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June 2014
14-Q2EA

Energy Access Review

Why policy, capacity and governance are not the greatest limitations to the spread of grid-based electrification in East Africa.

How does one reconcile 93%[1] of households in Kenya owning a mobile phone with less than 30%[2] of the same households having "access to electricity" yet phones are recharged using electric energy? Tanzania and by extension East Africa, had its first public power distribution project in the early 1880s courtesy of Sultan Seyyied Bargash[3] of Zanzibar. This was about the same time Thomas Edison threw the switch to power the first commercial power plant in lower Manhattan in New York serving an initial 52 customers[4]. Why has grid-based electricity access in the two regions, both at inception then, taken very different trajectories? And why is it that, besides Vietnam, no other country with a GDP per capita lower than US$2000 has so far attained universal electrification (i.e. 95% +)?

In this review we attempt to address some of the definitional challenges of electrification, explain why the reasons commonly perceived to limit progress in electrification play only a secondary role in East Africa and briefly discuss mini-grids as an option to advance electrification (continue to pg. 2).

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Figure 1: Students studying under a street light (Photo credits: Paul Romer, 2010)

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[1] World Bank (2012), Kenya's mobile revolution and the promise of mobile savings, Working Paper Series 5988, Washington DC.
[2] The electrification rate in Kenya ranges from 26% to 34% depending on the source and definition of electrification.
[3] Khamis, S. K. (2001) Lights of Zanzibar, Zanzibar Archives 1890 – 1940, www.zanzibarhistory.org
[4] NYISO, (2006) Bulk Electricity Grid Beginnings, New York Independent System Operator, New York NY.

Lack of enabling policies, limited technical capacity and failure of governance are often cited as the main reasons limiting the acceleration of electrification rates in many African countries. Data and information on electrification is commonly available at a national level and therefore sub-national comparisons, e.g. across provinces or counties within a country, are rare. One way to control or filter the influence of national policy, capacity and governance is to compare sub-national regions that exist within similar national regimes. Nairobi County in Kenya, for example has a high electrification rate of 72% in spite of the limited naturally occurring energy generating potential. Tana River County on the other hand, which hosts more than 75% of the hydro power generation capacity [1] in the country, has a low electrification of 2.5%. Why would such wide disparities occur within one country and are there more basic reasons that predetermine successes in electrification? First we discuss the notion of electrification and the existing definitional challenges.

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Defining Electrification

Electrification rate often means different things in different reports and statistics. The most basic and common definition is simply *the percentage proportion of households that are connected to grid-based electricity*. This however disregards off-grid solutions including stand-alone household based systems and isolated grid-systems. It also does not consider quality of supply, availability, reliability, social versus productive uses, and illegal or secondary connections. There is no single internationally-accepted definition of electrification. The International Energy Agency defines this as "*the number of people who have electricity in their home. It comprises of electricity sold commercially, both on-grid and off-grid. It also includes self-generated electricity for those countries where access to electricity has been assessed through surveys by government and government agencies*[2]." A variety of data sources are used to determine electrification. The leading sources include the World Bank Global Electrification Data and the World Health Organization Global Household Energy Database. These sources rely mainly on household surveys as opposed to utility sourced data which do not capture self-generating electric energy sources, decentralized sources and illegal access. Most commonly cited household surveys including the Demographic and Health Surveys (USAID), Living Standards Measurement Surveys (World Bank), Multi-indicator Cluster Surveys (UNICEF) and the World Health Survey (WHO) which all ask household-based respondents whether they have electricity[3]. It is unclear whether a lower threshold for electrification does exist within and across these surveys, for example, will a household powered by a single 5W solar lantern qualify as electrified? The Sustainable Energy for All (SE4ALL) initiative contends with this definitional challenge and proposes a framework that goes beyond the electrified versus unelectrified dichotomy to include the quality and type of electrification (see table 1 below).

