BIOMASS ENERGY STRATEGY (BEST)
UGANDA

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BIOMASS ENERGY STRATEGY (BEST) UGANDA

MINISTRY OF ENERGY AND MINERAL DEVELOPMENT (MEMD)- GOU

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Table of Contents

LIST OF FIGURES

LIST OF PLATES

LIST OF TABLES

LIST OF ACRONYMS

AACC	African Alliance on Clean Cooking
BAU	Business As Usual
BEETA	Biomass Energy Efficient Technologies Association
BEST	Biomass Energy Strategy
BRRA	Biomass Resource Regulatory Authority (Proposed)
CAI	Current Annual Increment
CDD	Community Driven Development
CG	Central Government
CFM	Circular Flow Model
CFR	Central Forest Reserve
CHP	Combined Heat and Power
CRM	Customer Relationship Management
CSO	Civil Society Organization
EAC	East African Community
EAP	Energy Advisory Project
ERA	Electricity Regulatory Authority
ESD	Energy for Sustainable Development

ESMAP	Energy Sector Management Assistance Programme
FDI	Foreign Direct Investment
FGDs	Focus Group Discussions
FIEFCO	Farm Income Enhancement And Forestry Conservation
FSSD	Forest Sector Support Division
GAAC	Global Alliance for Clean Cookstoves
GDP	Gross Domestic Product
GWP	Global Warming Potential
IAP	Indoor Air Pollution
ICS	Improved Cookstoves
LEAP	Long Range Energy Alternative Planning System
LFR	Local Forest Reserve
LG	Local Government
LPG	Liquid Petroleum Gas
IWA	International Working Agreement
MAAIF	Ministry Of Agriculture, Animal Industry And Fisheries
MEMD	Ministry Of Energy And Mineral Development

MFPED	Ministry Of Finance Planning And Economic Development
M&E	Monitoring And Evaluation
MIA	Ministry of Internal Affairs
MOES	Ministry of Education and Sports
MRV	Measurable, Reportable, Verifiable
MSMEs	Micro, Small And Medium Enterprises
MTEF	Medium Term Expenditure Framework
Mwh	Mega Watt Hours
NAADS	National Agricultural Advisory Services
NAMA	Nationally Appropriate Mitigation Action Plan
NARO	National Agricultural Research Organization
NAFORI	National Forestry Research Institute
NDA	National Development Authority
NDP	National Development Plan
NFA	National Forestry Authority
NPA	National Planning Authority
OBT	Output-Based Budgeting Tool

OPM	Office Of The Prime Minister
PEAP	Poverty Eradication Action Plan
PMA	Plan For Modernisation Of Agriculture
PPP	Public Private Partnership
PREEEP	Promotion of Renewable Energy and Energy Efficiency Programme
REDD	Reduction Of Emissions From Deforestation And Forest Degradation
RETs	Renewable Energy Technologies
SPGS	Sawlog Grant Scheme
STEI	Science, Technology, Engineering And Innovation
TOE	Tones Oil Equivalent
UAC	Uganda Agricultural Census
UAE	United Arab Emirates
UBOS	Uganda Bureau Of Statistics
UEDCL	Uganda Electricity Distribution Company Limited
UEGCL	Uganda Electricity Generation Company Limited
UETCL	Uganda Electricity Transmission Company Limited
USD	United States Dollar

FORWARD

BEST comes at a critical time both locally and globally. An Energy Efficiency and Conservation Bill has been developed by the Ministry of Energy and Mineral Development (MEMD) and it awaits approval by Cabinet before presentation to Parliament. Uganda's commitment to secure a stable energy supply for long-term social and economic development (including poverty reduction) is enshrined in Uganda's constitution (1995).

The potential for biomass to contribute to Uganda's energy development is recognized in the Renewable Energy Policy (2007). At an international level, the year 2012 was declared by the UN as the official year of Sustainable Energy for All among the efforts towards providing a clean, affordable, reliable supply of energy to poor households.

Planning for biomass is critical for the social economic development of Uganda. Biomass is used in all sectors of the economy, and more importantly, close to 100% of rural households and 98% of urban households use biomass energy for cooking.

The Ministry of Energy and Mineral Development (MEMD) thus saw it fit to launch the Biomass Energy Strategy for Uganda (BEST).This is in line with development strategy as stated in the Vision 2040, "A Transformed Ugandan Society from a Peasant to a Modern and Prosperous Country within 30 years". This vision is conceptualized around strengthening the fundamentals of the economy to harness the abundant opportunities around the country.

Biomass is a diverse resource and is easy to harness because unlike some other forms of renewable energy it is not site specific. Fortunately, Uganda has a comparative advantage in harnessing this resource because the soils and climatic conditions provide excellent growth conditions.

As the biomass situation analysis indicates, Uganda's main challenge is not insufficient supply of biomass but rather the technology to utilize the diverse forms of biomass. In fact Uganda has the potential to have surplus biomass for energy purposes for the next three decades and possibly beyond. Biomass is poised to be a significant source of modern and clean forms of energy like electricity and this is already happening in some sectors like the sugar industry.

But, as observed in strategic objective 1, 2 & 3, there is need for multi-sectoral planning and development of a framework for information gathering, archiving and dissemination. High upfront cost is a critical barrier to adoption of improved technologies. The strategy proposes what is termed 'innovative financing mechanisms' in a Public Private Partnership (PPP) arrangement whereby government and development partners provide seed money to test improved technologies.

With government support (guarantees, project designs) the private entity may acquire an approved technology using some of the available Payment for Ecosystem Services (PES) e.g. carbon emission reductions as collateral.

Finally, I want to thank all those who have been involved in preparing this strategy on behalf of the government of Uganda; Uganda government officials, the consultants, biomass users and all stakeholders. It is my hope that the strategy will be implemented for the benefit the present and posterity, for God and my Country.

Hon. Eng. Irene Muloni
Minister of Energy & Mineral Development

ACKNOWLEDGEMENTS

The Biomass Energy Strategy (BEST), 2013, development process was highly participatory involving a wide range of stakeholder consultations and consensus building both on the technical aspects and on the social economic aspects. The numbers of those who have helped to shape this strategy is long and cannot be listed.

However, I would like to mention just a few. I wish to acknowledge the contribution of the BEST Steering Committee headed by the technical team from the Ministry of Energy and Mineral Development (MEMD).

Special tribute goes to the Assistant Commissioner NRSE, Mr. Godfrey Ndawula, Energy Officer, Mr. John Tumuhimbise, Senior Energy Officer, Mr. Michael Ahimbisibwe and many other officers that I may not be able to mention here. Your technical input and facilitation is highly appreciated.

Special appreciation goes to all who participated in the regional workshops held in Arua, Lira, Mbale, Mukono, Hoima and Mbarara mainly the District Local Government officials, specifically the Chief Administrative officers, Natural Resources Officers and NAADS Coordinators.

The biomass users namely charcoal producers, charcoal dealers, brick makers and lime roasters who participated. Your valuable time and contributions are appreciated.

I would also like to pay special tribute to the United Nations Development Programme (UNDP) who provided technical and financial support for the development of the Strategy through policy review. Last but the not least, the Ministry of Water and Environment for the coordinating role between the consultant, MEMD and UNDP.

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Mr. Fred Kabagambe Kalisa
Permanent Secretary ,
Ministry of Energy and Mineral Development

EXECUTIVE SUMMARY

The Biomass Energy Strategy (BEST) 2013 development process was highly participatory involving presentation of the biomass sector situation analysis to a wide range of stakeholders such that consensus is built on both the technical and the social economic aspects.

The situation analysis reveals that the biomass energy sector is generally flawed: There is scanty and inadequate data with no clearly defined data collection, archiving and updating mechanisms; Facts about biomass energy and its contribution to Uganda's social, economic and industrial growth are not well known; There are several renewable energy awareness campaigns but some segments of the audience e.g. key government agencies, policy makers, legislature are not well targeted; Key responsible government agencies are not well coordinated and have thus failed to put in place a comprehensive regulatory mechanism; highly inefficient technologies are common at various levels of the biomass value chain i.e., harvesting, transformation into secondary energy (mainly charcoal), transportation and at end-use.

One symptom of the above situation is the over dependency and unsustainable use of tree biomass currently (2013), estimated at 44 million tonnes per annum (about 12 Tonnes Oil Equivalent [TOE]) which could easily rise to 135 tonnes if no interventions are put in place. Out of the 44 million tonnes, the tree resource is estimated to sustainably supply only 26 million tonnes, which is well below the demand.

Even though Uganda has got a high population growth rate (expected to grow at 3% for the next 1½ decades before it drops down to 2.5%),which is expected result in a population of up to 76 Million people by 2040 (UNDESA 2012), Uganda could achieve net biomass surplus levels if it adopted the right technologies. For example, Uganda could sustainably harvest over 45 million tonnes of biomass by including bushes, shrubs and a small portion of vegetal waste in its biomass energy mix. Supply would even be much higher if all other available forms of biomass potential were explored.

Technology improvements in charcoal production could easily lead to reduced cutting of trees for charcoal production even if inefficient charcoal stoves were kept in use. Introduction of improved charcoal stoves and fuelwood stoves would much further reduce on biomass demand given that the household sector uses highly inefficient stoves (i.e., the three stone open stove in rural areas and the metallic charcoal stove in urban areas) and accounts for 90% of biomass used. Efficient technologies for the brick baking and lime roasting would make tremendous biomass savings.

The need for better planning is important more than ever before given the current levels of supply and demand. Thermal energy use in the industrial sector is changing from Furnace Oils and tree biomass to vegetal waste. In the sugar industry, use of bagasse for thermal and electricity generation is gaining prominence.

Uganda has discovered commercially viable oil and gas reserves and production (to start at around 2017) is expected to have a positive spin off effect on economic growth. High economic growth may accelerate industrial growth which will in turn increase industrial biomass demand. At the household level, population growth is to remain the main driver of biomass demand until households attain levels of income whereby they can afford switching to modern clean forms of energy like electricity and gas. In the meantime electricity demand is expected to continue rising close to 10% per annum but mainly for lighting and other low intensity purposes like television and telephone charging.

A number of strategic objectives are proposed as plausible intervention to Uganda's biomass sector and summarised in table 1. They are broadly grouped into 4 categories namely; 1) policy and regulatory issues, 2) Supply management interventions 3) Demand management interventions and 4 Cross cutting issues. A Communication strategy, Development of a Biomass Information system action plan, A Financing Mechanism targeting technology upscale and the biomass sector policy brief are derived from the strategic objectives.

Table 1 Summary Strategic Objectives

Strategy Objective	Targeted Short and Long term impact
• **Policy and regulatory Frame work Issues**	
• 1 Communication strategy • Develop a communication strategy specially tailored to various audiences: end users, policy makers and technocrats.	• Informed policy formulation achieved • Discussions / debates and formulation of feasible regulation • Informed fuel and technology choices • Opportunities of investments in biomass energy production known
2 Biomass Information System (Data collection and archiving): • MOU towards creation of an interlinked biomass resource database and information centre with representatives from key line Government agencies e.g. NFA, UBOS, NEMA, MEMD	• Harmonized biomass information system as part of government information system

Strategy Objective	Targeted Short and Long term impact
• 3 Enhance Institutional Capacity to regulate use of the biomass resources • MOU towards creation collaboration framework in key govt agencies • Include biomass and wide range of RET in education curriculum and build capacity at ministry of Education to enforce it • Regular updates of energy statistics to stakeholders • Develop prototype timber and charcoal production plans for small woodlots and natural wood formations that can easily be replicated • Harvesting permits managed at regional level and linked to taxation and wood resource management plans • DFOs facilitated to develop wood resource database and management plans which ultimately form part of the regional database and management plan • Differentiated taxation system where by non-green charcoal and non-green timber attract penalties • Establish an Energy use certifying organ • Incentives to compliance • Give time lines as to when selling charcoal in volumes will be completely phased out • Investment plans and environmental mitigation plans of heavy biomass users like Tea industries, Tobacco industries, paper industries, Vegetable oil Industries and institutions should include a sustainable biomass energy supply plan and energy audit plans • Annual biomass energy stakeholder review forum established	• Laws and regulations adopted and harvesting of wood from private and public land regulated and professionally organized. • Taxation harmonised at regional level where by part of the funds are remitted to districts. • Forestry management plans developed and silvicultural assistance for both woodlots and natural wood formations on private land provided. • Better charcoal transportation and distribution system developed e.g., transported in box bodies, weighed, packaged and sold in Kgs. • Government agencies better informed and supervisory, regulatory and guidance organs enhanced. For example biomass harvesting and usage by sector will be well understood and thus planned for

Strategy Objective	Targeted Short and Long term impact
• Biomass Demand Interventions	
1 Fuel Efficiency and clean cooking environment: • Increase awareness of indoor pollution and associated health risks related to use of traditional stoves especially in rural areas. Partner with Ministry of health in the drive to eliminate indoor pollution related health hazards through introduction of improved stoves • Promote end user training programmes. • Increase awareness of benefits in the energy (including overall cost) savings related to fuel and appliance (stove and cooking appliance) choice in urban areas • Initiate Carbon Financing models that will subsidize ICS costs such that they can out compete traditional inefficient devices	• Reduction in illness related to indoor air pollution while at the same time making biomass energy savings • Reduced charcoal demand due to increased use of improved charcoal stove which translates into wood savings needed for charcoal production
2 Efficient technologies (Fuel Substitution): • Provide technology that will enable use of alternative biomass (apart from wood). Invasive species like Lantana camara, paper mulberry are potential sustainable un-carbonized briquetting material. • Harmonize the cross cutting interests of use of agro residues. • Promote use of biogas especially in institutions and in cattle keeping areas which at same time improves agricultural production by use of slurry as high quality fertilizer. • Promote increased use of LPG in urban areas (wealthier households) by provision of better distribution mechanisms and access to appliances through a credit scheme. • Provide technologies and include carbon financing such that current local gin producers transform into small scale industrial ethanol producers • Promote use of bio fuels in a sustainable and well harmonized (with other competing interests) approach.	• Technology to utilise 'Inferior' forms of biomass introduced resulting in less demand for charcoal. Use of non- traditional forms of biomass (e.g., briquettes) increased through creation of innovative financing mechanisms like carbon Payment for Ecosystem Services (PES). • Increased use of biogas and other related benefits like boosting agricultural production • Increased adoption of LPG especially among urban centres and wealthier rural households • Through carbon subsidies ethanol substitution for Kerosene and fuelwood (both for lighting and cooking) in rural areas attained.

Strategy Objective	Targeted Short and Long term impact
• Biomass Supply interventions	
• 1 Cost effective Increase in Biomass supply: • Build on existing programmes such as FIEFCO and ensure that biomass deficit areas are among the first beneficiaries. • Develop a Nationwide plan for multipurpose trees and shrubs. • Implement govt plans to invest in energy crops both annual and perennial crops and in addition encourage private sector to do the same. • Enhance current government and private sector tree planting efforts by tapping into existing Payment for Ecosystem Services (PES) like REDD, NAMAs, CDM, POAs. • Where substantial forest plantations exist promote usage of forest prunnings and thinnings for energy purposes. • Aggressively promote use of improved charcoal kilns and gasification technologies –partnerships between investors, research institutions and govt agencies needed.	• • Sustainable fuelwood supply attained in rural communities. • Maintain wood demand for charcoal at the 2013 level by increasing per cent of charcoal made using improved technologies to 75% by year 2020.
Cross Cutting	
1 Financing Mechanisms for Efficient Technologies and Renewable energy; Creation of SMART financing mechanisms such as Creation of a National Fund for renewable energy projects that will provide seed –money (Start-up capital) and use projected offsets (CERs) as collateral to access loans for heavy investments.	Innovative and sustainable financing programmes for renewable energy tec hnologies established.

Part I

The Biomass Energy Strategy

1 Introduction and background

1.1 Introduction

1. The ultimate aim of the Biomass Energy Strategy (BEST) 2013 is to propose rational and implementable approaches to manage the biomass energy sector. The process was highly participatory and systematic whereby the biomass energy sector situation analysis was presented to a wide range of stakeholders (users of biomass, traders, producers, natural resource managers and more importantly, policy makers) in order to generate discussions and debate and ultimately build consensus on better management of the biomass energy resource.

2. Uganda's constitution, policies and development plans recognize the importance of biomass energy and recommend its sustainable supply. The Constitution of Uganda (1995) as amended (2006), obligates government to, " promote and implement energy policies that will ensure that people's basic needs and those of environmental preservation are met."[1] In line with the constitution several policies, legal instruments and plans like National Environment Act, Cap 153 (1995), the National Forestry Policy (2002), National Forestry and Tree Planting Act (2003), the Land Act (2001), the Local Government Act (1997), National Environment Policy (1995), National Wetlands Policy (1994), the Uganda Wildlife Policy (2003) and the National Development Plan for 2010/11-2014/15 and Vision 2040 have been formulated. The above documents support sustainable use of natural resources including sustainable biomass supply.

3. In early 1995, the Energy for Sustainable Development (ESD) report presented a detailed analysis of biomass demand in Uganda and revealed that woody biomass provided about five times the value of electricity and petro-derived energy combined. Later in the year, the National Biomass Study provided a detailed (1:50,000) land use / cover spatial database for Uganda plus an estimation of the stock of tree, bush and agricultural waste biomass.

4. The Uganda Agricultural Census (UCA, 2008/09) covered all the 80 districts of Uganda (as of July 2007) and provides information on production of major crops. This report and subsequent agriculture production estimates are important inputs for estimating agricultural wastes (using crop harvest to agriculture waste ratios). Vegetal wastes derived from the forest industry (e.g., tree offcuts, wood shavings, sawdust) and crop residues (e.g., coffee husks, groundnut shells and rice husks) are already important sources of biomass energy especially for the industrial sector.

1 Constitution of Uganda as at 15th February, 2006 (Section XXVII: The environment: Subsection (iii)). Sixth Schedule, Article 189.

5. The ESMAP / World Bank reports, the Uganda Bureau of Statistics (UBOS) 2002 Population and housing census plus the 2005/06 and 2009/10 National household surveys and several Demographic and Health Surveys (the two most recent being the 2006 and 2011 surveys) all show that fuelwood and charcoal provides almost all thermal energy requirements for rural and urban households respectively.

6. Despite the economic importance and significance as a major fuel, biomass has received little recognition both in terms of funding (there is more willingness by government to invest in electricity and oil exploration rather than biomass) and lack of a concerted policy (e.g., enforcing efficiency in production and use). The National Forestry and Tree Planting Act of 2003 which places the regulation of local forest reserves under the jurisdiction of the District Local Government and does not provide concrete guidelines on how forests on private land (accounting for 70% of the forest estate) are to be managed worsens the situation.

7. Interventions so far both on biomass supply side and demand side are important but have not had any significant impact. The biomass resource especially the tree stock is being depleted in many parts of Uganda. For example, Sawlog Grant Scheme (SPGS) is an important long term strategic intervention towards improvement of supply of timber and may provide fuelwood in form of forestry industry waste but was not designed to tackle the fuelwood or charcoal supply crises. The Farm Income Enhancement and Forestry Conservation (FIEFCO) project had an integrated approach where small holder farmers are trained in improved farming practices and at same time supported to plant their own woodlots, hedgerows for fodder and fuel purposes. However, FIEFCO covered a few sub-counties in the country.

8. For more than 3 decades both government agencies and private sector have promoted use of efficient stoves as a measure to manage the demand side, but unfortunately without much success. Adoption of efficient charcoal and fuelwood stoves is about 10% or less in both urban and rural areas.

9. Recognizing that there was need to find plausible interventions and also recognizing that there was need to bring in all stakeholders so as to build consensus, MEMD with support from UNDP commissioned the development of the Biomass Energy Strategy. A situation analysis showing how the sector is managed, current demand and supply of all types of biomass fuels plus future forecast with and without interventions (business as usual situation) has been done.

10. An energy end-use model known as Long range Energy Alternatives Planning system (LEAP) rather than an econometric model was chosen to model energy demand and supply forecast projections. Acknowledging that there is need for technological improvements such as use of efficient devices, more efficient primary energy to secondary fuel transformation plus fuel substitution influenced the choice for use of an end–use model. This has enabled modelling changes in the technological structure of the energy demand and supply.

11. A number of strategic objectives are proposed. The proposals are aligned to strategies mentioned in the Renewable Energy Policy, the National Forest Plan, Plan for Modernisation of Agriculture (PMA), National Development Plan and Vision 2040. The proposed strategy has been formulated based on 6 major principles, namely;

    - Communication and awareness
    - Development and maintenance of a biomass information system
    - Promote use of efficient technologies

including Research and Development

- Promote effective ways to increase biomass supply to all sectors
- Innovative ways of mobilizing resources
- Institutional aspects especially multisectoral planning and public private partnerships

12. This document is in three main sections with section 1 providing the background and Biomass Energy Strategy, Sections 2 laying down the Basis for the strategy including demand and supply forecasts.

2 Biomass Sector Situation Analysis

2.1 Data Collection and Archiving

13. Data on the biomass resource is inadequate and scattered among various government agencies. For example, UBOS, the main provider of statistical data is mainly concerned with fuel types used and or the most preferred stove types. Apart from electricity which is metered, data on amount of (quantities) of energy used is not recorded. Most of the UBOS surveys are either concerned with household expenditure or health and demographic data. Detailed discussion with the concerned officials at UBOS revealed that the sampling strategy does not adequately address biomass energy consumption issues both at household level and institutional level.

14. Uganda Investment Authority keeps record of all big investments. The National Environment Management Authority approves major investments after a thorough assessment of environmental impact assessments and mitigation measures. However, there is no one stop centre where this information that can be accessed. Apparently there is no data sharing and monitoring protocol between MEMD and NEMA.

15. Traditionally, the forestry sector was concerned with gathering data on availability of merchantable timber. Though the importance of non-traditional forest products is well recognized, there is little investment in carrying out non-traditional forest resource assessment. For example, for almost one decade, the importance of the biomass surveys has not been high on the agenda of both of FSSD and NFA.

2.1.1 Institutional and regulatory framework

16. The institutional and regulatory framework of the biomass sector is scattered amongst various government agencies, lacks cohesion and clear mandates. Historically, the concern of the forestry sector was sustainable supply of timber. Other types of forest products like fuel energy, non-woody products have gained prominence in recent years but policy and regulatory mechanisms have not been adequately adjusted.

    Kazora2013 recognizes that "institutional framework for charcoal in terms of tree planting, research, extension, production, marketing, and utilisation is spread among so many institutions without a coordination mechanism. The mandated institutions for supply management like National Forest Authority, Local governments and private land owners have operated in isolation with the Ministry of Energy and Mineral Development

[MEMD] with mandate over energy demand management. This has complicated an informed approach to matching the supply side and demand side of charcoal energy resource."

17. In many instances, legislation targets specific components of a sector rather than having a multi sectoral and comprehensive approach. In some instances, ministerial pronouncements that were temporary measures have remained in place for several years.

18. Kazoora2013 observed that although the Ministry of Energy and Mineral Development has established a division for biomass energy, it cannot work effectively in the absence of decentralised structures at community level where practical actions for Sustainable Charcoal Production (SCP) are needed. Kazoora also recognizes that "the weak mandates and cooperation of government ministries have not been conducive to strategic partnership building".

19. A stakeholder consultation (Kazora 2013) shows that many stakeholders are of the opinion that a well funded national forestry plan and biomass energy strategy would adequately address existing problems of deforestation and land degradation rather than trying to address the existing institutional gaps.

2.1.2 Biomass Supply and demand

20. Total tree biomass demand is estimated at 44 million tones of wood equivalent providing about 440 Peta joules of energy (table 2). About 3.5 million tones of vegetal wastes mainly used in industries provide over 39PJ of energy. Total biomass delivered energy is thus over 479Pj.

21. The household sector accounts for the bulk of biomass used (74% of delivered energy) followed by the industrial sector (18%). Institutions (3%) and the commercial sector (5%) take the least.

22. Fuelwood is the most highly consumed primary fuel with annual consumption of about 28million tones of tree biomass. Another 16 million tones of wood are annually transformed into 1.8million tones of charcoal using highly inefficient kilns (table2). In addition to tree biomass, about 2.3 million tones of vegetal wastes are consumed annually.

23. At a subsector level, rural households are the largest biomass consumers followed by urban households and thereafter brick baking in highly inefficient kilns. Rural households and educational institutions are highly dependent on fuelwood.

Table 2. Biomass Demand

Sector	Fuelwood		Agro / Forest wastes		Charcoal			Total Wood Equivalent
	Million Tone	PJ	Million Tone	PJ	Million Tone	PJ	Wood Eq (Million Tone)	Tone
Household	20.9	314	1.7	21.2	1.5	44.8	13.2	34.5
Industrial	4.8	72.5	0.66+1.2**	8.2+10**		0.002		6.4
Commercial	0.54	8.1			0.3	8.8	2.6	2.8
Institutions	1.8	28.3				0.002		1.7
Total	**28.2**	**423**	**2.3+1.2**	**29.4+10****	**1.8**	**53.6**	**16**	**44.2**

24. Urban households, hotels, restaurants, and small eating places are highly dependent on charcoal. The sugar industry consumes a significant amount of biomass in form of bagasse. Use of biomass in other industries is relatively low but is on the increase with many industries switching from heavy furnace oil to vegetal wastes like coffee husks and rice husks for their thermal energy requirements.

Table 3. Sustainable biomass supply

Biomass Type	Sustainable harvest	Per Cent
Tree biomass	26.3	51%
Bush	10.5	21%
Papyrus and reeds	4.5	9%
Farm level vegetal waste; stalks of maize, sorghum, cotton stalks etc	6.2	12%
Agro processing Vegetal waste; Bagasse	1.4	3%
Agro processing Vegetal waste; maize cobs, rice husks, coffee husks etc	1.2	2%
Grass, forbs	1	2%
Sub Total	51	100%
Biogas based on animal waste (M3)	<1	
Biogas based on human waste mainly institutions (M3)	1<	
Biofuels e.g., ethanol, bio diesel (M3)	1.2	
Total Biofuels	**`2M3**	

25. Biomass is a diverse resource available in many forms such as trees, bush (multistemed plants and scrub), grass and forbs, papyrus and reeds and vegetal waste (wood waste and crop residues at garden level and from agro processing plants). Until recently, biomass consumed by rural households for their energy needs and construction of shelter was in many places gathered freely and most of it did not enter into Uganda's monetary system (non-monetary). Biomass use by household sector is so huge such that that substituting other forms of energy (e.g., petroleum products) for biomass would have big implications on Uganda's foreign exchange reserves and balance of trade.

26. It is estimated that tree biomass, which is the main form of tradition biomass, can only supply 26million tones (table 3) on a sustainable basis. There is a wide range of non-traditional forms of biomass that that have not been utilised mainly due to lack of technology to harness them.

27. Technology advancement has turned bagasse, once a big disposal problem in the sugar industry, into one of the major sources of energy for both thermal and electricity production.

28. On the other hand, there is little or no use of other forms of biomass that are abundantly available (and can be sustainably be supplied) like bush, grass, forbs, a variety vegetal waste, papyrus and reeds. In addition, there is a big potential of harnessing a variety of biofuels for energy purposes. Apart from inadequate awareness of the availability of appropriate technologies, the high upfront costs associated with these technologies is a big barrier for investment and adoption these technologies

2.2 Factors Expected to continue influencing biomass demand

2.2.1 Population

29. Uganda is among those countries with the highest population growth in the world. With fertility2 levels of over 6 children per producing female (UBOS DHS 2012), Uganda's population is expected to reach 76.4 million by 2040 (table4). Between 1950 and 2010 Uganda's urban population grew from 2.82% to 13.38% (UBOS 2002, UBOS 2012). Over 80% of Uganda's households (85% of the people) live in rural areas. Most of these people depend on quasi-subsistence agriculture for their livelihood and as a primary source of income (UNBOS, NHS 2006, UNBOS, NHS 2006, 2010).

