RAPID DESK-BASED STUDY:

Donor and Partner Programmes in Sustainable Forest Management and Fuelwood Value Chains in Eastern and Southern Africa

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List of Acronyms

AfDB	African Development Bank
AFREPREN	African Energy Policy Research Network
ASAL	Arid and Semi-arid Land
CBFM	Community-based Forest Management
ENDA	Environment and Development Action (International NGO)
ESMAP	Energy Sector Management Assistance Programme
DFID	Department for International Development
DRC	Democratic Republic of Congo
EU	European Union
FAO	Food and Agriculture Organization
GIZ	German Society for International Cooperation
IEA	International Energy Agency
IEPE	Institut d'Economie et de Politique de l'Energie (Grenoble, France)
IPCC	Intergovernmental Panel on Climate Change
LPG	Liquefied Petroleum Gas
MDB	Multilateral Development Bank
MJ	Megajoule
OECD	Organization for Economic Co-Operation and Development
PFMA	Participatory Forest-management Areas
PJ	Petajoule
SADC	South African Development Community
SSA	Sub-Saharan Africa
TE-CO_2	Ton of CO_2 Equivalent
TJ	Terajoule
TOE	Tonne of Oil Equivalent
USAID	United States Agency for International Development
UNEP	United Nations Environmental Programme
UN	United Nations
UNDP	United Nations Development Programme
UN-REDD	UN Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries

Report summary

Introduction: Forests and trees are the source of a myriad of products, services and functions (including income) for many people living in urban and peri-urban areas, as well as for rural communities, which earn their living by responding to urban demand. For many developing countries in Africa there are few accessible or affordable alternatives to biomass energy and even the most ambitious roll-out plans for alternative renewable energy are leaving the vast majority dependent on biomass for cooking and heating for the foreseeable future. One major concern of forestry, energy and agriculture policy makers and urban administrators in Africa is how to mitigate the negative impacts of urban centres on the surrounding environment, while at the same time enabling rural communities to take advantage of the opportunities available. Therefore, making biomass energy systems sustainable, efficient and pro-poor seems an obvious investment priority. This rapid desk-based study has identified key areas of need, bilateral donors, multilateral development banks (MDBs), other actors and their local partners currently working on forestry and fuelwood energy issues in eastern and southern Africa. It also highlights programmes in which they are involved, the component of value chains supported, countries of operation, examples of success, key challenges experienced, and opportunities for engagement. This study depended mainly on internet sources and experience of the researcher.

Biomass energy trends: The findings show that biomass energy provides about 84% of the energy for cooking and heating in eastern and southern Africa. It is therefore the dominant source of energy for the region; however, it is unsustainably excavated from existing wood resources. Promotion of tree-planting projects over the last four decades has not yielded sufficient wood resources to match demand. In addition, the level of adoption of biomass energy-conservation devices has not significantly reduced the total biomass energy demand. The result of this is a persistent biomass energy deficit in the region. The deficit is apparently met from standing stock that translates into deforestation, forest and land degradation, with all its associated negative consequences that affect many other sectors (besides contributing to climate change). The study indicates that the main constraint to sustainable supply of biomass energy resources is a lack of supportive policy, legal and institutional frameworks, and insufficient investment in the sector. This, in turn, is as a result of the general labelling of biomass energy as 'dirty energy' and the pursuit of elusive 'clean' sources of energy that are either not available or un-affordable for the majority of urban and rural populations. Other contributing factors are unsustainable population growth, low agricultural productivity (which leads to increased conversion of forest land for agricultural use) and limited livelihood opportunities in arid and semi-arid land (ASAL) areas (which result in increased charcoal production for income).

Key donors and partners in woodfuel programmes: The key donors identified in the study include USAID, SNV, DFID, the EU, and GIZ. Others include the World Bank, FAO, UNEP, AfDB, the Gatsby Foundation and IUCN. Key partners mainly include national governments, regional economic organisations, particularly the East African Community, COMESA and SADC, and private companies such as African Bamboo and KUSCCO Ltd. Key areas of engagement are tree planting, efficient cook-stove-promotion programmes, climate change and natural forest-management programmes. There is very little investment in efficient charcoal-production technologies.

Challenges identified: The key challenges identified to attaining sustainable forestry and biomass energy include the negative labelling of biomass energy as 'unclean energy', especially in the context of environmental destruction; a lack of accurate data on the biomass energy sector for planning purposes; a lack of enabling policy, legislation and regulations in most countries in the region; insufficient investment in the sector; a lack of or underdeveloped biomass energy markets; skewed distribution of economic returns from the fuelwood and charcoal trades among value chain actors. Other challenges exist, such as limited linkages with the private sector, overlapping institutional roles, and limited research on charcoal kilns and stoves, including quality control.

Opportunities for engagement: The study recommends the acceptance of biomass as an important source of energy for the foreseeable future in eastern and southern Africa by all stakeholders; this includes national governments in the region, regional economic blocs, donors and international organisations, such as UNEP and FAO. In addition, it recommends support for the regular generation of accurate data for planning purposes; more partnerships with the private sector which include cooperatives and private companies; the formulation of enabling policies, legislation and regulations that support commercial market-based forestry development, woodfuel supply, and utilisation programmes in the region. These have to be backed by sufficient allocation and investment of resources to match resource demand, while ensuring fair distribution of returns from the trade among value chain actors. Other opportunities include streamlining institutional roles in all countries to avoid overlaps and stagnation in the biomass energy sector. Research to develop efficient biomass energy conversion, particularly charcoal and utilisation technologies should be given sufficient attention and resources.

SECTION 1

Introduction

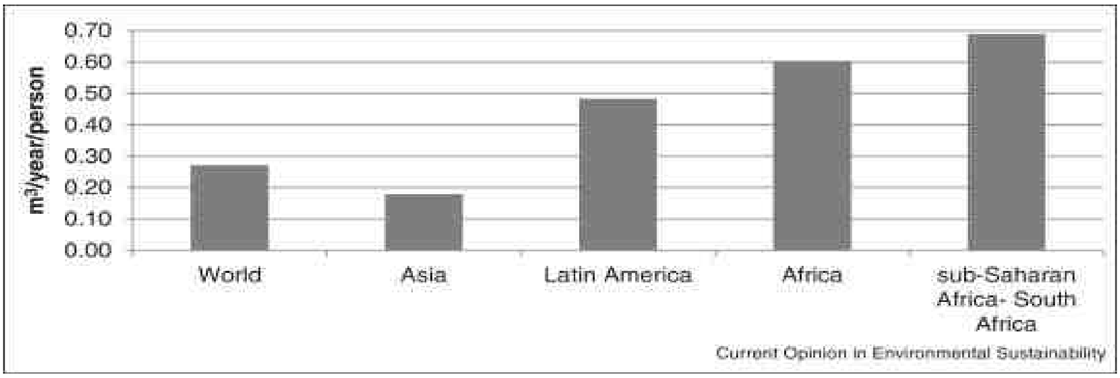
Forests and trees are the source of a myriad of products, services and functions including income for many people living in urban and peri-urban areas, as well as for rural communities which earn their living by responding to urban demand. Biomass that includes fuelwood and charcoal is the major source of energy for much of the developing world. Although solid biomass accounts for only 10% of primary energy supply globally, woodfuels continue to have a crucial and sometimes dominant role in energy provision in the developing world. A recent study by Miyuki et al (2013) on energy for Sub-Saharan Africa (SSA) countries found that they depend on biomass energy for over 80% of their national energy needs. Examination of various other studies indicated in Table 1 shows that woodfuel supplies over 84% of the total energy used for cooking and heating in eastern and southern Africa. This demonstrates the importance of biomass energy in the region.

Country	Percentage	Source
Rwanda	96	Wood, 1990
Ethiopia	90	Ibid
Tanzania	90	Ibid
Uganda	90	Ibid
Malawi	90	Zulu, 2010
Burundi	89	Ibid
Madagascar	80	Ibid
Zambia	75	PASA, 2012
Mozambique	74	Ibid
Kenya	70	Ibid
Average	84.4%	-

Table 1 Fuelwood as a percentage of total energy used

As indicated in Figure 1, SSA had the world's highest regional per capita woodfuel consumption in 2011, estimated at an average of 0.69m^3/year (compared with a global average of 0.27m^3/year). Therefore, the region requires attention to ensure sustainable supply and efficient utilisation of resources.

Figure 1 Regional comparison of per capita woodfuel consumption in 2011



(Source: *FAO, 2012*)

While woodfuels are not a major driver of deforestation on the global level, recent studies in the Democratic Republic of Congo (DRC) (UN-REDD, 2013) show that they can have negative effects at the local level. The studies in DRC demonstrated that the three major causes of deforestation are development of commercial agriculture, which accounted for 40%. Subsistence farming accounted for 20%, and collection of fuelwood accounted for another 20%. Other causes are commercial logging, infrastructural developments such as roads, mining, etc., which account for the remaining 20% (the report mentions the other causes but does not give their proportions. The researcher therefore assumed that all the remaining causes constitute the unaccounted 20%). Concerning forest degradation, the collection of fuelwood was reported to contribute 55%, industrial and artisanal forestry for 15%, and illegal forestry for 14%. The others include livestock grazing, hunting among others which could be estimated to consist of 16% of forest degradation (the report does not give the proportion in percentages; this is therefore an assumption that all the remaining causal factors add to 16%). The impacts of urban areas have also grown far beyond peri-urban boundaries, leading to, among others, forest degradation and deforestation around cities. As an analogy to 'watershed', the concept of 'urban woodshed' has been created to visualise, define and map the territory needed for a sustainable supply of the wood biomass demanded by cities.

For many developing countries in Africa, there are few accessible or affordable alternatives to biomass energy and even the most ambitious roll-out plans for alternative renewable energy are leaving the vast majority dependent on biomass for cooking and heating for the foreseeable future. Alternative renewable energies, such as include solar-, wind- and hydro-based electricity generation, are either unavailable or too expensive. Even in oil-rich Nigeria, woodfuel supplies 80% of national energy for cooking and heating (Wood, 1990).