[1] KPLC (2013), Annual Report and Financial Statements for the Year Ending June 2013, Kenya Power, Nairobi

[2] IEA (2010) World Energy Outlook, Energy and Development Methodology, Paris

[3] SE4ALL (2013) Global Tracking Framework, Chapter 2, Universal Access, New York

Table 1: Continuous Spectrum of Improving Energy Access (Source: SE4ALL 2012)

	TIER-0	TIER-1	TIER-2	TIER-3	TIER-4	TIER-5
Attributes of electricity access	No electricity	Electric lighting + radio	Multi-bulb lighting + television	Tier-2 + air cooling (fans), light mechanical applications	Tier-3 + refrigeration + heavy mechanical + space heating	All applications feasible
Technologies that can deliver the attributes	No electricity	Solar lanterns	Stand-alone Home System	Mini-grids with poor supply or limited access to the grid	Unreliable grid with limited supply	Reliable grid with 24 hour supply
	Continuous Spectrum of Improving Energy Access					

Few national entities have localized definitions of electrification and electricity access. None of the energy policies in Kenya, Uganda or Tanzania comprehensively defines the term electrification but most set electrification targets and the term is used repeatedly in the documents. Perhaps it is assumed that electrification means grid-based power supply although some mention captive solar-based solutions for clinics and schools in remote areas. The Rural Electrification Authority of Kenya (REA), for example, does distinguish electricity "access" from "connectivity" with the former defining the percentage households close enough to an electrical grid to be connected, and the latter the number of households already connected. "Access" is defined as being within 1.2 km of a medium voltage or low voltage distribution line[4]. This is one reason for the inconsistency in the number of mobile phone users and access to electricity. Granted not all mobile users have electricity in their houses but they all have some form of access. We observe that income and settlement patterns are key determinants of grid-based electrification rates within and across countries.

Household Income and Urbanization

If Nairobi County was a country, it would have a GDP per capita[5,6] comparable to Poland, Malaysia, Brazil, Mexico and Turkey. It follows then that the county, which hosts about 10% of the national population, consumed 53% of the total electric power sold by Kenya Power in the 2012-13 financial year. Nairobi also has the highest urbanization rate. In spite of the limitations attributed to capacity and governance Nairobi has attained an unusually high electrification rate. The same is true for Dar es Salaam and Kampala.

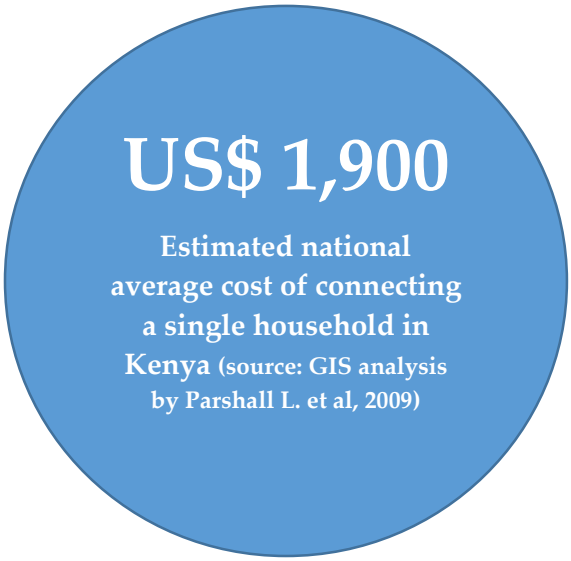
If Nairobi County was a country, it would have a GDP per capita comparable to Poland, Malaysia, Brazil, Mexico and Turkey.

[4] REA (2009) Rural Electrification Master Plan, Rural Electrification Authority, Nairobi

[5] Nairobi City County official website estimates Nairobi contributes 50%-60% of the national GDP (50% is assumed in this statement)

[6] Kenya's GDP = US$ 40.7 B (World Bank, 2012), Nairobi County Population, 2012 est = 3,510,925 (GoK, 2009 National Census and annual growth rates from Commission for Revenue Allocation, June 2013)

These two factors are not the only determinants but they display the strongest correlation. Households need relatively substantial income to connect and utilize grid-based services, and it



is easier and cost-effective to connect densely populated areas like the capitals of East Africa.

