Energy Systems:
Vulnerability – Adaptation – Resilience (VAR)

2009

Regional Focus: sub-Saharan Africa

Uganda

Report written by:
Timothy BYAKOLA
Pierre MUKHEIBIR

Email:
acs@starcom.co.ug
PMukheibir@gmail.com

This project is supported in part with funding from:

Mission d'Appui à l'Action internationale des Organisations non Gouvernementales

and gtz

56, rue de Passy – 75016 Paris – France |Tel: (33) 1.42.24.51.48 | Fax: (33) 1.42.24.86.33
Email: helio@helio-international.org | www.helio-international.org

Executive Summary

At a population growth rate of three percent per annum, Uganda has one of the highest growth rates in the world. The country depends predominantly on agriculture as the backbone of its economy. The sector employs well over 81 percent of the country's 28 million people and contributes about 34 percent of Gross Domestic Product (GDP). But despite the importance of the agricultural sector to the economy, most agriculture remains subsistence and relies mainly on the rains as the main source of water.

With a GDP per capita of 370 US Dollars and a Human Poverty Index value of 34.7, Uganda still remains as one of the world's poorest countries. The country still continues to struggle with the HIV/AIDS pandemic with prevalence rates of 6.4 percent and a high external debt burden of 3.2 Billion US Dollars.

Uganda's gross domestic savings ratio is extremely low standing at about ten per cent in the year 2004/5. Donor dependence remains significantly high with grants accounting for over 30 per cent of total government expenditure.

Climate change induced mainly by human activities like bush burning threaten to increase average temperatures in Uganda by up to 1.5 ºC in the next 20 years and up to 4.3 ºC by the 2080s. Such rates of increase are unprecedented. Changes in rainfall patterns and their amounts are expected to change the country's agricultural productivity and that of other natural resources like forests and rivers. Prolonged droughts seen in the last few decades, particularly in the northeast of the country, have brought increasing public attention to the long-term impacts of climate change to agriculture and other important sectors like energy.

The Ugandan census of 2002 reported that 81.8 percent of Uganda households use firewood for cooking and another 15.2 percent for charcoal. Biomass makes up 94 percent of all energy consumed in Uganda. In addition, in the 1990's hydro electricity contributed more than 99 percent of electricity generation; by 2009 this figure was around 48 percent. These two facts indicate that Ugandans are dependent on two key sources of energy: hydroelectricity and biomass. The lack of diversity makes them vulnerable climatic variations.

Biomass is mainly harvested from natural forests. The continued heavy dependence on biomass contributes greatly to the destruction of Uganda's forest cover with annual loss rate of two percent. Destruction of forests threatens the energy security of many poor households in rural and urban areas, worsening suffering and the poverty burden of women and children. Increasing desertification, attributed in part to climate variability, is increasing ecosystem's vulnerability and hence its capacity to deliver sufficient energy resources in the future. The situation is further worsened by poor and wasteful biomass harvesting and inefficient use technologies.

Climate change has not spared other energy systems in Uganda. Fluctuations in water levels of Lake Victoria, (partly due to climatic change) have had a devastating effect on the generating capacity of Uganda's two main hydroelectric facilities. This has necessitated power rationing of up to ten hours causing massive losses in the

economy. The high dependence of the hydro electricity sector on the quality and quantity of climate sensitive water resources presents a major point of vulnerability. The vulnerabilities of this energy system are further compounded by the high transmission and distribution costs due to centralisation of the two main generating dams and the dispersed housing patterns of many Ugandan households especially in rural areas.

Because Uganda is a land-locked country, the costs of transportation of oil products from the Kenyan sea port of Mombasa greatly increases the cost of petroleum products. Taxes on petroleum products are as high as 35-40 percent. The petroleum sector is also highly vulnerable to political conflicts that may arise in neighbouring countries as was seen by the December 2007 election violence in Kenya where imports to Uganda were blocked for over three weeks. Uganda imports 100 percent of all its petroleum products. To reduce this vulnerability, the country plans to start to produce its own oil by 2013 (The Times 2009). However other fuels sources like ethanol and bio-diesel may be used as alternative options for industrial operations.

The purpose of this work to assess the vulnerability of Uganda's various energy systems to climatic changes and outline recommendations for how the resilience of these energy systems can be increased in turn helping to ensure the Uganda's energy security. Among the recommendations are to:

- reduce the vulnerability of biomass energy systems brought about by the over dependence on the dwindling natural forests as the primary source of biomass;
- promote small scale rural based bio-energy technologies like gasification, co-generation, biogas production, briquetting, improved cooked stoves etc to ensure environmentally and economical sound use of biomass energy hence making good use of available natural resources;
- reduce pressure on the country's biomass resources by diversifying the energy mix with solar and wind; and,
- install smaller and more decentralized energy schemes, closer to users and requiring less power transportation, especially for rural areas and will reduce high distribution and transmission vulnerabilities of the hydro and biomass energy systems.

Table of Contents

List of Acronyms

AERDP	Alternative Energy Resource Development Programme
ADB	African Development Bank
EAP	Energy Advisory Project
ENSO	El Nino Southern Oscillation
ERA	Electricity Regulatory Authority
ERT	Energy for Rural Transformation
GDP	Gross Domestic Product
GEF	Global Environment Facility
GNP	Gross National Product
HDI	Human Development Index
HIPC	Highly Indebted Poor Countries
HPI	Human Poverty Index
IPCC	Intergovernmental Panel on Climate Change
Kwh/yr	Kilo-Watt Hour per year
KGOE	Kilogram Oil Equivalent
MEMD	Ministry of Energy and Mineral Development
MFPED	Ministry of Finance Planning and Economic Development
MW	Mega-Watts
MWLE	Ministry of Water Lands and Environment
NAPA	National Adaptation Plan of Action on Climate Change
NEMA	National Environment Management Authority
NFA	National Forestry Authority
PEAP	Poverty Eradication Action Plan
PRSP	Poverty Reduction Strategy Paper
PVs	Photovoltaics
REA	Rural Electrification Agency
REF	Rural Electrification Fund
SIDA	Swedish International Development Agency
SQ. Km	Square Kilometre
UBOS	Uganda Bureau of Statistics
UDC	Uganda Development Corporation
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme

Reporter Biographies

Timothy BYAKOLA holds a Bachelor of Science degree in Forestry Studies from Makerere University with postgraduate training in energy policy and environment studies. Currently he works with Climate and Development Initiatives, an NGO established in Uganda. He is an alumnus of the University of Cambridge post graduate course in Cross Sector Partnerships. Over the years Timothy has gained hands-on experience in building energy tri-sector partnerships involving government, the private sector and local communities. He has provided support to a number of small community based groups in identifying various opportunities for energy partnerships. He is the East African regional coordinator for the International Network for Sustainable Energy (INFORSE) and a country reporter for HELIO International. He has written and co-authoured a number of publications and journal articles on renewable energy, climate change and forestry in Africa.

Contact:
Timothy BYAKOLA
Programs Coordinator
Climate and Development Initiatives
P.O. Box 8849 Kampala, UGANDA
Tel: 256-414-342685, Cell: 256-77-2-584957
Suite 3, Plot 4, Muwuliza Road, Namuwongo
E-mail: acs@starcom.co.ug, timbyakola@yahoo.com

Pierre MUKHEIBIR holds a PhD in Geographical and Environmental Sciences and an MSc in Engineering. He previously worked at the Energy Research Centre (University of Cape Town), where he conducted research focusing on the adaptation to climate change, specifically in small towns and the water sector. He has presented and written a number of published papers and articles on climate change adaptation strategies. He is currently a planning engineer with a water corporation in Australia.

