

Energy Access Review

A case for promoting kerosene as a cleaner cooking fuel in SSA

Socio-economic development in the US, like in most parts in the West, has been founded on creating grids. In his 2016 bestseller *The Rise and Fall of American Growth*, Robert Gordon notes that in the US by “1940 houses were networked, most having five connections of electricity, gas, telephone, water and sewer.” America’s urban population grew from 24.9 percent in 1870 to 73.7 percent by 1970. A similar but more rapid demographic trend is being seen in Sub Saharan Africa (SSA). While no city in SSA had a population of more than 1 million in 1950, today there are more than 50 and counting, making this the fastest urbanizing region in the world. The problem is that in SSA, creating grids has not worked that well. Africa appears to be the only region in the world where urbanization does not correlate with poverty reduction (yet)¹. Future projections points to two critical issues – one is that the region is urbanizing very fast and two, average income levels will remain low in the interim. The African Development Bank estimates that by 2030 - barely 13 years from now - nearly 1 in every 2 citizens of SSA will be living in cities². What meaningful and dignified cooking fuel options will the urban poor have now and in the near future? In this review, we present a case for promoting kerosene as part of the cleaner cooking mix of options.



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Figure 1: Cooking using solid biomass energy



...by 2030 - barely 13 years from now – nearly 1 in every 2 citizens of SSA will be living in cities” (Africa Development Bank, 2014)

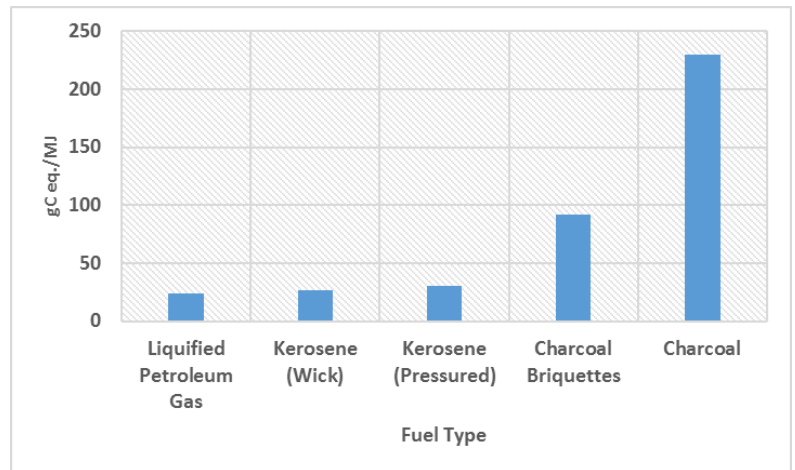
¹ World Bank (2016), Africa’s Pulse; An analysis of issues shaping Africa’s economic future, World Bank Group, Washington DC

² AFDB (2014), Tracking Africa’s Progress in Figures, African Development Bank, Statistics Department, Tunis, Tunisia

There are at least four main reasons that make kerosene a reasonable cooking fuel option for the urban (and rural) poor in SSA. First, (and this will come as a surprise to many) is the huge greenhouse gas abatement potential (see figure 2)³. At between 27 and 30 gC_{eq}/MJ (grams of carbon equivalent per unit of energy produced), kerosene has almost ten times lower global warming potential (GWP) than charcoal at 229 gC_{eq}/MJ within a cooking context. Charcoal benefits indirectly from the many global initiatives supporting the uptake of clean cooking stoves as the largest proportion of these stoves use charcoal. Kerosene also compares nearly 1:1 with liquefied petroleum gas (LPG) which is promoted as a cleaner and modern cooking solution although it has a global warming potential of about 24 gC_{eq}/MJ. Charcoal briquettes, also promoted as a cleaner fuel, have a much higher GWP at 92 gC_{eq}/MJ. Other papers give lower GWP numbers relative to kerosene but all are unanimous on the significant difference favouring kerosene over charcoal and charcoal briquettes. Disparities in the GWP numbers can be attributed to some papers factoring in land use emissions associated with charcoal production while others setting the boundary at the point of use. One of the most direct method of reducing GHG emission attributed to charcoal use in urban areas appears to be a deliberate promotion of kerosene for cooking.

