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Energy Access Review

A second look at Kenya's 5000 MW in 40 months plan

California with a population of 38 million comparable to Kenya, has 41 MW installed for every 1 MW powering Kenya's electricity matrix. This should call for an audacious electricity expansion plan for Kenya. Approximately 280,000 GWh versus 6,600 GWh total electric energy was sold by the utilities in the respective regions for the year ending in 2013[1]. Putting it another way – California uses more electric energy than any combination of 35 Sub Saharan Africa countries (excluding South Africa). Even with their limitedness, such comparisons are frequently used to illustrate the fact that Kenya and many countries in the region are energy poor. These comparisons are limited because they place undue emphasis on grid-based electricity (which contributes less than 15% of the Kenya's primary energy); compare dissimilar regions – urban based versus rural based; focus on generation capacity at the expense of transmission and distribution challenges, among other reasons[1]. Still, these mental pictures speak loudly and clearly about the energy and power deficiencies on the continent (cont. pg. 2).

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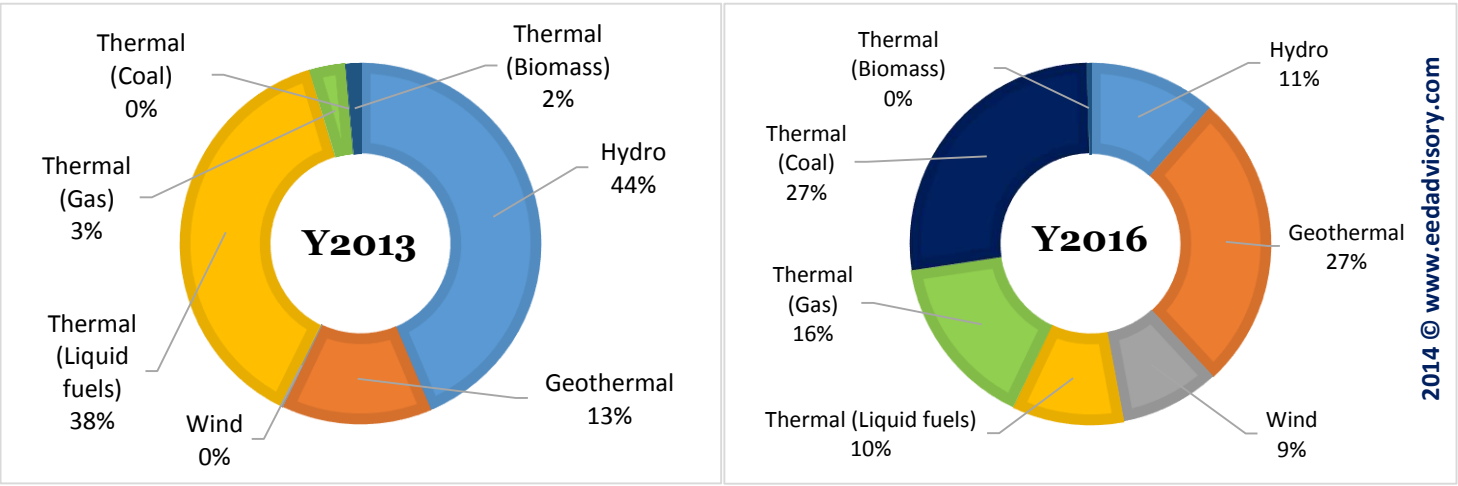
Figure 1: The before and after: Kenya's current electricity mix (2013) versus the 5000 in 40 plan



California uses more electric energy than any combination of 35 Sub Saharan Africa countries (excluding South Africa)

A lot has already been said and written about most ambitious electrification plan in the history of East Africa. Mega power projects and programs are not uncommon – Kwame Nkrumah's Akosombo dam, Sun Yat-sen's 22,500 MW Three Gorges Dam, India's 100,000MW "power for all" by 2012 program are a few. While many have failed, a few suggest that when vision is informed by the realities of execution, an audacious plan becomes exactly what is needed. With the current installed capacity at about 1700MW, if realized, this plan will mark a generation capacity increase of close to 400% in just 40 months. In this review we attempt to answer two questions with regard to the Ministry of Energy and Petroleum 5000MW in 40 months plan; can it be done in 40 months and perhaps more important, should it be done in 40 months.