30. The rate of urbanization is expected to increase with the number of people living in urban areas reaching 20.6% by 2030 (table 5). The percentage of households living in urban areas in the same year (2030) is expected to be 27.3% simply because urban households have a smaller household size (4 people per urban household as compared to over 5 in rural areas). This distinction is of particular importance because decisions on fuel type used and cookstove used are made at household level making the household a basic unit for estimating fuel consumption.

2. Fertility rate to remain high because of Uganda's age pyramid whereby over 55% of the population is below the age of 18 (UBOS 2007).

Table 4: Uganda's Projected population growth '000 adopted from UNDESA, 2011

Year	2015	2020	2025	2030	2035	2040	2045	2050
Population Projection	39,112	45,423	52,330	59,846	67,922	76,437	85,250	94,259

Table 5: Percentage of people living in urban areas

Year	1950	1960	1970	1980	1990	2000	2010	2020	2030	2040	2050
Urban Population (%)	2.82	4.42	6.66	7.53	11.08	12.08	13.3	15.94	20.56	26.54	33.52
Urban Households (%)							18.8	*21.6	*27.3	*34.4	*42.2

*Estimated by the Authors, based on UBOS data on urban household size and percentage of people living in urban areas

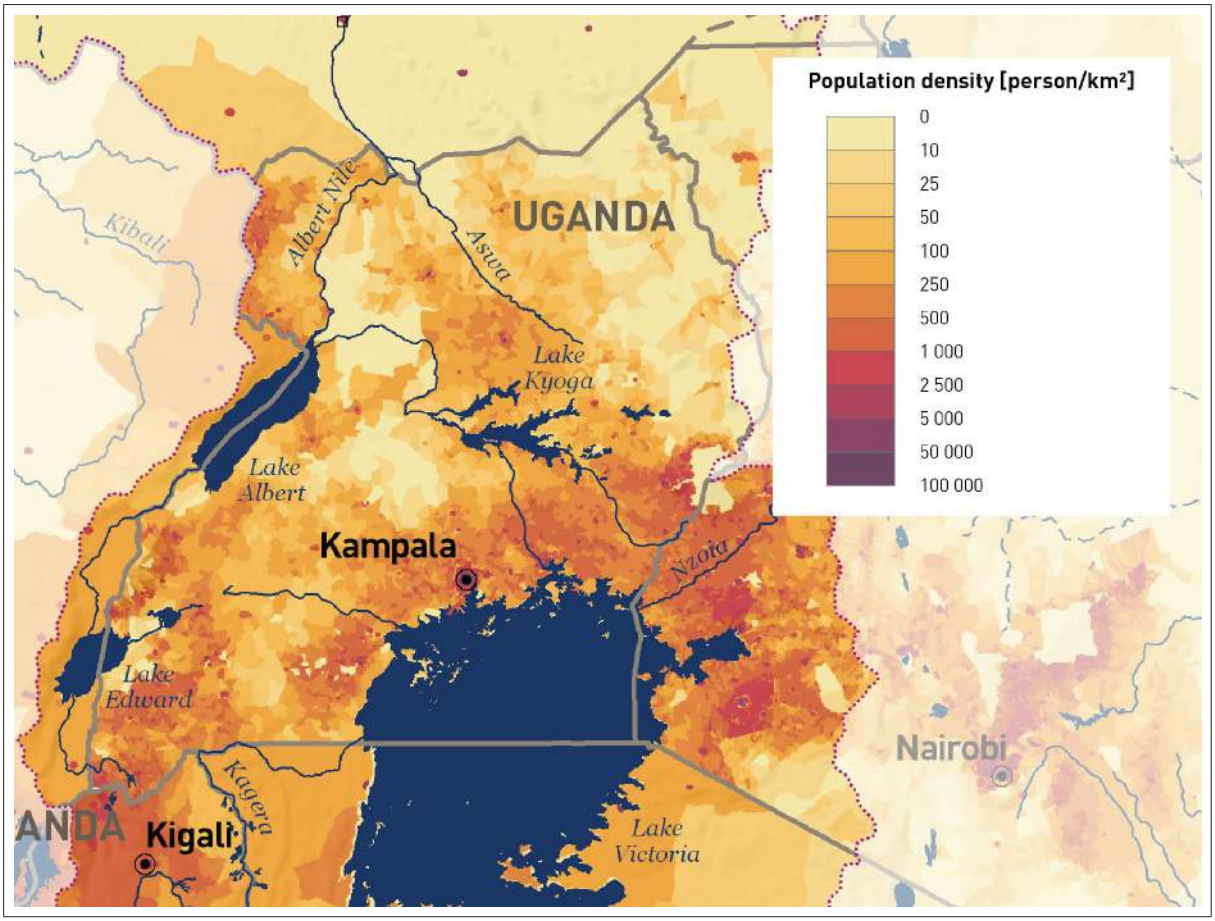


Figure 1UNDESA Projected population 2030, Uganda and neighbourhood

31. The Nile Basin countries are expected to hit a medium estimate of 654 million by 2030. Population density is and will remain highest in the East African Plateau, the Nile valley, the Nile delta, the Ethiopian highlands, and in Khartoum. High densities in the Lake Victoria region are in Uganda's capital Kampala, in Kenya's Nakuru town, and in Rwanda and Burundi.

32. The Lake Victoria crescent is expected to be among areas with high population densities (500 people per km2 and above) by 2030. Areas along the foothills of Mt Ruwenzori plus areas on the eastern part of the escarpment and the south-western highlands are also projected to have high population densities. In the north, high population densities are likely to be in the Gulu sub region, south of the Aswar river and along the major towns in west Nile region. In the east, population densities of up 1,000 people per km2 are expected on the western slopes of Mt Elgon (figure 1)

33. However, compared to other countries within the region, Uganda's urban population will still be relatively low – only higher than Burundi and close to that of Ethiopia.

2.2.2 Economic performance

34. In the last two decades Uganda has recorded robust economic growth, averaging about 6 percent per annum - adjusted for inflation (Figure 2). In spite of Uganda's economic recovery from the downturn of the 1970s and 1980s, the size of the economy and the country's per capita income are still very low compared to other economies in Africa and Asia. Nominal GDP per capita increased by 21.3% from Uganda Shillings 206,866 in 2010/11 to Uganda Shillings 1,463,961 in 2011/12.

35. The majority of the workforce, (around 70%) is still employed in smallholder agriculture where productivity per worker is very low; and average value added per worker in agriculture is only $200 per year (Mutebile, 2013, Kasekende, 2012). Although the size of the economy quadrupled (since the early 1990s), real per capita incomes have only doubled in this period because of high population growth rates (over 3%). In 2010, the incidence of the working poor3 was at 25.5% in the primary sector4 and 19.9% in the production sector (UBOS, 2012).

36. On the other hand, Uganda's leading economist and governor for Bank of Uganda, Mutebile, believes that Uganda's economy is on the threshold of the second stage of development5in which economies compete by continuously raising their productivity. He believes that if the country can make the transition to an efficiency driven economy successfully then Uganda can accelerate structural transformation of its economy and move towards middle income status.

3. The working poor are defined as individuals who were part of working labour force but whose incomes fell below the poverty line
4. Primary sector includes agriculture, forestry, fishing, mining and quarrying
5. The first stage being characterised by economies competing on the basis of their endowments; unskilled labour and natural resources

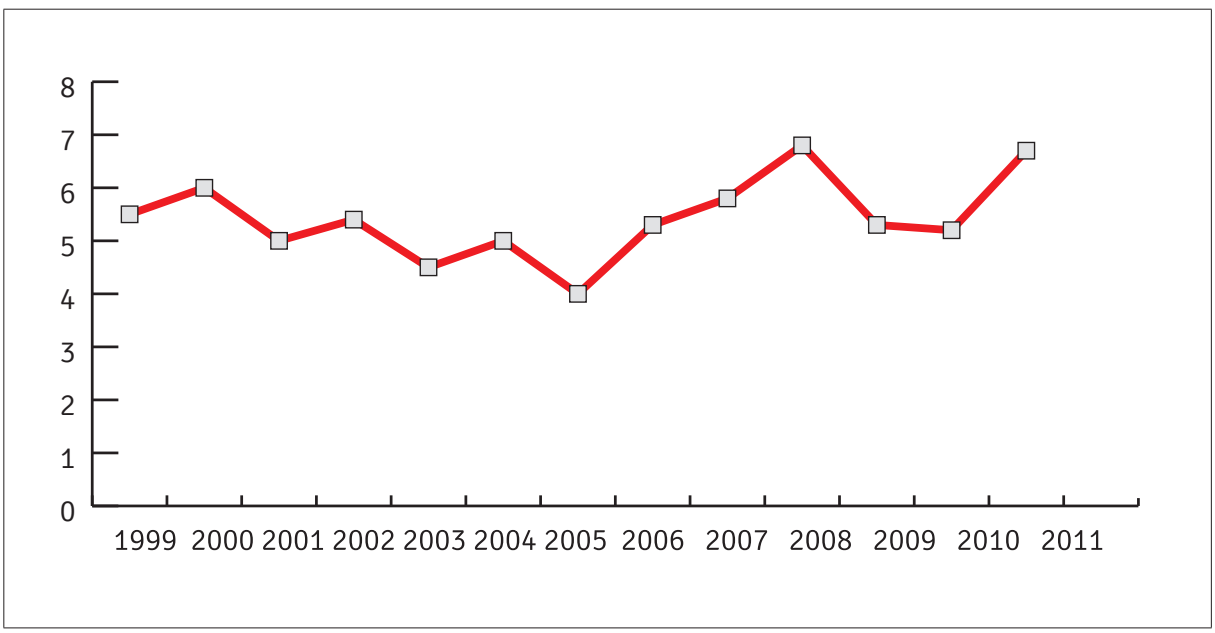


Figure 2: Gross Domestic Product Constant Price. GDP real growth annual basis, adjusted for inflation. Source: UBOS, 2012, International Monetary Fund (2012)

37. Uganda has discovered economically viable oil and gas reserves in the Albertine Graben and production is expected by 2017. The commencement of oil production may have a positive spinoff effect leading to double digit economic growth.. The commercial exploitation of the newly discovered hydrocarbon and mineral deposits offers both opportunities and challenges for Uganda. There is need for formulation of more sound fiscal policy to ensure that revenues derived from natural resources are not spent in an unsustainable manner. BEST tries to explain that biomass energy is potentially a renewable form of energy and will remain contributing substantially to Uganda's energy mix. The expectations and speculation by some sections of the population that there will be cheap and abundant energy is thus not well researched.

38. The Biomass Strategy tries to address issues to do with management of the biomass sector, efficiency and technology transfer and suggests ways of ensuring sustainable utilisation of the biomass resources. It is believed that implementation of the proposed biomass strategy will greatly contribute to the development of this country.

3 THE BIOMASS ENERGY STRATEGY

3.1 Rationale of the Biomass Energy Strategy

39. The Biomass Energy Strategy for Uganda is intended to provide a balanced view of all the options available for managing the all-important biomass resource in the country. Development of the strategy is guided by the TORs that require proposing rational and implementable approaches to manage the biomass energy sector. In addition, interventions are based on information that is generated in the subsequent section of biomass and demand analysis. For one to fully appreciate the genesis of the proposed strategic interventions, it is recommended that one reads the subsequent sections of this report.

40. Assessment of demand and supply shows that demand for tree biomass outstrips supply. That said, Uganda has got a high potential to use biomass in a sustainable manner. Uganda's soils and climate supports relatively faster growth rates of biomass within the region. In addition there is high potential to diversify to other forms of biomass rather than only focusing on tree biomass. As the assessment of biomass supply shows, biomass from bush can sustainably supply 10million tonnes of biomass annually. Introducing technologies to make briquettes from bush and other 'inferior' forms of biomass would in the short term halt mining into the tree resource. Interventions by projects like FIEFCO have shown that introducing fast growing shrubby plants like Sesbania and Caliandra enable households to quickly meet their fuel needs in addition to provision of fodder for goats, sheep and cattle.

41. Biofuels include fuels derived from biomass conversion, as well as solid biomass, liquid fuels, various biogases and a number of second generation6 biofuels have great potential in Uganda. Solid biomass includes wood, wood dust, agricultural residues, municipal solid waste, tree care waste, forest residues etc. Largely due to lack of awareness and appropriate technologies, utilization is never maximized. Energy crops including grasses,

6 Mainly biofuels under development like Cellulosic ethanol, Algae fuel biohydrogen, biomethanol, biohydrogen diesel, mixed alcohols and wood diesel generation

forbes and reeds plus commercial forestry plantations have a potential for utilizing biomass to provide clean energy forms like electricity generation. By applying the right technological interventions to avoid supply side and demand side wastage, Uganda can have a biomass surplus.

42. One of the mitigation measures towards unsustainable charcoal production in Uganda is the introduction of efficient wood to charcoal transformation processes whereby the traditional inefficient kilns (20% efficiency on energy basis) are replaced with more efficient ones (60% on energy basis).

43. Thus scaling up and promotion of multipurpose shrubs and trees on small farm holdings, introducing appropriate technologies to utilize the inferior forms of biomass and introduction of efficient wood to charcoal transformation technologies are some of the recommended ways of managing biomass supply for use by all sectors.

44. The demand side may be easily managed through fuel substitution and introduction of efficient technologies. Because biomass will continue to play a major role in the economy of Uganda for several decades to come, investment in efficient, clean and less polluting biomass energy devices should be a priority if poverty eradication targets are to be achieved.

45. Production of improved biomass energy technologies (cookstoves and fuels) is an income generating activity capable of growing into a full blown industry with well known downstream benefits, employing thousands of youth and women. Therefore MEMD could train professional players and equip them to maintain industry specific factors for the long term, rather than the conventional practice of training volunteer artisans. While it was necessary to have a starting point, time has come to move on and have a fully developed and commercialized biomass cookstove and fuels industry. It may not be advisable to train too many people who will not be able to adhere to quality and other standards that are necessary to have a thriving industry. A deliberate effort has to be made to attract large investments that will slowly bring on board the existing small scale enterprises for aggregated, quality controlled development. For instance having small enterprises acquire production and distribution franchises from large producers can provide a win-win relationship that ensures that both of them do good business producing and selling good quality products to a satisfied customer base for the long term. MEMD should actively encourage formation of stoves/fuels entrepreneurs associations. BEETA is a step in the right direction but it requires core support to enable it stand firm and deliver meaningful reforms to the sector.

46. It is recognized that shifting from traditional energy technologies to more advanced and cleaner alternatives is a long term ultimate objective. The implementation plan recognizes that this will be a gradual process and can only take place at certain levels of incomes. It requires ample time for initial exposure of communities to new technologies, to be duly followed by the establishment of support structures such as technical staff and maintenance workshops to ensure sustainability. Finally this has to be followed up with clear strategies for widespread promotion to create awareness of the mitigation options. Pronouncing the health benefits of improved cooking devices is a recommended paradigm shift in the promotional campaign to be spearheaded by the Ministry of Health.

47. There is considerable market for appropriate improved biomass energy technologies both in the urban and rural areas. What is lacking is intensive promotion and marketing. Initial market risks have to be taken up by development

agencies and government through a PPP approach. The micro enterprises that form the bulk of investments in the biomass energy sub-sector cannot afford the risks and also meet the market development costs. There is thus need for innovative funding mechanisms. One of the reasons why Africa has not attracted carbon projects is because of low energy intensities such that emission offsets of many proposed projects were very small and thus not attractive to the big polluters – the carbon buyers.

48. The proposed interventions are in line with the 12th AU Summit whose theme was infrastructure and energy, committed African governments to devise means of meeting energy demands for industrial, domestic and commercial activities while at the same time ensuring, efficient use, and sustainability as part of the global (MDGs) and Continental (NEPAD) commitments.

49. Above all, Africa is highly vulnerable to climate change and variability owing to the fact that most of the African economies and the people's livelihoods in general are largely dependent on the natural weather conditions. Adaptation to climate change and any possible mitigation measures are therefore a major priority. With support mainly from the EU, most African countries now have National Adaptation Programmes of Action (NAPA). However, largely due to lack of technical expertise, very little has been done to integrate the mitigation mechanisms into the development process. The BEST has potential to tap into the climate financing mechanisms like NAMAs.

50. The following are likely to dominate the practical issues of biomass going forward:

    - Globally, there are measures to have a pronounced increase in renewable energy production and use. In this, biomass energy will have to take its position;
    - Technology required to develop biomass energy is available and getting cost effective;
    - The biomass energy value chain is closest to rural based communities and is likely to receive social acceptability compared to other forms of energy available to the country. In addition participation in the value chain has the potential to reduce poverty and create conditions for wealth generation.

51. Capacity assessment for achieving these targets across the five member states of the East African Community is ongoing. Harmonizing the energy policies of the member states with the regional goals and targets is among the key recommendations of the capacity assessment report.

3.2 Objectives and Benefits of the strategy

52. Strategy objectives and expected impacts were based on the analysis of potential impacts derived from the demand and supply scenario analysis plus stakeholder consultations. The strategy aims at balancing the supply and demand of biomass energy by suggesting interventions that will ensure biomass utilisation without negative social, economic and environmental consequences. This is the reason why involving all key players in government, civil society organisation, research institutions and most importantly private sector- both users and producers of biomass is critical.

53. The suggested mode of operation has been influenced by analysis of barriers to the adoptions of renewable energy both in Uganda and within the region. The suggested interventions are summarized in table 6. The objectives are set to be as realistic as possible. Number one pillar of the strategy is increased awareness through effective communication right from the top policy makers down to the local person who is affected by indoor air pollution. Also of great importance is to make the private sector aware of the investment opportunities in efficient technologies and the renewable energy sector as a whole.

54. As already discussed, past interventions in Uganda have achieved little or no success. A long list of barriers is responsible for these failures among which are inadequate policies sometimes stemming from lack of effective communication. A key pillar of the biomass strategy is a communication mechanism that should demonstrate the economic and environmental benefits associated with BEST where necessary resulting in policy review. It is believed that the proposed measures will deliver the benefits if effective communication is coupled with promotion of appropriate technologies, training (including research and development) and of critical importance, innovative financing mechanisms (sometimes called smart financing). Lack of reliable up-to-date data on energy is a barrier to proper planning. It is proposed that a mechanism of continuously collecting and updating energy data be part of the Strategy.

55. Strategic objectives and potential benefits are summarized and presented in table 6.

Table 6.Strategic objectives and targeted benefits

Present Situation	Strategy Objective	Targeted Short and Long term impact
	Policy and regulatory Frame work Issues	
• Facts of biomass energy contribution to Uganda's social, economic and industrial growth not well known • Biomass considered a backward form of energy • Clean forms of biomass not well known and thus not promoted	**1. Communication strategy** • Develop a communication strategy specially tailored to various audiences: end users, policy makers and technocrats; • High level decision makers, Local govt policy makers etc. • Technical personnel • Policy formulators • Legislature • Urban poor and rural poor • Middle class urban and rural • Private sector especially industries • Institution (e.g., Educational institutions, prisons) • CSOs	• Informed policy formulation achieved • Discussions / debates and formulation of feasible regulation • Informed fuel and technology choices • Opportunities of investments in biomass energy production known

Present Situation	Strategy Objective	Targeted Short and Long term impact
▪ Various government institutions collecting data that relates to biomass energy are not well synchronised ▪ Data on biomass energy usage is incomplete ▪ Land use / cover maps outdated ▪ Biomass monitoring stalled	**2. Biomass Information System (Data collection and archiving;** ▪ MOU towards creation of an interlinked biomass resource database and information centre with representatives from key line Government agencies • Building on existing institutions and initiatives to achieve this e.g., • NFA- biomass resource assessment and monitoring • MAAIF and extension service collect and monitor crop production and agro-waste • UBOS- biomass use assessment be part of population census • Makerere and other research institutions research and disseminate information on appropriate RETS • MEMD coordination and guidance	▪ Harmonized biomass information system as part of government information system

Present Situation	Strategy Objective	Targeted Short and Long term impact
• Apart from activities in gazetted areas, currently no management plan exists for the wood resource on private land • Timber and charcoal harvest licencing regulated by several ministerial pronouncements some of which are either no longer relevant or practically impossible to implement especially under a decentralized system • Charcoal and timber taxation and movement permits decentralized with no proper guidelines. • Multiple taxation, tax evasion rampant • There is no requirement for a sustainable biomass plan for any investment • Overloading of timber and charcoal lorries • Lack of coordination amongst the MEMD, MWE and Local Govt on harvesting, licensing and technology transfer • Lack of biomass energy stakeholder forum	**3. Enhance Institutional Capacity to regulate use of the biomass resources** • MOU towards creation collaboration framework in key govt agencies • Include Biomass and wide range of RETs in education curriculum and build capacity at ministry of Education to enforce it • Regular updates of energy statistics to stakeholders • Develop prototype timber and charcoal production plans for small woodlots and natural wood formations that can easily be replicated • Harvesting permits managed at regional level and linked to taxation and wood resource management plans • DFOs facilitated to develop wood resource database and management plans which ultimately form part of the regional database and management plan • Differentiated taxation system where by non-green charcoal and non-green timber attract penalties • Establish an Energy use certifying organ • Incentives to compliance • Give time lines as to when selling charcoal in volumes will be completely phased out • Investment plans and environmental mitigation plans of heavy biomass users like Tea industries, Tobacco industries, paper industries, Vegetable oil Industries and institutions should include a sustainable biomass energy supply plan and energy audit plans • Annual biomass energy stakeholder review forum established	• Laws and regulations adopted and harvesting of wood from private and public land regulated and professionally organized. • Taxation harmonised at regional level where by part of the funds are remitted to districts. • Forestry management plans developed and silvicultural assistance for both woodlots and natural wood formations on private land provided • Better charcoal transportation and distribution system developed e.g., transported in box bodies, weighed, packaged and sold in Kgs. • Government agencies better informed and supervisory, regulatory and guidance organs enhanced. For example biomass harvesting and usage by sector will be well understood and thus planned for.

Present Situation	Strategy Objective	Targeted Short and Long term impact
• **Biomass Demand Interventions**		
• Uganda characterised by high share of traditional and inefficient technologies at household level, in institutions, industries, commercial sector. • Use of three stone fuelwood stove at 90% in rural areas • Low penetration of improved stoves with about 65,000 distributed annually through out Uganda. Possibly ¾ remain in use given a life span of 4 years. • Use of traditional metallic charcoal stoves estimated at 80% in urban areas	**1. Fuel Efficiency and clean cooking environment;** • Increase awareness of indoor pollution and associated health risks related to use of traditional stoves especially in rural areas. Partner with Ministry of health in the drive to eliminate indoor pollution related health hazards through introduction of improved stoves • Promote end user training programmes. • Increase awareness of benefits of the energy (including overall cost) savings related to fuel and appliance (stove and cooking appliance) choice in urban areas • Initiate Carbon Financing models that will subsidize ICS costs such that they can out compete traditional inefficient devices	• Reduction in illness related to indoor air pollution while at the same time making biomass energy savings • Reduced charcoal demand due to increased use of improved charcoal stove which translates into wood savings needed for charcoal production

Present Situation	Strategy Objective	Targeted Short and Long term impact
• Fuel substitution not happening because of lack of awareness and fuels not being competitive thus; • Wood is the most highly consumed form of biomass followed by charcoal • Vegetal wastes are becoming popular in industries but supply chain is not well developed • Biogas technology is not well developed and this has potential in cattle keeping area especially where animals stay in kraals overnight. • Even when the charcoal becomes more expensive than LPG in terms of energy delivered to the pot, many households do not switch to LPG because of high upfront costs	**1. Efficient technologies (Fuel Substitution);** • Provide technology that will enable use of alternative biomass (apart from wood). Invasive species like Lantana camara, paper mulberry are potential sustainable un-carbonized briquetting material. • Harmonize the cross cutting interests of use of agro residues • Promote use of biogas especially in institutions and in cattle keeping areas which at same time improves agricultural production by use of slurry as high quality fertilizer • Promote increased use of LPG in urban areas (wealthier households) by provision of better distribution mechanisms and access to appliances through a credit scheme • Provide technologies and include carbon financing such that current local gin producers transform into small scale industrial ethanol producers • Promote use of bio fuels in a sustainable and well harmonized (with other competing interests) approach	• Technology to utilise 'Inferior' forms of biomass introduced resulting in less demand for charcoal. Use of non- traditional forms of biomass (e.g. briquettes) increased through creation of innovative financing mechanisms like carbon Payment for Ecosystem Services (PES). • Increased use of biogas and other related benefits like boosting agriculture production • Increased adoption of LPG especially among urban centres and wealthier rural households • Through carbon subsidies ethanol substitution for Kerosene and fuelwood (both for lighting and cooking) in rural areas attained

Present Situation	Strategy Objective	Targeted Short and Long term impact
	• Biomass Supplyinterventions	
• Currently wood and vegetal wastes are used as God given with no obligation to ensure sustainable supply • Efforts by Government programmes like FIEFCO, and some NGOS are excellent but cover only small sections of the country • Most of these efforts and Private sector investment target timber production • Only a few private companies (e.g. Hima) are investing in sustainable coffee husk supply by providing coffee seedlings to neighbouring communities	**1. Cost effective Increase in Biomass supply;** • Build on existing programmes such as FIEFCO and ensure that biomass deficit areas are among the first beneficiaries • Develop a Nationwide plan for multipurpose trees and shrubs • Implement govt plans to invest in energy crops both annual and perennial crops and in addition encourage private sector to do the same • Enhance current government and private sector tree planting efforts by tapping into existing Payment for Ecosystem Services (PES) like REDD, NAMAs, CDM, POAs • Where substantial forest plantations exist promote usage of forest prunnings and thinnings for energy purposes • Aggressively promote use of improved charcoal kilns and gasification technologies –partnerships between investors, research institutions and govt agencies needed	• Sustainable fuelwood supply attained in rural communities • Maintain wood demand for charcoal at the 2013 level by increasing per cent of charcoal made in improved technologies to 75% by year 2020.

Present Situation	Strategy Objective	Targeted Short and Long term impact
Cross Cutting		
• Due to high upfront costs, Current Bank policies do not support high upfront cost investments • Local banks not very much interested in development financing • Local banks have not yet included carbon financing in their portfolio	**1. Financing Mechanisms for Efficient Technologies and Renewable energy;** Creation of SMART financing mechanisms • Creation of a National Fund for renewable energy projects that will provide seed –money (Start-up capital) • Organize interested local investors so that they access any of the following financing mechanisms • Less stringent collateral requirements into e.g. from cooperatives and Micro Finances • Use CERs (CDM or Voluntary market) as collateral to access loans for heavy investments	Innovative and sustainable financing programmes for renewable energy technologies established.

4 VISION OF THE STRATEGY

The vision / mission of best

"To secure a stable biomass energy supply for long-term social and economic development of Uganda including poverty reduction"

Institutional home of best

Government is to fast-track the formation of the Renewable Energy Department with a Division dedicated to the development, conservation and utilization of the biomass energy resource. This division will, among other critical roles, be charged with the implementation of BEST. Within the Renewable Energy Department, a Biomass Resource Regulatory Authority (BRRA) will be established to regulate the all-important sub-sector.

The National and Regional Energy Committees provided for under the Renewable Energy Policy will be established as a platform through which the regulatory agency and other stakeholders synergize to implement cross-sectoral programmes of national interest.