Contact:
Dr. Pierre Mukheibir
PMukheibir@gmail.com

Country Overview

Introduction

Uganda is a land-locked country covering 236,040 square kilometers. Uganda's vegetation is mainly composed of savannah grassland, bush land and tropical high forests. Climatic conditions are moderate year-round and rainfall levels range from 750 to 2000 mm annually. The country is well endowed with fresh water resources among which are the River Nile and Lake Victoria, where more 40 per cent of the population derive economic benefits in the form of fishing, water supply, transport, hydro energy and tourism.

Uganda has an estimated population of 30.7 million people (UBOS 2009). With a population growth rate of three percent per annum, Uganda has one of the highest growth rates in the world. The population is largely rural (88 percent) with women constituting the bulk of the rural population.

Uganda has experienced relatively robust economic growth rates—averaging over seven percent in real terms—for most of the past decade. Factors contributing to the steady GDP growth include, but are not limited to: a stronger export sector (primarily supported by coffee, flowers and fish), increased foreign direct investment into various sectors; a growing, fixed private investment (driven mainly by construction), large concessional inflows from donors, and a stable macroeconomic environment. However, further growth has been constrained by inadequate infrastructure. In particular, limited capacity in the energy sector created high costs and constrained the manufacturing sector. Finally, interest rates remained high, insecurity in Northern Uganda was experienced and the extreme weather conditions experienced in 2007 negatively affected agricultural outputs (MEPD 2008).

Annual headline inflation amounted to 7.3 percent for 2007/08. Although this is a moderate level of inflation, food crop prices increased significantly in the last few months of the financial year. The agriculture sector makes up approximately 16 percent of total GDP (compared with 30 percent just under 10 years ago). Despite this, the sector still employs approximately 80 percent of Uganda's total workforce, including approximately 70 percent of all Ugandan women (MEPD 2008).

Imports in 2007/08 were approximately 30 percent of GDP, while exports and re-exports climbed to 13 percent of GDP. Cash crops are an important source of foreign exchange in Uganda and make up at least 30 percent of total exports, including re-exports (MEPD 2008).

Major Development Challenges

Despite impressive economic performance figures Uganda still faces serious challenges regarding fulfilling its targets of key economic and social indicators. In the Poverty Eradication Action Plan (PEAP), the Government of Uganda projected a reduction of absolute poverty to below 10 percent by 2017 if the seven percent growth margin is maintained.

The agricultural sector where the bulk of the labor force is employed has grown slower than the overall economy. This implies that efforts to implement agricultural policies need to be substantially reinforced to ensure that a large section of the population remains employed.

Poor management of Uganda's water resources threatens the country's efforts to fight poverty particularly in rural areas. A rain-fed agricultural economy is highly vulnerable to the vagaries of weather.

The energy sector is heavily dependent on bio-mass resources, accounting for more than 90 percent of the national energy needs. Households, small-scale industries (such as lime, brick and tile making) and a number of agro-based industries (tea, tobacco and fishing) mainly depend on biomass energy resources. The continued heavy dependence on biomass is contributing significantly to the decimation of Uganda's forest cover with an annual loss rate of two percent (New Vision 2008).

The gross domestic savings ratio is extremely low at about 10 percent in 2004/5. Donor dependence remains significantly high with grants accounting for over 30 percent of total government expenditure.

Agriculture has experienced difficult times over the past few years, with revenues severely affected by droughts, floods and wilt disease. The 2005/06 national survey showed that agricultural inputs such as seeds, fertilizers, pesticides and manure are limited in all households in Uganda (Nayenga 2008). Moreover, the challenge exists for Uganda to produce value-added agricultural products, rather than raw materials. Another challenge remains sustaining and creating markets for agro-products.

In addition, it is estimated that for poverty rates to fall below 20 percent, agricultural growth must average six percent per annum, a figure well beyond current agricultural growth rates.

Key development statistics for Uganda are summarised below.

Table 1: General statistics

	Unit Value	Year
Physical land area		
Area of country	236,040 Km^2	2008
Cultivated areas (arable land and area under permanent crops) --as percent of the total area of country arable land --area under permanent cultivation for domestic use --area under permanent cultivation for export --area under permanent cultivation	 26.4 % 6.9 Mil ha Not available 10.6 %	2002
Population		
Total population --percent which is rural --growth rate --fertility rate (total births per woman --HIV prevalence rate	30.7 mil (est)[1] 88 % 3.2 % 6.7 % 6.4 %	2009 2007 2007 2007 2007
Population Density	125.4/ Km^2	2008
Population economically active in agriculture --percentage of women employed in agriculture (as a %of total women)	81 % 70 %	2007 2008
Economy and Development		
Gross Domestic Product (GDP) --Value added in agriculture (percent of GDP) --GDP per capita (USD)	11.7 Billon USD[2] 16 % 387	2008 2008 2008
Human Development Index (and Ranking)	0.581	2007
Human Poverty Index (and ranking) (HP 1-1) value	34.7	2006
Population without electricity (millions)	24.6 million	2007
Carbon dioxide Emissions (total) MT	1.8	2004
Carbon dioxide emissions average annual change (percent)	8.9 %	1990 – 2004
Population using an improved water source	67 %	2007
Rate of forest cover shrinkage	2 %	2007
Infant Mortality	77 per 1000 live births	2007
Literacy rate	84 %	2005/06

Source: Human Development Report 2007/ 2008 (UNDP 2008) and State of Ugandan population report (Republic of Uganda 2008)

[1] Population in 2007 was 29.6 million
[2] 1 U.S. dollar = 2 061.85567 Ugandan shillings

Key Vulnerabilities

Uganda's key vulnerabilities, classified according to the five pillars of ecodevelopment[3] are summarised below.

Table2: Key vulnerabilities by ecodevelopment pillar

Sector	Vulnerability	Impact
Environment	Biomass accounts for over 90 percent of total energy consumed[4] in Uganda	Biomass supply deficit is projected to be 27.7 percent by 2016. Currently biomass is predominantly used at the household level for cooking and boiling water. A considerable biomass amount is also used in the services/commercial and industrial sector. Consumption at the industrial and service sectors is so significant that it is said to be comparable to no other country in the region.
	Proportion of the country covered by semi-arid conditions estimated to be 51 percent in 2008 from 40 percent in 199.[5]	Between 1991 and 2000 Uganda experienced seven droughts[6] with over 1.8 million people affected. Drought conditions lead to loss of economic production especially in the cattle corridor districts.
	The country is experiencing increasing intensity and frequency of heavy rains in some areas	The El Nino related floods of 1997/98 are estimated to have killed 1000 people, displaced 150 000 and caused damage to infrastructure costing around $400 million.[7] There have been new epidemics of malaria and cholera disease.
Economic	Dependence on coffee as the main export crop is a major vulnerability.	In the absence of a diversified economic base, predominantly agricultural households are highly vulnerable to volatility in the prices of commodities such as coffee.
	With an external debt of over US$3.2 billion Uganda is one of the Highly Indebted Poor Countries (HIPC)	With a high debt service ratio (about 2.6), increases in GDP are eroded and this reduces the impact of any improvements in the economy. Funds that would support initiatives to build pro poor resilience to climate change impacts are diverted to service debt.

