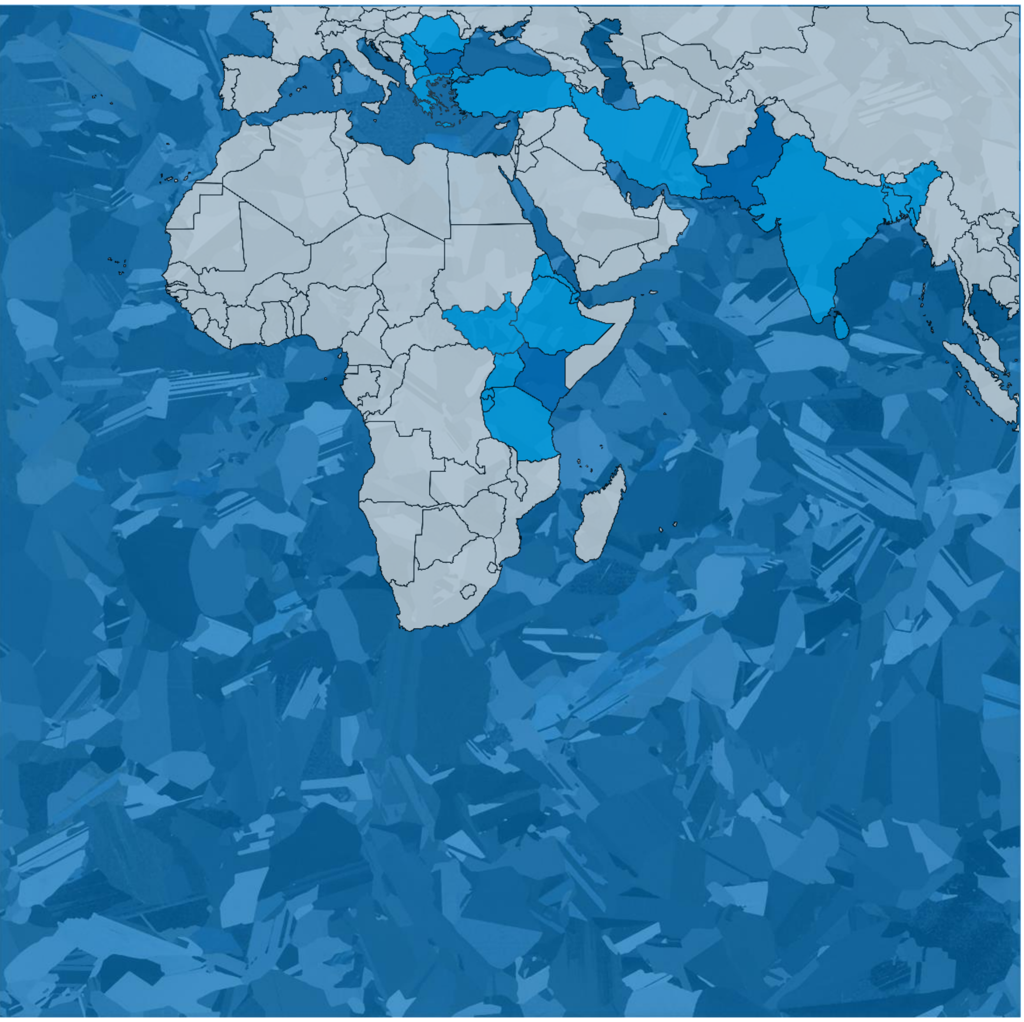
July 2015

KENYA – POWER SECTOR

Current Situation
Future Outlook



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Generating Capacity

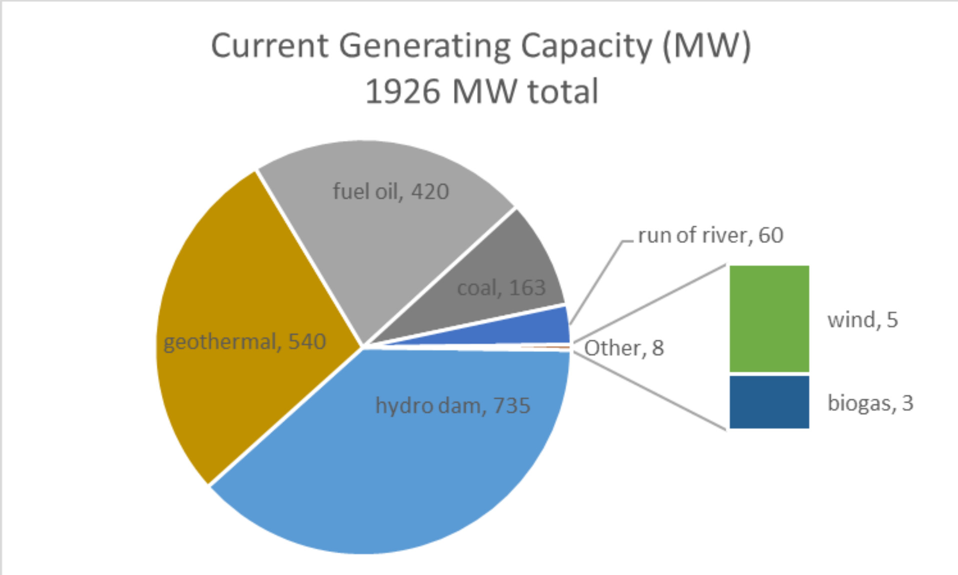
Kenya currently has a power generating capacity of ~1900 MW. This is expected to increase to ~3400 MW over the next 5 years.