One major concern of forestry, energy and agriculture policy makers and urban administrators in Africa, is how to mitigate negative impacts of urban centres on the surrounding environment, while at the same time enabling rural communities to take advantage of the opportunities available. Making biomass energy systems sustainable, efficient and pro-poor therefore seems an obvious investment priority.

This partner mapping exercise explores what programmes other donors and partners are implementing in support of sustainable forest management and efficient fuelwood value chains to inform DFID thinking. This rapid desk-based study was commissioned to answer the following questions:

- Who are the key bilateral donors, MDBs and other actors currently working on fuelwood energy issues in eastern and southern Africa?
- What are they doing? e.g. which part of the value chain are they supporting? Are there examples of integrated forestry and energy projects? Are there examples of success?
- In which countries are they working and with which local partners are they working?
- What are the key challenges in supporting and implementing forestry/fuelwood energy projects?
- What components of the value chain are least addressed?
- What are the current opportunities for engagement?

SECTION 2

Study methodology

This Helpdesk Enquiry is a useful quick-reference document for practitioners and decision makers in the woodfuel, forestry, biomass, energy, climate change, environmental protection, and agricultural sectors. It identifies and provides an overview of developmental trends, projects and other interventions related to woodfuel, biomass energy production and forestry management in eastern and southern Africa over the last 30-40 years, as well as the relevant literature, outlining changes in thought, practice and entry points for the future.

This study was heavily dependent on information available on the internet. The internet search was done using keywords that included key donor organisations in eastern and southern Africa in combination with keywords such as forest projects; woodfuel projects; charcoal projects; biomass energy projects; improved stove projects; natural resources management projects; bio-fuels; related terms. After exhausting these combinations, general internet searches on other studies using the keywords woodfuel, fuelwood, charcoal, and energy and forest policy were undertaken. The researcher’s experience in the forestry and woodfuel sub-sectors in the region also contributed significantly.

SECTION 3

Findings

3.1 Trends in the wood fuel sector in the region

3.1.1 Biomass energy policies, legislation and institutions

An article by Zulu (2010) examines woodfuel policy challenges and opportunities in Malawi two decades after woodfuel-crisis narratives and counter-narratives. An examination of woodfuel supply, demand, use, and markets illuminates options to turn stagnant policies based on charcoal 'bans' and fuel substitution into proactive, realistic policies which acknowledge woodfuel dominance and its socio-economic importance. The findings reveal growing, spatially differentiated woodfuel deficits in southern and central Malawi, and around the cities of Blantyre, Zomba and Lilongwe. This is a similar pattern to what is happening to other countries in the region; for example, in Kenya, the supply distance of charcoal sources to the cities of Mombasa and Nairobi has continued to widen, even as the quantities diminish.

Poverty, limited electricity access, reliability and generation, exacerbated by tariff subsidies, and complex fuel-allocation decisions in Malawi have restricted energy-ladder transitions from woodfuels to electricity (ibid). This has produced an enduring urban-energy mix dominated by charcoal, thereby increasing wood consumption. In Malawi, the study indicates that diverse socio-political interests have prevented lifting the charcoal 'ban' despite progressive forest laws.

The report concludes that, despite implementation challenges, lessons already learned, efficiency and poverty-reduction arguments, limited government capacity, and growing and persistent illegal production of charcoal in forest reserves are making targeted community-based forest management (CBFM) approaches more practical for regulated, commercial production of woodfuels than the status quo (ibid). New differentiated policies should include commercial woodfuel production, licensing for revenue, and ecological sustainability under CBFM or concessions within and outside selected reserves. In addition, an enterprise-based approach for poverty reduction, smallholder/private tree-growing, woodfuel-energy conserving technologies, improved electricity supply, and agricultural productivity should be prioritised.

The findings of the Malawi study mirror findings of a similar study (PA EA, 2010) for Kenya, which found that unfavourable policies had been a hindrance to woodfuel sector development over the last three decades. However, over time, Kenya has now formulated favourable policies that allow for sustainable production and utilisation of woodfuels. Nevertheless, there is insufficient investment in the sector both from the national government and development partners to make a significant difference.

Another desk study on Kenya (PA EA, 2010) reports that biomass is a key source of energy, providing 68% of Kenya's national energy requirements. It is expected to remain the main source of energy for the foreseeable future. In 1980, 94% of all wood harvested in the country was used for woodfuel, 4% for poles, and 2% for timber (ibid). By 1997, the proportions were estimated to be 90% for woodfuel, 5% for industrial feedstock (e.g. pulp), and another 5% for poles and posts. However, formal investment appears be higher for timber, pole and posts project than woodfuel. There is no comparison between investment in biomass energy and other forms of energy, such as electricity; it is estimated at around 10% of the energy budget. This may explain the persistent deficit of woodfuel in the country.

In 2000, Kenya was reported to be using 34.3 million metric tonnes of biomass for fuel, of which 15.1 million tonnes was in the form of fuelwood, 16.5 million metric tonnes was wood for charcoal, and 2.7 million tonnes was from crop residue (ibid). Only 43% of national consumption was from sustainable supplies. Of Kenya's total land area of 57.6 million hectares (has), only 6% (3,456,000 has) is forest cover; it is estimated to be decreasing at a rate of 52,000 has (0.09%) per year. In addition, 99% of the charcoal produced in the country is processed in kilns, which only have an efficiency rate of 10%.The technology in the country exists to convert wood to charcoal at efficiency rates of 30-45%; however, their adoption is limited, particularly because of high costs and scattered wood availability across landscapes. This leads to enormous losses of wood, and to the suggestion in a study on Uganda (Struhsaker, 1987) that efficient conservation may be more beneficial than a rush to plant more trees.

The PA EA (2010) study details the consequences of unsustainable extraction of biomass for energy: deforestation; land degradation; reduction in the ecological services of forests, woodlands and bushes; increased soil erosion; loss of biodiversity; loss of jobs; increased time used to find household energy sources (especially for women); increased food insecurity as a result of limited biomass for cooking; diversion of household income to purchase woodfuel for energy. Given the high contribution of wood biomass for energy, there is need to emphasise and deliberately invest in wood production, specifically for energy, and the manufacture and marketing of efficient end-use technologies, such as charcoal conversion kilns and fuelwood and charcoal stoves to ensure efficient utilisation of wood resources.

For a long time, a lack of appropriate policy, legislation and political will has hindered the development of the biomass energy sub-sector. However, in the last seven years, Kenya has formulated energy policy and legislation, forest legislation and charcoal rules to govern biomass energy development. Other relevant policy and legal provisions are a draft forest policy (currently in its final stage of review by stakeholders) and a draft environmental policy. With policy and legal frameworks in place, coupled with the huge effective urban demand for charcoal and the emerging and growing market for fuelwood, especially in the tea industry, the study recommends that commercial growing of wood for charcoal and fuelwood should be given priority. In addition, large-scale investment in the manufacture and marketing of energy-efficient stoves and kilns has promise. There are technologies in Kenya that can reduce the consumption of biomass energy by almost 80%. They include the improved Kenya Ceramic Jiko (KCJ) for charcoal which can save up to 50%, the improved Maendeleo Jiko firewood stove that can also save 50% energy, fireless cookers that can save up to 50% of all energy for cooking, and improved charcoal-making kilns which can save up to 60% wood when compared to traditional technologies. A KCJ adopted fully by an urban household will reduce consumption by half. When used in combination with a fireless cooker, there is a further 50% saving of the remaining half. This translates to an approximate 75% saving of the initial quantity. Additional saving techniques, such as soaking dry grains and improving knowledge on efficient utilisation, can save another 5% of the initial quantity. Investment in the development and promotion of other biomass technologies, such as biogas and wood crop residues and briquettes, should also be considered.

Another study by PISCES (2013), that examined the socio-economic impact of the charcoal sector in Kenya, reports that charcoal in Kenya is produced from different systems that include trust lands and ranches (45%), small-scale naturally growing trees and shrubs (particularly in ASAL) (40%), and government forests (15%). While it is more desirable to produce most charcoal from on-farm-produced wood, the study explains that more charcoal is coming from natural woodlands, as there is lack of alternative sources of income for ASAL communities. These communities produce charcoal as a livelihood coping mechanism, particularly during drought years. This study concludes that there should be more emphasis on on-farm commercial supplies of wood for the longer term. This should involve promoting the production of wood for charcoal using all the different production systems, ensuring efficiency in the conversion process to charcoal, effective marketing, and efficient utilisation. Although Kenya is slightly ahead in terms of woodfuel policy and legislation when compared to most other countries in the region, like the rest of the region, most policies are in the various stages of policy formulation and legislation drafting. This process needs to be speeded up, drawing from the lessons learned from earlier projects, for example not condemning woodfuel as a dirty source of energy, taking the commercial route for sustainable development and livelihood enhancement, and supporting sufficient formal investment in the sector.

Case Study 1 Deforestation from fuelwood collection and charcoal production in DRC forests

In DRC, fuelwood and charcoal collection has been classified as a key driver of deforestation: it accounts for 95% of the population’s energy needs (CIFOR, 2013b). The dependence on fuelwood for energy creates rings of fragmented forest around urban areas, which in turn calls for longer and longer forest excursions to supply a never-ending demand for fuelwood. UNEP’s Post-conflict Environmental Assessment Synthesis for Policy Makers reported that approximately 89 hectares of forest was lost each day due to illegal fuelwood harvesting during the peak of the post-Second Congo War. It is estimated that 72 million m^3 of fuelwood and charcoal are ‘produced’ annually. Charcoal is inefficient to produce but is a preferred source of energy in DRC. While it is virtually free to use fuelwood as a source of energy, charcoal has increased in popularity as an energy source due to several advantages over fuelwood. Charcoal has higher calorific value per unit weight (31.8MJ/kg) compared to fuelwood (16MJ/kg); charcoal is smaller and easier to store. Charcoal is also mostly smoke free and is less likely to deteriorate (as fungi and/or insects attack fuelwood). For these reasons, charcoal is particularly popular in cities. However, even in rural areas such as Goma in North Kivu, charcoal is also widely used. On average, each person uses 1-1.6m^3 of fuelwood and 80-95kg of charcoal annually. Regardless of whether it is for commercial or personal purposes, fuelwood and charcoal are mostly collected by women and children in most regions in Africa. The price of charcoal has increased dramatically in large cities, such as Kinshasa, because vast amounts of forest have been laid waste close to the city and the cost of transportation increases as wood is sourced from ever-more-distant sources.

