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Energy Access Review

When candles cost more than the cake – lesson from older mini-grids in East Africa.

Over the last eight years or so, the debate among development practitioners promoting electricity access in Africa has been whether mini-grids can work. This is a good question but one that has already been answered many times over. Mini-grids do work and are not new in Africa. Sayyid Bargash, one of the Sultans of Zanzibar, is reported to have acquired a generator to light his palace and nearby installations around 1880[1] - essentially building and operating one of the first mini-grids on record. In Tanzania, the installation of mini-grids started in earnest around the 1930s led by faith-based organizations powering inland schools and hospitals while in Kenya, the national utility was first set up as separate mini-grids in Nairobi and Mombasa around 1908[3]. Whether mini-grids in Africa can work is therefore not a very useful question. A more accurate question, perhaps, should be whether private sector built and operated mini-grids are or can be viable. In this review we use data from existing public sector mini-grids to track changes in electricity demand and discuss what this could mean for private sector mini-grids.

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Figure 1: Sultan Sayyid Bargash bin Said Al-Busaid; the first mini-grid developer in East Africa? (Credits: Maul & Co, 1875)

Sayyid Bargash, one of the Sultans of Zanzibar, is reported to have acquired a generator to light his palace and nearby installations around 1880[1] - essentially building and operating one of the first mini-grids on record.

[1] Khamis, S.K. (2001), Lights of Zanzibar, Zanzibar Archives 1890 – 1940, www.zanzibarhistory.org
[2] Bess, M. et al (2014), State of play – Preliminary analysis of mini-grid project developer skills, scale and scope, Royal Norwegian Embassy of Tanzania.
[3] Kenya Power, History and Milestones retrieved from http://www.kplc.co.ke/content/item/61/history-and-milestones in August 2018

Mini-grids have been built and operated mainly by public sector entities in East Africa. In Kenya the national utility operates about 23 diesel and hybrid mini-grid sites[1]. The Wajir site is among the oldest, having been commissioned in 1988. In Tanzania TANESCO operates 26 mini-grids, 19 of which are diesel powered and 7 hydro based. Public sector operated mini-grids represent over 90% of all connections from distributed utilities in Tanzania (see Table 1). With the contemporary focus now on developing private sector mini-grids, the number of such projects has been on the increase although the tally remains modest. While the common challenges of scaling private sector mini-grids have been well documented, the aspect of demand growth and forecasting is less spoken of. Here we do a quick analysis of the state of demand across public sector mini-grids.

After an IEA report of 2010 estimated that to achieve universal electrification by 2030 around 40% of the remaining connections will best be delivered through mini-grids[2], a coalition of development agencies has been working towards this end. This statistic has been used in association with the need to reach an estimated "645 million Africans who currently live without electricity"[3] (in a past publication, we argue that this number – 645 million, needs substantiation). It is also expected that the private sector will have to play a significant role in this effort by supplementing the limited public-sector resources. A key lesson from Kenya's publicly built and operated mini-grids is that large numbers of unconnected people, even if concentrated in and around demand centres, do not necessarily translate into substantial business opportunities. Many potential connections are simply not commercially attractive.

> "...that large numbers of unconnected people, even if concentrated in and around demand centers, do not necessarily translate into substantial business opportunities."

Table 1: Mini-grid operators in Tanzania by Type

#	Energy Source	Connections	Number of Sites			
			Community	Private	Utility	Faith-Based
1	Fossil fuels	170,065	0	0	19	0
2	Hydro	11,925	7	6	7	29
3	Solar	1,153	11	2	0	0
4	Biomass	562	1	24	0	0
5	Wind	-	0	0	0	0
6	Hybrid	-	0	3	0	0
	TOTAL	183,705	19	35	26	29

[1] Number is based on a 2014 KPLC call for Expressions of interest to install renewable energy solutions at already existing and operation mini-grids. http://kplc.co.ke/img/full/qLkRAc56Krvi_EOI%20-%20Consultancy%20Services%20for%20Retrofitting%20of%20existing%20Diesel%20Mini%20Grids%20with%20Renewable%20Energy.pdf

[2] IEA (2010), World Energy Outlook, International Energy Agency, Paris, France

[3] AfDB (2017), New deal on energy for Africa, A transformative partnership to light up and power Africa, African Development Bank, Abidjan.