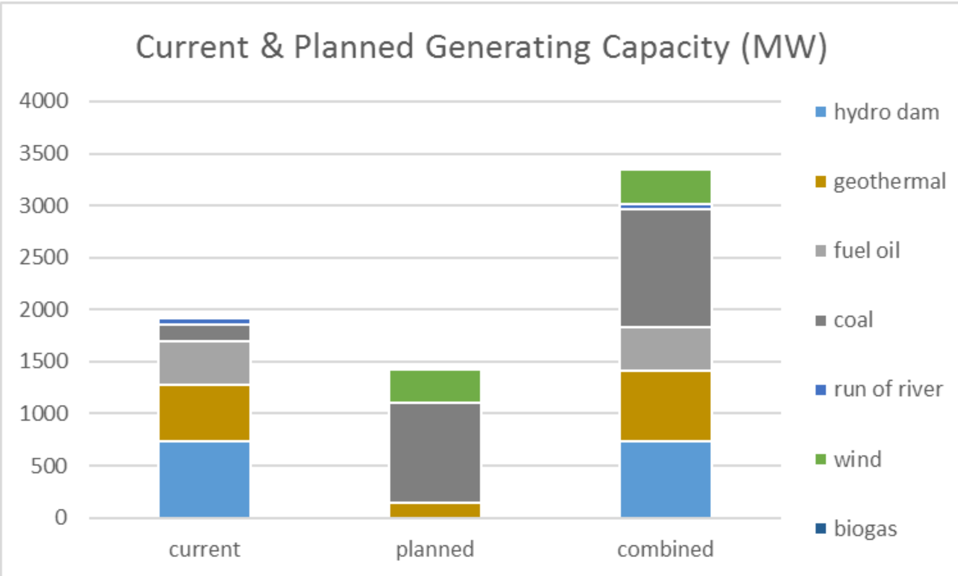
Currently hydropower dams and geothermal power plants supply the majority of Kenya's power followed by fuel oil and coal fired power plants. Significant capacity additions are planned for coal and wind power with a single ~1000 MW coal power plant and ~300 MW of new wind farms.

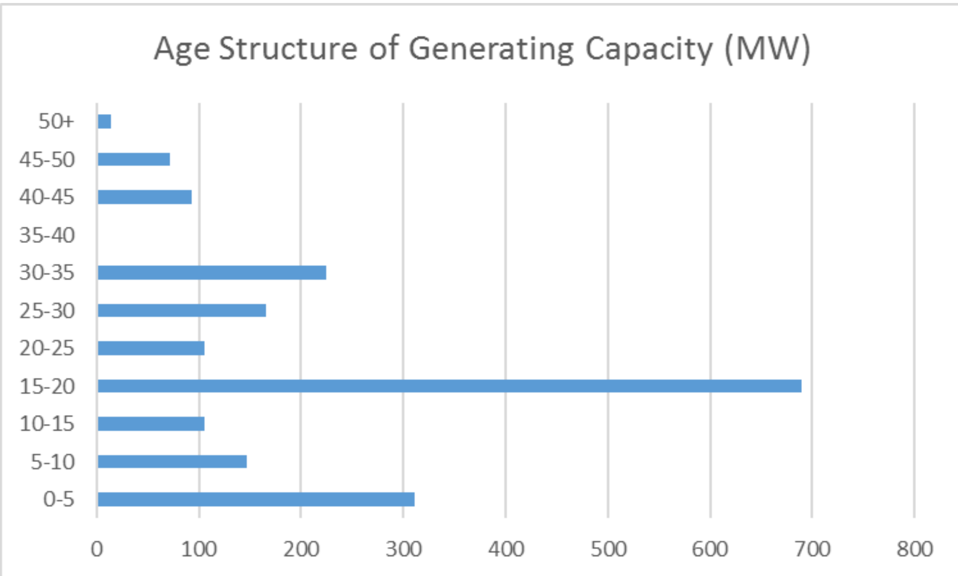
The majority of Kenya's power generating capacity is less than 20 years old.

Approximately 400 MW of generating capacity will reach the end of their technical life or will require overhaul over the next 10 to 15 years.

Generating capacity is centered around Nairobi, south of Mount Kenya. The planned addition of a ~1000 MW coal power plant at the coast, will disperse generating capacity as will additional wind and geothermal capacity planned for the north western area of the country.



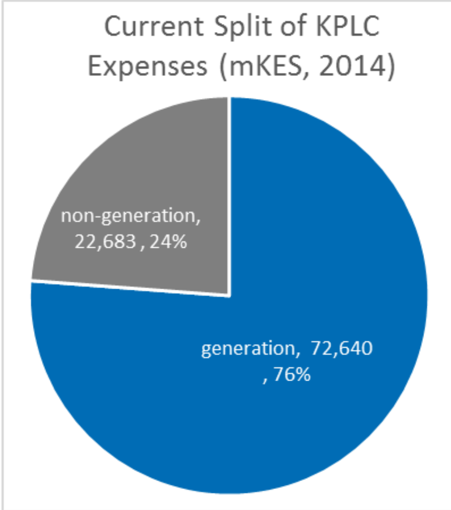




Current Electricity Prices

Current electricity prices, as charged by the Kenya Power and Lighting Company (KPLC), are driven by two major price components. The first is the outright cost of electricity bought from suppliers by KPLC. The second are all non-generation expenses that KPLC incurs for the transmission and distribution of power, the maintenance and expansion of its power grid and for general operational expenses and overhead.

