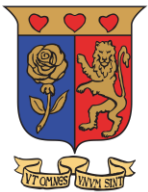


Evaluating the Need for Coal in Kenya's Electricity Generation Mix



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Definition of Terms

- Electricity Generation Mix: Combination of different **primary sources of energy** that are used to generate electricity that is supplied to a geographical region.
 - Primary source of energy: an energy source in its unconverted state.
- Electricity generation mix is determined using an **electricity generation plan**.
 - Electricity generation plan is a roadmap that defines the types of power plants to be built, the capacities of power plants and the time that power plants should be built.

Electricity Generation Plan

- Inputs into an electricity generation plan include.
 - Demand forecast – projection of future electricity demand within the planning period.
 - Techno-economic description of power plants available for electricity generation.
 - Techno-economic description of ‘environment’ e.g. discount rate, level of reliability required.
 - Committed projects and existing power plants.
 - Policy e.g. carbon tax.

Kenya's Electricity Planning Process



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- Typically published in documents known as the 'Least Cost Power Development Plans-LCPDP.'
- Updated every 2 years.
- The preparation of these plans is led by the Energy Regulatory Commission.

Scope

- For this presentation we focus on the following power plans with a in-depth look at the assumptions and methodology used for the commercial industrial demand forecast.
 - LCPDP 2010.
 - LCPDP 2013.



Scope

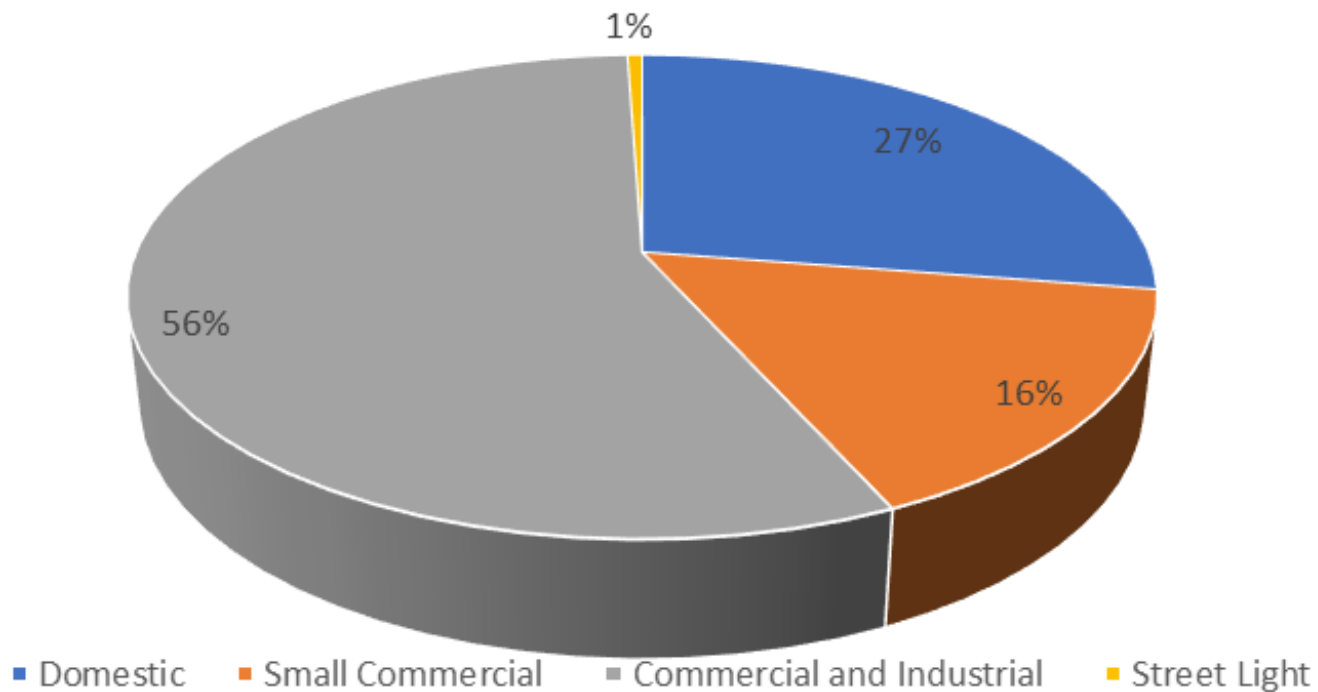
- We will focus on the assumptions and methodology used for commercial-industrial demand forecast.
- Demand forecast is a projection of future energy consumption and **demand**.
 - Demand is energy consumption per second
- Kenya's demand forecast is conducted within domestic, commercial industrial consumer and street lighting categories.