[3] Eco-development refers to development at regional and local levels, consistent with the potentials of the area involved, with attention given to the adequate and rational use of natural resources, technological styles and organizational forms that respect the natural ecosystems and local social and cultural patterns. The term is also used to describe an integrated approach to environment and development. OCED Glossary of Statistical Terms http://stats.oecd.org/glossary/detail.asp?ID=710

[4] (Alternative Energy Resource Development Programme (AERDP).0712771141,

[5] Stephen Muwaya, UNCCD Focal Point Uganda, New Vision, June 17th 2008.

[6] National Report on Drought Risk Reduction Policies and Programmes, Feb. 2008.

[7] Orindi and Eriksen 2005

Sector	Vulnerability	Impact
	Petroleum imports consume a considerable portion of Uganda's total export earnings (about US$ 120 million) which is equivalent to about 20 percent of the total export earnings.	The high petroleum import cost discourages the use of this energy for activities like irrigation and initiatives that would increase rural incomes necessary in building resilience to climate change impacts.
Technical	Uganda has a highly centralized energy infrastructure which requires huge investment for the distribution of the power across the country. This system is highly vulnerable to disruptions and entails high costs for distributing the power across the entire country.	This probably explains the low rates of electricity access, especially in the rural areas where access is just about 1.0 percent and the high tariff costs.
Governance and regulation	High corruption in the public sector means that available resources are not optimally used. Insecurity has been identified as one of the most important reasons for the increasing poverty in the northern region of Uganda. The twenty year old conflict in the region, has prevented people from long-term investments.	Undermines service delivery and quality of life.
Social	According to the 2004-05 Uganda HIV/AIDS Sero-behavioral Survey (UHSBS), 6.4 per cent (or slightly over 800,000 people) of adult population in Uganda is infected with HIV.[8]	AIDS eliminates the economically most productive members of the family. The disease has reduced agricultural productivity. HIV/AIDS pandemic increases financial burden to many poor households.

[8] The Republic of Uganda, 2005, pg. 2

Vulnerability Indicators

Environment

Indicator 1: Change in rainfall patterns[9]

Year	Rate	
1990	1130mm	
2006	1234mm	
1990 – 2006		percent change = + 0.92 percent

Changes in the severity and frequency of extreme events[10] (floods, heat waves, storms) are projected for the future (Goulden 2006):

- Models suggested a 20 – 30 percent increase in extreme wet seasons at a medium CO_2 emission scenario.
- A significant increase in mean annual rainfall beyond 2060 with the highest percent in December, February and January.

The seasonality of rainfall is projected to change. The highest percentage increase in rainfall is projected for December, January and February which is historically the driest season for many parts of Uganda. This indicates that the current wet season (from March to May when the long rains occur) may shift forwards in time.

There is already considerable variability in seasonal rainfall totals, much of which is linked to the ENSO. In the ten year period, 1991-2000, seven droughts were experienced, whereas, prior to this only three were experienced from 1971-1980 (Republic of Uganda 2007).

Indicator 2: Variation in temperature

Year	Rate	
1990	Not available	
2004-2007	Mean max – 28.5 ^{o}C Mean min – 17.2 ^{o}C	(EC 2009)
1990 – 2006		% change = N/A

Analysis shows sustained warming particularly over southern parts of Uganda. The fastest warming regions are in the Southwest of the country where the rate is of the order of 0.3^{o}C per decade. The minimum temperature is rising faster than the maximum temperature (Republic of Uganda 2007).

[9] Uganda is divided into three distinct climatic regions viz. Highland, Savannah tropical and Semi-arid, which makes referring to country averages somewhat misleading. The figures presented here are the average for the whole country.

[10] Review of modeling outputs for East Africa under a range of plausible carbon dioxide emission scenarios created by the IPCC. These results are consistent with those published in the IPCC's Fourth Assessment Report in 2007 (Goulden 2006)

Temperatures are likely to increase by up to 1.50 ^{o}C in the next 20 years and by up to 4.30^{o}C by 2080 (Goulden 2006).

Economic

Indicator 1: Proportion of households acquiring access to electricity

Year	Rate	
1991	National – 5.6 %[11]	
2006	National – 9 %[12] Urban – 41.8 % Rural – 2.9 % Rural – 2.7 % (2002)	
1991 – 2006		% change = 61 % (national) Absolute % change = 3.4 %

There was a 32 percent increase in electricity consumption in the domestic sector from 1990 to 2002 (Sebbit et al 2004). The average number of new connections and reconnections was estimated at 14 500 per annum or a per annum growth rate of about 9.6 percent.

The percentage of households using electricity for cooking is still relatively low at 4.3 percent in urban areas and only one percent in rural areas. With regards to energy for cooking, 90 percent of the households in urban areas depended on wood fuel compared to 98 percent in the rural areas.

Indicator 2: Level of increased energy autonomy

Proxy Indicator: Percentage of petroleum imported.

Year	Percentage of Petroleum Imported	
1990	100 %	
2008	100 %	
1990 – 2008		% change = 0 %

Uganda imports all its petroleum products. Imports increased from 6000 barrels/day in 1990 to 12000 barrels/day in 2007 (EIA 2008)

[11] Saundry 2009
[12] UBOS 2007 and UBOS 2006a

Technical

Indicator 1: Change in the amount of energy supplied by renewables

Year	Rate	
1990	Hydro = 100 %	
2008	Hydro = 64.5 %	(UETCL 2009)
1990 – 2009		% change = -35.5 %

Until 2002, almost all of Uganda's electricity came from hydroelectricity. In early 2009, Uganda's on-grid electric power supply was (Saundry 2009):

- Nalubaale & Kiira hydroelectric: 138 MW (average)
- Kiira, Mutundwe & Namanve thermal (diesel): 150 MW
- Kakira & Kinyara sugar works co-generation: 17 MW
- Mobuku I & Mobuku III, hydroelectric: 14.5 MW

Indicator 2: Level of diversity of renewable energy sources and technologies

Year	Rate	
1990	Electricity – 1 % Heating & cooking – 99 % Transport – 0 %	
2009	Electricity – 0.6 % Heating & cooking – 99.4 % Transport – 0 %	
1990 – 2009		% change = 0 %

There is a lack of significant solar powered water heating or use of geothermal.

Social

Indicator 1: Change in the prevalence of diseases

Year	Rate	
1992	Estimated at 15 %	
2006	58.5 % (2002) 49.6 % (2006)	
1992 – 2006		% change = 226 %[13]

Since in Uganda malaria is responsible for more illness and death than any other single disease, it has been taken as the prevalent disease. The percentages indicate the number of cases against the total population (Republic of Uganda 2008, WHO 2005).

[13] This large increase in malaria incidence is due in part to under reporting of cases.

Indicator 2: Change in unemployment

Year	Rate	
1990	12.0 %	
2007	6.9 %	
1990 – 2007		% change = -42.5 %

These statistics reflect the urban situation, since the rural population is difficult to quantify due to the subsistence nature of their livelihoods.

Civic (Governance)

Indicator 1: Land reform improvement

Year	Rate	
1990	0 %	
2006	27.8 %	
1990 – 2006		% change = N/A

This indicator reflects the percentage of households who have legal ownership of the land they occupy. Until the introduction of the Land Act of 1998, all land belonged to the State.

