OBJECTION TO THE GRANTING OF A LICENSE BY THE ENERGY REGULATORY COMMISSION FOR THE 3X350MW COAL PLANT AT LAMU:

AN ASSESSMENT OF THE TECHNICAL, ECONOMIC AND SITE EVALUATION THE COAL PLANT

by Hindpal S. Jabbal

(Former Chairman ERC)

1. About the Author

Mr. Hindpal Singh Jabbal is an authority in Kenya's power system, who joined EAPL (now Kenya Power) in 1961. He gradually rose to the position of Corporate Planning Manager (1979) before taking an earlier retirement from KPLC in 1987.

After leaving KPLC, he was appointed General Manager of a utility in the West Indies (1987 to 1991). He was then appointed Technical Advisor to the Ministry of Energy (1998 to 2004) under World Bank Funding and finally he was made Chairman of the Energy Regulatory Commission (2007).

Over the past few years, especially since 2008, when Vision 2030 was launched, he has made several presentations in the international conferences like EAPIC and IRENA and has published several articles in the local press including *Kenya Engineer* and the *Journal of Institution of Engineers of Kenya* (IEK).

Mr. Jabbal has been a strong opponent of the coal plant in Kenya, including the one at Lamu, mainly because of technical, economic and site considerations.

2. General background on Least Cost Planning and coal plants in Kenya

From 1963 up until 1997, all Least Cost Power Development Plans (LCPDPs), and feasibility studies were prepared by international consultants appointed competitively, mainly funded by World Bank.

In 2004 a 20 year LCPDP (2004 to 2024) was professionally prepared for the first time by KPLC with input from KenGen and some guidance from me, when I was in the Ministry of Energy. This plan was based on "reference" load growth of 6% (with "low" of 5% and "high" of 7%). There was no mention of any coal plant in this plan, and average growth in demand between 2005 and 2009 was precisely 5.5%.

After I had left the Ministry, another 20 year LCPDP was prepared in 2005 with very high load growth scenario of 12%. A 150MW coal plant appeared for the first time to be installed at Dongo Kundu, near Mombasa in 2009, for which a feasibility study had been undertaken by an international firm of consultants.

In 2007, yet another 20 year LCPDP was prepared by FICHTNER of Germany as part of a tariff study based on 8% growth. The completion of 150MW coal plant at Mombasa was moved to 2011.

Electricity tariff was finally approved in 2009 after I had been appointed Chairman of ERC in 2008, based on mid-term LCPD (2008 to 2013) at 7% growth. By that time the coal plant at Mombasa had been removed from the plan.

After the launch of Vision 2030 in 2008, another 20 year LCPD (2009 to 2029) was prepared, with a "reference" growth rate of 11.5%. Based on this plan, 2X150MW coal plant again featured to be installed at Kilifi in 2017 for which a feasibility report had been initiated.

And finally, after the launch of 5,000MW Prospectus launched in September 2013, another 20 year LCPD (2012 to 2032) was hurriedly updated at 15% growth rate. Based on this plan, tenders for 3X320MW coal plant were invited in early 2014 to be installed at Lamu, without any feasibility report for the project. The contract was finally awarded to Amu Power Company in September 2014 which forms the basis of this report.