> ...if realized, this plan will mark a generation capacity increase of close to 400% in just 40 months.

The question of the "can" is simple and straight-forward and will consider only the technical issues assuming cash in the bank, positive political will and the absence of force majeure (all of which cannot be taken for granted in this case). The question of the "should" is more subjective and has been a major talking point across the energy sector in Kenya since the Ministry launched this plan outlined in the 2013-2016 investment prospectus[1]. Discussions on the "should" will often drift from the fact-based logical considerations associated with the "can", inevitably settling on personal interpretation of values and preferences making an outright conclusion elusive. Still reflection, discussion and outright disagreement should be encouraged, if for nothing else, to draw attention to the critical issue Kenya's – and the region's, energy security.

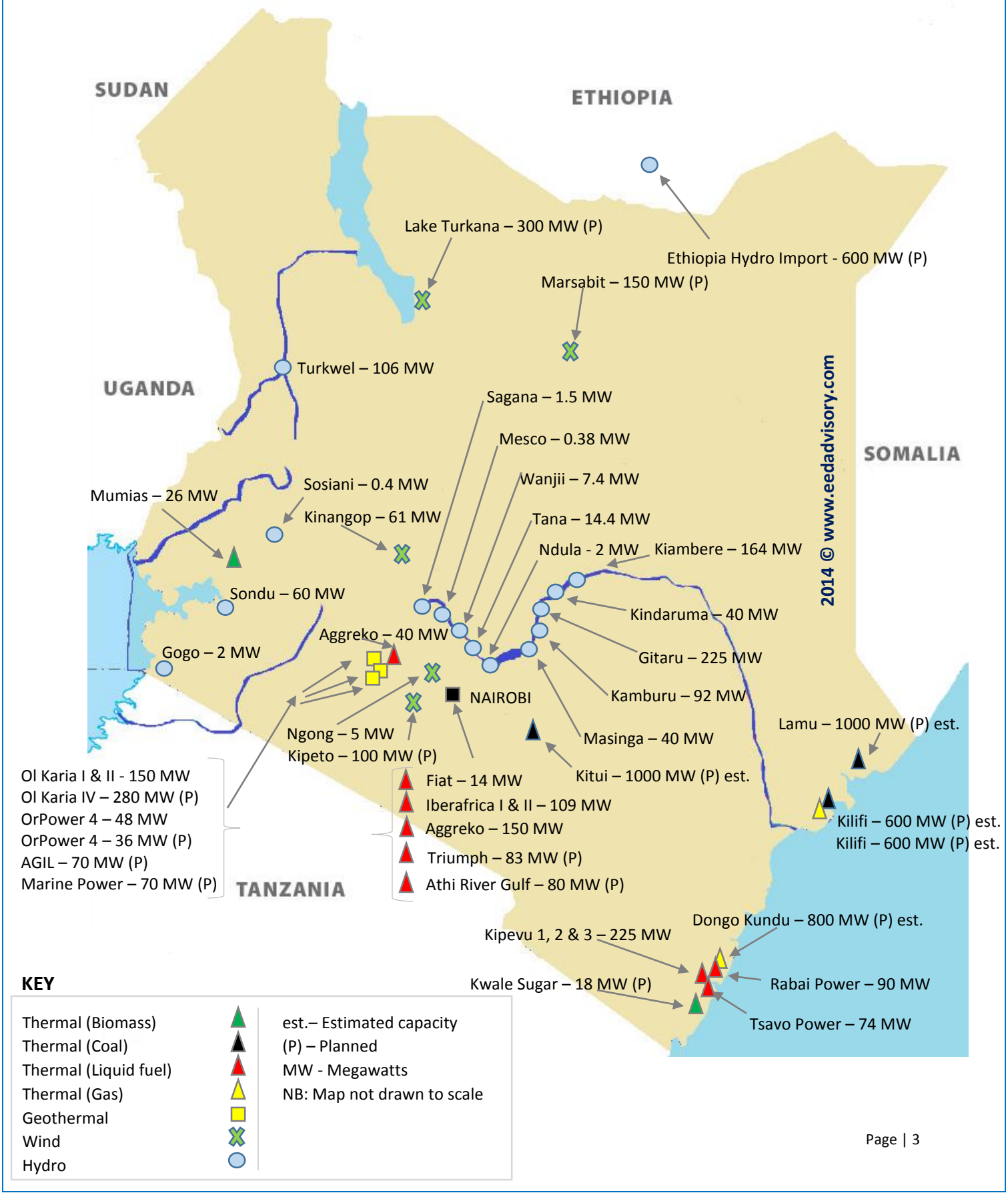
Before the "can" and "should", first a few thoughts on what 5000MW within the context of Kenya's energy history and present reality means. At the current capacity of 1700MW (see map of existing and planned power stations in Kenya on pg. 3) the average additional capacity has been 34 MW per year since independence 50 years ago. The 5000 in 40 plan will essentially ramp this up by 1500 MW per year going forward – a staggering 4400% jump. The Ministry estimates that the national electricity demand currently grows by an impressive 10% per year[2]. If supply was attuned to match this demand, Kenya's installed capacity would be expected to double every 7 years meaning an additional capacity of only 1700 MW by 2020 is what should be prescribed. This is however a static extrapolation that obviously does not consider the increase in demand driven by the Vision 2030 flagship projects among other drivers. The Least Cost Power Development Plan (LCPDP), which is an inter-government agency initiative led by the Energy Regulatory Commission (ERC), uses complex simulation models to determine the optimal structure of the power system expansion over 20 year periods and is a more reliable reference for projected power and energy demand [3] (cont. pg. 4).