Indicator 2: Change in public participation planning process

Year	Rate	
1990	Not available	
2006	Not available	
1990 – 2006		% change = N/A

Energy Situation

Uganda's Energy Sector

Uganda like most developing countries relies on biomass as its major source of energy. The country's energy mix comprises of biomass, petroleum and electricity. In 2005, the total energy consumption was estimated at 8 984 508 Tonnes of Oil Equivalent (TOE) while the energy consumption per capita was 0.330 TOE; commercial consumption per capita was 23.5 kgOE and electricity consumption per capita was 22 kWh/yr. The domestic sector energy consumption is 81 percent of the total energy.

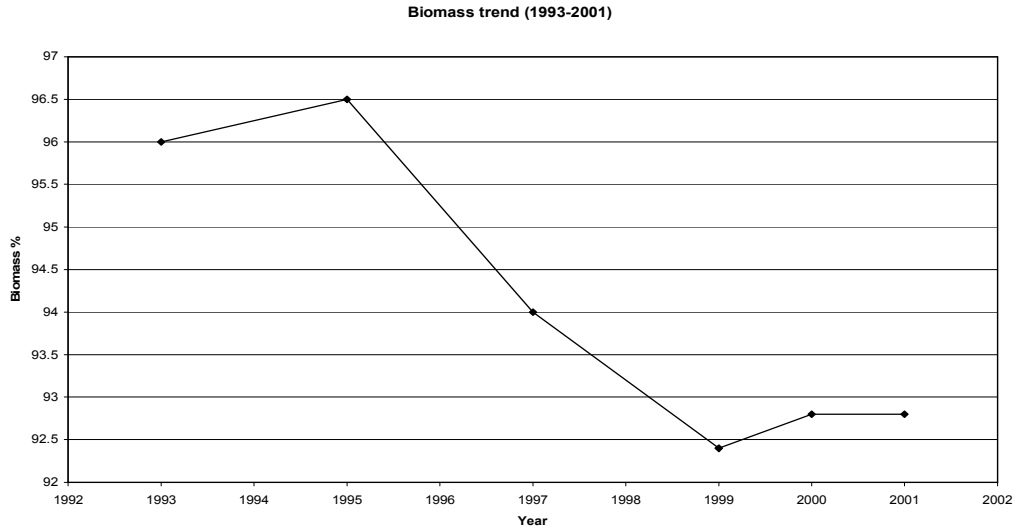
Biomass

Biomass mainly in the form of firewood or charcoal is used by 92.3 percent of the population for their energy needs (MEMD, 2007). The majority of the households (72.7 percent) use the three-stone method for cooking. The open charcoal stove is used by about 14.8 percent of the households. Only 8.7 percent of the households use improved stoves.

Per capita consumption of biomass in Uganda is 680 kg/year and 240 k g/year for firewood and 4 kg and 120 kg for charcoal for rural and urban areas respectively. Total biomass (firewood and wood for charcoal) demand for households was 22.2 million tons in 2006. Small scale industries account for about 20 percent of total biomass use, adding a further 5.5 million tons and bringing the total biomass demand to about 27.7 million tons countrywide (Kiza 2006).

This single issue lies behind much of the deforestation occurring in the country. It is also a major factor in terms of the productivity of Ugandan household as deforestation leads to increases in the distance and time required to gather woodfuel. The Uganda government estimates that from 1992 to 2000, the average distance traveled to gather fuelwood increased from 0.06 km to 0.73 km. Fuel is a significant part of the rural economy in Uganda (Saundry 2009).

Figure 1: Biomass Trend (1993-2001)



Source MEMD, 2004

Electricity

About 97 percent of Uganda's population does not have access to electricity and many towns, especially in the North of the country are without electrical power. In the rural areas only about two percent have access to electricity, of which less than half was provided through the national grid (the remainder comes from household generators, car batteries or solar photovoltaic (PV) units) (Mbendi 2009). In the urban areas, only 39.7 percent of the population uses electricity for lighting while 57.8 percent uses paraffin (UBOS 2006a).

Uganda will require 2,000 Megawatts (MW) electricity by the year 2025 to run its industries and homes. In addition, much of the electricity network in Uganda is at present poorly maintained and the country experiences frequent power cuts (Mbendi 2009).

The installed capacity in Uganda is about 300 MW, over 98 percent of electricity is generated by the hydroelectric plant at Owen Falls (the 180 MW Nalubaale station and the 200 MW Kiira station with five 40 MW units of which three have been installed) on the Victoria Nile. There exists a small hydro power station at Maziba with an installed capacity of about 2 MW and independent power generation at Kilembe Mines and Kasese Cobalt Ltd with a combined capacity of over 15 MW. It has been estimated that there is another 80 MW of privately installed captive generation capacity (Mbendi 2009)

Uganda has a high potential for hydro-power generation but only has an installed capacity of 280MW, generated at Kiira and Nalubaale stations located at the outlet of Lake Victoria. The development of Bujagali (250MW) Hydropower scheme is already underway and the Karuma Hydropower scheme (200 MW) will commence shortly, with the Isimba scheme (100 MW) to follow. The completion of these three schemes would add another 550MW to Uganda's power supply, which would go a long way in reducing the power deficit. Preliminary studies have been completed for three major schemes at Ayago South (234MW), Ayago North (304MW) and Murchison (642MW).

Besides the large-scale hydropower sites, Uganda also possesses a number of small sites with potential for mini- and micro-hydropower development.

Table 3: Installed capacity – mini hydro

Site	Capacity
Mobuku I 5.4 MW	5.4 MW
Kuluva	0.12 MW
Kagando	0.06MW
Kisiizi	0.3 MW
Maziba	1 MW

The current total installed capacity of mini hydro is about 16.9 MW. An additional 30 small schemes have been identified with a total estimated potential of around 80MW.

Since late 2005 water levels in Lake Victoria have been lower than anticipated resulting in a halving of the combined output of the two facilities (approximately 135-140 MW). The result has been unprecedented power shortages. This has forced the country to invest in thermal power plants. By the end of 2008 the electricity generated from thermal plants exceeded 150MW. Use of thermal power plants has increased the country's expenditure on petroleum and has hiked the retail price of electricity. Efforts to develop new hydro-power plants are ongoing but such investments take years to accomplish. Uganda currently spends about US$70 million annually as subsidy to the electricity sector. This figure is about 35 percent of the electricity tariff.

Figure 2: Map of electricity transmission network, present and future

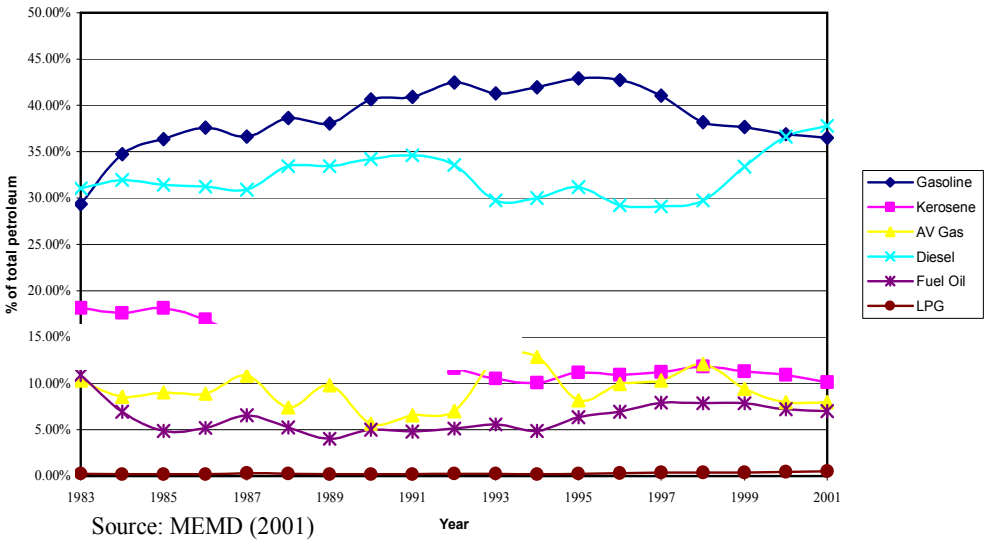
Source: UECTL 2008

Petroleum

Uganda is not yet producing any petroleum, although prospecting trials around the rift valley basins, particularly the Albertine Graben Western Uganda have revealed huge reserves. Since there is no local production at the moment, Uganda imports all its petroleum products with a petroleum import bill of about US$ 120 million per year. This constitutes about eight percent of total national imports and represents slightly above 20 percent of the country's total export earnings.

