THE NEW CLIMATE ECONOMY
The Global Commission on the Economy and Climate

SEI STOCKHOLM ENVIRONMENT INSTITUTE

Working Paper

Bringing clean, safe, affordable cooking energy to households across Africa: an agenda for action

Background paper to the Africa Progress Panel 2015 report *Power, People, Planet: Seizing Africa's Energy and Climate Opportunities*

Fiona Lambe, Marie Jürisoo, Hannah Wanjiru and Jacqueline Senyagwa

CONTENTS

Page

Executive summary

The majority of households in sub-Saharan Africa – some 700 million people – rely on traditional biomass for cooking, and while in other regions, biomass use is decreasing, in Africa it continues to rise. If current trends continue, almost 900 million people in sub-Saharan Africa are expected to cook with traditional biomass in 2020. Efforts to bring modern energy access to all – electricity and clean fuels – are far outpaced by population growth.

Traditional biomass use has multiple negative impacts, most notably on health: 600,000 lives are lost each year in sub-Saharan Africa due to exposure to biomass smoke. The economic costs of high reliance of biomass for cooking are also substantial, about US$36.9 billion per year, or 2.8% of GDP, including US$29.6 billion from productive time lost gathering fuel and cooking. The impacts are particularly severe for women and girls, who are typically responsible for these chores.

There is a growing body of knowledge and experience about how best to achieve a shift to cleaner and safer cooking fuels and stoves. Numerous cookstove interventions across sub-Saharan Africa are beginning to reach scale, with benefits to household health, livelihoods, environment and economies. There is an urgent need to ramp up these initiatives, tailoring them to the specific conditions in each country. The prize is market transformation to clean stoves with clean fuels, sold, supported and ideally even produced locally. Not only would such a transformation produce huge health improvements, but it would also create multiple business opportunities and jobs.

However, most cookstove markets in sub-Saharan Africa are still quite far from that goal. This means that transforming markets is likely to require several intermediate steps, starting with stoves that use the fuels currently used by households – such as wood and charcoal – but burn them more cleanly and efficiently. Given how rapidly the region is urbanizing, and how widely charcoal is used in urban households, it is also crucial to regulate charcoal production and ensure it is as efficient and sustainable as possible. While these measures cannot solve all the problems associated with traditional biomass use, they can move markets in a better direction and bring benefits.

This paper presents an overview of current household energy trends in Africa, and the reasons why access to modern cooking facilities remains so low. It then presents the latest evidence on the health, environmental and socio-economic impacts of traditional biomass use in sub-Saharan Africa, with a dedicated section on the particular challenges associated with charcoal as a household cooking fuel. Next, it highlights where interventions to provide access to clean and improved cooking options are having a positive impact, drawing on case studies in Mali, Ghana, Kenya and Ethiopia.

A woman cooks gnetum and peanuts in a village in Lekié, Center Region, Cameroon. © Ollivier Girard, Center for International Forestry Research (CIFOR) / Flickr

About this working paper

This paper was prepared as an input to the 2015 Africa Progress Report *Power, People, Planet: Seizing Africa's Energy and Climate Opportunities*, produced by the Africa Progress Panel led by Mr. Kofi Annan which can be found at: www.africaprogresspanel.org. The Africa Progress Report (APR) is the annual flagship publication of the Africa Progress Panel. The APR draws on the best research and analysis available on Africa and compiles it in a refreshing and balanced manner. The Panel makes policy recommendations for African political leaders and civil society who collectively have the primary responsibility for spurring Africa's progress. In light of the continent's dynamic links with the rest of the world, the APR also highlights critical steps that must be taken by leaders in the international public and private sector. This material has been partly funded by UK aid from the UK government. However, the views expressed do not necessarily reflect the UK government's official policies.

Citation

Lambe, F., Jürisoo, M., Wanjiru, H., and Senyagwa, J., 2015. *Bringing clean, safe, affordable cooking energy to households across Africa: an agenda for action*. Prepared by the Stockholm Environment Institute, Stockholm and Nairobi, for the New Climate Economy. Available at: http://newclimateeconomy.report/misc/working-papers.

New Climate Economy
c/o World Resources Institute
10 G St NE
Suite 800
Washington, DC 20002, USA
+1 (202) 729-7600

New Climate Economy
c/o Overseas Development Institute
203 Blackfriars Road
London, SE1 8NJ, UK
+44 (0) 20 7922 0300

www.newclimateeconomy.report
www.newclimateeconomy.net

Based on this research, the authors developed a set of draft policy recommendations, which were further refined and developed at a consultative workshop in Nairobi in April 2015. This meeting brought together private-sector actors, NGOs engaged in cookstove initiatives, policy-makers, health specialists and experts on cookstove design and performance from across sub-Saharan Africa to deliberate on the challenges and opportunities facing the sector. The resulting final recommendations are:

1. Biomass energy is of significant economic value to African economies, and is the single most important energy source for a majority of households. There is an urgent need for governments in the region to **recognize the value of biomass energy** to the larger economy, especially in rural areas, and design/reframe energy and economic development policies accordingly.

2. **The charcoal sector is in urgent need of regulatory reform**: Policy coherence is crucial for the emergence of a vibrant sustainable biomass energy sector, and regulatory reform is needed on both the supply and demand sides. Governments should consider removing woodfuel under-pricing policies to truly reflect the cost of sustainable charcoal production and incentivize the uptake of efficient charcoal cookstoves and charcoal production practices. Cross-subsidisation could then be used to target subsidies for charcoal to the lowest-income market segments.

3. Governments in sub-Saharan Africa could encourage the uptake of clean cooking stoves and their components by **removing taxes and duties to exempt technologies that are imported** and by reducing the number of licenses required by cookstove manufacturers and distributors. A specialized agency should be established to plan and promote clean cooking stoves, coordinate technology standards and testing and manage national and sub national data on biomass energy supply and demand.

4. Targeted funding should be provided, both through donor commitments and public finance, to build the **capacity of regional cookstove testing centres**. Governments could play an important role raising awareness about the benefits of clean and safe cookstoves and fuels by communicating information on cookstove standards to the public, for example, through product labelling.

5. There is a need to **tap local innovation**: Research and development in the local cookstoves sector should be promoted to match the support (finance and policy access) that larger, international cookstove partners can access. R&D institutions should be strengthened – governments should invest in special innovation funds.

6. To support market transformation of the cookstove sector, **subsidies** (whether carbon finance, donor or government) within cookstove businesses should generally be **targeted upstream** in the value chain (R&D, manufacture, distribution) rather than downstream to the end-user. Targeted end-user subsidies could be used to support very low-income households to gain access to clean cookstoves.

7. Clean cookstove businesses can **access end-user finance for their products through range of proven innovative approaches**, including microfinance loan schemes, payment in instalments, community savings clubs, etc. National, regional and local authorities can encourage such schemes by providing information, soft loans and loan guarantees to smaller actors seeking to set up business. Banks, MFIs and other lending institutions should provide interest-free or very-low-interest loans for stove purchasers. A specific governmental agency should be established to support and coordinate these activities, with a dedicated fund to finance the agency. This fund could be replenished using a combination of revenues from a reformed charcoal sector, donor funds, and ministerial budgets (e.g. energy, health and environment).

8. **Carbon finance can be a catalytic finance mechanism** for cookstove projects, particularly those that do not rely exclusively on carbon revenues to maintain and scale implementation. Carbon revenues can bring about a range of ancillary benefits for the project developer and end-user, including quality assurance, monitoring and reporting of progress over an extended time period.

9. **End-user behaviour and preferences should inform every clean/improved cookstove intervention**. All implementers of clean cookstove interventions, including businesses, NGOs, and governments, should take the **cookstove user's needs and behaviour as their starting point**. There will be no panacea for addressing the household cooking challenge in sub-Saharan Africa; instead, a differentiated approach based on specific socio-cultural contexts is recommended. Better and more disaggregated data on cookstove users' preferences, willingness and capacity to pay for a clean cookstove at the sub-national level will be invaluable for directing investment and innovation in the clean cookstoves sector.

1. Introduction

More than 700 million people in sub-Saharan Africa rely on traditional biomass cooking fuels – wood, charcoal, dung and agricultural residues. With population growth, that number is expected to rise to 880 million by 2020 (IEA 2014). Dependence on these fuels has many adverse impacts on people's health and on the environment, and it also holds back development, as collecting and cooking with these fuels is arduous and time-consuming (IEA 2014; Akbar et al. 2011; Cordes 2011).

Cleaner, safer alternatives are available, and momentum is growing among African governments, donors and the broader international community to scale up their use. There is significant potential for progress, as cookstove technologies have advanced considerably and innovations in end-user finance are making stoves more affordable. Many improved-cookstove businesses are already operating in sub-Saharan Africa, and their numbers are growing as entrepreneurs recognize a significant economic opportunity.

Yet there are also large challenges for African cookstove initiatives and enterprises. They have to generate demand for new products that may be expensive for low-income households. They have to develop functioning supply chains to reach dispersed populations, and overcome social and cultural barriers. They also need to ensure they have appropriate financial and human resources, not only to get off the ground, but to sustain operations and provide ongoing support to stove users. National policies and programmes may support them, but they may also pose obstacles.

In its flagship report, Better Growth, Better Climate (2014), the Global Commission on the Economy and Climate highlights the potential for low-carbon technologies, including clean cookstoves, to help advance both energy policy objectives – energy security, universal access, affordability, reduced import dependency – and broader economic and social development goals, such as reducing poverty and improving public health. The appropriate technologies and potential benefits will vary depending on local conditions: from the available energy supply options, to the strength of institutions.

This synthesis paper, an early draft of which served as an input to the 2015 Africa Progress Report (REF), examines how improved cookstoves can be scaled up to reach the hundreds of millions of Africans who need them. Our review is aimed primarily at African policy-makers engaged in expanding household energy access, as well as businesses and non-profits promoting improved cookstoves in the region.

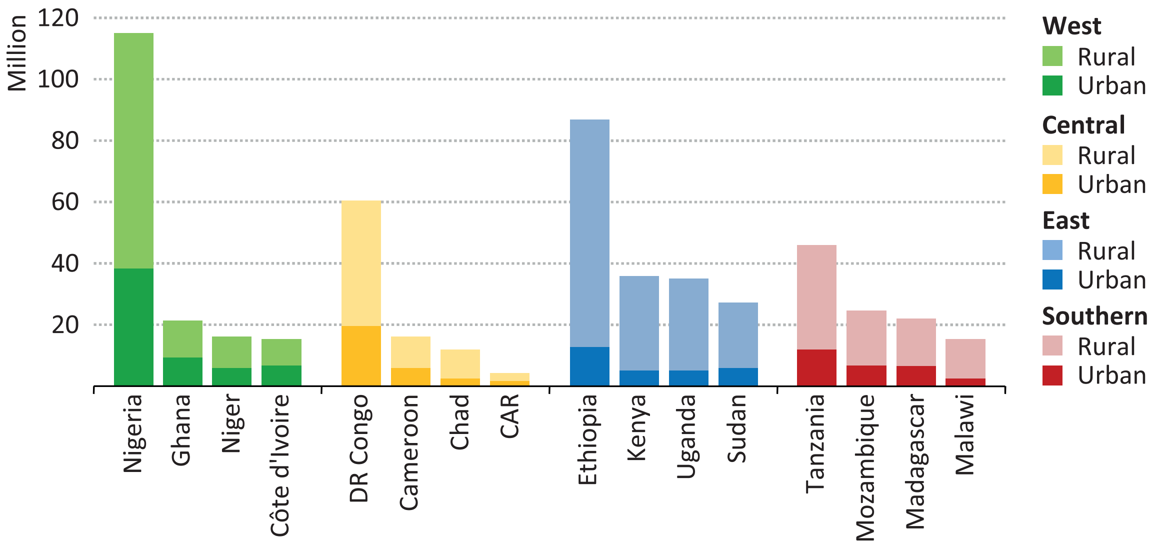
We begin with an overview of current household energy trends in Africa and the reasons for the current low levels of access to modern energy for cooking. We then present the latest evidence on the health, environmental and socio-economic impacts of traditional biomass use in sub-Saharan Africa, with a dedicated section on the particular challenges associated with charcoal as a household cooking fuel. Next, we highlight where interventions to provide access to clean and improved cooking options are having a positive impact. We use four case studies – of Mali, Ghana, Kenya and Ethiopia – to examine common policy bottlenecks and the costs and benefits experienced when implementing and scaling up promising interventions. We conclude with recommendations drawn from this work and further refined through a consultative workshop held in Nairobi on 28 April 2015.

Carrying charcoal bundles by bike in Madagascar. © Francesco Veronesi / Flickr

2. Household energy patterns in sub-Saharan Africa

Nearly 730 million people in sub-Saharan Africa rely on the traditional use of solid biomass (mainly fuelwood, charcoal and dung) for cooking, typically with inefficient stoves or simple three-stone fires, in poorly ventilated spaces (IEA 2014). Access to modern energy services remains limited; more than 620 million people have no electricity. In 42 countries, more than half the population relies on solid biomass for cooking, and in 23, the share is above 90%. Figure 1 shows the largest populations relying on traditional biomass by sub-region. Rural households are particularly dependent on traditional biomass, but many urban households cook with it as well, mainly in the form of charcoal.

Figure 1
Largest populations cooking with traditional biomass in sub-Saharan Africa, 2012



Source: IEA (2014), reproduced from Figure 1.8.

Achieving a shift to modern cooking technologies and fuels has proven to be challenging and complex. Not only does it require making new stoves and fuels available and affordable to all – a daunting task in itself. It also requires changing a fundamental aspect of domestic life, or finding a way to fit modern technologies into deeply engrained customs and practices. Thus, even when households begin to cook with electricity or with clean fuels such as liquid petroleum gas (LPG), they typically keep using their traditional stoves as well, at least for some foods; the shift to a cleaner cooking system is rarely immediate and complete.