Low income levels is often assumed and overlooked as a cornerstone barrier to grid-based electrification as most commentaries focus on external institutional and technical challenges – which still play a major role, but are less influential in comparison to the ability of the customer to pay for the connection and the services provided by the utility. Even with ideal governance structures and policies, low income households will still be unable to afford the true cost of connection to the grid as currently structured. It is estimated that the national average cost of connecting a single household in Kenya is US$ 1900, with lower-cost connection opportunities in and around major cities and in dense rural areas[7]. Unless grid connections are heavily subsidized, which is unsustainable, organic growth in grid-based electrification rates is limited by household income levels. If connections are subsidized, the question then is whether this is a cost-effective approach in view of other electrification options besides the grid. The charged cost of a single phase connection payable to the national utility in Tanzania, Kenya and Uganda is at a minimum US$ 94, US$ 399 and US$ 38 respectively (see table 2 below). These costs increase with distance from the grid and other factors. To put these numbers into perspective, an average household in Tanzania consumes TSH 58,000 [8] (US$ 35) equivalent of goods and services per month which means the connection fee (at a minimum) is comparable to three months' worth of expenditure. High connection fee (which in most cases is already subsidized) is a leading barrier to increased connectivity. Most urban areas of East Africa have an existing medium voltage (MV) infrastructure but are far from universal electrification. This points to a problem of connectivity and not proximity to the grid. In urban areas, there is a substantial cost advantage of focusing on infilling opportunities which, due to the short inter-house distances, will cost significantly less. Uganda seems to have taken this approach as UMEME has relatively low connection fees for "no pole connections". Compounding the connectivity challenge is the actual cost of electricity. On levelized cost per joule, electricity in Kenya, for example, costs about US$ 55/GJ[9] compared to US$ 16-26, US$ 28 and US$ 54 for briquettes, charcoal and LPG respectively[10].

[7] Parshall L. et al (2009) National electricity planning in settings with low pre-existing grid coverage: Development of a spatial model and case study of Kenya, Energy Policy, doi: 10.1016/jenpol.2009.01.021

[8] United Republic of Tanzania (2009) Poverty and human development report - Brief 4: An analysis of household income and expenditure in Tanzania, Dar es Salaam.

[9] Price of electricity in Kenya = US¢ 20/kWh (KPLC 2013 extrapolations)

[10] EEP (2013), Analyzing briquette markets in Tanzania, Kenya and Uganda, Energy and Environment Partnership, South Africa.

Table 2: Minimum domestic connection charges (in US$)

Country	Description	US$
Tanzania[a]	Single phase 30 meters (rural)	94*
	Single phase 30 meters (urban)	168*
Kenya[b]	Single phase less than 600 meters from a transformer	399
Uganda[c]	Single phase no pole connection	38
	Single phase one pole connection (LV)	125

*inclusive of TSHS 5,000 (US$ 3) application form fee

[a] TANESCO (2014), Tariff Rates and Service Charges, Tanzania Electric Supply Company Limited, Dar es Salaam

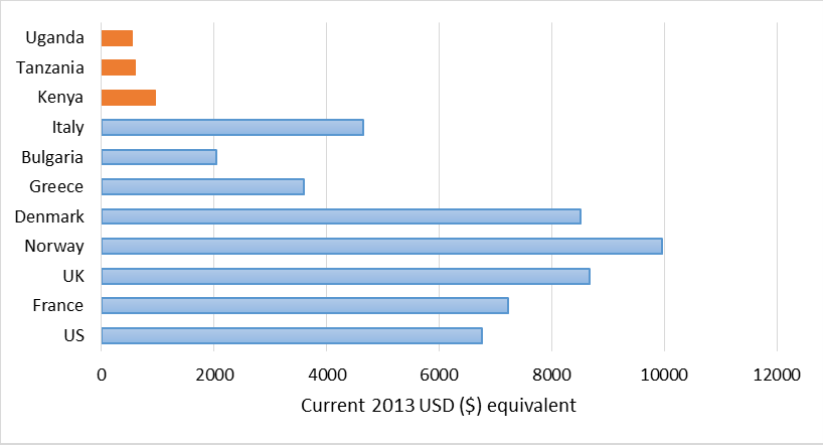
[b]KPLC (2013), Kenya Power guidelines on connection, Nairobi

[c]UMEME (2014) Electricity End-user Tariffs and Charges, UMEME, Kampala

As mentioned above, the advent of public electricity distribution in the USA, UK and East Africa circles emerged around the same period between 1880 and 1885. What is also similar across the three regions is the pioneering role of the private sector including Edison Illuminating Company operating in New York in the late 1880s, Merz and McLellan pioneering the three-phase electricity supply in the UK, Mombasa Electric Power and Lighting Company and the Nairobi Power and Lighting Syndicate of Kenya in 1900s. Also regulation seems to follow implementation and hardly the other way round, therefore somewhat discounting the influence of enabling policy frameworks in general. This however, does not mean appropriate regulations are not necessary. Clear differences emerge when the regional are compared in terms of economic output. Countries in Europe and America where rapid grid-based electrification was experienced had significantly higher GDP per capita[11] levels then (1930s) compared to present day Tanzania, Kenya and Uganda (see figure 2). Rapid electrification in Europe and USA took off in the early 1930s. Electrification rates in the two regions then (1930s) were comparable to current electrification rates in Sub Saharan Africa. To date only one country with a GDP per capita less than US$ 2000 has attained universal electrification.