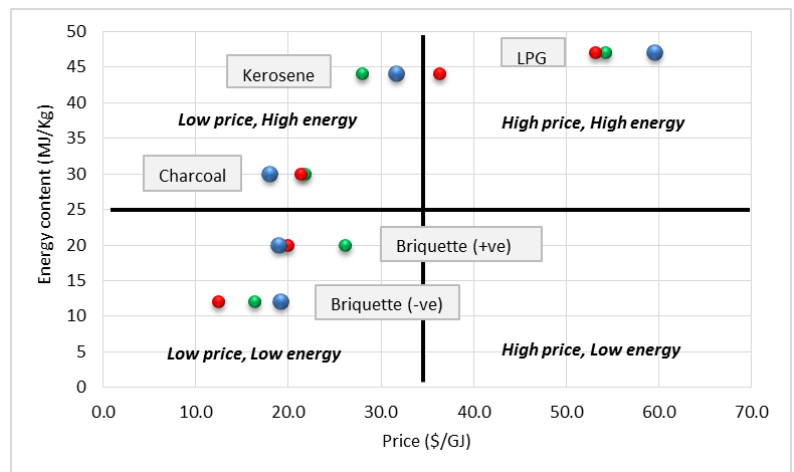
Second, kerosene appears to be the only cooking fuel option that could compete favourably with charcoal on the basis of financial cost per energy output. A study supported by the Energy and Environment Partnership (EEP) in 2012⁴ comparing cooking fuels in Kenya, Uganda and Tanzania reveals one of the reasons why charcoal remains the undisputed household cooking fuel of choice in urban area (see figure 3). Charcoal has the lowest price when compared on an energy output basis. Kerosene is slightly more

Figure 2: Average Carbon Emission per Megajoule (20-year cumulative GWP)



Source: Smith, K., R. Uma, et al. (2000) - although dated, this study remains one of the most comprehensive on this matter.

Figure 3: Comparing price and energy content of various types of cooking



NB: Red dots – Tanzania, Green dots – Kenya and Blue dots – Uganda (2012 estimates); Briquette –ve = uncarbonised; Briquette +ve = carbonised

Source: Barasa, M., Mutimba, S. and Bosibori, N (2012)

³ Smith, K., R. Uma, et al. (2000). Greenhouse Gases from Small-Scale Combustion Devices in Developing Countries Phase IIa: Household Stoves in India. Research Triangle Park, NC, US Environmental Protection Agency: 98.

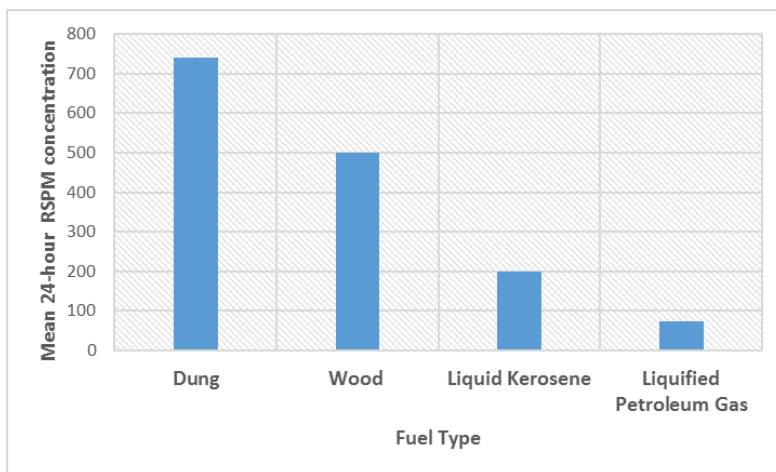
⁴ Barasa, M., Mutimba, S. and Bosibori, N. 2013. Analyzing Briquette Markets in Tanzania, Kenya and Uganda. Energy and Environment Partnership (EEP), Johannesburg, South Africa

expensive but has a higher energy content than charcoal per unit mass. Price of charcoal in Kenya, for example, stood at about US\$22/GJ compared to kerosene at US\$28/GJ even though kerosene has up to 50% more energy per mass (Kg). Kerosene could outcompete charcoal on price if the real value of the biomass resources at production are built into the end-user price of charcoal.