In much of the world, the use of traditional biomass as an energy source has generally peaked or will do so in the near future. In sub-Saharan Africa, however, reliance on biomass as the predominant source of energy for cooking is predicted to grow in the coming decades (Sander et al. 2011). These trends are due to rapid population growth which has outpaced efforts to scale up access to modern energy services in the region. More than 95% of people in countries such as Burundi, Central African Republic, Chad, Liberia, Rwanda, the Gambia and Sierra Leone lack access to modern energy, with the rural population relying almost exclusively on wood-based biomass energy for cooking (IEA 2014). Wood-based biomass as the main source of energy is reported at 96% in Ethiopia, 90% in Tanzania, 76% in Kenya, and 67% in Nigeria.

3. Impacts of heavy reliance on traditional biomass for cooking

3.1 HEALTH IMPACTS

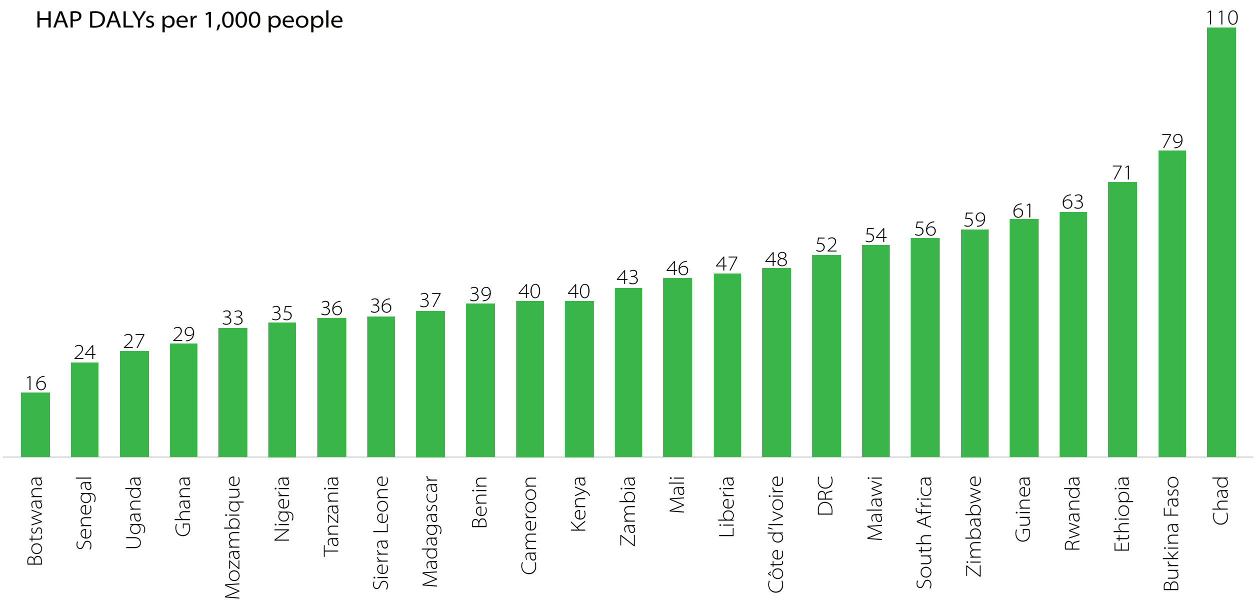
According to the World Health Organization (WHO), there is substantial evidence that household air pollution from burning solid fuels increases the risk of acute lower respiratory infections in children under 5. It also increases the risk of a number of adverse pregnancy outcomes, and may impair cognitive development (Bruce and Smith 2012). Furthermore, the WHO estimates that exposure to wood smoke can more than double the risk of severe and fatal respiratory infections in children under 5 (Bruce and Smith 2012).

In sub-Saharan Africa, exposure to smoke from traditional biomass cookstoves is estimated to have caused almost 600,000 deaths in 2012 (Lim et al. 2012). Almost half of these deaths occurred in children under 5 and were due to acute lower respiratory infections or pneumonia (Dherani et al. 2008). The health burden of indoor air pollution can also be expressed in disability-adjusted life years or DALYs.[1] In sub-Saharan Africa, household air pollution was the second-highest risk factor for DALYs and third-highest driver of premature deaths in 2010. Across these illnesses, it contributes to at least 581,000 premature African deaths per year and the loss of more than 26 million DALYs (Lim et al. 2012). If no action is taken, by 2030, an estimated 870,000 people will die each year from acute lower respiratory infections and chronic obstructive pulmonary disease linked to solid fuel cooking (Rysankova et al. 2014).

Among adults, household air pollution increases the risk of chronic obstructive pulmonary disease (COPD), lung cancer and cataracts. A number of other conditions including cardiovascular diseases, acute lower respiratory infections and tuberculosis, are linked with exposure to household air pollution from cookstoves, though the evidence base is weaker (Bruce and Smith 2012).

Figure 2

Total DALYs linked to household air pollution for five African countries



Source: Rysankova et al. (2014), reproduced from Figure 3.

1 The disability-adjusted life year (DALY) is a measure of overall disease burden, expressed as the number of years lost due to ill health, disability, or early death. One DALY can be thought of as one lost year of "healthy" life. The sum of these DALYs across the population, or the burden of disease, can be thought of as a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability.
See the WHO metrics overview: http://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/.

3.2 ECONOMIC IMPACT OF RELIANCE ON BIOMASS FOR COOKING

The economic impacts of relying on traditional biomass for cooking, both at the household and national level, are staggering. Total annual spending on biomass cooking fuels (wood and charcoal) in sub-Saharan Africa was estimated to be US$12 billion in 2010 (or 0.9% of the region's GDP that year); this figure is set to increase to US$29 billion by 2020, assuming that current fuel price and consumption patterns continue (Rysankova et al. 2014).

Using cost-benefit analysis methods developed by the WHO,[2] the World Bank recently estimated the annual economic losses and opportunity costs of solid-fuel dependence in terms of health, environment and economic cost to households (Rysankova et al. 2014). The opportunities and costs are considered in relation to a best-case scenario of full adoption of higher-performing biomass stoves by African households (Low), intermediate Tier 2–3 rocket stoves at the bottom of the range (High) and Tier 3–4 gasifier biomass stoves at the top of the range (Mid). As shown in Table 1, in the worst case scenario, where biomass reliance is highest, the combined health, economic and environmental impacts are close to US$60 billion per year. It is also clear that the economic costs are substantial, US$36.9 billion or 2.8% of GDP, including US$29.6 billion in time wastage alone. This suggests significant opportunities for cost-saving from a shift to modern cooking, even after accounting for potential costs associated with the new stoves and fuels.

Table 1

Annual economic losses and opportunity costs associated with solid-fuel dependence in sub-Saharan Africa, 2010 (in billion USD)

	Low	Mid	High
Mortality from household air pollution	$0.3	$3.5	$6.8
Morbidity from household air pollution	$0.2	$0.7	$1.1
Other health conditions (burns, eye problems)	$0.1	$0.8	$1.5
Total health	**$0.6***	**$5.0**	**$9.4**
Spending on solid fuels	$0.4	$3.8	$7.3
Time wastage (fuel collection)	$0.6	$6.5	$12.4
Time wastage (cooking)	$3.3	$10.2	$17.2
Total economic	**$4.2**	**$20.6**	**$36.9**
GHG emissions (fuel consumption)	$0.2	$2.1	$3.9
GHG emissions (charcoal production)	$0.2	$0.7	$1.2
Deforestation	$0.2	$3.5	$6.7
Total environment	**$0.6**	**$6.3**	**$11.9**
Total all categories	**$5.4**	**$31.8**	**$58.2**

Source: Rysankova et al. (2014). Sums may not match due to rounding.

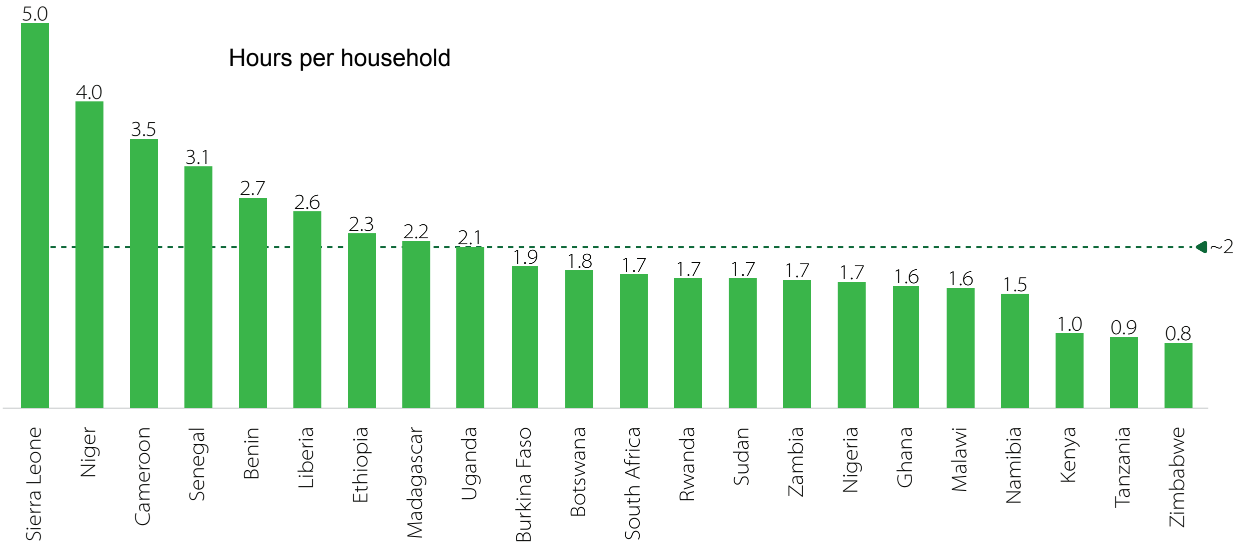
2 For environment and climate change impacts, the model estimates the costs of deforestation (valued via potential afforestation costs) and the carbon credit value of avoidable greenhouse gas emissions. The opportunity costs of time and related values throughout the model (e.g., cost of death due to household air pollution) are based on average gross national income (GNI) for sub-Saharan Africa and agricultural value-added using human-capital methodology. Cooking-fuel mix and fuel-use data draw on an up-to-date database of national fuel consumption surveys for all 47 countries in the region. The core methodological framework is derived from Hutton et al. (2007) and Jeuland et al. (2014). Underlying assumptions are derived from the extensive existing literature on solid fuel impacts, with strong weighting toward examples in sub-Saharan Africa. For a detailed explanation, see Rysankova et al. (2014).

3.3 IMPACT ON WOMEN'S TIME

In most sub-Saharan African countries, the task of gathering fuelwood falls primarily on women and girls. In some countries, women can spend as many as five hours per day gathering fuelwood for cooking; the average across 22 countries in Africa was found to be 2.1 hours (see Figure 3). Women can suffer serious long-term physical damage from strenuous work without sufficient recuperation. This risk, as well as the risk of falls, bites or assault, rises steeply the farther from home that women have to walk. The dangers are particularly great in conflict settings, where women face an increased vulnerability to physical and sexual violence when leaving the safety of their communities or refugee camps to gather fuelwood (Hart and Smith n.d.). Even after the fuel is gathered, preparing and cooking food can take several more hours. Reducing this drudgery would free up time for girls and women to rest, complete other household tasks, pursue an education, and/or engage in income-generating opportunities — as they choose.

Carrying firewood on the road from Kisangani, Democratic Republic of Congo.
© Ollivier Girard, Center for International Forestry Research (CIFOR) / Flickr

Figure 3
Hours spent gathering fuelwood in a selection of 22 African countries



Source: Rysankova et al. (2014), reproduced from Figure 6.

3.4 ENVIRONMENTAL AND CLIMATE CHALLENGES

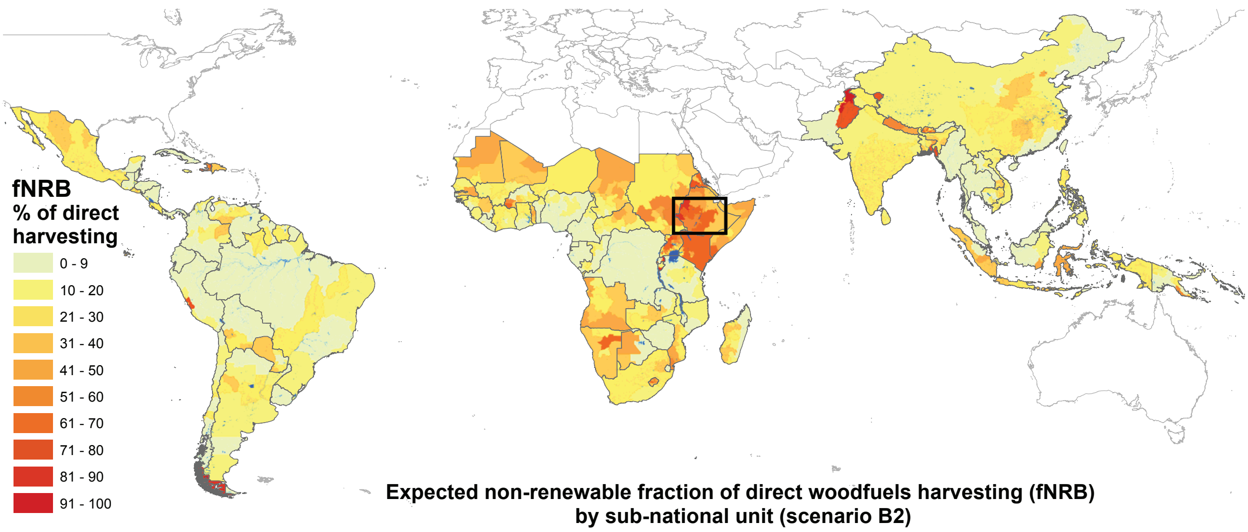
The production and use of solid fuels for cooking consumes more than 300 million tonnes (Mt) of wood annually across sub-Saharan Africa,[3] including 130–180 Mt of wood for charcoal production (Rysankova et al. 2014). All of this contributes to forest degradation, biodiversity loss, and in some cases, clear-cutting of patches of forest. In terms of climate change, solid fuel use and charcoal production in the region generate 120–380 Mt CO_2e of Kyoto Protocol greenhouse gases[4] (0.4–1.2% of global CO_2 emissions) and up to 600 Mt CO_2e when particulate matter is included. A 50% reduction in biomass use in the region could be expected to save 60–190 Mt CO_2e of Kyoto Protocol greenhouse gases or 300 Mt CO_2e if non-Kyoto emissions are included. It is important to stress, however, that it matters how that reduction is achieved; if it occurred through fuel-switching, for example, the net emissions impact would be lower, after accounting for the emissions associated with the alternative fuels.

