primarily animal dung, which is plentiful in many rural areas of East Africa. See http://africabiogas.org/ for more information.
As shown in Table 12, over 1000 units of biogas digesters have installed in Tanzania (Winrock International, 2007).

Table 12: Number of Installed Biogas Digester in East Africa

Country	Units
Kenya	1,884
Tanzania	1,334
Ethiopia	1,640
Uganda	1,143
Sources: Karekezi and Kithyoma, 2005; Winrock International, 2007, http://africabiogas.org	

Households in the region that have installed biogas units have recorded a number of benefits. The production of methane for fuel reduces the amount of woodfuel required, thus contributing to reduced deforestation. In addition, organic waste is reduced to slurry that has a high nutrient content, making an ideal fertiliser for agricultural farms. Biogas is an effective solution to human and other organic waste disposal, especially in large institutions such as prisons, rural schools, and hospitals.

Other small-scale renewables, such as solar and wind, have gained popularity in rural areas through initiatives by community-based associations, women's groups, and donor assistance. For example, solar cookers, which rely on the principles of reflection, absorption, and insulation and make use of the greenhouse effect to trap heat. In 1995, the US-based group Solar Cookers International (SCI) started a pilot project in Kakuma, Kenya,[2] that provided refugees with portable, lightweight solar cookers called CooKits. Since the project began in 1995, SCI has purchased and distributed 15,000 CooKits to families in Kakuma. Extensive field tests have provided valuable technological insights that could be effectively deployed in the dissemination of low-cost solar cooker technologies to the rural poor of East Africa (Karekezi, 2002).

Solar driers have been developed as an alternative to open-air sun drying and other conventional drying methods (Karekezi and Ranja, 1997). Solar driers are available for drying agricultural products such as grain, tealeaves, other crops, fish, and timber (called solar kilns). In general, research has shown that solar dryers perform well and produce better results than the traditional method of drying crops in the open sun (Karekezi et al, 2008; Karekezi and Ranja, 1997). Solar dryers can assist in reducing post-harvest losses because produce is less susceptible to natural deterioration and insect infestation. They also reduce drying times.

A simple, yet not common, solar technology that could improve the health of poor women and children in rural areas is solar water disinfection. Solar water purifiers use energy from the sun to destroy pathogens in water. The cost of this technology is negligible (mainly plastic bottles), yet its benefits could prove crucial to improving the health of the rural poor (Karekezi and Kithyoma, 2002).

The bulk of wind machines found in East and Southern Africa are used for water pumping for irrigation and to meet domestic and livestock water needs in rural areas (Karekezi, 2002). The most commonly used wind pumps in East Africa are of the Kijito type, manufactured by Bob Harries Engineering Ltd in Thika and come

[2] Kakuma Refugee Camp is in North West Kenya and is home to about 100,000 refugees mainly from Ethiopia, Somalia, Uganda and Sudan. Kakuma is sunny and very dry (receiving less than 250mm of rain annually).

in rotor diameters ranging 8–26 feet (Karekezi et al, 2005). In areas where wind pumps are being used, they have supplied communities with drinking water for domestic use and livestock watering, with an option for water storage. The reported benefits to farmers have been substantial (ApproTEC, 1999, 2002). These include increased land area under irrigation, reduced work time compared with bucket irrigation, full irrigation of fields resulting in improved crop quality, reduced frequency of irrigation to two or three times a week, less strenuous irrigation work compared to bucket irrigation, additional and new crops grown each season, increased number of growing cycles (as crops are able to grow faster with full irrigation), and improved farm incomes.

Small hydropower is a growing source of power for the rural poor in Kenya and parts of Uganda. Of special interest are small hydro installations on tea estates that allow electrification of the large number of tea estate employees and lower the cost of tea production, allowing more tea sale revenues to low-income tea outgrower farmers. Small hydro is now underway in both the larger transnational-owned tea estates, such as Unilever and James Finlay Tea Company, as well as the smaller Kenya Tea Development Authority factories, which are jointly owned by small-scale tea farmers (see Appendices for more details).

Cogeneration in agro-industries has also been instrumental in promoting sustainable energy in rural areas of East Africa. For example, through the support of the Cogen for Africa project coordinated by AFREPREN/FWD (www.afrepren.org), a civil society organisation based in Kenya, with support from the United Nations Environment Programme, the Global Environment Facility, and the AfDB (African Development Bank), Kakira Sugar Ltd (KSL) of Uganda installed a cogeneration plant. The sugar factory now generates excess electricity, which is sold to Uganda's national grid, thereby improving the revenues and profitability of the factory, which in turn benefits over 50,000 Kakira inhabitants directly or indirectly dependent on the sugar sector (for more details see Appendices).

The afore-listed case studies of successful, albeit largely pilot-scale, sustainable energy development in rural East Africa demonstrate the potential for wider use of sustainable energy options in the region. Many of these relatively successful initiatives have been a result of sustained efforts by key national and regional civil society organisations (CSOs) and regional initiatives. For instance, through a low-cost solar drying for food security project, Sustainable Community Development Services has managed to reach many poor farmers and empower them in fresh produce preservation.