[1] MoEP (2013), 5000 + MW by 2016, Power to Transform Kenya – Investment Prospectus 2013-2016, Ministry of Energy and Petroleum, Nairobi.

[2] Observed average annual peak demand increase in of 9.96% between 2002 and 2009, MoE (2009) Kenya Electricity Access Investment Prospectus, Government of Kenya, Nairobi

[3] Republic of Kenya (2011) Least Cost Power Development Plan, Government of Kenya, Nairobi

Figure 2: Existing and planned power stations in Kenya (2014)



Discounted rates, cost escalation, dispatch orders, reserve margins, loss-of-load-probability and other dynamic indices are factored in the LCPDP simulations. The LCPDP forecasts a peak load demand of 2,866 MW by 2016, which is 3,834 MW or 138% less than the installed capacity under 5000 in 40 plan. Even while accounting for the Vision 2030 flagship projects, such a surge in such a short time is hard to justify. If successfully executed within 40 months, the cost of electricity will actually increase significantly in the short to medium term before demand catches up with supply. It remains unclear how the power purchase agreements will be structured but it is likely that customers will have to weigh in on the cost associated with the idle capacity. Installed capacity, or the ability to generate power, is only a small part of the energy access equation. Energy use (commonly measured in Watt-hours consumed), a firmer indicator of energy access, is predictably determined by the availability of transmission and distribution infrastructure. The inadequacies of transmission and distribution are often overshadowed by the discussions on generation. Many critics of the 5000 in 40 plan highlight this shortcoming. Contrary to common sentiments, the 5000 in 40 plan does indeed include ambitious expansion plans in transmission and distribution. The plan highlights the construction (on-going and planned) of 4,679 kilometers of high voltage transmission lines (132 KV – 500 KV) estimated to cost KES 213 billion (US$ 2.5 billion) and 3,579 kilometers of distribution lines priced at KES 38 billion (US$ 0.45 billion) – excluding costs of substations[4].