This is to be linked to the Key guiding principles/ opportunities

i. Uganda has a comparative advantage of having good soils and climatic conditions that support fast growth of biomass. This gives Uganda the potential of utilising biomass sustainably for many decades to come. Unfortunately, the tree biomass stock is being depleted mainly due to lack of information, wide use of inefficient technologies and lack of technology to utilise other forms of biomass. Uganda has got high potential for developing biomass into modern and clean forms of energy in the form of gas and even electricity production. Biogas and electricity generation from CHP systems are good examples.

ii. The Government of Uganda and investors have a common interest in identifying the most efficient and reliable energy sources to sustain future growth. The investment cost for conversion of biomass into clean and modern forms of energy is comparatively lower than other sources such as hydropower.

iii. Capacity and technology exist for Uganda to tap into the opportunities presented by the clean development mechanisms under the Kyoto Protocol. Development and adoption of efficient biomass energy technologies can potentially result into tradable certified emission reductions and thus provide an avenue for investment finance.

iv. The use of efficient biomass energy technologies has positive social economic and health impacts such as reduction of indoor air pollution which is a major health risk factor in developing countries. Biomass energy issues are crosscutting.

4.1 Six Pillars of BEST

BEST is built on six pillars as summarised in table 6

1) Specially Targeted Awareness Creation

The need for creating awareness through development of communication strategy specially tailored to various audiences: end users, policy makers, potential investors and technocrats so that it leads to;

- Informed policy formulation achieved
- Discussions / debates and formulation of feasible regulation
- Informed fuel and technology choices
- Opportunities of investments in biomass energy production known

2) Creation of a Biomass Resource Information System

A biomass information system that is regularly updates is critical for proper planning and monitoring of BEST. Data sets from various entities both on supply side (e.g., The proposed FSSD forest ownership database) and demand side(e.g. household, institutional and industrial consumption) would be integrated and continuously updated. Various government agencies e.g. NFA, UBOS, NEMA, URA, MEMD would be key contributors to the system with clearly agreed upon mandates, responsibilities and obligations.

This would be an integral part of government information system. It is important that Regular updates of energy statistics is disseminated to stakeholders. One of such system is the Long-range Alternative Planning System (LEAP).

3) Enhanced Institutional Capacity to implement BEST

Government is to fast-track the formation of the Renewable Energy Department with a Division dedicated to the development, conservation and utilization of the biomass energy resource. This division will, among other critical roles, be charged with the implementation of BEST. Within the Renewable Energy Department, establishment of the Biomass Resource Regulatory Authority (BRRA) which will regulate the sector is proposed. The National and Regional Energy Committees provided for under the Renewable Energy Policy will be established as a platform through which the regulatory agency and other stakeholders synergize to implement cross-sectoral programmes of national interest.

However, in order for BRRA to be effective, there will be need for better coordination through a multi sectoral planning approach. MOU towards creation collaboration framework in key govt agencies would enhance this approach. For example, one of the proposed multisectoral planning approach is where FSSD and NFA jointly develop forest produce management plans (prototypes) as a basis for issuing harvesting permits (and licenses) and application of the differentiated taxation regime with penalties for illicit trade of biomass products.

Establishment of annual biomass energy stakeholder review forum, continuous enhancing of capacity of technocrats plus including RET in education curriculum are proposed.

4) Biomass demand Interventions

Managing biomass demand entails not only promotion of efficient technologies but also provision of clean cooking environment. This is to be done through a multidisciplinary approach

technology and health issues are discussed in one package. Ministry of health should be brought on board in the drive to eliminate indoor pollution related health hazards through introduction of improved stoves. MOH should spare head increasing awareness of indoor pollution and associated health risks related to use of traditional stoves especially in rural areas.

Related to the above is to increase awareness of benefits in the energy (including overall cost) savings related to fuel and appliance (stove and cooking appliance) choice especially in urban areas where the cost of energy critical.

In addition to efficiency, the strategy promotes reduced over dependency on tree biomass and instead suggests introduction of technologies to harness the abundant and diverse forms of biomass for energy purposes e.g., technology that will enable use of inferior forms of biomass and invasive species like Lantana camara, paper mulberry. Promote increased use of LPG in urban areas (wealthier households) by provision of better distribution mechanisms and access to appliances through a credit scheme.

Promote use of biogas especially in institutions and in cattle keeping areas which at same time improves agricultural production by use of slurry as high quality fertilizer.

5) Biomass Supply Interventions

Increasing biomass supply needs to build experiences learnt from programmes such as FIEFCO and ensure that biomass deficit areas are among the first beneficiaries.

Involving private sector participation in a nationwide plan for multipurpose trees, shrubs and energy crops would greatly improve biomass supply for both thermal and electricity generation.

Aggressive promotion improved charcoal kilns and gasification technologies in partnerships that involve investors, research institutions and govt agencies is needed to improve and increase the biomass energy supply base. Where substantial forest plantations exist promote usage of forest prunnings and thinnings for energy purposes.

6) Cross cutting Issues (Innovative Financing)

Several improved technologies both at end-use and biomass transformation exist. These technologies are normally associated with high upfront costs such that it would be need to develop a number of innovative funding mechanisms such as grants, challenge fund and use of carbon credits as collateral. BEST communication strategy will popularise these technologies.

The private sector is expected to be a major player only if technologies and investment opportunities are effectively communicated to them and if government makes a deliberate effort to break barriers curtail adoption of the technologies.

The need for creating awareness on issues and possible solutions at various levels especially government decision makers thus need not to be over emphasized. A dedicated biomass energy investment fund is proposed to be managed by the authority in the implementation of PPPs that achieve the Government's biomass energy development objectives.

Government agencies should create specialized units that will work with and help private sector to tap resources in existing carbon financing mechanisms and Payment for Ecosystem Services (PES) like REDD, NAMAs, CDM, POAs and VCS.

Tapping into these resources would make it more attractive and viable to invest in a number of improved technologies. For example Improved Cooking Stoves costs could be subsidized such that they can out compete traditional inefficient devices. A combination of subsidies and improved technologies would transform a number of cottage industries into small scale industries that produce products like lime, bricks and ethanol.

4.2 Institutional Aspect

56. Biomass energy should not be viewed as an isolated sub-sector but as an integral part of the development process. Uganda's economy is agro-based and biomass plays a key role at household and institutional level plus the commercial and industrial sectors; therefore developments in the biomass energy sub-sector will contribute towards the National Development Plan and Vision 2040.

    To operationalize the proposed interventions it might require public institutions to change from the current business as usual mode to a more result oriented approach and multi sectoral planning approach. This approach is in line with newly proposed public service delivery strategy. For example, one of the greatest impacts on wood savings would be to ensure that the bulk of charcoal is produced from improved technologies. This requires three key actions to be taken as outlined below:

57. Actions

    - Create awareness so that investors (local and international) know the investment opportunities.
    - Attract loans for investment – make good feasibility studies and include carbon financing such that the carbon streams work as collateral.
    - Provide incentives for the investor – government should help investors make the necessary documentation, provide guidelines and regulations that favour green charcoal.
    - The above will create a conducive operating environment where by cheap non-green charcoal does not out compete the green charcoal on account of high cost of production.

58. In order for this to happen, multisectoral planning and programme implementation between FSSD and NFA within MWE, MEMD and Local Government is needed. Government agencies need to be on the same platform so as to be able to explain the underlying factors that may impair technological transfer.

    In addition, government agencies are expected to take the lead in demystifying the technologies and to help identify seed money for both demonstrations and initial start-up investment capital. As itemized in the communication strategy, policy brief and action plan for the implementation of BEST, the regulatory function of the government agencies need not to be overemphasized.

4.3 Mobilizing Finances

59. Experience has shown that most renewable energy technologies (especially those that can be locally manufactured) require subsidies in the initial stages, and can become financially sustainable in the short to medium term after a certain level of technology dissemination has been attained (Kimani et al, 2002). After attaining a dissemination of certain critical mass in terms of number of units and assemblers / manufacturers, the renewable energy industry can become self-sustaining and subsidies can be gradually withdrawn without any adverse effects on continued dissemination of renewable energy technologies.

60. One of the proposed ways to break investment barriers in renewable technologies is through innovative financing models. A 'SMART' investment model (Figure 3) is proposed whereby a local investor is connected to an international investor (a venture capital investor). The local investor comes in with local expertize and is probably guaranteed by government under a PPP (Public Private Partnership).

    Feasibility studies, business plans and due diligence assessments are carried out by a reputable entity. Based on these studies the international investor provides start-up capital and uses carbon streams generated by the investment (activity) as collateral.

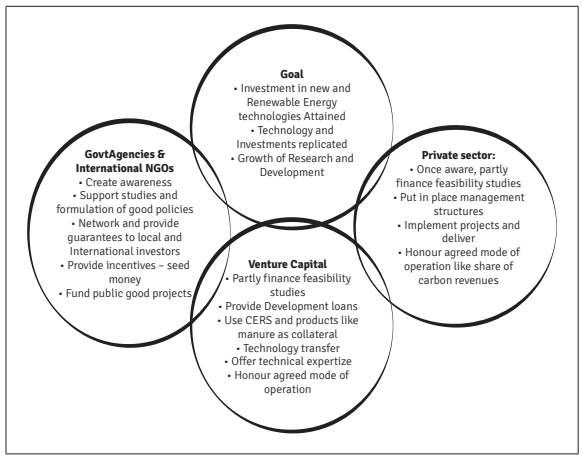


Figure 3. Proposed financing mechanism to break the high upfront costs in RETs (major barrier)

4.4 Research and Development

61. Technologies that improve existing methods and build on already established industries are likely to be successfully disseminated (Kimani et al, 2002). It is thus recommend that choice of renewable energy technologies for dissemination and development take into account the existing technical knowledge. Meaningful development of the biomass energy will require mobilisation, strengthening and effective organisation of human resources in the country.

62. Far eastern countries like India, China and Indonesia have got a tropical setting and at a global scale are still heavily dependent on fuelwood. These countries have, however, advanced a lot in research and development of renewable technologies many of which are appropriate to the African setting. Investment in biomass technologies are thus more likely to benefit in south to south technology transfer.

63. It is thus proposed that educational institutions like Nyabyeya Forestry College, Makerere University Faculty of Technology and research institutions such as NARO attach students in

a model that will generate more research that would eventually be transferred and piloted at the proposed regional energy demonstration centres.

64. Kimani et al (2002) also noted that maintenance of mechanical and thermal/heat technologies (e.g. wind pumps) is generally less of a problem since it builds on local knowledge and skills such as improved charcoal kilns, briquetting machines and improved cookstoves). In addition, these technologies are modular (can be increased gradually over time), and can be locally manufactured. This translates into opportunities for employment and enterprise creation locally. In the short term, optimum use of existing skills would yield the highest benefits at the lowest cost. It is therefore necessary to establish the existing human resource capacity in the country. Over the years, there has been great dependence on external expertise in the energy sector and it is proposed that BEST targets increased utilisation of local expertise.

65. It is also important that technology puts into consideration the social aspects. Under BEST various tools will be designed and customized to ensure that communities in their diversity and different levels of sophistication receive the key messages that raise awareness of, say, the health impact of household smoke. The tools and messages have to be developed after proper research as it may be costly to correct a wrong message sent to the community. Qualitative surveys to establish the unique settings and cooking habits of various communities are recommended. This research can be done at a fairly low cost if it is done in collaboration with the institutes of social research/public health in all the universities. A deliberate effort should be made to encourage university students to select topics that are relevant to the household health and energy issues highlighted in the BEST.

66. Research findings of the studies conducted across the different regions and cultures should be the guide for the engineering students to design new or improve existing RETs suitable for each social setting.

67. During the design stage or performance improvement stage the engineers have to take the vital step of getting the input of the potential users of the technologies to guide their design process. The views collected through well selected focus group discussions and prototype demonstrations have to be incorporated in the design process and new prototypes produced and retested until the acceptable model of the RET is established. For in the case of improved cookstoves, the FGDs should include the people who matter most in making the decision to purchase a cooking device. Generally, the women who do the cooking and fuel gathering feel the impact of shortage more than the men. But on the other hand, the man usually provides the money to make the purchase. Therefore both family heads have to get the correct information regarding RETs. Sometimes energy efficiency is not the primary motivation for a household to purchase an improved stove. Other aspects include good quality of stove, it cooks faster hence reducing time for cooking, improvement of kitchen environment, status symbol, etc. Demonstrations are made using the prototypes with the objective of engaging communities to contribute their views and preferences for a device that suits their cooking and heating needs in the real life setting. The goal is to avoid the danger of promoting interventions or producing RETs that are incompatible with the end user requirements. Only the generally accepted prototypes are recommended for mass production and dissemination.

68. When the acceptable designs have been established, market research has to be carried out and the findings made freely available

to intending investors. This will be a great incentive for the large scale investors who consider the uncharted area of RETs too risky for their undertaking. By providing them with the numbers related to effective demand, cost of investment and projected returns on their investment, more investors will be attracted in the RET sector. As of now the level of investment (largely artisanal) is too low to create the desired impact. The small scale entrants will only copy a few models that have worked for their peers; which partly explains why most of them are concentrated in and around Kampala. Understandably, they cannot invest in research, prototyping, promotion etc; hence they are hesitant to venture into new technologies.

69. Laboratory testing and field testing have to be made part of the RET design improvement and promotion. Uganda is honoured to be host to an internationally accredited Cookstove and fuels testing facility- Centre for Research in Energy and Environment Conservation (CREEC) based at Makerere University. CREEC has been commissioned by the Global Alliance for Clean Cookstoves for development as a regional testing centre. It should also be recalled that a lot is going on at the global level to develop standards for ICS and fuels. According to the GACC the global standards:

    - Help consumers and users make informed purchases
    - Allow designers and manufacturers to affirm product quality and drive innovation
    - Provide policy makers, donors, investors, programs with a credible basis for evaluating and comparing stove performance and safety7

70. In February 2012 at a meeting in The Hague, Netherlands, the ISO approved the International Working Agreement (IWA) for cookstoves. The IWA is a consensus process agreed to by stakeholders and it can be a first step towards ISO formal standards. The cookstoves IWA provides a framework for rating cookstoves on 4 indicators, each along 5 tiers. Among other resolutions, the IWA allows organizations and countries to select tiers and indicators according to local priorities. Under this framework, Uganda has opportunity to set standards for RETs that are acceptable to the ISO approved IWA.

4.5 Targets and Funding Requirements

71. Knowing that developing countries are always faced with budgetary constraints and thus find it difficult to finance investments in renewable energy technologies, we propose that government and development partners provide seed money to break barriers of investment in this sector and also to focus resources on projects that are more of public good in nature. In addition to seed funding, the mechanisms for providing guarantees for long term borrowing need to be made investor friendly provided the appropriate due diligence has been conducted.

7 http://community.cleancookstoves.org/user_content/files/002/955/2955562/dceb64fb3e9313de5108c8c9ff23c02f-alliance-iso-standards-process.pdf

Part II

Biomass Supply and Demand (Current and Forecasts)

5 BIOMASS DEMAND AND SUPPLY DETAILS

72. This section gives details of biomass demand and supply, drivers of biomass demand and underlying factors that affect the biomass supply and demand in Uganda. Understanding the drivers helped in developing forecasts using the Long Range Energy Alternatives Planning (LEAP) model. The analyses were great basis for proposing the strategy that is presented in the previous section.

73. The section provides details on a number of cross cutting issues related to biomass energy sector. Some of these nitty-gritty details have influenced what is proposed in the strategy but not all of them could be listed. They could be useful in developing a number of interventions for the sector especially issues that may not be fully addressed by the strategy.

5.1 . Household demand and related Social economic issues

5.1.1 Fuelwood use (mainly at household level)

74. The majority of the people in rural Uganda are poor, largely consume fuelwood that is gathered as dry, fallen pieces and twigs and in some instances agricultural wastes. The poverty rate for rural households was estimated at 34.2%, which was almost triple the rate for urban households (UBOS, 2006). Median nominal wages in rural areas are only one-third of the urban level also (UBOS 2007b). Rural households allocated about 50% of their total expenditure to food, drink, and tobacco. About 15% of rural households had fewer than two sets of clothes per household member, and only 43% reported that each member of the household had a pair of shoes in good condition. It is thus unlikely that majority of these people may afford to pay for fuel and later on an improved stove. When fuelwood gets scarce, such people are hit hardest.

75. Preferred fuelwood sizes are normally short and small size. Some studies indicate that pieces as short as 0.33 m to 2.32 m long and as small as 1.3 cm -to 5.6 cm in diameter are preferred (Ageaet al., 2010). When there is scarcity, any form of biomass is used raging from grass, banana leaves, papyrus, splitting huge tree stumps and tree roots (personal observation in Kapchorwa and Ntungamo).

76. The most common cooking device in the rural households is the traditional three-stone fire, whose efficiency is very low (about 15%). This method of cooking is wasteful in that much of the heat from the fuel is dispersed before it gets to the cooking pot. Where cooking is done

in doors, as is normally the case, it exposes the user to indoor air pollution which is a major health hazard. This is exacerbated by the fact that the firewood used is sometimes wet and hence combusts poorly. The urban poor also use fuelwood for cooking. Unlike folks in rural areas, they use a mixture of fuelwoods and pay a price for it (plate 1).

77. Extraction of wood beyond natural replenishment is sometimes associated with other external factors like commercial fuelwood extraction or clearing of land for agriculture and pasture improvement. This manifests in the long distances that the rural women and children have to move in search of firewood. (In most cultures in Uganda, fuel gathering is a responsibility of the women, and by extension, the children.) Another indicator pointing to reduced supply of biomass for household cooking in the rural setting is the fact that firewood now has a price and is sold as a commodity in many areas, with the price rising. A study carried out in Kalisizo Sub county in Rakai District found that some families would make a return journey of 8 to 12 kilometres to collect firewood and that very few (18%) travelled less than 8 km in search for firewood (Ageaet al., 2010).

78. Situations like the Kalizo situation are close to what Eckholm (1975) described as "the other energy crisis", which "will probably be longer and more difficult to overcome" than the energy crisis associated with the rise in petroleum costs. Given the growth rate potential of trees in Uganda, and given that biomass for fuel can be provided for from shrubs and twigs, it is a paradox that some rural areas in Uganda are facing fuelwood crises. Simple interventions like integrating hedgerows of species like Caliandra within the general farming system can easily provide for such needs.

79. Given the complexity of the subject, equating wood fuel use exclusively with deforestation can lead to misleading conclusions in planning future wood fuel supplies. However, this does not mean that there are no instances where biomass extraction, especially for commercial purposes, leads not just to destruction of the forest but to complete removal of all tree and scrub cover. In eastern Uganda, lime production has resulted in vegetation destruction including cutting down of fruit trees.

Plate 1. An example of cooking on an open fire three stone stove in a peri- urban setting

5.1.2 Charcoal Use (mainly in urban areas)

80. Charcoal is the most preferred form of energy in urban areas both by households and commercial enterprises. In many respects charcoal is a high-quality fuel and in terms of efficiency of domestic use it may actually be cheaper than fuelwood. Many factors such as burning characteristics, the flavour charcoal imparts to food, ease of storage, smokeless burning, affordability, simplicity and portability of charcoal stoves make charcoal the most preferred form of energy by urban households (EARL, 1975).

81. Because between 30 to 50 percent of the heat value of wood is lost during conversion to charcoal, it may be more efficient to use fuelwood where transport distances are short and transport costs are low. However, because charcoal has got a relatively higher density (30MJ per Kg compared to fuelwood 15MJ per Kg) charcoal becomes increasingly attractive over longer distances. The balance between fuelwood and charcoal, and the limits of economic supply for the latter, depend on production costs, transport costs and market prices of charcoal and alternative fuels. Earl (1975) found that within East Africa, fuelwood was more attractive up to a road distance of 82 km, and charcoal beyond that distance. Currently in Uganda, charcoal supplies are transported over distances of up to 500km.

82. Charcoal is produced throughout Uganda with the highest levels of production occurring in areas with woodland ecosystems that support high-quality vegetation for charcoal production. The major charcoal producing regions include central Uganda and parts of western and northern Uganda. The main species utilized for production include: Combretum;Terminalia; Albizia; Acacia; Allophylusand Grewia spp. (Shively, 2010).

83. Between 2005 and 2008, Uganda experienced a dramatic rise of charcoal prices of 14% per year at a nominal rate. In 2008-2009, LPG was much cheaper than charcoal in terms of energy delivered to the pot. It is worth noting that even when it was cheaper to use LPG households (and small enterprises like restaurants) seem not have switched from charcoal mainly due to upfront costs (stove and gas cylinder) that are related with use of LPG (based LPG import data).

84. From regional consultative meetings and field observations under this energy strategy, it was found that the overall increase in the profitability of the charcoal trade in 2008/9 has since driven many rural poor into charcoal production for a livelihood. Now charcoal is being produced all over the country and the prices are much lower than the 2009 in nominal value.

5.1.3 Impact of Kampala city alone to biomass stock (in reachable area)

85. Inventory carried out from 1995 to 2002 (FD 1995, NFA 2005) indicated that tree biomass stock of undisturbed woodlands in major charcoal producing areas stood at an average 40 tonnes per hectare with a potential annual increment, Current Annual Increment [CAI] of 4.2 tonnes per hectare per year. Due to the heavy biomass extraction mainly for charcoal production and commercial fuelwood, the biomass stock has dwindled over the years. The land cover in some of these areas has changed from woodland to agriculture, both commercial and subsistence farmland. Such instances have not only led to a reduction in the biomass stock but also caused land use/cover change. The combination of all these factors implies that the capacity of these areas as sources of charcoal has been affected.

86. Since there are no organized charcoal production systems in Uganda, it is not possible to compare biomass taken out that is attributable to charcoal production and biomass annual increment and thus make reliable estimates of biomass balances. To get some understanding on the biomass supply/ demand dynamics some assumptions were made. These assumptions are based on previous studies on charcoal business, charcoal inflows studies and the National Biomass Study 1992, 2002 and 2005 (NBS 1995, NBS 2002).

87. Mapping using Geographic Information Systems (GIS), areas that fall in major charcoal producing areas and were classified as woodlands in the 1995 – 2002 (FD Database 1995) were identified and selected. It was assumed that 80% of the charcoal demand in major charcoal consumption centres is supplied from these woodlands. Biomass demand (needed to produce charcoal) over a period of 11 years was deducted from stock (including annual increment). The upper and lower limits of the comparison indicated that biomass stock has been dwindling at a rate of 0.5 - 1.25 tonnes per ha per annum. This is considered a conservative estimate given that trees cut as a result of agriculture expansion and pasture improvement are not factored in. Actual annual stock change in 2005 was estimated at 1.9 tonnes per ha per year (FD, 2002). With increased demand due to increased urbanization the rate might be much higher than this.

88. Based on the above rate of degradation, biomass stock in the major charcoal supply areas is estimated to have reduced by between 25-50% of the year 2000 stock levels. In terms of stock, current tree biomass stock is estimated to be between 20-30 tonnes per ha (down from an average of 40 tonnes per ha). It is important to note that in addition to degradation, some woodlands have been converted into other land use/cover types (e.g., bush and farmland) though this may not solely be attributable to charcoal production.

89. Whereas Kampala's reachable area has changed in recent years (and thus above assumptions may be flawed) it is still adequate to conclude that charcoal demand from major consumption centres has led to a reduction in average tree size in the major supply areas and that the percentage of bush cover compared to tree cover has increased (plate 2).

Plate 2.Woodland turned into bush in some areas of Kilangirizi and Ngoma, in Nakaseke and Nakasongola Districts

90. The overall effect is that the number of trees that can be converted into charcoal has reduced and a much bigger area is now needed to produce the same amount of charcoal. In addition, charcoal density is also expected to be affected since the proportion of young trees to old ones is now higher. The charcoal producers have tried to cope with the above situation by going much deeper into the woodlands. This also partly explains why charcoal is being transported over longer distances (from Gulu and beyond to Kampala).

5.1.4 Charcoal Stove efficiency

91. Most commonly used charcoal stove is the traditional metallic stove (sigiri). From efficiency studies conducted by GIZ , the improved charcoal stove was found to have a cooking efficiency of 24% compared to 15-17% of the traditional metal stoves. This means that the stove can save about 35% of the fuel used by the traditional metal stove. These figures are comparable to the results of a comprehensive Kitchen Test conducted for the Ugastove Gold Standard project to substantiate the fuel savings of the ICS in a real life setting: "In the case of conventional charcoal stove users, the baseline study shows the average consumption of families sampled using the traditional stove was 1.13 tonnes per year, in conditions where they are cooking only with charcoal. Families in the sample moving to the improved charcoal stove (size 2) and using it for the same purpose and thermal load (cooking meals of the same type, number and sizes) were found to reduce their consumption to 0.72 tonnes per year on average. The adoption of the improved stove, therefore, resulted in a saving of 0.41 tonnes of charcoal on average each year by each user. This figure reduces to 0.30 to take account of the statistical error margin arising from the variation in the sample and adoption of the lower bound of a 90% confidence interval."8

8. Gold Standard PDD Efficient Cooking with Ugastoves 090324 Pgs 23-24

92. There are three main attributes to the efficiency of the improved charcoal stove: 1) Ability to burn the fuel completely, 2) transfer the resulting heat to the cooking vessel and 3) retain heat due to the insulation. These 3 attributes combine to ensure a higher efficiency of the ICS as compared to the traditional metal stove. Design improvements intended to increase the efficiency of the ICS have to focus on these three attributes.

93. Earlier on, Shrestha 2001, revealed that there is a difference between the combustion efficiency of a stove and its cooking efficiency. The study came up with a relationship which can be summed up as follows:9

Overall efficiency = hc * hr
Where.
hc = combustion efficiency
hr = Heat transfer efficiency
Overall efficiency = Percentage of chemical heat that enters the pot (table 7).
Nominal combustion efficiency = A rough estimate of combustion efficiency
= The fraction of airborne carbon emissions thatare released as carbon dioxide.

The following results were recorded:

Table 7. Nominal and overall efficiency

Fuel/Stove	Nominal Combustion Efficiency %	Overall Efficiency %
Biogas	99.4	57.4
LPG	97.7	53.6
Kerosene	96.5	49.5
Wood	90.1	22.8

94. Comparable results recorded by TATA Energy Research Institute (TERI) can be viewed at www.teriin.org/renew/tech/biogas.

9. www.energv.demon.nl/GHG/stoves.htm

95. However, it should be noted that the overall efficiency of any cooking device is very much impacted by the ability of the user to apply the device correctly. It follows that end-user training is key to the successful execution of ICS programs at scale. In a society where generally women/ wives do most of the cooking in homes, the gender aspects of any large scale ICS program have to be considered. Even in households where the woman goes out to work, the house help who is hired to do the cooking and other household chores is a female. Female children are more inclined to helping their mothers with cooking especially in the evenings and on weekends when out of school.

96. Price is one of the major factors influencing the decision by a household to acquire an ICS. Keeping the price of the improved cookstoves low and affordable is still a challenge because of high production costs. The price of a small size ICS (charcoal based) is about shs. 15,000/= as compared to shs. 5,000/= for the traditional metal stove of the same size. Medium size improved charcoal stoves go for about 20,000/= to 30,000/= as compared to 6,000/= to 8,000/= for the traditional metal stoves of comparable size. It follows that the decision for a household to purchase an improved stove can an only be made after a thorough assessment of the benefits of the ICS.

