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PLANNING LARGE SCALE GEOTHERMAL DRILLING IN KENYA

Paul K. Ngugi
Geothermal Development Company Limited
Nairobi
KENYA
pngugi@gdc.co.ke

ABSTRACT

Two large scale drilling projects are currently underway in Kenya and one is scheduled to commence soon. The 280 MW Olkaria I & IV entails drilling of 62 wells most of which have already been drilled proving over 360 MW. The 400 MW Menengai Phase I projects aims at 120 steam and re-injection wells, five of which five have been drilled and 800 MW Bogoria – Silali phase I in which 200 wells are scheduled to be drilled. Altogether, Kenya seeks to drill about 400 wells by 2019.

The national least cost power development plan requires that geothermal develop at least 5000 MW additional capacity by 2030.

1. INTRODUCTION

Kenya is currently undertaking two large scale drilling projects. The 280 MWe Olkaria I & IV that has a drilling scope of 62 wells where five rigs have been used at one point. About 59 wells have been drilled proving steam in excess of 360 MW. The 400 MWe seeks to drilling 120 wells using six rigs, two of which are on the project location, two are to be delivered soon and the balance will be delivered early 2013. In addition, the third 800 MWe project is scheduled to commence soon which aims at the drilling of 210 wells using 8 rigs by 2018/19.

2. NATIONAL PLANNING

Since 1996, Kenya has been undertaking power studies that are frequently updated culminating into a 20 years national least cost power development plan (LCPDP). The current study is an update focusing of the period 2012 – 3031 (Energy Regulatory Commission, 2011). It is in particular aligned to the aspiration of Kenya Vision 2030 which aims to transform the country to middle income by 2030. The LCPDP is prepared under the Ministry of Energy, coordinated by the Energy Regulatory Commission with participation by key National agencies including staff from the Ministry of Energy, the national power utility, Kenya Power & Lighting Company Limited, the leading power generator, KenGen, GDC and Kenya National Bureau of Statistics. In summary, the studies forecast demand through evaluation of various alternative sources of power, carry out an economic analysis of each alternative by optimization and rank the alternatives based on their expected bulk tariff prices, the cheapest ranking highest. The most economic plan is then developed matching demand to most practically feasible plan to implement giving priority to the cheapest alternative to be implemented

first. Table 1 shows demand projection. It is anticipated that the peak demand will grow from the current estimate of 1,200 MW to about 16,905 MW.

TABLE 1: Load forecast

YEAR	LOW SCENARIO			REFERENCE SCENARIO			HIGH SCENARIO		
	GWh	MW	Load factor	GWh	MW	Load factor	GWh	MW	Load factor
2010	7,296	1,227	67.88%	7,296	1,227	67.88%	7,296	1,227	67.88%
2011	7,729	1,293	68.24%	7,775	1,302	68.16%	7,943	1,331	68.11%
2012	8,967	1,498	68.35%	9,084	1,520	68.21%	9,458	1,584	68.14%
2013	10,335	1,723	68.49%	10,560	1,765	68.32%	11,224	1,877	68.25%
2014	11,985	1,993	68.64%	12,376	2,064	68.44%	13,396	2,236	68.38%
2015	14,516	2,398	69.10%	15,155	2,511	68.90%	16,644	2,760	68.83%
2016	16,298	2,693	69.10%	17,300	2,866	68.91%	19,344	3,207	68.86%
2017	18,507	3,053	69.19%	19,902	3,292	69.02%	22,650	3,749	68.97%
2018	20,660	3,408	69.20%	22,685	3,751	69.04%	26,128	4,322	69.01%
2019	23,014	3,796	69.21%	25,512	4,216	69.08%	30,069	4,970	69.07%
2020	25,591	4,220	69.23%	28,795	4,755	69.13%	34,537	5,703	69.14%

Figure 1 depicts the current screening curve which is an economic representation of the various alternative power sources available for Kenya. It indicates that geothermal source is the only competitive for load factors exceeding 60% and is therefore best suited for base load power.

Table 2 represents the current least cost power development plan that matches power plants to the projected demand taking into consideration probability of the additional new plants to be implemented and retirement of the old ones. It is anticipated that the increased demand will be met by installation of additional capacity from Geothermal sources (5,000 MW), and from various other sources of energy including imports, nuclear, coal and hydro.

The studies also put in place plans for evacuating the power to be generated. The resulting document is used for sector coordination by ensuring that all value chain work is synchronous and for prioritization of various alternative projects not only for access to the market but also financing by government and donors is attained.