4,679 Km

Combined length of transmission lines under construction and planned as reported in the 5000MW in 40 months electrification plan

To answer the first question of "can" - the mix prescribed by the 5000 in 40 plan includes 1,646 MW from geothermal (KenGen, GDC, Marine Power, AGIL and Orpower projects), 1,050 MW from natural gas (450 MW in Dungo Kundu and 600 MW in Kilifi), 630 MW from wind (mostly through independent power producers) and 1,920 MW from coal. All power plants are not built equal. Their cost and construction period will depend on the type, size, technology, location and source of energy, among other factors. We will skip the power project cycle discussion and simply mention some examples, although variably useful, of similar projects for a more general comparison. Like stated above, the question of the "can" is a simple. It is a question of technical possibility assuming all the ingredients are in place. There are no typical project cycles for geothermal plants as construction follows a complex resource identification and

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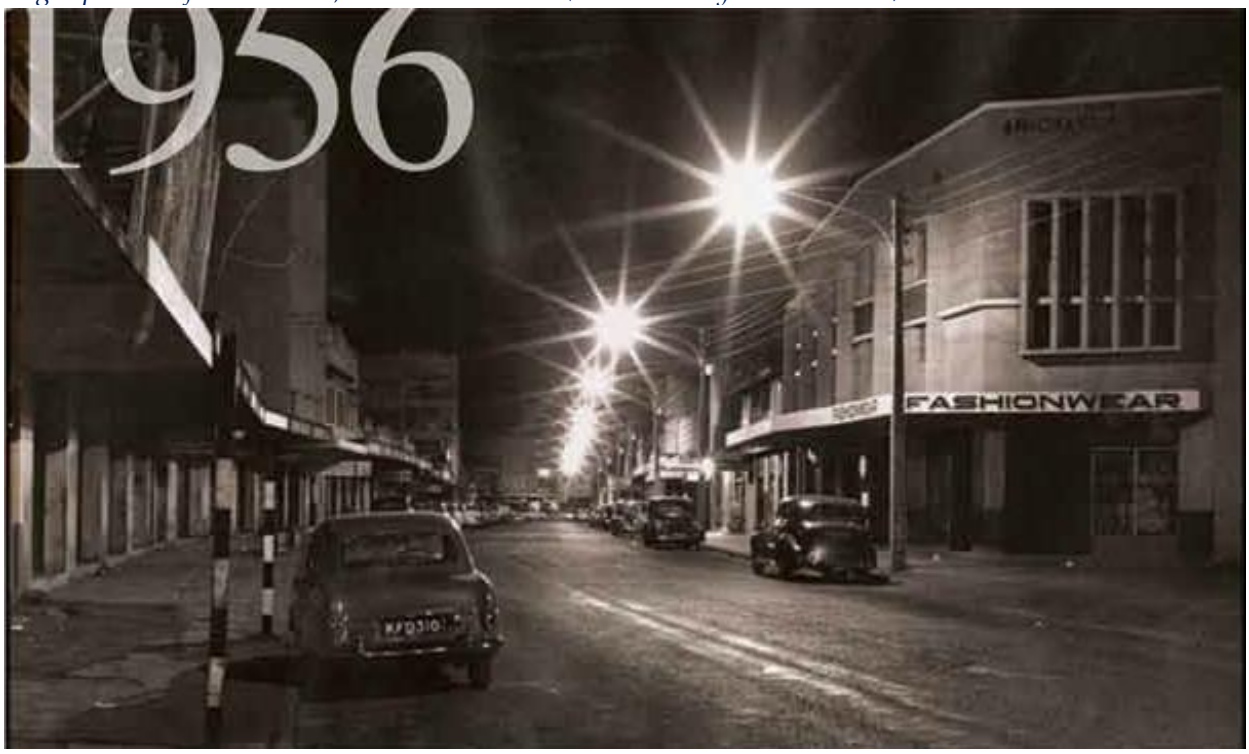
[4] MoEP (2013), 5000 + MW by 2016, Power to Transform Kenya – Investment Prospectus 2013-2016, Ministry of Energy and Petroleum, Nairobi.