Distribution of Electricity Consumption among Consumer Categories



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Percentage Consumption of Consumer Categories





LCPDP 2010 AND 2013

- In 2010, the Kenyan Government released the Least Cost Power Development Plan (LCPDP) which saw the return of coal into Kenya's future electricity generation mix and, for the first time, the entry of nuclear power.
- It was heavily influenced by the vision 2030 which aimed to transform Kenya into a middle income economy by 2030 through:
 - Universal electricity access by 2022.
 - 10% GDP growth rate from 2010.
 - Inclusion of flagship projects which had the objective of increasing economic growth.
 - Increase energy security.



LCPDP 2010 and 2013

- In 2013, an update to the LCPDP 2010 was released.
- The methods and assumptions used in the LCPDP 2010 were largely similar to those in the 2013.



Differences between LCPDP 2010 & 2013

LCPDP 2010	LCPDP 2013
8%, 9% and 10% for GDP growth rate in the year low, reference and high demand growth rate scenarios respectively	6%, 10% and 12% for GDP growth rate in the year low, reference and high demand growth rate scenarios respectively
Assumption of 100MW suppressed demand	Assumption of 200MW suppressed demand
Domestic Load forecast divided into categories based on income	Domestic Load forecast divided into categories based on income and region
Results indicate a requirement for 2,420MW of coal in the reference case by 2030	Results indicate a requirement for 2,000MW of coal in the reference case by 2030
Completion dates of flagship projects between 2014 and 2021	Completion dates of flagship projects between 2014 and 2033

Commercial Industrial Load Forecasting



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- Due to sparse data a bottom up approach could not be used to conduct the electricity demand forecast in the commercial industrial sector.
- Inputs to the forecast are electricity consumption growth rate and GDP growth rate. The equation below was used to calculate the coefficient used to forecast demand.

Coefficient = electricity consumption growth rate/GDP Growth rate.

- An additional input are flagship projects which are to be implemented by the government to enhance economic performance.
- Consumption by flagship projects are estimated and added to the energy forecast.



A word on GDP Growth Rate

Year	LCPDP 2010 (%)	LCPDP 2013 %	Actual (%)
2010	4.5		5.8
2011	5.4		4.4
2012	6.3	4	4.6
2013	7.2	6	4.7
2014	8.1	8	5.3
2015	9	10	5.7
2016	9	10	5.8
2017	9	10	4.9
2018	9	10	5.8
2019**	9	10	6.1

More on GDP growth rate

- A 10-year moving average of GDP growth rates of 217 countries in the World Bank's data base from the year 1990-2016 reveals that only 17 countries were able to attain GDP growth rates of 10% or higher for a 10 year period.
- Further, only 39 out of 217 countries attain a GDP growth of 8% and over indicating that even the low growth scenario is overly optimistic.
- Utilisation of high GDP growth rates for the forecasts presents a compounding error that occurs throughout the modelling horizon and serves to inflate the demand forecasts.
- An average of a 10 year moving average of Kenya's average GDP growth yields 5.82%.

The Assumptions

- According to the Power Generation and Transmission Master Plan 2015, the correlation between the electricity consumption growth rates and the GDP growth rate is much lower than that conducted using absolute values of GDP and electricity consumption.