3. STRATEGIC PLANNING LEVEL

Geothermal is the most economic option for Kenya and is therefore the preferred option for development. This has been the case since 1996 when the first least cost power development plan was prepared. Despite this being the case, development in the sector has been very slow. The slow development has been attributed to large upfront capital requirement, high upstream resource risks, limited financing for exploration drilling, long gestation period and lack of drilling equipment in the country. The Government has now prioritized geothermal development and has mandated GDC to accelerate development. To achieve the desired development at an accelerated pace various strategies are being developed and implemented.

3.1 Facilitation of independent power producer (IPP)

The Government recognizes that without public and private investor participation, it will be impossible to realize the desired level and pace of development of geothermal in the country. As such there has been strategy change that has led to formation of GDC. GDC's business model deviates from the previous public dominated development of facilitating private sector entry as a way of

mobilizing development capital. GDC's immediate strategy is to avail as much steam and as quickly as possible which will be sold to the IPP (Figure 2). Tremendous expression of interest to construct power plants has made large scale drilling feasible. In addition, ownership of the resource remains with the Government. The importance of these factors is that many different IPPs can tap the same reservoir with good management hence having much parallel development.

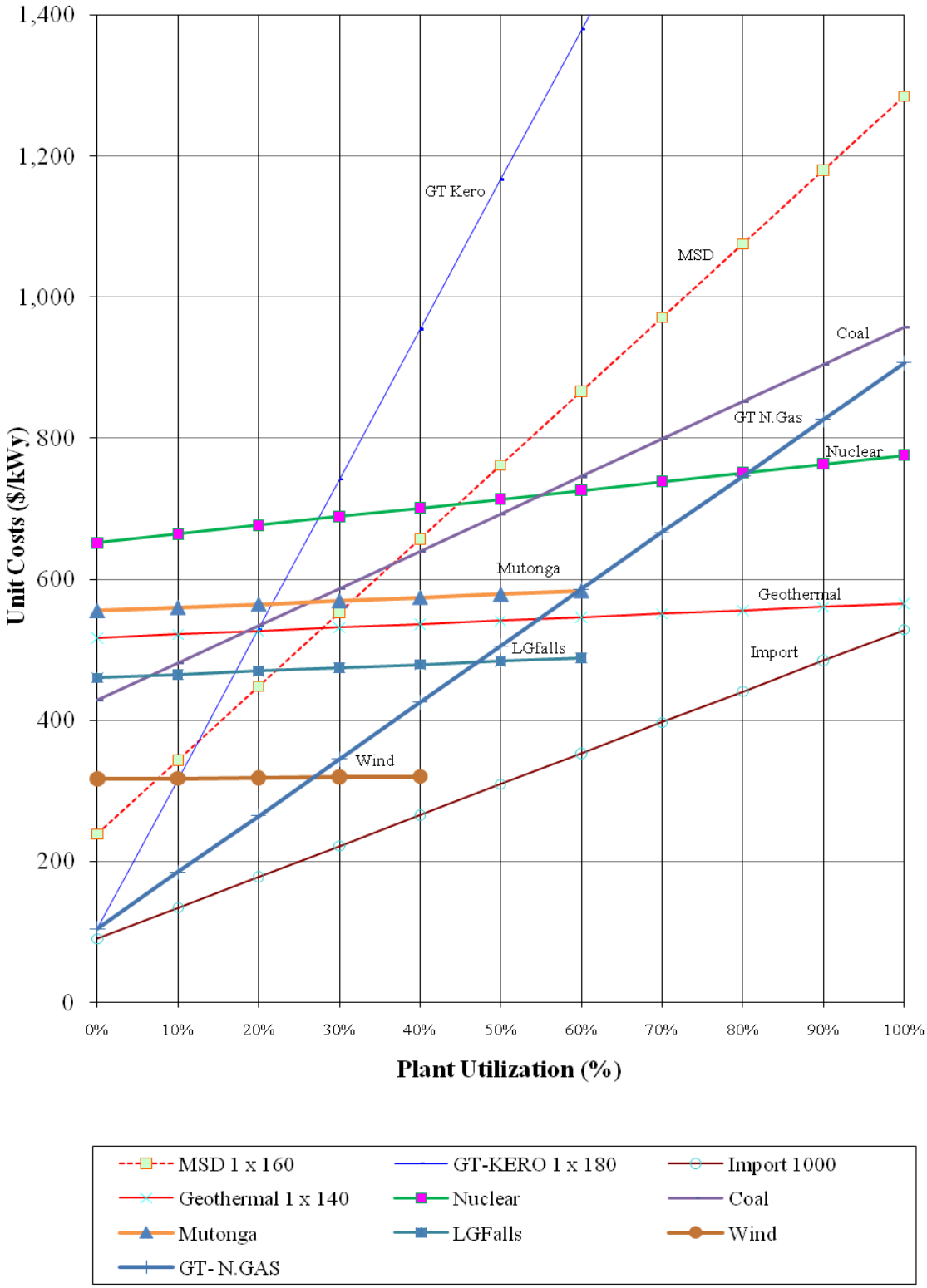

FIGURE 1: Screening curves

TABLE 2: Least cost expansion plan

Year ending 30th June	Configu-ration				Capital cost (Mln US$)	Type	Added capacity MW	Total capacity MW	System peak MW	Reserve margin MW	Reserve margin as % of peak
2010								1,363	1,227	136	11%
2011	1	×	10	TANA		HYRO	20				
	12	×	10	KIP3	156	MSD	120	1,503	1,302	201	15%
2012	1	×	2.2	EBURRU		Geothermal	2				
	1	×	5	OLKWH		Geothermal	5				
	2	×	10.3	SANG	78	HYDRO	21	1,531	1,520	11	0.7%
2013	10	×	16	AEOLUS		WIND	160				
	5	×	16	TRIUMPH		MSD	81				