confirmation process. For the purposes of this discussion, let's assume that the resources has been identified and confirmed as is the case in the Ol Karia units (I – IV) in Naivasha. Construction of Ol Karia II, which is presently the jewel in the crown and Africa's largest geothermal power plant, began in Y2000 and commissioned in Y2003, about 36 months in total. Resource confirmation works were however done between 1986 and 1993. Ol Karia IV with a combined capacity of 280MW is due for commissioning in the fourth quarter of 2014. It is difficult to see, even with the diverse pipeline consisting of private and public sector projects how the current geothermal generating capacity of about 250 MW will top 1,646 MW in 40 months. For gas-fired power plants, only a handful exist in Africa with the largest being the 140 MW Sasol Gas Engine Power Plant in Sasolburg, South Africa commissioned in December 2012 and reported to have been constructed under 20 months at a cost of ZAR 1.9 billion (US$ 0.2 billion)[5]. Takoradi III, 132 MW in Ghana is a combined cycle thermal plant which can be powered by both gas and light crude oil was completed in less than 14 months although this short period is attributed to the modular design of the larger Takoradi power program[6]. Proposed gas-fired projects under the 5000 in 40 are much larger than this. The 758 MW Panda II natural gas fired combined cycle plant in Texas, USA has a 24 to 30 months construction period[7]. This would be a safe ballpark figure to have in mind although the

Night picture of River Road, Nairobi in Y1956 (Source: Kenya Power 2012)



[5] Sasol official website; "Sasol gas engine plant goes live" – December 28th 2012, sourced March 2014.
[6] HPI (EPC contractor), official website; sourced March 2014
[7] Electric, light and power official website; Article " Temple, Texas 758 natural gas plant expansion takes a step forward", April 2013 – sourced March 2014.

environments are very different. Needless to say, for such plants to operate an elaborate gas storage (and transportation) infrastructure – not to mention adequate sources of the gas which involves long-term supply negotiations, have to be in place. Interestingly, the target set for wind seem most attainable. Summing the installed capacities of the most advanced wind projects including the 300 MW Lake Turkana, 61 MW Aeolus Kingangop, 50 MW KenGen Isiolo, 150 MW KenGen Marsabit, 100 MW Kipeto in Kajiado highlights not just the possibility, but the high probability of the expected capacity from wind being realized. Even with a firm pipeline as such, reaching financial close, procurement and construction are not linear undertakings and 40 months may still be short for some of these projects. Still, this category stands the highest chance of success when all things are considered. An International Energy Agency (IEA) study across 21 countries reviewing 190 power plants including 34 coal-power fired plant placed the average construction time at 48 months[8]. Within this context, the 5000 in 40 plan seems possible but remains a highly unlikely outcome.

The question of the "should" is less straight forward but we offer a shorter response. The 5000 MW plan should remain, but be divorced from the 40 months and made to align with the LCPDP. Audacious plans are needed especially in the current state of power and energy deprivation. In 1935, when rural electrification rates in the USA stood at 12%, President Franklin D. Roosevelt established the Rural Electrification Administration. By 1965 (under 30 years), 98% of all rural areas in the expansive USA were electrified[9]. China likewise attained a 98% rate of electrification in just over 50 years[10]. The fact that developing countries like Ghana, Colombia, Jamaica and Chile all have an electrification rates above 70% and are marching fast towards universal electricity access should be a great motivator that it can and should be done – but not necessarily in 40 months.

> The 5000MW plan should remain, but be divorced from the 40 months....

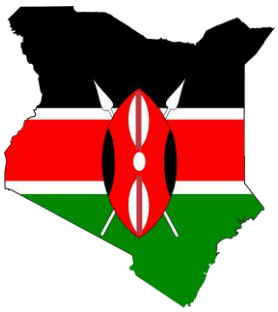
[8] IEA (2010) Projected Costs of Electricity, International Energy Agency, Paris France.

[9] USDA (1982) A brief history of the rural electric and telephone programs, Rural Electrification Administration, Washington DC.