The long distance from Mombasa and Dar es Salaam increases the costs of transportation and for this reason Government is promoting the Kenya-Uganda Pipeline Project.

Figure 3: Petroleum products (1983-2001)



Source: MEMD (2001)

Uganda's petroleum sector is fully liberalised with taxes on petroleum products as high as 35-40 percent. Very high fuel costs are contributing to the high transport costs in the country. Uganda had the 5th highest gasoline price of 25 African countries and the 23rd highest price in the world during the period 1998 – 2002 (UBOS 2006b).

The fuel bill for a country like Uganda constitutes almost 50 percent of the budget. The escalating prices of fossil fuels have made it imperative for government to promote the development and utilization of renewable energy resources including bio-energy and their associated technologies.

Large oil deposits have been discovered in the Lake Albert basin, estimated at 400 million barrels. Commercial production is not likely to start before 2013 (The Times 2008).

Solar

Uganda is endowed with plenty of sunshine giving solar radiation of about 4-5 kWh/m^2/ day. This level of insolation is quite favorable for all solar technology applications. Solar energy applications in Uganda include solar PV, water heating, cooling and crop drying.

However rates for solar energy dissemination in Uganda remain relatively and are attributed to the high initial investment costs. The technology remains only affordable to government programs and NGOs that typically import them with tax waivers. Currently a solar unit that can be used for lighting and probably to run a radio set costs about US $ 550; a price that is unaffordable to many Ugandans whose annual per capita income is estimated to be less than US$ 350

Moreover, because most of the solar businesses are located in Kampala (the capital) rural towns have a problem accessing solar technologies. Activities in up country districts are on and off with very few programmes in place to disseminate solar energy countrywide.

Policy Mechanisms

International Development Partners and Cooperation

World Bank – one of the major development partners in Uganda and currently supports projects in Utility Sector Reform, Power Investment, funds the Energy for Rural Transformation programme.

Sida – funds several grid extension projects to service five remote districts of Uganda.

AfDB – contributing investment capital for power plant and electricity transmission lines as well as supports improvement of health facilities.

GTZ – has been supporting the MEMD since June 1999 in a number of areas principally through the Energy Advisory Project (EAP) that provides policy advisory services and direct implementation of projects in energy access, renewable energy and energy efficiency projects.

UNDP – supports programmes specifically targeting increasing energy access for the poor, mainstreaming energy in the planning process and multifunctional platform, mini hydro and solar projects.

WHO – offers expertise and technical support linked to household energy, indoor air-pollution.

Financing Mechanisms

Currently, energy access is financed within the Government's Poverty Eradication Action Plan (PEAP) which is Uganda's Poverty Reduction Strategy Paper (PRSP).

There are several government channels funneling funding to the energy sector. Some of these include.

- Energy Fund which is a budgetary provision by the Government of Uganda as investment capital for construction of large hydropower and emergency thermal power generation plants amounting to US$55m in 2007/08.

- Rural Electrification Fund (REF) established under the 2001 Rural Electrification Strategy and Plan and administered by the Rural Electrification Board (REB) and implemented by the Rural Electrification Agency (REA). REA uses a demand – driven approach in that any capable sponsor such as private company, NGOs, local authorities and communities can initiate electrification projects. For areas which are not attractive to the private sector and/or public – private – partnerships, financing is provided via a subsidy provision. The REF is funded through:
    - appropriation of Parliament;
    - five percent levy on bulk purchases of electricity from generation; and,
    - loans and grants from development partners.

- Private Sector - The Central Government has mobilised substantial private investment in the large power sub-sector particularly the establishment of power generation plant – diesel plant, HFO plant, hydropower plant.

- Development Partners - There is substantial financing from development partners. Of particular significance is the World Bank/GEF ERT US$400 million and the GTZ- funded EAP that has funded the dissemination of improved cooking stoves in the rural districts of Uganda and energy efficiency measures.

- Energy for Rural Transformation Programme under which the Bank of Uganda manages a credit component of US$6.8 million given to private investors for generating electricity. Some US$3.8m is earmarked to be lent to MFI's for provision of loans to rural households/enterprises that are in need of acquiring/purchasing solar equipment in their homestead.

- Sub-county Development Strategy that assists the micro-finance sector in rural and urban areas by supporting the establishment, strengthening, expansion and consolidation of both MFIs and SACCOs. These are to provide the credit lines to households and cooperatives.

Energy Policies

The Energy Policy for Uganda was put in place in September 2002 soon after the Power Sector Reform and Privatization Strategy of 1999 and enactment of the electricity law (Electricity Act 1999). The policy has a vision for increased and improved modern energy supply for sustainable economic development as well as improving the quality of life of the Ugandan population.

The policy recognizes that wood fuel harvesting contributes to degradation of forests as wood reserves are depleted at a rapid rate in many regions, the impact on the

environment, health of end-users and the burden of collecting firewood on women and children as a result of increased use of biomass energy.

The vulnerability of the biomass energy system could be mitigated to some extent through demand side management, which may include the use of energy efficient devices and diversifying into alternative energy sources.

The Renewable Energy Policy was approved in March 2007 by the Government of Uganda and was formulated to reinforce the Energy Policy of 2002. The overall objective of the Renewable Energy Policy is to diversify the energy supply sources and technologies in the country. In particular, the policy goal is to increase the use of modern renewable energy from the current 4 percent to 61 percent of the total energy consumption by the year 2017 (MEMD 2007).

Small-scale renewables have remained marginal compared to large scale commercial energy yet they produce quantities of energy ideal for the available market in rural areas. Present renewable energy policies do not encourage financial support to institutions involved in RETs production and its dissemination. And as such RETs remain financially out of the reach of many Ugandans.

The 2001 Uganda Forestry Policy is another key policy instrument in the energy sector. Policy documents point out that forest cover in Uganda is fast diminishing, the shrinking rate being estimated at 55,000 ha per year or two percent annually. It further points out that 70 percent of the 4.9 million hectares of Uganda's forest coverage is mainly woodland that grows on private or customary lands with no or limited regulation and management. Moreover it is experiencing very high rates of clearance for agriculture and charcoal production. While the forest policy acknowledges that forest resources are diminishing because of unsustainable consumption. In practice, the policy has not done much in encouraging private sector and individual involvement in forestry for fuel purposes.

Uganda's Energy Mix

Biomass is the main source of energy in Uganda, contributing about 94 percent of all energy consumed, followed by petroleum and electricity. The bulk of this biomass is consumed mainly in rural and poorer households which often can not afford the high costs of modern energy services like electricity and LPG.