Direct generation expenses account for three quarters of KPLC's expenses with non-generation expenses accounting for the remaining quarter.



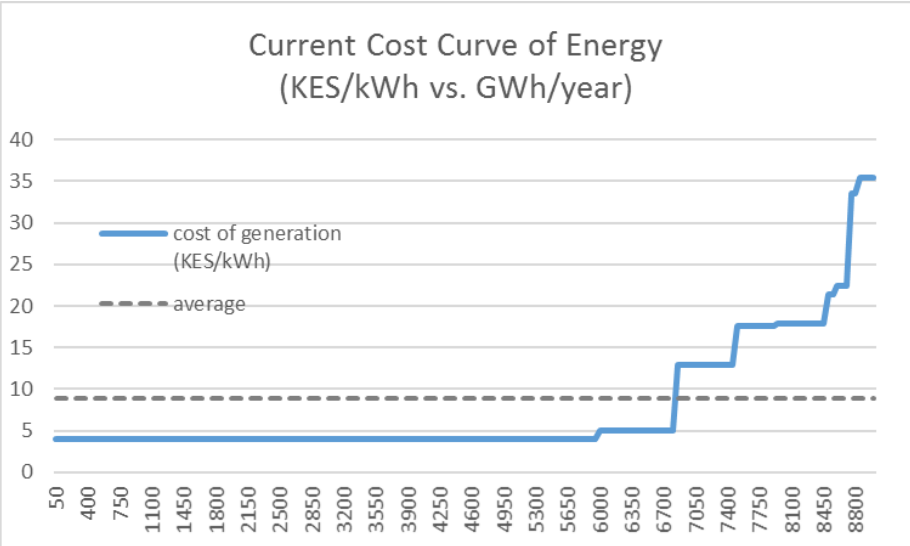
Generation Expenses

KPLC buys the majority of its electricity, two thirds, from the Kenya Electricity Generation Company (KENGEN). In addition KPLC buys electricity from another 12 suppliers including cross border electricity imports from Uganda, Tanzania and Ethiopia. The bulk of its electricity was purchased at a cost of 5.1 KES/kWh in 2014 from KENGEN. The additional electricity was purchased at prices ranging from 4 to 35 KES/kWh. The table alongside summarizes the cost and share of the individual suppliers in KPLC's overall electricity purchases.

supplier	GWh	share	KES/kWh
KenGen	5931	67%	5.1
OrPower	851	10%	8.1
Rabai	633	7%	17.6
Iberafrica	550	6%	21.4
Thika	454	5%	17.9
Tsavo	152	2%	27.8
Aggreko	94	1%	35.5
Uganda	83	1%	22.5
Mumias	57	1%	4.1
Off-grid	33	0%	33.6
Tanzania	1	0%	12.9
Imenti	0.2	0%	4.0
Ethiopia	0	0%	-
Total	**8839**	**100%**	**8.9**

The volume weighted average cost (VWAC) of generation expenses for KPLC in 2014 was 8.9 KES/kWh.

KPLC's current cost curve of generation expenses as a function of the total number of GWh purchased per year is set out in the below stack curve.



Future Electricity Prices

To estimate future electricity prices we modelled the development of both the generation and the non-generation expenses of KPLC separately. We then determined the over all annual expenses of KPLC relative to todays overall expenses.

Generation Expenses

To model KPLC's future generation expenses we assume that the expenses for electricity purchases from its current supplies will remain unchanged in both the amount of electricity purchased and the purchase price. This is a conservative assumption, as several of the power purchase agreements (PPAs) allow for the increase of purchase prices with inflation.