Recent data confirm longstanding concerns that woodfuel use in certain parts of sub-Saharan Africa is unsustainable – that is, that the rate of depletion of renewable biomass outstrips the rate of regrowth (Bailis et al. 2015). The "hotspot" of unsustainable use is a swathe of East Africa extending from Eritrea through western Ethiopia, Kenya, Uganda, Rwanda and Burundi; woodfuel use in parts of West Africa, including Ghana, is also considered unsustainable. In a business-as-usual scenario, GHG emissions from woodfuel use in Africa would rise to 6.7 billion tonnes (Gt) of CO_2e by 2050, which is 5.6% of Africa's projected business-as-usual emissions.

Whereas firewood serves mostly rural populations' fuel needs, charcoal demand is associated with urbanization, and is primarily met by unsustainable supply from drylands resources (Zulu 2010). More than 80% of urban households in sub-Saharan Africa use charcoal as their main source of cooking energy, and the demand is likely to increase for several decades. The increasing demand for wood energy, especially by urban consumers, places heavy pressures on forest resources. Most charcoal producers in sub-Saharan Africa use traditional earth kilns, with wood-to-charcoal conversion efficiencies of 8–20%, so large quantities of wood are used per unit of charcoal produced (Liyama 2013). It is thus crucial to improve the efficiency of charcoal production, for both economic and environmental reasons.

Across most of the region, however, charcoal production is either not regulated, or banned. In both situations, this means governments forgo the opportunity to steer producers towards more sustainable practices, or collect revenues from licensing fees for charcoal production and trade. Moreover, the market price of charcoal is kept artificially low, as it does not reflect the real cost of production). Undervaluation of woodfuel is closely linked with wasteful and inefficient production and consumption practices, and creates a formidable disincentive for forest management and tree cultivation (Sepp 2014).

Figure 4
Unsustainable woodfuel use 'hot spots'



Source: Bailis et al. (2015). Reprinted by permission from Macmillan Publishers Ltd: Nature Climate Change, 5(3), copyright 2015.

3 This figure, which includes 200 million tonnes of firewood and 22 million tonnes of charcoal for cooking, is based on sub-Saharan Africa country fuel-mix surveys and average-per-household consumption data. It assumes 6 kg of wood per 1 kg of charcoal and is comparable to the 2010 UN Food and Agriculture Organization (FAO) estimate (which included non-household and non-cooking fuelwood uses) of 25 million tonnes of charcoal and 280 million tonnes of firewood (Rysankova et al. 2014).

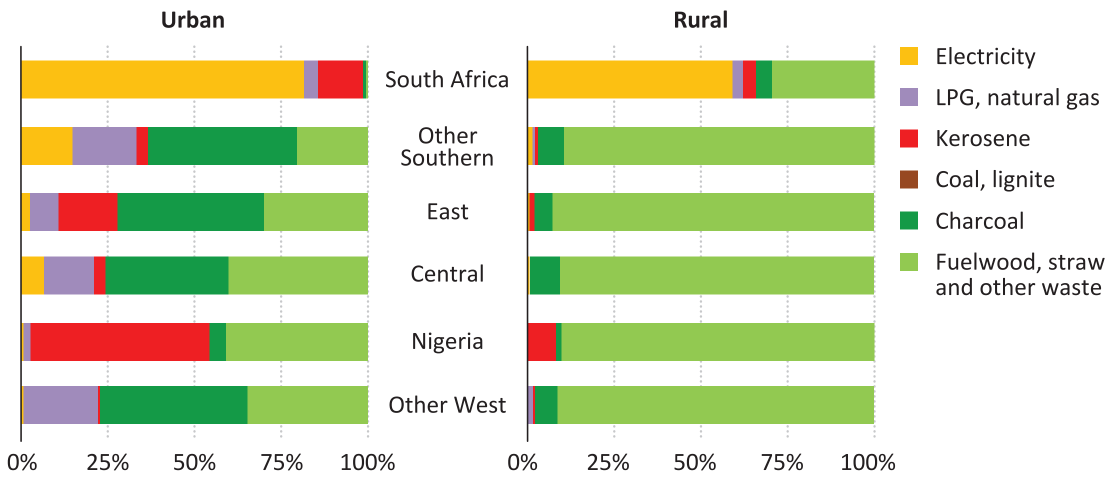
4 For a list of all Kyoto Protocol greenhouse gases, see http://unfccc.int/kyoto_protocol/items/3145.php.

4. Options for addressing the cookstove challenge

A large-scale shift from traditional biomass to clean fuels[5] or to electricity brings about the largest reductions in household air pollution, and consequently, the most significant improvements in health. As discussed above, it can also deliver a wide range of other benefits related to poverty reduction and environmental sustainability (Malla et al. 2011) – And across sub-Saharan Africa, this is governments' ultimate goal. However, the reality is that in many poor rural communities, clean fuels may not be reliably available or affordable, and access to grid electricity may be many years off (Scott forthcoming). Figure 5 shows a breakdown of the fuels currently used by urban and rural households in different regions of Africa. Low-cost improved biomass cookstoves are increasingly available in most countries, and they can bring limited, but still significant, benefits to households. Such stoves – provided they are properly designed, installed, used and maintained – can reduce household air pollution considerably (Foell et al. 2011); they can also reduce fuel use and associated costs and drudgery. It is important to stress that these stoves should not be seen as the end point; they are a pragmatic interim solution, given the access challenges and urgent need for alternatives, on the pathway towards truly clean, modern cooking facilities.

Figure 5

Main fuel used by households for cooking



Source: IEA (2014), reproduced from Figure 1.10.

4.1 WEIGHING TECHNOLOGY AND FUEL OPTIONS

There are many different types of cookstove technologies in use across Africa, ranging from stoves that are just slightly more efficient than a three-stone fire, to efficient biomass cookstoves (ranging from rocket stoves[6] to pellet gasifier stoves) and clean fuel options using LPG and ethanol. Different technology choices imply different efficiencies, costs, distribution models, and challenges in terms of meeting end-user needs. The WHO recently published a set of guidelines for indoor air pollution from household fuel combustion, indicating the levels of indoor air pollution that should not be exceeded for health protection (WHO 2014). The approach to development of the indoor air quality guidelines has been pragmatic, taking into account the fact that not all countries can meet the stringent health guidelines. Thus the guidelines provide both interim targets (for 60% of homes meeting the targets) and aspirational targets (for 90% of homes meeting the targets). These guidelines are serving as the basis for an ongoing process to develop international cookstove standards, currently under development (see box).

Taking the guidelines as a starting point, the WHO went on to publish the most comprehensive review to date on the effectiveness in terms of reducing emissions of harmful pollutants of various improved biomass cookstove technologies

5 Clean fuels can be defined as fuels that do not cause indoor air pollution in homes (IEA 2010). and include biogas, ethanol and LPG (GACC 2012). Processed biomass (e.g. wood pellets) can also be a clean fuel when burned in a highly efficient stove. A related, but much broader term is "modern energy" for cooking, which the International Energy Agency defines as facilities that are considered safer, more efficient and more environmentally sustainable than the traditional facilities using solid biomass that are commonly used across sub-Saharan Africa (IEA 2014).

6 The rocket stove design is the most commonly used type of improved cookstove in sub-Saharan Africa. It is designed to reduce the amount of heat that is lost during cooking by insulating the stove chamber, which increases efficiency and ensures almost complete combustion within the chamber.

and clean fuels, including LPG, biogas and kerosene (Bruce et al. 2015). This review found that the technologies with the largest potential in terms of improved health and climate outcomes were advanced biomass cookstoves and clean fuels (e.g. biogas, LPG and ethanol).

Developing international standards for clean and improved cookstoves

There is an urgent need for cookstove standards that clearly define levels for technology performance, quality and impact assessment as well as provide common terminology for communicating, understanding, and improving the performance of clean cooking solutions.

In parallel to the development of the WHO guidelines, the Global Alliance for Clean Cookstoves has been facilitating development of international standards for cookstoves. The Alliance has partnered with the International Organization for Standardization (ISO), a nongovernmental agency which supports national standards organizations. Under the ISO, the GACC and partners are using a process of International Workshop Agreements (IWAs) as an intermediate step towards formal ISO standards for cookstoves.

The most recent International Working Agreement IWA 11:2012 Guidelines for Evaluating Cookstove Performance established a framework for rating cookstoves using four indicators: efficiency, total emissions, indoor emissions and safety (WHO 2014). Each of these indicators is quantified and mapped to yield five tiers of performance. The IWA was designed to allow the sector to acknowledge progress (from a baseline of Tier 0) while setting aspirational goals (Tier 4), and to be in line with the WHO guidelines, where Tier 4 cookstoves are those which meet the guidelines for particulate matter (PM2.5) and carbon monoxide (CO).

Once international standards are in place, the challenge will be to ensure that they are implemented at the national level and integrated by cookstove developers and businesses into the process of cookstove design. Ensuring that standards are met will involve building local capacity to test and evaluate cookstove performance. Although regional test centres do exist (for instance, in Kenya and Ghana), they are underfunded and are lacking in technical capacity and awareness of the latest methods of cookstove performance measurement.

The approach taken in terms of cookstove technology/fuel choice will have particular implications for the cost of the programme, the health benefits that can be expected, and the potential for climate change mitigation (through avoided emissions and deforestation). It is important to note that not all cookstove interventions targeting household health have climate co-benefits; for example, improved cookstoves with chimneys can be an effective means of removing smoke from the home, but the ambient air pollution remains unchanged. Table 2 below compares the options.

Under laboratory conditions, "intermediate" improved cookstoves for solid fuels, when used properly, have been found to significantly improve energy efficiency and reduce household air pollution. As a result, they have been widely disseminated to promote cleaner cooking. In 2009, US$70 million in capital investments were made to provide 7 million people with advanced biomass cookstoves (IEA 2010). However, achieving high efficiency "on paper" – in the laboratory – is only one part of the puzzle; ensuring that cookstoves are used correctly and consistently by households is crucial for potential health and climate benefits to be realized. There is often a large discrepancy between how well improved cookstoves perform under laboratory conditions and their performance in the field. Recent evidence from two randomized control trials found no statistically significant improvement of health outcomes where these stoves have been introduced (Polsky and Ly 2012).

Another challenge is that, as noted earlier, it can be extremely challenging to ensure that households actually use improved cookstoves. Several studies have found that following the introduction of a new cookstove, many (if not most) households continue to use the existing traditional device or fuel in parallel, and they may revert to it entirely (see, e.g., Ruiz-Mercado et al. 2011). This may be due to practical reasons, such as the stove uses a commercial fuel that is not affordable or is not always available. Households may also continue to use the old stoves for cultural reasons, or to prepare particular dishes, such as grilled breads or meats (see, e.g., Rehfuess et al. 2013). Thus, the World Bank estimates that less than 5% of African households use

LPG exclusively for cooking (Rysankova et al. 2014). It should be understood that the transition to exclusive use of very-low-emission devices and fuels will occur over time, with a progressive shift towards a higher proportion of energy usage provided by the newer, cleaner options. This is an important consideration for policy-makers planning large-scale improved cookstove interventions (Rehfuess et al. 2013).

Ultimately, policy-makers and cookstove programme designers will need to weigh all of these factors when selecting which fuel/cookstove technology to promote. There is no "one size fits all" when it comes to designing an approach – a point that is reflected in the wide diversity of cookstove technologies in use or being promoted in sub-Saharan Africa. Given the WHO guidelines and the emerging standards for cookstoves discussed above, it would seem pragmatic for policy-makers to take a differentiated approach to cookstove promotion, whereby advanced cookstove technologies are, in some cases, promoted alongside intermediate "transitional technologies" and in others, advanced cookstoves are introduced when the market is deemed mature and the wider innovation system needed to support the technology is in place (Johnson et al. 2015).

Table 2

Comparison of improved cooking stoves and clean fuel options in terms of health impact, climate impact, and cost

Technology evaluated	Health impact	Climate impact	Renew-able potential	Unit cost of technology (USD)	Comments
Advanced biomass stoves using forced ventilation	High	High	High	30–100	Fuel processing is required (e.g. pellets or small cuttings), which may increase fuel cost.
Intermediate stove technologies using improved combustion chambers	Moderate	Moderate	High	10–40	Performance varies widely between models, and on how used/maintained
Simple improved stoves with some improvement to combustion	Low	Low	High	5–15	Performance varies greatly depending on design and condition.
Liquefied petroleum gas (LPG)	High	High	None	45–60	Convenient, clean and relatively safe, but relatively expensive
Kerosene	Moderate	Moderate (high with efficient pressurized combustion)	None	15–25	Emerging evidence has linked kerosene use with a number of respiratory diseases, including tuberculosis.
Biogas	High	High	High	100–1,000	Digesters require a water supply and a waste supply from at least two livestock. Initial cost of digester is high.

Source: WHO (2014).