	5	×	17	GULF		MSD	84				
	5	×	17	MELEC		MSD	87				
	7	×	5	OLKWH		Geothermal	35				
	3	×	7	WIN1		Ngong 3	21	1,999	1765	234	13%
2014	2	×	70	OLK4		Geothermal	140				
	353	×	0.85	LTWP		Turkana	300				
	1	×	-30	KGT1		Gas Turbine	-30				
	1	×	-30	KGT2		Gas Turbine	-30				
	2	×	26	OLK3		Geothermal	52				
	5	×	10	OSIWO		WIND	50				
	1	×	200	IMPORT		HYDRO	200				
	7	×	5	OLKWH		Geothermal	35				
	1	×	32	KIND		HYDRO	32				
	2	×	70	OLK1-4&5		Geothermal	140	2,888	2,064	824	40%
2015	3	×	-15	OLKI		Geothermal	-45				
	1	X	25	SMHY		Hydro	25				
	2	×	140	GEOT	1022	Geothermal	280				
	1	×	20	ARM		Coal	20	3,168	2,511	657	26%

3.2 Government funding resource assessment

Kenya experimented by granting concession for green field without success. This is primarily due to the fact that cost of resource assessment estimated at about 100 million US$ for Kenya was way beyond what many private entities would raise for a high risk venture. Financial institutions will also not finance this phase of development due to the perceived risks that may jeopardize their investment. On the contrary, the Government has in the same period developed over 380 MWe worth of steam in two fields. The effect of the Government intervention is that the country has been able to attract funding to the tune of 1.3 billion (Ngugi, 2012). The large sum of money has made it possible to undertake the large scale drilling operations with limited financial strain. In addition, over 19 private investors have expressed interest to develop geothermal in various fields in Kenya after GDC has committed to undertake resource assessment. GDC and the Government are amassing funds to open a third field in order to take advantage of the large interest expressed by privates sector. Continued Government financing of resources assessment is therefore imperative.

3.3 Integration of modular generation units for early power generation

At Olkaria today, 385 million dollars has been sunk in drilling 59 wells over a period of five years. Unless early power generation is employed, the assets will remain idle for the next two years as the power plants are constructed. Any wise investor in this circumstance would wish to stop further