Table 3: Energy mix by percentage

Sector	percent contribution
Biomass	
--woodfuel	80 %
--crop residues	4 %
--charcoal	10 %
Electricity	1 %
Petroleum	5 %

Source: MEMD, 2007

Energy Systems in Uganda

Biomass

The biomass energy sector is currently under threat because forests as the primary source of biomass are being decimated and unfortunately very little effort is going in the country to engage in commercial biomass production. There is also very little effort to utilise the large amounts of agricultural residues left to rot in the fields. Most of this biomass is used in its traditional and unprocessed form resulting in significant wastage.

The heavy dependence on biomass threatens to affect the energy security of many rural poor households as well as increasing the burden to women and children who are mainly responsible for collecting fuel-wood. According to WHO, nearly 20,000 deaths annually are attributable to indoor air pollution from solid fuel use which is responsible for 4.9 percent of Uganda's national burden of disease. As urban populations increase, biomass has to be transported over longer distances thus increasing costs for the consumer.

Electricity

Uganda's per capita electricity consumption of 22kwh/year is very low compared to its neighboring countries. This is due to high electricity tariffs (US $0.24 per kwhr) brought about by high distribution costs. Because of its highly centralised supply system (the two main hydro power dams are located in Jinja), distributing power across the country is very expensive. The situation is exacerbated by and the dispersed housing patterns of many Ugandan households especially in rural areas, making it costly to transmit and distribute electricity to many parts of the country, in particular rural areas. Due to these exorbitant costs, low income households in rural areas can not afford to pay for the power. This lack of access affects the speed of rural development as many areas are unable to benefit from electricity services needed for rural commercial activities like micro agro businesses.

The sector is also highly vulnerable to increasing incidences of drought as the water levels drop during severe droughts.

Petroleum

Petroleum products are an important source of energy in the country, especially paraffin which is mainly used for lighting by rural communities and poor urban households. A number of diesel and petrol generators are also run by individuals and businesses to meet their electricity needs in areas not connected to the grid, and in other cases where the supply is rationed. In addition to privately owned generators, government operates diesel generators to meet the energy needs of some rural towns not connected to the grid.

In the last few years, the volume of petroleum imports has increased considerably. All these products are imported and consume a considerable portion of Uganda's total export earnings. The total importation cost for petroleum products is about US$ 120 million, equivalent to about 20 percent of the total export earnings. The cost of

petroleum products is very high and this is primarily due to the high tariffs levied on these products. Taxes of petroleum products in Uganda can be as high as 35-40 percent.

Because of being a land-locked country, the costs of transportation of oil products from the sea port of Mombasa greatly increases the cost of oil products in Uganda. The sector is also highly vulnerable to political conflicts that may arise in neighboring countries as evidenced by the impact of the December 2007 election violence in Kenya.

The high import cost of petroleum also makes Uganda highly vulnerable to external price shocks and it has obvious implications for the country balance of payments.

Between 1990 and 1998, Uganda's total carbon emissions increased by 57 percent compared to the 10 percent average for sub-Saharan Africa (WRI 2003). Within the same period, the per capita CO_2 emissions increased by 133 percent. Although, Uganda's contribution to global carbon dioxide remains negligible, these drastic increases are a clear indicator that the country's current energy path is highly unsustainable. The upward trend in emissions is greatly attributed to increasing fossil fuel consumption in the country.

Energy System Vulnerability

Vulnerability Indicator	**Calculation**
Coal	
1. Number of coal mine plants located at less than 1 metre above sea level and within the area that could be flooded by a flood with a current recurrence period of 100 years *Uganda does not possess any fossil fuel reserves*	0
Oil and gas	
1. Share of offshore oil and gas installations likely to be hit by a storm of more than 70 m/s gusts within the next 20 years (percent) *Uganda does not have a coastline*	0
2. Share/ number of refineries likely to be hit by a storm of more than 70 m/s gusts within the next 20 years *Uganda invited bids in August 2009 to carry out a feasibility study into building its first oil refinery capable of producing 150,000 barrels per day (Reuters 2009).*	0
All fossil fuels	
1. Number of thermal (coal, oil and gas) power plants located at less than 1 metre above sea level and within the area that would be flooded by a flood with a current recurrence period of 100 years *Uganda does not have a coastline*	0

Vulnerability Indicator	Calculation
Nuclear	
1. Number of nuclear power plants located at less than 1 metre above sea level and within the area that would be flooded by a flood with a current recurrence period of 100 years *Uganda does not have access to a coastline or any nuclear plants*	0
2. Number of incidents /accidents since the plant was built 3. Describe the most significant incidents	N/A
Hydro	
1. Expected precipitation change over next 20 – 50 years (percent) and or probability of floods in each watershed *Uganda has differing climates across the country. Results from hydrological vulnerability assessment using three river basins indicate a 10-20 percent increase in runoff for most of the country, although runoff may decline in semi-arid areas Climate change scenarios, from a recent global climate model experiment, are applied to Lake Victoria rainfall inflow series and evaporation data to estimate future water balances of the lake. The scenarios produce a potential fall in lake levels by the 2030s horizon and increasing again by the 2080s, This is significant for hydro-electricity production since the vast majority of hydro is generated from the outflow of the Lake.*	Lake Victoria: Outflow reduction of 3-4 % by 2035 against the 1945 baseline.[14] Outflow increase of 6-10 % by 2085 against the 1945 baseline.[15]
2. Number of multiple-use dams in the country today *A number of Valley dams/tanks have been constructed in several districts in Uganda, mostly the cattle corridor, predominantly for livestock water supply and to a small extent, human consumption. The storage of these valley dams/tanks ranges from 6,000 m^3 to 400,000m^3. There are a total of 316 valley dams and 765 valley tanks in the country, out of which only 111 valley dams and 268 valley tanks are operational.* *The total water withdrawal of the country was 300 million m^3 in 2002, representing 0.4 percent of total renewable water resources.*	316 valley dams[16] Total water use: Domestic – 32 % Industrial- 8 % Agricultural- 60 %
Transmission and Distribution indicators	
1. Length of in-country above ground transmission and distribution lines(km)	14,366km
1b. Distinguish between (2 sub-indicators) --High transmission --Middle/low voltage lines (distribution) Describe any transnational lines *This network provides power to only 33 of the 56 districts in the country.*	1115 km high voltage 132kV transmission lines [17] 54 km 66 kV transmission lines Distribution facilities: 3,258 km of 33 kV lines 3,443 km of 11 kV lines

[14]East African Regional Climate models Source: IPCC Report, climate change 2001: Working Group 11: Impacts, Adaptation and Vulnerability
[15] Tate E 2004 and MWLE 2002
[16] MWLE 2005
[17] ERA 2009

	6,496 km of low voltage lines.
Vulnerability Indicator	**Calculation**
2. Number and length of power cuts (differentiate between failure due to weather or equipment failure and those cuts due to rationing) 2b. Average hours of interruption per year	N/A N/A
3. Percentage of energy supply requiring regional transport over 50 km 3b. percent transportation of fossil fuel *All fossil fuels are transported from Mombasa sea port* 3c. percent that of transportation of biomass	90 % 100 % 80 %
Biomass	
1. Proportion of biomass used for energy purposes (%) of total biomass production. *95 percent of the wood supply in Uganda is for energy consumption. Even if the entire hydroelectric potential in Uganda was fully utilized (about 2000 MW), wood would supply more than 75 percent of the total energy consumption in year 2015.* *Only 50 percent of crop residues available for energy purpose are consumed. An increased supply from this source needs to be considered with care.* --Forest cover loss *Uganda's total forest cover has halved in the last two decades. In 1988, 26 percent of the country was covered by forests. This has reduced to 13 percent in 2008* 2. Expected precipitation change over next 20 – 50 years (%) *A percentage precipitation change expected over the next 20-50 years is varies across the country*	95[18,19] 1.9 % annually[20] N/A
Wind	
1. Number of wind turbines less than 1 meter above sea level 2. Project change of overage wind speed in the next 20 years based on regional climate models	0 N/A
Solar	.
1. Capacity of solar installations already in place. *36,355 PVs were imported since 2000. If a figure of 30,000 is considered as already being in place total number of PV units stand at around 66,355[21]. Imports of water heaters over the same period were 3,757 units. Despite these recent efforts, solar remains a very minor part of Uganda's actual energy balance*	N/A

[18] National Biomass Energy Demand Strategy 2001-2010, MEMD, June 2001.