3.1.2 Distribution of income among value chain actors

A study by Practical Action Southern Africa (PA SA) (2012) explored the potential for adopting eco-charcoal production as an alternative economic activity for the charcoal-producing rural communities of Zambia. The results show that one hectare of well-wooded natural woodland can produce about 20 tons of charcoal. With all costs removed, the net return per hectare was estimated at US$3,171. Of these, the wholesaler gets the highest share (41.9%), followed by the retailer (30.7%). Hired transporters get 5.9% of the share, but the producer gets the lowest proportion, estimated at 2.6% (see Table 2) (ibid). Government return is estimated at 18.9%, which appears reasonable if the wood is effectively collected and used, and if sustainable production of the wood resource and maintenance of the road infrastructure in charcoal-producing regions are ensured. While the study concludes that eco-charcoal production can be a viable project, it emphasises the need to improve the distribution of benefits along the charcoal value chain to ensure fairness. The most straightforward way to distribute benefits is by improving producer and transporter returns without changing consumer prices; this could potentially be done by forming producer associations or cooperatives.

Value Chain Actor	Net Returns (Profit) per ha (US$)	Percentage (%) of total net returns per ha (20 tons)
Government (taxes)	600	18.9
Producer	82	2.6
Transporter (hired)	188	5.9
Whole seller (using hired transport)	1,329	41.9
Retailer	972	30.7
Total	3,171	100

Table 2 Proportion of returns (%) to the different charcoal value chain actors

3.1.3 Biomass energy information and data quality issues

A study by Amous (1999) reports that, despite important interactions between development, environment and social welfare, there have only been a few attempts in Africa to include woodfuels as a basic sector in planning processes. Inclusion is seriously hampered by the scarcity, limited scope, and poor quality of existing data. This is in spite of several past efforts to improve woodfuel information systems. These shortcomings make it very hard to undertake relevant impact studies of woodfuel use on the environment and forestry resources, in particular forecasting studies and energy and forest planning. In Kenya, for example, the first national study on wood energy was conducted in the 1980s (O'Keefe et al, 1984). The second was done in 2000 and informed the energy policy formulated in 2004. However, the methods used in both studies were not the same, which makes comparisons over time difficult. The first national charcoal study was undertaken by Energy for Sustainable Development in Africa (ESDA) in 2005. There is no information on when the next study will be done. Thus, the negative trend in information generation is a major hindrance to planning and monitoring developments in the biomass energy sector.

The evaluation of various existing woodfuel data sources in Africa has led to the conclusion that the FAO database is the only source of data that includes almost all African countries (except 6 minor-consuming countries) and provides continuous time series for each country (Amous, 1999). However, the FAO database presents estimates rather than actual figures, and provides no detailed sectorial figures. The International Energy Agency (IEA) database presents individual data for only 23 countries, and provides approximate global estimates for the 31 other countries under the heading 'OTHER AFRICA' (ibid). In addition, sector-based consumption of woodfuels is only available for the years 1995 and 1996, while the data for the remaining years are presented in aggregated form (aggregate primary supply of combustible renewable and waste).

The Energy Sector Management Assistance Programme (ESMAP) documents data for 39 countries at various quality levels, generally reporting only one reference year rather than a historical series. The Environment and Development Action (ENDA) and Institut d'Economie et de Politique de l'Energie (IEPE) document reported data for only 28 countries and one reference year. In addition, no detailed sector-based consumption figures are provided. Other national and international sources of data provide various levels of detail, consistency and accuracy; however, they focus on the demand side of woodfuel issues, neglecting the supply side, and generally do not mention any indication related to the origin, quality, or even estimation approach of the data, making it difficult to undertake an adequate assessment.

Box 1 Kenya biomass energy information availability and quality

- First ever national study done in 1984 (O'Keefe et al, 1984).
- Second National Study done in 2000 (Republic of Kenya, 2000) after 16 years. This was used to inform energy policy.
- First ever and only national study on charcoal alone done in 2005(ESDA, 2005).
- The methodology used for each study is different and the results are not necessarily comparable.

The evaluation concludes that, since woodfuels will remain a major energy source and a determining environmental and development issue in Africa in the mid- and long-term future, there is a need to improve information generation and availability on woodfuel demand and supply, as well as on its economic and social role. This should be achieved through regular, sustainable and systematic data collection, compilation and analysis processes. The approach used should be unified/standardised with the involvement of major international organisations in this field, such as FAO, UNEP, CIFOR, ICRAF, etc.

These processes could be orientated in four different directions:

a) In the short term, it is recommended that a more efficient data-collection process be created. This might be achieved through identifying the relevant institutions and experts in each African country and formulating a new collaboration process; modifying the data query procedure; defining a new questionnaire to address the issues relevant to woodfuel use.
b) In the medium term, the quality of woodfuel data in Africa should be improved considerably by launching a pilot programme which targets major-consuming countries or the countries where data quality is particularly poor. The programme should be centred around field surveys, using an adequate methodology and surveying approach.
c) In the longer term, it will be necessary to develop and establish a data-collection and updating framework in each African country, as well as a systematic transmission process to FAO. FAO would act in an observatory role, compiling, aggregating and storing the data. It is worth noting that this new process would need to be accurately defined in order to facilitate the aggregation process. Suggested programme components could include: launching an ongoing observation process for woodfuel data; defining a collaboration framework between African countries and FAO on woodfuel in order to monitor the process appropriately; defining regional collaboration and exchange of experience frameworks among African countries.
d) The evaluation study did not address socio-economic issues related to woodfuels; however, they constitute a crucial subject for which information needs to be collected and improved internationally, or even produced at the national level. As a first step, it may be possible to adopt a simplified approach aimed at improving knowledge, and subsequently use the results to launch localised pilot studies that could be extrapolated to the whole of Africa.

3.2 Key donors and partners in biomass energy

The information reviewed shows three generations of biomass energy projects in eastern and southern Africa. The first was from the early 1980s into the 1990s, which included activities such as tree planting, and improved stove development and dissemination. This was followed by projects on climate change mitigation. Over the last three years, tree-planting and stove-dissemination projects have resurfaced; however, these now have a market focus and place more emphasis on channelling most of the activities through the private sector (see Table 3).

Donor	Countries	Name of Programme	Partner(s)	Value chain component	Size of project/ remarks
USAID	Zambia	Community-based Forest Management Programme	Government of Zambia	Woodfuel supply	Sustainably manage 700,000 has
USAID	Ethiopia	Bamboo Sector	African Bamboo		US$1.75m
SNV	Kenya, Tanzania, Ethiopia, Senegal, Burkina Faso	Africa Biogas Partnership Programme		Utilisation of biomass	Target of 70,000 biogas units by 2013
SNV			Public-private Initiative led by the UN-Foundation. Global Alliance for Clean Cookstoves		US$250m, SNV contributing US$250,000 in cash and kind and also expertise. Target is to reach 100m households to adopt clean and efficient cookstoves by 2020
GIZ	Kenya		Ministry of Agriculture and Ministry of Energy	Promotion of efficient biomass energy stoves and biogas	
World Bank	Kenya	Kenya Natural Resources Management Project	Ministry of Environment, Water and Natural Resources	Water-shed approach	
World Bank	Africa			Information generation on the whole value chain	
EU, UNEP,	Kenya	Rehabilitation of the Northern Mau Forest in Kenya			€22.3m
IUCN	18 countries			Whole value chain	

Table 3 Summary of donors and partners working on forestry and woodfuel value chains in eastern and southern Africa

3.2.1 World Bank projects with African governments

In November 2012, the World Bank (2012) released the special report: *Forests, trees, and woodlands in Africa: an action plan for World Bank engagement*. This report highlights the importance of Africa's forests for economic growth and development, and for key ecosystem services supporting livelihoods and increased resilience to climate change. The report emphasises that the objectives of World Bank investments in forests and woodlands in Africa are to: create jobs, improve competitiveness, build resilience, and reduce vulnerability.
It recognises the diversity of forests in Africa, ranging from dry woodlands in the Sahel

Region to the tropical rainforests of the Congo Basin. The report highlights the diverse uses of forests and forest resources, which make key contributions to livelihoods such as agro-forestry in southern Africa and ecotourism in eastern Africa. It concludes that many of the uses of forests, trees and woodlands in Africa fall outside traditional forest industries and, as such, require cross-sector responses. Although the report stresses sub-regional differences in forests and forest-management challenges and opportunities, a number of common action areas are highlighted. These include: the development of sustainable wood-based energy markets; the restoration of degraded forests and woodlands; the development of timber plantations; improved governance of domestic timber industries; enhanced protected area management; improved forest sale management and additional investments in reducing emissions from deforestation and degradation; the important role of conservation. Others include: sustainable management of forests and the enhancement of forest carbon stocks in developing countries (REDD+); improved information and knowledge management related to forests, trees and woodlands; improved governance, transparency and stakeholder participation.

3.2.2 International Union of Conservation of Nature (IUCN)

IUCN's Forest programme strategic directions covering eastern and southern Africa are:

i. Restoration and maintenance of forest-related species diversity and ecosystem functions;
ii. Livelihood security, equality and sustainability of development at the local, national and regional level;
iii. Enhanced capacities of actors and groups influencing forest and woodland species and ecosystems;
iv. Enhanced institutional frameworks, including policies and forest governance.

IUCN works through its members (101 organisations in eastern and southern Africa spread across 18 of its 23 countries). The region has 11 state members, 11 government agency members, 5international NGO members, 72 NGO members, and 2affiliate members. Different members focus on relevant priority themes in their respective geographical locations.