A snapshot of improved cookstove markets

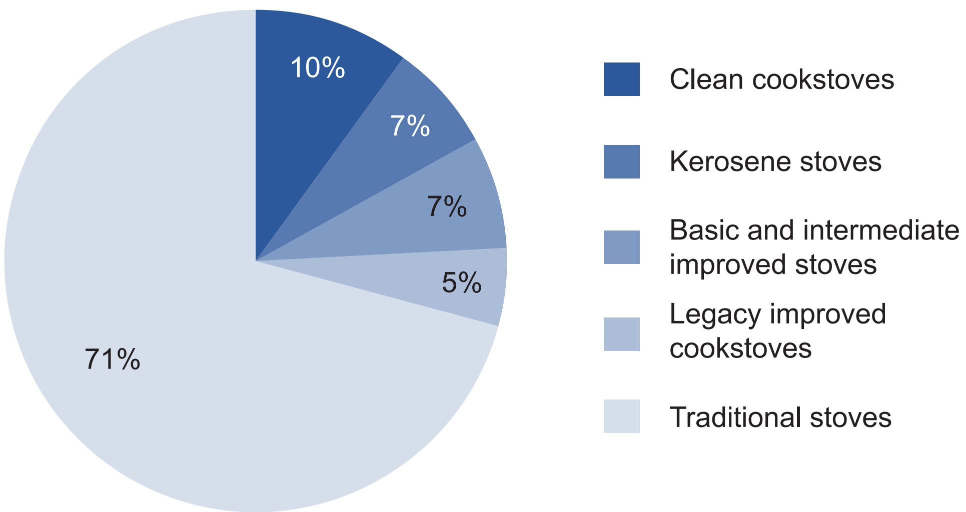
The overall penetration of clean cookstoves and fuels in sub-Saharan Africa is low, with estimates suggesting that only one in six African households has transitioned to clean cooking energy for most cooking needs. Advanced biomass cookstoves (ACS) and clean renewable cooking alternatives such as biogas, solar and liquid biofuels cumulatively reached fewer than a half-million African families by 2010 and as many as 1.3 million by late 2013 (Rysankova et al. 2014). The most recent figures available (late 2013/early 2014) show that the penetration of advanced biomass cookstoves is at a very early stage, with 40,000–100,000 natural and fan draft gasifiers distributed across pilot project sites in Africa.

Excluding basic improved cookstoves, which, as noted above, have low potential to reduce household air pollution, the aggregate clean and improved cookstoves penetration in sub-Saharan Africa was 24% in 2010–2011. However, sales of more efficient stoves are growing rapidly; for example, the penetration rate of intermediate technologies (i.e. rocket stoves) in Africa doubled from roughly 4 million in 2011 to 8 million by the end of 2013.

The sales mix and range of actors involved in improved-cookstove production is also changing quickly. Manufacturer and stove programme data for Africa suggest that industrial and semi-industrial stoves enterprises and programmes have had much more rapid growth (35–200% annual sales growth) relative to the annual sales growth trend of 10–25% for the artisanal sector over the past five years. Factoring in replacement sales, these growth trends suggest a significant expansion of improved industrial and semi-industrial stove manufacturing capacity in Africa over the past 5–10 years, albeit from a very low base. There are now more than 40 such companies manufacturing or assembling their cookstoves across a dozen countries, reflecting growing demand across the region for high-quality stoves.

Source: Summarized from Rysankova et al. (2014).

Figure 6
Cookstove mix in sub-Saharan Africa, 2011–2013



5. Challenges and opportunities in the African charcoal sector

As noted above, charcoal is an important household cooking fuel in sub-Saharan Africa, in particular for urban and peri-urban households. Nearly 60% of urban dwellers rely on charcoal for cooking (IEA 2010). Demand for charcoal as a cooking fuel is expected to double by 2030 due to population growth and accelerated migration to urban areas (Arnold et al. 2006). Charcoal is preferred by many consumers, especially those in urban areas, due to its higher energy density per unit weight, cheaper transport costs; since it produces less smoke than fuelwood, it causes fewer deaths from respiratory diseases (Liyama 2013; Bailis et al. 2015). This section focuses on the role of charcoal production in economies across sub-Saharan Africa, and on policy reforms to realize the potential of charcoal as a high-value, locally produced resource.

5.1 THE ECONOMIC IMPORTANCE OF CHARCOAL IN SUB-SAHARAN AFRICA

Charcoal is not only an important cooking fuel across sub-Saharan Africa; its production and trade also provide important seasonal and supplementary income to rural and peri-urban farming households (Zulu and Richardson 2013). In 2007, the charcoal industry in sub-Saharan Africa was estimated to be worth more than US$8 billion (up from US$6 billion in 1995), employing more than 7 million people (close to 1% of the population) in production and marketing (Sepp 2014; Liyama 2013). Largely due to population growth and accelerated migration to urban areas, by 2030, the market is predicted to exceed US$12 billion, employing 12 million people (Sander et al. 2011).

In contrast to fossil fuel-based energy sources, such as kerosene or LPG, that are often imported and negatively affect countries' macro-economic balance sheets, wood-based bioenergy has the potential to add value to the economy, supporting development and poverty alleviation (Sander et al. 2011). In most countries in sub-Saharan Africa, producing and selling fuelwood and charcoal is a source of income for large numbers of people. For example, the charcoal sector for Dar-es-Salaam, Tanzania, alone is estimated to provide opportunities for labour and cash income for several hundred thousand of the nation's poorest people, who have limited alternative livelihood options (Peter and Sander 2009). In Kenya, an estimated 700,000 people work in the charcoal sector (Sepp 2008a). In Malawi, Openshaw (2010) estimates, 93,500 and 133,000 were employed full-time in 1996 and 2008, respectively, in the biomass supply chain, compared with about 3,400 and 4,600 people employed in the supply chains of other fuels during the same period. A study in Uganda found that if households are involved in charcoal production, they are about 14% less likely to fall below a poverty line (Khundi et al. 2011). In Ghana, it is estimated that the charcoal sector employs 3 million people, of whom 65% are women (Mombu and Ohemeng 2008).

Table 3
Charcoal production and employment in some African countries and cities

Country / urban area	Amount of charcoal produced (tonnes)	Value (million USD/year)	Charcoal producer	People involved in charcoal trade
Kenya	1 600 000	400	200 000	500 000
Malawi	231 177	41	46 500	46 300
Maputo	130 000	13	20 000	20 350
Dar es Salaam	440 000	44	54 000	71 200
Lusaka	250 000	25	37 000	40 700

Source: Sepp (2014).

Yet despite its enormous social, economic and environmental significance, charcoal has not received the same attention as large-scale commercial forms of energy — oil, gas, coal and electricity — at the national and international levels (Sander et al. 2011). As discussed previously, most African governments – rightly – aim for a complete transition to a modern energy supply, but despite substantial progress, achieving this goal is likely to take many more years or decades. Given this situation, and bearing in mind the significance of charcoal to African economies, it would make sense for governments to take steps to make the most of

Charcoal sellers in Mokolo Market, Yaoundé, Cameroon. © Ollivier Girard, Center for International Forestry Research (CIFOR) / Flickr

their charcoal markets. Ensuring more sustainable production and consumption of the fuel could bring far-reaching benefits for households and national economies (Sepp 2014; Neufeldt et al. 2015).

However, in most sub-Saharan African countries, charcoal markets are viewed negatively. Not only are most energy policies focused on electrification, but wood energy is often viewed as dirty or "backward", and is thus ignored or downplayed (Owen et al. 2013). Policies and laws regarding wood fuels tend to focus on a "command and control" type regulation, enforcement, restriction and, where possible, moving completely to other energy sources (Sander et al. 2011). Even data-gathering is neglected; although designing pragmatic charcoal policies requires reliable baseline information, baseline data on wood energy demand – including households' fuel use preferences – and supply, as well as on wood energy value chains, are often outdated or missing (Sepp 2008b).

Many African governments have imposed outright bans on the production and trade of charcoal. But demand continues to grow rapidly, so enforcement of bans and restrictions has driven production underground. That, in turn, drives up the cost of charcoal (since producers and middlemen take greater risks when engaging in illegal production and often have to pay fines or bribes), feeds corruption, and deprives governments of potential tax revenues (Zulu and Richardson 2013). For example, national and local government in Tanzania are estimated to lose about US$100 million per year due to their failure to effectively regulate the charcoal sector (Peter and Sander 2009).

5.2 REGULATORY REFORM TO SUPPORT A SUSTAINABLE CHARCOAL VALUE CHAIN

Given the continued importance of wood-based energy in sub-Saharan Africa, and the rapid urbanization of the continent – already 38% of the population lives in urban areas, and by 2040, it will be 50% (UN 2014) – it is important to make charcoal production far more sustainable. A well-designed and operated sector could significantly reduce GHG emissions and help launch low carbon-growth strategies. At the same time, measures are needed to reduce the demand for charcoal for cooking, such as the promotion of more efficient charcoal cookstoves and stoves that use clean fuels (see discussion in Section 4).

On the supply side, policies need to start by recognizing that charcoal is a valuable energy source, then regulating its production to ensure sustainable practices. A key policy measure is to regulate charcoal production and sale by collecting revenue from charcoal production (license fees and fines on the illegal production and trade of charcoal), with strong enforcement. Incentives are needed to ensure that this revenue is collected; for example, local authorities could be allowed to retain what they collect, which could be used to cover the costs of managing the charcoal sector (Peter and Sander 2009). Further important steps include shifting from open-access forests to secure tenure and sustainable forest management, and the introduction and promotion of efficient charcoal kilns (Sepp 2008b).

Regulatory reform requires policy coherence at all levels to ensure that the measures introduced are synergistic and do not contradict one another. For example, in some African countries where charcoal trade is officially banned, fuel-efficient charcoal cookstoves are still promoted. Coordination between ministries is also necessary to gather key data on charcoal supply and demand and ensure that these databases are maintained.

Pushing through such reforms also requires political will. Regulation of the charcoal sector is likely to result in an increase in the price of charcoal to the end user, to reflect the real cost of sustainable charcoal production. This will not be popular among charcoal users, but price hikes will incentivize users to invest in and use more efficient charcoal cookstoves. Governments can learn from successful reforms in other countries; see the box for an outline of reforms in Sudan.

Charcoal regulatory reform in Sudan

Sudan, which derives 72% of its energy from biomass, including charcoal (IEA 2014), has recently adopted specific legislation to govern its charcoal industry, recognizing charcoal as an important source of energy and vesting the power to regulate it in the Forest National Corporation.

The agency is responsible for planning and organizing production from natural and planted forests and has formulated a clear plan for forest management. Forest land is initially leased to farmers for a five-year period. Charcoal producers are contracted to clear the land for crop production and use the wood to make charcoal. The land is then farmed for five years, after which it is left to regenerate for 14–20 years. For planted forests, the agency sets aside land and funds to plant and manage more than 100,000 hectares of trees per year. The trees take about 14–17 years to mature for harvesting. The government has recognized charcoal producers to whom it sells the trees by tender at officially set prices.

The Sudan Charcoal Producers Association was started to negotiate with the government on behalf of traders. Grouping producers, transporters and traders, the association has set up its own rules in addition to those laid down by the government. For example, it expels members who fail to pay taxes or engage in corruption. The expulsion means one cannot trade in charcoal. The organization has paid off, with some members producing 2,000–5,000 bags of charcoal (100 kg each) and earning up to US$50,000 per season.

Aside from establishing the charcoal traders association, a key feature of the initiative was the yearly allocation of resources (gathered revenues from licenses and taxes) for investing in forest plantations. This affirmed the government's continued commitment to the programme and brought tangible benefits at the district level.

It should be noted that these are mostly supply-side reforms. Ideally a sector-wide approach would consider reforms targeting both supply and demand. Recognizing the growing demand for charcoal as a cooking fuel, one of the strategies adopted by the Sudanese government was to promote the use of liquefied petroleum gas (LPG) by increasing the price of charcoal to up to three times that of gas. However, this did not reduce demand for charcoal, suggesting that LPG is not a direct substitute for charcoal as a household cooking fuel. The promotion of improved charcoal cookstoves would thus appear to be a feasible option in Sudan, though it is not clear whether this option has been considered at the national level.

Source: Summarized from Mugo and Ong (2006).

6. Case studies: Cookstove interventions across sub-Saharan Africa

Providing sustainable access to clean and improved cookstoves to households relying on traditional biomass energy is challenging, but there are multiple examples of innovative and scalable improved cookstove interventions being implemented in sub-Saharan Africa. Below we present several case studies, selected from a longer list of potential case studies on the basis of three criteria: initiatives that are disseminating at least Tier 3 technologies (capable of achieving health and environmental benefits); innovative approaches (either in terms of finance model used or terms of last mile delivery mechanism); and case studies representing different fuels and technologies (to include charcoal, fuelwood and clean fuel). We attempted to include examples from diverse geographical regions, though not all regions of sub-Saharan Africa are covered. Case study material was then provided by representatives of each cookstove initiative. A common template was provided to each partner (see Annex 2 for case study template). Section 7 presents an analysis of insights from the case studies.

6.1 THE SEWA CHARCOAL COOKSTOVE, MALI

Background

Mali is a Sahelian country with almost two-thirds of its land area in the Sahara Desert, and only about 10% forest cover. This leaves the country particularly vulnerable to the impacts of land degradation and climate change. Only 10% of its 14 million people have access to electricity, mostly in urban and peri-urban areas. Biomass, which is in acutely short supply, meets 81% of the country's energy needs, and 95% of households rely on it for cooking.

In 2004 the national government, through the Mali Energy Agency (AMADER) and with financial backing from the World Bank and the Global Environment Facility, launched the Household Energy and Universal Access Project (HEURA). One of its goals was to reduce household consumption of traditional biomass by facilitating the production and dissemination of 500,000 efficient cookstoves.

Intervention and implementation

Katene Kadji is the largest cookstove manufacturer and distributor in the country, producing ceramic liners for efficient charcoal stoves. It has been in business since 1997. The liners are distributed to a network of metal artisans in Bamako who manufacture the stoves under the brand name SEWA. To date, around 180,000 stoves have been sold, and 1.6 million people have benefitted from the technology.[7] The ultimate goal is 300,000 stoves.

From 2005 to 2007, Katene Kadji was one of several beneficiaries of a direct subsidy for improved cookstove production and dissemination under HEURA. The subsidy lasted for three years and was gradually phased out, from 50% in year 1, to 25% in year 2, to 0% in year 3. Other vendors entered the programme later, which put Katene Kadji in direct competition with first-year vendors with 50% subsidies, making it difficult to sustain operations (Ford and Kumar 2009).

To overcome this barrier, in 2007, Katene Kadji teamed up with E+Carbon, a U.S. carbon project developer, to develop a carbon offset project. Since 2009, Katene Kadji and E+Carbon have sold carbon credits (Voluntary Emission Reductions, VERs) to private companies in Europe and the U.S., to be used for corporate social responsibility purposes. The income from sales has covered the costs of carbon registration and monitoring, and allowed for expanded production and subsidized sales of stoves. The carbon project is due to end in 2017, and aims to have sold 300,000 stoves by that time (E+Carbon 2008).