The Africa Biogas Partnership Programme managed by SNV with support from HIVOS and the government of the Netherlands has been instrumental in disseminating biogas plants in six African countries. Biogas offers the multiple benefits of providing poor farmers clean energy, and enhanced sanitation, as well as organic fertiliser. In Kenya the Africa Partnership Biogas Program, through the Kenya National Domestic Biogas Programme implemented by the Kenya National Federation of Agricultural Producers, had constructed a total of 1,884 plants as of June 2011 (http://africabiogas.org). About 2,200 plants are earmarked for construction in 2011, with a flat subsidy of Kshs 25,000 (approximately 200 Euro).
AFREPREN/FWD has been instrumental in promoting sustainable energy practices throughout the eastern, horn and southern regions. Initial efforts were primarily focused on improved cookstoves for households and institutions, and played a role in the successful dissemination of the KCJ in many parts of Africa. AFREPREN/FWD's work then expanded to include energy policy research and documentation, resulting in the publication of a wide range of books and reports on sustainable energy in Africa. This solid research base, combined with its practical experience in disseminating the KCJ in the region, provided the basis for AFREPREN/FWD's work on promoting sustainable energy investments in the eastern, horn and southern regions, with an initial focus on cogeneration based on renewable fuels as well as small hydro. AFREPREN/FWD investment promotion activities have now expanded beyond cogeneration and small hydro to include solar driers, institutional biofuel stoves, gasifiers, and small-scale windpumps.

TaTEDO is a development organisation based in Dar es Salaam that has been instrumental in promoting sustainable energy options in Tanzania. For the last 19 years, TaTEDO has been actively involved in sustainable energy development projects and programmes in rural Tanzania. It also hosts and is affiliated with several local and international sustainable energy development partners and networks, which has enabled it to draw on and share successful sustainable energy experiences and knowledge from and with such networks and partners at local, national, and international levels. TATEDO has lead the promotion of

sustainable modern energy technologies in marginalised rural, peri-urban, and urban communities in Tanzania through technological adaptations, community mobilisation, capacity building, and advocacy for increased access to sustainable energy services, poverty reduction, environmental conservation, and self-reliance. This has contributed to availability of improved and sustainable energy services (such as the wide-scale dissemination of improved and efficient household stoves), employment, and income-generating opportunities, which are key to poverty reduction.

In Uganda, Kakira Outgrowers Rural Development, a non-profit partnership between KSL and the 7,000-member Busoga Sugar Growers Association, provides finance and infrastructure services to communities within a 30km radius of KSL (four districts) and has played a key role in promoting improved institutional cookstoves in rural parts of Uganda.

There nevertheless remain a number of open questions on technical options that civil society in East Africa need to address, namely:

- Should CSOs promote improved wood/charcoal stoves and efficient charcoal production and supply of fuelwood, or should CSOs only promote clean renewables such as solar PVs, biogas, and small wind power?

- Would it be wise for CSOs to promote cleaner fossil fuel-based options such as kerosene and LPG? Will the investment in fossil fuels lock the poor into an energy path that would prove unsustainable and costly as the switch to sustainable energy picks up speed?

- Should CSOs support conventional rural electrification, which relies on centralised conventional energy options such as large-hydro and fossil-fuel based power generating plants?

- How about centralised renewables energy options (geothermal and large wind farms) that deliver cleaner energy to the rural poor through the distribution system? Do such options deserve the support of East African CSOs?

In addition to identifying priority technical options, East African CSOs need to identify the most effective policy and institutional options for promoting cleaner energy services for the poor, the subject of the next chapter.

4. Possible Priority Policy Options for Expanding Access to Cleaner Energy Services for the Poor in East Africa

Small-scale non-electrical renewables are ideal for meeting rural energy needs for agriculture, productive use and commercial enterprises. Small and medium-scale technologies can play an important role in poverty alleviation. This is particularly true of small-scale RETs that are made locally and operate on the basis of solar, thermal, or animate power. Such systems can not only provide energy services that are affordable to the poor but can also be a source of employment and enterprise creation (Karekezi and Kithyoma, 2005) – see the following table.

Table 11: Renewables and Rural energy Applications			
Renewable Energy	**Agricultural Process**	**Production Enterprises**	**Commercial & Service Enterprises**
Solar Drying	Crop drying, fish and meat drying, fruit drying	Processing of tobacco, timber, coffee, tea	
Solar PV	Pumping, lighting, cooling, crop processing	Dairy Processing	Refrigeration for clinics Electrification of small shops, bars, food kiosks, and powering of mobile communication devices
Solar water heaters	Dairy processing and heat energy for poultry	Hot water for processing	Hot water for clinics, schools
Wind pumps	Irrigation, crop processing	Water lifting	Water lifting
Animal driven vehicles	Transport	Transport	Transport, Water pumping
Pico- and Micro-Hydro	Crop processing, irrigation	Saw milling, grain milling	Lighting, water provision
Biogas plants	Production of fertiliser	Lighting	Food preparation for clinics, hospitals and schools; Lighting for enterprises
Bio-fuel cookstoves	Milk pasteurisation, heat energy for poultry, crop drying, crop processing	Process heat	Food kiosks, food preparation for clinics, hospitals and schools
Source: Karekezi et al, 2008			

There is a wide range of policy options for promoting sustainable energy options among the rural poor in East Africa, including:

- Reducing the up-front cost of sustainable energy options
- Instituting attractive, pre-determined feed-in tariffs for both medium-scale and small-scale renewable energy power plants that are larger than 1MW
- Allowing the establishment of mini-grids and removing the de facto distribution monopoly enjoyed by national utilities
- Allowing the independent negotiation of tariffs in mini-grids supplying power to low-income communities for installations of less than 1MW of renewable power
- Expanding the mandate of rural electrification authorities to include support for renewables-based mini-grids and non-electric options such as windpumps, improved cookstoves, and solar driers, which will effectively transform rural electrification authorities into rural energy agencies
- Pushing ministries of finance and energy and national utilities in East Africa to improve the performance of the power sector and dramatically expand provision of cleaner and more modern energy services to the rural poor.