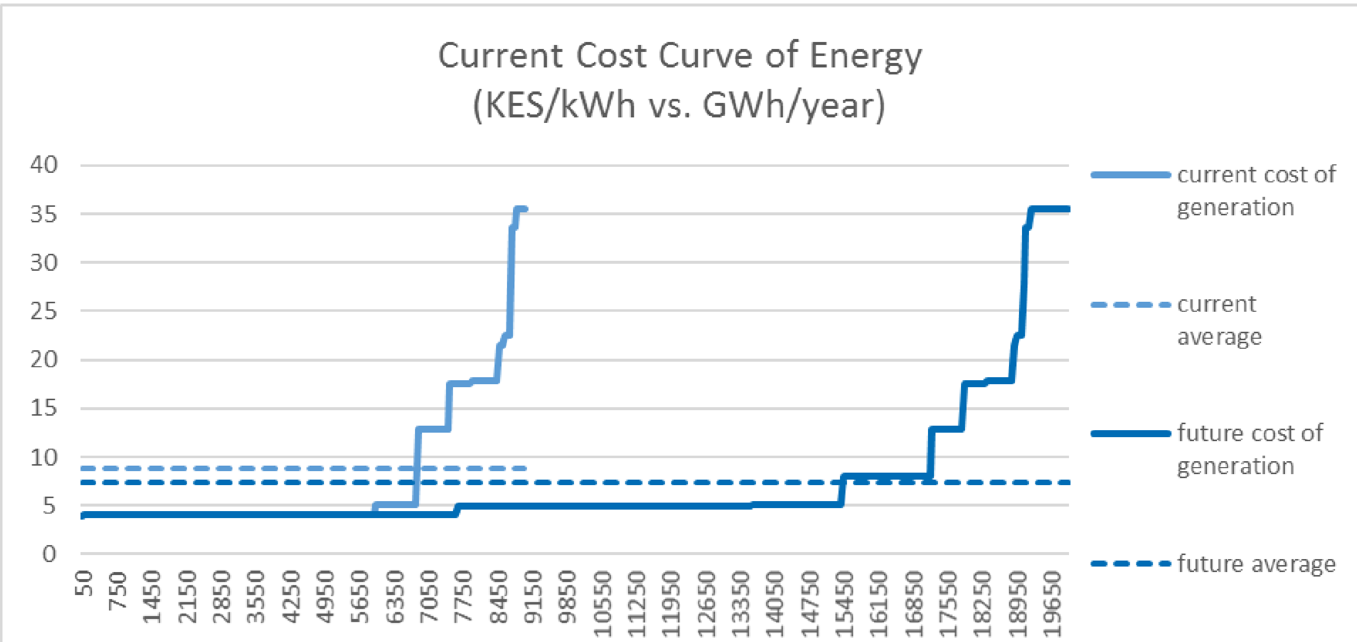
We further assume that all of the currently planned new power plants will realized. We assume that both the planned 960 MW coal power plant at Lamu and an additional 240 MW of geothermal power will be operating at a capacity factor of 90 %. We assume that the coal power plant will be selling electricity at a rate of 5 KES/kWh and will be operation from the start of 2019 while the geothermal plants are assumed to sell at 8 KES/kWh, equal to the price paid to the current geothermal plants and are assumed to become operation from the start of 2018. An additional 300 MW of wind power are assumed to be realized and operating with a typical capacity factor of 35 %. The purchase price for electricty from wind power is set at the 11 KES guaranteed under the current tariff regime and the plants are assumed to start operation at the beginning of 2017. All of these assumptions are conservative in that they assume an unrealistically fast commissioning, high capacity factors and for the coal power station low tariffs.

These assumptions would yield the new generation capacity, annual electriciy purchases and future VWAC set out alongside.

With the realization of all of these future power plants the total amount of elecitricity purchased by KPLC would more than double from it's current 8,800 GWh per year to over 19,000 GWh per year.

type	MWh	capacity factor	GWh/a	price
coal	960	90%	7,569	5
geothermal	240	90%	1,892	8
wind	300	35%	920	11
new plants	**1500**	**79%**	**10,381**	**6.1**
existing plant			8,839	8.9
total			**19,220**	**7.4**

The VWAC of the new power plants would amount to 6.1 KES/kWh. This would in turn lower the overall VWAC of generation for KPLC from its current level of 8.9 KES/kWh to a future 7.4 KES/kWh. This is equivalent to a 17 % reduction in generation expenses. The change to KPLC's cost curve of generation expenses as a function of the total number of GWh purchased per year is set out in the below stack curves.

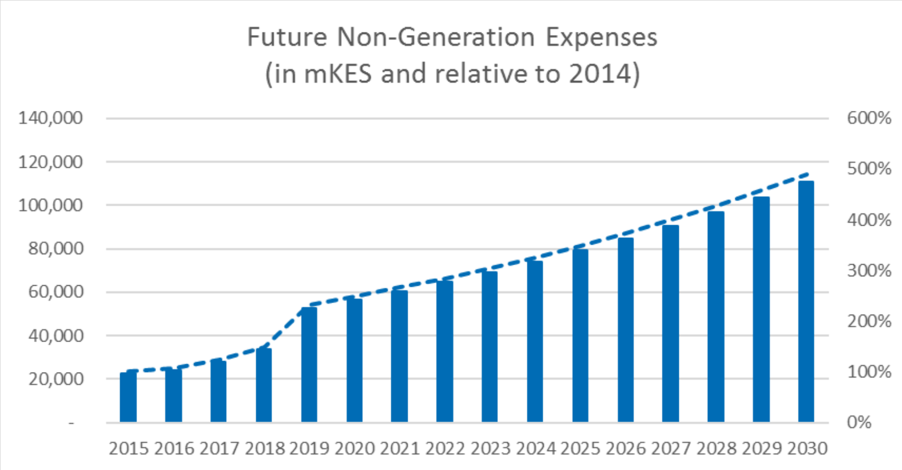


Non-Generation Expenses

To model future non-generation expenses, we make two assumptions. First, we assume that non-generation expenses will increase at a rate of 7 % per year equivalent to the current rate of inflation of around 7 %. Further we assume that non-generation expenses will increase with the increase of the amount of electricity handled by KPLC. To allow for a fixed base cost component, we assume that the increase in non-generating expenses will be equal to only 75 % of the increase in the amount of electricity handled by KPLC. This is a conservative assumption as the more than doubling of total electricity sales would have to go hand-in-hand with a significant expansion of the transmission and distribution grids as well as the number of clients serviced by KPLC.

The result, as summarized in the graph alongside, is that non-generation expenses would increase in 2017, 2018 and 219 as the wind, geothermal and coal power plants become operational and the total amount of electricity handled by KPLC increases.

Post 2019 non-generation expenses increase steadily in line with inflation.