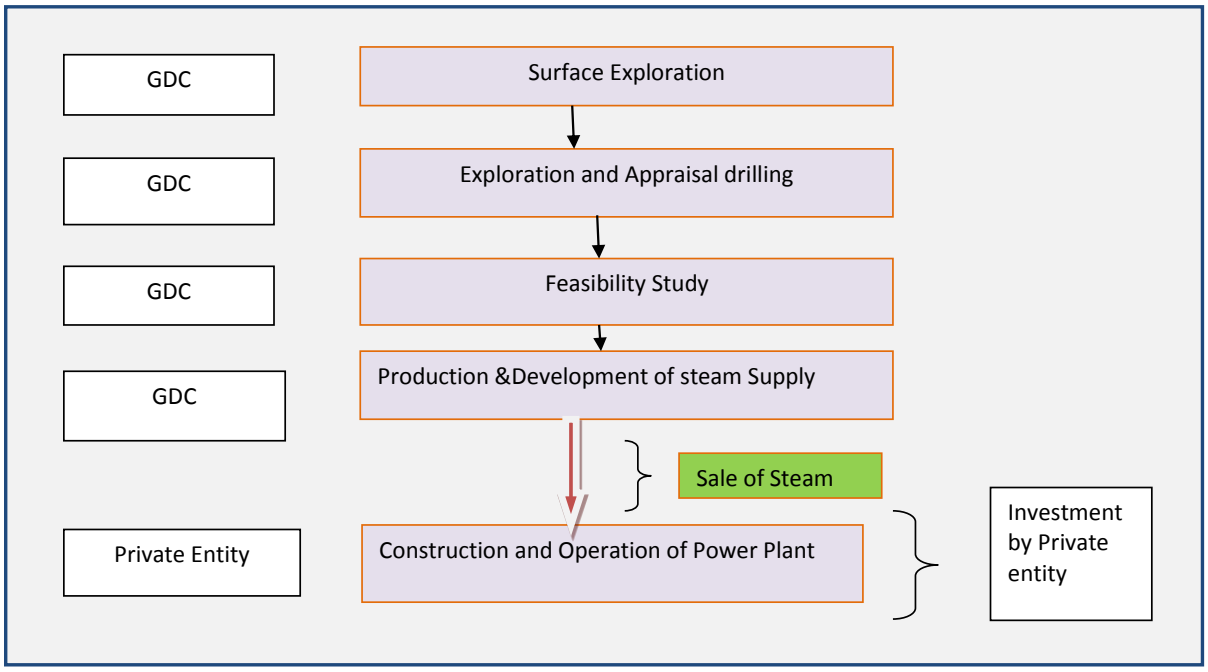

FIGURE 2: GDC business model

drilling until the available steam is put to use after commissioning of the plant. However, integration of early power generation using modular units will not only provide power early for the nation but also generate revenue for the project and the assets (wells) will not be idle. The gestation period of the project will be greatly reduced and investor will be more confident with further drilling.

3.4 National human and equipment capacity

Kenya has undertaken detailed surface studies on most of its 14 prime prospects and continues to update the studies through infill work. The greater understanding of the fields has empowered Kenya geoscientist and engineers who are driving the geothermal development in terms of making decisions. These national human resource and equipment capacity has been instrumental in undertaking large scale drilling. In addition, the study documents are used by financiers as a basis for evaluating financial proposals for a specific field.

Kenya already possesses 5 rigs and is scheduled to acquire 4 more in the next one year. This rig capacity will enhance drilling in opening up green fields as well as increasing the drilling pace for ongoing projects.

4. OPERATIONAL LEVEL

4.1 Project preparation

For any of the green fields, the Government through GDC endeavors to finance the field opening activities. These include rights to access project area, the environmental permit to undertake the envisaged development, the construction of the main access road, installation of water reticulation system, and drilling of exploration and appraisal wells. Acquisition of land rights, environmental license and a successful exploration wells are strong framework by which external financing is solicited. At this level of development, Kenya has observed that both financing institutions and IPP are willing to commit financing for further development. It takes about two years to prepare a project to this level of development.

4.2 External funds mobilization

Kenya has found it very useful to prepare a development concept note for each of its projects. The concept note will detail the project objectives and scope, the approach to development, basic roles and responsibility of various major parties anticipated in the project, a project budget, time schedules, proforma income and cash flow statements based on derived or assumed bulk supply tariff and preliminary project appraisal in terms of its break even and pay-back period (Figure 3). This information memorandum helps financial institution field staff most of whom are non-technical to appreciate the project and conduct the initial consideration for financing of the project. Supported by a positive detailed surface study document, an environmental and social license, land rights and a discharging discovery well with sound financial projections, financial institutions will be keen to support projects.

