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Developing sustainable tree-based bioenergy systems in sub-Saharan Africa



Charcoal for sale in Nairobi. Urbanization increases demand for a range of energy options – liquid fuel for transportation, electricity for lighting, while charcoal remains important for cooking. Photo: Miyuki Iiyama/ICRAF

Introduction

Worldwide over 1.3 billion people are without access to electricity and 2.6 billion people are without clean cooking facilities. In Africa, over 80% of the population depends on firewood and charcoal for cooking and less than 50% has access to electricity.

The need to bring people out of energy poverty in Africa is well-recognized, including by the United Nations Sustainable Energy for All initiative (SE4ALL), and the Sustainable Development Goals (SDG) include a goal to “ensure access to affordable, reliable, sustainable and modern energy services for all”.

Given the rising demand for energy due to population growth and increasing urbanization, there is an urgent need to invest in the sustainable development of tree-based bioenergy systems in Africa that include solid and liquid fuels to address the needs of all sectors of society as traditional forms of energy generation for cooking and heating will grow in the coming decades.

Over 80 experts from government, private sector, research and civil society, mainly from the African continent, met in May 2015 to discuss the opportunities and challenges of tree-based bioenergy. This policy brief outlines the participants’ collective recommendations around firewood, charcoal, liquid biofuels and biomass for heat, power and transport in sub-Saharan Africa.

Key messages

- Tree-based bioenergy has the potential to sustainably provide fuel for cooking and heating in households and to services requiring the provision of accessible, affordable and reliable energy sources.
- Improving the cooking of food using wood-based fuels in Africa requires an in-depth understanding of the full production-to-use cycle, and investments in improvement should be based on this understanding.
- Tree-based bioenergy systems, ranging from fuelwood and charcoal to liquid biofuels and power generation, offer great opportunities for sustainable green growth pathways combined with sustainable forest management and forest and landscape restoration in sub-Saharan Africa.
- What is needed to effectively promote the use of tree-based biofuels is a shift in perception to improve their negative image, a holistic approach that considers the full production to end-user cycle, collaboration of relevant stakeholders to overcome investment barriers and political coordination at subnational to national and regional levels.

Background

According to the International Energy Agency over 1.3 billion people worldwide are without access to electricity and 2.6 billion people are without clean cooking facilities¹. In Africa, over 80% of the population depends on firewood and charcoal for cooking and less than 50% has access to electricity². According to a World Bank estimate, the charcoal industry in the region was worth more than \$8 billion in 2007, with more than 7 million people dependent upon the sector for their livelihoods³. It is projected that this might grow to over US\$ 12 billion by 2030, employing almost 12 million people⁴.

Population growth and urbanization will drive the demand for wood fuels, in particular charcoal, in the next decades⁵. The practical and economic challenges for households to transition from solid fuels to gas or electricity will remain high⁶. In addition to household consumption, there is also a growing demand for tree-derived fuels in industry and services, such as textile and food industry, cement production and other chemical processes, bakeries, restaurants, and dry cleaning⁷. The transport sector is a new area where wood-based biofuels may be playing an increasing role in the future⁸.

The scale and severity of environmental impacts of wood-based biomass fuel use vary greatly in space

and time. There is agreement (for example referring to FAO data) that collecting fuelwood has not led to major deforestation, although it can lead to local landscape degradation and alterations, sometimes causing local fuelwood shortages⁹. This analysis is much more complex and divergent for charcoal, which is nearly exclusively consumed for cooking and heating in urban settlements, including industrial and commercial service uses¹⁰. While some recent findings suggest that about 40% of the charcoal is produced unsustainably¹¹, other analyses argue that there is a serious and widespread uncertainty on the actual role of the use of woodfuel on deforestation and forest degradation, which is mainly due to incomplete demand and supply data and a result of common misconceptions on the sources of woodfuels and the role of trees outside of forests contributing to wood supply¹².