Impacts of the intervention

The project has achieved a number of social, economic, and environmental benefits. The efficient stoves and resulting reduction in fuel use saved families about 25% of their previous fuel costs. The project estimates that a household using a SEWA medium-sized stove, which costs US$5.33, can save about US$25 per year – translating to a payback period of 2.6 months per stove.[8] Although field testing to establish the health impacts has not be conducted, a variation of the SEWA stove, the Gyapa stove, underwent cookstove performance testing, including household air pollution testing, at Aprovecho in the U.S. Tests showed that although CO emissions remained high, the Gyapa stove reduced emissions of particulate matter by 56% compared with a three-stone fire (Still et al. 2011).

7 Calculated by multiplying the number of stoves sold from 2007 to 2014 with the average number of people per household: 172,988 * 9.6. Source: Written correspondence from project manager.
8 http://www.climatefriendly.com/Projects/Projects/Project_Resources/Mali_Cookstove_Project_PDD/.

Both skilled and unskilled jobs have been created all along the SEWA production value chain, including artisans, retailers and distributors. For instance, more than 60 artisans were trained to produce the stoves. The distribution of 300,000 cookstoves is expected to require 130 new external artisans and 260 dealers.[9]

On average, the stoves save each household 340 kg of charcoal per year, which results in 2.2 tonnes of avoided CO_2e emissions every year. This aspect is anticipated to slow down deforestation in the vulnerable regions, which will protect ecosystems and biodiversity more broadly.

Moving forward and lessons learned

Carbon finance has brought several benefits for Katene Kadji. The subsidized price has allowed the company to maintain a commercial relationship with users who would not otherwise have been able to purchase a stove. Carbon revenues also allowed for scale-up in the wake of the retracted government subsidy. The continuous monitoring and reporting required has introduced a quality assurance component, enabling Katene and E+Carbon to verify that customers are using the stoves. This follow-up process also allows producers to identify problems in stove design and production, with the possibility to replace, repair, and adjust the design process. If used wisely, this information could contribute toward introducing a new set of quality expectations of consumers and contribute to scaling-up sales.

Another important lesson is that a supportive policy environment, which goes beyond creating financial incentives for users, is essential for supporting sustained adoption of improved cookstoves. While on paper the environmental and energy policies in the country are in favour of improved cookstoves, there are no regulations or incentives in place to facilitate the long term adoption of the technology. According to the SEWA project manager, the lack of national-level cookstove quality standards makes it difficult for improved cookstove companies to build trust and brand loyalty with their customers. Furthermore, weak regulation of the charcoal sector results in under-pricing of charcoal in the market and lack of demand for more efficient, fuel-saving cookstoves.

6.2 THE TOYOLA COOKSTOVE PROGRAMME, GHANA

Background

Charcoal is the main cooking fuel for about 1.3 million households in Ghana: 53% of urban and 14% of rural households depend on it for cooking (Edjekumhene and Cobson-Cobbold 2011). At the same time, charcoal production, which is typically very inefficient, has been identified as a major cause of forest degradation and deforestation in Ghana (see Section 5).

These challenges have drawn attention from the central government and non-governmental organizations alike. Several government policies and goals have been put in place which provide a supportive policy framework for advancing clean cookstoves to reduce fuel use and associated problems. For instance, Ghana's Energy Sector Strategy & Development Plan (Ministry of Energy, Ghana 2011) seeks to promote the production and use of improved and more efficient woodfuel utilization technologies (e.g. improved cookstoves). There is also a national strategy focused on providing 50% of the country with a sustainable supply of affordable and accessible cleaner cooking fuel alternatives (e.g. LPG), while the other 50% will be encouraged, through health advocacy, to produce and consume charcoal in an efficient and sustainable manner by using improved cookstoves (Ministry of Energy, Ghana 2011). The Ghana Action Plan under the UN Sustainable Energy for All (SE4ALL) initiative also has embedded strategic interventions of high impact for accelerating the deployment of improved cookstoves.

Intervention and implementation

Toyola Energy Limited (TEL) was established in 2006 by two local entrepreneurs who received training from EnterpriseWorks/VITA[10] in technical stove manufacturing skills. They have gone on to implement one of the most successful and sustainable charcoal cookstove businesses in the world, promoting a stove that uses a ceramic liner in a casing made from scrap metal.

9 Gold Standard Verification Report, February 2012: http://klimaohnegrenzen.de/system/attachments/55/original/Mali_GS_Final_Verification_Report_12June2012.pdf.

10 EnterpriseWorks/VITA (EWV), a not-for-profit organization based in Ghana, is a pioneer in the Ghanaian cookstove market. It started promoting a Kenyan sourced alternative cookstove (Kenya Ceramic Jico-Stove) called "Gyapa" (meaning "good fire") under the Energy for Household Cooking Project with funding from U.S. Agency for International Development (USAID) and the Shell Foundation. The project focused on the manufacture and commercialization of stoves that reduce indoor air pollution, use less fuel, last longer and are safer than traditional stoves.

Carbon finance as a mechanism to support the uptake of clean cookstoves

A shipping container serves as a store for Baker Stoves in Kenya © Sam Nuttman, Session 7 Media, Top Third Ventures Global

Addressing the complex barriers to cookstove uptake requires funding, and many cookstove programme implementers see carbon finance as an attractive revenue option. Indeed, despite the dip in the global carbon market, carbon finance continues to be an important source of revenue for African cookstove implementers. According to the Global Alliance for Clean Cookstoves in 2013, 43% of new funding reported by its partners was attributed to carbon offset sales ($45 million) or carbon fund investments ($3.6 million) and the sale of carbon offsets drove the distribution of 1 million cookstoves (GACC 2014).

An SEI study identified both risks and opportunities for cookstove implementers engaging with carbon finance in Kenya (Lambe et al. 2015). One of the biggest risks in carbon-financed cookstove interventions was that the number of credits generated is contingent on the individual end-users' uptake of the improved stove. Project designers often struggle to make reliable uptake predictions at both the individual household and aggregate levels because they do not have reliable data on household behaviour and fuel use. Another key benefit that this research highlighted was an appreciation for the possibility to quantify additional development benefits to get an indication of how livelihoods are improving as the project is implemented.

Carbon finance calls for rigorous monitoring and evaluation of cookstove use, which requires regular follow-up with individual stove users, as noted in the Mali case study. This follow-up can allow for important quality assurance and opportunities for the project developer to improve the service to the customer.

The single biggest threat to the implementation of carbon projects – not just those distributing cookstoves – is that the demand for carbon credits is currently minimal. This is particularly risky for projects that rely on carbon finance as their only source of funding. The SEI study showed that the cookstove project developers who were best placed to benefit from carbon revenues were those that had a sustainable business model and alternative revenue streams to support their operations (Lambe et al. 2015).

Traditional financing through commercial banks or commercial lending institutions has not been a viable option for many cookstove businesses operating in Ghana. The inability to predict monthly sales, the actual return on investment per stove sold, the lack of collateral and credit history, and the large informal economy mean that commercial banks hesitate to provide loans to cookstove businesses. Dealing with commercial banks was therefore a major barrier for the TEL founders.

However, TEL received assistance from the Kumasi Institute of Technology, Energy & Environment (KITE), under the African Rural Energy Enterprise Development (AREED) programme sponsored by the United Nations Environment Programme (UNEP). KITE advised and helped TEL to develop a business plan, which was approved for funding by the AREED Investment Committee, leading to the release of TEL's initial loan facility of 70,000 USD. TEL subsequently received two more loan facilities of US$100,000 each from E+Co, for a total of US$270,000, payable in five instalments (Edjekumhene and Cobson-Cobbold 2011).

In partnership with E+Co, TEL also pursued carbon credit generation. TEL developed its crediting scheme at a time when it was popular to apply a "buying down the price of the stove" concept. Applying this concept, TEL sells the stoves at a reduced price or for a lower profit margin, and makes up the difference by selling carbon credits for the emission reductions that stove users generate. Though the exact revenue shared between TEL and its carbon finance partner is not known, at the peak of carbon prices, TEL made an estimated US$154,000 from carbon credits and US$396,000 from selling about 61,000 stoves.

TEL is implementing an innovative business model that involves the poor along the whole value chain as suppliers, manufacturers, retailers and customers. The company has trained about 300 artisans who are each encouraged to specialize in the production of one of the stove's 26 constituent parts. This specialization is believed to have led to a sixfold increase in the productivity of the artisans. TEL buys the metal frames for the cookstoves from scrap metal dealers. The company also pre-finances orders from local artisans for the other components of the stove, such as the handles and lids. The ceramic liners are manufactured at a central facility in eastern Ghana (at KT Ceramics, fully owned by TEL). The various components of the cookstoves are then assembled by a group of artisans who specialize in stove assembly. TEL has five production centres in Ghana, one in Togo and one in Nigeria.

TEL often sells its products, priced from US$8, on credit to local vendors who earn a 10% commission on each product sold. In some cases, TEL also sells directly on credit to end-users, to be paid back over two months using the savings from reduced charcoal use, with many stashing cash in a "Toyola Money Box". In some cases, the company does business on a barter basis to give the most deprived segments of the rural population the opportunity to acquire its products.

Impacts of the intervention

Testing for carbon finance verification shows that the Toyola stoves cut charcoal use by about a third, saving a total of about 26,000 tonnes per year and thus reducing the use of wood to make charcoal. This directly affects deforestation, as about 73% of the wood used in Ghana to make charcoal (and directly as fuelwood) is considered non-renewable – i.e. it is not replaced by new trees. Detailed assessments show that an improved cookstove in use for one year in Ghana saves 1.03 tonnes CO_2e – 84% of which is CO_2 from avoided non-renewable wood use, and most of the rest from avoided methane emissions during charcoal production. Thus the Toyola stoves currently in use are saving about 150,000 tonnes/year of CO_2e. The stoves are also popular with cooks, because they cook food more quickly and keep it warm for longer. Stove-related burns have been reduced by 90%, and eye irritation and breathing problems are also lower (Ashden Awards 2011).

Annual stove sales have increased from 21,000 in 2007 to 52,000 in 2010, with a cumulative total of 154,000 stoves sold by the end of March 2011, cooking meals for about 1 million Ghanaians (Ashden Awards 2011; Edjekumhene and Cobson-Cobbold 2011). The current production level is an estimated 100,000 stoves per year, with an overall production of 400,000 units sold between January 2009 and May 2014 (Ruiz and Savadogo 2014). User surveys in 2010 showed that households with improved cookstoves spent about 160 GHC/year on charcoal, compared with their coal pot expense of 200 GHC/year. This saving of 40 GHC (about US$27) per year is significant for households with cash incomes that are typically about 1,200 GHC (USR800) per year. It means that the cost of buying an improved cookstove can be recovered from savings in charcoal within three to four months. Note that the savings do not take into account the fact that charcoal prices roughly doubled from 2008 to 2011, so the real savings are now higher (Ashden Awards 2011).

Moving forward and lessons learned

Carbon finance has enabled Toyola to grow, but the need for capital by both producers and end-users is still a constraint. Toyola is looking for a suitable bank or microfinance institution (MFI) partnership, and is also considering setting up a separate finance subsidiary.

Toyola Energy has grown rapidly, developing a franchise system that now extends to Togo and Nigeria, with a diversified range of energy products (cookstoves, solar PV). With the falling price of carbon credits, and new improved cookstove players in Ghana, Toyola has chosen to enter new markets, which allows it to balance out costs across the organisation. Toyola has also started producing wood-burning stoves as another option for regions of the country that use mainly wood. Plans to open similar production and training centres in Sierra Leone and Benin are also far advanced.

6.3 SMALL-SCALE ETHANOL PRODUCTION FOR HOUSEHOLD COOKING IN ETHIOPIA

Background

While many African nations face similar challenges, Ethiopia ranks particularly low in terms of energy progress – in 2012 the IEA's *World Energy Outlook* ranked Ethiopia last out of 80 countries listed, with an Energy Development Index of 0.04 (IEA 2012). In order to close its substantial energy access gap, it has been argued that Ethiopia needs to implement a diverse portfolio of approaches, including not only grid expansion and rural electrification, but also small-scale, decentralized solutions such as the promotion of clean cooking fuels and efficient stoves (Tessama et al. 2013; Rogers et al. 2013).

According to a recent survey by the Central Statistics Agency (CSA), 96% of Ethiopian households (15.5 million in 2011) used biomass fuels as their main sources for cooking (Central Statistical Agency 2012). At country level, about 81.4% of the households use firewood, around 11.5% cook with leaves/dung cakes, and only 2.4% use kerosene for cooking. The majority of rural households use firewood (84.4%). Exposure to pollution from biomass burning cookstoves is responsible for approximately 45,697 deaths annually, with a total of 89,894,272 Ethiopians being affected by household air pollution each year.[11]

A new ethanol micro-distillery in Addis Ababa aims to provide new income-earning opportunities for local women while providing a reliable supply of cooking fuel. © Sarah Odera / SEI

Intervention and implementation

For 10 years the Ethiopian NGO Gaia Association has been working to improve household energy access by making use of surplus ethanol produced locally from molasses, a by-product of large, state-owned sugar factories. Gaia Association promotes bio-ethanol for cooking, and has piloted the ethanol fuelled "CleanCook" stove in diverse settings ranging from refugee camps to middle-income condominium homes in Addis Ababa (Rogers et al. 2013). Indoor air quality studies conducted in these settings show that the ethanol stoves reduce levels of CO emissions to below the WHO recommended thresholds and $PM_{2.5}$ emissions to close to the WHO threshold when compared with a three-stone fire, and households using the stoves report improved health outcomes (CEIHD 2007); Approximately eight thousand stoves are currently in use in Ethiopia (nearly 7,000 in refugee camps near the Jijiga area and an additional 1,000 in Addis Ababa).