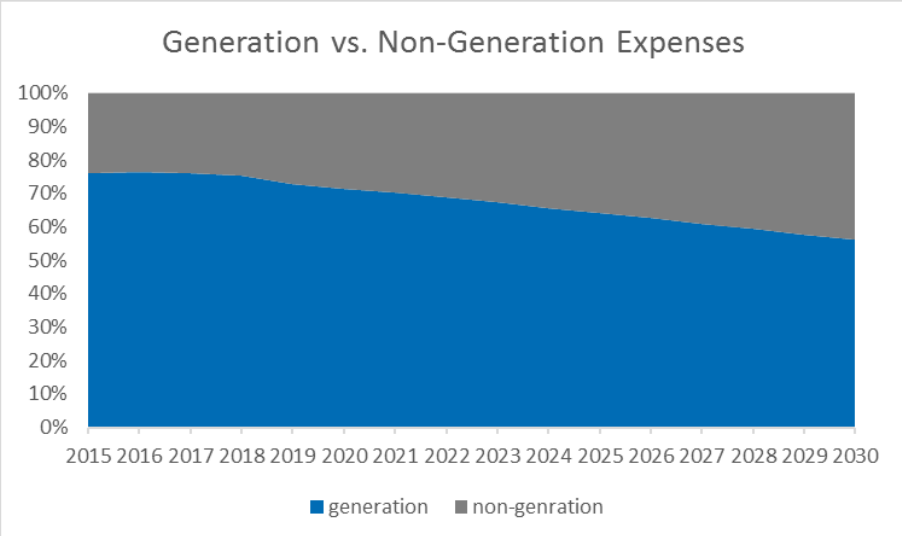


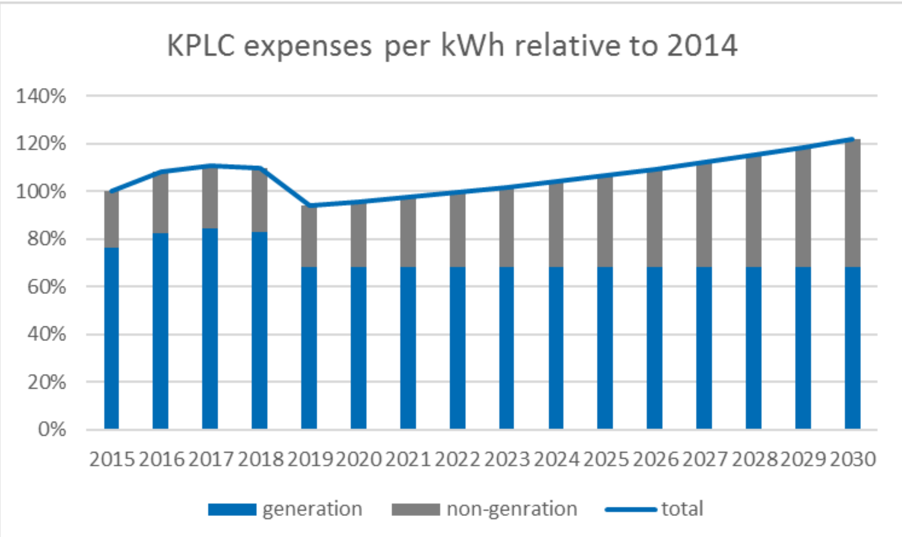
Conservative Result

Combining the models for future generation and non-generation expenses yields the following results.

As the graphs alongside show, the relative shore of generation expenses in overall expenses will decrease over time from its current level of 76 % to 56 % in 2030. This is based on the assumption that power generation expenses will stay fixed in nominal terms regardless of inflation. The result is in line with the typical split between generation and non-generation expenses of electrical utilities in European and North American markets.

The overall result, set out alongside, is that KPLC expenses in with this electricity rates will continue to increase until 2018. In 2019, as the coal power plant comes online, prices will fall to 94 % of today's level. After this prices will increase steadily, reaching today's prices again in 2022 and reaching 122 % in 2030.