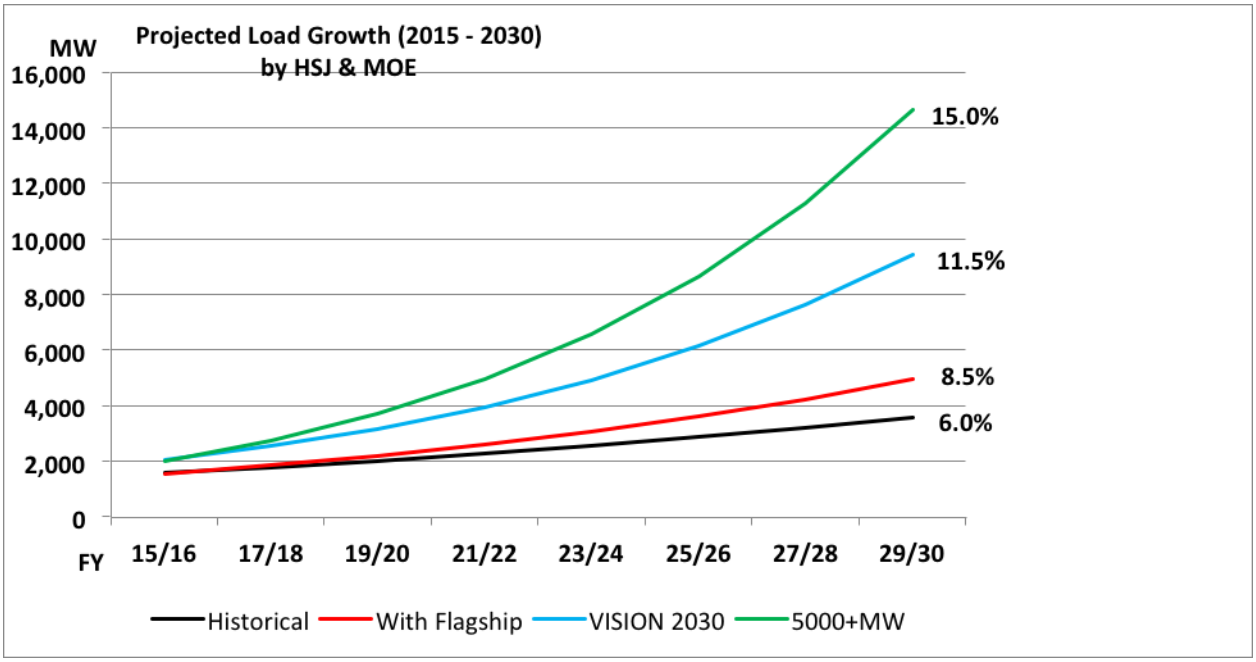
3. Peak demand (MW) projections based on various load growth scenarios

Since 2008 I have been consistently projecting base load growth of 7% (without flagship projects) and 8.5% (with flagship projects).

Recently Lahmeyer of Germany was commissioned by African Development Bank to prepare a medium-term generation and transmission plan (2014 to 2019) to assess the viability of Lamu coal plant. They came up with load growth projections of 10% between 2004 and 2019, and 8% beyond 2019, to give an overall growth rate of about 9% (between 2014 and 2030). This is very similar to what I have been projecting since 2011 for all my studies on the power sector.

Figure 1 below gives the peak demand (MW) projections between 2008 and 2030, based on different load growth scenarios ranging between 6% (the historical growth) to 15% (as projected by MoE for the 5,000MW prospectus). Both I and Lahmeyer have projected an average load growth of 8.5% and 9% respectively, which are still quite generous by any international standards, as benchmarked by them in their Medium-Term Report.

As observed from the graph below, peak demand as projected by both Lahmeyer and I will be around 5,000MW in 2030, and not between 10,000MW-15,000MW as projected by MOE. Lamu Coal Plant of 960MW capacity was tendered in 2014 on very high grow scenarios which cannot be realized. And therefore this Coal Plant is a misfit in the more realistic demand scenario of 9% growth.



4. Size of each Machine for the Lamu coal plant

For security of supply and best industry practices, the size of any single machine operating on base load at high capacity load factors (above 0.7), must not be more than 10% of base load and 5% of peak demand.

In accordance with load projections as given above, the size of a single machine of coal plant must not be higher than 150MW if installed in 2020, or 200MW if installed in 2025, or 300MW if installed in 2030.

Hence the size of Lamu coal plant, if ever installed in 2020, must not be more than 2X150MW, and **NOT** 1X320MW as is being proposed in certain quarters.

5. Site location of coal plant at Lamu

Apart from environmental and land issues, the coal plant has three other major drawbacks if installed at Lamu. First, harbour/jetty and coal storage facilities must be built at Lamu at a total estimated cost of US$360 million. Second, a 400kV transmission line between Lamu and Nairobi must be built to evacuate 1,000MW of power upcountry, at an estimated cost of US$270 million. And third, if coal is exploited in Kitui in commercial quantities to be used for the Lamu Coal plant in future, then a 300km railway line must be built between Kitui and Lamu at an estimated cost of some US$1.5 billion.