[10] Jiahua, p., et al (2016) Rural Electrification in China, Historical processes and key driving forces, Energy and Sustainable Development, Stanford University, California

First Quarter 2014 Energy Access News Roundup

- **Commercialization of natural gas by 2020**: With the discovery of 45 trillion cubic feet of natural gas (mostly offshore deposits), the Tanzania Petroleum Development Corporation is confident that the country will start commercial production by 2020.
- **Off-grid Electric (OGE) raises US$ 7 million for solar PV energy solutions:** OGE is a solar energy service company with over 10,000 clients in Tanzania. Unlike several solar energy service providers, OGE maintains ownership of the solar PV hardware, leaving the clients to only pay for the services. The company raised US$ 7 million to scale up their operations.
- **EWURA considering bids for Bagamoyo gas-fired plants:** Two companies; BS Limited and Kamal Steel have been shortlisted to build two 200MW gas-fired power plants in Bagamoyo, about 70 kilometers north of Dar es Salaam.



- **M-Kopa receives US$ 20 million funding**: This includes a US$ 10 million syndicated debt facility provided by the Commercial Bank of Africa (CBA) and grants from the UK Department for International Development (DfID), Bill & Melinda Gates Foundation and Shell Foundation. M-Kopa currently has a customer base of 50,000 and services off-grid homes with solar PV systems on a 12 months mobile payment plan.
- **280 MW additional geothermal power to come online by end of first quarter:** Kenya's installed capacity will get a massive boost with part of the 280 MW geothermal power expected to come online by mid-April 2014. An initial 70 MW will be dispatched to the grid during this testing and calibration period. When fully operational the Ol Karia IV 280 MW plant will be one of the largest in the world.
- **GCube to provide insurance for Kinangop wind:** GCube a specialist renewable energy underwriter is to provide insurance for Aeolus Kenya's 60.8 MW wind farm in Kinangop. The facility will feature 38 General Electric (GE) 1.6 MW turbines and expected to be completed in the first quarter of 2015.

- **Parliamentary report recommends cancellation of UMEME's contract**: A report by a parliamentary committee set up to investigate the energy sector in Uganda has asked the government to cancel UMEME's 25 year distribution concession. UMEME distributes 99% of electricity in Uganda and is listed on both the Kampala and Nairobi Stock Exchanges. London based private equity fund Actis is the controlling shareholder. The same report also recommends the cancellation of Eskom's concession to operate and maintain leading power generators in Uganda.
- **Refinery linked compensation dispute now in court:** Residents who lived on the planned refinery site along Hoima-Kaiso road in Uganda have filed a law-suit that could delay oil production in Uganda expected to start by 2018.

Comparing electricity tariff structures across East Africa for domestic users

Seyyied Bargash one of the Sultan of Zanzibar is reported to have acquired a generator to light the palace and nearby streets around 1880[11]. This marked the first attempt at public power distribution in East Africa, and was remarkably achieved about the same time that Thomas Edison threw the switch in 1882 that would start the first commercial power plant in America. It has been said that Benjamin Franklin may have discovered electricity but it was the person who invented the meter who made the money.

Electricity tariffs across East Africa are structured differently. Tanzania (TANESCO) and Uganda (Umeme) both have 5 tiers that classify the consumers into different categories. Kenya (KPLC) has 8 tiers and uniquely has pass through costs including the fuel cost charge (FCC), foreign exchange rate fluctuation adjustment (FERFA), inflation adjustment (IA), Water Resources Management Authority (WARMA) levy, Energy Regulatory Commission (ERC) levy, Rural Electrification Program (REP) levy and Value-added Tax (VAT). This makes the cost of electricity in Kenya unpredictable with external factors beyond the consumers' control contributing significantly.

> Of the three, Tanzania stands out as the only country that does not charge a monthly fixed rate for domestic consumers...

All the three countries have a life-line tariff for very low domestic consumers of electric energy. A unique tariff is applied for usage below 15kWh (US$ 0.06), 50kWh (US$ 0.03) and 75kWh (US$ 0.06) in Uganda, Kenya and Tanzania respectively[12]. Domestic users have to pay 247%, 365% and 250% more for electricity above these thresholds in Uganda, Kenya and Tanzania respectively. Kenya has three energy use bands under the domestic tariff structure (0-50 kWh, 50 – 1500 kWh and above 1500 kWh). For the purposes of comparison, 1 kWh is equivalent to the energy used when watching a 100W rated TV for 10 hours, or using a 1000W rated micro-wave for one hour.