[19] New Vision 2008

[20] East African Regional Climate models (IPCC 2001)

[21] National Biomass Energy Demand Strategy 2001-2010, MEMD, June 2001.

2. Quality of the insulation and of the building on which systems are installed and type of ownership	N/A
3. Expected Temperature increase in next 20 years	N/A

Energy System Resilience

Adaptation Indicator	Calculation
Implementation Indicators	
1. Domestic Capital formation (2007) --Gross Domestic savings	24.5 5.8
2. Domestic investment in renewable energy	N/A
3. Number of technical engineers graduating annually as a percent of the total population	N/A
4. Availability of hazard maps for floods /droughts *Uganda government has carried out hazard mapping/assessment and has developed hazard maps for Wetlands, Environment, Forests, Earthquakes, Landslides, Drought and Floods*[22] *The country has also carried out vulnerability and capacity assessments in 30 out of 56 districts*[23]	Yes
5. Existence and enforcement of power plants siting and construction guidelines taking consideration of climate change	No
6. Existence of emergency plans to react to meteorological extreme events and availability of local emergency repair teams *The country has developed other major national strategic prevention plans that are intended to mitigate the impacts of drought, these include the National Disaster Risk Reduction and Management Plan and the development of a Drought Risk Reduction Policy National Adaptation Plan of Action (NAPA) on climate change* *The National Platform for Disaster Risk Reduction and Management - is already in place to facilitate implementation of the policy on Disaster Risk Reduction (OPM, 2007). It runs from the center to the grassroots; at the top is the Department of Disaster Management which coordinates/chairs a National Platform on DRR.*	No
7. Domestic availability of insurance schemes *Centenary Rural Development Bank in Uganda has developed a weather index insurance scheme for its customers. The scheme is designing innovative approaches to reduce premiums from an unaffordable 20 percent of crop values to around six percent.*	Yes

[22] DDMR, 2004
[23] Idem

Adaptation Indicator	Calculation
8. Existence of citizen user groups in energy governance (participatory decision making) *The Electricity Regulatory Authority (ERA) has established user groups that are supposed to get comments from the public on quality of service delivery and tariff costs.*	Yes
Coal, oil and gas	
1. Existence and use of siting map for mines and power plants taking account of projected storms, floods and drought areas.	N/A
2. Implementation of national regulations for thermal power plant sites with sufficient cooling water availability over the next 50 years.	None
Hydro	
1. Existence of a national plan for optimized operation of hydro plants under projected flow regimes for systems	No
2. Number of dams equipped with de-silting gates and or number of upstream land use management and water-catchment plans for each hydro installation.	2 of 2 large scale dams (as at 2008)
Biomass	
1. Research, Development and Dissemination budget for heat and drought resistant crops, bio-fuels, agricultural waste for energy and vulnerability of forest (million /USD/year).	N/A
2. In country utilisation of biomass fuels not traditionally used by private enterprises and cooperatives (% of total fuels) *The only business that utilises residues in energy production to some extent is sugar manufacturing. A small amount of coffee and rice husks is also utilized in heat production in cement and tiles manufacturing. Available in quantities of 60 000 and 10 350 tons annually.*[24] *Otherwise all residues are either used as a fertilizer and/or animal fodder.*	94 %
3. Percent of households using improved woodstoves out of total number of households using woodstoves	8.7 % [25]
Wind	
1. Existence and enforcement of national regulations requiring storm proofing of wind power plants to withstand highest anticipated windspeed. 2. Existence of siting maps that detail projected changes in wind-speed, flood plains and areas impacted by sea level rise	N/A N/A

[24] Okure, 2005
[25] MEMD 2007

Adaptation Indicator	Calculation
Solar	
1. Existence of a siting map that detail projected changes in cloud cover.	No
2. Existence and enforcement of national regulation requiring storm proof concentrating solar power plants (CSP) to withstand the highest anticipated windspeed	N/A

Recommendations

This section presents some recommendations for policy makers based on the vulnerabilities identified in the energy sector and how to make the sector more resilient in the face of increasing climate change.

Strategies

The following strategies are proposed to increase the resilience of specific energy systems:

Renewable Energy Sources

Currently the main source of renewable energy is hydro and there are plans to extend the capacity of this sector (see below). The country has solar and wind potential. The high yielding areas should be researched and mapped. This, together with financial incentives (such as waiving import taxes and subsidies to generators and users) and grid feeder tariffs, should attract local and foreign investors to the sector.

Hydro Energy Systems

Uganda also has more than 60 mini hydropower sites with a total potential of about 210 MW. These are located throughout the country and provide a good opportunity to provide cost effective electricity using mini grids or to feed into the national grid. Investment in small hydro power schemes provides immense opportunity to break the dependence on the Nile River for power generation. These small power schemes can support pico- and other micro-hydro power which can be used to provide energy for milling, grinding and to generating electricity.

Given that hydro provides the majority share of electricity generation, contingency plans should be developed to cope with periods such as drought, when flows are reduced, and electricity production is reduced due to climatic factors.

Liquid Fuels

Uganda imports 100 percent of all its petroleum products and to reduce this vulnerability, the country is starting to produce its oil in 2010. But other fuels sources like ethanol and biodiesel can be an option to diversify the liquid fuel market. In addition, since Uganda is wholly dependent on imported liquid fuels, a policy to establish national petroleum reserves should be encouraged to avoid shortages during world scarcity or high international prices.

Biomass Energy Systems

To reduce on the vulnerability of the biomass energy system brought about by the over-dependence on the dwindling natural forests, initiatives such as the establishment wood-fuel plantations and the improved processing and use of agricultural residues from farms should be promoted to encourage the efficient use of the resource. Research and pilot programmes in this field should be funded and managed. It is however important to avoid competition for land between these energy crops and food crops.

To ensure environmentally and efficient use of biomass energy, it is proposed that small scale rural based bio-energy technologies are promoted and incentivised. This could be done through the use of technologies like gasification, biogas, co-generation, briquetting, improved cooking stoves etc. Improved stoves for rural institutions such as schools and hospitals could be a focus area.

Household Energy Sources

In addition to improved biomass cooking technologies, the following household energy strategies should be adopted:

The promotion of other cleaner energy sources like LPG in areas where this is economically feasible" especially in the slightly higher income urban areas. It is commendable to note that Government of Uganda has waived the duty on imports of LPG to make it affordable. Improving the distribution networks for LPG is central to increasing the uptake of this fuel type.

A proactive electrification programme that includes decentralised electricity systems should be driven by government.