The need to bring people out of energy poverty in Africa is well-recognized, including by the United Nations Sustainable Energy for All initiative (SE4ALL) and the outcome document of the Open Working Group of the Sustainable Development Goals (SDG) includes a goal (number 7) to “ensure access to affordable, reliable, sustainable and modern energy services for all”¹³. An indicator of the recognition of the importance of



charcoal across the continent is that the United Nations Development Programme has supported the African Union in the preparation of an “African Sustainable Charcoal Policy Framework” (September 2013)¹⁴. However, the realities of the dominance of bioenergy in the African energy mix are seldom recognized in national energy policies, and the use of bioenergy in Africa is often unsustainable.

Given the growing demand for wood energy and the low capacity for appropriate responses under a business-as-usual scenario, there is an urgent need to invest in the sustainable development of tree-based bioenergy systems in Africa that include solid and liquid fuels to address the needs of all sectors of society. Tree-based bioenergy has the potential to sustainably provide fuel for cooking and heating in households requiring the provision of accessible and reliable energy sources.

Cooking fuels

The workshop discussed cooking systems that depend on firewood and charcoal, and recognized the huge efforts that have gone into understanding and improving all elements of the system, from wood production through transformation and marketing to improved cooking technology. It was agreed that in order to make progress, all of these issues will need to be addressed together systematically.

The workshop participants envisioned a firewood sector that is *socially responsible, ecologically sustainable and economically viable*. At least nine out of every ten households in rural areas in sub-Saharan Africa depend on firewood for cooking and heating houses. The participants focused on the benefits that the sustainable access to firewood can bring, and stressed that the generally negative reputation of firewood is unwarranted. Poor people are unfairly blamed for deforestation while according to FAO their impact is minimal and other drivers are the cause. Using home-grown firewood is made difficult where inappropriate forest laws and the coercive activities of forest agents prevent people from pruning or felling trees on their own land. Discouraging firewood use would be unfortunate where men and women derive income from firewood collection, sometimes for direct sale to other users and sometimes to larger scale marketers. Firewood is usually collected sustainably, and the drudgery experienced by women and children in walking long distances for firewood is usually caused by local scarcity rather than widespread deforestation. Burning wood in unventilated kitchens produces emissions that

Tree-based biomass can be used to generate electricity and heat and for this to be done at appropriate scales by communities in places that are remote from distribution grids. There is an urgent need for national entities, donors and the research community to move onto an action footing to ensure that tree-based bioenergy is fully utilized, in a sustainable fashion, to help to achieve SDG number 7.

This document is based on a workshop held in Nairobi from 26 to 28 May 2015 that brought together over 80 experts from government, private sector, research and civil society, mainly from the African continent, to discuss the opportunities and challenges of tree-based bioenergy. It outlines the participants’ collective recommendations around firewood, charcoal, liquid biofuels and biomass for heat, power and transport in sub-Saharan Africa.

cause deaths from illnesses associated with smoke, mainly respiratory infections that mostly affect women and children who spend many hours in kitchens. Cooking problems in the kitchen are aggravated by issues in other parts of the cooking system, including the use of poor quality wood, tree varieties that are more toxic and burning poorly-dried wood. It was recognized that health and safety issues extend to dangers experienced by women and children while collecting wood, and to the effects on nutrition of inadequate cooking.

The workshop participants envisaged a *sustainable charcoal value chain where more charcoal would be produced from trees and bamboo outside of forests, including agroforestry systems, woodlots, and home gardens*. Producers would earn more from charcoal and have incentives to produce it sustainably, value chains would be improved and the increasing number of users in urban environments would be able to buy charcoal at a fair price. While the UN Sustainable Energy for All initiative and other efforts such as the “Last Mile” connection projects are setting out to ensure that all Africans have access to electricity by 2030, the workshop participants agreed that increasing the provision of electricity and creating sustainable woodfuel value chains are complementary objectives as there will be a growing demand for both sources of energy for many years. In other developing parts of the world where electricity is more generally available, people still use woodfuels for heat-intensive purposes, such as cooking, as electricity remains too expensive for poorer people.