5.2 Cross cutting Issues

5.2.1 Indoor Air Pollution (IAP) and Poverty

97. Indoor Air Pollution (IAP) IAP is the poverty issue linked to energy. There is a close relationship between the level of poverty and fuel choice (the energy ladder). Because of the high installation, operating and maintenance costs, very few Ugandans can afford to use electricity and gas systems for household cooking. This implies that the majority of the population (over 90%) has to settle for solid fuels such as wood and charcoal. Moreover, due to poverty, most of these people use rudimentary cooking appliances with incomplete combustion, resulting into the burden of indoor air pollution. As indicated in the EAC energy access strategy, reducing energy poverty is key to the achievement of the Millennium Development Goals. There is need to address the predicament of households which (because of poverty) have to bear the largely preventable disease burden resulting from the use of solid fuels on inefficient cooking appliances.

98. Approximately four (4) million deaths occur globally every year from effects of indoor smoke inhalation. (Global Alliance for Clean Cookstoves, year; UN Foundation, 2012). In Uganda, both rural and urban areas are confronted with IAP. Generally, women and female children are most at-risk to the health hazards associated with IAP as they do most of the cooking. The majority of the country population (56%) live in detached dwellings, followed by huts (26%) and muzigos (17%). In Kampala, muzigo is the dominant type of dwelling (64%). These are tenements which sometimes double as the living quarters and cooking places. Although cooking takes place on the verandas of the tenements during day, the charcoal stoves are usually moved indoors by night or in the case of rain. The population that dwells in huts in the rural setting has very much the same challenges. In addition to cooking and living in the same hut, it sometimes provides shelter for domestic animals and poultry as well (Uganda Participatory Poverty Assessment Report, 2004).

99. The traditional three-stone wood stove is the primary cooking device in the rural areas. Most of the cooking in the rural areas takes place indoors in detached kitchens, exposing the women and children to danger of inhaling smoke from the open fires. Urban households prefer using various types of charcoal stoves: clay, insulated, and traditional metal stoves, of which the traditional metal charcoal stove is the most commonly used. Higher income households often use gas and electric stoves. Ugandans enjoy a relatively uniform diet of traditional dishes such as steamed banana (matooke), rice, mingled maize meal (posho), cassava, beans, groundnuts etc., depending on the region and cultural setting. Meals are generally cooked 2-3 times a day depending on income, availability of fuel, and family size. In Kampala, meals are generally cooked 3 times a day: breakfast, lunch, and supper.

100. While traditional three-stone wood stoves are home-made, charcoal stoves are only available for sale in markets and retail shops or supermarkets. Rural households usually personally and freely gather their firewood, while urban households have to pay for both charcoal and firewood. Institutions such as schools and small and medium sized restaurants also have vast cooking needs. Most of them use firewood for cooking. Finally this has to be followed up with clear strategies for widespread promotion to create awareness of the mitigation options. Pronouncing the health benefits of improved cooking devices is a recommended paradigm shift in the promotional campaign to be spearheaded by the Ministry of Health and conservation agencies .

101. Because biomass will continue for several decades to play a major role in the economy of Uganda , investment in efficient, clean and less polluting biomass energy devices should be a priority if poverty eradication targets are to be achieved. The shift from traditional energy technologies to more advanced and cleaner alternatives is only gradual. It requires ample time for initial exposure of communities to new technologies, to be duly followed by the establishment of support structures such as technical staff and maintenance workshops to ensure sustainability.

5.2.2 Climate Change Issues

102. Inefficient cookstoves contribute to global emissions of greenhouse gases such as carbon dioxide and other short lived climate forcing agents such as methane, and black carbon aerosols, major contributors to current global warming (GACCA, 2012).

103. At the same time felling of trees for charcoal production and supply of fuelwood for institutional and industrial use is generally unsustainable and amounts to the removal of vital carbon sinks. The inefficient traditional methods used to produce charcoal release significant amounts of methane whose Global Warming Potential (GWP) is 21 times higher than that of carbon dioxide. The highly inefficient kilns used in wood to charcoal conversion amplifies the problem. These issues combine to make an urgent case to improve efficiency both on the supply side and demand side of the biomass value chain. The BEST will analyse the issues at both ends and provide recommendations for plausible interventions and options that mitigate climate change.

5.2.3 Social and Behavioural aspects and Choice of Technology

104. Uganda has a diversity of cultures whose household cooking behaviour differs considerably as do the staple foods consumed in different parts the country. For instance the preparation of a millet/sorghum bread meal enjoyed by people in parts of Eastern, Northern and South Western Uganda differs

significantly from that of the steamed and mashed banana (matooke) largely consumed in Central region. These differences have to be properly understood so that customised approaches targeting specific behavioural issues are designed and incorporated in the implementation framework for BEST.

105. The major issues in the design of well-functioning cookstoves is to account for site specific factors such as pot, fuel and food to be cooked, hence need to adapt to local socio-economic conditions. For instance in the rural setting, on site local construction of wood stoves allows the construction team to maximize performance by making design adjustments customised to address specific site issues. On site construction of stoves reduces transport costs and helps to meet site specific client needs. While training on construction is important, even more important is the ability to use the stove correctly and develop trouble shooting competence. These attributes are sometimes missed when cookstoves are manufactured in the urban centres and "dropped" in the rural household; in many cases such stoves end up in the corner of the kitchen as the household soon reverts to their three stone stove.

106. To achieve widespread adoption especially in the rural setting (85% of the population is rural) it is vital to have a critical mass of trained entrepreneurs in the different cultural settings. Improved cookstove production/construction is an income generating activity capable of growing into a full blown industry with well known down-stream benefits. Therefore, MEMD should train professional players who are ready to maintain industry-specific factors for the long term, rather than the conventional practice of training volunteer artisans. While it was necessary to have a starting point, time has come to move forward and have a fully developed and commercialized cookstove and fuel industry. It may not be advisable to train too many people who will not be able to adhere to quality and other standards that are necessary to have a thriving industry. A deliberate effort has to be made to attract large investments that will slowly bring on board the existing small scale enterprises for aggregated, quality controlled development. For instance having small enterprises acquire production and distribution franchises from large producers can provide a win-win relationship that ensures that both of them do good business producing and selling good quality products to a satisfied customer base for the long term. MEMD should actively encourage formation of stove entrepreneur associations. Biomass Energy Efficient Technologies Association (BEETA) is a step in the right direction but it requires core support to enable it stand firm and deliver meaningful reforms to the sector.

107. Pre-financing for market development and training is crucial. Only through facilitating investment at scale can the opportunities like carbon finance be accessed gainfully. There is great potential for attracting carbon finance in the cookstoves and fuels programs if the right industry reforms are undertaken to favour large scale investment.

108. MEMD has already taken steps to promote Renewable Energy Technologies (RETs) nationwide through trade fairs and the now popular Energy Efficiency Week. However, these initiatives have to be scaled up and conducted more regularly. As noted above, the approach has to change so that improved cooking devices are promoted primarily for their health benefit of mitigating IAP (a paradigm shift). The strategy should involve the Ministry of Health taking centre stage to include the use of ICS in the mitigation of IAP among the key health enhancement messages for dissemination through the health marketing programs. The model has worked for immunization, malaria prevention using mosquito nets, HIV/AIDS awareness raising

etc. It can work for Improved Cookstoves. A nationwide campaign with posters at every health centre and hospital would go a long way in changing the mindsets and breaking down cultural beliefs which are among the key barriers to entry especially in the rural setting. This intervention calls for special training programmes for the health workers across the board to internalise indoor air pollution and its mitigation. With proper recording and reporting in place, it will be possible to monitor the impact of the interventions over time.

109. In fulfilment of the objectives of the Energy Policy and the Renewable Energy Policy in particular, the Ministry of Energy and Mineral Development (MEMD) has been implementing a number of interventions in the biomass sub-sector. Emphasis has been on promotion of efficient use of biomass through promotion and dissemination of improved biomass energy technologies and initiatives to promote sustainable production of charcoal and utilization of animal waste. However, the scope of implementation of these activities has been limited.

110. In 2001, a draft for a National Biomass Energy Demand Strategy was prepared by MEMD, but was never adopted due to lack of stakeholder participation, neglect of the supply side and lack of dedicated resources. The implementation of projects and other interventions in the biomass energy sub-sector has, therefore, been on ad hoc basis and haphazard, with no proper strategy and plan in place. In spite of its enormous contribution to the country's energy balance, the sub-sector continues to be one of the least funded and least understood by top policy and decision-makers.

111. It is against this background that Ministry of Energy and Mineral Development (MEMD) with financial and technical assistance from United Nations Development Programme (UNDP) has developed a comprehensive Biomass Energy Strategy for Uganda. The strategy is intended to establish a framework for sustainable management and utilization of biomass resources in meeting the country energy needs. To facilitate biomass energy strategy development, MEMD sought the services of a team of national consultants to lead the development of a national biomass energy strategy.

5.3 Industrial demand Details

5.3.1 Artisanal Brick Making

112. Between 2005 and 2010 the number of houses built using baked bricks is estimated to have increased by 6% in the rural areas and 10% in urban areas (NHS, 2010 ; DHS, 2011). Based on these trends Uganda is estimated to be using about 6 million tonnes of wood in the brick burning industry.

113. However, it should be noted that the majority of the houses being constructed are for replacement or modification of existing houses from mud and wattle to burnt brick wall houses. This explains why there is still a significant shortfall of housing units in spite of the high rate of house construction.

114. All the baked bricks utilized in the construction industry are produced by individuals or small groups of artisans (Plate 3). The technology used is not only inefficient but also requires cutting of big trees (Plate 3) a process that is directly linked to deforestation and forest degradation. All brick makers visited presented fuelwood scarcity as their biggest challenge. Price of fuelwood has gone up as distance to source increase. All brick makers were worried about future wood supplies.

Plate 3.An example of logs used by artisanal brick makers

115. The high energy consumption is attributed to the technology and kiln size (Plate 4). Artisanal brick makers use the traditional clamp kiln where the furnace is filled with wooden logs and set on fire. Heat is transmitted through the bricks and through the slits between the bricks. The heat losses are high and there is no regulation of combustion air or draught. The technology lacks temperature control measures and thus wet wood (wood with high moisture content) is used as means of starting with low temperatures at the beginning of the baking process (some energy used to drive water out of the wood).

Plate 4.Left: typical kiln size in the villages, Right: slightly larger size in peri-urban areas

116. In rural areas brick kilns are much smaller than in peri-urban areas (Plate 4). Small kilns have higher surface volume ratio and thus have much higher fuel energy intensities. In rural areas, brick kilns are typically 4,000 – 6,000 bricks while in peri urban like Mukono kilns contains 20,000 pieces.

117. The above technology, it was found that on average, a brick of 2kg requires 1.3 Kg of wood. With the overall effect of high level of inefficiency, it is estimated that the brick industry requires 90 Peta Joules which is equivalent to 6 million tonnes of wood annually.

5.3.2 Tea industry

118. The tea industry in Uganda has been growing at a rate of 2-4% for the last decade with average tea production of about 35,000 tonnes per annum. Tea is heavily dependent on fuelwood (Plate 5). The old and well established Tea companies can meet 70% of their fuelwood requirements from own dedicated Eucalyptus forest plantations. The tea industry is currently estimated to consume 71,000 tonnes of round wood.

119. Though the Tea industry in Uganda has tried to improve on fuelwood energy efficiencies (1kg of tea requiring 1.5kg of wood compared to 2kg in other countries) there is still room for improvement like investing in chipping machines so that wood pellets are used instead of logs. This increases the exposed surface area thereby quickening the drying process and making it more effective. The resulting dry pellets combust much better, hence increasing the overall efficiency with which the fuelwood is used.

Plate 5.Fuelwood stockpile at a Tea factory

5.3.3 Small Scale Lime Production

120. Small scale lime production is among the heavy fuelwood user industry (Plate 6). Each tonne of lime requires 1.5 tonnes of wood. About 10% of the small scale lime production in Uganda use vertical shaft charcoal kilns while the rest (90%) use fuelwood either in traditional earth kiln (about 70%) or improved firewood kilns (30%). The artisanal lime industry is estimated to consume 270,000 tonnes of wood and 75 tonnes of charcoal annually. Interventions for improvement have to focus on upgrading technology for the majority to use improved kilns. Introducing alternative fuel options like briquettes could yield additional benefits.

Plate 6.Small scale lime production uses huge logs and tree stumps

121. The small scale lime producers in Tororo and Kasese are worried about future sources of fuel wood. In Tororofuelwood is sourced from as far as Idudi in Iganga, a distance of at least 80km. This is considered a long distance to transport fuelwood which has an energy content of only 15MJ per Kg.

5.3.4 Tobacco Sub-sector

122. The tobacco industry is the most energy intensive industries where by each kilogram of tobacco requires about 8 kilograms of fuelwood. Tobacco production has fluctuated a lot over the past years reflecting annual average production of about 25,000 tonnes with an annual consumption of 200,000 tonnes of wood. Improving burner technology, introducing biomass fuel alternatives, investing in chipping to use wood pellets instead of round wood are some of the plausible interventions for reducing consumption. Planting dedicated woodlots is an appropriate supply side intervention.

5.3.5 Sugar Industry

123. Sugar crop processing is energy intensive, requiring both steam and electricity. The energy is supplied as bagasse in the case of the cane processing. Originally (early 1900s) sugar factories intentionally used inefficient boilers as means of burning off excess bagasse. Later on cogeneration was introduced as a means of producing electricity.

124. Cogeneration is a process of producing both electricity and usable thermal energy (heat and/or cooling) at high efficiency and near the point of use. The combined generation of electricity and heat increases the total efficiency by nearly 50% as rated against separate production of electricity and heat. Cogeneration is a well-known process in the sugar industry and it is used in every single sugarcane mill. Practically every phase in sugar manufacturing (juice extraction, bagasse/pulp drying, juice purification, evaporation and crystallization) requires heat. The co-product of heat generation is electricity, which is also needed for lighting and running motors in the industry. Relatively low-steam-temperature installations generate sufficient electricity to meet the processing need of a plant. However, high efficiency boilers will not only provide sugar processing with cheaper heat but can also produce electrical output much higher than the internal processing needs(captive consumption). The excess can be exported to the national grid if the electricity market regulations and rules allow it, such as the case in Uganda.

125. Cogeneration and, hence, additional income revenues from electricity sales to the national grid may contribute substantially to the economic viability of the sugar sector. Kinyara has got a 14.5MW electric power facility and has plans to increase it to 35MW by 2015. Kakira commissioned a 52MW high pressure boiler plant in May 2013. Tilda has plans of installing 1 MW electric power plant that will utilize rice husks.

5.3.6 Sugar Jaggeries

126. Cane from out growers is over 1.3miilion tones per year (Table 8). It is estimated that 1% of out growers may be producing 45,00tones ofsukari- gulu.

127. Sugar jaggeries are estimated to consume 500 tonnes of wood and 2,000 tonnes of bagasse annually. The number of local processors engaged in this activity is on the increase. No studies have been done on how to improve efficiency of these artisanal producers of solid brown sugar / molasses mix (sukari-gulu). The consumption of the brown impure sugar concentrate as a substitute for molasses by local distilleries is also on the rise. Some dedicated jaggery operators in Eastern Uganda (mainly Busoga sub-region) grow their own sugarcane which they are not willing to sell to the mainstream sugar factories. There is room for improvement of the heating systems to increase efficiency and thus reduce consumption of biomass.

Table 8. Small out growers produce 1.3 million tones of cane

Sugar Industry	Source	Cane (tonnes/ha)	Ratoons (tonnes/ha)	Total (tonnes/ha)	Period in Months	Annual Production (tones/ha-yr)	Actual Production (tonnes)	Harvested Area (Hectares)
	Estate	106	5	112	20	67	538,705	5,072
Kakira	Outgrowers	103	5	108	20	65	862,760	8,416
	Average	104	5	110	20	66	1,401,465	
	Estate	92	5	97	18	63	381,224	4,153
Kinyara	Outgrowers	102	5	107	21	61	320,631	3,132
	Average	97	5	102	20	62	701,855	
	Estate	80	4	84	18	57	417,832	5,229
Lugazi	Outgrowers	80	5	85	17	61	142,505	1,767
	Average	80	5	85	17	59	559,337	
Total							**2,662,657**	**27,768**

5.3.7 Vegetable Oil Processing

128. Even as Uganda's vegetable oil production registers tremendous growth, demand for the product has continued to outstrip supply, forcing the country to rely on imports. Vegetable oil demand has continued to outstrip local supply due to unmatched growth in production resulting from a drop in output of cotton seeds - one of the main sources of the product. Efforts to diversify the raw material for cooking oil production through the use of vegetable oils and fats have not helped to correct the deficit. According to millers, the slow growth in production is hinged on a number of factors including poor seed quality, lack of sufficient and available varieties of raw material, high operational costs as well as uncontrolled markets

129. Sunflower, mainly grown in Northern and Eastern Uganda has helped to shore up production even as cotton seeds continue to dwindle. Currently it is estimated that between 500,000 and 900,000 metric tonnes of the grain are harvested annually and consumed mainly by BIDCO, Mukwano Industries, AK Oils and Fats, Rafiki Industries and Mount Meru among others.

130. 40,000 tonnes of oil are estimated to be produced annually consuming 170,000 tonnes of agricultural wastes and 75,000 tonnes of wood. Introduction of industrial grade briquettes and matching burner technology is a plausible intervention which could eliminate the use of fuelwood in the oil processing industry.

5.3.8 Fishing Industry

131. The fishing sector has been important to the Ugandan economy as a foreign exchange earner. With the liberalization of the economy and the establishment of a conducive investment environment in the fishing sector, the country experienced an increase in the fish volumes particularly for export. With the increase in the number of fish exports and the increase in the local demand for fish coupled with the inadequate regulation of fishing activities, the volumes caught began to spiral downwards. For the catch of fish reached its peak in 2004 and started declining until 2007 (Figure 4).

Fish production trends by lake body from 2003-2009

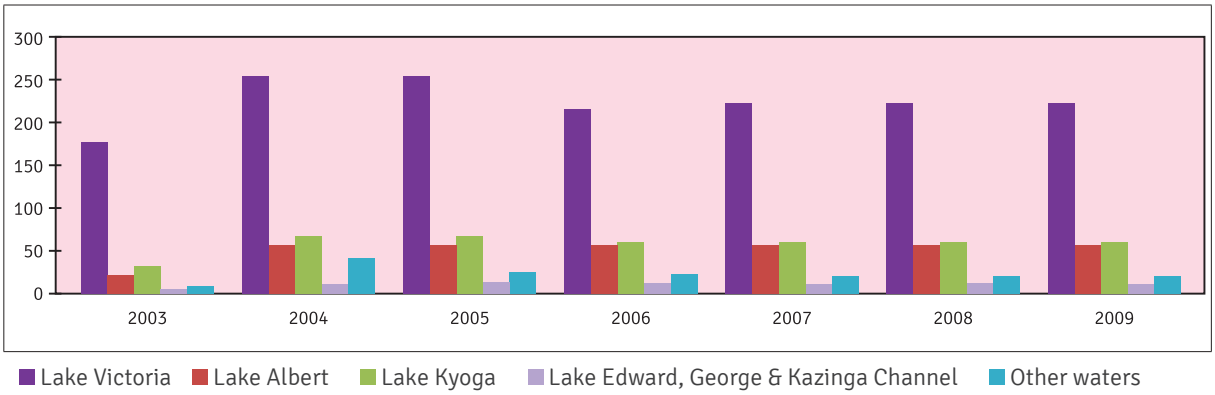


Figure 4.Uganda' fish catch trends by lake body, adopted from UBOS / NPA- adopted from PSF- (A synopsis of Uganda's private sector growth challenges and proposals for policy reform-2012

132. According to MEMD (2009) (Energy for Rural Transformation productive use of traditional fuels in high energy consumption SMES) 20% of fish landed in Uganda undergoes one of the four traditional fish processing methods which are sun-drying, salting, frying and hot smoking. Thus, it can be assumed that 5% of total fish landed in Uganda is smoked. It is important to note that a certain per cent of the remains of the fish (Mugongowazi) that is processed for the international market is also smoked and sold locally. Some is informally exported to DRC.

Plate 7.Plate 6.Traditional pit kiln. Source: MEMD, 2009.

133. It is estimated that about 20,000 tones of fish are smoked annually using both pit kilns (70%) and improved kilns (30%). Pit kilns (plate 7) and improved kilns have fuelwood energy intensity of 1.2 kg and 0.4 Kg per fish respectively. Fish smoking is estimated to consume 22,4000tones of wood annually.

5.3.9 Cement Industry

134. The cement manufacturing process demands a lot of thermal and electric energy. Thermal energy is required to raise the temperature of the rawmeal mixture (powdered mixture of limestone and clay) to about 1300oC for the cement compounds to form (clinker). Tororo cement factory has switched from furnace oil to coal, also a fossil fuel which has to be imported from South Africa. Current production at the plant stands at 1.4 million tonnes of cement annually, consuming 150 tonnes of coal daily. Plans are underway to replace 35-40% of this quantity with biomass starting next year.

135. Hima has switched from furnace oil to use of coffee and rice husks. To ensure sustainable supply Hima is investing 1.53 Billion Ugandan Shillings (UGX) to boost coffee production which in turn increases the quantity of coffee husks used as an alternative fuel for burning clinker at the new line and to improve the livelihoods of households through increased incomes. Under the arrangement, Hima will provide 42,000 farmers with around 14.2 million seedlings in three phases. Hima has been using furnace oil to burn raw materials to form the key product clinker; however, due to innovation at the plant, Hima started using coffee and rice husks as alternative fuels which are part of the carbon cycle unlike Heavy fuel oil.

136. Introduction of this project will provide Hima with regular supply of coffee husks, a raw material for producing alternative fuels which guarantees that Hima products shall be produced under friendly environmental conditions because it greatly reduces on carbon emissions. The plant is currently estimated to be producing 850,000 of cement annually consuming about 80,000 tones of agro-wastes.

5.3.10 Textile Industry

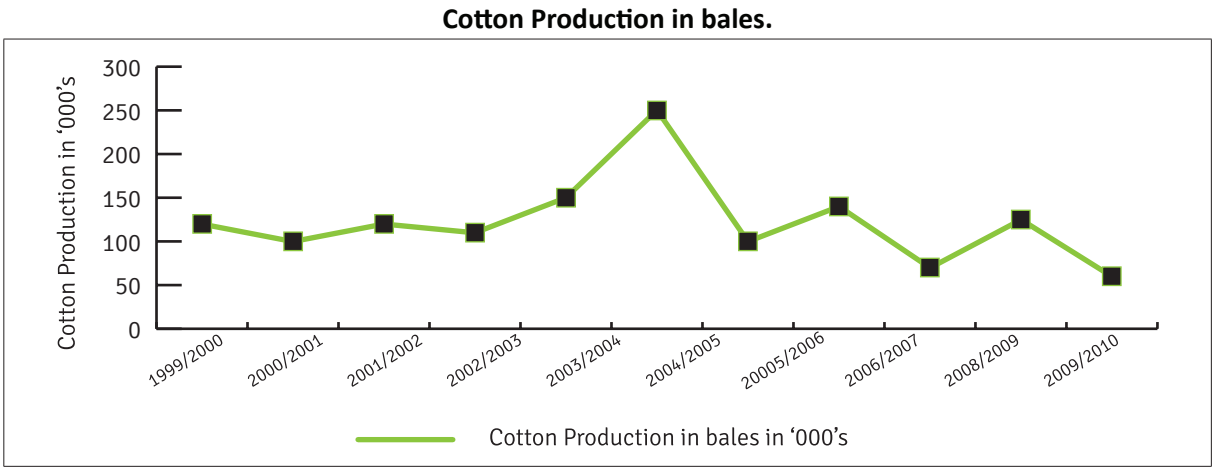


Figure 5.National cotton production, in bales

137. Uganda has potential of producing 1,000,000 bales of cotton a year but the highest production it has attained in recent years is only 254,000 bales (Figure 5). Most of the textile industries such as Mulco Textiles in Jinja, African Textile Mills (ATM) in Mbale and Lira Spinning Mill in Lira are non operational. Only Southern Range Nyanza Limited and Phoenix Logistics Limited are operational but operating below capacity (15,000 bales per annum) out of target of 50,000 bales.

138. Energy is the highest operational cost (20% of the production cost) aggregating to at least Uganda Shillings 3.5 billion annually. It is against this background that a company like Southern Range Nyanza Limited has switched to agro wastes. Southern Range Nyanza Ltd has been involved in textiles and printing for the last 17 years. It produces a range of textile fabric and paper products. The plant uses large boilers of capacity 4-10 tons with a total power rating of 4 million kilocalories per hour. This power was until 2005 generated by burning heavy fuel oil (a fossil fuel). However, for the past eight years, modifications have been made to enable the use of biomass in the form of agro-waste, thereby phasing out the use of fuel oil. The agro-waste utilized includes coffee husks, cotton husks, maize cobs and groundnut shells. Current consumption stands at 35 metric tons per day, 1,300 tons per month or a total of 17,000 tons annually.

139. The company's future plan is to generate power for own use from renewable sources such as solar and wind. There is also a plan to utilize the biodegradable effluent from the processes to generate biogas which will be burnt to power thermal generators. This is intended to minimize losses and equipment failure risks caused by the frequent power cuts/ fluctuations. A major challenge the company faces is maintaining regular supplies of the agro-waste.

140. The seasonal production systems of the local farmers affects the supply of the agro-waste, leading to significant price fluctuations based on availability. To counter this challenge, the company proposes to support groups of entrepreneurs with demonstrable potential to produce large volumes of un-carbonized biomass briquettes of acceptable quality.

5.4 Commercial Enterprises demand details

5.4.1 Bakeries

141. The bread ovens in the majority of bakeries are traditional ovens designed and built by artisan oven builders according to tradition. Apart from being inefficient, their efficiency varies from producer to producer, from bakery to bakery and also depends on the operator (MEMD, 2009).

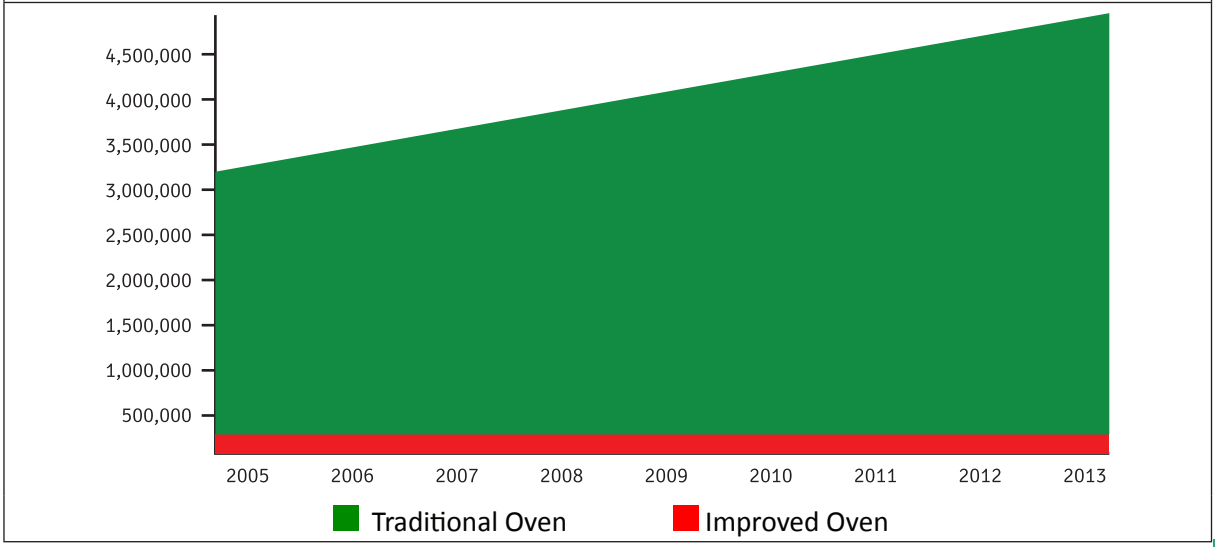
142. The typical bakery in Uganda has two or more ovens, each with 6 -8 baking chambers in two decks. The furnace and the oven is brick-build (MEMD, 2009).The furnace is located outside under an open shed or in open connection with the inside of the bakery. The furnace is fired through an open fire hole withoutdoors or dampers to regulate supply of combustion air. Wood is fired in whole logs sticking out of the opening and pushed inside the furnace as they burn rendering the oven very inefficient.