Electricity Transmission

To reduce the vulnerability of this energy sector brought about by the high distribution and transmission costs, it is suggested that a priority for future investments should look at the option of "smaller and much more decentralized electrification schemes", especially for rural areas. These could include mini-hydro, solar and wind installations.

Research and Development

A review of the State funding policy and allocation for energy research should be conducted. Recommendations on how this could be improved should be solicited from stakeholders in the sector.

Research into the sound utilisation of energy sources, conversion to electricity and transmission should be defined and stimulated through the appropriate government departments.

Proposed Policies and Measures

Policy Area	Suggestions for Voluntary and Compulsory Measures
Environment	
	--Assess additional vulnerability introduced by climate change to key energy sectors like hydro, biomass. --Strengthen the use of short and medium term climate change and energy system monitoring and assessments.
Technology	
	--Design climate resilient infrastructure by including vulnerability assessment information in project appraisals. --Develop climate related codes and standards for energy system infrastructure design. --Improve management systems and technology to change the way resources like biomass are produced and used
Economic and Social	
	--Enhance the resilience of the poor by building upon existing social capital and coping mechanisms of poor people. --Support the financial resilience of the poor by setting up rural based micro credit institutions that would make it possible for poor rural people to sustain ably use new and modern energy sources. --Enhance and support the management of natural assets (like forests, rivers) by the poor. --Develop human capacity to cope.
Energy Governance	
	--Improve energy governance by promoting responsive and accountable energy institutions. --Processes for energy policy and planning should take into account regional disparities. Current energy policy does not seem to recognize that different parts of Uganda have differing energy needs. The decentralisation policy in Uganda offers a good opportunity to implement decentralised energy planning which caters for regional disparities and constraints and allows participation of various stakeholders i.e. (women, landless etc) in decision making. --Integrate energy system adaptation to climate change into national, sub-national and sectoral planning processes

Bibliography

Alternative Energy Resource Development Programme (AERDP)

Electricity Regulatory Authority (ERA), 2009 http://www.era.or.ug/Statistics.php, Accessed 15/08/2009

Energy Information Administration (EIA) 2008, Uganda Energy Profile, http://tonto.eia.doe.gov/country/country_time_series.cfm?fips=UG

European Commission (EC) 2009, Average maximum temperature (C°) 2004 -2008 Uganda, http://www.phlosses.net/index.php?form=home, Accessed 24/08/2009

Goulden 2006, Modelling outputs for East Africa under a range of plausible carbon dioxide emissions scenarios.

IPCC 2001, Working Group II, Impacts, Adaptation and Vulnerability.
KAMFOR Company Limited Technical Assistance for Renewable Energy Resource Information and Capacity Building Assessment

Kiza M 2006, The role and potentials of bioenergy in Uganda`s energy sector. Proceedings "World Bioenergy and Pellets 2006"

Macro Economic Policy Department (MEPD) 2008, Annual Report – Uganda's Economic and Financial Overview 2007/08, Ministry of finance, Planning and Economic Development, Uganda.

Mbendi Information Services 2009, Electrical Power in Uganda - Overview http://www.mbendi.com/indy/powr/af/ug/p0005.htm, Accessed 16/08/09

Ministry of Energy& Mineral Development (MEMD) 2001 National Biomass Energy Demand Strategy 2001 – 2010, June 2001.

Ministry of Energy& Mineral Development (MEMD) (2007): Renewable Energy policy for Uganda. Ministry of Energy and Mineral Development

Ministry of Energy& Mineral Development (MEMD) 2004, Annual Report 2004

Ministry of Finance, Planning and Economic Development (MFPED) 2009, The Poverty Eradication Action Plan (PEAP), www.finance.go.ug/peap/index.html Access on 15/08/2009

Ministry of Water, Lands and Environment (MWLE) 2002, The Draft National Forest Plan.

Ministry of Water, Lands and Environment (MWLE) 2005, Uganda National Water Development Report

National Report on Drought Risk Reduction Policies and Programmes, Feb 2008.

Nayenga R 2008, Gender Dynamics in Agriculture in Uganda: What are the Key Policy Considerations? Policy Summary Paper 3, July 2008, p. 5

New Vision 2008, Uganda's energy crisis deepens, 22nd Dec. 2008, http://www.newvision.co.ug/PA/9/36/665641

New Vision 2008, Uganda's forest cover dwindling, 18th August 2008, http://newvision.co.ug/D/9/36/645103, accessed on 25/08/2009

New Vision, June 17th 2008.

Office of the Prime Minister (OPM) 2007, The National Disaster Risk Reduction and Management Policy: Office of the Prime Minister –Ministry for Disaster Preparedness and Refugees. Republic of Uganda, August 2007

Republic of Uganda 2007, Uganda National Adaptation Programmes of Action

Republic of Uganda 2008, State of Ugandan Population Report 2008

Republic of Uganda 2008a, National Report on Drought Risk Reduction Policies and Programmes, February 2008, Office of the Prime Minister.

Reuters 2009, Uganda wants bids for oil refinery study, http://af.reuters.com/article/investingNews/idAFJOE57G09220090817, Accessed on 17/08/09

Saundry, Peter (Lead Author); Energy Information Administration and Library of Congress (Content Sources); Langdon D. Clough (Topic Editor). 2009. "Energy profile of Uganda." In: Encyclopedia of Earth. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment). [First published in the Encyclopedia of Earth July 11, 2009; Last revised July 14, 2009; Retrieved August 18, 2009]. http://www.eoearth.org/article/Energy_profile_of_Uganda

Sebbit A, Bennett K& Higenyi J 2004 Household Energy Demand Perspectives for Uganda in 2025, Domestic Use of Energy Conference 2004.

Tate E, Sutcliffe J, Conway D & Farquharson F 2004, Water Balance Of Lake Victoria: Update To 2000 And Climate Change Modeling To 2100, Hydrological Sciences–Journal, 49(4) August 2004, 563-575

The Department of Disaster Management and Refugees (DDMR) 2004, Uganda National Report and Information on Disaster Risk Reduction Efforts for the World Conference on Disaster Reduction (Kobe-Hyogo, Japan; 18-22 January 2005). The Department of Disaster Management and Refugees, Republic of Uganda. 18th June 2004.

The Times 2009, Fresh Uganda oil find 'Africa's biggest', 14 January 2009, http://business.timesonline.co.uk/tol/business/industry_sectors/natural_resources/article5512531.ece,

Uganda Electricity Transmission Company Limited (UETCL) 2009, UETCL energy purchases (GWh), 2004 – 2008, http://www.ubos.org/onlinefiles/uploads/ubos/exceldocuments/energyt209.xls, accessed on 24/08/2009

Ugandan Bureau of Statistics (UBOS) 2006a, Population and Household Census 2002, October 2006

Ugandan Bureau of Statistics (UBOS) 2006b, Uganda National Household Survey 2005/2006, December 2006

Ugandan Bureau of Statistics (UBOS) 2007, Demographic and Health Survey 2006, August 2007

Ugandan Bureau of Statistics (UBOS) 2009, www.ubos.org, Accessed on 15/08/2009

Ugandan Electricity Transmission Company Ltd (UETCL) 2008, Map of electricity transmission lines, April 2008, www.uetcl.com

UNDP 2008, Human Development Report 2007/2008.

WHO 2005, Uganda Profile, http://rbm.who.int/wmr2005/profiles/uganda.pdf, accessed 15 August 2009

WRI 2003, Earthtrends: Climate and Atmosphere - Uganda http://earthtrends.wri.org/pdf_library/country_profiles/cli_cou_800.pdf