4.1 Reducing the up-front cost of sustainable energy options

The up-front costs of sustainable energy options constitute a key barrier to the rural poor, who can often meet the lower cost of operating sustainable energy options and feedstock provision, but cannot raise the capital to pay the up-front cost of equipment. Up-front costs of sustainable energy equipment can be reduced through various policy measures ranging from straight subsidies, reduced import taxes, and subsidised local manufacture of sustainable energy equipment and preferential concessionary finance for local manufacturers and distributors of sustainable energy equipment.

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4.2 Institution of attractive pre-determined feed-in tariffs for both medium-scale renewable energy power plants that are larger than 1MW and that sell excess power to the national grid.

Medium-scale renewable energy installations of more than 1MW that sell excess power to the national grid would benefit the rural poor indirectly by enhancing the profitability and competitiveness of rural industries that benefit the poor. Small-scale renewable energy power that directly benefits the poor can be allowed to install reversible that can in the short-term provide attractive rates (effectively transforming the customer tariff into a feed-in-tariff paid to renewable energy power).

4.3 Allowing the establishment of mini-grids and removing the defacto distribution monopoly enjoyed by national utilities.

The de facto distribution monopoly enjoyed by national utilities needs to be addressed to allow more independent mini-grids, particularly in areas the national utilities are unlikely to reach for many years. At the moment, national utilities simply cherry-pick the most attractive customers in rural areas (mainly institutions and industries) and connect them to the grid. Surrounding low-income households and small-scale businesses are either simply ignored because they do not represent attractive customers, or asked to raised enormous capital down-payments to cover the cost of distribution and local transformers.

4.4 Allowing the independent negotiation of tariffs in mini-grids supplying power to low-income communities for installations of less than 1MW of renewable power.

The negotiations of tariffs with national regulators in East Africa is currently an arduous process that requires a battery of high-cost lawyers to peruse detailed contract agreements and manage a lengthy negotiation process with regulators, as well as to undertake public consultations. This process often occurs in the face of undiluted hostility from the dominant national utility, which is unwilling to cede its distribution monopoly. Consequently, only a few pilot distribution mini-grids are in place in the region. What is needed is a regulation freeing small-scale mini-grids of a capacity of less than 1MW to undertake independent negotiations of tariffs with its targeted customers. It may initially result in unruly practices , but as the mini-grid industry matures, self-regulation can be encouraged to set the basis for more rapid expansion in the future.

4.5 Expanding the mandate of rural electrification authorities to include support for renewables-based minigrids and non-electric options such as windpumps, improved cookstoves and solar driers which will effectively transform rural electrification authorities into rural energy agencies.

Rural electrification authorities in the region receive substantial revenues from levies imposed on all national utilities customers. It is important that the full range of renewables used by the poor can access this large and sustainable source of finance. Expanding the mandate of rural electrification authorities to include renewables – electric and non-electric – would dramatically increase financial flows to sustainable energy options by using these large electrification levies to finance sustainable energy initiatives.

4.6 Pushing Ministries of Finance and Energy and National Utilities in East Africa to enhance performance of the power sector and dramatically expand provision of cleaner and more modern energy services to the rural poor.

In addition to the wide range of decentralised renewable energy options discussed in the preceding sections, it is important that East African CSOs do not allow the ministries of finance and energy and national utilities to escape their responsibility to provide energy services to the poor. Rural electrification programmes need to be dramatically expanded with much larger budgetary allocations and aggressive targets that ensure the electrification of and provision of modern energy services to the rural poor within a decade or so. Examples from North Africa, South Africa, and Mauritius clearly demonstrate that it can be

done within a decade. The national utilities working under the guidance of ministries of energy are the largest recipients of electricity-related revenues, and enjoy unparalleled political support. They should take the lead not only in electrifying the poor, but in expanding the range of sustainable energy services available to the rural poor through provision of subsidies and attractive feed-in tariffs, as well as through ministry- or utility-led renewable energy programmes.

There are clearly a number of important policy options that can assist in expanding access among the rural poor to sustainable energy. There nevertheless remain important questions about how best to influence energy policy and energy investments. For example, CSOs have not yet adequately addressed the question of identifying the most important opportunities (entry points) for gender mainstreaming and contributing to gender equality and women's empowerment in the sustainable energy sub-sector.

The other important energy policy question that East African CSOs need to address is the most appropriate policies for promoting forestry/biomass energy practices that are sustainable and supportive of more efficient biomass use, and set the region on a path towards wider use of modern and clean biomass-based electricity and fuels.

It is important, however, that East African CSOs understanding the limitation of policy-based initiatives to promote sustainable energy for the poor, and moderate their expectations. East African countries' energy policy documents have become more elaborate but are increasingly divorced from implementation, which tends to be driven by short-term considerations (and, increasingly, fire-fighting concerns related to power and oil supply shortages), and, more importantly, by facts on the ground. Policy makers are generally more impressed by actual investments than in elaborate document-based arguments, however convincing they may be.

This is, partly, a reflection of the still-embryonic stage of state development (and relatively short technocratic/bureaucratic tradition) in East Africa, as well as of limited recourse to evidence-based government decision-making. This does not mean that policies do not influence decision-making in some fashion, but highlight the limitations of energy policy in East Africa. It is therefore important for CSOs to combine policy advocacy with practical demonstrations of what is possible on the ground.

This is one of the reasons many East African CSOs have begun to dedicate more of their efforts towards field-related sustainable energy initiatives as an important supplement to their long-standing work on energy policy. A combination of sound policy advocacy efforts backed by sound research studies and data, combined with proven field pilot installations that demonstrate the viability of recommended options, would place East African CSOs in a much stronger position to push for more financing from national governments and bilateral and multilateral development agencies for a dramatic increase in cleaner energy services for the rural poor in East Africa.