Of the three Tanzania stands as the only country that does not charge a monthly fixed rate for domestic consumers regardless of energy use. In Kenya and Uganda the fixed rate US$ 1.40 and US$ 1.31 respectively.

TANZANIA		
CATEGORY	**COMPONENT**	**TARIFF (US$)/ MONTH**
D-1 (Domestic)	Fixed Charge	0
	Energy Charge (0-75 kWh)	0.06
	Energy Charge (Above 75 kWh)	0.21

UGANDA		
CATEGORY	**COMPONENT**	**TARIFF (US$)/ MONTH**
10.1 (Domestic)	Fixed Charge	1.32
	Energy Charge (0-15 kWh)	0.06
	Energy Charge (Above 15 kWh)	0.20

KENYA		
CATEGORY	**COMPONENT**	**TARIFF (US$)/ MONTH**
DC (Domestic)	Fixed charge	1.40
	Energy Charge (0-50 kWh)	0.03
	Energy Charge (50 - 1500 kWh)	0.14
	Energy Charge (Above 1500 kWh)	0.23
	FCC	Variable/kWh
	FERFA	Variable/kWh
	IA	Variable/kWh
	WARMA Levy	0.0006/kWh
	ERC Levy	0.0004/kWh
	REP Levy	5% of the base rate
	VAT	16% of all minus WARMA, ERC, REP and IA

[11] Khamis, S. K. (2001) Lights of Zanzibar, Zanzibar Archives 1890 – 1940, www.zanzibarhistory.org

[12] TANESCO (2014) Electricity End-User Tariff, Kenya Power (2013), ERC Approved Tariffs and Umeme (2014) Electricity End-user Tariffs and Charges

The definition given for the additional charges that Kenyan domestic electricity consumers pay for are as follows:

- ***Fuel Charge cost***: amount used to generate electricity by thermal generators and is variable every month due to fluctuations in the price and quantity of fuels used in the generation. It is published by KPLC every month on the Kenya Gazette.
- ***Foreign Exchange Rate Fluctuation Adjustment (FERFA)***: sum of extra costs incurred due to fluctuations in foreign exchange rates. Consumers pay in KES while some costs, for example fossil fuels, are purchased in foreign currency.
- ***Inflation Adjustment (IA):*** amount charged as a result of the effect of domestic and international inflation on the supply of Electricity.
- ***WARMA Levy:*** fee paid to the Water Resource Management Authority for water used by the hydro power plants in generation of electricity. It is 5.00 Kenya cents/kWh (Kilowatt-hour)
- ***ERC Levy***: Energy Regulatory Commission (ERC) is paid a statutory levy of 3 Kenya cents/kWh.
- ***REP Levy***: 5% of the revenue from the unit sales submitted to Rural Electrification Programme (REP) aimed at improving access to electricity in rural areas.
- ***VAT***: Value added tax, currently at 16%, imposed on every charge except the WARMA, ERC and ERP levies. Prior to the VAT Act 2013, consumptions less than 200KWh were tax exempt.