The third reason is relatively safety and ease of transportation. The reason why kerosene is sold in and through many informal channels in rural and urban areas is because, unlike petrol or LPG, it is not volatile, expands only slightly with changes in ambient temperature and is extremely stable in storage. Throwing a flaming match stick into a bowl of kerosene will put out the match (again unlike petrol or LPG). Kerosene is so easy to move around that it is commonly transported in public service vehicles including *matatus* (in Kenya), *daladalas* (in Tanzania), *macombi* (in Zimbabwe) and similar means in other parts of SSA. It can be stored in plastic containers, capped soda bottles, oil drums and moved around even on bicycles. Kerosene can also be purchased in almost any quantity – an important factor for households with income constraints. These characteristics makes it a preferred fuel of choice in urban slums that lack formal transportation routes or systems.

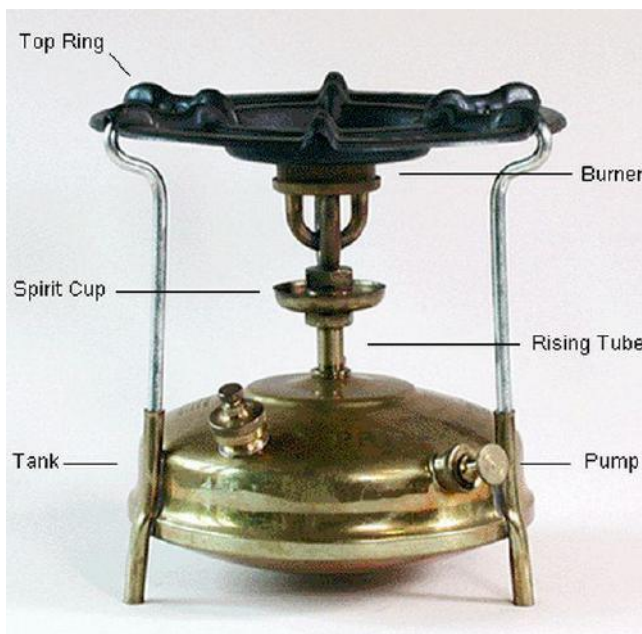
Fourth is the potential to reduce indoor air pollution which according to the World Health Organization contributes to an estimated 4.3-million premature deaths per year globally. A collaborative UNDP and WB ESMAP¹ study in India measuring respirable suspended particulate matter (RSPM)¹ in 412 households in India (see figure 4) observes that “kerosene is cleaner than solid biomass, and gaseous fuels, only second to electricity, are cleaner again.” The same report finds that RSPM concentration in kitchens using kerosene to be less than half of those using wood when averaged over a 24-hour period.

Figure 4: RSPM concentration by fuel type ($\mu\text{g}/\text{m}^3$)



Source: UNDP & WB ESMAP (2004) – this paper is one of the few that reviews primary data collected in actual cooking environments

Figure 5: Example of a kerosene high-pressure stove (Photo credits: <https://chiefio.wordpress.com/>)



Similarly, Njenga, M. et al (2014)⁵, when comparing indoor air concentration of carbon dioxide (CO₂), carbon monoxide (CO) and particulate matter (PM_{2.5}) per meal in households from kerosene and charcoal finds kerosene less harmful. This paper reports kerosene emitting 752g of CO₂, 66g of CO and 0.5 g of PM_{2.5} per meal compared to 1665g of CO₂, 260g of CO and 0.9 g of PM_{2.5} from charcoal. In some studies, for example Straif, K., et al (2013)⁶, household air pollution attributed to kerosene lighting does exceed WHO air quality guideline levels for particulate matter and the same is expected for cooking. The takeaway here is that kerosene is not ideal but appears to be better than charcoal on all household air pollution measures. Although kerosene is commonly used as a liquid fuel, there are affordable high pressure stoves (figure 5 above) that can produce gasified kerosene which compares favourably with LPG on household air pollution measures. This review will be incomplete without pointing out measures in which kerosene for cooking can be promoted and the obvious challenges of doing this. Several papers show great inefficiencies with subsidizing kerosene but there may be merit in eliminating taxes on kerosene. Often the repercussion of this is leakages and adulteration of other fuels. Strong enforcement with stringent repercussions appears to be the most effective means of ensuring that this does not happen. In Kenya for example, the Energy Regulatory Commission (ERC) reported in March 2016 that over 96% of petroleum outlets sampled were free from contaminated fuels. A total of 8,945 random tests were carried out and those stations or outlets found to be non-compliant were