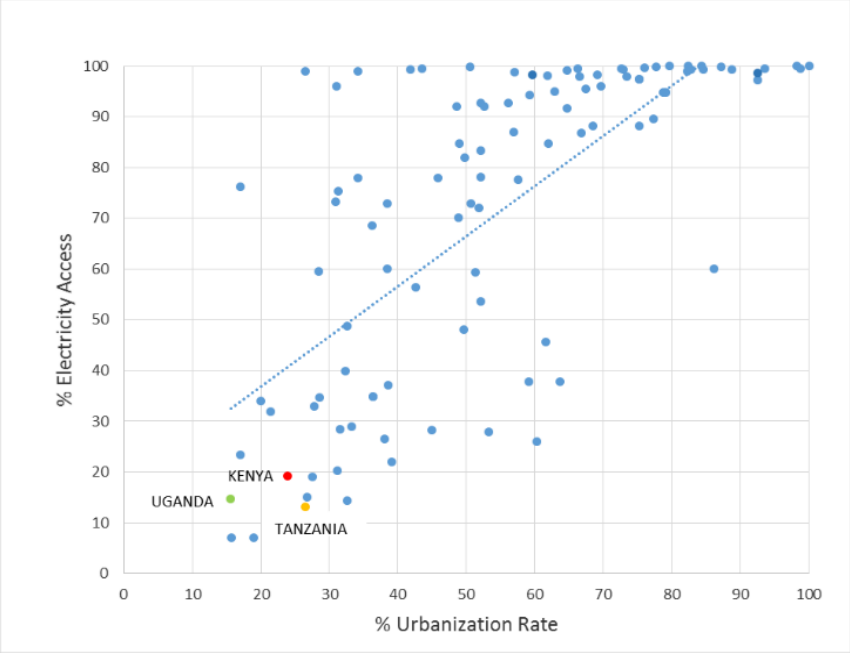
Urbanization, which is the increase in number of people that live in urban areas, is also a key determinant of electrification. In the absence of affirmative action, expansion of electricity grids should reflect both cost considerations and demand-side considerations. Urban areas score much higher than rural areas on both accounts.

Figure 2: Comparing current GDP per capita of Tanzania, Kenya and Uganda with 1930 values for Europe and America (adjusted to 2013 US$)



[11] While GDP per capita is not equal to average household income, it is a strong indicator of a country's material standard of living.

Figure 3: Relationship between urbanization and electrification (World Bank 2011)



We argue that the acceleration in grid-based electrification observed in Europe and USA is unlikely to be seen in East Africa due to lower income levels and low urbanization rates and not because of the secondary reasons of governance and capacity.

Energy access in Sub Saharan Africa has generally taken two extreme approaches in part due to factors associated with income and urbanization. On one hand there are those that promote stand-alone energy solutions including solar home systems, solar lanterns and biogas digesters, and on the other, those that promote grid-based electrification. It is estimated that 850,000 solar home systems have been installed in Africa with Kenya hosting about 320,000 systems[12] for example. Grid-based electrification has been promoted since the early 1970s through various Rural Electrification Programmes across East Africa. The first approach is suitable for areas that are far from the grid and have a low population density while the second for areas close to the grid and with high population densities. An emerging narrative points to the fact that there is a forgotten middle; areas far from the grid but with high population densities (e.g. islands).

Figure 4: Illustration of a mini-grid (Picture credits: www.ipowersa.co.za)

Mini-grids and the missing middle

Mini-grids are being seen as a possible solution to the missing middle. The EUEI mini-grids policy toolkit [13] elaborates this point further and presents a stylized system of categorizing mini-grid business models. While there are no universally accepted definitions, mini-grids are essentially isolated power distribution systems independent of the main

[12] World Bank (2010) Lighting Africa Program: Solar lighting for the base of pyramid – An overview of an emerging market, Washington DC.

[13] EUEI (2013) Minigrid Policy Toolkit: Opportunities for Rural Development in Africa; AEI workshop in Arusha, Tanzania

national or subnational grid. Mini-grids differ in terms of size, technology, business model and purpose. It is therefore futile to discuss the viability of mini-grids in general.