According to a study conducted by Monjane (2009) for IUCN, eastern and southern Africa are largely covered by woodlands, but also considerable areas of forest. These are of importance for livelihoods, tourism and national economies, and serve protective and social functions, such as water regulation. Direct causes of and threats to forest decline, biodiversity conservation and protection, and social services largely stem from the agriculture sector. These are in the form of conversion to small-scale permanent agriculture followed by large-scale permanent agriculture and, to a lesser extent, due to the intensification and expansion of shifting cultivation. These threats are compounded by high regional dependency on woodfuel energy, both in rural and urban areas. Recent developments on land acquisitions for agriculture and biofuels pose a threat of further encroachment into forest lands, potentially exacerbating food insecurity and fuelling conflicts derived from insecure land tenure. These findings are similar to the findings of the DRC deforestation and forest degradation studies mentioned in Case Study 1. Other related threats include the widely limited understanding of the impacts of climate change and its implications on ongoing development strategies; inadequate structured forest institutions at the regional, national and local level; unarticulated polices within the sector and with other sectors of the economy; the lack of momentum in seizing private sector opportunities.

The IUCN study reveals that the key challenges for sustainable management of forests and woodlands in the region include:

a) The lack of an evidence base on the importance of woodland resources on livelihoods and economies of countries;
b) Ambivalent and limited enforcement of policies in relation to land and forest tenure;
c) Limited and unreliable data on resource bases, production and trade. This limits decision making and opportunities to mainstream the sector in wider regional and national development agendas;
d) The lack of evidence on the opportunity cost of woodlands and forests compared to other land uses;
e) The unaccounted value of forest and woodland regulatory and protection services e.g. water and tourism;
f) Limited acknowledgment of the trans-boundary effects of mismanagement of forest and woodlands, coupled with limited capacity to influence the global environmental agenda as a result of the limited and underestimated advantages to approaching regional concerns as a bloc.

In view of these challenges, Monjane argues for the most part that most national forest institutions require additional capacity to further reform themselves and proactively promote and develop new strategies and policies to respond to complex dynamics. These will include adaptation and mitigation to climate change, environmental services markets, and trends in energy markets. The sector also requires urgent cross-sector and integrated policy and development responses to negative impacts emanating from outside the sector. To succeed, forest and woodlands strategies must bring livelihoods to the fore. Regional bodies provide important platforms to strengthen national institutions and approaches to sustainable forest and woodlands management; however, they ultimately require strong national institutions to adequately perform their functions. In addition, this means reducing dependency and promoting the financial sustainability of regional blocs to internalise processes and proactively drive regional agendas.

Case Study 2 Gatsby Charitable Foundation/DFID

The Gatsby Foundation, in collaboration with Mondi Forests, started supporting tree biotechnology projects in Kenya, Uganda and Tanzania in 1997. Since then, the Foundation has evolved from engaging in research and propagation of eucalyptus clonal materials to looking holistically at the entire wood-product value chain, as well as the necessary supporting institutions and policy environment. The aim of Gatsby is to increase smallholder planting and employment in sustainable private forestry, raise net incomes for smallholders engaged in sustainable private forestry, and increase the supply of higher-value wood products and energy from sustainable sources. It also aims to ensure that quality services and industry functions are provided sustainably. Gatsby, with additional funding from DFID, is supporting forestry programmes in Kenya, Uganda and Tanzania.

Kenya and Uganda programmes: Gatsby supported the implementation of 40 clonal tree material trials conducted by the Forestry Research Institutes of Kenya, Uganda and Tanzania. The partners also started professional clonal tree nurseries in strategic sites in the three countries. The nurseries in Kenya and Uganda are now independent, self-financing entities running commercially, but with a social mandate. The Kenya and Uganda nurseries have independent local boards that also include relevant government agencies. The private-public partnership nature of these institutions ensures that they are well positioned to understand and engage with all activities in the forestry sector, from policy through to processing. In Kenya and Uganda, Gatsby is supporting capacity building of micro-, small- and large-scale private forest growers to enhance the commercial viability of tree growing. In Kenya, the Foundation is working with the Kenya Forest Growers Association (KEFGA) to review forest policy to improve the investment environment.

Tanzania programme: In Tanzania, a clonal tree nursery was established with the national forest research institute (TAFORI) and is yet to become fully independent. Gatsby has recently established the Forestry Development Trust (FDT) in Tanzania, with financial support from DFID and public support from the government. FDT is an independent entity working for the interests of the whole forestry sector, and has a long-term mandate and funding structure. While assisting with public-private partnerships, research and development activities, the programme focuses on market-based interventions with clear financial accountability. FDT is intended to adopt a portfolio approach to identify and alleviate constraints and inefficiencies at all levels of the timber and wood-product value chains. The target beneficiaries are smallholder tree growers. All interventions seek to improve the commercial viability of tree growing in order to add sustainable value to the sector.

East Africa regional programme: Gatsby intends to build on the FDT in Tanzania and the two clonal tree nursery companies in Kenya and Uganda to establish a large-scale forestry programme in East Africa. The aim is to tackle some of the key challenges to growth of private forestry in the three countries, as well as to share the lessons learned. In particular, Gatsby sees opportunities for regional benefits through sharing information and research on new planting materials, training tools, information systems, and government policies. Gatsby recognises that the challenges of long-term supply/demand balances affect all countries in the region, with private tree growing as one of the most viable solutions. The Foundation has been instrumental in driving the development of a regional tree improvement strategy for these three eastern African countries to ensure that available opportunities are exploited. In all its activities, Gatsby intends to work through and with legitimate local institutions, and in close collaboration with local governments and other relevant stakeholders. The larger part of the work is with the private sector, i.e. growers and processors, to ensure that wood-product markets are competitive and returns are fair.

Lessons learned from the Gatsby East Africa programmes:

a) Forestry development projects are generally long term and should be planned as such to at least complete a full cycle, depending on the target species and expected product, e.g. 5-6 years for fuelwood; 6-7 years for charcoal and transmission poles; 10+ years for timber.

b) Promoting tree growing for subsistence purposes is not sufficiently attractive. Growing for a structured market is more attractive.

c) Promoting small sub-components of the value chain seriously affects the effectiveness of projects, e.g. investing in raising seedlings or product marketing alone is not sufficient. The whole product value chain, e.g. timber value chain, poles value chain, fuelwood value chain, charcoal value chain or components of the value chain (fuelwood conservation, efficient stove projects), should be considered.

d) A conducive policy environment is necessary for the successful implementation of forestry and biomass energy projects.

Box 2 Successful forest project by the Gatsby Foundation in East Africa

The Gatsby Foundation East Africa regional programme has:

- Raised and sold 25 million clonal tree seedlings in different parts of East Africa at a population of 2,500 seedlings per hectare (equivalent to over 10,000 has of forests).
- At an estimated price of US$0.85 per seedling, the value of seedlings alone is US$21.25 million.
- If the products are sold for transmission poles at an estimated conservative price of US$30 per pole and assuming 80% survival of the trees, this translates to about US$600 million.
- A similar strategy can be used for fuelwood and charcoal production, where the key product from the plantations is charcoal or firewood.
- Three institutions have been formed to continue project activities on a commercial basis (hence translating to sustainability).

3.2.3 UN-REDD main drivers of deforestation and forest degradation in DRC

In early 2013, the UN Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD) released five reports from the DRC on the causes of deforestation and forest degradation.

The reports, prepared in collaboration with FAO, UNEP, the Catholic University of Louvain, and DRC civil society, are one component of the DRC's REDD+ preparation process and include an analysis of drivers based on field studies, remote sensing, and statistical analysis of deforestation and forest degradation in post-conflict DRC. Overall, the reports contain information on moist tropical forests, mountain forests, *Miombo* forests and the forest-savanna mosaic. In these forest types, the publications conclude that the main drivers of deforestation are:

i. The development of commercial agriculture, accounting for about 40% of deforestation;
ii. Subsistence farming (20%);
iii. the collection of fuelwood (20%).

With regard to forest degradation, the report cites the main causes as:

i. The collection of fuelwood, accounting for about 55% of all degradation;
ii. Industrial and artisanal forestry (15%);
iii. Illegal forestry (14%).

These studies, conducted in 2011-2012, have enabled DRC to reach a national consensus on the main drivers of deforestation in the country. Previously, various stakeholders had very different understandings about what these drivers were. The studies are, therefore, a very important step in advancing REDD+ efforts in the country. Various tools and methodologies were used to conduct these studies, including focus groups, remote sensing and statistical analysis. Their results have been compared in order to ensure the reliability of the final conclusions.

3.2.4 USAID – Zambia deforestation control

According to a report by USAID (2013b), Zambia risks depleting its forest cover in 15 years if the current rate of deforestation is not controlled. The Centre for International Forestry

Research (CIFOR) says it is important that forests are conserved because they are essential for food and fuel security. The country is estimated to be losing at least 300,000 hectares of forest each year. Driven by agricultural expansion and charcoal production, Zambia’s forests were under severe threat and the country Zambia is in the top 10 countries in the world for producing emissions from deforestation (ibid).

However, the implementation of global initiatives such as REDD+ could assist protect Zambia’s forest cover. REDD+ is an initiative that is attempting to create a system to pay countries to conserve their forests. The basic concept is that if the world needs trees, those countries that have trees (and are making efforts to keep them) should be rewarded by companies, organisations or governments that are contributing to global warming emissions. Zambia is one of the 16 countries in the world that is currently subscribed to the REDD+ concept and is currently implementing the Nyimba Forest project in a bid to generate scientific evidence through impact-oriented studies that will help in the formulation of a National REDD+ Strategy (NRS). That said, awareness at the community level on the changes in forest use is essential for the protection of forests. Forest cover requires protection as forests provide almost a quarter of household earnings for people living in or near forests, producing diverse foods that are essential sources of micronutrients and proteins (bush meat), and that serve as a safety net in times of crisis (ibid).

3.2.5 USAID – Zambia CBFMP for REDD+

The USAID-funded Community-based Forest-management (CBNFM) Programme for REDD+ Readiness in Zambia is a four-year project. USAID/Zambia's climate change programme objective is to improve natural resource management through:

a) Improved livelihoods in forest-dependent communities;
b) Improved joint management of natural resources, particularly forests;
c) Strengthened government capacity to develop policies & plans with stakeholders for REDD+ & EC-LEDS technologies for addressing climate change adopted.