A recent national feasibility study indicates that there is strong demand for ethanol among households in all regions, especially in urban areas. It also estimates that ethanol could displace kerosene in 100% of urban households, and charcoal in up to 50% of rural households, with considerable savings in fuel expenditure. Furthermore, a financial analysis shows that based on current prices, the average urban household would save around ETB 136 per year (US$6.50) if switching from charcoal, and ETB 450 (US$22) per year from kerosene (Gaia Association 2014). Although the SCIP study also indicated a demand for ethanol as a cooking fuel in rural areas, it will be more challenging to encourage rural households to start using ethanol as part of their energy mix than urban households, given that most rural people rely on gathered fuelwood for cooking – which is cheap or free – and because average incomes are so much lower than in urban areas.

In an attempt to overcome the challenge of supply fluctuation, the Gaia Association and its partners, including the Ethiopian government, have begun to explore the technical, financial, environmental and socioeconomic feasibility of small-scale, decentralized ethanol production. In July 2015, Gaia and partners commissioned the first micro-scale ethanol plant in East Africa – to produce ethanol from surplus sugarcane molasses for the household market in peri-urban Addis Ababa. The distillery will have the capacity to produce 1,000 litres of ethanol per day, supplying fuel to a low-income neighbourhood in Addis Ababa. Although this initiative is supported in large part by donor finance, it will nonetheless serve as a model for replication elsewhere in Ethiopia, and is providing a test case for the government, highlighting where regulatory reform is needed for a national scale-up of the initiative to be possible.

11 Learn more on the Global Alliance for Clean Cookstoves website: http://cleancookstoves.org/country-profiles/15-ethiopia.html.

Moving forward and lessons learned

The most significant barrier to the scale up of the initiative is the fact that currently, there is no supply chain for ethanol in Ethiopia. With only one ethanol retailer in Addis Ababa, the price per litre is prohibitively high for lower-income users. Though there is great potential for private-sector actors to be involved in developing the household ethanol value chain, from feedstock production to construction and operation of ethanol micro-distilleries, to cookstove manufacture and fuel retail, major barriers are deterring them. The main barrier is low profit margins. The government sets an unrealistic retail price for ethanol of ETB 13.99 per litre, while the factory gate price is ETB 10.78. This means that potential small-scale ethanol producers can't cover their costs, or compete with kerosene, which is subsidized by the government. The private sector will not invest until these risks are tackled through regulatory reform – e.g. reducing kerosene subsidies and lowering the VAT on ethanol destined for the household market.

6.4 ECOZOOM IMPROVED WOOD AND CHARCOAL STOVES, KENYA

Background

In Kenya, 2.7 million households are not connected to the electrical grid, and 7.8 million use solid fuels for cooking. Every year, about 15,000 Kenyans die from illnesses associated with household air pollution. Acknowledging this problem, the Kenya Climate Change Action Plan includes an action item to undertake "a programme to support the use of improved cookstoves and of LPG cookstoves, including increasing awareness of improved cooking practices, undertaking pilot initiatives which promote the use of LPG, increasing awareness of stove quality, increasing access to soft loans, building capacity of stove producers, and improving access to testing facilities".[12]

Intervention and implementation

EcoZoom is a social enterprise with the mission of transforming lives by supplying healthy, efficient, eco-friendly products (efficient charcoal and wood burning cookstoves and solar lights) and offering the services needed to support the long term uptake of these products. The company was founded in April 2011 and has sold more than 300,000 clean cookstoves in 14 countries. EcoZoom Kenya was launched in October 2013 as EcoZoom's first country office and since then has sold more than 17,000 efficient charcoal and wood burning cookstoves.

The charcoal cookstove costs US$47 and saves households on average US$14 per month, with a payback time of 3.3 months. EcoZoom estimates that its charcoal stove will save the average household US$845 during its lifetime. The wood-burning stove costs US$39 and will save the average household US$5 per month, amounting to an average payback period of 8.3 months. The wood burning stove will save the average household US$283 during its lifetime. EcoZoom stoves also have climate benefits, avoiding about 1–3 tonnes CO_2e per stove per year.

EcoZoom does not provide end-user subsidies. Rather, the company works to make products affordable to all customers by providing credit terms to distributors who then pass them on to end-users; by working with MFIs to provide loans for product purchases; and by partnering with corporations that use "check-off" programmes with their staff.[13] The company is also piloting a direct financial inclusion programme where loans are provided to end-users and are repaid over a three- or six-month period via mobile money. EcoZoom Kenya's customers include private businesses, individual entrepreneurs, MFIs, SACCOs and corporations. This means end-users acquire the stoves as a result of mutually aligned goals of multiple actors. For example, the MFIs are able to increase their loan portfolio through offering specialized loans for EcoZoom products, Corporations are able to engage in CSR and employee-benefit efforts, and individual entrepreneurs are able to create sustainable, robust livelihoods.

EcoZoom largely attributes its success in tapping the Kenyan cookstove market to the company's "human centred" design process, where products are carefully developed to meet the specific needs and preferences of their customers. However, just as important as the product are the after-sales services it provides to customers and end-users. These include:

- Training – ensures products are used and maintained correctly for maximum uptake and impact;
- Monitoring and evaluation – closes the loop with end-users to address problems quickly and ensure a positive experience with the EcoZoom brand;
- Product warranty;

12 See http://www.kccap.info.
13 A check-off programme is a system where the employer pays the whole cost of the product to EcoZoom upfront and deducts the cost of the product from staff wages over a three- to six-month period.

A micro-entrepreneur sells EcoZoom stoves (and nuts) on the side of the road outside Nairobi. © Living Goods / Flickr

- Maintenance and repair – increases product life and value for money to end-users; and
- Financial inclusion – interest-free loans through Kiva for sales agents and distributors as well as a grant-funded pilot to provide credit to end-users.

These services, plus the "human-centred" product design and mass manufacturing, combine to create what the company calls the Sustainable User Uptake Programme (SUUP) – what EcoZoom thinks is needed in the market to ensure that once end-users get a product, they will use it correctly and use it throughout its life.

Moving forward and lessons learned

Although the company is growing, some key barriers remain, mostly related to difficulties importing the cookstoves. The Kenyan government levies a 25% import duty on cookstoves. This, combined with the VAT and railroad tax, adds about 47% to the cost of a stove, making it difficult to maintain healthy margins throughout the value chain while keeping stove prices affordable to end-users. As local manufacturers cannot produce enough improved cookstoves to meet the demand, this policy is keeping some Kenyans from gaining access to clean stoves. EcoZoom also says that the import duties levied on raw materials and the unwillingness of the government to engage in negotiations have prevented it from setting up a factory in Kenya. A similar pattern is seen in Ethiopia, where the government is applying a high VAT (equivalent to that applied to ethanol used in the beverage industry) to ethanol as a cooking fuel, making it impossible for ethanol to compete with subsidized kerosene.

7. Success factors for scaling up cookstove programmes

Despite more than three decades of efforts by governments and development agencies, progress on scaling access to cookstoves has generally been limited, and we have yet to witness a large-scale shift to cleaner cookstoves and fuels in sub-Saharan Africa. There are many reasons posited for this. Many past stove programmes – and even some current ones – were based on cookstoves designed in laboratories and built by local artisans. These stoves often performed well in the laboratory or when first installed, but over time, their efficiency and ability to remove smoke from the household deteriorated (Akbar et al. 2011). Furthermore, the model of dissemination of these stoves was often supply-driven in nature, where households received free or highly subsidized improved cookstoves. It has become clear that in order to make a substantial and long-term impact, cookstove initiatives need to produce a transformation of local stove markets which is self-sustaining and demand-driven.

Studies of past projects have identified several elements needed for innovation and market transformation of the cookstove sector to take place:

- **Stove technical factors** (improved efficiency and reduced emissions); design factors (including how well the stoves meets the diverse needs of heterogeneous users, and whether users perceive the cookstove as a real improvement); quality and durability; accessibility to consumers (including affordability, availability of stove and fuel in local markets, and ease of installation and use in the home);
- **Finance:** access to start-up finance for the business/enterprise; access to finance for the household/use;
- **Enabling policy and regulatory environment**, including an established system of standards/regulations for cookstoves (Simon et al. 2012; Rehfuess et al. 2013; Cordes 2011);
- **Commercial approach:** GIZ has found that a fully commercial approach – as opposed to simply distributing clean stoves through development programmes – is the most important factor in achieving long-term sustainability in cookstove initiatives (GIZ 2011).

Many cookstove projects use subsidies to keep prices affordable, either direct (price subsidy) or indirect, covering the costs of research and development, producer training, public awareness-raising, etc. (Rai and McDonald 2009). Notably, cookstove programmes that have been most successful have not applied direct subsidies to the price of the stove, but have instead used indirect subsidies to support R&D, manufacturing, and marketing (Akbar et al. 2011; Cordes 2011). A recent systematic review of literature on the enablers and barriers to the uptake of improved cookstoves found that large subsidies can diminish the perceived value of the stove, and thus reduce users' willingness to use, maintain and eventually repurchase the product (Rehfuess et al. 2013). The same study found that overall, an entrepreneurial mode and appropriate business skills are crucial to the success and financial viability of cookstove interventions.

The case studies presented in Section 6 highlight the challenges involved in bringing an improved cookstove project to commercial scale, and how these are being overcome by cookstove entrepreneurs and practitioners on the ground. We synthesized the key insights emerging from the case studies and presented them to a group of energy access stakeholders during a consultative workshop in Nairobi in April 2015. This meeting brought together private-sector actors, NGOs engaged in cookstove initiatives, policy-makers, health specialists and experts on cookstove design and performance from across sub-Saharan Africa to deliberate on the challenges and opportunities facing the sector (see Annex 1 for list of participants and description of workshop methodology). The discussion that follows, and the recommendations in Section 8, are informed by insights and feedback gathered through the workshop.

7.1 COSTS AND BENEFITS OF COOKSTOVE INTERVENTIONS

Despite the many challenges, it is clear that improved cookstove interventions yield health, development and environmental benefits, creating a clear imperative to act. Table 3 summarizes the benefits found in the case studies.

All of the stoves featured in the case studies appear to be having an impact on household health. For three of the five stoves, lab tests suggested a reduction in $PM_{2.5}$ concentrations (i.e. particulate matter) of between 56% and 80%. For two of the three charcoal stoves, significant reductions in carbon monoxide (CO) are reported, 56–57%.

Not surprisingly, there is significant variation in the prices of the stoves, some of which use more advanced technologies than others. More unexpected is the fact that relatively cheap technologies could generate significant savings for households. For example, the EcoZoom improved charcoal stove, which costs US$7, can save a household $168 annually on fuel. On average, households using improved cookstoves are saving US$60 per year on fuel. Although some of the stoves require a significant upfront investment by households, the average payback period on the biomass cookstoves (four out of five cookstoves) is four months. Payback time on the ethanol cookstove is significantly longer due to the high upfront cost. The average GHG savings annually per biomass cookstove is 1.5 tonnes CO_2e per year (this increases to 1.85 tonnes per cookstove if the ethanol stove is included).

Table 4
Costs and benefits of improved cookstove interventions in case studies

Cookstove technology	Cost to household (USD)	Reported health benefits	Savings annually (USD)	Payback period	CO_2e savings annually per cookstove
TEL improved Charcoal	8	Less coughing, less irritated eyes (Self reported)	27	3-4 months	1.03 tonnes
SEWA improved charcoal	5.33	None reported (lab tests suggest 56% reduction in CO)	25	2.6 months	2.2 tonnes
EcoZoom improved charcoal	7	Lab results show 57% reduction in CO (compared with traditional charcoal stove)	168	3.3 months	1–3 tonnes
EcoZoom improved wood	39	Less coughing, wheezing and eye irritation. Lab results show 73% reduction in CO and 57% reduction in $PM_{2.5}$ (compared with open fire)	60	8.3 months	1–3 tonnes
Gaia Association (ethanol fuelled "CleanCook" stove)	40	Less coughing, wheezing, less irritated eyes; field tests show reduction in $PM_{2.5}$ and CO to below WHO recommendation)	15-20	2 years	3 tonnes

7.2 KEY INSIGHTS FROM THE CASE STUDIES

Bringing cookstove interventions to scale takes time (the World Bank and others estimate the average to be 5–10 years), and **therefore requires long-term commitment from governments.** Financial commitment is important, but even more crucial is to integrate supportive policies into the wider policy framework. For example, the Toyola case study highlights the importance of the Renewable Energy Act in Ghana, which provides a comprehensive legal and regulatory framework to support the scale-up of efficient renewable energy technologies such as improved biomass cookstoves. The SEWA case study demonstrates what can happen when shifts in policy occur – Although the HEURA subsidy encouraged more cookstove businesses to enter the market, the phase-out of the subsidy after just three years left cookstove implementers such as SEWA in a precarious financial position. In Ethiopia, government policies that set high prices for factory-gate ethanol while subsidizing kerosene have deterred private-sector involvement in developing the value chain for ethanol as a household cooking fuel.

In all case studies mentioned above, a **public-private partnership** approach was taken to support the dissemination of cookstoves. Indeed, a public-sector/donor-driven approach with a clear market based rationale has been a feature of many of the more successful national cookstove programmes in sub-Saharan Africa. In such approaches the government and donors play an important role early on in raising awareness about the benefits of adopting the new technology. As described in the Toyola cookstove case, early and sustained donor support served to lay the foundation for a successful commercial venture later on. Similarly, donor finance was used early on to conduct extensive market surveys and pilot studies of the ethanol stove in Ethiopia.

Early public-sector support often takes the form of subsidies along the improved cookstove value chain. This was clearly demonstrated in the Mali case, where the government provided incentives early on for business development. As discussed earlier in the paper, care should be taken in designing subsidies for improved cookstove programmes. Successful improved cookstove programmes tend to apply indirect subsidies to support research and development, manufacturing and distribution, or entering new markets, rather than direct subsidies to reduce the cost to the consumer. However, given the health and development impacts associated with traditional biomass use, end-user subsidies should be considered for lower-income market segments for which improved cookstoves are unaffordable.

The case studies show that **market-driven approaches have been most successful in scaling up improved cookstove programmes**. Market-driven approaches create incentives along the value chain to improve the quality of products and create demand. Although indirect subsidies and market facilitation were required at early stages of all of the case study programmes, the most successful efforts have minimized direct subsidies and relied on enterprise-based and market-based mechanisms for growth.