143. Unimproved bakeries are energy intensive. In these systems 2 Kg of firewood are needed for baking every kilogram of bread. Consumption reduces to 1.25 kg of firewood for baking smaller loaves. Similarly 1.6 kg of wood is needed to produce a range of confectionary. This rate of consumption calls for urgent intervention given the high demand for bread.

144. Plausible interventions include technology upgrades to improve burner efficiency and fuel switching to introduce alternatives like briquettes instead of fuelwood.

145. On average Uganda imports about 360,000 tonnes of wheat per annum (i.e., less exports or wheat in transit to neighbouring countries). About a third of this wheat is assumed to be used in the confectionary industry to produce bread and an assortment of several types of confectionary. It has been assumed that 70% of bakeries in Uganda use the inefficient kiln described above. It has also been assumed that 25% of the bread and other confectionery uses improved while 5% uses electricity (mainly the new super markets in Kampala). Total fuelwood energy consumed in the confectionery industry is estimated at 4.7 million GJ equivalent to 313,000 tonnes of wood (Figure 6).

Figure 6 Wood consumption in Bakeries (15GJ/tone of wood)



5.4.2 Hotels, Restaurants and Bars

146. Large hotels consume energy in the form of LPG and electricity for cooking and water heating purposes. The use of biomass is limited. On the other hand, Restaurants, Fast Food points and commercial food vendors are a major consumer of biomass in the form of charcoal and firewood. Roadside vendors for barbequed stuff and chapatti dealers also largely consume charcoal. They are widely spread in the urban centres and rural based trading centres. Most of the operators in this sub-sector use traditional metal stoves, some of which are so big that about 5Kg of charcoal is needed at each filling. Kampala alone is estimated to have over 10 thousand commercial food vendors. For a deeper understanding of this sub-sector, we recommend a detailed study possibly by UBOS in collaboration with municipalities.

147. The estimates presented in this report are based on registered hotels, restaurants and eating places which are about 35,000. Each of these places is estimated to have an average of 3 stoves (charcoal and fuelwood mixed). Thus the estimate is based on three devices each. About 200,000 tonnes and 50,000 tonnes of fuelwood and charcoal respectively, are consumed annually in this industry.

148. Given the largely entrenched user behaviour, the most plausible intervention in this sector is improving efficiency through dissemination of improved technologies. Improved cookstoves and barbeque systems of comparable size/capacity have been designed but their production levels remain far below the demand. Deliberate effort to increase investment in the supply of improved commercial cooking technologies is highly recommended.

149. This intervention faces some constraints, though. In addition to the obvious capital constraints to increase production the sheer expanse of the sector is prohibitive. The vendors are spread all over the country and a good outreach plan has to be designed involving all the stakeholders in their various local settings and capacities.

5.4.3 Traditional Breweries and Local Distilleri

150. In 2005, the World Health Organisation ranked Uganda as the leading consumer of alcohol in the world. According to the 2004 World Health Organisation report per capita consumption of alcohol in Uganda was estimated at 19.5 litres which translates into 300,000,000 litres of alcohol. Although the report does not give categories of alcohol it gives an indication of the volumes involved.

151. Three biomass energy intensive alcohol (local gin) processing categories are considered and these are; Distilling molasses into local Gin, commonly known as Nkangari or Waragi (from sugar factories and those locally made sukariGulu), distilling of banana beer to local gin commonly known as Kasese, and local brew made out of millet and sometimes maize (malwa).

152. The 2009/10 Agriculture survey statistics indicate that 243,000 tonnes of banana beer are produced annually (UBOS 2009) in various parts of Uganda but mainly in Kibaale district. Based on production ratios established during the field surveys it is estimated that local gin distilled out of these bananas is 6.8 million litres.

153. It is also estimated that 76,000 tonnes of molasses are produced annually by sugar factories (93%) and jagerries (7%). All molasses in Uganda are currently distilled into local gin using highly inefficient technologies. Locally produced molasses are estimated to produce 27,000 Cubic meters (27 million litres) of alcohol.

154. Distillation of local brew (Waragi) from molasses is said to be the major economic activity in the area which is about 10 km from Kakira Sugar works. The process involves heating several locally fabricated boilers on three-stone open fires using firewood. The consumption of firewood is very high and the crude process leaves a lot of room for improvement. For instance improved stoves would greatly reduce the consumption at each distillation unit. Additionally, utilizing larger capacity boilers would reduce the need to heat several units on separate three-stone fires.

155. According to the entrepreneurs interviewed, the cost of firewood had risen too high and it was affecting their profit margins. It takes four days to distil about 2,000 litres of the local brew (Waragi). The quantity of firewood used is 3 truckloads at a total cost of UGX 750,000. All the firewood is harvested from forests as far as Mayuge (about 30 Km away). The entrepreneurs notice the scarcity and they welcome assistance towards planting their own woodlots.

5.4.4 Improved Distillery – Buwembe Breweries Ltd - Jinja

Buwembe Breweries is designed to produce alcohol for human consumption. The company processes molasses into a 95% ethanol concentrate which is sold to local entrepreneurs for onward dilution and packaging. The plant produces 25,000 litres of the ethanol every month, using 4-5 lorry loads of dry firewood. The wood burner is well aerated and efficient, being used to heat a boiler for steam generation. By comparison, it utilizes one third of the firewood consumed by the local distilleries at Magamaga while at the same time saving a third of the time it takes for the locals to produce the same quantity. According to the Plant engineer at Magamaga, the burner can consume other forms of biomass as fuels including briquettes and agro-waste. It can also burn waste plastic bottles with equal efficiency. The company has contracted a local fuel wood supplier who harvests from various eucalyptus plantations. All the firewood seen at the factory was of the same quality.

156. This is an indication that as the demand for fuel wood increases, a commercialized supply chain is evolving on the periphery of large scale consumers. With sufficient support this level of entrepreneur can be mobilized to produce large quantities of fuelwood from renewable sources. There should be deliberate efforts to link this kind of entrepreneur to the potential buyers and thus catalyse adoption.

157. Present technology employed in distilling the local gin has a fuel intensity of ranging from 6 to 1.25 Kg of wood per litre of gin produced. Local gin production is estimated to consume 180,000 tones offuelwood.

5.5 Institutional Demand details

5.5.1 Educational Institutions

158. Uganda has a got 23,000 registered educational institutions with a total population of about 9.5 million pupils. The majority of these (over 85%) are in primary schools. Education institutions heavily rely on fuelwood for cooking. All educational institutions combined are estimated to consume 25.9 Peta Joules equivalent to 1.7 million tonnes of wood annually (Figure 7).

159. A mid-term evaluation by MEMD (MEMD 2007) found out that only a few schools had an improved cooking system. The ministry estimates the number of improved institutional stoves to be only 1,500.

160. Introduction of improved Institutional stoves can see fuel energy requirements reduced by half of the current consumption while at same time providing a clean and healthy cooking environment. With the right model of institutional stoves, this intervention can be made even more effective by switching from fuelwood to uncarbonized briquettes.

5.5.2 Prisons

161. Uganda Prisons is estimated to have an average of 37,000 inmates. A mixture of stoves with varying energy intensities are in use. With the help of German Technical Services (GIZ), the Uganda Prison Service has set up 38 institutional rocket stoves and matching saucepans in 31 government prisons to cut down on the cost of wood fuel for cooking. Fuelwood intensity of improved stove is estimated to be 125 kg while the traditional system is estimated at 250Kg of wood per person per year. With this approach it is estimated the prison service is saving up to one million shillings per month. Currently, total fuel energy consumed in Uganda prisons is about 5,435 tonnes of wood. Prisons department has plans of installing energy saving stoves in all the 100 prison units.

5.5.3 Hospitals

162. Information on biomass energy in hospitals is scanty. The country is estimated to have 13,300 beds (UBOS, 2011). Total annual consumption is estimated 1,900 tones of wood.

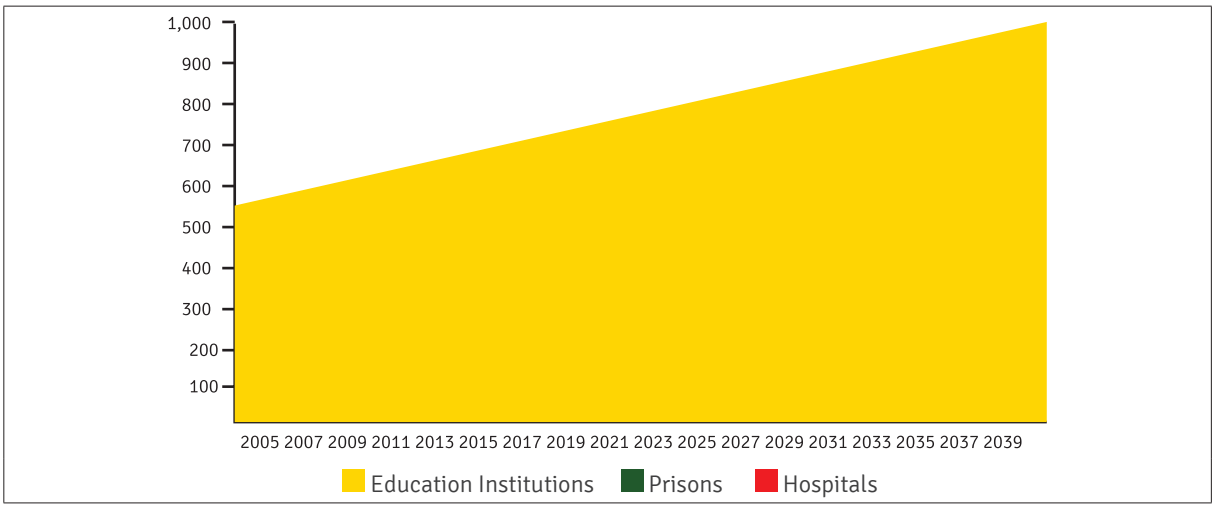


Figure 7.Biomass demand among institutions

6 BIOMASS SUPPLY DETAILS

6.1 Land use change and Biomass Assessment

163. In Africa and the rest of the developing world where fuelwood to is a major source of energy, periodic biomass assessment provides vital information for planning. Tree biomass is also an important indicator of land use and land use change and is a critical input to the development of climate change mitigation policies such as REDD+. Carbon budgeting is another important area that requires biomass monitoring.

164. In the last 100 years Uganda's forests have faced severe pressures mainly from agricultural conversion as a result of population increase, urban demand for charcoal, over grazing, uncontrolled timber harvesting and policy failures. The forestry cover has shrunk from over 10 million ha in 189010(FAO) to slightly less than 5 million Ha in 1990 and 3.6 million ha by 2005 (Table 9).

165. Between 1995 and 2005, the highest levels of degradation were outside protected areas and in the woodlands and Tropical High Forests of Kibale, Kagadi, Kyangwari (NFA 2005).

Table 9: Deforestation in Uganda

Date	Forest type	Size (ha in 106)	Authors
1890	THF and woodland	10.8	FAO, 1997, 2001
1995	THF and woodland	4.9	FD, 2003
2005	THF and woodland	3.6	NFA, 2005

10 Most likely through modelling based on conditions that could have supported forest growth at that time.

166. About 30% of central Uganda is burnt during the dry months of January and February as evidenced by MODIS satellite imagery below. The fires are commonly seen in the woodlands of central Uganda (Mubende, Hoima, Masindi) and northern Uganda (Figure 8). It is interesting to note that fires also occur in farmland areas, as well as in Tropical High Forests of Elgon, Rwenzori plus Bugoma and Budongo. The impact on the vegetation by these fires depends on intensity and frequency.

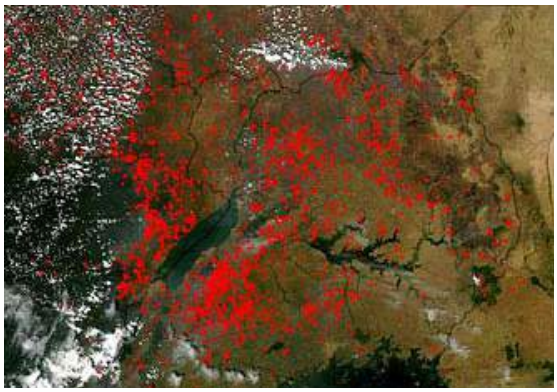


Figure 8: Wild fires as seen on MODIS satellite imagery (red dots show fire incidences)

167. A series of biomass inventories throughout Uganda from 1993 up to 2006 showed that where deforestation is as a result of agriculture expansion, the trend is that biomass (forest cover) gradually reduces to almost zero before it regains to a level where biomass supply is in equilibrium with the local needs such as supply of fuelwwod, construction poles, fruits etc.

The big difference, however, is that woody biomass formation and species composition change from natural to woodlots and scattered

trees of exotic or naturalized species. This trend is explained by Mather (1992) and Hosonumaet al. (2012) in the Forest Transition (FT) concept where the decreasing and expanding forest cover in many developed countries and subsequently tested in several developing countries (Rudel et al 2005, Kauppi et al 2006) was found to follow an inverse J-shaped curve over time (figure 22).

168. Putting the forest transition curve into Uganda's context many major charcoal producing areas especially the woodlands of central Uganda and some islands on Lake Victoria may be considered to be in the early forest transition stage which is characterised by having forest cover that is greater than 15% and rate of deforestation is at an increasing rate (phase 2 in Figure 9).

169. However some few areas like Bushenyi and some isolated areas in central regions may be considered to be in post transition stage where by the biomass supply is in equilibrium with demand. In such areas trees are considered as a crop and are thus established for commercial purposes.

170. What is happening in areas like Bushenyi and neighbouring Rwanda is evidence that with proper interventions, attitude and perhaps change of mind-set deforestation in parts of Uganda may eventually be halted and possibly up to the stage when biomass starts to increase again.

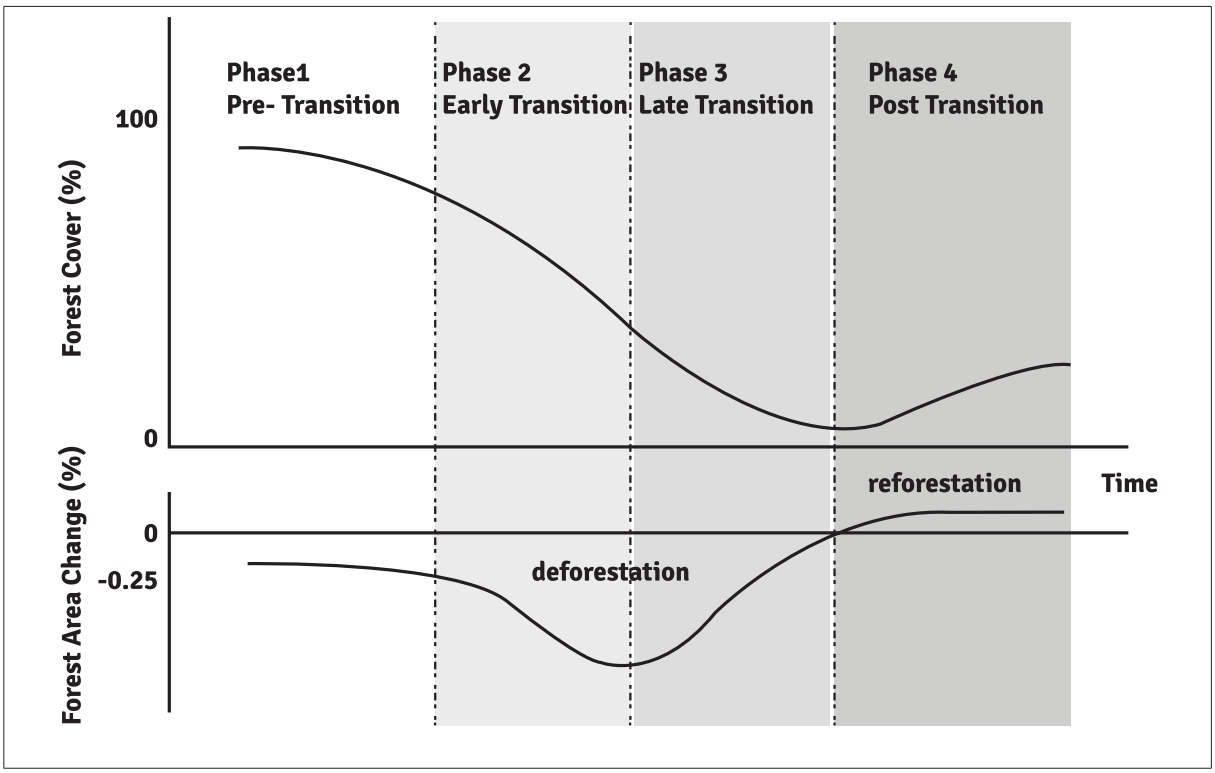


Figure 9. Forest transition curves

6.2 Biomass stock, increment, availability and allowable cut

6.2.1 Biomass stock

171. Biomass stock refers to total standing stock or weight of woody biomass (including branches and twigs) normally expressed in tons per hectare. On an annual basis, this includes vegetative growth (increment) within that year. Many traditional forestry inventories present wood quantities in terms of cubic metres of stem volume (or merchantable volume) per hectare. For woodfuel purposes, both stem wood volume and branch volumes are normally converted into weight (dry weight or oven dry weight). Weight is then derived as a product of stem volume, wood density[11] and biomass expansion factor.

6.2.2 Estimating Increment

172. In forestry, two methods of estimating increment are commonly used. One is known as Current Annual Increment (CAI) and another one is known as Mean Annual Increment (MAI). How increment is estimated is very important because it has a bearing on deriving the fraction of Non-renewable Biomass.

- CAI; Refers to increment in a year of reference
- MAI; Mean Annual Increment (MAI) is the averaged growth over a rotation period of a forest. It is derived as total volume of biomass at a desired rotation age divided by that age. Rotation age varies from forest to forest but generally refers to the age that would be most beneficial to harvest the forest.

173. In uneven aged, mixed species woody formations like most vegetation types in Uganda it is more meaningful to use CAI for the following reasons;

- The age of trees in these natural forests is not known and there is no clear set rotational age.
- Species are of different age, different sizes and for woodfuel purposes they can be harvested at any age
- There is a lot of ingrowth both from sprouts and regeneration from the forest floor and thus increment is a summation of growth from all these different components. Thus, unless a new term is formulated, CAI seems to be more appropriate.

6.2.3 Estimating Allowable Cut

174. The Annual Allowable Cut (AAC) or harvestable biomass is the amount of wood permitted to be harvested in a given area within a one year period without degrading the forest's (or any woody formation's) ability to maintain its sustainability and productivity. Determining AAC is very comprehensive, usually taking a couple of years to complete- the process now being speeded up with the aid of computer models. The principle behind AAC is that that what is harvested in a year should not exceed what the given vegetation type is able to replenish by itself through annual increment and ingrowth i.e., CAI or MAI in forest plantations with a known rotation age.

6.2.4 Biomass availability

175. Biomass supply is discussed in the context of the biomass fuel needed. For example sugar cane plantations have very high stocks of biomass of over 50 tonnes per hectare but this biomass is only available to the sugar

11 Air density is more relevant for woodfuel purposes. Basic density is important when the aim is to estimate oven dry biomass and later on carbon.

industries that have the facilities to crush cane and process it into sugar and bagasse.

176. Likewise biomass in form of vegetal wastes like maize stalks, cotton stalks, sorghum stalks or bushes and thickets like Lantanacamara, Rhusvulgaris, Securinegaviroa, Harizoniaspp, etc., may not be usable for charcoal production but could be an important source of biomass for the briquetting industry.

6.3 Sustainable Biomass Supply form Traditional Sources

177. Until recently, biomass consumed by rural households for their energy needs and construction of shelter has been in many places gathered freely and some of it may not enter into Uganda's monetary system and is considered non-monetary. This usage forms the bulk of the biomass such that substituting it with other forms of energy (e.g., petroleum products) would have big implications on Uganda's foreign exchange reserves and balance of trade. This biomass is supplied from subsistence farmland as a mosaic of crops, fruit trees, bush, grassland (open and wooded), and pockets of forest remnants or woodlots of exotic or naturalised species mainly pine and eucalyptus (Plate 8). Only a fraction of this biomass may be used for domestic fuelwood needs. A substantial portion of biomass may be for other purposes like fodder and shade trees (e.g., ficus), fruits (e.g., jackfruits and guavas) or ornamental (e.g., casuarina species). To get an understanding of the impact biomass extraction has on the stock, it is conventional to compare amount taken out with what the resource can potentially add on (increment). In uneven age mixed species like Uganda's farmland and forests, using Current Annual Increment (CAI) is considered more realistic.

178. Net annual productivity of subsistence farmland in Uganda varies greatly from region to region. Productivity in wet areas with deep humic soils may be significantly higher than in semi-arid sandy loams. In addition, tree biomass in areas that practice agro-forestry systems may generally be higher than in areas that predominantly grow cereals in open gardens with no tree cover.

Plate 8: Banana woodlots, fruit trees and bushes in Uganda's subsistence farmland

179. Woodlands and areas under subsistence farmland are important sources of tree biomass each being able to sustainably 13 million and 8.9 million tones annually (Table 10). Farmlands are important sources of tree biomass than other vegetation types because this is where people are settled.

Table 10. Tree biomass and what is considered sustainable in various vegetation types

Land use / cover	Area Private+ (Million Ha)	Biomass Stock (Million tone)	Allowable harvest (Million tone)	Available for energy (million tone)
Broad Leaved Plantation (old)	0.02	1.6	0.2	0.1
Coniferous Plantation (old)	0.01	0.4	0.1	0.02
New Afforestation efforts	0.1	2.0	1.2	0.2
THF on Private Land	0.3	40.0	2.0	0.6
Degraded THF on Private Land	0.2	18.8	0.9	0.3
Woodland	3.2	89.4	13.4	13.4
Trees in Bush land	1.1	13.1	1.3	1.3
Grass land (including wet)	4.0	29.7	3.0	1.5
Subsistence Farmland	8.3	89.0	8.9	8.9
Total	17.2	284.1	31.1	26.3
Average % growth and available			11%	9%

All biomass in National parks excluded, a small fraction of biomass in forest reserves included

6.4 Sustainable Biomass Supply from non-traditional sources

180. Vegetal wastes (or residues) are not preferred as fuelwood. Residue collection is time consuming, and it burns fast. Extensive use of this fuel source should be seen as a symptom of shortage of other and more proper types of woodfuel sources. Removing too much of the residues will deplete the soil and might thus contribute to land degradation and thus only 50% of the agricultural residues may be regarded as harvestable (NBS, 1992).

181. In 1990-1992, NBS carried out a study on some commonly used vegetal wastes (NBS 1992). Stalk densities and moisture content used are based on NBS (1992). Commonly used vegetal wastes in rural areas are cassava stems, maize stalks, sorghum stalks and coffee prunnings.

182. With regard to agricultural residues only crop categories found to be commonly used as fuel are included. Data on vegetal waste or residues are in most cases lacking. Therefore, the data for residues is derived by calculating the production figures of each crop with appropriate conversion factors (residue to crop production).

183. Vegetal waste estimates are done at two levels. At level one is the assessment of material left in garden mainly in form of stalks (table 11). The second level of assessment is material that is as a result of grain processing mainly in form of husks, shells and cobs (table 12). Material left in gardens is what is sometimes used by rural households to supplement woody biomass.

Table 11.Vegetal waste of major crops at - at garden level. Harvestable estimated at 50% of available

Crop	Area (Ha)	Available air- dry tons/ ha/ yr	Harvestable*
Sorghum	328,000	3	492,000
Cassava	1,000,000	5	2,500,000
Coffee	600,000	1.5	450,000
Maize	1,539,000	3.7	2,847,150
Total			6,289,150

184. Harvesting 50% of available vegetal wastes at garden level generates over 6 milion tones of biomass fuel (Table 11). Agro processing is normally done at village collection centres, in small trading centres and towns. Common vegetal wastes at processing level are maize cobs, groundnut shells, coffee husks, rice husks, sunflower seed cake and palm shells. Forestry operations like conversion of saw logs to timber and carpentry operation produce various types of vegetal wastes. The mentioned processes are estimated to produce over 1 million tones of vegetal wastes (Table 12).

185. Banana pills are produced both at garden level and in household level rural and urban. Banana pills can greatly and easily become an important source of energy especially in urban area once the smoke element is handled

Table 12.Vegetal wastes at processing level

Crop	Annual Production (Tons)	% VW	VW (Tons)
Maize cobs	2,400,000	30%	720,000
*Coffee husks	200,000	50%	100,000
*Ground nut shells	245,000	20%	49,000
*Rice husks	191,000	20%	38,200
Sun flower	50,000	20%	10,000
Palm shells	210,000	20%	42,000
Cotton seed (147,000 bales)	25,000	140%	37,004
Banana pills			
Sub Total			996,204
Saw dust, wood shavings	350,000	5%	17,500
Forestry operations	560,000	30%	168,000
Total			1,181,704

186. Supply of bagasse is generally considered sustainable a part from the new jagerries that do not own any sugar cane plantations. It is estimated that over the years, the Ministry of Trade and Industry has licensed 15 jaggeries for sugar production that do not own any cane plantation. This may have a big negative impact to industries that rely heavily on out growers and have invested heavily in electricity generation facilities

187. In 1995, bush was estimated to constitute 22% of woodland and 12% of both farmland and grassland. Vegetation mapped as bush was estimated to be 64% of bush. Though this data set is close to 2 decades old, we do not expect bush to have decreased. On the other hand, field observations show that in many instances, bush cover has been increasing as tree biomass decreases. Annual harvestable bush was estimated as a product total area of cover, per cent cover and annual harvestable stock. Average bush stock is estimated at 12.5 tones (NBS. 1992) with allowable cut 30% to 50%. Bush has potential to supply about 10miilon tones of biomass annually on a sustainable basis (table 13).

Table 13. Allowable cut bush

Vegetation Type	Per cent bush	Area (Ha)	Annual harvestable
Woodland	22	2,686,715	2,386,351
Bush	64	1,117,114	2,841,306
Grassland	12	3,223,910	1,660,306
Subsistence farmland	12	7,895,213	3,625,607
			10,513,570

188. Usage of these fuels is not popular but quantities are not well known. The UBOS DHS, 2005 and 2010 indicate that very few households (0.2-0.3%) use straw, shrub or grass. However many studies indicate that over 50% of fuelwood pieces used in rural areas are within the range of what many biomass inventories would not categorize as trees. These pieces of fuelwood could be from tree branches or shrubs or even herbaceous plants- rarely quantified and difficult to quantify in biomass assessments. There is need for forest inventory specialists to work closely together with agencies like UBOS so as to get a common understating on usage of terms like tree, bush and scrub. This will improve in comparing demand data and supply data.

189. Use of biofuels, peat, papyrus, grass and forbs is very minimal in Uganda. The potential to be used for energy purposes could be much higher than presented in table 14. For example there is a proposal to generate 200MW from dedicated plantations of reeds / grass.