Figure 2: Typical daily load curves at 4 smaller KPLC off-grid stations

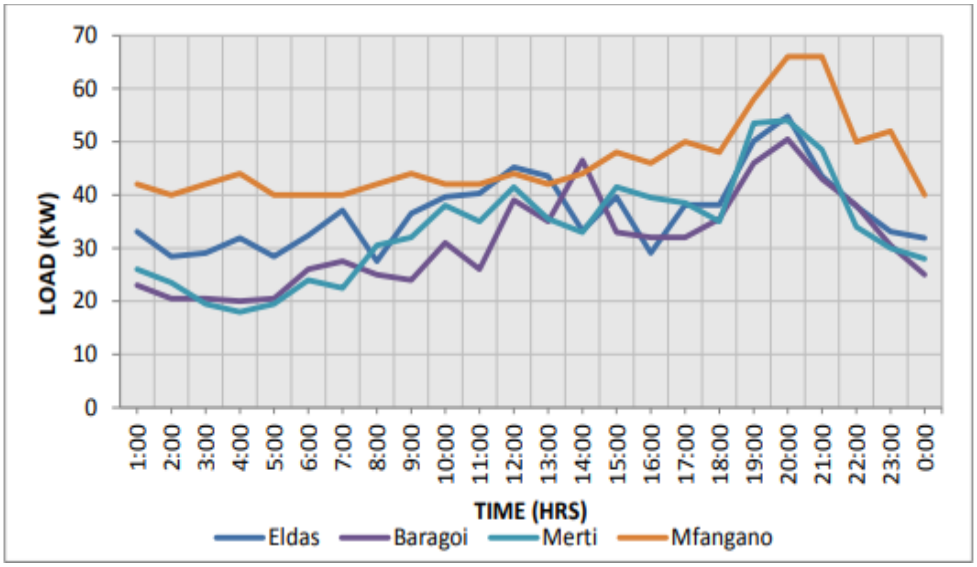

Figure 2[4] above demonstrates this lesson. Although Mfangano island has only about a quarter (120) of the total connections in Merti (436), the island consistently records a higher peak demand with a baseload of about 40 kW. While total number of unconnected persons is a critical indicator, this number alone cannot be used to size the extent of a commercially attractive market. Due to fishing activities, Mfangano Island unlike Merti has an economy characterized by relatively higher cash circulation contributing to high electricity consumption. Merti, a town in the semi-arid Isiolo county, mostly relies on pastoralism. This discrepancy – large population not being synonymous with high electricity demand, is demonstrated in very many other similar examples. Perhaps, this is the leading reason that many of the mini-grids in East Africa are public sector built and operated. Whether the 645 million unconnected are more like Mfangano or Merti is a critical next question as practitioners consider appropriate and cost-effective methods of connecting the underserved.

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[4] Energy Regulatory Commission, 2015, Kenya Market Assessment for Off-Grid Electrification. https://renewableenergy.go.ke/asset_uplds/files/ERC%20IFC%20mini-grids%20-%20final%20report%20-%20Final.pdf

Demand across many of these mini-grid sites remains subdued even with the various subsidies provided. With private sector mini-grids typically charging cost reflective tariffs that are significantly higher than public sector operated sites, this demand is expected to be constrained even further. Additionally, the notion that access to electricity automatically spurs economic growth which in turn leads to increased demand has not been realized across many of these public sector mini-grids. Access to modern energy is only part of a wider matrix of factors needed to spur socio-economic growth. Without this ecosystem of factors, no amount of electricity, regardless of the price per unit, will translate to widespread growth.

The 15 mini-grids listed in Table 2 below represent about 70% of the operational public sector built and operated sites in Kenya. Only 3 of these have achieved peak demand that is more than half of the installed capacity yet their average years in operation is 11 years. Sites such as Marsabit, Elwak, Baragoi and others are still below 40% utilization more than 15 years after commissioning. Sites like Mfangano and Lokichoggio may have been oversized having an average installed capacity greater than 4 kW per connection. Factoring in commercial and institutional connections, the other sites seem to have reasonable averages of below 1.2 kW per connection (apart from Eldas at 2.3 kW). Such levels of underutilization are expected to have negative impacts, not only on the expected rate of return on investment, but also the ability to meet recurrent operational