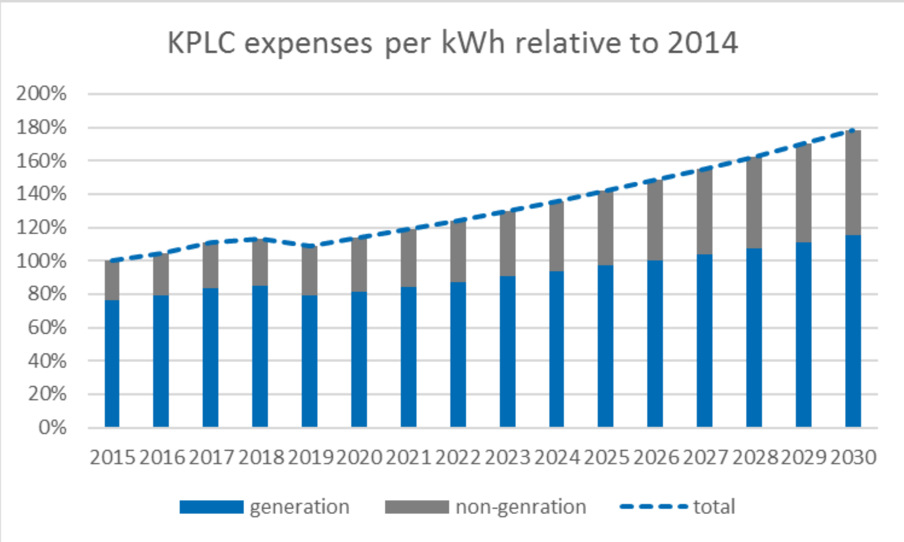


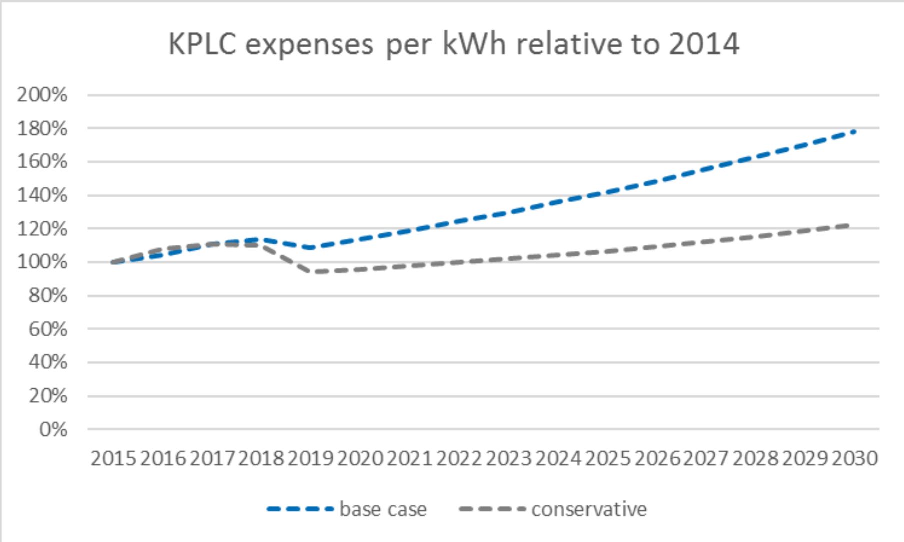
Base Case Result

As explained above the asumptions used to arrive at the above result as conservative. As an alternative we have repeated our model calculation with a set of assumption, which we believe to be more realistic. These changed assumptions are:

- The coal power plant will sell electricity at 7 KES/kWh instead of 5 KES/kWh
- The coal power plant will operate at a capacity factor of 85 % instead of 90 %
- The geothermal power plants will operate at a capacity factor of 75 % instead of 90 %
- Generation expenses will increase at a rate of 3.5 % per year to account for increased operating expenses of power plants, inflation and currency devaluation of the KES versus the USD as the primary currency of fuel (coal and oil) supplies
- Non-generation expenses will increases fully proportional to the increase in electricity handled by KPLC

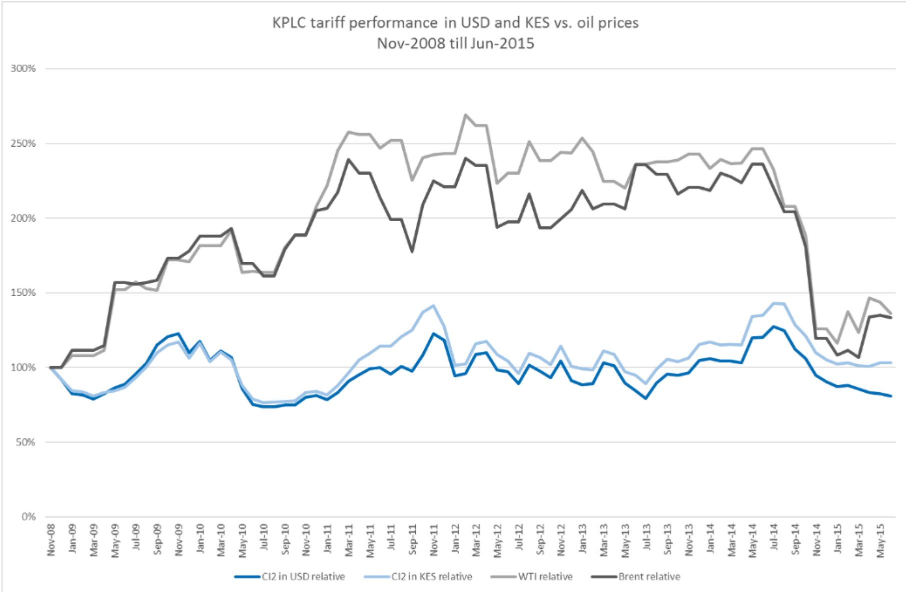
The result, as summarized alongside is that **KPLC's expenses and with this electricity rates would rise to 113 % of today's level in 2018. In 2019 rates would dip to 109 % as the coal power plant comes online. Thereafter rates will increase steadily from 114 % in 2020 to a final level of 178 % in 2030.**