The technical viability of mini-grids is not in question as several models exist and are currently powering various regions in East Africa. What is unclear is whether commercially viable and scalable business models exist, and whether there are conducive regulatory and business environments to develop them. Cost competitiveness, policy gaps and competing interests with national utilities will remain the primary deterrents for private sector investment in mini-grids. Secondary deterrents will include access to commercial finance, local capacity issues, unattractive demand markets, high capital costs that include distribution systems, lack of information on RE resources and long-term energy demand forecasts. Mini-grids will address the issue of proximity but not necessarily the issue of connectivity and cost (due to anticipated higher cost per kWh). There are several initiatives that are addressing these barriers. If successfully addressed, mini-grids will join the two pole approaches in tackling the low electrification rates in East Africa.

Conclusion

In conclusion, electrification rates do increase with rapid urbanization and increased household income although the relation is not necessary of the cause-effect kind. The message therefore is not "increase household income and urbanization to increase electrification" but that development practitioners need to take note of these cornerstone determinants. It is important to establish localized definitions of electrification and gather sub-national data on the same. Additionally, there is need to officially broaden the notion of electrification, especially in view of the differentiated energy demand structures among households. This is already being done by government agencies across East Africa, especially those mandated to improve rural electrification. Proximity and connectivity are two dissimilar challenges of electrification requiring different (but most often complementary) approaches. On connectivity, there is need for rapid infilling of urban areas that have operational distribution infrastructure (proximity) but no connectivity. Although there are several efforts to subsidize connection fees in rural areas, it is urban areas that hold the greatest potential to rapidly increase grid-based electrification rates in East Africa.

Although policy, capacity and governance are not the greatest limitations to the spread of grid-based electrification in East Africa, these issues still need to be addressed in order to compliment organic socio-economic growth that will demand more and better quality of grid-based electricity.

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Second Quarter 2014 Energy Access News Highlights

- **Lighting Rural Tanzania Competition Closes**: Applications to the competition closed on May 30th. LRTC is a competitive grant program that aims to increase access to modern energy services including the substitution of kerosene for lighting in rural areas. This year's theme was "Promotion of micro-grids for remote off-grid electrification.
- **GE to increase Tanzania's installed power capacity by 15%**: In mid-June General Electric (NYSE: GE) announced that it is providing four gas turbines (two already delivered) for a new natural gas turbine power plant in Kinyerezi area of Dar es Salaam. The new plant owned by TANESCO is being implemented under the "Big Results Now" initiative of the Government of Tanzania. The four dual-fuel gas turbines will provide approximately 44.5 MW of power each at about 40% efficiency. The new facility is expected to being commercial operation in late 2014 or early 2015.
- **Oil and gas licensing closes**: The Government of Tanzania closed its fourth oil and gas licensing round on 15th May, 2014. With this round, the GoT published a new 2013 Model Production Sharing Agreement (the MPSA) replacing the earlier 2008 agreement.

- **GreenMax secures US$427,000 grant for a 10 MW Solar PV Project**: The grant from the US Overseas Private Investment Corporation (OPIC) will support the final stages of project preparation for the project to be constructed at Kona Baridi in the Ngong hills area.
- **Power bills set to increase**: Starting 1st of July Kenya Power electricity users will pay a monthly fixed charge of USD 1.76 up from USD 1.40. The new energy charge per kWh for the first 50 kWh is USD 0.03 (KES 2.50), for the next 50 to 1500 kWh USD 0.16 (KES 13.68), and thereafter at USD 0.25 (KES 21.57) up from USD 0.03, USD 0.14 and USD 0.23 respectively.
- **Oil and Gas Association launched**: The newly established Kenya Oil and Gas Associate (KOGA) was launched in early April. Gurjeet Phull Jenkins, the chairperson, said that this was a great step in bringing together the players at this early stage to promote the industry's activities as well as work with stakeholders in building the new sector.

- **CIF expands to 63 counties**: Fourteen developing countries including Uganda, have been invited to participate in the Scaling-up Renewable Energy Program in Low Income Counties (SREP) program that is part of the Climate Investment Fund (CIF). The decision was reached during the CIF trust fund committees meeting in Montego Bay, Jamaica in late June. This bring the total number of countries eligible for CIF support to 63. Kenya, Tanzania and Ethiopia are already part of this program
- **Umeme sale**: On 16th June Actis, a private equity firm, announced the successful conclusion of the sale of 45.7% of the Ugandan electricity distribution company for US$98 million.
- **Ministry of Energy signs a major deal with 3 companies**: Earlier in the year, the Government of Uganda signed a deal with Tullow Oil, Total SA and CNOOC Limited on oil refinery and pipeline which may clear the way for the start of crude production. Uganda has an estimated 3.5 million barrels of crude according to the Ministry.