5. Whit Whom Should Civil Society Work With to Expand Cleaner Energy Services for the Poor?

State ministries of energy continue to dominate energy issues in East Africa despite deregulation and the establishment of "independent" energy regulators, as well as privatisation of parts of the energy sector. This dominance is a result of:

a) Exclusive powers to appoint or nominate (and, in some cases, dismiss) key executives and board members of national utilities, regulatory agencies, and rural electrification agencies

b) Close to exclusive powers in authorising major changes in electricity tariffs, despite the existence of "independent" energy regulators who are appointed by ministries of energy

c) Close to exclusive powers to introduce and amend key energy laws

d) Dominant role in authorising public finance for energy investments as well as public guarantees for private sector energy investments

e) Key partner in discussions and negotiations with international institutions on energy policies, e.g., in country strategy papers that are agreed with the EU (http://www.hivos.nl/eng/News/News/Assessment-of-EU-Policy-on-Sustainable-Energy) or similar documents with the World Bank or the AfDB.

Although parliaments and ministries of finance are legally responsible for enacting laws and authorising investment finance, respectively, they both rely on ministries of energy for expertise and, more importantly, key energy data and information.

Other important players associated with the ministries of energy include national utilities in charge of distribution (the Kenyan and Tanzanian national utility are still state-owned, and work in accordance with ministry of energy directives), transmission (state-owned in all East African countries), and generation (growing private sector participation). Other institutions include national energy regulators and rural electrification agencies, all of which are ostensibly "independent", but effectively follow ministry of energy directives.

East African ministries of energy are pre-occupied with the large-scale energy investments associated with conventional energy options and associated energy prices. They pay limited attention to small-scale renewables for the poor. This subject is usually delegated to renewable energy departments that are often perceived as backwaters, with limited budgets, clout, and influence. CSOs could potentially work with renewable energy departments to enhance their visibility and clout by collaborating in compiling more up-to-date and comprehensive information on sustainable energy options, persuasive case studies of successful sustainable energy initiatives, and innovative sustainable energy pilot projects. By forging strong links with renewable energy departments, CSOs could assist in raising the profile of these under-resourced and overlooked departments.

The recurrent power crises and fuel shortages that are now a dominant feature of the East African energy sector have deepened ministers of energy's almost total pre-occupation on centralised conventional power systems. Only renewables perceived as sources of large-scale power generation (large hydropower plants, windparks, and large geothermal power plants) receive some attention.

For example, Kenya appears to be more resilient to drought-induced power generation shortfalls because of its modest investments in renewable energy-based power generation, primarily geothermal, cogeneration, and, to a lesser extent, windpower. Geothermal energy accounts for over 10% of Kenya's electricity

generation (KPLC, 2010). Working with ministries of energy on large-scale clean renewables options such as windparks and geothermal power plants could provide CSOs with an important entry point for promoting renewables in general. After gaining the confidence of senior policy makers, CSOs could begin to push for smaller scale renewables that directly benefit the rural poor.

The other major players in the energy sector are the bilateral and multilateral donor/development agencies and development finance institutions that are often lumped together as the "international development community". They have enormous influence in determining the "official" agenda and priorities of the energy sector in East Africa. What they cannot influence is the enthusiasm and commitment of East African governments, nor are they able to ensure long-term commitment.

As the experience of privatisation and the establishment of independent agencies in the energy sector has shown, East Africa governments can "officially" concur with the international development community, but often manage to circumvent any agreement because they control the detailed implementation. They can also, in the long term, reverse previous agreements. CSOs could play a constructive watchdog role, encouraging East African governments to adhere more closely to past commitments to promoting small-scale renewable energy options that expand the poor's access to cleaner and modern energy services. They can also pressure national governments to expand financing for pro-poor rural energy services as well as observe negotiations between national governments and the international development community.

The private sector consists of relatively small players with limited clout in policy circles. CSOs could play a role by bringing small-scale renewable energy enterprises into large associations that would have significantly more influence at national level.

Better-established private sector companies are largely interested in conventional centralised systems, which they believe will lower the cost of energy. Energy efficiency is of growing interest among private enterprises, however, because of the quick return on many energy efficiency initiatives, which often require modest up-front investments. By supporting energy efficiency programmes and initiatives, CSOs could potentially forge strong links with the larger private sector, and eventually use the closer relations to gain some support for small-scale sustainable energy initiatives that expand access among the rural poor, possibly through corporate responsibility programmes.

A few major private companies are showing increased interested in the profitable revenue streams that sustainable energy investments can deliver. Of particular note are agro-industries, which are becoming major investors in sustainable energy and would be very open to working with CSOs in promoting sustainable energy options that benefit the rural poor. Many of these agro-industries rely on poor rural farmers for feedstock, and would be keen to promote initiatives that improve the living conditions of one of their key stakeholders.

The media are increasingly independent, and a growing and important player in the energy sector. They have the power to shift public and policymakers' attention to key energy concerns. The ability to maintain long-term focus on any energy issue is a challenge, however, as is the difficulty in communicating new energy concepts, such as decentralised renewables and energy efficiency. By collaborating with the media through regular weekly columns and regular electronic media programmes, CSOs could ensure that sustainable energy options for expanding access among the poor remain in the public eye. CSOs can also organise regular awareness-creation and training workshops for media personnel interested in sustainable energy for the poor. This will strengthen media expertise in and understanding of sustainable energy issues.

Because of limited expertise, skills and funding, regional agencies such as the East African Community, IGAD, ECA, and AU have not yet been able to influence energy policy in a major fashion but they do provide neutral venues for sharing experiences. CSOs could work with regional agencies to raise their profile and expand their activities on sustainable energy for imporoved access among the rural poor in East Africa.