The Assumptions

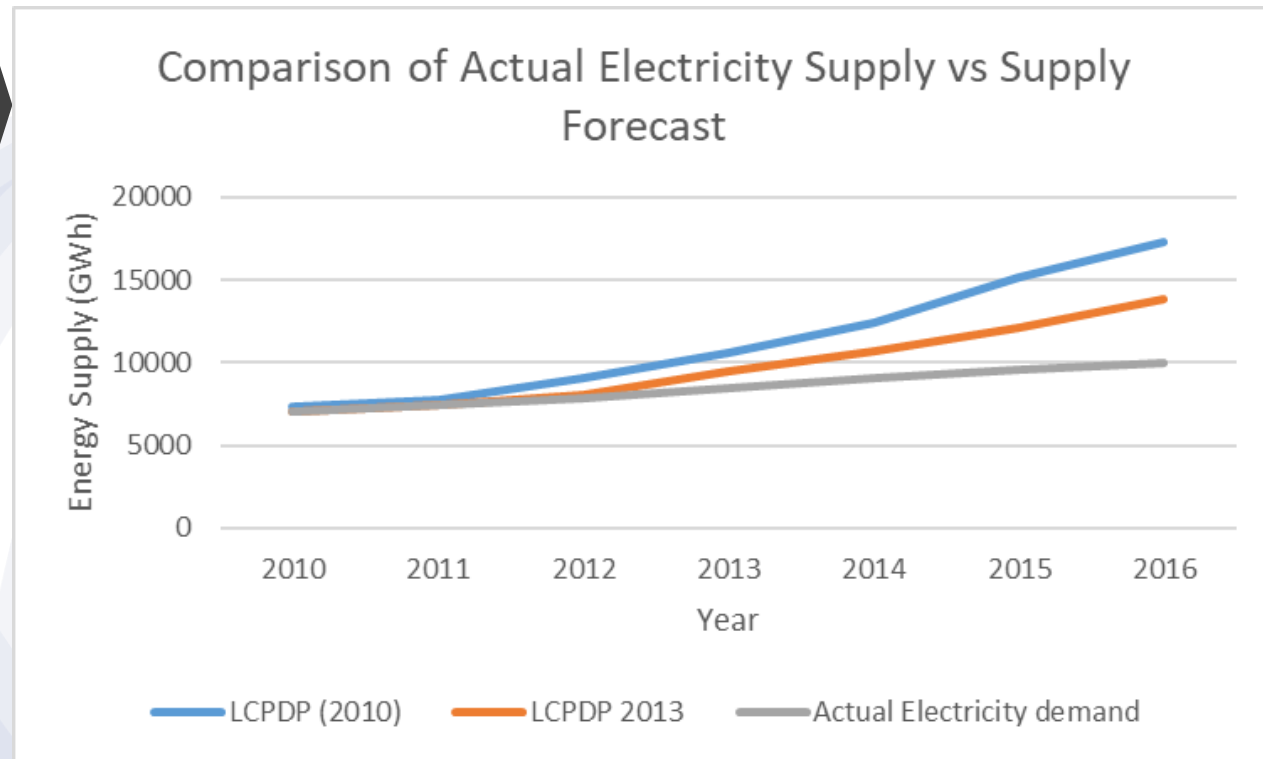
- Regression analysis conducted using 20 years of electricity consumption data reveals the following:

Regression Data	P Value
Electricity Consumption Growth rate vs GDP Growth rate	0.26
Electricity consumption vs. GDP	(4×10^{-18})

- This non-correlation could also be the cause for inflated electricity demand in the LCPDP 2010.



Comparison of actual and projected supply





**Error
Between
Actual and
Forecasted
Electricity
Demand in
2016**

Plan	Error
LCPDP 2010	58%
LCPDP 2013	84%



Back to the Question

“Do we need Coal?”