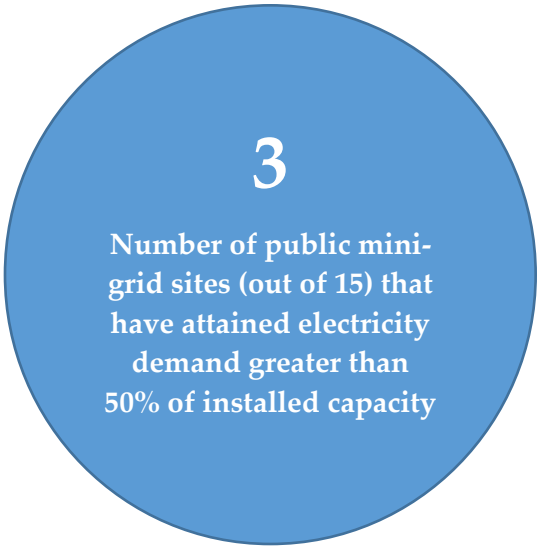

Table 2: Public sector mini-grids in Kenya

#	Mini-grid	Year	Energy Source	Installed Capacity (kW)	Maximum load demand (kW) (2014)	Number of connections	Maximum Utilization (2014)
1	Mfangano	2011	Diesel + Solar	520	72	120	14%
2	Elwak	2009	Diesel + Solar	740	166	802	22%
3	Merti	2008	Diesel + Solar	250	68	436	27%
4	Habaswein	2008	Diesel + Solar + Wind	760	209	1015	28%
5	Baragoi	2009	Diesel	248	79	230	32%
6	Marsabit	2000	Diesel + Wind	2900	980	3300	34%
7	Lodwar	2001	Diesel + Solar	2740	1064	2380	39%
8	Takaba	2012	Diesel + Solar	244	95	300	39%
9	Wajir	1988	Diesel	3400	1412	4100	42%
10	Eldas	2012	Diesel	184	79	80	43%
11	Lokichoggio	2012	Diesel	680	296	166	44%
12	Mpeketoni	2008	Diesel	1285	589	1503	46%
13	Hola	2008	Diesel + Solar	1220	686	1956	56%
14	Mandera	2000	Diesel + Solar	2350	1390	4000	59%
15	Rhamu	2012	Diesel	184	131	2132	71%

costs if run on a purely commercial basis. These sites only work because the capital costs were largely met by public finance and operational costs cross-subsidized by other clients on Kenya Power's network. It is plausible that the private sector can inject higher levels of efficiency in building and running these sites with the same level of capital support but even then, the expected returns may not attract purely commercial capital.

The realization that large concentrated demand centers do not necessarily translate into attractive commercially viable investments is further compounded by competing energy solutions that challenge the mini-grid business model. On the one hand - the need for lighting, phone charging and powering basic entertainment systems of less than 40 W could be competitively met using solar home systems. On the other hand, and for users with electricity demand of more than 1,000 W – welding points, hair driers, metal works fabricators, the mini-grids need to compete with diesel generator sets and comparable systems. This in no way implies that only one type of electricity delivery options should serve one site at a time. Africa's electrification landscape is more complicated than that. Like the mobile telephone market where users have several SIM cards for different applications – data, mobile money and calls, there are sites served by multiple options. The pressure to elevate one technology or business model over another misses the point completely. Mini-grids are technically structured to take advantage of the economies of scale to power larger energy loads relative to those that can be optimally supported by smaller systems such as solar home (or institutional) systems. To scale, rather than seeking ring-fenced geographic sections, private sector mini-grid developers should strive to get immersed into the electrification mix. Success may be inevitably linked to their ability to weave into the mainstream electrification fabric of Africa, moving away from the on-grid off-grid dichotomy.

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Second Quarter 2018 Energy Access News Highlights

- **World Bank approves US$ 455 million loan for Tanzania power projects** – The World Bank under its International Development Assistance (IDA) programme approved a US$ 455 million loan to Tanzania to support financing of power projects in Tanzania. The loan is to primarily fund construction of high voltage transmission infrastructure to connect Tanzania to regional power markets in southern and eastern Africa to in turn support the electrification of the southern and north-western regions of Tanzania. According to funding documents, Tanzania will start receiving the funds from 2019 over a five-year period — starting with US$ 27.55 million rising to US$ 60.27 million the following year; US$ 80.28 million in 2021; US$ 88.77 million the year after; US$ 97.26 million in 2023 and a final disbursement of US$ 110.88 million in 2024. A further US$ 10 million grant will go towards the East Africa Power Pool for boosting regional power trade.
- **Kinyerezi II, 240 MW natural gas power plant, launched** – Tanzania launched a natural gas power plant in April with a capacity of 240 megawatts (MW), part of a plan to end chronic power shortages. The power plant, Kinyerezi II, was built on the outskirts of Tanzania's commercial capital Dar es Salaam by Japan-based Sumitomo Corp using combined-cycle technology for US$ 353.72 million.
- **Tanzania to use locally assembled electric meters** – The government through the Energy Ministry banned the importation of electric meters, effective July 2018 after launching an electrical meter manufacturer- Baobab Energy Systems Tanzania (BEST). BEST is set to produce 500,000 meters, annually, against the country's demand of 450,000 meters. BEST is targeting government authorities responsible for electric supply, that is, Tanzania Electric Supply Company (TANESCO) and Rural Electrification Agency (REA). The banning on importation of electric meters follows similar bans on transformers and electric poles. The company has invested about US$ 1.7 billion in the business that eyes US$ 43 million annual turnover, with sales in the domestic and export markets.
- **Tanzania signs deal to build first wind farm** – Tanzania has licensed Windlab Developments Tanzania Ltd, a subsidiary of Australia's Windlab Ltd, to build the 300MW Miombo Hewani wind farm near Makambako town in the central part of the country. Windlab Ltd has obtained an environmental and social impact assessment certificate for the project – a first in Tanzania for a wind farm. The project will be undertaken in phases with the initial part using US$ 300 million for 100MW comprising up to 34 wind turbines and a transmission line to the national grid at Makambako substation. Windlab has secured a grant from the Ministry for Foreign Affairs of Finland to fund the undertaking and hopes to secure further financing.