6. Electricity Tariff Structure of the Lamu coal plant as proposed in the offer.

The following details were provided by Amu Power Company in the PPA (Power Purchase Agreement) attached with the application to ERC for grant of license to generate electricity at Lamu.

Size of coal plant	=	3X350MW
Total installed capacity	=	1,050MW
Contractual generation output	=	981MW
Contractual capacity factor	=	0.85
Energy available at 0.85 CF	=	7,308GWh
Period of contract	=	25 years

Electricity tariff will be in two parts;

Annual fixed capacity charges will be based on US$/kW/yr for the contractual supply of 981MW, irrespective of the capacity factor of dispatch. **OR**

on **"Take or pay"** basis in UScts/kWh for the total contractual energy available at 0.85 capacity factor, i.e. 7,308GWh per annum, irrespective whether this energy is dispatched or not.

Both alternatives amount to the same figure, except the second one is merely to confuse the issue.

Variable energy charges (pass through) will be based on consumption factor of 0.427kg/kWh, calorific value of coal at 21,000kJ/kg, and assumed landed price of coal on site at US$ 50 per ton.

Any variation on these figures are passed on to Kenya Power at the time of delivery, including price of fuel which is currently about US$99 per ton landed in Mombasa as advised by a cement manufacturer.

Site location: the power station is located near Lamu at the end of LAPSSET corridor, on an 865acres plot to be leased by GoK/KPLC for a 25 year period.

Port facilities: all port facilities, including deep harbour and jetty (approximately US$300 million as estimated by Lahmeyer) for importation of roughly 3 million tons of coal per annum will be the responsibility of GoK/KPLC.

Transmission line: the 400kV transmission line between Lamu and Nairobi (approximately US$270 million as estimated by Lahmeyer) to evacuate 1,000MW of power will be the responsibility of GoK/KETRACO.

7. Electricity tariff as proposed in the PPA

Based on the above, tariff structure and tender prices as offered by Amu Power Company are as follows;

AS TENDERED by AMU POWER IN 2014

Based on capacity factor of 0.85 and coal price of US$50/ton

Annual capacity charges

	Capacity charges in US$/kW/yr	Converted to UScts/kWh at 0.85 CF
Basic capacity charges fixed	289	3.881
Basic O&M charges (Escl.)	80	1.074
Total capacity charges	**369**	**4.955**
Contracted capacity @0.85CF	981MW	7,308GWh
Annual fixed charges on full capacity	US$ 362mil/yr	US$362mil/yr

(In other words, US$362 million must be paid every year as capacity charges irrespective of power dispatch)

Variable energy charges	**UScts/kWh**
Fuel costs based on US$50/ton and consumption factor of 0.427kg/kWh	2.137
Variable energy charges (Escalated)	0.125
Total variable charges	**2.262**

Total charges @0.85LF and assumed coal price of US$50/ton **7.12**

(As stated earlier, the fuel prices are only indicative at the time of tender award in 2014. The actual price will be paid based on coal price ruling at the time of delivery)

TARIFF AS AT TODAY (OCT 2016)

Based on capacity factor of 0.75 and coal price of US$100/ton

Annual capacity charges

	Capacity charges in US$/kW/yr	Converted to UScts/kWh at 0.75 CF

Basic capacity charges fixed	289	4.40
Basic O&M charges (+10%)	88	1.27
Total capacity charges	**377**	**5.67**

Variable energy charges

	UScts/kWh
Fuel costs based on US$100/ton and consumption factor of 0.427kg/kWh	4.27
Variable energy charges (+10%)	0.14
Total variable charges	**4.41**

Total charges @0.75LF and assumed coal price of US$100/ton	**10.08**

(Kenya Power will be required to pay UScts10.1/kWh for Lamu coal plant at today's price of coal at US$100/ton and expected capacity factor of 0.75 and NOT US$7.5/kWh as Amu Power Company has been falsely claiming at various forums and press releases).