deregistered. Denaturing kerosene brings about mixed results and works in some cases but also fails dismally in other contexts. Another measure is to promote the development of cheaper high-pressure and more efficient kerosene stoves – similar to the current efforts to promote improved cookstoves for solid biomass. Additionally, formalizing and licensing small scale kerosene distributors further ensures that basic safety standards and fuel quality are maintained. Promoting safer packaging including refillable plastic containers for lower income groups will help reduce accidents associated with use. Risks and challenges of promoting kerosene cooking is an unhealthy competition with pico-solar solutions for lighting, unpredictable global prices of fossil fuels, dependence on a non-renewable source (same for LPG), effects on livelihoods among charcoal producing communities and safety concerns at use (as many household fires are attributed to improper handling of kerosene).

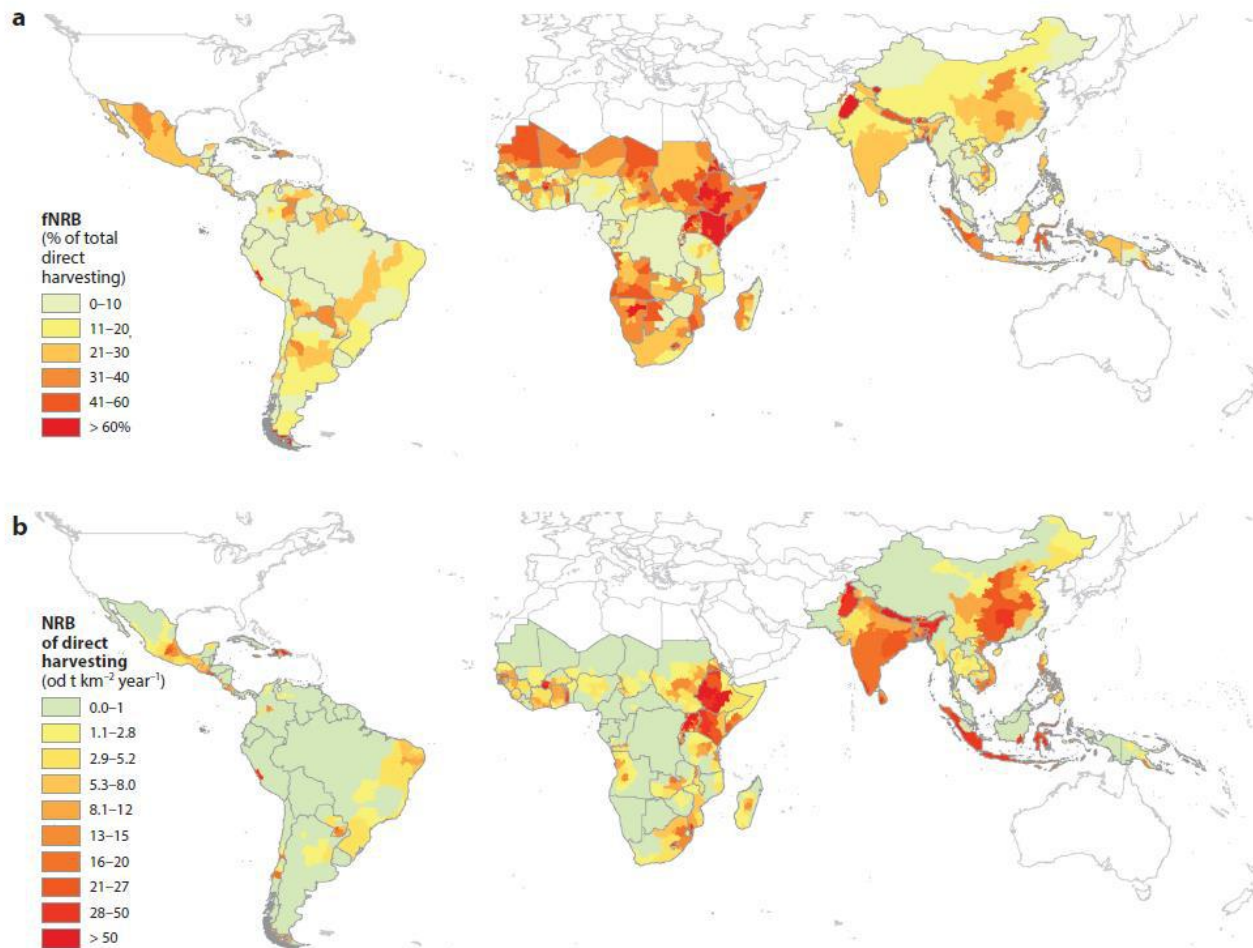
In conclusion, this proposition is not about promoting one solution over another but a call to allow kerosene to sit on the cleaner cooking table together with LPG, briquettes and charcoal (based on improved cookstoves). Often times the words energy and electricity are used synonymously in the context of development within SSA. Most of the attention is placed on increasing electricity generation capacity and expanding distribution networks, which is good but we need to remember that the “E” in SE4ALL stands for energy, not electricity – meaning that comparable resources and effort should be directed towards energy for cooking.