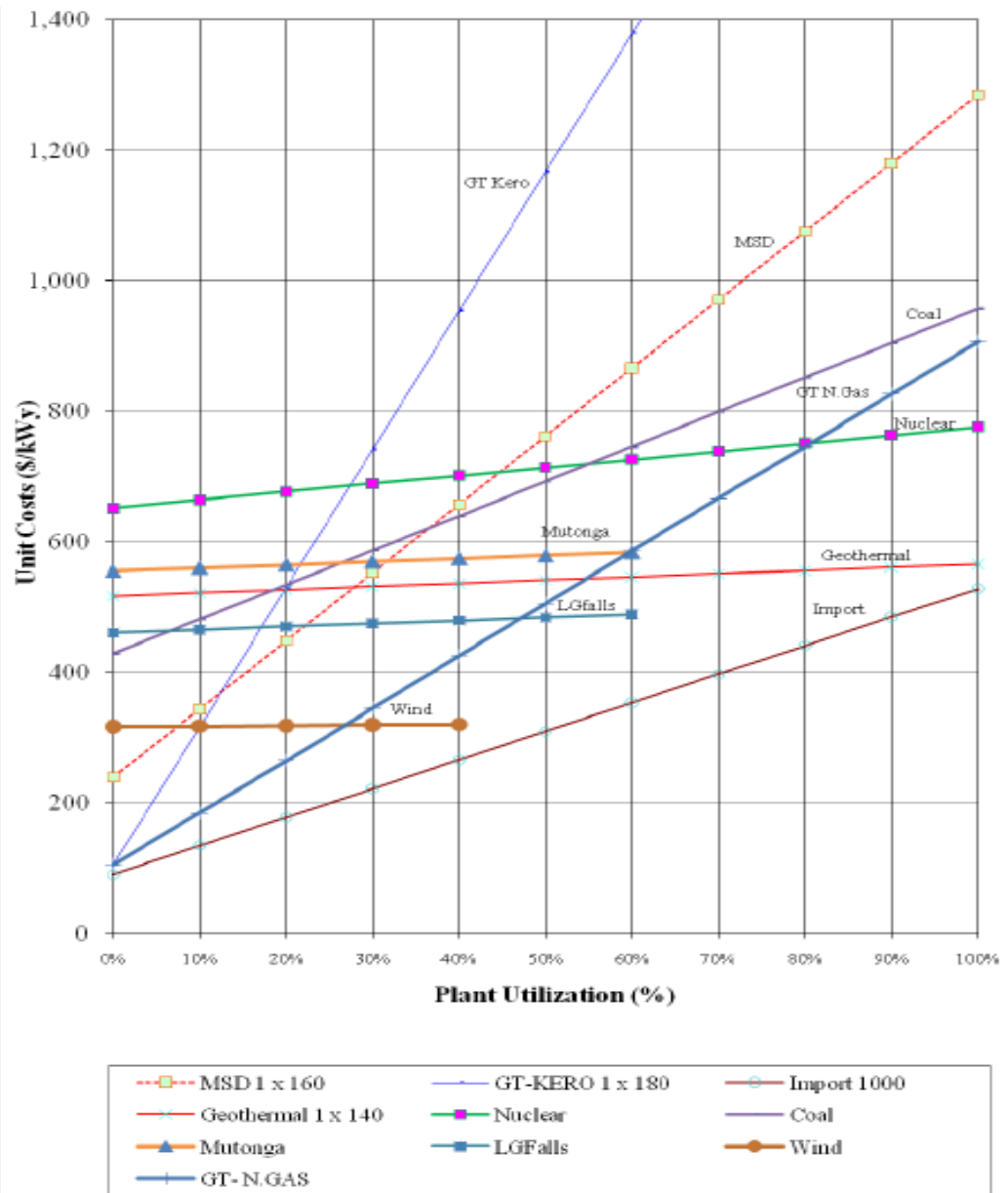
- The LCPDP 2010 notes that coal is more expensive than local resources geothermal and wind and therefore local resources should be used as much as possible.
- The government in an article published in the Standard Newspaper say that electricity demand was not growing as fast as was expected and therefore decide to slow down the implementation of the 5000MW+ project.
- The Power Generation and Transmission master plan notes that if coal was not forced into its model it would only be required towards 2035.



Alternative Sources of Energy

Resource	Capacity (MW)	Potential (MW)
Geothermal	663	7000
Hydropower	818	1484
Solar	40.25	4-6 kWh/m ² /day
Wind	336	4600
		12,000
Thermal*	776.5	
Biogas	2	unmeasured
Cogeneration	26	300
	2661	

A snippet on the Economics



Recommendations

- Data should be collected that would enable load forecasting using a bottom up approach.
- Methodology of load forecasting in the country should be improved.
- The decision of coal should be postponed until such a time as Kenya's electricity demand reflects the need.