- **Africa Climate Change Fund (AACF) launches its first call for grant proposals**: The ACCF housed at the African Development Bank (AfDB) invites African governments, NGOs, research and regional institutions to apply for grants of US$ 250,000 or more for climate finance readiness activities. Submissions should reach africaclimatechangefund@afdb.org before midnight CET on August 8th 2014. Further details available here.
- **US government launches "Beyond the Grid" energy effort for Africa**: Under President Obama's Power Africa initiative, a new framework dubbed "Beyond the Grid" will leverage the resources of 27 investors committed to investing more than US$ 1 billion in off-grid and small-scale energy solutions. Overall, it is reported that the initiative has leveraged more than US$ 15 billion for new on-grid, mini-grid and stand-alone projects. Power Africa, which Obama launched in 2013, aims to provide 20 million new electric connection in Sub Saharan Africa.
- **REACT R3 set to open on 15th July 2014**: The AECF Renewable Energy and Adaptation to Climate Technologies (REACT) window is a special fund that is open to business ideas based on low cost clean energy and solutions that help rural people adapt to climate change. REACT supports solutions that help farmers adapt to climate change, increase access to low cost clean energy and financial services that increase access to low cost clean energy and climate adaptation technologies. Further details available here.

The UNECA Energy Access and Security in Eastern Africa Report in Numbers

The UN Economic Commission for Africa (UNECA) launched a report in June 2014 detailing the state of energy access and security in 14 Eastern Africa countries. The report finds that the Eastern African population has one of the lowest electricity access rates in the world and the lowest MW installed per capita ratio. Below is a list of some of the key numbers in the report.

UNECA was established by the Economic and Social Council (ECOSOC) of the United Nations (UN) in 1958 as one of the UN's five regional commissions, ECA's mandate is to promote the economic and social development of its member States, foster intra-regional integration, and promote international cooperation for Africa's development.

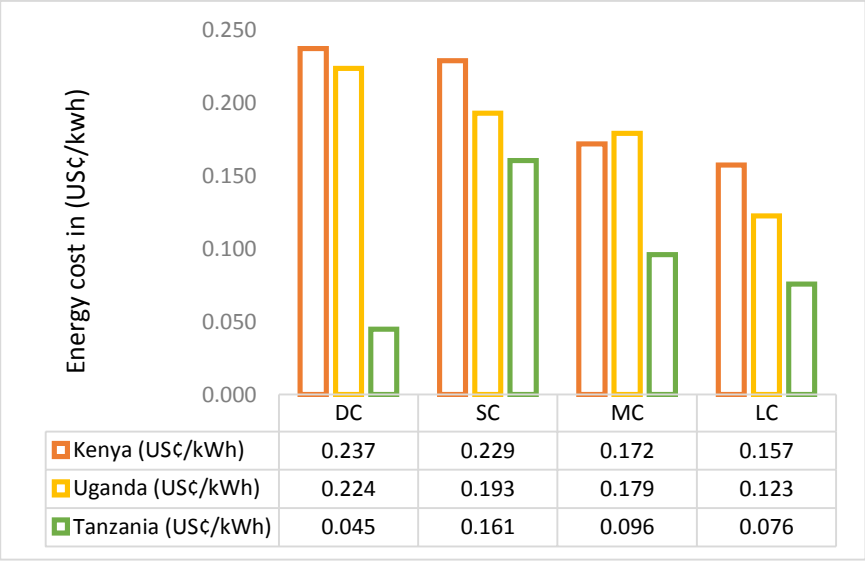
]	%	Electricity access rate in South Sudan
18	Projects	Number of CDM PoA projects in Africa that had reached the validation stage by July 2012
20	%	Percentage decline in forest cover observed in Uganda, Somalia, Ethiopia and Tanzania using 1990 as a base year
120	MW	Installed capacity of the Ashegoda Wind farm in Ethiopia – the largest operational wind project in Africa
123	MW/ million	Africa's installed electricity generation capacity per million people – the lowest in the world
1788	MW	Tanzania energy medium term plan targeted increase in installed electricity generation capacity by 2015
70,000	Units	Biogas plants to have been constructed in 6 African countries under the African Biogas Partnership Programme by 2013
75,000	Heaters	Estimated number of solar water heaters installed in Kenya
140,000	MW	Estimated hydropower potential of all the Nile Basin countries
1,300,000	People	Estimated lives lost globally due to health complication resulting from inhalation of smoke from biomass burning
657,000,000	People	Estimated number of people in Africa relying on biomass energy for cooking
80,000,000,000	US$	Estimated construction cost of the 39 GW Grand Inga hydro power plant on the Congo River