⁵ M. Njenga, N. Karanja, H. Karlsson, R. Jamnadass, M. Iiyama, J. Kithinji, C. Sundberg, Additional cooking fuel supply and reduced global warming potential from recycling charcoal dust into charcoal briquette in Kenya, *Journal of Cleaner Production*, Volume 81, 15 October

2014, Pages 81-88, ISSN 0959-6526,
<http://dx.doi.org/10.1016/j.jclepro.2014.06.002>.

⁶ K. Straif, A. Cohen, J. Samet, Air pollution and cancer, IARC Publication No. 161, France – Chapter 9

Estimating the burden of traditional biomass use – a snapshot (Masera, O., Drigo, R., Bailis, R., Ghilardi, A., Ruiz-Mercado, I., 2015)



A recent publication⁷ estimates that almost 300 million rural people live in wood fuel harvesting hotspots concentrated in South Asia and East Africa. In Africa, 443Mt is harvested for fuelwood, charcoal and construction material per year with the fraction of non-renewable biomass (fNRB) ranging from 34.8% to 35.7% in a scenario that assumes land cover change by-products are not used for fuel. Rapid population growth in SSA is expected to exacerbate the pressure on wood fuel resources unless appropriate measures are taken to address, among others, the cooking fuel crisis.

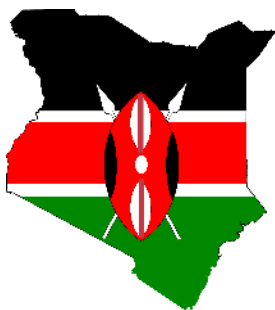
**Map (a) Fraction of non-renewable biomass as a percent of total direct harvesting and Map (b) Non-renewable biomass harvested in oven-dry tons per square kilometer per year.*

⁷ Masera, O., Drigo, R., Bailis, R., Ghilardi, A., Ruiz-Mercado, I., 2015. Environmental burden of traditional bioenergy use. *Annu. Rev. Environ. Resour.* 40, 121e150.