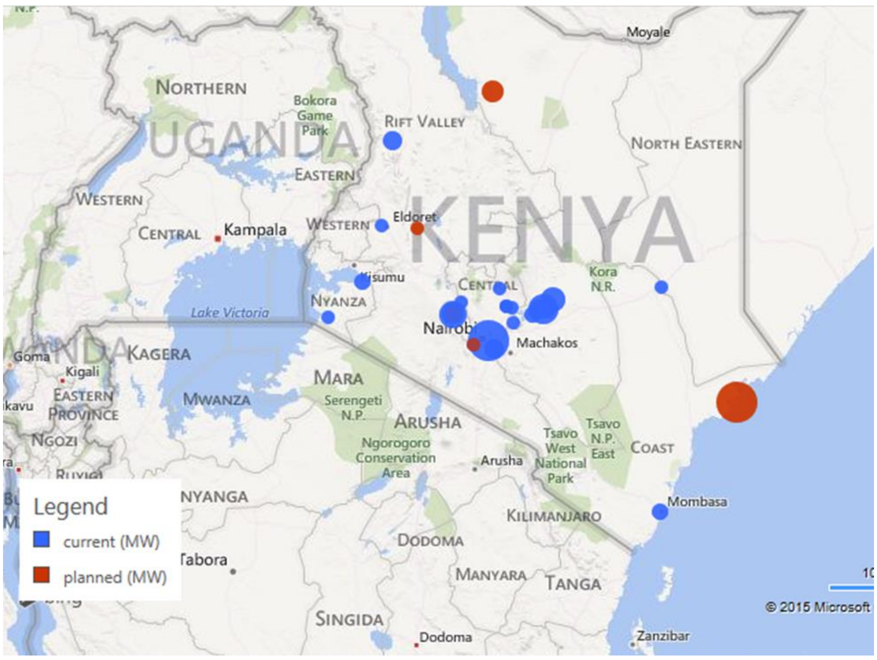
Model Constraints

Our model does not take into account a number of factors, which can significantly affect the development of future electricity prices. This include the following factors and aspects:



- We have not modelled changes in global energy prices, namely the price of coal and oil. As the graph alongside of KPLC rates (CI2 industrial rate) versus oil prices depicts, electricity prices in Kenya are strongly correlated to oil prices, as it is oil fired power plants that provide marginal and balancing energy. This means that a recovery of oil prices or a further erosion can significantly increase or decrease electricity prices in Kenya
- Our model does not take into account the demand side of the electricity market. As the next section will set out, Kenya will face significant electricity demand growth which will, all else equal, lead to upward pressure on electricity prices.
- The doubling of electricity generation, transmission and distribution in the country within the course of three years, as in our model, would pose tremendous technical challenges. The planned wind power plants are to be located near lake Turkana and would require over 400 km of new high voltage transmission lines to reach the Nairobi region, which accounts for more than half of Kenya's electricity consumption. The distance between Nairobi and the new coal power plant at Lamu would, as the map below shows, be even greater. These challenges on the transmission side are mirrored by the challenge of doubling the number of consumer connections on the distribution or demand side. The likely result are significant costs paired with later comissioning of the planned power plants, which in addition would like be operating at significantly lower capacity factors, and thus higher costs, until sufficient consumer demand has been connected on the distribution level to take up the additional generation.

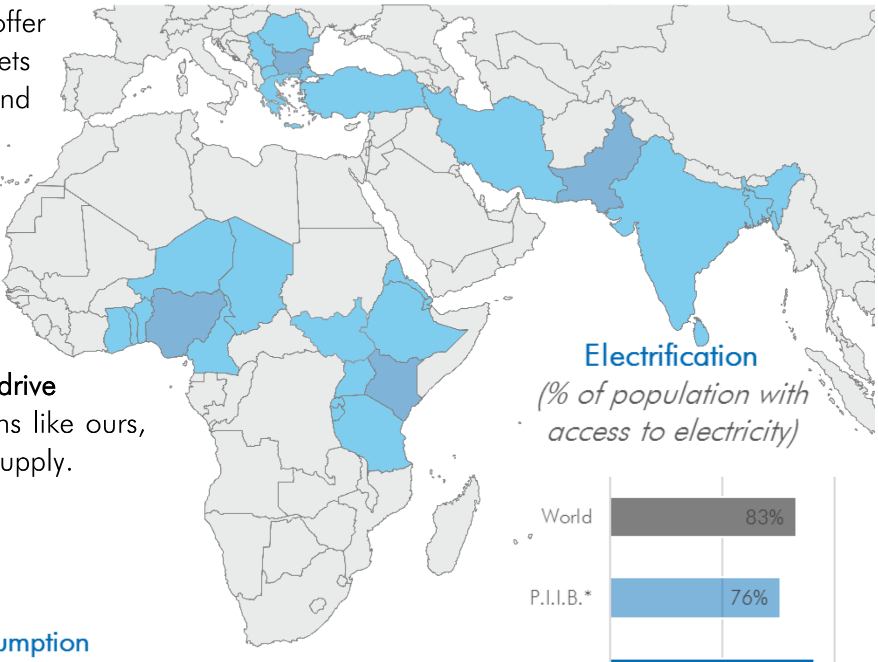
The combination of these factors lead us to estimate that actual electricty prices will likely outperform both our conservative and our base case model predictions.



Growth potential

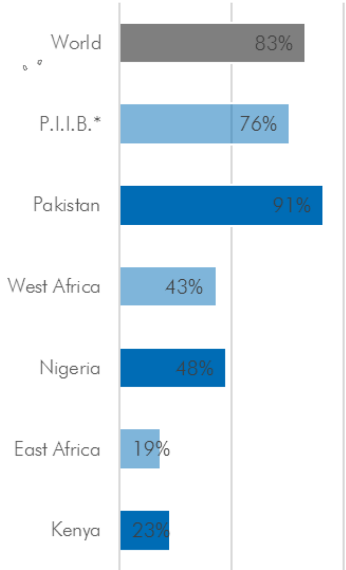
Our target markets and regions offer tremendous growth potential. Our markets are defined by **low electrification rates** and **low per capita electricity consumption**.