The project is expected to work with the Government of the Republic of Zambia (GRZ) to establish at least 700,000 has of forest in participatory forest-management areas (PFMA) in forest reserves, game management areas, and customary lands within these PFMAs. CBFMP utilises the sustainable methodologies of joint forest and natural resource management between GRZ and communities. The programme is also expected to collect and analyse empirical data on carbon stocks within PFMAs to develop recommendations for national-level decision makers in GRZ. The programme will be used as a replicable and scalable mode of sustainable natural resource management that prepares GRZ and communities for direct pay-for-performance programmes and a diversification in income-earning opportunities.

3.2.6 Community-based natural forest management in Africa

This review of CBNFM initiatives in Sub-Saharan Africa considers those initiatives that evolved from early USAID investments in environmental and natural resource programmes. The authors argue that the potential for CBNFM projects in Africa remains untapped when compared with Asia and Latin America. The document provides a summary of CBNFM approaches that have proved successful, an overview of their impacts, and the conditions required to foster and sustain such efforts. The authors suggest that in the absence of comprehensive land use planning in most African countries, areas for CBFM can be prioritised by their likelihood of success using such criteria as quality of resources, access of markets and community interest in community forestry. Drawing from first-generation CBNFM projects in Niger, Benin, Ethiopia and Zambia, the authors outline a systematic process of strengthening local institutions, developing a forest-management plan, and implementing CBFM projects. The authors recommend the following to guide future CBNFM efforts in Africa:

a) Secure legal recognition of citizens' rights to exploit forest resources;
b) Strengthen community-based organisations;
c) Improve local governance and relations between government and local communities;
d) Invest in the planning process to get quality forest-management plans;
e) Develop management capacity of forest-based enterprises;
f) Understand the market and costs involved in reaching it;
g) Reduce recurrent costs of management for financial sustainability;
h) Include involvement of foresters and NGOs from pre-investment through post-project;
i) Make long-term commitments to external assistance;
j) All things equal, larger forests offer economies of scale;
k) Work with women and other marginalised groups (herders, for example).

3.2.7 USAID – Ethiopian bamboo sector

A study by the International Institute for Environment and Development (IIED) in 2009 revealed that Ethiopia had 959,662 has of highland and lowland bamboo (Seyoum, 2014). This equates to two thirds of Africa's current total bamboo resources. Benishangul Gumuz region is home to the largest proportion of it. Many farmers in the highlands manage and harvest highland bamboo in small stands on their farms. They harvest the culms from November to February and from June to September. The buyers of the culms include local furniture makers and consumers who use it for construction materials. Large-scale bamboo manufacturing is little known in Ethiopia, with only two factories currently in operation, and a third one currently having its machinery installed.

Bamboo Star Agro-Forestry, established four years ago, employs 250 people in Benishangul Gumuz region, Assossa Zone, and has 393,000 has of bamboo plantations. Adal Industrial Group Plc is also involved in large-scale production at its factory in the Sidama Zone of the Southern Region of Ethiopia. The company, established in 1989, first began its relationship with bamboo by producing incense sticks. In 1995, it expanded its use of the plant and started producing bamboo toothpicks. Nine years later, in 2004, the company introduced technology from the Far East and began producing bamboo flooring, curtains, table mats and charcoal briquettes.

African Bamboo follows on from these two companies and plans to get involved in bamboo production. It is currently installing machinery at its facility. The company intends to produce bamboo panels for outdoor decking, construction and pre-fabricated bamboo houses. It has already entered into agreements for bamboo farming with over 30 cooperatives, benefiting over 2,000 farmers in Sidama Zone. African Bamboo plans to export 100% of its production. While the total investment needed for production is estimated at ETB250 million,[1] the company has so far been able to raise just half of this amount. African Bamboo has already secured 52% of the market in Germany and is hoping to find the remainder in the rest of the world.

USAID awarded a total grant of US$1.75m to African Bamboo (ibid). US$1m of the grant is for developing and testing a heating process to make industrial and commercial quality bamboo using biofuels from organic waste, such as coffee husks and residue from processing the bamboo. The second grant of US$750,000 is to help the company prepare feasibility studies and market analyses to attract investment capital, and to meet requirements for exports to the United States and the European Union. The award arguably

[1] Approximately US$12.9m.

illustrates the commitment of the US government to assist Ethiopia's five-year Growth and Transformation Plan (GTP) through public-private partnerships.

African Bamboo is one out of a total of 475 organisations that applied for the award, which targets supporting innovative projects and integrating clean-energy technology into the agriculture sectors of developing countries to improve production. The company wants to engage more aggressively in its innovative work in renewable energy and agro-forestry processing now that it has won the award.

3.3 Key donors and partners in efficient biomass cook-stove programmes

Case Study 3 The Kenya Ceramic Jiko (KCJ) project

One of the most successful urban stove projects in the world is the Kenya Ceramic Jiko (KCJ) initiative. Over 85% of the urban population had adopted the stove by 2000 (Republic of Kenya, 2000). Known as the Kenya Ceramic Jiko, KCJ for short, the improved stove is made of ceramic and metal components and is produced and marketed through the local informal sector. One of the key characteristics of this project was its ability to utilise existing cook-stove production and distribution systems to produce and market the KCJ. Thus, the improved stove is fabricated and distributed by the same people who manufacture and sell traditional stove designs. Another important feature of the KCJ project is that KCJ design is not a radical departure from traditional stoves. It is, in essence, an incremental development from the traditional all-metal stove. It uses materials that are locally available and can be produced locally. In addition, the KCJ is well adapted to the cooking patterns of the large majority of Kenya's urban households. The KCJ design was not selected or identified at the onset of the stove programme; it was arrived at through a series of iterative and dynamic research and development steps that involved a large number of individuals, including existing artisans producing stoves, interested NGOs, government ministries, and research agencies. In many respects, the KCJ project provides an ideal case study of how an improved stove project should be initiated and implemented.

3.3.1 USAID grants for fuel-efficient cook-stove distribution in Kenya

In November 2013, USAID announced three awards made through the $1 million Fuel-efficient Cook-stove Distribution in Kenya Grants Competition to overcome distribution and financing bottlenecks in the Kenyan cook-stove sector. This is a major component of USAID's 'Developing a Sustainable Cook-stove Sector' project, and is part of USAID's $18-million commitment to the Global Alliance for Clean Cook Stoves, the members of which hope to foster the adoption of 100 million clean stoves by 2020. This project supports the development of private sector-driven markets that will promote the widespread adoption of clean, efficient cooking solutions among the 2.8 billion people worldwide who lack modern cooking stoves and fuels. The thought behind the project runs that creating commercially viable supply chains for fuel-efficient stoves is key to resolving distribution challenges and encouraging large-scale uptake of these efficient cook stoves, as well as unleashing the social, economic and environmental benefits which emerge from their use.

The Kenya Union of Savings & Credit Co-operatives (KUSCCO) will develop a cook-stove-specific credit facility to be accessed by 1,350 Savings and Credit Cooperatives (SACCOs) to lend to individual members seeking to purchase cookstoves. Demonstrating their strong commitment to the long-term sustainability and success of the fund, KUSCCO and its member SACCOs will provide two dollars of their own funds to the credit facility for every dollar provided by the grant –this effectively triples the impact of USAID's investment. Boma Safi, a Kenyan women-owned business, will expand and strengthen its distribution network, which includes KUSCCO member SACCOs, as well as other sales agents. With the resources provided by the USAID grant, Boma Safi seeks to demonstrate success in woman-owned, woman-led entrepreneurship in the energy sector, and to increase productive opportunities for women along the fuel-efficient cook-stove value chain.

BURN Manufacturing and the Micro Enterprises Support Programme Trust (MESPT) will create a revolving fund that will provide financing to cook-stove distributors in Kenya. MESPT and BURN have also committed to matching the USAID financial resources allocated to the revolving fund, expanding its ability to alleviate the capital constraints experienced by many cook-stove enterprises.

3.3.2 Potential Energy: Fuelling cook-stove markets in East Africa

Each year over two million people die from illnesses related to breathing smoke from cooking fires, and many women are exposed to violence as they travel up to seven hours a day to search for fuel wood to cook for their families. Potential Energy is an energy-efficient stove promoted in Darfur Sudan & Ethiopia. It is a US$1.5 million project funded by USAID. The stove was introduced to address health illnesses and hazards of dependence on wood-burning fires.

Many models for high-efficiency stoves exist to replace traditional open fire methods, but few have achieved widespread use or commercial sustainability, partially due to consumer behaviour and the expense of the products. Originally the Darfur Stoves Project, Potential Energy was founded as a volunteer organisation in 2005. A team of scientists and engineers then developed a Berkeley-Darfur stove, aggressively pursuing market-testing and end-user feedback in Darfur. Using lessons learned from early work on cook-stove adoption in Darfur, Potential Energy is pursuing a market creation strategy in Ethiopia. The organisation will expand its distribution and marketing network and develop innovative pricing models and flexible financing options for consumers. With support from Development Innovation Ventures, Potential Energy and partners will assess the group’s impact and the relative effectiveness of the different marketing strategies it pursues using a randomised control trial. The potential cost effectiveness, impacts and implications of the Berkeley-Darfur stove is that it requires only half as much firewood as traditional cooking methods; users save more than US$300 per year in fuel costs, or half the labour time and effort gathering firewood. Over the five-year lifespan of the stove, this saving is approximately US$1700 per household.

Case Study 4 GIZ Kenya energy-efficiency stove project

GIZ has been working on cook-stove programmes in Kenya since the early 1980s. However, the most recent project in Kenya started in January 2006 and is now in its third phase. According to the project report, traditional biomass accounts for 97% of the national domestic energy requirement in Kenya, mainly cooking (GIZ, 2013). Biomass energy demand in the country is 3.5 million tonnes per year, while its supply is 1.5 million tonnes per year. The massive deficit of 2 million tonnes in fuelwood supply has led to high rates of deforestation in both exotic and indigenous vegetation, resulting in adverse environmental effects such as desertification, land degradation, droughts and famine. The high demand for fuelwood in the country has created a need to enhance the adoption of energy-saving stoves in rural areas where firewood is the main source of cooking energy. It is in an effort to reduce these negative impacts that the Private Sector Development in Agriculture (PSDA), through collaboration with other development partners, initiated the ‘Promotion of Improved Energy Stoves’ project in January 2006. The aim of the project was to triple the production and adoption of improved energy stoves from 15,000 to 45,000 within 1 year in 12 sub-counties in Kenya. This was achieved by taking the pilot results and scaling up activities to extend to other areas through a project extension until 2011.