The final and, in many respects, the most important player consists of the target group – namely, the rural poor. It is a large and diverse group that accounts for a substantial majority of the population of East Africa. Its characteristics include low and irregular incomes, limited education, and limited access to effective organisational structures. It is unlikely that East African CSOs would, in the short term, have the ability to reach the rural poor in a systematic fashion, but there may be options for forging links with key representative groups through some of their more effective organisational structures (such as farmer organisations) to promote pro-poor sustainable energy options and decentralised renewable energy production. Other institutions with large outreach in rural areas include micro-credit networks, health services, and local government.

This section shows the enormous diversity and scale of key players. As East African CSOs interested in promoting sustainable energy options for the poor are relatively small organisations that have yet to jell into an effective structure, it would probably be wise to start with modest ambitions and targets. Limiting the number of institutional entry points that East African CSOs engage with is, in many respects, the most appropriate next step in any embryonic initiative aimed at expanding access to cleaner energy services among the rural poor through sustainable energy options. This is precisely the subject of the next section.

The increasingly frequent energy crises that now afflict the East African region on a regular basis offer an important and recurrent opportunity to influence key energy institutions. East African CSOs interested in pro-poor sustainable energy options can tactically intensify their work with the media and other key players whenever an energy crisis affects an East African country. This is precisely when the public and key players are interested in energy and open to new ideas and initiatives. It is possible to argue and convincingly demonstrate through pilot initiatives that sustainable energy options for the poor can mitigate energy crises by reducing the demand for energy from overloaded centralised energy systems.

6 Which Institutional Entry Points Should be Targeted for Promoting Cleaner Energy Services for the Poor

The previous section identified the following potential key players in expanding access to cleaner energy services for the rural poor:

a) Media
b) b) Other civil society forums such as residents' associations, professional associations, and academia
c) National parliaments and/or East African Parliament
d) National utilities
e) Regulatory agencies and concerned line ministries (energy, agriculture, water, etc.) and finance ministries
f) Private sector associations and manufacturing industry associations
g) International-level structures
h) Donor and financing agencies (e.g., bilateral & multilateral donors, development banks such as the World Bank, the AfDB, the European Development Bank)
i) Target group – the rural poor, through their representative structures such as government, micro-credit institutions, health networks, and agricultural support organisations.

It can be argued that the media is, in many respects, the single most important entry point for CSOs to use to promote sustainable energy options for expanding access among the rural poor of East Africa. Through the media, outreach to all the other key players can be assured.

It would therefore make sense for East African CSOs interested in pro-poor sustainable energy options to consider targeting the media in the initial phases, then expand outreach to other key players.

As mentioned earlier, the media are a growing and important player in the energy sector, with the power to shift public and policymakers' attention to key energy concerns. The media is, however constrained by its short attention span and limited understanding of relatively new energy concepts that sustainable energy brings to the fore.

To address the constraints faced by the media, East African CSOs working on sustainable energy options for the poor could organise regular awareness-creation and training workshops for media personnel interested in sustainable energy for the poor. This will strengthen media expertise in and understanding of sustainable energy issues. Should the training and awareness-creation workshops prove successful, it could encourage media personnel interested and specialised in pro-poor sustainable energy who would, in turn, assist in tackling the short attention span of the media.

A core group of media personnel specialised and interested in pro-poor sustainable energy options combined with efforts by concerned East African CSOs to publish regular weekly columns, articles, and electronic media programmes could ensure that the challenge of reversing the limited access to cleaner energy services among the rural poor remains in the public eye.

The other important strategic option that East African CSOs interested in pro-poor sustainable energy options should consider is to target new institutions that are starting to take root in East Africa. The logic here is that new institutions are often more open to new ideas and external influences. Established organisations are likely to be dominated by entrenched interest groups, and resistant to change.

East Africa CSOs working on pro-poor sustainable energy options can target the following newly established decentralised government structures that are gaining importance at district and city level, especially in Kenya, where their responsibilities and finance are entrenched in the new constitution.

In the same vein, close attention can be paid to new appointments in strategic institutions such as ministries of energy (minister and permanent secretary), parliament (new chairpersons of parliamentary committees in

charge of energy), ministries of finance, ministries of agriculture, large banks and credit institutions that target the rural poor, and the international and regional development community.

There are a large number of international development initiatives and agencies that promote sustainable energy for the poor and that provide entry points for promoting pro-poor sustainable energy initiatives. Of special interest are initiatives related to carbon credits (official and voluntary) and a large number of studies and initiatives that promote access to modern energy.

One important initiative is the UN-led Sustainable Energy for All initiative announced by UN Secretary General Ban Ki-moon as one the five priorities that will guide his second 5-year term. The initiative has ambitious goals: universal access to energy, improved efficiency, and enhanced deployment of renewable sources in order to combat endemic poverty.

The Sustainable Energy for All initiative calls for private sector and national commitments to bring global attention to the importance of energy for development and poverty alleviation. The goal is to meet three objectives by 2030:

- Ensuring universal access to modern energy services
- Doubling the rate of improvement in energy efficiency
- Doubling the share of renewable energy in the global energy mix.

In recognition of the importance of energy access for sustainable economic development and supporting the achievement of the Millennium Development Goals, the United Nations General Assembly has designated 2012 as the International Year of Sustainable Energy for All. A large number of initiatives linked to the International Year of Sustainable Energy for All are now underway in different parts of the world (see Appendix 9) and are likely to feature prominently at the forthcoming Durban Climate Summit of late 2011.