There are several **regulatory barriers preventing a rapid scale-up of commercial cookstove initiatives** in sub-Saharan Africa. Companies wishing to manufacture and distribute higher-end cookstoves face particular challenges. Since there is often a lack of local capacity and skills to produce higher-quality stoves, companies often opt for importing cookstoves or cookstove parts. The import duties levied on goods coming in often increase the price to the end-user and reduce the margin for cookstove distributors, thus reducing the incentive to market and sell the products. As noted above, EcoZoom reports that import duty combined with the VAT and railroad tax adds approximately 47% to the landed cost of a stove, making it difficult to maintain healthy margins for actors along the value chain.

At the same time, it should be noted that import taxes and duties are in place to protect local markets and products. For example, it emerged during the consultative workshop in Nairobi that the relatively recent emergence of semi-industrial advanced cookstoves with higher health and climate benefits has led to tensions with local small-scale producers. The new cookstove actors, many of whom have financial backing either from private investors or donors, often apply end-user subsidies to deliver their products to households, distorting the local market and making it difficult for the local producers to compete.

Crucially, **cookstove programmes tend to be most successful when the end-user is considered at every point along the value chain,** from design to marketing and delivery, including the type of end-user finance mechanism applied. Incorporating users' needs and preferences into the design of the cookstove is critically important for ensuring that the stove is used consistently and correctly by the household. This may sound like an obvious point, but historically, this has not been the practice in African cookstove programmes, many of which developed their technologies in laboratory settings, without the direct input of end-users. The case study on EcoZoom's improved cookstove business in Kenya clearly demonstrates the importance of user-focused design processes in developing products that household are willing to pay for and use. However, conducting consumer research is costly, particularly for smaller companies. Disaggregated demand data on user needs, preferences, capacity and willingness to pay is often missing at the sub-national level, making it difficult for cookstove project developers to target their efforts efficiently.

Even with a well-designed improved cookstove that meets the users' needs, **consumer finance is often a major barrier to the wider uptake of these technologies**. There are a number of innovative mechanisms in operation throughout sub-Saharan Africa to enable access to finance for consumers in different market segments. Spreading out the high upfront cost over time, as the Toyola cookstove case demonstrated, can be a pragmatic way for customers to afford the cookstove. Both the Toyola and the SEWA cookstove programmes are tapping into carbon revenues to overcome the consumer finance barrier and scale-up their operations. The "financial inclusion" approach taken by EcoZoom is providing end-user finance options via established MFIs to allow households at every income level to access their products.

As noted in the box in Section 6, evidence suggests that pursuing carbon finance can entail significant risks for projects that do not have other sources of revenue to support their operations. A number of ancillary benefits are associated with the use of carbon finance in cookstoves projects. These include the requirement to monitor and follow up with end-users (which ensures that the supplier is accountable to the customer and can allow for user feedback/improvement of the technology) and enhanced quality assurance on the production line. These benefits were noted in both the cookstove case studies presented in this section.

In the absence of carbon finance, quality assurance may be harder to ensure for cookstove businesses and implementers. The lack of nationally promulgated and enforced cookstove standards is a major impediment for the development of vibrant cookstove markets in sub-Saharan Africa. Without enforced standards, the end-user can never be certain of the quality of the product, and there is a risk that poor-quality products will spoil the market for others promoting high-quality products. This was noted as a major challenge for the cookstove implementer, SEWA, in the Mali case study. Developing standards requires the establishment of regional cookstove test centres, including the development of local capacity in stove testing.

8. Policy recommendations

In preparation for the April 2015 workshop, SEI prepared a synthesis paper with a set of draft recommendations, which were discussed and refined as part of the workshop. What follows is the final set of recommendations:

1. Biomass energy is of significant economic value to African economies, and is the single most important energy source for a majority of households. There is an urgent need for governments in the region to **recognize the value of biomass energy** to the larger economy, especially in rural areas, and design/reframe energy and economic development policies accordingly.
2. **The charcoal sector is in urgent need of regulatory reform**: Policy coherence is crucial for the emergence of a vibrant sustainable biomass energy sector, and regulatory reform is needed on both the supply and demand sides. Governments should consider removing woodfuel under-pricing policies to truly reflect the cost of sustainable charcoal production and incentivize the uptake of efficient charcoal cookstoves and charcoal production practices. Cross-subsidisation could then be used to target subsidies for charcoal to the lowest-income market segments.
3. Governments in sub-Saharan Africa could encourage the uptake of clean cooking stoves and their components by **removing taxes and duties to exempt technologies that are imported** and by reducing the number of licenses required by cookstove manufacturers and distributors. A specialized agency should be established to plan and promote clean cooking stoves, coordinate technology standards and testing and manage national and sub national data on biomass energy supply and demand.
4. Targeted funding should be provided, both through donor commitments and public finance, to build the **capacity of regional cookstove testing centres**. Governments could play an important role raising awareness about the benefits of clean and safe cookstoves and fuels by communicating information on cookstove standards to the public, for example, through product labelling.
5. There is a need to **tap local innovation**: Research and development in the local cookstoves sector should be promoted to match the support (finance and policy access) that larger, international cookstove partners can access. R&D institutions should be strengthened – governments should invest in special innovation funds.
6. To support market transformation of the cookstove sector**, subsidies** (whether carbon finance, donor or government) within cookstove businesses should generally be **targeted upstream** in the value chain (R&D, manufacture, distribution) rather than downstream to the end-user. Targeted end-user subsidies could be used to support very low-income households to gain access to clean cookstoves.
7. Clean cookstove businesses can **access end-user finance for their products through range of proven innovative approaches,** including microfinance loan schemes, payment in instalments, community savings clubs, etc. National, regional and local authorities can encourage such schemes by providing information, soft loans and loan guarantees to smaller actors seeking to set up business. Banks, MFIs and other lending institutions should provide interest-free or very-low-interest loans for stove purchasers. A specific governmental agency should be established to support and coordinate these activities, with a dedicated fund to finance the agency. This fund could be replenished using a combination of revenues from a reformed charcoal sector, donor funds, and ministerial budgets (e.g. energy, health and environment).
8. **Carbon finance can be a catalytic finance mechanism** for cookstove projects, particularly those that do not rely exclusively on carbon revenues to maintain and scale implementation. Carbon revenues can bring about a range of ancillary benefits for the project developer and end-user, including quality assurance, monitoring and reporting of progress over an extended time period.
9. **End-user behaviour and preferences should inform every clean/improved cookstove intervention.** All implementers of clean cookstove interventions, including businesses, NGOs, and governments, should take the **cookstove user's needs and behaviour as their starting point**. There will be no panacea for addressing the household cooking challenge in sub-Saharan Africa; instead, a differentiated approach based on specific socio-cultural contexts is recommended. Better and more disaggregated data on cookstove users' preferences, willingness and capacity to pay for a clean cookstove at the sub-national level will be invaluable for directing investment and innovation in the clean cookstoves sector.

References

Akbar, S., Barnes, D. F., Eil, A. and Gnezditskaia, A., 2011. *Household Cookstoves, Environment, Health, and Climate Change: A New Look at an Old Problem*. Working Paper, #63217. The World Bank, Washington, DC. Available at: http://documents.worldbank.org/curated/en/2010/03/14600224/household-cook-stoves-environment-health-climate-change-new-look-old-problem.

Arnold, J. E. M., Köhlin, G. and Persson, R., 2006. Woodfuels, livelihoods, and policy interventions: Changing Perspectives. *World Development*, 34(3). 596–611. DOI:10.1016/j.worlddev.2005.08.008.

Ashden Awards, 2011. *Toyola Energy Limited Ghana*. Ashden Awards for Sustainable Energy, London. Available at: https://www.ashden.org/files/Toyola%20winner.pdf.

Bailis, R., Drigo, R., Ghilardi, A. and Masera, O., 2015. The carbon footprint of traditional woodfuels. *Nature Climate Change*, 5(3). 266–272. DOI:10.1038/nclimate2491.

Bruce, N., Pope, D., Rehfuess, E., Balakrishnan, K., Adair-Rohani, H. and Dora, C., 2015. WHO indoor air quality guidelines on household fuel combustion: Strategy implications of new evidence on interventions and exposure–risk functions. *Atmospheric Environment*, 106. 451–457. DOI:10.1016/j.atmosenv.2014.08.064.

Bruce, N. and Smith, K. R., 2012. *WHO Indoor Air Quality Guidelines: Household Fuel Combustion, Review 4: Health Effects of Household Air Pollution (HAP) Exposure*. 4. Geneva. Available at: http://www.who.int/indoorair/guidelines/hhfc/Review_4.pdf?ua=1.

CEIHD, 2007. *Indoor Air Pollution Monitoring Summary for Gaia Association-Ethiopia's CleanCook Stove Tests in the Bonga Refugee Camp Gambella Regional State Ethiopia*. Indoor Air Quality Report. Center for Entrepreneurship in International Health and Development (CEIHD) School of Public Health, University of California. Available at: https://projectgaia.com/wp-content/uploads/2013/10/Bonga-Camp-IAP-Monitoring-Report-11-07.pdf.

Central Statistical Agency, 2012. *Ethiopia – Demographic and Health Survey 2011*. Prepared with ICF International, Calverton, MD, US, as part of the worldwide MEASURE DHS project. Addis Ababa. Available at: http://www.measuredhs.com/publications/publication-FR255-DHS-Final-Reports.cfm.

Cordes, L., 2011. *Igniting Change: A Strategy for Universal Adoption of Clean Cookstoves and Fuels*. Global Alliance for Clean Cookstoves, New York. Available at: http://www.cleancookstoves.org/resources/fact-sheets/igniting-change.pdf.

Dherani, M., Pope, D., Mascarenhas, M., Smith, K. R., Weber, M. and Bruce, N., 2008. Indoor air pollution from unprocessed solid fuel use and pneumonia risk in children aged under five years: a systematic review and meta-analysis. *Bulletin of the World Health Organization*, 86(5). 390–398C. DOI:10.1590/S0042-96862008000500017.

E+Carbon, 2008. *Project Design Document for Gold Standard Voluntary Offset Projects Improved Household Charcoal Stoves in Mali*. E+Carbon. Available at: http://www.stop-climate-change.de/fileadmin/user_upload/documents/Klimschutzprojekte/Mali/GS414PDD_deviations_approved20July2011.pdf.

Edjekumhene, I. and Cobson-Cobbold, J., 2011. *Low-Carbon Africa: Leapfrogging to a Green Future: Ghana*. Low-Carbon Africa: Leapfrogging to a Green Future. Christian Aid. Available at: http://www.christianaid.org.uk/images/low-carbon-africa-Ghana.pdf.

Foell, W., Pachauri, S., Spreng, D. and Zerriffi, H., 2011. Household cooking fuels and technologies in developing economies. *Energy Policy*, 39(12). 7487–7496. DOI:10.1016/j.enpol.2011.08.016.

Ford, W. and Kumar, A., 2009. *An Analysis of the Barriers to Achieving Scale in Mali's Efficient Cookstove Sector*. E+Co, Bloomfield, NJ.

GACC, 2012. *Fact Sheet: Clean Fuels and the Global Alliance*. Fact sheet. Global Alliance for Clean Cookstoves, Washington, DC. Available at: http://cleancookstoves.org/binary-data/ATTACHMENT/file/000/000/52-1.pdf.

GACC, 2014. *2013 Results Report: Sharing Progress on the Path to Adoption of Cleaner and MOre Efficient Cooking Solutions:* Global Alliance for Clean Cookstoves, Washington, DC. Available at: http://cleancookstoves.org/resources/285.html.

Gaia Association, 2014. *Holistic Feasibility Study of a National Scale-up Programme for Ethanol Cook Stoves and Ethanol Micro Distilleries (EMDs) in Ethiopia*. Feasibility study of EMDs and ethanol cookstoves: market, financial and economic analyses. Available at: https://projectgaia.com/wp-content/uploads/2013/10/8-Feasibility-study-Market-Financial-and-Economic-Analyses-pdf.pdf.

GIZ, 2011. *Lessons Learned from Improved Cooking Stove Projects*. Available at: https://energypedia.info/images/8/82/GIZ_HERA_Lessons_learnt_from_improved_cooking_stove_projects_2011_.pdf.

Global Commission on the Economy and Climate, 2014. *Better Growth, Better Climate: The New Climate Economy Report*. The Global

Report. Washington, DC. Available at: http://newclimateeconomy.report.

Hart, C. and Smith, G., n.d. *Scaling Adoption of Clean Cooking Solutions through Women's Empowerment*. Global Alliance for Clean Cookstoves, Washington, DC. Available at: http://cleancookstoves.org/binary-data/RESOURCE/file/000/000/223-1.pdf.

Hutton, G., Rehfuess, E. and Tediosi, F., 2007. Evaluation of the costs and benefits of interventions to reduce indoor air pollution. *Energy for Sustainable Development*, 11(4). 34–43. DOI:10.1016/S0973-0826(08)60408-1.

IEA, 2010. *Energy Poverty: How to Make Modern Energy Access Universal?* Special early excerpt of the World Energy Outlook 2010 for the UN General Assembly on the Millennium Development Goals. International Energy Agency, Paris. Available at: http://www.un-energy.org/publications/618-energy-poverty-how-to-make-modern-energy-access-universal.

IEA, 2012. *World Energy Outlook 2012*. International Energy Agency, Paris. Available at: http://www.worldenergyoutlook.org/publications/weo-2012/.

IEA, 2014. *Africa Energy Outlook: A Focus on Energy Prospects in Sub-Saharan Africa*. World Energy Outlook Special Report. International Energy Agency, Paris. Available at: http://www.worldenergyoutlook.org/africa/.

Institute for Health Metrics and Evaluation, 2014. *Total DALYs Linked to Household Air Pollution for Selected African Countries*. University of Washington, Seattle, WA.

Jeuland, M., Bhojvaid, V., Kar, A., Lewis, J. J., Patange, O. S., et al., 2014. *Preferences for Improved Cook Stoves: Evidence from North Indian Villages*. Duke Environmental and Energy Economics Working Paper Series, No. EE 14-07. Duke University, Durham, NC. Available at: http://papers.ssrn.com/abstract=2467647.