Jiko Kisasa and rocket stoves are the two types of firewood stoves promoted by the project. Jiko Kisasa is a stove that was developed in Kenya in the 1980s after intensive research by many institutions under the leadership of the Ministry of Energy, GIZ (at the time called GTZ) and Maendeleoya Wanawake Organisation (MYWO). Kisasa (also known as Maendeleojiko and Upesijiko) stoves have an efficiency of 35-40% compared to more traditional three-stone fireplaces, which have about 10%. Over the last 30 years many organisations, such as the Ministries of Agriculture and Energy and Practical Action (formerly ITDG), have been disseminating and promoting this technology. The rocket stove, on the other hand, is a recent technological development of the APROVECHO research centre, with trials done in many African countries. Rocket stoves have an efficiency of 50-60% compared to three-stone fireplace efficiency of 10%. PSDA introduced the technology on a pilot basis in Keumbu division in Kisii County for one year before scaling up to other areas. Within project areas, rocket stoves are made in different versions and sizes to meet each client's need, ranging from households and hotels to institutions and ovens. The project focuses on capacity building at the local level to continue increasing access to fuelwood-efficient stoves for many rural households and institutions.

Achievements: At the start of the project, the improved stove adoption rate was only 5%. However, after two years of intervention, the adoption rate had risen to38%. This project has seen the entry of new value chain actors known as Jiko Kisasa Installers and Rocket Stove Builders. These are unemployed youths trained by the project on stove installation and construction skills. They have emerged as a key driving force to stove adoption in the country. Stove producers have increased and expanded their business because of high demand. The Improved Stoves Association of Kenya (ISAK) is now registered and is taking up stove quality control in collaboration with the Kenya Bureau of Standards (KEBS). The association's responsibility is to ensure the sustainability of stove activities. Many new jobs (over 5,000) have been created, particularly for young people. Taking the 1,017,272 (June 2010 figure) stoves produced and sold to households for an average price of US$2, an income of US$2,034,544 for stove producers has been generated over a period of three years. By June 2010, 850,000 energy saving stoves were installed, saving 930,000 tonnes of fuelwood per year. This is equivalent to over 50,000 has of forest. Annual carbon dioxide emissions have been reduced by 1,700,000 tonnes. The stove business is now commercialised, with different value chain players able to profit from it. ISAK has taken responsibility for sustainability and will work with the government to ensure quality control.

Box 3 Successful efficient stove dissemination project - GIZ Kenya

- Many new jobs (over 5,000) have been created, especially for young people.
- An income of over US$2,034,544 for stove producers has been generated over a period of three years.
- By June 2010, over 850,000 energy-saving stoves were installed, saving an equivalent of 930,000 tonnes of fuelwood per year (equivalent to over 50,000 has of forest).
- Annual carbon dioxide emissions have been reduced by 1,700,000 tonnes.

3.3.3 Potential Energy: USAID Fuelling the cook-stove market in East Africa

In 2012 Potential Energy established itself as an independent 501(c)3. The organisation has thus far distributed more than 22,000 fuel-efficient stoves in Darfur; most were donated to women in IDP camps in North Darfur in the wake of the humanitarian crisis; however, in the past year, the Potential Energy has moved to a market-driven approach and the remaining stoves have been sold to women in urban and rural locations outside of the camps. Through its work, Potential Energy has developed critical partnerships with organisations like Oxfam America and Plan International, increased the capacity of local organisations in Darfur, built its distribution and marketing network, and is developing innovative pricing models and flexible financing options for consumers.

Based on its success in Darfur, Potential Energy has replicated its market creation strategy to develop and sell stoves in Ethiopia, starting in 2013. The $1.5 million, three-year grant from USAID's Development Innovation Ventures Initiative supports Potential Energy's transition to a social enterprise approach by supporting it to test pricing strategies and market and distribution channels via local organisations. Potential Energy is collaborating with the Lawrence Berkeley National Laboratory's Institute for Globally Transformative Technologies for research and development, and has engaged with the Center for Effective Global Action (CEGA) to assess the project's impact and relative effectiveness of different marketing strategies.

3.3.4 Charcoal production in Tanzania

Charcoal is an important household fuel and, to a lesser extent, industrial fuel in many developing countries. It is mainly used in urban areas where its ease of storage, high energy content (30MJ/kg as compared with 15MJ/kg for woodfuel), lower levels of smoke emissions, and resistance to insect attacks make it more attractive than woodfuel. In Tanzania, charcoal accounts for an estimated 90% (roundwood equivalent basis) of biofuels consumed in urban centres (World Bank, 1988). The production of charcoal spans a wide range of technologies, from simple and rudimentary earth kilns to complex, large-capacity charcoal retorts. Various production techniques produce charcoal of varying quality. Improved charcoal production technologies are largely aimed at attaining increases in the net volume of charcoal produced, as well as at enhancing the quality characteristics of charcoal. Typical characteristics of good-quality charcoal are shown in Table 4.

Characteristics	
Ash content	5%
Fixed carbon content	75%
Volatiles content	20%
Bulk density	250-300kg/m^3
Physical characteristics	Moderately friable

Table 4 Typical characteristics of good-quality charcoal

Efforts to improve charcoal production are largely aimed at optimising the aforementioned characteristics at the lowest possible investment and labour cost while maintaining high production volume and weight ratios with respect to the wood feedstock. The production and distribution of charcoal consist of seven major stages that include:

a) Preparation of wood;
b) Drying-reduction of moisture content;
c) Pre-carbonisation – reduction of volatiles content;
d) Carbonisation – further reduction of volatiles content, e.g. end of carbonisation – increasing the carbon content;
e) Cooling and stabilisation of charcoal, e.g. storing, packing, transport, distribution and sale.

The project in Tanzania was part of a World Bank-financed programme; external financial support provided the initial funds for undertaking scheduled activities. There appears to have been limited efforts to involve local credit and banking institutions in the activities of the project, which may account for the almost total absence of local entrepreneurs in its initial phases.

3.4 Bioethanol and biogas

Recently, interest in using bioethanol as an alternative to petroleum fuel has been escalating due to decreases in the availability of crude oil. The application of bioethanol in the motor-fuel industry can contribute to a reduction in the use of fossil fuels and decreased carbon emissions, as well as stress the rapid decline in crude oil availability. Bioethanol production methods are numerous and vary with the types of feedstock used. Feedstocks can be cereal grains (first-generation feedstock), lignocellulose (second-generation feedstock), or algae (third-generation feedstock). To date, the US and Brazil are the leading contributors to global bioethanol production. In Sub-Saharan Africa, bioethanol production is stagnant. During the 1980s, bioethanol production was successful in several countries, including Zimbabwe, Malawi, and Kenya. However, because of numerous challenges such as food security, land availability and government policies, achieving sustainability was a major hurdle. The case studies below examine the history and challenges of bioethanol production in Sub-Saharan Africa (SSA), and demonstrate the bioethanol production potential in SSA with a focus on using bitter sorghum and cashew apple juice as unconventional feedstocks.

Case Study 5 Malawi

Malawi commenced its bioethanol programme in 1982 utilising ethanol from a distillery located at Dwangwa sugar mill owned by The Ethanol Company Ltd (Ethco), which had the capacity to produce 10 million litres per year. It produces ethanol from molasses and raw sugar. Ethco currently produces ethanol to supply a national blend of 15% ethanol which could be increased to 20%. Production of 20 million litres/year could be achieved with minimal capital investment by operating the present fermentation/distillation plant all year round. A further option under consideration is the construction of a second plant near the Sucoma estate, the by-product molasses of which are of little or no opportunity value. The potential exists to double ethanol production immediately and, in the longer term, produce sufficient bioethanol to displace the country’s entire gasoline imports. Annual demand is approximately 60 million litres of gasoline and 80 million litres of diesel oil (Moncrieff and Walker, 1988). Tests indicate that Malawi can displace 10-20 million litres of imported petroleum with ethanol in the medium term.

Case Study 6 Kenya

In the 1970s, the combination of high oil prices, large fluctuations in world molasses prices, and a sharp rise in transport costs paved the way for the creation of the economic and political conditions to set up a bioethanol programme in Kenya. However, this programme was plagued with difficulties from the start. Initially, the idea was to set up two ethanol plants (Madhvani and Muhoroni) using sugarcane molasses. The Madhvani plant was never completed due to a number of technical, economic and political reasons: it was too costly, too sophisticated, and took little advantage of the local conditions. Due to the lack of access to information and untied finance, the choice of technology in the international market was severely constrained; the resulting technology chosen was very sophisticated and capital intensive. Unlike the Kenya Ceramic Jiko wood-stove programme, government involvement in the joint project had a negative impact and distorted the economics, which was further complicated by the absence of a clear and cohesive long-term government policy on ethanol production (Rosillo-Calle et al, 1991). The smaller Muhoroni plant, integrated into an existing sugar refinery, was, however, successfully constructed (inland from Kisumu) and completed in 1983. It is an integrated sugar-ethanol plant which also produces four tons of baker's yeast per day. At the current capacity of 60,000 litres/day, it produces all of Kenya's ethanol using sugarcane molasses. This has been blended at 10% with gasoline; but blending at 10% ended in 1993. The project continuously registered losses due to uncompetitive pricing, poor management, resistance from oil companies, and loan-servicing burdens. Ethanol from Muhoroni is currently being exported.