Table 14. Potential supply form biofuels, papyrus, grass and forbs in million tons or million M3

Vegetation Type	
Papyrus and reeds	
Grass, forbs	1
Peat	<1
Biogas based on animal waste (M3)	<1
Biogas based on human waste mainly institutions (M3)	1<
Biofuels e.g., ethanol, bio diesel (M3)	1.2

7 BIOMASS SUPPLY / DEMAND CENARIOS

7.1 BAU demand compared to demand with Interventions

190. The urban households largely consume biomass in the form of charcoal for cooking, although there are still some few households that consume firewood. The tendency to adopt alternatives like carbonized briquettes is on the rise. Some households also keep a kerosene stove but this is usually used to cook quick, light meals. The more affluent households have advanced further on the energy ladder to include alternatives like LPG in their household energy mix. The consumption of charcoal is said to be growing at the same rate as that of urbanization which is about 6% per annum. The choice of the fuel type in the urban setting is influenced by the convenience to handle, availability and finally the cost. This tends to explain why firewood is not the obvious choice much as it is cheaper as compared to charcoal.

191. Total charcoal consumption under BAU scenario is expected to reach 2.5 million tonnes of charcoal annually by 2040 equivalent to 22.5 million tonnes of wood.

192. One of the ways of curbing such a high demand would be to increase the use of efficient charcoal stoves mostly in urban households and in commercial enterprises.

193. Two scenarios of stove penetration have been tested and the results show that increasing the share of improved stove to 15% and up to 70% in years 2015 and 2040 respectively (low improved charcoal stove scenario in Figure 10 has very low impact. In order for improved stoves to have a significant impact their usage need be scaled up to 30% by 2015 and gradually be increased 90% by 2040. Such an intervention would reduce charcoal demand to 1.9 million tonnes by 2040 and thereby make wood savings of close to 5 million tonnes annually (improved charcoal stove scenario in Figure 10).

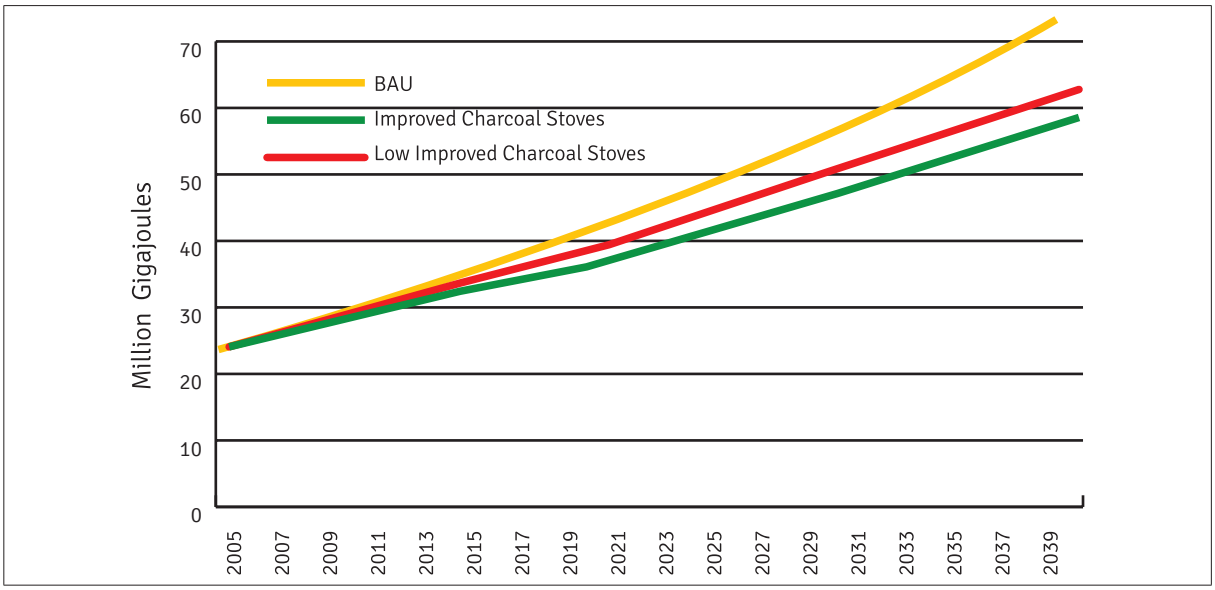


Figure 10: Impact of low and high improved charcoal stove penetration rates (1 tonne = 30GJ)

194. Under BAU scenario total wood demand is expected to reach 75.6 million tonnes (annually) by 2040. A small fraction of this is attributable to non-energy purposes like timber, poles, fencing posts. It is proposed that improved fuelwood stoves should not be based only on the gains resulting in energy savings but consideration should be given to general improved living conditions in terms of avoidance of indoor air pollution, ability to use inferior fuels (e.g., the gasifier stove) and ultimately less time needed to gather wood. In fact the LORENA stove which is the most highly adopted improved stove in rural Uganda may not be very efficient depending on the liners that were used. The chimney that takes away smoke and creates a more comfortable cooking environment makes this stove very popular.

195. Under BEST it is proposed that a strategy of partnering with the Ministry of Health in promoting use of improved fuelwood stoves in rural areas be adopted. This would easily fit in the Global Initiatives to curb in-door air pollution which fall under the docket of Ministry of Health. The Ministry has developed a strong marketing programme and as such it would be easy to add a component like avoidance of indoor pollution.

196. Overall, massive promotion of improved cookstoves and other efficient biomass technologies is necessary to address the invisible problems associated with mindsets at various levels. The approach used in the development of BEST is intended to bring the whole nation as one people on board such that all communities in their diversity and different levels of sophistication can comprehend, identify with, embrace and own the Strategy and support its successful implementation. The sustainable use of the biomass resource in Uganda is presented as a responsibility for every citizen.

197. A test on an intervention that would deliver substantial impact shows that increasing share of RORENA stove to 20% and 80% in 2015 and 2040 respectively wood reduce fuelwood demand to 69.9 million tonnes thereby saving about 5 million tonnes annually (improved rural stove scenario in Figure 11).

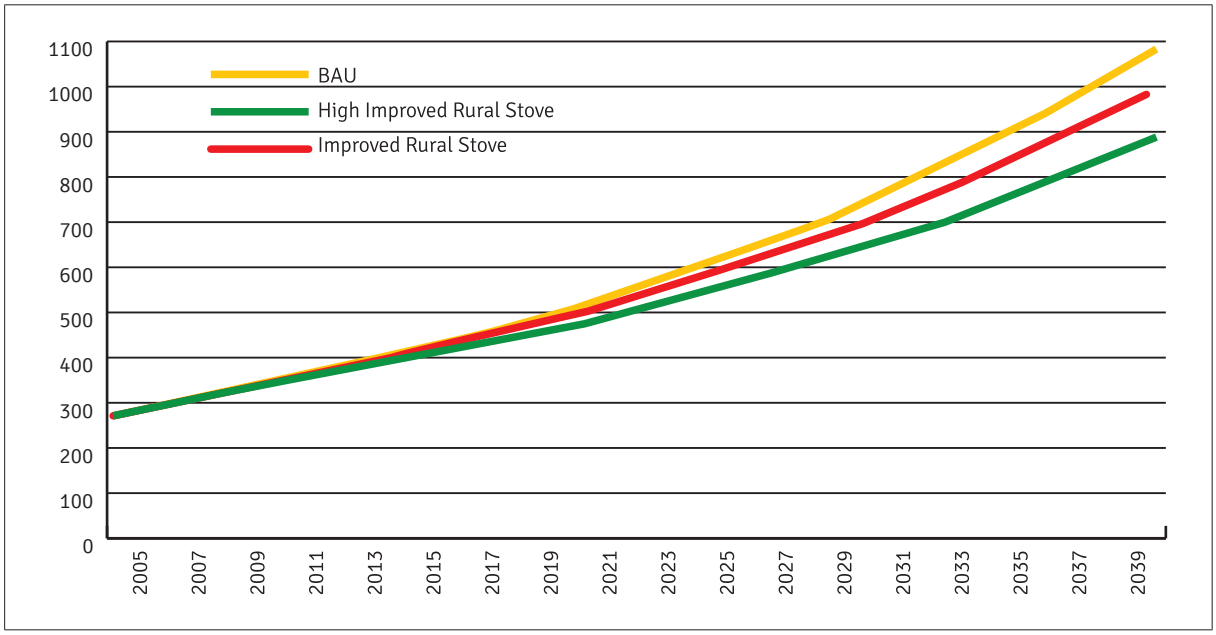


Figure 11: Impact of low and high improved fuelwood stove penetration (1 Tone = 15 GJ)

198. A greater impact is however got when a RORENA and gasifier stove mix is introduced. By replacing about 30% of the RORENA stove with a gasifier stove results in a wood saving 13 million tonnes annually (high improved rural stove scenario in Figure 12).

199. In the BAU scenario the estimated wood needed for charcoal production will rise from the current 9.5 Million tonnes to 20.9 million tonnes by 2040 (Figure 12)12.

12.Divide GJ by 15 do derive tones of wood

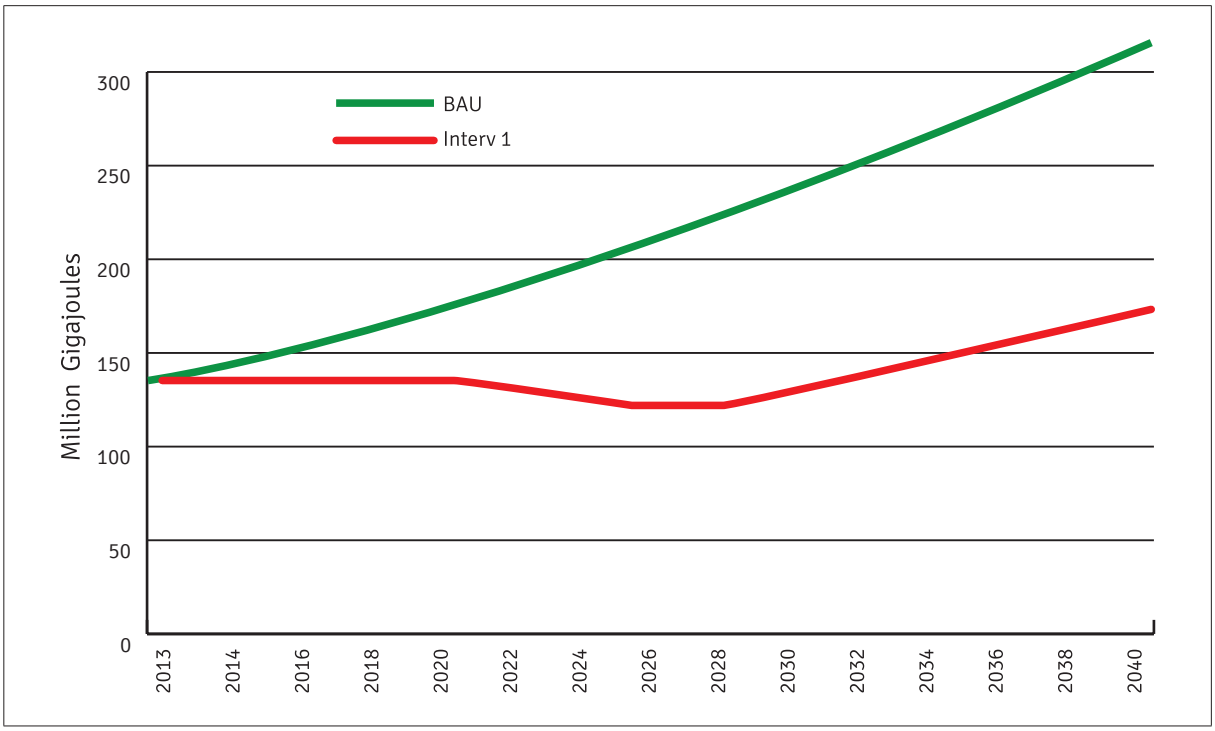


Figure 12: Wood needed in charcoal production in BAU is 20.9 million tonnes versus 9 tonnes under interventions (15Gj = 1 tone of wood)

200. One of the mitigation measures towards unsustainable charcoal production in Uganda is the introduction of efficient wood to charcoal transformation processes. Studies in Uganda have indicated that the traditional charcoal kiln (known as Kinyankole kiln) has wood conversion efficiency of 10 to 12% on weight-out to weight-in basis (FD 1995). This implies that about 9 kg of wood are needed to produce 1 kg of charcoal which translates into 22% efficiency on an energy output to energy input basis. Introducing improved technologies may increase efficiency to achieve 3 to 4 kg of wood per kg of charcoal which is 60% to 50% efficiency respectively on an energy basis.

201. Introduction of such technologies can thus result in significant wood savings of close 6 tonnes per tonne of charcoal produced .

202. The Nationally Appropriate Mitigation Action (NAMA) Study on Sustainable Charcoal in Uganda project (UND undated) proposes introduction of both Casmance kiln and Adam retort kiln as means of producing green charcoal in the country.

203. By adopting the above strategy it is possible to maintain the wood required for charcoal production between 8 and 9.7 Million tonnes (from 2014 resulting up to 2040) which is an annual wood saving of over 10 million

tonnes. This intervention is considered to have the greatest impact on the biomass demand supply equations. Most importantly, this is an intervention that has already secured funds and is about to become operational.

204. The NAMA charcoal project recognizes that the unorganized nature of existing production would inhibit rapid deployment of these technologies. It is thus suggested that a gradual deployment of efficient charcoal kilns be adopted by first introducing the Casamance kiln so that charcoal producers experience the benefits of green charcoal and later on introduce the Adam retort kiln (Table 15).

Table 15.Proposed share of Casamance and Retort kilns 2011 to 2031, adopted from NAMA charcoal study (UND undated)

Year	Casamance Share	Retort Share	% Green charcoal
2011	0%	0%	0%
2013	0%	0%	0%
2015	10%	0%	10%
2016	20%	0%	20%
2017	25%	0%	25%
2018	29%	2%	30%
2019	32%	4%	35%
2020	32%	8%	40%
2021	32%	14%	45%
2022	25%	25%	50%
2023	14%	41%	55%
2024	6%	54%	60%
2025	0%	65%	65%
2026	0%	70%	70%
2027	0%	75%	75%
2028	0%	75%	75%
2029	0%	75%	75%
2030	0%	75%	75%
2031	0%	75%	75%

205. The upward trend of the intervention curve after 2027 (Figure 12) gives a strong warning against complacency thus giving a strong reason for continuous research and deployment of improved technologies to avoid undoing efforts gained.

206. BEST considers that interventions should be at the five components of the charcoal value chain: Forest management, Charcoal production, Transportation, Charcoal retail and lastly charcoal consumption as identified in the Charcoal NAMA. Given that charcoal is produced by itinerant individuals with low capital, it is proposed that a business model that will attract investors with substantial cash outlay be developed. Leaving charcoal production 100% in the hands of unorganized capital strapped producers may not deliver the desired results. The business model that has a carbon financing component would be more attractive.

207. In the BAU scenario, fuelwood demand of government and private institutions is expected to reach as high as 3 million tones per annum by 2040 (BAU curve in Figure 13) . This demand could however be maintained at 1.5 million tones (half the BAU requirement) if improved stoves were aggressively promoted (Institutional improved curve in Figure 13). This could be achieved if improved stoves could take a share of 20%, 60% and 100% in the years 2015, 2025 and 2040 respectively.

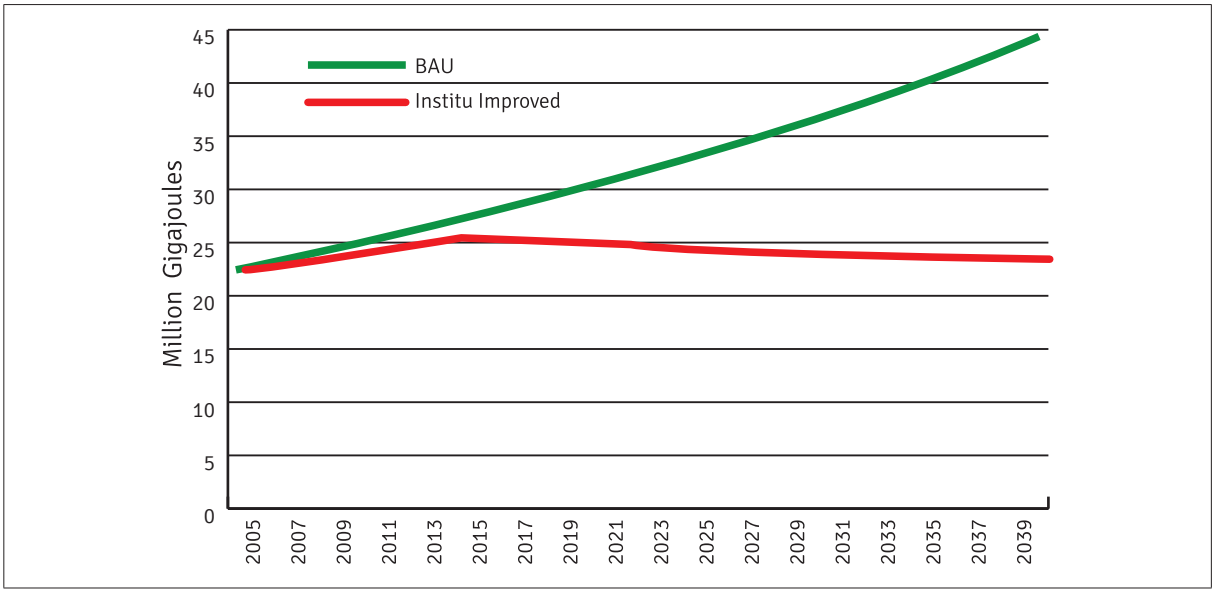


Figure 13 Institutional fuelwood forecast BAU and under improved stoves (1tones =15 GJ)

208. The above scenario indicates tremendous wood savings can be made if government (MOE, MEMD and MWE) was to formulate an energy saving policy and enforce its implementation.

209. The brick baking industry (artisanal) and small scale lime producing industry combined are projected to consume 26.5 million tones of wood by 2040 under BAU. By gradually replacing all inefficient kilns in the lime industry with improved ones demand of fuelwood could be maintained at 0.28 million tones (improved kiln curve in figure 14 instead of 0.47 million tones (BAU curve in Figure 14).

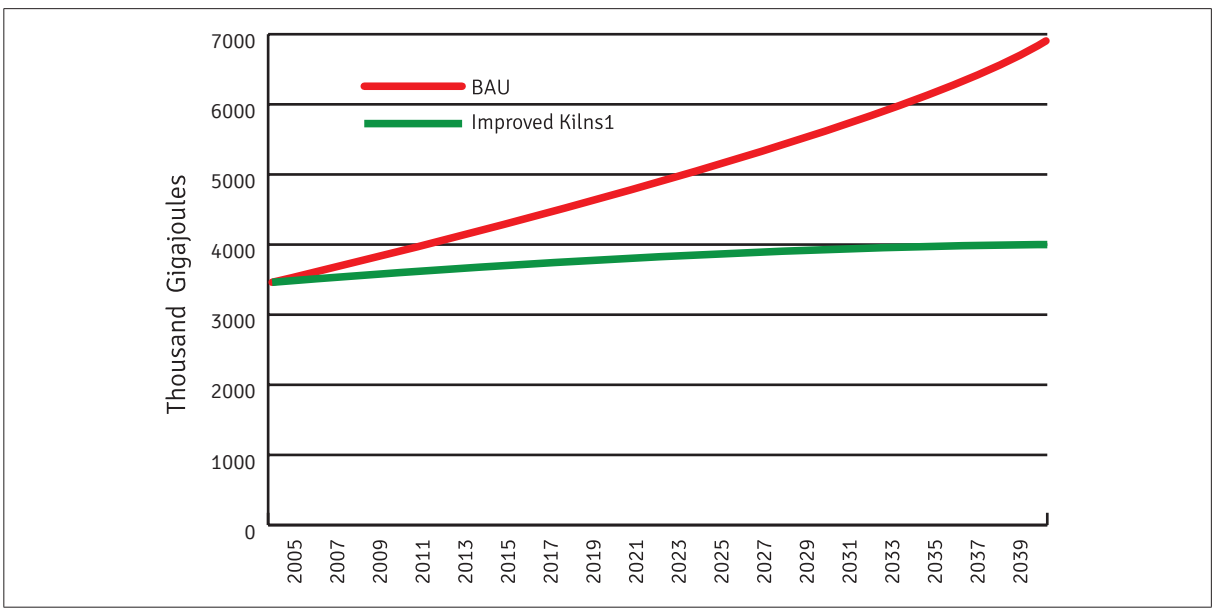


Figure 14 Lime Potential energy (wood) savings in the lime industry (1 tone wood = 15GJ)

210. Demand by the brick burning industry could be maintained at 14.8 million tones(improved kiln in Figure 15) instead of rising to 26.5 million tones (BAU curve in figure 15 in the BAU scenario by gradually introducing improved kilns such that by 2040, 60% of bricks are made from improved kilns and 20% of all bricks are stabilized sun-dried bricks.

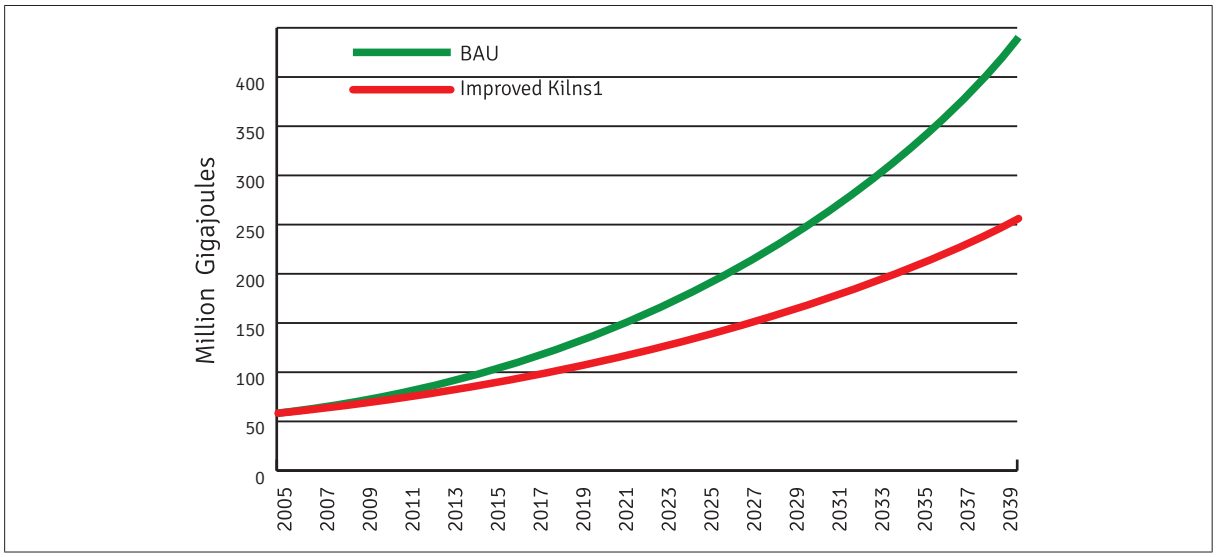


Figure 15.Potential Energy (wood) savings in the brick baking industry (1 tone of wood = 15 GJ

7.2 Other Considerations

211. The fuels discussed in the above section are those that are currently on high demand or in usage. However there are other fuels that might become important in future especially those that are potential substitutes for the biomass fuels. These include (Liquid Petroleum Gas) LPG, Electricity, water waste briquettes, etc. The potential of these fuels is explained below.

7.2.1 LPG

212. Charcoal is the most popular urban fuel as explained in section 5.1.2 and is likely to remain so especially for low income households where the cost of appliances is a major barrier for them to switch from charcoal to cleaner forms of energy. However, the upper 5% wealthy households in urban areas would possibly switch to cleaner forms if distribution channels of fuels like LPG are improved.

213. To assess the impact of fuel switching, a scenario was developed whereby increasing distribution channels of LPG use in urban areas would increase usage of LPG to 4% by 2014 and 20% by 2023. The impact would result in fall in charcoal demand by 0.5million tonnes by year 2040. This would result into a wood saving of 4.5 million tonnes.

7.2.2 Electricity

214. In the BAU it has been assumed that due to impact of rural electrification the number of households using electricity in rural area is going to increase to about 6% by 2020 and 10% in 2040. However only 2% and 4% in 2020 and 2040 respectively are expected to use electricity for cooking.

215. Use of electricity in urban areas is expected to continue rising such that the number of

households using electricity for lighting and other less energy intensive activities like watching Television and telephone charging could reach 70% and 85% in 2020 and 2040, respectively. The number of households using electricity for cooking could reach 10% by 2020. Under such scenario, BAU electricity demand at household level is expected to rise from the current 240,000 Mwh to 2,800,0000MWh by 2040. By factoring in losses at generation and transmission, demand by the household sector alone would require increasing current electricity generation capacity by an extra 500MW. Current investments in electricity generation are considered sufficient to cover this demand.

216. However, if a 70% of Ugandans were to have access to electricity (for lighting and other purposes) by 2040 and if 25% and 70% of rural and urban households respectively were to use electricity for cooking by 2040, the household sector alone would require about 12.7Million MWH of electricity which would require an additional installed capacity of 500MW by 2020 and 2,500MW by 2040. Total electricity installed capacity (including commercial and industrial) would be in the range of 5,000MW to 10,000MW.

217. Apart from the required heavy investment in electricity generation, for households to afford the use of electric cookers to such a magnitude would require tremendous increase in levels of income (more than quadruple). The possibility of this happening is for oil production to start on schedule and revenues to be wisely invested in other production sectors like agriculture and industry.

7.2.3 Vegetal waste briquettes

218. Replacing charcoal transformed from wood with other forms of biomass such as carbonized or uncarbonized briquettes in the same ratios as LPG doubles the wood savings to nine (9) million tonnes. Charcoal replacement thus gives high wood savings at low level of replacement making fuel substitution one of the ways to gain high wood savings.

219. Under BEST, supporting industries that will sustainably increase use of non-traditional biomass in the energy mix is recognized as one of the ways of supporting a sustainable biomass energy production system. There is a possibility that many more households would be willing to switch to briquettes or pellets because of the relative low cost compared to charcoal. Switching from charcoal to briquettes is however only envisaged if variances in calorific value of briquettes are kept low which is only possible under industrial production. It might also be important that briquettes are accompanied by specially designed stoves.

220. Uganda has a lot of vegetal waste, shrubs, and bushes that can sustainably supply industrial briquette making with capacity to supply 40% of required biomass at sustainable level. Depending on the business model adopted, it is possible for briquettes to capture a substantial portion of the biomass market

7.2.4 Promotion of Biogas

221. Biogas digesters have proven to be successful in other areas of the world including China and India, where more than 40 million digesters have been installed. However uptake of Biogas technology in Uganda and Africa in general has been considerably slow and faced a lot of barriers.

222. Progress by a tripartite Uganda Domestic Biogas Programme, composed of Heifer International (as the National Implementing Agency), HIVOS as Fund Manager and SNV as a Technical Advisor to install biogas systems countrywide has been very slow. The Uganda Domestic Biogas Programme targets small-scale livestock farmers to address the challenge

of domestic energy (woodfuel and its associated problems) and has plans to construct 12,000 digesters by end of 2013.

223. Use of biogas is supported under BEST not that it has a big impact on the biomass energy supply and demand equation but because of other benefits associated with it, especially, reduction in indoor pollution and the potential to increase agriculture productivity through use of the high quality fertilizer – the slurry.