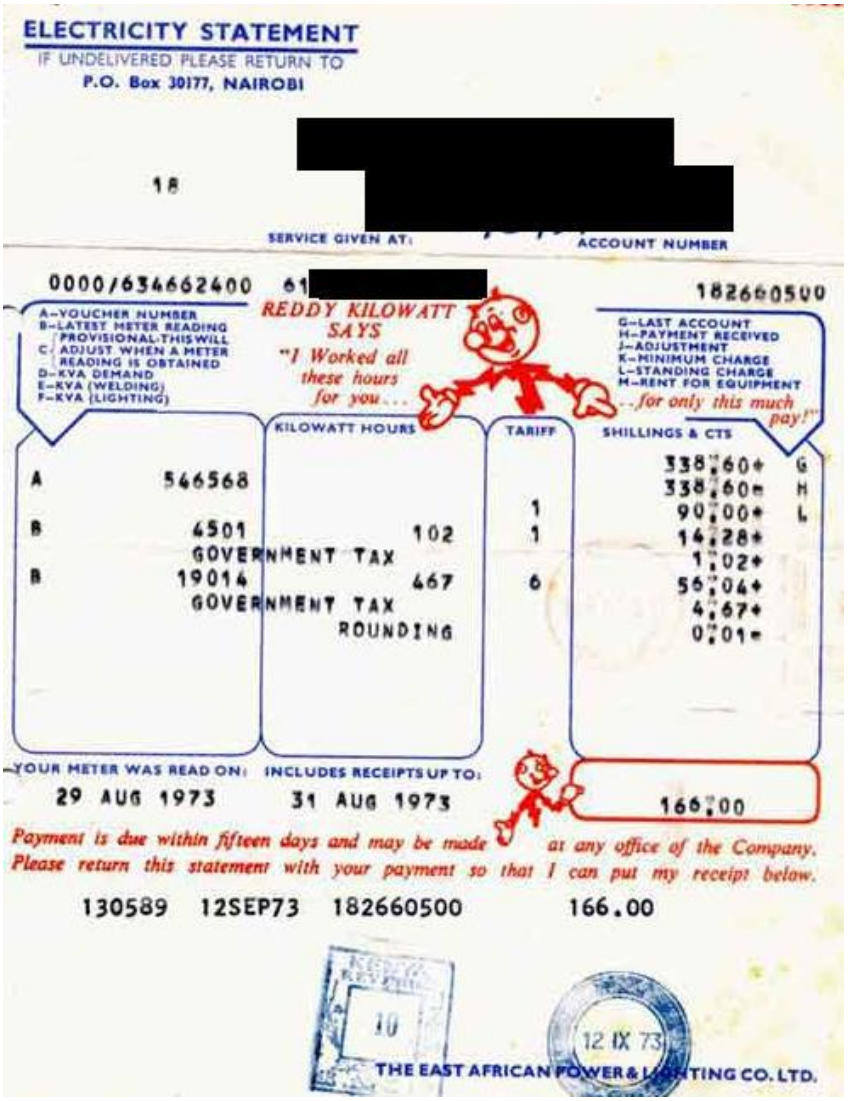


***Figure 3**: **Down memory lane** - a 1973 electricity bill from the East African Power and Lighting Company (now Kenya Power) showing the various charges including KVA demand charge, minimum charge and standing charge (source: http://www.sikh-heritage.co.uk/heritage).*

The cost of electric power is only one measure of assessing the energy services delivered by the three utilities. Quality and reliability of supply are other key determinants. Proximity to the grid (for potential new customers), grid connection fees, turn-around time from application to connection, ease of payment and quality of customer care all play into the overall rating.

Electricity Access Numbers Across East Africa

COUNTRY	BURUNDI	KENYA	TANZANIA	UGANDA	RWANDA
YEAR	2011/2012	2012/2013	2011/2012	2012/2013	2012/2013
INSTALLED CAPACITY (MW)	36	1664	1438	819	111
ELECTRIFICATION RATE (%)	10	29.1*	18	7.9*	16
CONNECTED CUSTOMERS	76,000	2,330,962**	900,000	574,000	338,870
TRANSMISSION LOSSES	-	18.6	24.97	23.4	-
ELECTRIC ENERGY SOLD (GWH)	200	6581	4076	2118	-
POPULATION (MILLION)	9.85	43.18	47.78	36.35	11.46

*Estimated from the number of recorded customers by the utilities against the total number of households
** Includes Rural Electrification Program customers

In the Next Issues of Energy Access Review

- The forgotten middle: A case for mini-grids in East Africa?
- Mapping the leading international and local players in the East Africa oil and gas bonanza
- Defining "electrification rate" and its shortcomings in the context of Sub Saharan Africa

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