Case Study 7 Zimbabwe

In 1980 Zimbabwe pioneered the production of fuel ethanol for blending with gasoline in Africa. Initially, a 15% alcohol/gasoline mix was used, but due to increased consumption, the blend is now about 12% alcohol. This is the only fuel available in country for vehicles powered by spark-ignition engines (Scurlock et al, 1991). Annually, production of 40 million litres has been possible since 1983, although this has recently been severely constrained by drought. Plans for an expansion to 35 million litres per year have been finalised, but expansion depends on the availability of water. Production costs in 1988 were approximately $0.75 per gallon (Steinglass et al, 1988) which broke even with landed gasoline imports when compared with local molasses prices of approximately $25 per tonne. Zimbabwe's sugar industry consists of two private sugar companies, Hippo Valley Estates Ltd and Triangle Ltd. Together they operate two of the world's most efficient irrigated sugarcane estates and factories. With sufficient water, each was able to grow 2 million tons of cane per year.

Estimates show that the area of land which would be needed to grow cane to provide enough alcohol to replace all imported gasoline and meet domestic sugar needs (but with none for export) is about 52,000 has, which represents less than 0.2% of available agricultural land in Zimbabwe. An alcohol programme that would power all Zimbabwe's cars with pure alcohol would not therefore necessarily compete for land with food crops. However, the major challenge would be water for irrigation. There is an expansion plan to be implemented in five phases. The first started with the opening of the Mushwe Dam in 1991. This would allow for an extra 3000 has of cane to be planted. The capacity of the ethanol plant could be expanded to 50 million litres per year, provided there be no appreciable increase in the demand for sugar. The ethanol plant at Triangle is an example of a biomass-to-energy system which has operated successfully for over a decade. The plant was designed to produce 120,000 litres of ethanol per day, with on average, one tonne of sugarcane giving 125kg of sugar and 7.5 litres of alcohol. Zimbabwe has pioneered the production of fuel ethanol in Africa and provided valuable experience for other countries wishing to diversify their sugar industry to include fuel production.

3.4.1 Biogas technologies for Eastern and Southern Africa

Biogas is produced by the anaerobic fermentation of organic material. Biogas production can be considered as being one of the most mature biomass technologies in terms of the numbers of installations and years of use in countries such as China and India. It has the potential for multiple uses, e.g. cooking, lighting, electricity generation, running pumpsets and other agricultural machinery, and use in internal-combustion engines for motive power (Bhatia, 1990). Biogas technology is currently receiving increasing attention due to a combination of factors. Anaerobic digestion can make a significant contribution to the disposal of domestic, industrial and agricultural wastes which, if untreated, could cause severe public-health and water-pollution problems. The remaining sludge can then be used as a fertiliser (providing there is no polluting contamination). It therefore contributes to the control of environmental hazards and recycling of nutrients while alleviating dependence on imported fuels (Gunnerson & Stuckey, 1986). When manure is used in digesters, the sludge actually performs better as a fertiliser since less nitrogen is lost during anaerobic digestion, the nitrogen is available in a more useful form, weed seeds are destroyed, and the sludge does not smell and does not attract flies or mosquitoes. Furthermore, it yields more useful energy than when burned for cooking (as is the common practice in many rural regions).

Biogas production systems are relatively simple and can operate at small and large scales in both urban and rural communities. Almost all current biogas programmes, however, are based on family-sized plants which lose significant economies of scale, are suited more for cooking than electricity generation, and often do not produce enough output just to supply this need. Community biogas plants are more economical and can provide enough electricity for pumping water, lighting, etc. However, there are social difficulties of organisation and equity in the contribution of feedstock and the distribution of costs and benefits.

The basic designs of biogas plants – fixed-dome (Chinese), floating-drum (Indian) and bag (membrane) – have been used in a number of countries for many years. The designs reflect modest optimisation for reduced capital costs and increased volumetric gas yields. Biogas can be used in internal-combustion engines, using either the gas alone in an adapted petrol engine, or using a mixture of biogas and diesel in an adapted diesel engine. The main advantage of a diesel/biogas engine is the flexibility in operation, since it can operate as a dual-fuel engine using biogas and/or diesel. Usually, dual-fuel engines are designed that, when biogas is available, the engine will utilise it, and when it is exhausted, the engine automatically switches over to diesel without any interruption. Diesel engines are reliable, simple to maintain, and have a longer working life and higher thermal efficiency than petrol engines. They are also more extensively used in rural areas.

Biogas technology has made some important advances in recent years, e.g. in China, Denmark and the United States. However, the technology of anaerobic digestion has not yet fully realised its promised potential for energy production. In industrialised countries, biogas programmes have been hindered by operational difficulties, a lack of basic understanding, and innovation. In some developing countries, the development of biogas programmes has lacked urgency because of readily available and inexpensive traditional fuels, such as fuelwood and residues. A lack of local skills, coupled with high costs, tend to be a significant deterrent to optimisation and widespread acceptance of biogas technology (Hall & Rosillo-Calle, 1991).

3.5 Other programmes of relevance to the study

3.5.1 French Development Assistance (AFD) in East Africa

A 2013 French Development Assistance report (AFD, 2013) indicates that the services provided by the organisation include technical assistance, training, product development and credit line implementation. East Africa's transition process towards renewable energy (RE) sources is essential for the region's overall development. The project's objective is to achieve diversification of energy sources in a technically, economically, and financially viable manner. Target investments are mainly projects of maximum US$13 million in hydroelectricity, biomass, biogas, and photo-voltaic solar and wind power. Other eligible projects are energy efficiency (EE) improvements, mainly in the agribusiness sector. These EE/RE investments will also contribute to the sustainability of investors' businesses through more secure power supply and lower energy expenses. AFD provides a credit facility to financial institutions in Kenya, Uganda, and Tanzania for financing these investments. The Kenya Association of Manufacturers (KAM) manages the Regional Technical Assistance Programme (RTAP). The consortium of Burgeap/ICE and Frankfurt School of Finance and Management implements the RTAP by supporting financial institutions, investors and project developers through the entire investment process. Sufficient awareness needs to be raised, particularly among private companies in the region, to utilise these provided opportunities.

3.5.2 Africa-EU Energy Partnership (AEEP)

In the Second High-level Meeting (HLM) of AEEP, which was jointly hosted by the Ethiopian Austrian, German and Mauritian governments and the African and European Co-Chairs of AEEP, the African Union Commission (AUC) and the European Commission, concluded with the adoption of the Addis Ababa Communiqué, which contains key messages and recommendations on achieving the AEEP's 2020 Targets for Africa, and is to be forwarded to African and EU Heads of State and Government at the EU-Africa Summit in April 2014 (IISD, 2014). The Communiqué contains nine recommendations for accelerating access to sustainable energy on both continents and achieving the AEEP Targets, as well as four key messages to be forwarded to African and EU Heads of State and Government at the EU-Africa Summit scheduled to take place in April 2014. SSA delegates need to be sensitised to constructively engage with the importance of investing in biomass energy and associated technologies.

The AEEP HLM took place in February 2014, in Addis Ababa, Ethiopia, and gathered over 450 participants to review progress in implementing the 2020 Targets under the theme 'Taking the Next Step: Africa and the EU are tackling energy challenges together'. Delegates discussed experiences, tools and approaches for enhancing energy access in Africa, as well as accelerating inclusive energy-access solutions and policy through partnerships with civil society; the Africa-EU Renewable Energy Cooperation Programme; a mini-grid policy toolkit consultation workshop; making sound energy decisions; the role of data collection in Africa; attracting investment for clean energy in Africa (the Climate Scope Index); rural electrification (financial models and commercial project examples). Energy ministers also reviewed the AEEP's achievements since the first HLM and explored how to improve cooperation between the policy and business sectors in order to attract and substantially accelerate private investments to meet the AEEP 2020 Targets.

3.5.3 European Environment Agency and climate change impacts

A new report published by the European Environment Agency (EEA) (2014) on measuring black carbon in the air reviews monitoring networks currently measuring black carbon, measurement methodologies, and the use of data. The report, titled *Status of black carbon monitoring in ambient air in Europe*, provides a summary of: black carbon definitions as discussed in the air quality monitoring community; the current status of black carbon-related monitoring in Europe; available measurement techniques and associated technical issues; monitoring networks; current data reporting practices. Noting that black carbon can harm human health and contribute to climate change, the EEA stresses that cutting its emissions has many potential benefits. In recent years, its effects have become better understood, and black carbon is increasingly perceived as a target for environmental control.

According to the EEA, black carbon is the sooty part of particulate matter formed by the incomplete combustion of fossil fuels and biomass, and is mostly emitted by vehicles, non-road mobile machinery, such as forestry machines, ships, and coal- or wood-burning stoves. Of all air pollutants, particulate matter is the most harmful to health in Europe, with the black carbon being particularly harmful as it represents a mixture of very fine, partly carcinogenic particles. The EEA points to the existing debate over whether reducing this pollutant could make significant inroads in reducing climate change, with some suggesting that black carbon's effect on climate is more potent than previously thought. In the atmosphere, black carbon absorbs solar radiation, leading to a warming of the atmosphere. When it settles on snow or ice, the darker colour absorbs more heat, accelerating melting. While this study is based in Europe, it has implications on Africa because of its high dependence on biomass energy (used especially for cooking) and also the types of stoves used. The findings can therefore also be applied in Africa; however, many studies need to be conducted to verify these fears.

3.5.4 CIFOR summarises global REDD+ study findings

In October 2013, The Centre for International Forestry Research (CIFOR) released a series of factsheets on the research findings and goals of the *Global Comparative Study on REDD+*, which is being implemented to identify challenges and enabling conditions for REDD+ (CIFOR, 2009a). The factsheets focus on the first phase of the study, which began in 2009, and consider REDD+ policies, sub-national initiatives, measurements of carbon emissions, synergies between climate change adaptation and REDD+, and REDD+ benefit sharing. The factsheets also note that the first and second phases of the project will examine multi-level governance, carbon management, land use decisions, and knowledge sharing. The findings of these factsheets are relevant to eastern and southern African countries, as they are in various stages of formulating their national REDD+ policies and programmes.