The confluence of these two factors means that, **as our markets catch up to regional leaders, energy demand will grow multifold**. This demand increase poses tremendous challenges. It will **sustain high electricity prices** and it will **drive demand** and political support for solutions like ours, which can rapidly add significant energy supply.



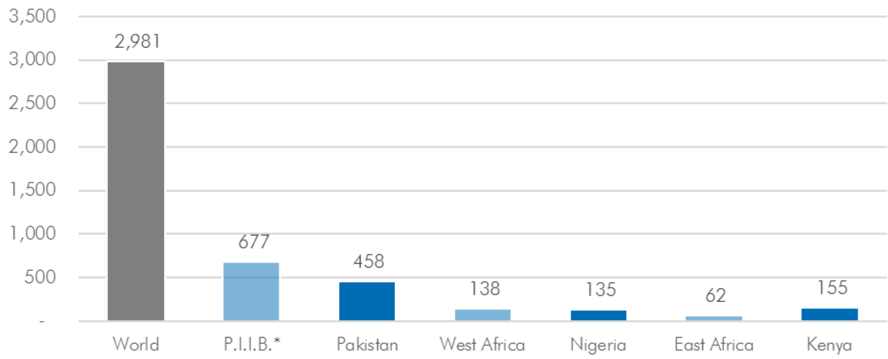
Electrification

(% of population with access to electricity)



Electricity Consumption

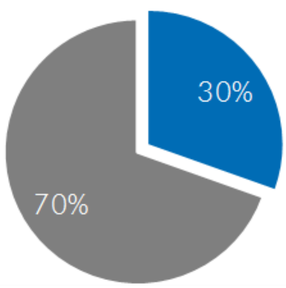
(kWh/capita)



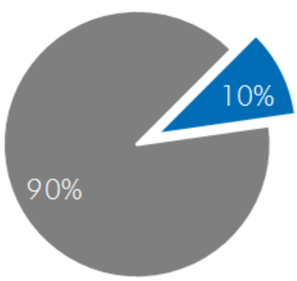
** P.I.I.B = Pakistan, Iran, India, Bangladesh*

The growth potential of our markets is driven by **a growing, huge population. Over 370 million people live in our current markets** – Pakistan, Nigeria and Kenya. Over 120 million of them have no access to electricity.

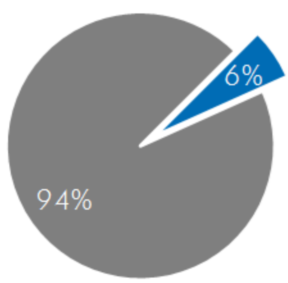
share of world **population**



share of world **GDP**

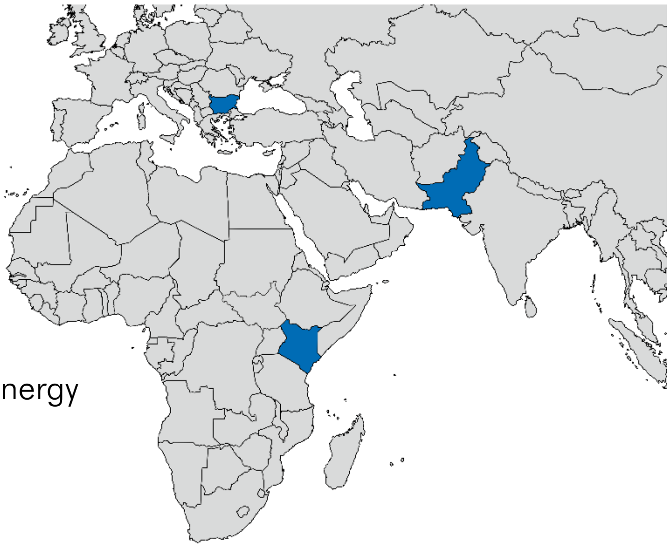


share of world **power use**



Our **neighboring markets** – East Africa, West Africa and Pakistan-Iran-India-Bangladesh boast a population of **over 2 billion**. Together these markets represent **30 % of the world's population but only 10 % of world GDP and only 6 % of world power consumption**. The inherent growth potential.

Contact us



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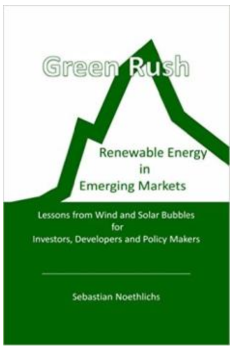
For further background



Title: Green Rush
Author: Sebastian Noethlichs
ISBN: 978-1505805970

Green Rush is written for policy makers, investors, developers and everyone with an interest in wind and solar energy in emerging markets.

The book presents a concise overview of the science and economics of climate change. The technology and development process of wind and solar energy plants are explained in a straightforward, non-technical manner. The book reviews development, repeated boom-and-bust cycles, run-away markets and the challenges they have posed in many emerging markets. The drivers behind these developments are identified and used to develop a framework for understanding, predicting and regulating the performance of wind and solar energy in emerging markets. Lessons to be learned and practical advice for developers, investors and policy makers are presented.