Comparing the cost of electric power in Tanzania (TANESCO), Kenya (Kenya Power) and Uganda (Umeme) for the period July 2013 to March 2014

The cost of electric energy (kWh), even within each of the East Africa countries varies by season, tariff structure and usage. As discussed in our previous review, electricity tariffs across these countries are structured very differently. Tanzania and Uganda both have five tiers while Kenya has up to eight. The next times someone asks you, "What is the cost of power in Tanzania, Kenya or Uganda?" you should answer, "It depends". In this review we illustrate the cost of electric energy across the three countries for domestic, small commercial, medium commercial and large commercial over a nine month period.

Based on KPLC latest annual report[14], an average domestic consumer utilizes 68.52 kWh/month and small commercial consumer utilizes 335.47 kWh/month[15]. There are several tiers of medium and large commercial consumers in all the three countries. In order to determine the cost of power one has to ring-fence the period of use, type of user and the aggregate usage (in kWh) per month.

Figure 5: Average electricity prices (US¢/kWh) over the 9 month period

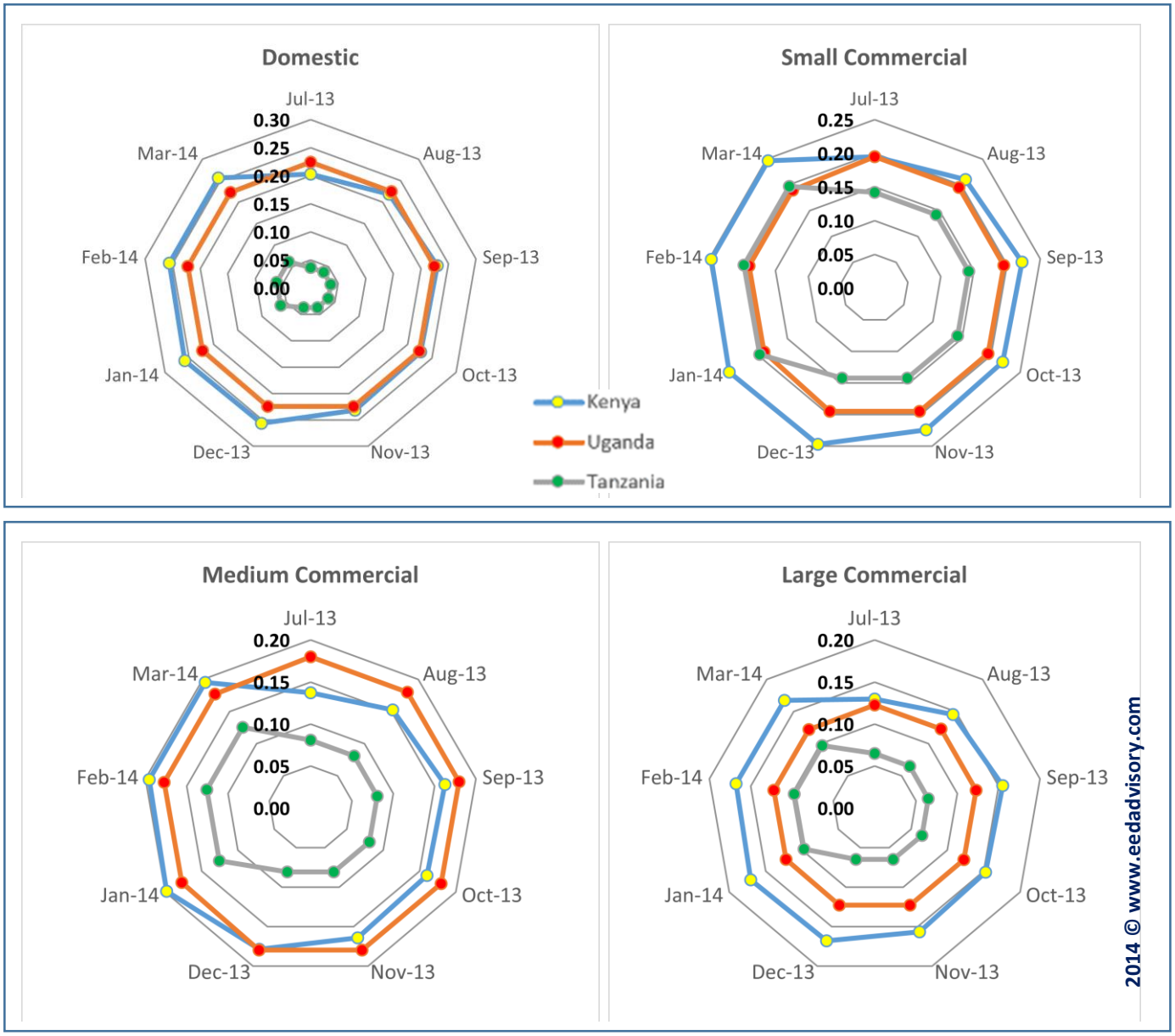


	DC	SC	MC	LC
Kenya (US¢/kWh)	0.237	0.229	0.172	0.157
Uganda (US¢/kWh)	0.224	0.193	0.179	0.123
Tanzania (US¢/kWh)	0.045	0.161	0.096	0.076

For this assessment the period runs from July 2013 to March 2014. Based on the KPLC data, we will classify an average domestic user (DC), small commercial users (SC), medium commercial user (MC) and large commercial users (LC) as those that utilize 70kWh, 335kWh, 25,000kWh and 75,000kWh on average per month. Demand charges for medium and large commercial are not factored in this calculation. For ease of comparison we denominate the currencies to the US¢ using a conversion rate of 1634, 86 and 2553 to the Tanzania Shilling, Kenya Shilling and Uganda Shilling respectively. From this analysis and based on parameters above, the cost of electric energy is much lower in Tanzania on all four category of users. An average domestic consumer in Kenya and Uganda as described above pays up to five times more compared to those in Tanzania for a kWh of energy. TANESCO has a life-line tariff of US¢ 6/kWh (TZS 100) for all consumers using less than 75kWh per month which explains this huge disparity. Tariffs per unit of energy sold decreases as the amount of energy used increases