SECTION 4

Summary and opportunities for engagement

4.1 Forestry and biomass energy programmes

a. Biomass energy provides over 80% of energy for countries in eastern and southern Africa and will continue to do so for the foreseeable future. Governments in the region should therefore acknowledge this and invest in the sustainable production and utilisation of biomass resources.

b. Evidence from the studies reviewed shows a trend towards more commercial/market models and more private sector partnerships. However, there is a disproportionate distribution of benefits among the woodfuel value chain actors, with producers being the most disadvantaged. While commercial models should be scaled up and strengthened to ensure the effectiveness and sustainability of biomass energy programmes, fair distribution of returns among all value chain actors should be upheld.

c. The traditional three years for biomass energy programmes is too short a period to realise the full results of such programmes. Forestry/biomass energy programmes should therefore be established with a funding timeframe of a minimum of six years.

d. Reliable information/data are key to effective planning and the implementation of biomass energy programmes in the region. There is need for systematic, standardised and regular generation of information in the biomass energy sector in order to facilitate planning, investment and monitoring of trends and impacts. Supported by donors, relevant international organisations such as FAO, UNEP, CIFOR and ICRAF should engage with national governments, national forest and energy research institutions, academic institutions and regional blocs to fill the information gap. Where appropriate institutions do not exist, they should be created. A regular timeframe of, for example, 10 years could be considered.

e. Many countries in the region depend on unsustainably harvested wood from naturally growing woodlands for their biomass energy supply. This is contributing to deforestation, woodland degradation, and a loss of biodiversity. Harvesting wood for charcoal and fuelwood from naturally growing woodlands should therefore be guided by approved management plans to ensure sustainable supply of wood resources while maintaining biodiversity of tree and shrub species.

f. Depending on agricultural crops and the efficiency in processing wood resources, there are plenty of low-value biomass resources that could be improved through value addition, e.g. briquettes to improve on acceptability by consumers. This can significantly contribute to a reduction in demand for solid fuelwood and charcoal.

g. Institutional competition and rivalry has greatly contributed to the non-performance of the biomass energy sector in the region. This is particularly the case where sectorial activities appear in several government ministries such as energy, forests, environment and agriculture, so that none of the ministries takes full responsibility for the sector's development. This, together with institutional territorial supremacy wars, means that not much is achieved. Growth in the biomass energy sector will therefore require a clear definition of institutional roles in each country, the strengthening of institutions, policy and legal framework capacities at the national and regional level, and greater human resource capacity to implement biomass energy policies.

h. Forests, woodlands, woodlots and individual tree resources are grossly undervalued in the region. Knowledge of the true value of these resources could greatly inform decision making at all levels. This can also tilt political will in favour of biomass energy development. There is, therefore, a need to pursue forest and woodland accounting and build valuation systems in order to reflect the appropriate value of these resources.

i. Communities have not seriously appreciated the value of biomass energy resources. There is a need to promote participatory methods for data collection that deliberately and constructively engage communities. This will help communities to understand the value of wood resources and generate willingness to manage the resources sustainably. There is also a need to promote resource-based small-to-medium enterprises aimed at improving market share of the value chain of the resources traded among local producers.

j. Most of the deforestation and forest/wood degradation that occurs also has origins in the lack of clear land and forest tenure rights. Decentralisation and secure tenure rights to forests/woodlands for local communities can contribute to responsible and sustainable management of these resources. This too needs to be pursued.

k. Private sector firms sometimes tend to be more profit driven at the expense of environmental health. There is need to cultivate and promote environmentally sound practices and partnerships between private sector entities and local communities to sustainability manage forest and woodland resources.

l. There is limited understanding of the effects of climate change and mitigation strategies, particularly among at the local level. There is, therefore, a need to create sufficient awareness among local communities and other key players on climate change effects and mitigation strategies in order to effectively engage them in the implementation of associated programmes to reduce carbon emissions from deforestation and degradation. This will, in turn, lead to the sustainable management of forests and the enhancement of forest carbon stocks in all the countries of the region (REDD+).

m. There are a number of land- and infrastructure-based sectors of the economy that intersect with the biomass energy sector and affect the sector's performance. The key sectors include agriculture and rural development, tourism, water, mining, and transport. These sectors should be appropriately engaged for the successful development of the biomass energy sector.

4.2 Biomass Energy Efficiency Programmes

a. While stove programmes for urban populations have been successful in some countries, like Kenya, other countries in the region still require a lot of catalytic engagements to set the process moving, drawing heavily on previously implemented projects. To ensure the sustainability of efficient stove programmes, there is a need to promote expanded enterprise-/commercial-based manufacture of energy-efficient stoves and to build business capacity along the whole value chain. The model adopted by USAID in Kenya through KUSSCO Ltd and other private companies appear to be very promising and should be explored in other countries.

b. While the KCJ in Kenya is a successful, urban, energy-efficient stove, it is still struggling with quality control. Capacity for improved stove quality control should be enhanced through stakeholder organisations and national and regional regulatory institutions.

c. Regular studies on the conservation effectiveness of promoted energy-efficient stoves are scarce in the region. It is, therefore, possible to continue promoting stoves, the performance of which in homes and institutions is insignificant. Incorporated in a biomass energy information-generation and -management system, such studies should be undertaken regularly in a systematic manner in order to monitor their economic, social and ecological impacts (and usefulness).

d. Investment in charcoal-production efficiency has received the least attention of all woodfuel value chain components. Charcoal is in very high demand, especially in urban areas in the region. With the high regional growth rates of urban populations, there is a need to invest sufficiently in the efficient production of charcoal by developing and promoting appropriate charcoal-production kilns and streamlining marketing of both kilns and charcoal.

Reference	Method of data gathering of study	Summary of findings
1. Zulu, L.C. (2010) 'The forbidden fuel: charcoal, urban woodfuel demand and supply dynamics, community forest management and woodfuel policy in Malawi', *Energy Policy*, *Volume 38*, *Issue 7*, p3717–3730.	Secondary data and survey	The study indicates that there is limited government capacity and growing illegal production of charcoal in forest reserves. The study recommends that new policies should include commercial woodfuel production, licensing for revenue, and ecological sustainability under community-based forest management or concessions within or outside selected reserves. Enterprise-based approaches for poverty reduction, small holder tree growing, woodfuel energy conserving technologies, improved electricity supply and agricultural productivity should be prioritised.
2. Practical Action South Africa (PA SA). (2012) *Business plan for the adoption of eco-charcoal as an alternative economic activity in Chongwe district of Zambia*. Harare.	Secondary data, key informant interviews, field observation	The study summarises that commercial charcoal production by rural communities is viable from natural woodlands if investment in sustainable production of wood is upheld through appropriate institutional arrangements that include community charcoal associations and government. In addition, there has to be fair distribution of income along the value chain.
3. Practical Action Eastern Africa (PA EA). (2010) *Biomass Energy Use in Kenya*. Nairobi.	Desk study of secondary data	Kenya derives 68% of its energy from biomass. Over 90% of the wood harvested is used for woodfuel. Up to 99% of the charcoal used is from low-efficiency kilns (10%). There are policies and legislations in place to facilitate sustainable forestry and biomass energy development, but there is very little formal investment in the sector.
4. PISCES. (2013) *Socio-economic impact assessment of a sustainable charcoal sector in Kenya*. Nairobi, Kenya: Practical Action.	Desk study of secondary data	Kenya derives charcoal from three major systems that include ranches (40%), trust land (45%) and government forests (15%).

Reference	Method of data gathering of study	Summary of findings
		Future strategies should aim more at on-farm production, efficient conversion from wood to charcoal and efficient end-use technologies.
5. Foster, J. (2014) *Independent Private Forest Commercial Growers Stakeholders* (Presentation). Nairobi.	Secondary data review	The paper summarises project activities and achievements for the Gatsby Foundation Trust in East Africa since 1997 and indicates the strategies that can be adopted for success. This includes longer-term engagement for tree projects, identification of flying technologies (high-demand technologies), and commercial focus for sustainability.
6. Miyuki, I. Neufeldt. H., Dobie, P., Njenga, M., Ndegwa, G. &Jamnadass, R. (2013) 'The potential of agroforestry in the provision of sustainable woodfuel in sub-Saharan Africa', *Current Opinion in Environmental Sustainability*, *Volume 6*, p138–147. Available at: http://dx.doi.org/10.1016/j.cosust.2013.12.003	Secondary data review	The study argues that woodfuel is the main source of energy in SSA and will continue to be so for a long time to come. There is a lack of reliable data and consistent methodologies to assess the impact of the magnitude of the impacts of charcoal and fuelwood demand and supply in SSA. In addition, charcoal conversion technologies are grossly underdeveloped. The authors recommend that, while efforts are made to promote other cleaner energies, sufficient efforts should be invested in the sustainable supply and utilisation of charcoal for energy.
7. Monjane, M. (2009) *Eastern and Southern Africa: Forest and Woodlands Situation Analysis*. IUCN.	Secondary data review	The study is a situational analysis of the forest sector in eastern and southern Africa to feed into the strategic planning process for the forestry programmes of IUCN. It recommends interventions in institutional and legal frameworks, forests and woodland accounting, and increased environmental sensitivity by the private sector.
8. Thomas, J. (2006) *The Environmental Problems in Angola. Case Study of Cabinda*. Portland Independent Media Center.	Secondary data from a PhD thesis	The study reports that fuelwood and charcoal provide 70-80% of energy used. Demand for fuelwood and charcoal is increasing rapidly because of

Reference	Method of data gathering of study	Summary of findings
		increasing populations; despite there being oil and gas in the country, the government does not have the capacity, interest and plan to supply gas, oil and electricity to the population.
9. Amous, S. (1999) *The role of wood energy in Africa*. Apex-ebbd/Food and Agricultural Organization of the United Nations, Forest Department: Tunis, Tunisia/Rome, Italy.	Review of secondary data and simulations	The study evaluates availability of data on wood fuels and reports that woodfuel will remain the main source of energy in Africa for the foreseeable future. It indicates that while fuelwood has been the main source of energy in the region, with rapid urbanization, charcoal will become more important. It concludes that FAO has the most comprehensive wood energy data but it is based on estimates and not actual data. The author recommends regular, systematic, standardised data collection for the sector coordinated by FAO.

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