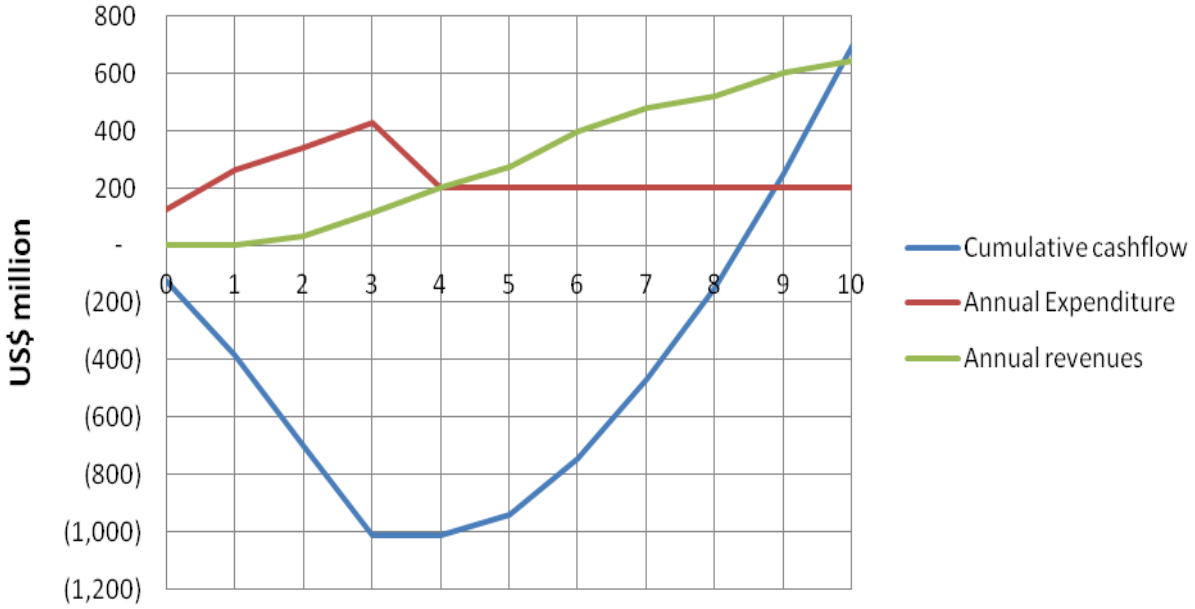

FIGURE 3: Cash flow projection

4.3 Procurement of drilling hardware and consumables

Kenya procures it drilling equipment, hardware and consumables from overseas mainly China, Japan and United States of America. Procurement lead time at about six months for most goods but casings could take a year. The long procurement lead times pose serious challenges to large scale drilling. For this reasons, Kenya aims at bulk purchases.

4.4 Infrastructure

Each drilling rig requires a minimum of 2000 lt. a minute of drilling water. Drilling activities employing three rigs or more on one project site will poses great challenge to adequately provide drilling water. Kenya has several large water bodies within the development areas. Where feasible, these water bodies have come in handy. However, boreholes are also being used to provide water. In order to manage the water situation, large reservoir water tanks (Figure 4) have been built. In addition, use of brine for drilling is becoming a common option to alleviate the need.

FIGURE 4: Water reservoir tanks at Menengai

4.5 Well siting

During exploration, appraisal and in the early production phases, the resource is not delineated. At this point of development subsequent wells are sited based on information obtained from the previously drilled wells. It is not uncommon to change new well site at short notice. Rigs require drilling pad that take on average about 2 months to construct. Such short notice of change of location can result in rig idle time waiting on pads, access road and water to be made available. This challenge is aggravated when two or more rigs are on project location. To manage this situation additional resources are necessary to prepare alternative pads in parallel. Multi-well drilling pad coupled with directional drilling is also a strategy being employed to reduce pressure on drilling pad construction and the risk of drilling multiple dry wells.

4.4 Staffing

As a result of 5000 MWe development goal, for a 12 rig operation, Kenya will require to develop a 1000 strong technical team ranging from scientists and engineers to drilling crew and field and laboratory technicians, who will be involved in the geothermal resources development. Kenya has had only one rig operation team numbering about 200 people in the resource development. This team has formed the backbone of the geothermal resourced development expansion plan that the Country is undertaking. There is however a capacity gap that requires to be speedily filled.

As a policy, critical members of the rig crew are being employed one year ahead of rig delivery. The employment lead time allow the staff to be inducted and trained. Kenya is employing enhanced skills development approaches to meet the skills gap especially on-the-job and group trainings rather than individual training. Kenya has further entered into collaborations with training institutions most importantly the United Nations University – Geothermal Training Program in Iceland to facilitate enhanced training. Further, expertise brought into the country to fill in skill gaps enjoins training as a deliverable so as to enhance on-the-job training.

4.5 Coordination

Large scale drilling puts great demand to management and carries higher probability of making wrong and expensive decisions. Regular management meetings are held to review plans, stock inventory, well siting, conceptual model update and drilling operations.

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