across categories (except within the domestic user category). In other words, large commercial consumers will pay less per unit of energy compared to medium commercial consumers. The average costs of electric energy (kWh) over the 9 months assessed in US¢ ranges from 4 to 16, 16 to 24 and 12 to 22 in Tanzania, Kenya and Uganda respectively as illustrated in figure 6 below.

[14] Kenya Power (2013) Annual Report and Financial Statement for the year ending June 2013, Nairobi, Kenya.
[15] Averages computed from Kenya Power data by the authors

Figure 6: Electricity price (US¢/kWh) variation over the 9 month period



The cost of electric energy is only one measure of assessing the standard of energy services delivered by the three utilities. Quality and reliability of supply are other key considerations. TANESCO's creditworthiness has repeatedly been questioned resulting in other systemic problems that have hindered effective expansion of services. Unlike Kenya Power and Umeme, TANESCO is yet to be privatized, perhaps a reason why the cost of electricity is much lower than the rest. Either approach has its positives and negatives.

Sources of data:

EWURA (2013), 7th annual report for the year ended 30th June 2013, Dar es Salaam
TANESCO (2014), TANESCO 2014-2015 new tariff structure, Dar es Salaam, http://www.tanesco.co.tz/index.php?option=com_docman&Itemid=275
ERA (2013), Decision of the 220th authority meeting held on the 31st of July 213, Electricity Regulatory Authority of Uganda, Kampala. Available at: http://www.era.or.ug/index.php/2013-12-14-14-58-04/authority-decisions
Umeme (2014), Electricity end-user tariffs and charges, Kampala. Available at: http://www.umeme.co.ug/articles/TariffAdNV.pdf
KPLC (2013), Annual report and financial statements for the year ending June 2013, Kenya Power, Nairobi

In the Next Issues of Energy Access Review

- The Rise of the FiT (Feed-in Tariff) in East Africa: Basis, design and impacts on renewable energy markets in Tanzania, Kenya and Uganda.
- The geothermal appeal in East Africa: Fifty years in the making
- Mapping the leading international and local players in the East Africa oil and gas bonanza (This topic will now be covered in the quarter 3 review and not this edition as earlier stated)

Citation: EED Advisory (2014) *Energy Access Review*, Energy, Environment and Development Advisory, Publication number; 14-Q2EA, Nairobi, Kenya.

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