The value of the charcoal business in Africa is estimated to be approaching \$12 billion per year, and ensuring that it becomes a legal and sustainable business where all participants derive benefits will require ignoring the many myths that exist about charcoal (eg consumption by the poorest; low value commodity; main cause of deforestation) and basing decisions on real evidence. Beneficiaries of a reformed and modernized wood-based bioenergy sector are not only producers and consumers, but also governments who are currently estimated to lose many millions of dollars in foregone revenues due to the informal and often illegal nature of the sector. The workshop participants recognized that charcoal production has the potential to degrade large areas of woodland, but that the real drivers of loss of tree cover are often the expansion of other sorts of land use, and converting the trees to charcoal is only an incidental part of the transformation. While charcoal extraction has been blamed for extensive loss of and damage to tree cover,

there remain many uncertainties concerning the scope and scale of tree cover loss. The uncertainty of current supply and demand modelling remains high as important factors, such as natural regeneration, growth and yield data, and trees outside forest resources are insufficiently accounted for due to lack of data and information. The charcoal sector is complex, and simplistic solutions like banning charcoal have not worked. Across Africa charcoal trade is either informal or illegal and this leads to a situation where improving the system is made impossible while rent-seeking and corruption proliferate. Sustainable charcoal systems will depend upon fixing legislation and governance, ensuring functioning land and tree tenure, improving the efficiency of charcoal production, doing much more research to improve understanding of all parts of the system and restoring charcoal's reputation as a much-desired and potentially sustainable source of energy. More objective research is needed to overcome the many knowledge gaps.



Different kiln types with efficiency rates of 28-30%. More advanced high-end kilns have efficiency rates of up to 75%. Iiyama M, Neufeldt H, Dobie P, Jamnadass R, Njenga M, Ndegwa G (2014) The potential of agroforestry in the provision of sustainable woodfuel in sub-Saharan Africa. Current Opinion in Environmental Sustainability. Vol. 6C, pp. 138-147. <http://dx.doi.org/10.1016/j.cosust.2013.12.003>. Photo 1: Valter Ziantoni/ICRAF Photo 2: with metal kiln Miyuki Iiyama/ICRAF

Liquid biofuels and power generation

The workshop participants envisaged *green growth in Africa fuelled by renewable energy to power household, commercial, industrial and transport demand, part of which is derived from tree-based bioenergy*. Development in Africa requires access to energy in forms that can allow enterprises to flourish and businesses to prosper. It is possible for farmers to drive pumps and engines on their farms from biodiesel that they grow themselves. Biofuels have the potential to drive transport fleets and generators. Woody biomass has a great potential to generate electricity at both community level for off-grid use and for larger commercial size plants. The workshop participants enthusiastically debated the potential of biofuel use and biomass generation in Africa, recognizing the need for more research on both liquid biofuels for engines and biomass electricity generation, both from the supply and demand sides. Most energy policies in Africa barely recognize the potential of bioenergy, commonly providing

a governance framework that disincentivizes the use of tree-based bioenergy. Consequently, increasing biofuels in the energy mix and electricity generation from wood (possibly in systems that also use other sources of biomass such as crop wastes) will require action at policy level as well as identifying sources of finance and investing in projects that will demonstrate the potential of bioenergy to a wider group of investors. Workshop participants raised valid concerns about the possibility for bioenergy production to compete with food production. The need for integrated energy-food systems was recognized, and examples were given where food production could even be increased, for example where the by-products of biofuel production are being used to improve soil fertility. There is a severe lack of knowledge on the potential of biofuels across Africa, including among decision-makers. Similarly, there has been little experience of dendro thermal electricity generation that is produced from sustainably grown biomass.

Recommendations

Cooking systems

A major recommendation of the workshop is to *recognize that improving the cooking of food using wood-based fuels in Africa requires an in-depth understanding of the full production-to-use system, and investments in improvement should be based on this principle*.

A fundamental challenge for biomass cooking systems is to rehabilitate the reputation of firewood and charcoal as appropriate fuels for Africa at this time. This should be done by:

- Developing advocacy tools and publicity materials that accurately portray the role of firewood and charcoal in Africa today
- Presenting available knowledge evidence to show that poor people should not be blamed for deforestation when they collect firewood, and that charcoal can be produced, sold and used sustainably
- Providing objective comparisons of advantages and disadvantages of different energy systems in national and regional contexts

While elements of the cooking system have been extensively studied, and very good information is available, much of the existing evidence has not been collated and there has been a lack of evidence-based decision-making relating to tree-based bioenergy. Further research is needed along with the development of better decision tools. This should be done in specific countries by:

- Carrying out a review of knowledge of fuelwood production chains
- Carrying out studies of the current status of availability of firewood from different sources within reasonable reach of households and develop plans to increase supply where it is lacking
- Carrying out a review of knowledge of the charcoal value chain and developing proposals to introduce improvements
- Carrying out sustainability research to better model and understand the dynamics of wood extraction, processing, trade and use in order to provide data to advise policy decisions

There is a challenge to include firewood and charcoal into national energy policy processes. This should be addressed by:

- Carrying out policy research to ensure that policies can be improved and harmonized
- Preparing knowledge-based materials for policy makers and engage in debates with them
- Integrating firewood and charcoal into national energy policy processes in order to develop appropriate policies and legislation
- Integrating firewood and charcoal into land use planning processes at national and local (landscape) levels



Women in sub-Saharan Africa are still burdened with walking long distances to collect firewood and water. In areas affected by deforestation, they need to take longer trips. Photo: Daisy Ouya/ICRAF

- Promoting charcoal to policy-makers as a multi-million dollar business that countries and districts can derive income from
- Reforming policies and setting standards

There is a need to improve technology throughout the cooking system. This should be done in a manner that fully respects social issues by:

- Using sustainability studies and studies of woodfuel availability to develop participatory national and local plans to ensure a sustainable supply of wood through agroforestry, woodlots or natural regeneration
- Ensuring that the most suitable tree species are made available based on knowledge of their physical properties, lack of toxicity and local preferences
- Establishing systems to grow and disseminate excellent planting materials
- Carrying out local participatory trials of improved charcoal production methods
- Using knowledge of the social benefits along the charcoal value chain to ensure that improvements are equitable
- Introducing enhanced cooking techniques, including

clean cook stoves, but doing so in a manner that integrates their use into a full cooking system including fuel quality, kitchen management and cooking space ventilation

There is a need for incentives to reform the use of firewood and charcoal. This should include:

- Applying participatory processes throughout the cooking systems development process to identify challenges and solutions
- Reviewing energy taxation policies to ensure that woody biomass is not unfairly treated
- Encouraging the involvement of the private sector by removing obstacles to their participation (e.g. the distortions of current charcoal value chains)

Liquid biofuels and energy generation

A major obstacle to developing the use of liquid biofuels is the high level of doubt among investors that biofuels can be cost-effective in Africa. This should be countered by:

- Analyzing why many biofuels projects in Africa have failed and providing advice on how to learn from the experience

- Preparing case studies on successful biofuels initiatives outside of Africa

There is also poor understanding of the potential of bioenergy among African decision makers, and there is very little experience of using woody biomass for electricity generation in Africa. These should be overcome by:

- Preparing policy documents for policy makers and engaging in debate with them
- Exposing policy makers to experience from other parts of the world
- Preparing case studies of electricity generation from biomass in other parts of the world and using them to demonstrate potential business models
- Integrating people and institutions with knowledge of bioenergy into national energy planning processes
- Recognizing differences in economic and financial viability between countries at different socio-economic development status and with different

resource endowment

There are many possible ways of developing bioenergy in Africa, and mistakes could be made through poor choice.

This challenge should be overcome by:

- Setting up a source of advice on new bioenergy ventures
- Carrying out studies to identify new biofuels options (there are literally hundreds of oil-bearing trees in Africa) and to investigate their potential
- Providing advice on sustaining feed stocks of biofuels
- Financing demonstration projects to eliminate risks and uncertainties

Energy policies usually provide perverse subsidies for fossil fuels, which are disincentives for investment in new approaches. It will be important to:

- Ensure that bioenergy can operate on a level playing field with already existing energy sources by removing market distortions especially perverse policies

Conclusion

Tree-based bioenergy systems, ranging from fuelwood and charcoal to liquid biofuels and power generation, offer great opportunities for sustainable green growth pathways in sub-Saharan Africa, with sustainable forest management and forest and landscape restoration. What is needed to effectively promote them is a shift

in perception to rehabilitate their negative image, a holistic approach that considers the full production to end-user cycle, collaboration of relevant stakeholders to overcome investment barriers and political coordination at subnational, national and regional levels.

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