East African CSOs could use this global focus on sustainable energy to mobilise their partners, increase awareness of sustainable energy, and accelerate the provision of cleaner and affordable modern energy services for rural poor of East Africa.

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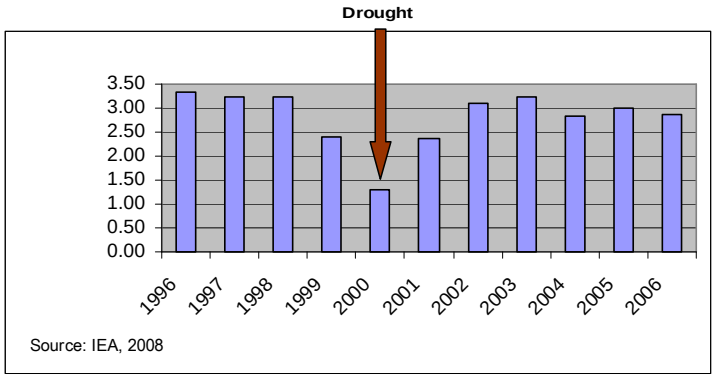
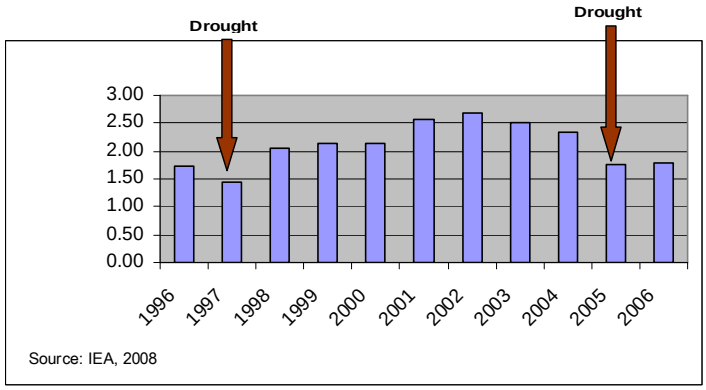
Appendices

Appenedix 1 Impact of Drought on Hydropower in East Africa

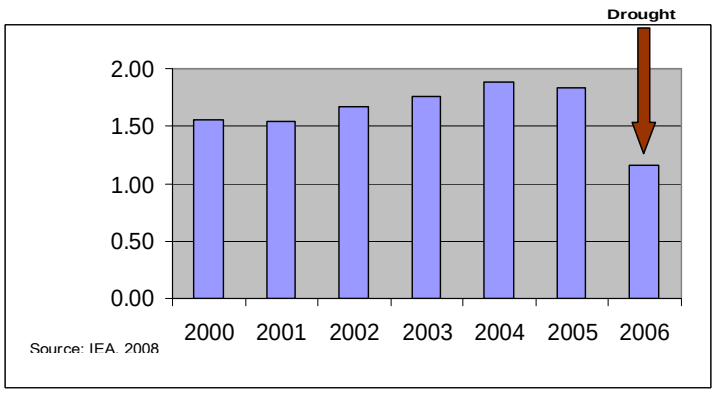
Appendix 1: Impact of Drought on Hydropower in East Africa (1996-2006 in Billion kWh)



Kenya



Tanzania



Uganda

Source: IEA, 2008

As has already been mentioned, the region is heavily dependent on hydropower electricity generation – accounting for 79% of total electricity generated in East Africa. In spite of despite the past experiences and warnings of foreseeable reduction in precipitation, several countries in the region continue investing heavily in ambitious hydropower projects. Notable examples are in Uganda with the 250 MW Bujagali hydropower plant and, more recently, Ethiopia's ambitious 2,000 MW Mendeya large hydropower plant that is to be located at the junction of the Abay and Dedessa (Xinhua News Agency, 2009).

With most of the countries in the region lacking a diversified power sector, a combination of increased drought and shortened rainy season is likely to cripple the power sector. This could lead to sharp drops in

their respective GDPs. In addition, the prevailing encroachment of water catchment areas for agricultural use appears to make hydropower development more vulnerable.

Appendix 2 Renewable and Rural Applications

Appendix 2: Renewables and Rural Applications			
Renewable Energy	**Agricultural Process**	**Production Enterprises**	**Commercial & Service Enterprises**
Solar Drying	Crop drying, fish and meat drying, fruit drying	Processing of tobacco, timber, coffee, tea	
Solar PV	Pumping, lighting, cooling, crop processing	Dairy Processing	Refrigeration for clinics Electrification of small shops, bars, food kiosks, and powering of mobile communication devices
Solar water heaters	Dairy processing and heat energy for poultry	Hot water for processing	Hot water for Clinics, schools
Wind pumps	Irrigation, crop processing	Water lifting	Water lifting
Animal driven vehicles	Transport	Transport	Transport, Water pumping
Pico- and Micro-Hydro	Crop processing, irrigation	Saw milling, grain milling	Lighting, water provision
Biogas plants	Production of fertiliser	Lighting	Food preparation for clinics, hospitals and schools; Lighting for enterprises
Bio-fuel cookstoves	Milk pasteurisation, heat energy for poultry, crop drying, crop processing	Process heat	Food kiosks, food preparation for clinics, hospitals and schools
Source: Karekezi et al, 2008			

Appendix 3 Savings from Improves Stoves in Kenya and Rwanda

The results in savings in the amount of fuel used, translates to direct cash savings as in the table below.