8. Levelised electricity cost of various generation candidates in Kenya

In the latest mid-term plan, Lahmeyer have given the following long-term average levelised costs in UScts/kWh for various generation plants at 10% discount rates and available operating capacity factors.

Rank	Type of Plant	Size (MW)	Available CF	Per unit cost UScts/kWh	Remarks
I	Ethiopia Interconnection	400	0.70	7.0	Transmission cost not included
II	Geothermal (Wellhead)	14X5	0.90	7.5	
III	Geothermal (Conventional)	2X70	0.90	8.5	
IV	Wind (Turkana)	310	0.55	9.0	Transmission line at US$210 million included
V	Wind (Others)	50	0.36	11.0	
V	Coal Plant at Lamu (Amu)	3X327	0.75	11.0	Transmission line at US$270 million included
V	Coal Plant at Kitui	3X320	0.75	11.0	Coal storage facilities at US$60 million included
VI	LNG/CC at Wajir	700	0.75	12.0	Transmission line at US$250 million included
VI	Solar PV (Generic)	10	0.25	12.0	Does not provide any firm capacity, only energy
VII	Coal plant at Lamu (Generic)	3X320	0.75	12.5	Transmission line at US$270 million plus port facilities at US$360 million included
VIII	High Grand Falls (Hydro)	500	0.35	15.0	Transmission line at US$110 million included
IX	Nuclear	600	0.85	17.0	Transmission line at US$250 million included

In terms of per unit costs, Coal plant at Lamu is ranked at fifth (without port facilities) and eighth (with port facilities) position after Ethiopia interconnection, Geothermal, and Wind. Taking into account the port facilities, only the High Grand Falls and Nuclear are more expensive.

9. "PESTEL" Analysis

In their medium-term plan (2014 to 2016), Lahmeyer has also done the "PESTEL" (Political, Economic, Social, Technical, Environmental and Legal) Analysis for the candidate generation plant as follows;

TYPE OF PLANT	POLITICAL	ECONOMIC	SOCIAL	TECHNICAL	ENVIRONMENT	LEGAL
ETHIOPIA I/C	++	+	0	++	0	0
GEOTHERMAL	++	++	0	++	+	-
WIND	++	+	0	+	+	+
HIGH GRAND FALLS	+	+	-	++	-	0
LNG Wajir	+	+	0	+	+	0
COAL	+	0	-	0	-	-