7.2.5 Municipal waste

224. The volume of solid waste generated by the urban population is a major challenge. But if handled as an energy resource it presents an opportunity to have large quantities of raw material within a small geographical area. Taking the example of Kampala, the daily per capita solid waste generation lies between 0.5 Kg and 1.1 Kg. With a population of about 2 million, it implies that the minimum amount of solid waste generated daily is 1000 tons. According to reports from the GoU/UNDP PPPUE pilot project (2002 – 2004), 70% of this solid waste is biomass. KCCA is developing a municipal waste master plan whose details are yet to be made public. Like the case of biogas, municipal wastes double as an energy and high value manure.

7.3 Biomass demand / Supply scenario forecast

225. A combined effect of a number of interventions on the supply side (improved wood to charcoal conversion technologies) and on the demand side (fuel substitution, efficient thermal production systems and appliances in households, institutions and commercial enterprises) results in a low demand curve, about 65 million tones in 2040 rather than over 130 million tones in the BAU(Figure 16).

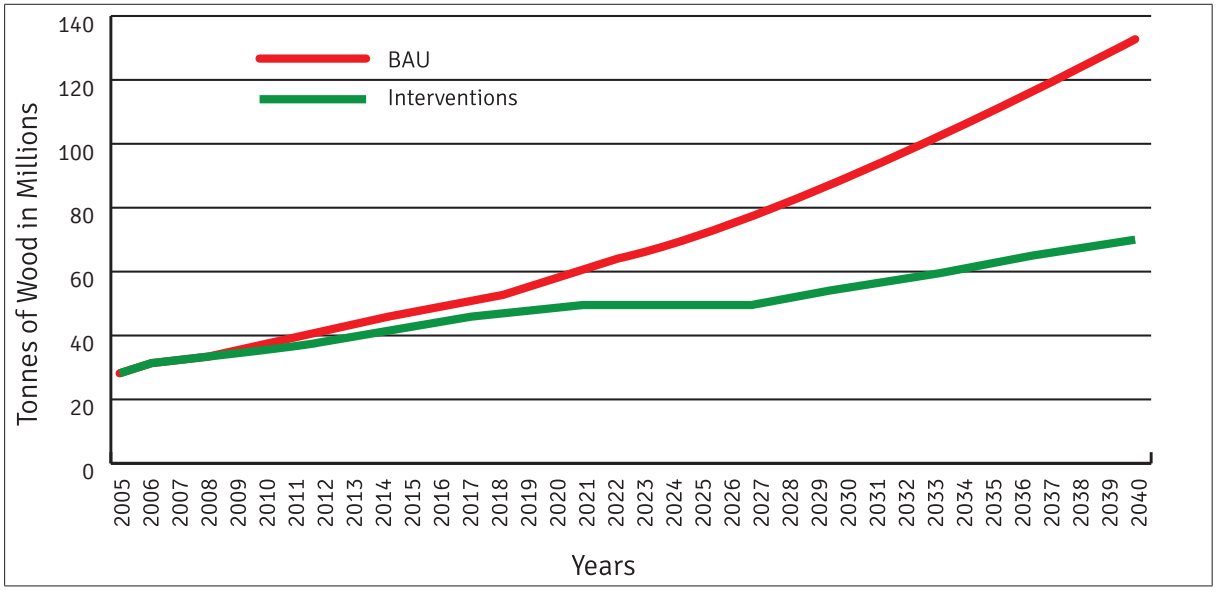


Figure 16.BAU versus reduced demand as a result of combined interventions

226. This shows that managing the demand side alone may not be able to result in sustainable biomass supply. Although introduction of efficient technologies and fuel substitution will tremendously lower demand there is need to increase biomass supply as well in order to manage the increase in demand that is pure as a result of population growth.

227. Current afforestation programmes are mainly targeting timber and pole production and they take long (about 10 years) to accumulate substantial biomass (Figure 17). Forest plantations are good interventions in that they target increasing levels of income in addition to fuelwood (a by-product). However, to tackle the biomass crisis in some areas of Uganda, interventions that introduce fast growing hedgerows have the greatest and immediate impact. The proposed extension of FIEFCO should thus focus on such interventions in biomass deficit areas.

228. On the positive side, it is contended that Uganda has capacity to sustainably meet its biomass demand both for energy and non energy purposes. Section 3 propose a biomass energy strategy and what is required is the relevant government agencies to put in place mechanisms and systems to implementing the proposed interventions

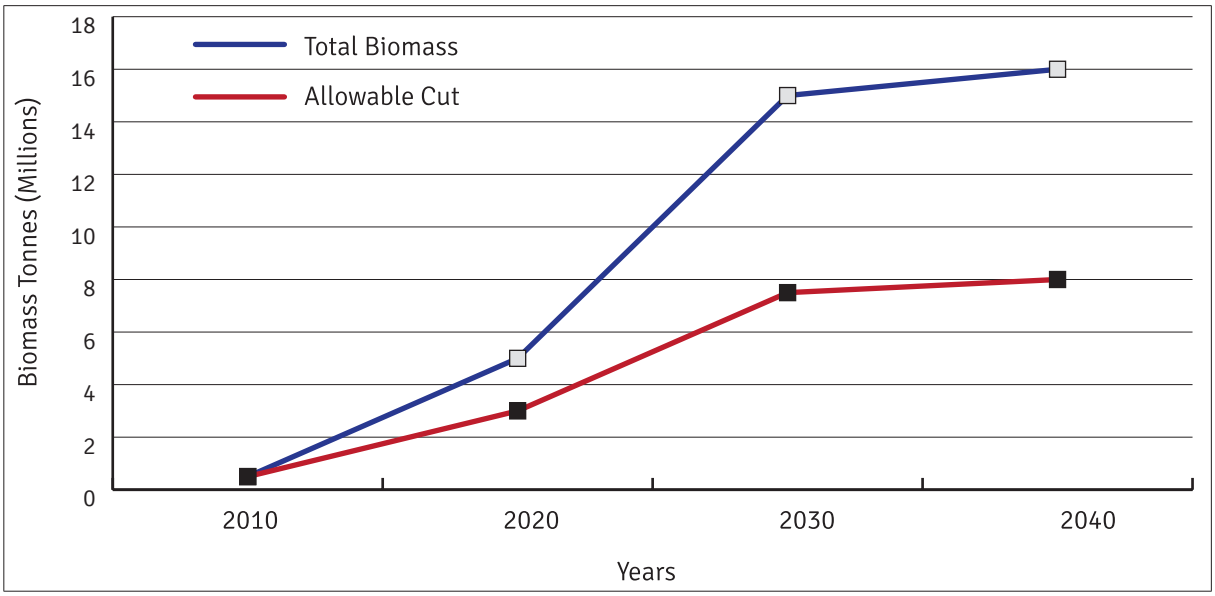


Figure 17. Current afforestation initiatives are important but impact may take long

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Part III

BEST Building Process

9 ANNEX I STRATEGY FORMULATION PROCESS

229. The Strategy formulation process was guided by the National BEST Steering Committee chaired by the Ministry of Energy and Mineral Development. Other departments on the committee were the Ministry of Agriculture, Animal Industry and Fisheries, Ministry of Water and Environment, Ministry of Local Government, NEMA, NFA, BEETA, UBOS, GIZ and UNDP. The BEST Steering Committee was responsible for setting the general agenda for the proceedings of the formulation process as well as approval of workplans and action plans. The Committee also approved the plans for the stakeholder consultation, including the composition of participants at the various consultative workshops. It also set the dates for the workshops to ensure that all the vital agencies were represented at the workshops. The Chair of the Committee, MEMD, was responsible for inviting the participants to the workshops. The logistics were directly administered by UNDP at the request of the Ministry of Energy. Stakeholder Mapping (categories and analysis)

230. A stakeholder is a person, group or organisation that has a legitimate interest in a project or entity. This includes everyone with an interest (or "stake") in what the entity does or who is affected by its output.

231. Identifying and involving relevant stakeholders in the BEST formulation process was considered a precondition for its success. Only with the participation of the leading organisations and individuals working on energy issues can a realistic understanding of the problems and opportunities in the field be achieved. The stakeholders' early involvement also helps to create awareness and ownership of the BEST process, maximising the chances of their later support in the design and implementation of the proposed interventions.

232. Because stakeholders may have conflicting interests a detailed mapping was done to establish the various categories and their level of engagement in the formal planning for the biomass energy sector. An understanding of organisations and actors (figure 18) in the biomass energy sector, their interests, views and potential contributions was critical during the analytical stage of the BEST. The most critical group of stakeholders was identified: those who are influential but opposing (figure 31). These groups in particular were addressed and involved in the process.

	Influential	Less Influential
Supportive		
Opposing	CRITICAL	

Figure 18.Critical is the Stakeholder category that is powerful and yet opposing initiative

233. There are several individuals, groups, institutions and practitioners that have got varying interests and influence on biomass energy sub-sector in Uganda. These stakeholders include relevant government agencies, formal and informal biomass energy users, private sector entities, civil society, indigenous peoples and other forest dependent communities. They use biomass energy differently and therefore the demand and supply of biomass energy affects them differently too.

234. The influence of the respective groups on biomass energy and how they can be affected by availability or scarcity of biomass energy may be positive or negative. It was therefore important to consider the various stakeholder categories, their role, mandate, relevance and influence in the biomass energy sub-sector (table 16).

Table 16.Stakeholder categories

Category	Stakeholders	Role/influence on biomassenergy	List of some of the Insituionss	
Government institutions	Relevant ministries and their departments , Agencies and Parastatals of Government, Local Governments	Policy direction, harmonization/coordination and implementation, regulation, awareness, data bank, Monitoring and Evaluation	Ministry of Energy and Mineral Development (MEM); Ministry of Agriculture, Animal Industry and Fisheries (MAAIF); Ministry of Education Ministry of Finance / planning Ministry of Health Ministry of trade and tourism Ministry of Water and Environment (MWE); National Environment Management Authority (NEMA) National Forestry Authority (NFA); Promotion for Renewable Energy and Energy Efficiency Programme (GIZ PREEEP); Sawlog Production Grant Scheme (SPGS) Uganda Bureau of Statistics (UBOS); Ministry of Internal Affairs Security agencies : Prisons, Police, Army	Uganda Industrial Research Institute (UIRI) Uganda National Bureau of Standards (UNBS) Uganda Bureau of Statistics (UBOS) Government Universities Local government Rural development schemes Transport sector

Category	Stakeholders	Role/influence on biomassenergy	List of some of the Insituionss	
Development partners including Multilateral Agencies	Donor agencies, Embassies, Diplomatic missions	Supporting biomass energy sub-sector (financing key activities of the sector.	European Union (EU) German Government Global Environment Facility (GEF) UNDP DGIS World Bank DFID USAID Shell Foundation HIVOS Norwegian Embassy? Development Partners (UNDP, GIZ, SNV WWF)	REEEP NORAD USEPA GIZ UNDP UNCHR World Food Program (WFP)
Local communities	Women, vulnerable/ marginalized groups, Forest dependent communities, farmer groups	These closely interact with biomass energy sources; they play a big role along the demand and supply chain, costs, benefits and impacts.	Tree farmers, brick makers, charcoal producers, landlords (where charcoal is produced)	
Civil Society and initiatives	Local NGOs, CBOs, international agencies, Faith Based organizations and cultural institutions.	Lobbying, mobilizing, and raising awareness and advocacy including offering technical support and expertise for sustainable utilization of biomass energy.	African Alliance on Clean Cooking Aktion Africa Hilfa (AAH Alternative Basic Education for Karamoja (ABEK) BRAC Women's fora at International level and in Uganda CARE International CIRCODU Consumer groups (will be gender-disaggregated to establish preferences for different cooking methods and combinations of fuels) EAETDN	Ecotrust Farmer's forum GVEP International Impact Carbon Integrated Rural Development Initiatives (IRDI) International Lifeline Fund Jinga Empowerment Organization Joint Energy and Environment Projects (JEEP) Living Goods Mercy Corps Millennium Village Projects PRIED Rural Agency for Sustainable Development SNV Winrock International World Vision

Category	Stakeholders	Role/influence on biomassenergy	List of some of the Insituionss	
Private sector	Energy producers, Waste-to-energy technology promoters, industries, charcoal associations	Production and Marketing, Production of new technologies; they have a role to play on chain of custody and value chain addition for biomass energy	Forestry companies Large Medium and small Agribusiness Tea companies Tobacco processing Sugar factories Cocoa processing Dairy processing Farmer Associations and cooperatives Financial institutions e.eg micro credit banks Timber processing Alternative (to biomass) companies Energy efficiency Technology Co Energy supply companies (HEP, Pico / Mini , Wood based / Agro waste, Biofuels co etc UMEME ESKOM Mini Hydro Bioenergy (U) ltd Private universities Stove producers Ugastove Friends of Wealthy Environment (FOWE)	Envirofit Ecozoom Paradigm Project BEETA Network The Private Sector Foundation of Uganda Uganda Energy Foundation Up Energy Wana Energy Solutions PEES PETSD AEESS Prime Equipment & Co Carbon Developers CO2Balance Uganda Carbon Bureau JP Morgan Climate Care Research CREEC Aprovecho Berkeley Air Monitoring Group Financing e.gFINCA
The academia	Universities, research institutions, training colleges, schools	Capacity building, research, generating and dissemination new knowledge, skills and technologies for reduced usage of biomass energy, and sustainable production of biomass energy.	NARO and its affiliated Institutions Government and Private Technology based Universities and Technical Colleges Private run research initiatives	
The media	Print, electronic, telecoms, social media	Advocacy for sustainable/responsible usage of biomass energy. Putting biomass mass energy issues in the public domain.		

9.1 Studies and Literature Review

235. Previous studies on the biomass situation in Uganda were reviewed with the prime objective of considering the approach used and analysis of the dynamics that have changed since the publication of such studies. Several case studies were also reviewed including the implementation of level of biomass energy strategies that have been designed and adopted. Literature on the historical and forward outlook of the forestry sector was also studied, as well as published reports, policies, regulatory and institutional frameworks on the regional and global energy balance.

9.1.1 Review of the Legal, policy and institutional context

9.1.1.1 Institutional framework

236. The lead institution responsible for the energy sector is the Ministry of Energy and Mineral Development (MEMD). The energy sector under the MEMD is divided into the energy resources subsector, the petroleum supply subsector, the petroleum exploration and production subsector; and supporting especially to the petroleum subsector, is the geological survey and mines subsector.

237. Several formal and informal meetings of the BEST steering committee were held to ensure that there was proper guidance and coordination at each step of the Strategy formulation process. The composition of the consultative workshops was agreed upon by the Steering Committee. MEMD chaired the National BEST Steering Committee, as well as providing guidance for the formulation the BEST vision and goals to fall in line with the overall Energy Policy goals. UBOS was responsible for providing the official data necessary for developing the scenarios. MAAIF was responsible for guiding the estimates and projections for agricultural production in order to provide a reasonable ground for the use of agro-wastes as a potential source of biomass for energy. NFA provided the data and outlook for the CFRs as well as the forestry development plans.

238. The mandate of the sector is "to establish, promote the development, strategically manage and safeguard the rational and sustainable exploitation and utilization of energy and mineral resources for social and economic development". In the medium term, the sector focuses on increasing electricity generation capacity and improving the transmission network, access to modern forms of energy, promoting and monitoring petroleum exploration and development and promoting mineral investment. The institutions which contribute to achieving the sector objectives and mandate are the Electricity Regulatory Authority (ERA), the Uganda Electricity Generation Company Limited (UEGCL) which manages generation concessions, the Uganda Electricity Transmission Company (UETCL), Uganda Electricity Distribution Company Limited (UEDCL), which manages distribution concessions and the various oil and gas exploration and mining companies.

239. There is need to review the framework at the national level to provide for a Renewable Energy Department with a Division dedicated to the development, conservation and utilization of the biomass energy resource which accounts for over 90% of the total energy consumed in the country. This division will, among other critical roles, be charged with the implementation of BEST. In the past, absence of a sector-based plan and strategy meant that there was limited

budgetary consideration to directly address the biomass energy component. Interventions were largely donor-driven such as the Energy Advisory Project (EAP) and its successor, Promotion of Renewable Energy and Energy Efficiency Project (PREEEP), both spearheaded and largely funded by GIZ. The ministry's capacity to influence/monitor these projects is eroded by the relatively low contribution to their overall budget.

240. Within the Renewable Energy Department, a Biomass Resource Regulatory Authority (BRRA) is proposed to regulate the all-important sub-sector and work with other regulatory bodies like local governments, NFA, FSSD, KCCA and other urban authorities and the Land Management Authority to effectively plan for a sustainable, zero-waste exploitation of the biomass resource. The National Energy Committee provided for under the Renewable Energy Policy should be a platform through which these regulatory agencies and other stakeholders synergize to implement cross-sectoral programmes of national interest. At a regional level, the Energy officer (and committee) will have a higher impact and performance as opposed to the district environmental committees which have remained largely non-functional due to lack of anchorage to a specific regulatory agency.

241. A dedicated biomass energy investment fund is proposed to be managed by the authority in the implementation of PPPs that achieve the Government's biomass energy development objectives.

242. Decentralization of the energy ministry as provided for in the Renewable Energy Policy should not stop at the district level. Rather it ought to continue to the sub-county and parish levels and all urban authorities in order to maximize opportunities for popular support towards the zero waste targets. There is need for a special financing mechanisms (possibly begged on performance) that addresses the cost implications of the decentralized structure. For an actionable start to the decentralisation process, the establishment of Regional Energy Offices is proposed as a step towards laying the vital implementation framework for BEST.

243. It is very clear that the energy sector is large and mandates for planning and delivery of energy sector wide responsibilities, especially those related to biomass energy sources, are shared with other sectors, including but not limited to the:

a) Forestry sector
b) Agricultural sector
c) Land sector
d) Municipal waste sub sector (biomass fraction)
e) Industrial and manufacturing sub sector
f) Public and private finance sectors
g) Environment sub sector
h) Other sectors

244. To deliver more effectively on the biomass energy component, the MEMD will have to enlist the services of other government departments, ministries and agencies that have responsibility for coordination, so that all sectors and sub sectors on which biomass energy depends act in order to deliver as one.

245. FSSD is trying to setup a forest produce monitoring process and has designed a Forest Produce Declaration Form. The form indicates among other things, the source of forest produce i.e., if it is a forest reserve, public land and /or private land and the exact location where the product has been harvested. The form is supposed to track source of product and ensure that the volumes extracted from the respective sources are tracked. This system has however not been in force since the Ministerial ban of timber was instituted. Despite the

current ban on timber trade, there is evidence that harvesting of forest products (timber charcoal and firewood) has never stopped.

246. Due to lack of a clear guidance on how forests on private land are supposed to be managed, management of the forest sector has for long used a fire fighting approach which is evidenced by several ministerial pronouncements most of them either declaring a ban or a restriction on harvesting one forest product or the other. This has greatly affected the performance of the sector given that 70% of the forest estate is on private land.

9.1.1.1 Legal framework

247. Though the Energy Policy for Uganda (published in September 2002) did not clearly pronounce itself on sustainable biomass supply, it laid down ground for the development of the Renewable Energy Policy document (2007) which endorsed a holistic approach towards promotion of modern and clean renewable forms of energy with a target of increasing use of such forms of energy up to 61% of the total energy consumption by the year 2017.

248. The forest sector is governed by the 2003 Forest Act and a number of statutory instruments as well as ministerial declarations / pronouncements. Examples of such ministerial declarations are; the "the 1992 ministerial ban of export of round wood timber, the 2004 ban on use of chain saws (for wood conversion into timber), the recent (2012 ban of timber harvesting)and many others. There is need to harmonise the above statutory instruments and ministerial pronouncements into one document.

249. Being fully aware that developing new legislation may take a bit of time, we propose that in the meantime, all past pronouncements be revoked and one comprehensive standing order regulating the forestry sector be instituted. Among other measures, the biomass strategy proposes that a sustainable biomass plan should be a condition for licencing all investments that consume biomass (including timber, fuelwood and charcoal harvesting licences). This would form a basis for the proposed preferential taxation system whereby a higher levy is imposed to noncompliance to green biomass use (starting with noncompliance to green charcoal production).

250. As noted among the utility challenges, institutions like schools, Police, Army and prisons are major consumers of biomass in the form firewood and charcoal. Institutionally, the mother sectors of these major consumers (Ministry of Education and Sports and Ministry of Internal Affairs respectively) have no obligation to plan for the supply/conservation of the biomass they consume. One of the cardinal roles of the BRRA would be to recognize such deficiencies in the institutional framework and bring major consumers on board to address the sustainability aspects.

251. Many industries are using biomass for their thermal energy requirements. We propose that for any new investment, plans or strategies for sustainable biomass energy supply should be clearly indicated in the business plans and Environment Mitigation plan. At household level, charcoal is predominantly an urban fuel and has to be transported to the urban centres. It is thus much easier for BRRA to collaborate with municipalities to regulate charcoal distribution, impose the correct levies and thus improve tax collection procedure. This may raise the prices of charcoal but it is also positive for uptake of ICS. As prices of charcoal continue to rise, more and more urban households are expected to use improved stoves so long as a combination of factors merge, some of which are listed below:

a. They are aware of the savings that can be achieved
b. The stoves are reasonably durable, and affordable (Good quality)
c. Improved stoves provide a cleaner and safer cooking environment (Guaranteed performance and assured health)

9.1.1.1 National Plans

252. The Five-year National Development Plan (NDP)13 with the theme: Growth, Employment and Socio-economic Transformation for Prosperity" was formulated and launched in 2010. This plan was formulated on the basis of a broader National Vision for "transforming Uganda from a peasant society to a modern and prosperous country over the next 30 years", by improving significantly specific development indicators associated with socio-economic transformation. During this NDP period and subsequent ones, it is envisaged that the country will graduate to the middle income segment by 2017. In addition, National Planning Authority in collaboration with the Ministry of Finance, Planning & Economic Development, is ensuring continuous alignment of the NDP with the annual Budget through ensuring that instruments such as Output-Based Budgeting Tool (OBT) and Medium Term Expenditure Framework (MTEF) as well as the legal framework are aligned.

253. Uganda Vision14 2040 framework provides plans and strategies to transform Ugandan society, " from a peasant to a modern and prosperous country within 30 years". It aims at transforming Uganda from a low income country to a middle income country with per capita income of about US$9,500 from the current US$506.

254. One potential weakness of the NDP and Vision 2040 is that the set targets may not be attainable unless Uganda's economy grows at a rate of between 12% and 14% per annum, (Mutebile, 2013). On the positive side, oil production is expected to start at around 2017. Managing oil revenues prudently is likely to trigger double digit economic growth rate. In addition, oil and gas production is expected to increase the country's capacity to generate electricity and also offer biomass fuel substitutes like LPG.

255. Vision 2040 will require vast energy resources to be achieved. Biomass energy has enormous but untapped potential that would greatly contribute towards achieving some the desired targets. These action plans are discussed later in this document - under the strategies section.

256. For greater impact, BEST provisions should be built into the National Development Plan and all local government development plans. Some of these programmes and plans can be implemented under existing budgetary provisions such as the Community Demand Driven (CDD), the REED plus strategy, extension of FIEFCO (which is supposed to cover the whole country), integrated statistics system under UBOS. Also as part of the strategy to maximize opportunities for synergy, related research programmes like NARO and NAFORI as well as extension programmes like NAADS should be reviewed to include a sustainable biomass energy component.

257. National youth development programmes should be refocused to deliberately encourage local investment in biomass energy development. Encouraging youth and women to invest in production of biomass energy feed stocks within their local settings not only assures the sustainable supply of the resource but it also empowers the producers, strengthens the rural economy and reduces the tendency for urban migration.

13 The National Development Plan 2010/11 – 2014/15.
14 Uganda Vision 2040.

9.2 The Field Surveys

258. Field surveys were conducted to establish specific biomass supply and demand aspects relevant to the formulation of the Strategy. The prime objective was to get a clear overview of the baseline situation and thus make a credible basis for selected interventions. Among the key areas surveyed were the biomass hot spots in charcoal producing areas such as the cattle corridor and major biomass consumption centres such as the brick industry, small scale lime works, cement factories, tea factories ,sugar factories, jaggeries and many others. Simple surveys were also conducted to examine the consumption of fuelwood and charcoal by households in the rural and urban setting in different regions of the country. Attention was also given to the farmers who have attempted to plant trees on a fairly large scale. Land owners who are contracting the charcoal makers were also interviewed. All these categories of people were later invited to the stakeholder consultation workshops to, among others, validate the findings associated with these interviews.

9.3 The Consultations

259. The formulation of the BEST was a highly consultative process. The consultations were designed in such a way that views were collected from a wide selection of stakeholders from all over the country. Among the District Local Government officers consulted were the Natural resources Officers, Environment Officers, NAADS Coordinators, District Forestry Officers, Chief Administrative Officers and Political leaders. At each of the six regional workshops held in Mukono, Mbale, Mbarara, Hoima, Arua and Lira a selection of private sector players in the biomass energy value chain as well as local community representatives were consulted.

260. The consultative workshops also served as a platform to create awareness about the Strategy and its goals. Each workshop was addressed by officials from MEMD, MWE and UNDP, all aiming to draw the participants' attention to the overall importance of BEST and the need for the stakeholder consultation process.

261. The formal addresses were followed by the consultants' presentation of the technical aspects of the BEST including overviews of the salient supply side and demand side challenges which could not be addressed without a well formulated national strategy. The presentation was designed to arouse interest and voluntary involvement in the open discussion of the issues at stake by all participants. Ample time was allocated to the open discussion before involving the participants in guided group work. The groups were guided to discuss key strategy formulation and implementation aspects including the legal and institutional framework for BEST. Participants were encouraged to bring up the challenges currently faced by those involved in regulating the use of the biomass resources in their respective districts. The discussion notes of each group were presented by a group representative to the plenary session.

9.3.1 Key Issues from Arua

The major threats to biomass supply in the identified hotspots in Arua District were listed as charcoal production and land use change as a result of agricultural expansion. Both of these are directly linked to population growth and are therefore expected to increase with increase in population.

- In Yumbe District, charcoal, fuelwood, poles and timber were listed as the major threats.
- In Nebbi District charcoal production and fuelwood were the major drivers for the increasing demand for biomass.
- In Zombo District, timber, poles and charcoal were identified as the major threats.
- In all the sub-counties of Maracha District, the major driver was identified as fuelwood supply.
- In Moyo District charcoal production and fuelwood were identified as the major threats.

Participants also discussed the plausible interventions that could be implemented to counter the identified threats. They also looked at the constraints that such interventions would have to overcome.

Possible interventions	Foreseen challenges
Promoting of energy efficient stoves	• Poor attitude towards the technology. • Cooking day meal in garden.
Tree planting	• Land shortage. • Poor attitude to investing in tree planting. • Climate change. • High cost of management. • Bush fires. • Weak enforcement of legislation
conversion of agro-wastes to energy (Briquettes)	• Skills and knowledge lacking. • Low adoption. • Waste sorting. • Comparatively costly (Biogas)
Promotion of agro-forestry	• Knowledge and skills
Strengthen legal framework to regulate biomass usage utilization	• Lack of political will and enforcement.

Interventions

There was also an attempt to consider the possible interventions that could be implemented to counter the challenges foreseen.