Appendix 3: Savings from Improved Stoves in Kenya and Rwanda					
Average daily charcoal consumption (kg per person per day)			**Yearly savings per family (kg)**	**Value of Savings (US$)**	**GNP Per Capita (US$)**
	Traditional Stove	**Improved Stove**			
Kenya	0.67	0.39	64.70	613	360
Rwanda	0.51	0.33	84.10	394	210
Source: Karekezi and Ranja, 1997; World Bank, 2004a					

Furthermore, the production and dissemination of improved biomass energy technologies provides employment and job opportunities for a significant proportion of the population, particularly women (Njenga, 2001).

Appendix 4: Number of customers connected to grid electricity through KPLC and REA

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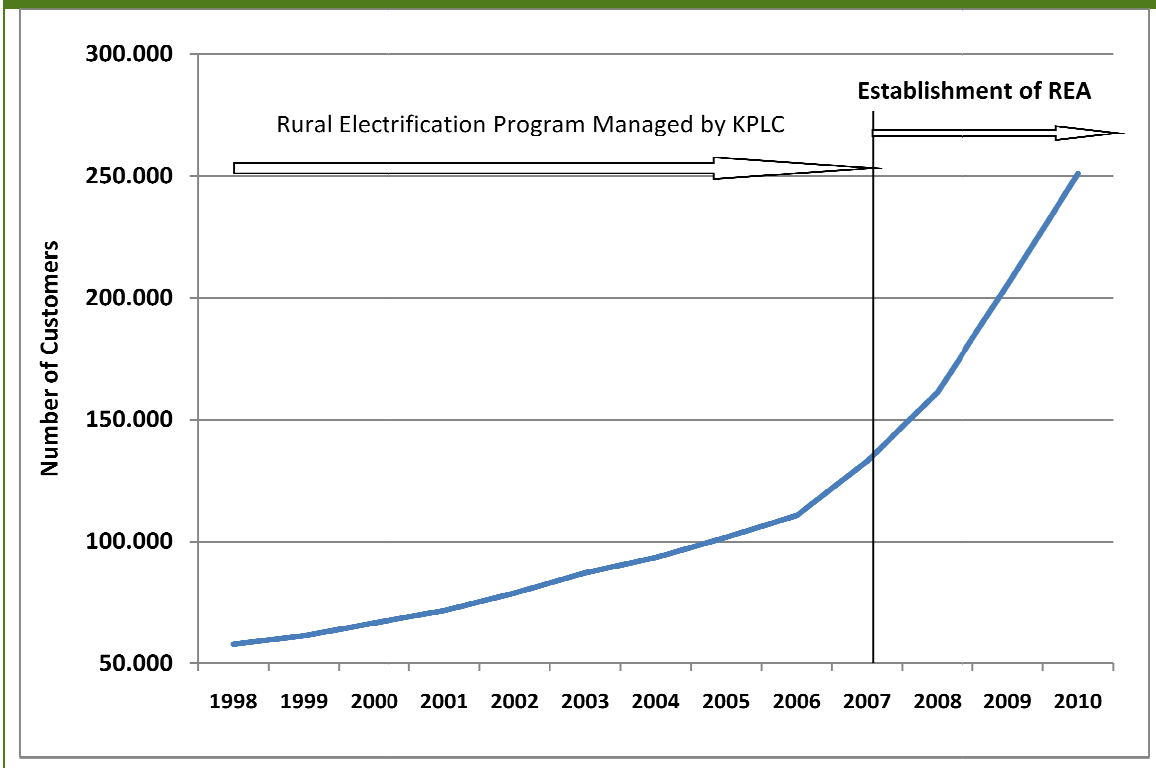

Source: KPLC, 2003; KPLC, 2006; KPLC, 2007; KPLC, 2008; KPLC, 2009 and KPLC, 2010

Appendix 5: Small hydropower sites identified close to KTDA tea factories

A pre-feasibility study of several small hydropower projects carried out by the French firm IED in the Eastern Aberdares tea growing region served by Kenya Tea Development Association (KTDA) factories found that there are indeed substantial hydropower resources that could supply the tea factories in this area. The table below shows a list of 7 projects of which six, in the power output range of 1.0 to 2.8MW, with a total design power output of 11.245 MW are found to be economically attractive. The tea factories that can benefit from the development of these schemes include Kenyenyaini, Gitugi, Iria-ini, Chinga, Kiru, Gathuthi, Gatunguru and Githambo.

Appendix 5: Small hydropower sites identified close to KTDA tea factories

Site Name	Watershed area	Mean flow	Gross head	Design Flow	Power Out	Energy Production	Plant factor	Investment cost	Cost/kW
	km2	m^3/s	m	m^3/s	kW	GWh	%	M Euro	Euro
Gura	117	5.0	113	4	2755	17	70	4.38	1,750
North Mathioya 1	105	6.5	101	3.1	2010	17	94	3.48	1,728
North Mathioya 2	107	6.6	80	3.1	1540	13	94	3.04	1,974
North Mathioya 3	112	6.9	101	3.1	1960	16	94	3.40	1,740
South Mathioya	51	3.1	98	2.5	1010	8	77	2.95	1,700
Maragua	31	2.5	153	2	1970	13	76	3.30	1,678
Thaina	32	0.3	123	0.5	336	1.6	50	-	-

The pre-feasibility studies show that the sites can generate sufficient power to meet the electricity needs of seven adjoining tea factories and provide rural electrification to neighboring communities. It is found however that the load factor of the tea estates comes to around 0.48 and the combined load factor of the tea factories and rural electrification comes to around 0.43. The remaining energy produced by the power project will have to be sold to KPLC in order for the project to generate a reasonable Internal Rate of Return.