++ VERY GOOD

+ GOOD

0 SATISFACTORY

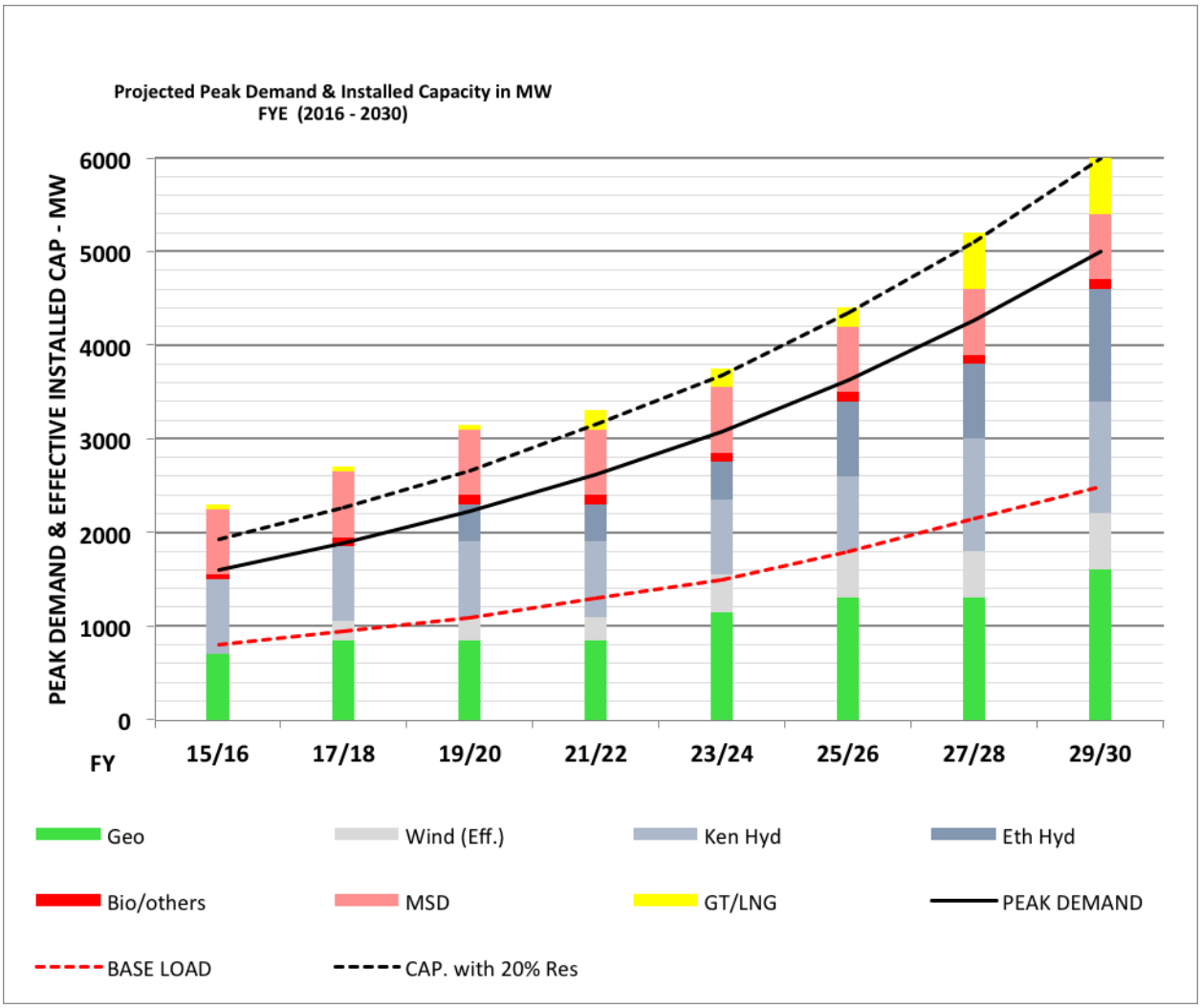
- SUFFICIENT

- - INSUFFICIENT

Again, according to Lahmeyer, coal plant rates bottom on "PESTEL" Analysis.

10. Proposed LCPDP (2015 to 2030)

The following Least Cost Plan is based on all factors considered above and load growth of 8.5% to include all flagship projects as in the Vision 2030.



As observed from the above Least Cost Plan, shown graphically, the entire demand for the country right upto 2030 can be met economically by renewable energy resources available to the country, including hydro imports from Ethiopia, with a lot of geothermal and wind capacity still untapped. Thermal plant will only be used sparingly as a stand-by plant.

As such there is no place for coal plant at Lamu to be installed for the next 15 years.

11. Conclusions

Based on all technical, economic, site location, social and environmental considerations, Lamu Coal Plant of 3X327MW capacity (or even 1X327MW capacity), cannot be justified for the next 15 years. The contract with Amu Power Company for installation of coal plant at Lamu should therefore be terminated forthwith, or completely reviewed, and no generation license be issued by ERC for the time being.

In the meantime exploration and mining of coal in the Kitui area should continue and coal so exploited, be used for industrial purposes in the cement and mining industries. In future it can also be used for power generation in the vicinity of mining areas.

The sector should continue with the development of enormous geothermal and excellent wind resources to meet the base load demand for Kenya upto 2030. Kenya's own hydro resources and those imported from Ethiopia should be used to meet the variable load. Thermal plant (currently MSD and in future LNG gas turbines) should only be used as a standby plant to meet the peak demand and provide back-up to the hydro resources in extremely dry weather conditions.

PV Solar power should only be used for off-grid supply in small quantities to provide lighting load in rural areas. In future, thermal-solar or hybrid bio/solar, which can supply both capacity and energy, can be used for grid as well as off-grid supplies.

HSJ 25/10/2016