- **World Bank approves US$180 million loan guarantee to Kenya's largest electricity producer –** The World Bank approved a US$180 million loan guarantee to the Kenya Electricity Generation Company (KenGen) to help strengthen the financial position of the state-run company. The guarantee will help in long-term commercial financing of up to US$ 300 million to refinance part of KenGen's existing commercial loans, enhance its credit quality and promote further development of renewable energy in Kenya.
- **Kinangop Wind Park loses US$ 310 million claim against Kenyan government –** The International Court of Arbitration in London, has dismissed a claim against the Government of Kenya for over US$ 310 million that had been filed by Kinangop Wind Park Limited. Kinangop Wind Park has proposed to build a 60.8 MW wind turbine farm in Kinangop at a cost of US$ 154 million. The project stalled due to community protests which centred on the lack of proper community engagement and sensitization, compensation of the people around the site areas, relocation and the way the land was leased. Kinangop Wind Park was seeking compensation and damages under the Letter of Support issued by the Kenyan Government alleging that the government had failed to eliminate a political event emanating from the protests. The Government of Kenya on its part filed a defence denying the allegations and filed a counterclaim and an order for costs. The Tribunal in its ruling declared that there was no Political Event within the meaning of the Letter of Support and dismissed Kinangop Wind Park Limited's claims and request for reliefs.

- **ADFD grants US$ 10.89 million for a rural electrification project –** Abu Dhabi Fund for Development (ADFD) has approved a US$ 10.89 million concessionary loan to develop a 33kV rural electrification project at Kalongo in Uganda. ADFD and Uganda signed the loan agreement at the ADFD headquarters in Abu Dhabi in July. The project seeks to help the government achieve its objective to meet electricity demand in rural Uganda, increasing electricity output from less than seven per cent to 26 per cent by 2022. The project is expected to benefit about 20,634 consumers over the next 10 years. The rural electrification project will involve civil and electrical works for the installation of a 139km transmission line, as well as 88 distribution stations and 415 volts distribution lines over a 167km stretch.

- **East Africa singled out as world moves slowly towards SDG 7 goals –** At the SE4ALL forum in Lisbon in May international agencies stated that the world is moving too slowly to meet SDG 7 targets by 2030. Governments are still not on track to achieving "access to affordable, reliable, sustainable and modern energy for all" by 2030. The Energy Progress Report, released at a two-day forum, highlighted that some countries have however made big strides in getting electricity to their people in recent years. Sub-Saharan Africa and South Asia – regions which have the highest access deficit – had strong gains; the number of people without access fell in absolute terms and overtook population growth. Of notable exception were Bangladesh and the East African countries of Ethiopia, Kenya and Tanzania where access increased by at least 3% every year between 2010 – 2016. Progress in East Africa was reported to have been fueled by a jump in small-scale solar power, driven by a rise in "pay-as-you-go" systems in countries such as Kenya and Tanzania, where users can make payments via mobile phones. Rwanda's minister of state for energy, water and sanitation, said the country was pushing off-grid solar power hard as a way of hitting its goal of providing electricity to all its people by 2024. It was stated that in Rwanda today, 42 percent have access to modern energy as compared with just 6 percent in 2009. A shift towards cleaner cooking is however lagging globally partly because it lacks policymakers to champion the cause. Markets for modern cookstoves also remain undeveloped. WHO stated that on current trends, by 2030, only 73 percent of people will have access to clean fuels for cooking, which would have an enormous negative impact on the health of people.
- **Korea pledges to support Africa's energy sector –** The Government of South Korea has pledged to support the development of the energy sector in Africa through the Korean-Africa Energy Investment Facility (KEIF). The support deal was reached on by the government of Korea and the African Development Bank during the signing of a Letter of Intent to launch the Korea-Africa Energy Investment Facility (KEIF). The initiative was disclosed during the Korea-Africa Economic Cooperation ("KOAFEC") meeting at the African Development Bank's Annual Meetings in Busan. Under this Facility, the Bank will take the lead in project development in close consultation with Regional Member Countries. On the side of Korea, the Asian country is committed to inject about $600 million over a period of five years in both concessional and non-concessional financing. During the same meeting, the South Korean Government also signed a Memorandum of Understanding with Power Africa to support the development of power Transmission Infrastructures like power Transmission lines.

In the Next Issues of Energy Access Review

- Geoengineering and its prospects in Africa
- QTR 3 news and updates
- New look, wider scope

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