There is a correlation between tea plantations and hydro potential in Kenya. Clearly tea is grown in those areas with the highest yearly precipitation. Also, the hilly and mountainous areas of Kenya are rather wet, thus providing the right conditions for tea growing as well as sufficient water and head to assure local hydro potential. However, hard data to demonstrate this has not been collated and analysed. However, analysis of questionnaires obtained from tea factories in Kenya (based on the EATTA/UNEP survey in 2004) has been done. A total of 72 tea factories responded out which over 80% are located 3 – 15 km from a potential hydropower site.

Appendix 6: Population benefiting of Cogeneration at Kakira Sugar Ltd

Appendix 6: Population benefiting of Cogeneration at Kakira sugar Ltd	
Description	**Population**
Current Farmers (Out growers)	**7,786**
Current Beneficiaries (no. of farmers multiply by five)	**38,930**
Total Projected Farmers by 2015/2016	**10,074**
Total Projected Beneficiaries (no. of farmers multiply by five)	**50,370**
Source: Cogen for Africa	

Appendix 7: Countries Affected with Power Shortages in Africa

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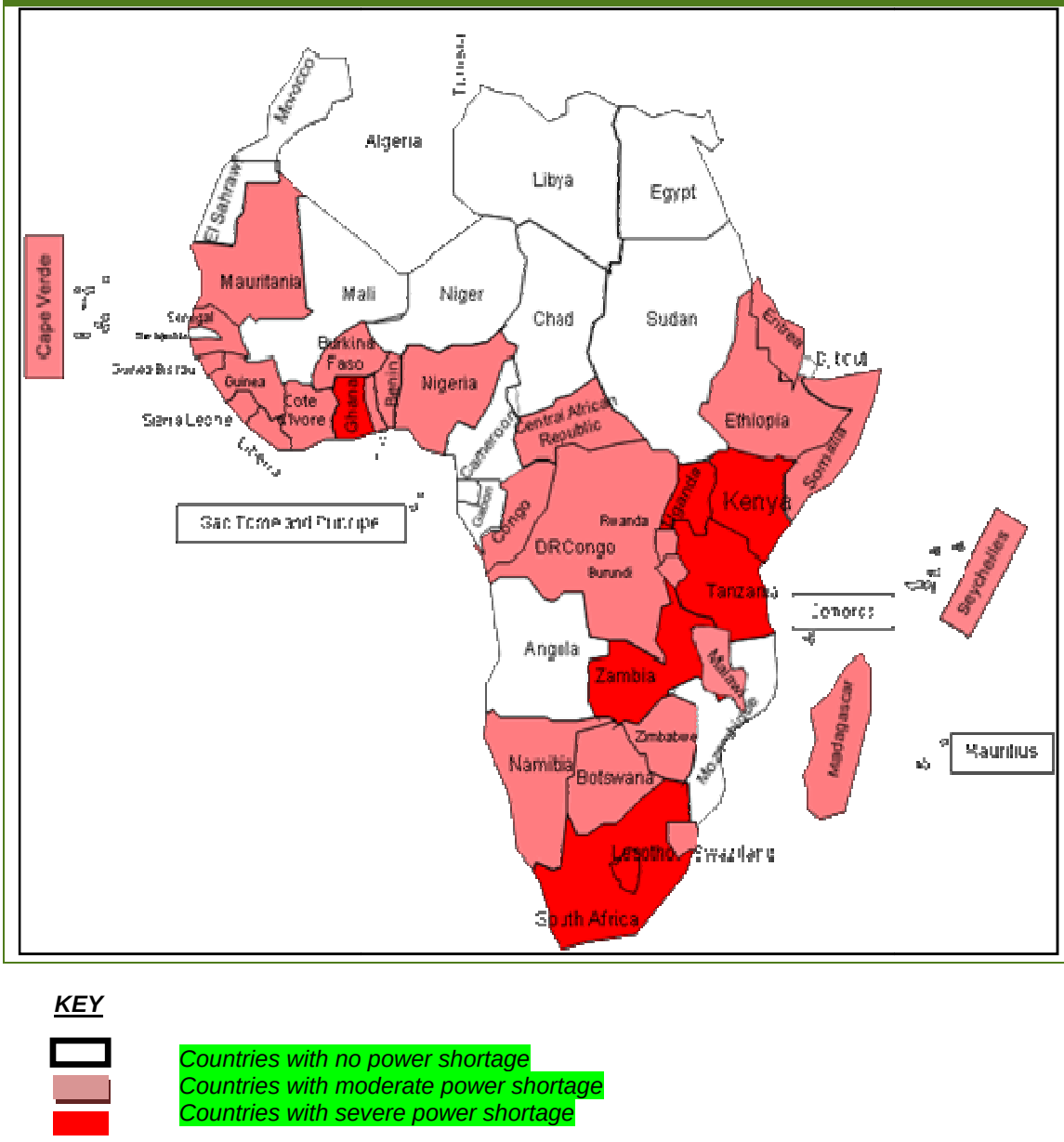

KEY

Countries with no power shortage
Countries with moderate power shortage
Countries with severe power shortage

Appendix 8: Rural Electrification Program in Kenya

The Kenya Rural Electrification Programme (REP) was started in 1973 (Abdullah and Markandya, 2007; KNBS, 2011), it was untill 2007 when a dedicated rural electrification agency was set up that the rural electrification levels increased significantly. The REP was initially managed by the Government of Kenya with its management delegated to the country's main utility, Kenya Power and Lighting Company (KPLC).

As mid of 2010, the number customers connected through REP stood at over 250,000 compared to mid of 2007 which was slightly above 133,000 (See Appendices), an increase of nearly 90 percent (KNBS, 2009; 2011). This is, in part, due to an institutional and structural change in the rural electrification program which established a dedicated rural electrification agency that manages a 5% levy on on all electricity bills as well as uses a variety of cooperative models to promote rural electrification.

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