Third Quarter 2016 Energy Access News Highlights



- **IFC unveils web portal to support renewable mini-grids in Tanzania** - The International Finance Corporation (IFC), launched a web portal to accelerate the development of energy mini-grids in Tanzania. The portal will support efforts directed towards helping the country boost its energy production and increase access to electricity through renewable sources such as solar and hydro. The portal, found at <http://www.minigrids.go.tz/>, will provide licensing, financing, regulatory, and other information and support to small, renewable power producers in Tanzania who want to sell electricity to consumers, especially those not connected to the main grid. IFC’s mini-grid program is being implemented in partnership with the Scaling-up Renewable Energy Program of the Climate Investment Funds.
- **TanESCO seeks International Centre for Settlement of Investment Disputes award freeze** - The Tanzania Electric Supply Company (TANESCO) has decided to seek annulment of the award issued by International Centre for Settlement of Investment Disputes (ICSID) over payments of US\$ 148.4 million to a bank despite emerging victorious on a power tariffs dispute. The World Bank-affiliated International Centre for Settlement of Investment Disputes (ICSID) made a ruling in favour of Standard Chartered Bank of Hong Kong (SCB-HK) but Tanesco is against the award, noting that the decision is contrary to an initial declaration made by the tribunal in 2014.
- **Tanzania to sign 400 MW power purchase deal with Ethiopia** – Tanzanian authorities revealed that the country will sign a 400 megawatts power purchase agreement with Ethiopia. Felchesmi Mramba, Managing Director of state-owned Tanzania Electric Supply Company, said the official signing of the power pact will be preceded by a meeting in Arusha of 10 member states of the Eastern Africa Power Pool. He said the agreement will be followed by installation of power generation and transmission facilities that will not only foster economic integration but also cater for the region's power needs for the next 25 years.



- **Kenya signs 361 MW power deals under the Power Africa plan** – Six power projects – which will add 361 megawatts of clean energy to Kenya’s national grid – will be developed across several sites in Kenya following signing of deals between the United States Trade and Development Agency (USTDA) and Kenya, witnessed by the Deputy President William Ruto at the US-Africa Business forum in New York. They include a grant agreement to support the development of a 10-megawatt (MW) solar photovoltaic (PV) project in Gitaru, a 40 MW solar PV power plant in eastern Kenya at Nyakwere Hills and a Solar Microgrid Solutions for Island and Village Electrification at eight locations across Kenya with a combined 1.5 MW of new power generation capacity.

Also in the pipeline is the development of a 70 MW geothermal power plant in Olkaria, Naivasha, the development of Lamu Gas-to-Power Project which is projected to add 50-200 MW of new electricity generation capacity to the island, and the Isiolo Solar PV Power Plant where USTDA will partner with Green Millennia Energy to develop a 40 MW solar PV power plant in Isiolo town. The programme makes Kenya one of the biggest beneficiaries of the US\$ 9.7 billion Obama initiative which seeks to double electricity access in Africa.

- **Kenya's power imports from Uganda now rise 32 per cent** – Kenya's electricity imports from Uganda grew by nearly a third in the year to July saddled by the shutdown of geothermal power grid for lines maintenance. Kenya imported 40.7 million kilowatt hours (kWh) from Uganda compared to 31 million units in the first seven months of last year – marking a 32 per cent growth, according to official data. This is a departure from last year when Kenya cut by half electricity imports from Uganda following the injection of the additional 280 megawatts (MW) geothermal power to the national grid a year earlier. Kenya has a direct transmission line connecting with Uganda via Tororo, enabling bulk power trade.
- **Use of cooking gas by households rises 233pc on lower global oil price** – Households' use of cooking gas has risen sharply as low petroleum prices make the energy source affordable to low income groups. Official data shows that the uptake of liquefied petroleum gas (LPG) surged by 233 per cent in the first five months of 2016 as more Kenyans took advantage of falling prices. Data from the Kenya National Bureau of Statistics (KNBS) shows that in the five months to May households bought 76,800 tonnes of LPG compared to 23,000 tonnes in a similar period last year. The increase in consumption of cooking gas by households corresponds to a drop in prices driven by the global fall in crude oil costs. The rise in LPG consumption suggests that more households are turning to the cheaper cooking gas due to the rise in costs of other energy sources like charcoal. The KNBS data covers a period before Treasury scrapped value added tax (VAT) on LPG in June. The Treasury's move, which seeks to cut reliance on toxic firewood and charcoal as well as kerosene for cooking, is expected to further push up LPG uptake in the country.
- **World Bank eyes green enterprises with US\$ 20 million fund** - Kenyan startups and entrepreneurs in the green technology space stand to benefit from a US\$ 20 million fund launched in Nairobi last week. The Kenya Climate Innovation Centre (KCIC) launched the facility dubbed Kenya Climate Ventures targeting small and medium enterprises that operate in the renewable energy, agribusiness and water management sector. The World Bank-sponsored fund will focus on investing capital (equity or long-term debt) in early stage clean ventures that have already tested the viability of their