Johnson, O., Wanjiru, H., Muhoza, C., Lambe, F., Jürisoo, M., Amatayakul, W. and Chenevoy, A., 2015. *From Theory to Practice of Change: Lessons from SNV's Improved Cookstoves and Fuel Projects in Cambodia, Kenya, Nepal and Rwanda*. SEI Working Paper No. 2015-09. Stockholm Environment Institute, Nairobi and Stockholm. Available at: http://www.sei-international.org/publications?pid=2787.

Khundi, F., Jagger, P., Shively, G. and Sserunkuuma, D., 2011. Income, poverty and charcoal production in Uganda. *Forest Policy and Economics*, 13(3). 199–205. DOI:10.1016/j.forpol.2010.11.002.

Lambe, F., Jürisoo, M., Lee, C. and Johnson, O., 2015. Can carbon finance transform household energy markets? A review of cookstove projects and programs in Kenya. *Energy Research & Social Science*, 5. 55–66. DOI:10.1016/j.erss.2014.12.012.

Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., et al., 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet*, 380(9859). 2224–2260. DOI:10.1016/S0140-6736(12)61766-8.

Liyama, M., 2013. *Charcoal: A Driver of Dryland Forest Degradation in Africa?* Fact sheet. World Agroforestry Centre, Nairobi. Available at: http://blog.worldagroforestry.org/wp-content/uploads/2013/10/CharcoalFactSheet-ICRAF.pdf.

Malla, M. B., Bruce, N., Bates, E. and Rehfuess, E., 2011. Applying global cost-benefit analysis methods to indoor air pollution mitigation interventions in Nepal, Kenya and Sudan: Insights and challenges. *Energy Policy*, 39(12). 7518–7529. DOI:10.1016/j.enpol.2011.06.031.

Ministry of Energy, Ghana, 2011. Ghana's Energy Sector Strategy & Development Plan. Available at: http://ghanaoilwatch.org/images/laws/energy_strategy.pdf.

Mombu, V. and Ohemeng, J., 2008. *Towards Sustainable Charcoal Production in Ghana: Negotiating a Community-Based Charcoal Association in Nkoranza District*. Nature Conservation Research Centre, Accra. Available at: http://www.ncrc-ghana.org/downloads/Charcoal_Negotiation_Rpt_final.pdf.

Mugo, F. and Ong, C., 2006. *Lessons from East Africa's Unsustainable Charcoal Trade*. ICRAF working paper. World Agroforestry Centre, Nairobi. Available at: http://www.worldagroforestry.org/downloads/Publications/PDFS/wp06119.pdf.

Neufeldt, H., Fuller, J., Liyama, M. and Dobie, P., 2015. *From Transition Fuel to Viable Energy Source: Improving Sustainability in the Sub-Saharan Charcoal Sector*. ICRAF Working Paper No. 196. World Agroforestry Centre, Nairobi.

Owen, M., van der Plas, R. and Sepp, S., 2013. Can there be energy policy in Sub-Saharan Africa without biomass? *Energy for Sustainable Development*, 17(2). 146–152. DOI:10.1016/j.esd.2012.10.005.

Peter, C. and Sander, K., 2009. *Environmental Crisis or Sustainable Development Opportunity? Transforming the Charcoal Sector in Tanzania: A Policy Note*. The World Bank, Washington, DC. Available at: http://documents.worldbank.org/curated/

en/2009/03/11022403/environmental-crisis-or-sustainable-development-opportunity-transforming-charcoal-sector-tanzania-policy-note.

Polsky, D. and Ly, C., 2012. *The Health Consequences of Indoor Air POllution: A Review of the Solutions and Challenges*. University of Pennsylvania, Philadelphia, PA. Available at:http://ldihealtheconomist.com/media/The_Health_Consequences_of_Indoor_Air_Pollution.pdf.

Rai, K. and McDonald, 2009. *Cookstoves and Markets: Experiences, Successes and Opportunities*. GVEP International. Available at: http://www.gvepinternational.org/sites/default/files/resources/Markets_and_Cookstoves__.pdf.

Rehfuess, E. A., Puzzolo, E., Stanistreet, D., Pope, D. and Bruce, N. G., 2013. Enablers and Barriers to Large-Scale Uptake of Improved Solid Fuel Stoves: A Systematic Review. *Environmental Health Perspectives*, 122(2). 120–130. DOI:10.1289/ehp.1306639.

Rogers, C., Sovacool, B. K. and Clarke, S., 2013. Sweet nectar of the Gaia: Lessons from Ethiopia's "Project Gaia." *Energy for Sustainable Development*, 17(3). 245–251. DOI:10.1016/j.esd.2013.02.005.

Ruiz-Mercado, I., Masera, O., Zamora, H. and Smith, K. R., 2011. Adoption and sustained use of improved cookstoves. *Energy Policy*, 39(12). 7557–7566. DOI:10.1016/j.enpol.2011.03.028.

Ruiz, S. R. and Savadogo, W., 2014. *Building Business Cases to Reach Scale: A Study of Biomass Cookstove Business Models in Asia and Africa*. Stove+ and GIZ. Available at: http://stoveplus.org/uploads/reportPdfs/Building_Business_Cases.pdf.

Rysankova, D., Putti, V. R., Hyseni, B., Kammila, S. and Kappen, J. F., 2014. *Clean and Improved Cooking in Sub-Saharan Africa: A Landscape Report*. Report No. 98664. Africa Clean Cooking Solutions Initiative. The World Bank, Washington, DC. Available at: http://documents.worldbank.org/curated/en/2015/07/24853349/clean-improved-cooking-sub-saharan-africa-landscape-report.

Sander, K., Hyseni, B. and Haider, S. W., 2011. *Wood-Based Biomass Energy Development for Sub-Saharan Africa: Issues and Approaches*. Working Paper No. 74545. The World Bank, Washington, DC. Available at: http://documents.worldbank.org/curated/en/2011/09/17121432/wood-based-biomass-energy-development-sub-saharan-africa-issues-approaches.

Scott, A., forthcoming. *Building Electricity Systems for Growth, Access and Sustainability in Africa*. Background paper for the Africa Progress Report 2015. Overseas Development Institute, London.

Sepp, S., 2008a. *Promotion of Sustainable Charcoal Production Through Community Level Approaches: Experiences and Lessons Learned from Selected Sub-Saharan African Countries*.

Sepp, S., 2008b. *Shaping Charcoal Policies: Context, Process and Instruments as Exemplified by Country Cases*. GIZ, Eschborn, Germany. Available at: https://energypedia.info/images/1/1e/Shaping_charcoal_policies.pdf.

Sepp, S., 2014. *Wood Energy: Renewable, Profitable and Modern*. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn, Germany. Available at: https://energypedia.info/wiki/File:2014-03_Wood_Energy_renewable_modern_profitable_GIZ_HERA_eng.pdf.

Simon, G. L., Bumpus, A. G. and Mann, P., 2012. Win-win scenarios at the climate–development interface: Challenges and opportunities for stove replacement programs through carbon finance. *Global Environmental Change*, 22(1). 275–287. DOI:10.1016/j.gloenvcha.2011.08.007.

Still, D., MacCarty, N., Ogle, D., Bond, T. and Brydan, M., 2011. *Test Results of Cookstove Performance*. Partnership for Clean Indoor Air, Portland, OR. Available at: http://www.ewb-usa.org/files/2015/05/TestResultsCookstovePerformance.pdf.

Tessama, Z., Davis, M., Lambe, F. and Vilchis Tella, P., 2013. *Mainstreaming Sustainable Energy Access into National Development Planning: The Case of Ethiopia*. SEI Working Paper No. 2013-09. Stockholm Environment Institute, Stockholm. Available at: http://www.sei-international.org/publications?pid=2445.

UN, 2014. *World Urbanization Prospects: The 2014 Revision*. United Nations Department of Economic and Social Affairs, Population Division, New York. Available at: http://esa.un.org/unpd/wup/.

WHO, 2014. *WHO Guidelines for Indoor Air Quality: Household Fuel Combustion*. World Health Organization, Geneva. Available at: http://www.who.int/indoorair/guidelines/hhfc/en/.

Zulu, L. C., 2010. The forbidden fuel: Charcoal, urban woodfuel demand and supply dynamics, community forest management and woodfuel policy in Malawi. *Energy Policy*, 38(7). 3717–3730. DOI:10.1016/j.enpol.2010.02.050.

Zulu, L. C. and Richardson, R. B., 2013. Charcoal, livelihoods, and poverty reduction: Evidence from sub-Saharan Africa. *Energy for Sustainable Development*, 17(2). 127–137. DOI:10.1016/j.esd.2012.07.007.

Annex 1: Workshop information

In April 2015 a consultative workshop was organised jointly by SEI and the Clean Cooking Association of Kenya (CCAK) with the purpose of reviewing a set of draft policy recommendations for overcoming barriers to scaling up access to clean and improved cookstoves in SSA. Participants included representatives from the private sector, government, civil society and academia. Though most participants were Kenyan, there was an international presence, with experts joining from Ghana, Tanzania, Rwanda and South Africa.

METHODOLOGY: THINK, WRITE, SHARE

The methodology used for gathering insights was "Think, Write and Share", an approach to workshop facilitation first developed by the Icelandic organizational development company Vendum and frequently used by SEI to facilitate discussions with multiple stakeholders on complex topics. Workshop participants were divided into six groups and asked to consider two questions each on overcoming barriers to clean and improved cookstoves in their own country contexts. Participants wrote down answers to the questions, which they then shared with the group as a whole. The participants then took turns to present their ideas to the group.

Next, each group was asked to consider two recommendations from the APP paper and to discuss whether these recommendations would go far enough to address the barriers in question. Participants were invited to make suggestions for changing or improving the recommendations. The group then categorized the answers as being relevant or not to one or more of the recommendations and grouped them accordingly. Finally, the group members voted individually for the solutions that they considered most important for overcoming the questions they had been asked to consider.

Each group then reported to the plenary on the amendments made to the recommendations and the results of the vote and comments elicited from the group as a whole.

LIST OF WORKSHOP PARTICIPANTS

Name	Organization
Charles Owuso	KITE, Ghana
David Kimemia	University of Nairobi (researcher)
Estomih Sawe	Tatedo, Tanzania
Hilawe Lakwe	Ethio Resourse Group, Ethiopia
Mildred Janet Odeyo	Improved Stoves Association of Kenya
Joseph Kimani Njuguna	Kiambu County (KE)
Julius Ochieng'	Kisumu
Millicent Anyango	Rongo
Samuel Mutahria	Meru
Timothy Kayumba	Rwanda Energy Agency
Weche Akala (Peter Malomba)	Improved Stoves Association of Kenya
Amanda West	EcoZoom stove
Anjali Saini	African Enterprise Challenge Fund
Ashington Ngigi	Integral Advisory
Dan Waithaka	Wisdom Innovations (stoves)
Edward Mungai	CIC
Emmanuel Cyoy	Practical Action
Eng. Mkibiru	Ministry of Energy, Electric Power
Faith Odongo	Ministry of Energy
Fiona Lambe	SEI - Stockholm
George Onyango	Weeffect
Hannah Wanjiru	SEI - Nairobi
Jacob Kithinji	University of Nairobi
Jacqueline Senyagwa	SEI - Nairobi
James Mwangi	INTASAVE
Joan Sang	World Vision Kenya
Job Orina	My Climate
John Kapolon	Practical Action
Josephat Karuiki	EFWES
Karin Sosis (Mark Hankins)	African Solar Designs
Keneth Ndua	Stamp Investment
Kevin McOkwiri	Busara Centre
Lara Fleischer	Busara Centre
Laura Patel	EcoZoom stove
Lucas Belenky	Top Third Ventures
Mabel Kirabo	Trocaire
Mary Njenga	CGIAR
Maurice Onzere	GVEP
Maxwell Musyoka	GIZ
Mbaari Kinya	WEET Enterprises
Michael Njoroge	Multi link
Myra Mukulu	CCAK
Nathan Bogonko	KIRDI
Nicholas Ozor (Kevin Urama)	ATPS network
Oliver Johnson	SEI - Nairobi
Paul Healy	Trocaire
Robert Mwingi	AO
Stacey Noel	SEI - Nairobi
Steve Andrews	SolarAid
Teddy Kinyanjui	Cookswell Jikos
Timothy Mwangi	SNV
Tom Owino Oduol	Climate Care
Winnie Waudo	Researcher
Wycliff Amakobe	ACTS
Wycliff Musungu	REECON
Zulfikar Ali	Keyo Women Group

ABOUT THE NEW CLIMATE ECONOMY

The Global Commission on the Economy and Climate, and its flagship project The New Climate Economy, were set up to help governments, businesses and society make better-informed decisions on how to achieve economic prosperity and development while also addressing climate change.

In September 2014, the Commission published Better Growth, Better Climate: The New Climate Economy Report. Since then, the project has released a series of country reports on the United States, China, India and Ethiopia, and sector reports on cities, land use, energy and finance. In July 2015, the Commission published Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate. It has disseminated its messages by engaging with heads of governments, finance ministers, business leaders and other key economic decision-makers in over 30 countries around the world.

The authors

Authors: Fiona Lambe, Marie Jürisoo, Hannah Wanjiru and Jacqueline Senyagwa

Stockholm Environment Institute

Editor: Marion Davis

Design and production: Richard Clay, Austin Morton

Acknowledgements

The authors would like to thank the contributors of the case studies used in this paper: Charles Kofi Owusu, of KITE Ghana; Catherine Diam-Vella, of Accessible Energy; Amanda West, of EcoZoom, and Desalegn Getaneh, of the Gaia Association Ethiopia. We are extremely grateful to all who participated in our expert consultation on 29–30 April in Nairobi for the valuable comments and feedback provided on the paper's recommendations. We would like to thank our partner, the Clean Cookstove Association of Kenya (CCAK) for co-organizing this event with us, and for mobilizing their member organizations to participate so actively. This paper benefited enormously from the comments received from external reviewers, Dr. Sumi Mehta, research director at the Global Alliance for Clean Cookstoves, and Monika Rammelt, energy access advisor at GIZ.