CHALLENGES	POSSIBLE INTERVENTIONS
Un regulated use of biomass	• Enforcement of the existing regulations
Under staffing	• Lobby for more funds. • Recruitment of more staff.
Under funding	• Increase funding
Export of biomass resources	• Enforcement of existing export regulation at immigration points.
Law extraction technology	• Adoption of modern technologies
Poor attitude to invest in large scale biomass production	• Sensitization importance of biomass production
Stability of southern Sudan	• Trans boundary resource management

Data collection challenges

Absence of official data on some of the issues raised was discussed. Suggestions were made on how to address data needs:
a) Organize stakeholders
b) Identify the categories of data
c) Analyse the demand and supply sides

Sources of data were identified as:

- Information from baseline surveys, researchers, reports from other development partners (UBOS) and government agencies.
- Adequate resource allocation for data collection, analysis and subsequent management.
- Involvement of private sectors funding in the energy development sector.
- Data obtained be utilized in policy formulation and policy adjustments.
- Development tools be developed together with the lead ministries incorporate community systems in data collection.
- Systems be put in place to allow cheaper ways of data sharing.

9.3.2 Key issues from Mukono

At Mukono issues that would favour investment by the private sector were discussed. Specifically the roles of the private sector in the biomass value chain (supply and demand) were discussed.
Challenges for tree planters were stated as follows:

- Inadequate knowledge on which species to plant where and for what purpose.
- Theft – thieves steal the crop before it matures.
- Poor planning – no business plans, no forest management plans.
- Cost of investment – it is a very expensive venture.
- Middlemen in the market – they want to earn more than the owners who have been looking after the crop for years.
- Shortage of land; competing with arable land for crop production.
- Climate change impacts – prolonged droughts (where wild fires are a real danger); pests and diseases, some of which are new and there is no known cure.
- Land tenure systems – the issues surrounding landlords and Kibanja owners in the current land laws may not favour such long term investments.

The overall impact of the above challenges was a reduced incentive for tree planters to invest in this area. This affects supply negatively. Participants argued that if such challenges are addressed, Uganda has potential to recover and even have a biomass surplus.

On the demand side, the key issues that came out surrounded the brick making industry. The demand for fuelwood to fire the huge, inefficient local brick kilns was seen as a threat to the existence of trees in the areas within a radius of 50Km.

Charcoal producers face a challenge of reduced supply of raw material. During the dry season, it is not easy to dig up the soil to cover the logs, and several losses are made during which the poorly covered logs simply burn to ashes. Paradoxically, the dry season attracts many people into charcoal production, since they are not actively engaged in farming practices. This affects supply and prices. Local Government officials have to be bribed. There is an increasing shortage of labour, especially in the wet season. It is difficult to have associations.

9.3.3 Key issues Hoima

Land owners appreciated to have been given chance to learn and pledged to be part of the solution once given direction.

- Conflict of roles within the natural resources sector was identified.
- Data gathering was identified as real problem and called for the better communication amongst government institutions.
- Deforestation was blame on lack of indepth understanding of issues by the locals and government agencies exploiting the ignorance the loop holes in the system.
- Lack of involvement of local government in the planning process was seen as barrier to BEST

9.3.4 Key issues from Lira

A major issue that came out clearly in Lira is that of multiple taxation of charcoal dealers and transporters by some district local governments. The private sector players involved in the charcoal trade gave a desperate account of the way they are mistreated by the local authorities saying they are required to pay undisclosed amounts to the LCI at village level; apparently they are also required to pay some kind of forest levy (perhaps to the Forest Rangers); they are then taxed on the road as they leave the production area; and still taxed as they enter the municipalities to sell the charcoal.

A clearly disgruntled charcoal dealer wanted to know the official rates and number of different taxes that they are required to meet. It was also clear that none of the District officials present could refute her allegations. And none of them could provide the guidance on the kind of levies she claimed to have been paying. It was also clear that some of the levied amounts were never remitted to the District finance officers, which points to a possible abuse of the system by some officials.

Natural resources officer admitted that they are under employed. They do not know how much revenue comes from charcoal or any forest products since revenue collection is tendered to private companies that work independently. They role as regulators has been thus usurped.

The Natural resources sector has the least budgetary allocation. With the winding up of the first phase of FIEFCO there is almost no forestry related work going on.

Co-ordination amongst government agencies was very poor. Even NGOs that deal in improved stoves or tree planning work independently. There is no one stop centre to know who is doing what in the Lango and Acholi sub region. To enhance data gathering and achieving will need establishment of a system that obliges all players submit information.

Among the Natural Resources Managers, there was a misunderstanding as to whether charcoal producers and charcoal traders should be treated as criminals or not. Some though restrictions on charcoal was the solution but others said this contravenes the constitution where it is very clear that land belongs to the people and thus it was not proper to impose such restrictions. It was agreed that putting a ban on charcoal production when it is on high demand and is being used by the very people supposed to enforce the ban would be a futile effort.

Rice husks and agricultural wastes were being burnt to ashes for lack of knowledge that there was market for such a commodity. Sun flower was identified as one of the vegetal waste in the Lango / Acholi sub region.
Local improved stove manufacturers wanted government to recognize there contribution to wards sustainable biomass supply. They also requested government or donor agency support.

9.3.5 Key issues from Mbale

In Mbale, threat and challenges to tree planning and sustainable biomass supply were identified to include the following;

- Poor post-harvest technologies
- Pests and diseases
- High cost of technology to convert waste to energy
- Climate change
- Unsortable municipal waste
- Land tenure and ownership
- Population pressure
- Conflicting and competing usage
- Poor Agriculture practices
- Conflicting Land-use
- Poverty
- Rural –Urban migration
- Economic factors: social-economic status and market forces
- Lack of sustainability strategies
- Low conversion efficiency of production methods
- Inadequate knowledge on the choice of tree species planted
- Theft of planted mature trees
- Limited funding resources
- Market's existence of middlemen
- Shortage of land for tree planting
- Climatic conditions e.g.-Drought and floods
- Lack of enough capital
- Lack of enough improved species
- Drought/natural hazards
- Bush fire
- Negative attitude towards tree planting
- Poor relationships between tree planters and neighbors
- Lack of necessary skills
- Labor shortage
- Length of gestation period(options/ opportunities)

The above challenges will impact on the private tree planters:

- Negative attitude to tree planting
- Reduce on commitment to increase planting
- Reduced appetite to plant trees by the private sector
- Decline of forests/tree cover
- unsustainable/deforestation/climate changes/deficit /poverty

A number of interventions towards improving sustainable biomass supply were

- Tree planting, area planted, spp, age:
- Encourage (communities, owners, chiefs) to register tree resources
- Update forest inventories
- Train farmer/tree owner and grower in record keeping
- Train and empower local environmental communities
- Availability of improved/demand responsive tree species
- Register tree nurseries and train them on record keeping
- Awareness creation/strategies
- Capacity building
- Tree planting campaigns
- Subsidies on improved technologies
- Make use of data-banks from different service providers(NGOS,CBO,NFA)
- Regular update of forest/biomass inventories(knowledge of regeneration and depletion rates)
- Creation of enabling policy and legal frameworks
- Promote bio-technology research and development

It was recognized that there need to improve data in biomass energy sector. The following strategies were proposed towards addressing data gaps

- Develop a comprehensive mechanism of estimating agriculture production as a means of estimating Agro waste.
- Conduct baseline surveys
- Improve on methods of collecting agricultural statistics
- FIEFOC database,NFA
- Natural resources department.
- Use of community based facilitators
- Use of parish chiefs
- Use of sub county technical staff
- Using local revenue collection estimates in finance department
- Active charcoal dealers association in districts

Other methods of collecting data identified as;:

- State of environment reports, inventory reports etc
- Using existing organizations data banks
- Charcoal production (fuel/fuel wood)
- Register charcoal burners/producers
- Register source of wood
- Developing a register of rumber/volume of trees used
- Register traders in fuel wood production
- Register tree growers (area/type)
- Establish harvestable stock(by volume, spp etc)
- Create a database to be used as a basis to authorize harvesting (permits, licenses, etc.)
- Track and authorize movement of the producers(charcoal, firewood, timber, poles etc)

BRICK MAKERS

One person produces or bakes 5 kilns per year- each kiln contains 15,000 bricks therefore 75,000 per year. Each kiln is baked by 4 dyna trucks full of firewood ; 1 dyna equals 4 tonnes therefore 4 x 4 x 5 equals 80 tonnes of fuelwood per year.

Problems associated with brick making

- Not easy to estimate but quantity varies with species
- One can make as many kilns as possible but wood is bought from external sources usually mostly Eucalyptus
- Land for brick making is hired

Charcoal Producers challenges

- The natural trees for charcoal have been exhausted in this region, most charcoal is imported in the region.
- Better technologies are lacking to make good use of all tree species-introduces appropriate technologies
- Cost is inflated due to
- Transport costs: long distances
- Haphazard taxation by different local government officials
- Shortage of trees increasing
- During the dry seasons covering of the Kiln is difficult. But the roads are better which increases charcoal supply
- Bribe of the forestry officers and local government officials
- Shortage of labour during the rainy season, as many people are on working on their gardens
- Increasing costs of labour
- Associations are not easy to form because of constant migration

E) Brewers local gin distillers and Malwabreweres

One person uses 780kgs of fire wood per year. Gin distillers; one person uses: 3,120kgs of firewood per year. It was however recognized that tree planning

is profitable business for those who have the patience to wait for five to 10 years. The following were observed as the benefits.

- Income
- Timber from trees
- Source of fuel in form of firewood and charcoal.
- Shades
- Decorations or beautification.
- Climate modification
- medicines
- Control soil erosion
- Source of food and fruits
- Ecological balance of nature

Charcoal burning was also recognized as a profitable business. The following were observed as the benefits..

- Source of income
- Source of energy
- Employment opportunity
- Saves time
- Less pollutive to the user and the environment
- Source of revenue to the government

General threats / challenges to biomass as a resource were identified as the following.

- Poor attitude
- Over population
- Pests and diseases
- Bush fires
- Human activity
- Limited investment in the natural resources sector
- Limited enforcement of laws and regulations
- Slow staffing levels
- Poor co-ordination among stakeholders

The following were identified as general soultions

- Gazeting land for tree planting e.g. hills
- People with small pieces of land should plant fruits
- People should consider their capacities inform of land
- Long term loans with affordable interest rates
- Planting resistant species
- Use of pesticides
- Fire control measures like fire line and regular clearing
- Community good relations
- Sensitization of the community
- Trainings on good production methods
- Tax reduction
- Improving transport system
- Planting trees/forest both artificial and natural.

Problems associated with excessive use of biomass energy

- Healthy related problems (carbon)
- Environmental degradation
- Movement formalities-licenses
- Poor roads
- Poor charcoal production methods-local methods
- Global warming
- High taxes
- They are less considered productive to the economy
- Shortage of trees

IMPROVED BIOMASS TECHNOLOGY INTERVENTIONS

- Biogas plants by SNV,SOCADIDO
- Lorena stoves by NGO'S like LWF,SOCADIDO
- Charcoal briquetting

The following areas were identified as critical biomass deficient areas; Iganga(urban centers) Tororo,Pallisa,Kumi,Sironko and Mbale.
The following were identified as biomass hot spots

- Natural forests e.g. busitema, mt.elgon national park
- Forest reserves
- Woodlands i.e. Katakwi, Amuria,Kumi(tisai)- Major charcoal production sites
- Woodlots/plantations
- Wetlands
- Communal forests

The following sectors were identified as major biomass users

- Industries i.e. cement, lime
- Institutions like schools, prisons
- Brick kilns
- Households
- Bakeries
- Local distillers

HOW TO ADDRESS LEGAL AND INSTITUTION FRAMEWORK IN RELATION TO MANAGEMENT OF BIOMASS RESOURCE.

LAWS AND GUIDELINES

- Constitution of the republic of Uganda
- National environment Act
- Natural forestry and Tree planting Act
- Local Government Act
- NAADS policy and guidelines
- Land Act
- Wetlands policy
- Energy policy
- Wildlife Act etc

Inadequacies in current laws and guidelines were identified as;

- Other laws have never been revised to meet the current demands e.g soil conservation of 1964
- Restriction of access to energy resources by neighboring communities e.g. wildlife Act, forestry Act
- Existing laws conflict with each other. E.g. conservation Versus use
- Emphasis is put on hydro-electricity visa vis biomass energy
- Inadequacy of byelaws/ordinances on biomass energy resource
- No clear laws compelling the communities to plant trees
- Some of the policies lack regulations to enforce them e.g. forestry and tree planting Act

The following were identified as weaknesses amongst government institutions;

- Political pronouncements which contract existing legislation
- Disjointed implementation amongst stakeholders e.g. UWA and LGs
- Duplication of mandates e.g. NFA and DFS
- Management of shared resources across district boundaries-not co-ordinated
- Lack of a common force for the players
- Lack of prioritization of the ENR management across all stakeholders

The following were identified as roles of CSO and the Private sector

- Provision of inputs
- Off budget support
- Investment
- Community mobilization
- Action researches and monitoring
- Advocacy for ENR sector
- Consumers of resources

- First line managers
- Involved in production e.g. labor
- Whistle blowers
- They are degraders of resources e.g. bush burning
- Academic institutions/professional bodies
- Research
- Advocacy and information Dissemination

9.3.6 Key issues from Mbarara

A key issue that came out at Mbarara was that the roles of the District Natural Resources officers and staff had been rendered hopeless by the current set up at the district. Apparently the issues of monitoring of the natural resources were made impossible due to lack of a budget allocation. The officers asserted that there was no way they could carry out such monitoring roles without a vehicle or fuel. They were not part of the taxation system for charcoal as the system for collection of local taxes had been tendered out to private companies.

There were also issues regarding the tendering process and the ownership of the companies that won the tenders to collect taxes from charcoal dealers and transporters. Apparently the system has been usurped by some district leaders/ politicians and not much was being achieved in the form of revenue for the district local government. It was not clear how much was collected by each of the collection companies, let alone who audited their operations.

ANNEX 1

BIOMASS ENERGY STRATEGY (BEST)
ACTION PLAN

Table of contents

1 Need for an Action Plan and Monitoring Framework

The institutional and regulatory framework of the biomass sector is scattered amongst various government agencies, lacks cohesion and clear mandates. This is the reason why involving all key players in government, civil society organisation, research institutions and most importantly private sector- both users and producers of biomass is critical. The newly formulated Biomass Energy Strategy (BEST) was highly participatory involving a wide range of stakeholder consultations and consensus building both on the technical aspects and on the social economic aspects.

A number of strategic objectives and specific interventions aimed at balancing the supply and demand of biomass energy in a manner that will ensure biomass utilisation without negative social, economic and environmental consequences have been suggested. These suggestions are multidisciplinary and require a multispectral planning approach. An action plan and monitoring framework is thus important in guiding various players that will be involved in the implementation of BEST

2 Development of a Biomass Information System

It is important to develop a biomass information system where data sets from various entities (supply side and demand side) are integrated and continuously updated. There is also need for keeping track of technologies and success rate of introduced technologies. This will help in continuously updating the Strategy, hence enabling decision making and planning from an informed position.

Biomass users

Institutions, households, commercial enterprises, industries (artisanal and big industries): Information to be captured includes: location of entity, biomass type used, technology used, capacity of the facility, energy intensity. Households and commercial enterprises may require sampling, stratified by setting (rural or urban), social-cultural and economic disparities.

Biomass energy producers

Natural vegetation, Agricultural enterprises, Afforestation companies and individuals, entities involved in growing of energy crops, and companies involved in biomass energy transformation e.g., charcoal processing, transportation and retailing, biomass pellets and briquetting manufacturing, transportation and retailing.

Linkage between research institutions and technology users

BEST recognizes the role of research institutions and the need to get the most appropriate technologies to users. Nyabyeya Forestry College conducts studies and training in biomass energy including biomass gasification, CREEC at Makerere has got a laboratory for testing various types of renewable energy technologies. There is renewed global interest in biomass and other renewable technologies. It is import to note that Ugandan universities and other tertiary intuitions are joining this effort. BEST proposes linking research institutions to specific supply side and demand side aspects, hence making research more relevant for conservation and end use efficiency enhancement.

2.1 Existing Data Archiving Entities

Currently, various government institutions collecting data that relates to biomass energy are not well synchronised.

2.1.1 National Forestry Authority (NFA)

NFA produces data on land use / cover change and biomass stock. This information is updated every decade or half a decade. The database has spatial attributes. Data can be accessed using common database formats and also Geographical Information System.

Proposed action plan:

NFA maintains the role of updating the database. Funding of such activity could be contracted by government of Uganda. Government should take advantage of local and international initiatives such as REDD+ and FAO's forest resource assessment to ensure that funding, capacity building and generation of data is secured. Estimated cost: USD 500,000 (assumed to be covered under REDD+)

There should be an MOU between NFA and MEMD on how this data is shared or accessed. MEMD could use a relational database or could have the data directly linked into LEAP.

2.1.2 Uganda Bureau of Statistics (UBOS)

UBOS collects data on household energy use patterns in terms of fuel types used and type of stove used. UBOS also collects data on housing units and materials used for construction.

Proposed action plan:

UBOS maintains its role in data gathering while at same time provides extra parameters needed to have the information more usable in estimating energy consumption. Such parameters could be: fuel type and amount by household size and by stove type, number of bricks by housing unit rural and urban.

Estimated cost; USD 100,000

MEMD has been carrying out studies on energy intensities of various technologies and should continue doing so. This should systematically cover all technologies such that it forms a basis for technology choice. Examples of energy intensities for technologies are: stove types, brick kilns, ovens etc. Financing of these studies could be by government and development partners.

Estimated cost; USD 40,000

2.1.3 Uganda Investment Authority (UIA) and National Environment Management Authority (NEMA)

UIA and NEMA have records of all industries by category, capacity and location both operational and planned. NEMA carries out Environmental impact assessments and Environmental Audits.

Proposed action plan:

The above information should be provided in a database where by MEMD estimates energy use by factoring energy intensity values. UIA and NEMA maintain the role of updating the database.

Estimated cost: harmonizing database and capturing/ transferring old data: USD 10,000

2.1.4 Ministry of Agriculture Animal Industry and Fisheries (MAAIF)

MAAIF in conjunction with UBOS provides data on Agriculture production by crop types and location (district and region). Apart from the 2007/8 UBOS/MAAIF report, the methodology used in carrying out annual estimates is not well documented. Even then, Animal production was not captured.

Proposed action plan:

NAADS has got extension staff up to sub-county level. All districts and some sub-counties currently have access to computers. MAAIF should use staff at district and sub-county level to capture information on crop and animal production. Database design should be done at headquarters and all extension workers trained on how to collect and capture data into the system. This calls for high level of collaboration between UBOS, MAAIF and a number of agriculture and animal research institutions.

Estimated cost: USD 400,000

Renewable Energy Department in MEMD

Much as the mandate of generating various aspects of biomass energy falls within different government intuitions there is need for coordination and financing for the system to be put in place.

It is assumed that Government is to fast-track the formation of the Renewable Energy Department with a Division dedicated to biomass energy.Within the Renewable Energy Department, a Biomass Resource Regulatory Authority (BRRA) will be established to regulate the all-important sub-sector. This body, among other critical roles, should be responsible in coordinating the development and maintenance of the biomass resource information system. This will enhance implementation of the proposed multisectoral planning approach. There will be need for training in Long-range Energy Alternatives Planning System (LEAP) and regular updating as new data is acquired.

Estimated cost: USD 200,000

Table 1. Overall Biomass Information System Cost

Proposed activity	Responsible Entity	Estimated Cost (USD)	Time frame
Land use / cover and biomass stock	NFA	500,000* Assumed to be covered under REDD+	2014- 2015
Energy consumption patterns	UBOS	100,000	2014- 2015
Energy intensity	MEMD	40,000	
EIA/Investment data capture and harmonization	NEMA/UIA	10,000	2014-2015
Crop and Animal Production database and data capture	MAAIF	400,000	2014
Hosting of Biomass Energy Information System and coordination	MEMD (BRAA)	200,000	2015-2016
Related Consultancies		200,000	2014-2017
Total		**950,000**	

3 BEST Communication strategy

The BEST situation analysis revealed that among other shortcomings, facts about biomass energy and its contribution to Uganda's social, economic and industrial growth are not well known. It was also recognized that there are several renewable energy awareness campaigns but some segments of the audience e.g. key government agencies, policy makers, the legislature are not well targeted.

The result of these weaknesses is that responsible government agencies are not well coordinated and have thus failed to put in place a comprehensive regulatory mechanism.

As Uganda starts the process for implementing a Biomass Energy Strategy (BEST), it is critical to address this challenge of initiating mechanisms for effective communication and collaboration between science, technology and the society.

One of the interventions is proper communication of specially tailored information to various audiences in these areas:

- High level decision makers, Local government policy makers etc.
- Technical personnel
- Policy formulators
- Legislature
- Urban poor and rural poor
- Middle class urban and rural
- Private sector especially industries
- Institution (e.g., Educational institutions, prisons)
- Civil Society Organizations

Action Plan

The success of a BEST will be closely linked to how strictly all categories of actors adhere to it. This compliance does not simply happen. It will have to be encouraged, maintained and supported through developing and implementing a realistic communications action plan with solid supporting arguments, differing approaches for each target group and the use of appropriate communication channels.
Two types of communication will have to occur:

- Global communication for the entire sector
- Local communication about specific activities targeting specific stakeholder audiences.

This will require a mix of techniques and technologies to disseminate the right information to the public. The awareness campaign will aim to publicize the BEST process, related policy and legal frameworks, the opportunities for engagement (CSO, Private Sector), the role of central and local government in regulation (of the sector) and planning for the sector and a set of actions for communities that are directly along the chain of production and utilisation of biomass energy.

Framing communications for BEST

Public awareness campaigns are among the measures that are necessary to support the development of the BEST for Uganda. Since biomass energy accounts for 90% of the energy used in Uganda, there is an urgent need to promote energy saving technologies and avoiding Indoor Air Pollution (IAP), diversification of use of biomass resources and promotion of fast growing shrubs (trees) to meet fuelwood needs. This, among other issues, will frame and shape the desired communication initiative to support the process. Information, education and public awareness on biomass energy will enrich people's understanding of the sector and therefore contribute to development of the strategy from an informed point of view.

Communication objectives

- Foster a co-ordinated approach to communication by the multiple actors in the biomass energy sub-sector.
- Make the information needs for the BEST development process public through regular information dissemination, exchange and sharing.
- Promote accurate coverage of BEST process in Uganda through proactive communication.
- Engage and promote communication synergies with key stakeholders in the sector for the development of BEST.

Key messages

The key messages will be framed around the following questions:

- What should energy supply look like in the future?
- What is the ideal energy supply system for Uganda?
- How should biomass energy be used?
- Which improvements are desirable?
- What should the biomass energy market look like in the future?
- In the long run, is it preferable to stabilise the current situation and make it more sustainable, or would it be better to shift to other energy resources?
- What major changes should be promoted?

Targeted Long term Impact

- Informed policy formulation achieved
- Discussions / debates and formulation of feasible regulation
- Informed fuel and technology choices
- Opportunities of investments in biomass energy production known

The Communication Action Plan

Table 2: Budget for communication to support BEST

No.	Action	Indicative budget (USD)	Outputs	Outcomes	Responsibility	Timeframe 20'		
						14	15	16
	Central information							
1	Avail process for BEST development on website	1,000	Visibility of the process to all online stakeholders	Online discussion supports BEST development	Ministry			
2	Develop BEST website and facebook account discussion platform	1,000	Facebook site	Stakeholders contribute to discussions on biomass energy	Consultant			
3	Develop and maintain email group (Annual)	10,000	e-mail group used to share information and regular updates on BEST process	Email group used to disseminate information	Consultant			
4	Information material - Brochure	300,000	2,000,000 leaflets developed and disseminated	Familiarity with information on BEST	Ministry/ Consultant			
5	Radio talk shows	20,000	5 radio station in 5 regions hold talk shows	Increased knowledge among stakeholders about BEST	Ministry/ Consultant			
6	Radio spot messages	10,000	5 different spot messages in 5 different languages	-do-	Ministry/ Consultant			

No.	Action	Indicative budget (USD)	Outputs	Outcomes	Responsibility	Timeframe 20'		
						14	15	16
7	TV Talk show	100,000	3 TV stations, 4 talks shows per month for 3 months	-do-	Ministry/ Consultant			
	On-the-spot communication approaches							
8	Regional workshops	50,000	5 regions	Presentations made detailing BEST process, content and implementation	Ministry/ Consultant			
9	Focus Group Discussion	25,000	5 stakeholder groups identified and interacted with.	Clear understanding of the sector	Ministry/ Consultant			
10	Government Agencies meeting	15,000	1st meeting held	Buy-in	Ministry/ Consultant			
11	Government Agencies meeting	15,000	2nd meeting multispectral planning issues BEST	Buy-in	Ministry/ Consultant			
12	Special Parliamentary groups	15,000	3 meetings	Buy – in to appreciate BEST process	Ministry/ Consultant			
	Publicity and public relations							
13	Advertising	20,000	50 adverts in the print media	Improved access to information on BEST	Ministry			
		20,000	200 adverts on Radio	Improved access to information on BEST	Ministry			
		100,000	50 adverts on TV	Improved access to information on BEST	Ministry			
14	Media relations	5,000	5 press releases, briefings, press conferences, study visits, interviews and features published.	Level of uptake of key messages and accuracy of stories	Ministry/ Consultant			
Total		**707,000**						

4 Investment in efficient biomass energy technologies

Several improved technologies both at end-use and biomass transformation exist. These technologies are normally associated with high upfront costs. Experience has shown that most renewable energy technologies (especially those that can be locally manufactured) require subsidies in the initial stages, and can become financially sustainable in the short to medium term after a certain level of technology dissemination has been attained (Kimani et al, 2002).

There is thus need to develop a number of innovative funding mechanisms such as grants, challenge funds and use of carbon credits as collateral. After attaining a dissemination of certain critical mass in terms of number of units and assemblers / manufacturers, the renewable energy industry can become self-sustaining and subsidies can be gradually withdrawn without any adverse effects on continued dissemination of renewable energy technologies.

One of the proposed ways to break investment barriers in renewable technologies is through innovative financing models. One of such financing model is presented in the figure below.

In the proposed model a local investor is connected to an international investor (a venture capital investor). The local investor comes in with local expertize and is probably guaranteed by government under a PPP (Public Private Partnership). Feasibility studies, business plans and due diligence assessments are carried out by a reputable entity. Based on these studies the international investor provides start-up capital and uses carbon streams generated by the investment (activity) as collateral.

4.1.1 Centres for testing Technologies

Uganda has a number of educational institutions, research organization and private sector where technologies in biomass energy are being designed and tested. Some are already in operational stage.

Research and Academic Institutions

Nyabyeya Forestry College has research and training in biomass energy including biomass gasification.
CREEC at Makerere University: CREEC has got a laboratory for testing various types of renewable energy technologies housed under Makere Department of Mechanical Engineering.

Private Sector

Briquetting e.g. Kampala Jellotine Supplies.
Stove manufacturers .e.g. Ugastove and other BEETA members.
MUSA body has attempted to automate production of some renewable energy technologies but the scale of production is still low.

Table 3.budget for Innovative Financing to support BEST

Proposed activity	Responsible Entity	*Estimated Cost (USD)	Time frame
Forest Fund	FSSD	4Million FIEFCO project, IFAD bank	2014-2020
Improved charcoal production	MEMD	3Million, GEF	2014 +
Gasification technology	Nyabyeya, MEMD		
Challenge fund for private sector improvement in briquetting technology		100,000	2014-2015
Challenge fund for private sector improved gasifier stove		200,000	2014-2015
Challenge fund for private sector gasification for electricity		300,000	2014- 2016
Capitalization fund (several renewable energy projects)		100Million	
Sub total		**107.6 Million**	

*It is here suggested that these funds should support viable projects in the private sector. The grants or capitalization should be paid back so as to form a sustainable fund for supporting future projects. Government agencies should

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