idea and need to move on to commercialisation. The new facility will give a maximum of US\$ 50,000 to startups with viable ideas in order for them to proof their business concept. To qualify for funding, startups must have good management teams to implement their innovative business plans which market green technology products that have a sustainable competitive advantage.



- Renewable energy projects receive a US\$ 10 million boost** - France's Agence Francaise de Development (AFD) and Diamond Trust Bank, Uganda (DTB-U) have signed the Green Energy Line of Credit agreement valued at US\$ 10 million. The credit line will particularly benefit SMEs which have invested in renewable energy technology in Uganda. It is one of the components of the Sustainable Use of Natural Resources and Energy Finance (SUNREF) regional program aimed at promoting innovative solutions for renewable energy and energy efficiency in East Africa through the local banking system. The credit line comes with a technical assistance program funded by the EU's Africa Infrastructure Trust Fund and managed by the Kenya Association of Manufacturers (KAM). It will include project design, capacity building, feasibility study and public awareness. KAM recently entered an agreement with the Uganda Manufacturers Association (UMA) to extend SUNREF to Uganda and to run its day to day activities there. The loans will range between US\$ 50,000 and US\$ 1 million with a 12-year maximum payback period.
- Uganda's first solar power plant is ready** - Uganda's first solar power plant will start feeding the electricity grid later this year. The plant, spread over a 34-acre piece of land in Soroti District, will supply 10 megawatts. The plant's owner, Access Uganda Solar Limited, will sell each unit to the Uganda Electricity Transmission Company Ltd, at US\$ 0.11. The company is now erecting a 3.4-kilometre transmission line from the plant to the Lira-Opuyo electricity substation nearby.



- Rockefeller Fund backs Mainstream Renewable Power's US\$ 177 million African project push** - The Rockefeller Brothers Fund (RBF), the family foundation created from the proceeds of John D. Rockefeller's Standard Oil, has joined a group of investors backing a wind and solar investment deal in Africa to the tune of US\$ 117.5m. The investment will fund the developer, Mainstream Renewable Power (MRP), to build more than 1.3GW of new wind and solar capacity in Africa over the next two years, in a project known as the Lekela Power Platform. The investment follows a pledge made earlier this year by RBF that it would withdraw from all its fossil fuel holdings "as quickly as possible" and focus its financial clout on promoting the growth of cleaner energy sources.

- **BBOXX raises US\$ 20 million funding to boost African off-grid solar presence** –BBOXX, a London-based off-grid solar company, successfully closed a US\$ 20 million Series C investment. Founded in 2010, BBOXX has been active in many parts of sub-Saharan Africa, distributing its solar energy platform comprising of data-driven technology and a unique solar home system design to off-grid areas in Kenya and Rwanda. BBOXX revealed it has provided off-grid electricity to more than 350,000 people in 35 countries around the world. This latest round of investment is supported by co-investors MacKinnon, Bennett & Company (MKB), ENGIE Rassembleurs d’Energies and KawiSafi Ventures, as well as existing investors Khosla Impact Fund, Bamboo Finance and DOEN Foundation. The investment will support an expanded presence in the company’s existing markets, Kenya and Rwanda, where BBOXX owns and operates retail distribution networks and after sales service centres. The investment will also accelerate the provision of licensed BBOXX products and services in other markets, including the creation of three franchises in the West African countries of Cameroon, Ivory Coast and Nigeria.

In the Next Issues of Energy Access Review



- The economics of grid expansion in SSA
- What would success look like in SSA under the SDG 7?
- Regular updates on energy access from Tanzania, Kenya, Uganda and the Africa region

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