Development Phases of Olkaria IV Geothermal Power Plant Project.

A Case of Kenya Electricity Generating Company PLC

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Introduction

- Geothermal projects are distinctive in nature and their development involves various phases.

- They are governed by different political, social, environmental, technological, economical and legal factors.

- Geothermal professionals consider a 5 to 10 year period from new field development to commissioning a single unit ideal.
Introduction

Development of geothermal resources can be categorized in various ways;

- Geothermal projects are categorized into four phases namely resource procurement and identification, resource exploration and confirmation, permitting and initial development and resource production and construction (GEA, 2010).

- Energy Sector Management Assistance Program, (2012) describes the phases as preliminary survey, exploration, test drilling, project review and planning, field development, construction, start-up and commissioning.
Geothermal Development Phases

1. Preliminary study (Desktop & Reconnaissance)
2. Detailed surface exploration
3. Well siting and exploration drilling
4. Appraisal drilling and well testing
5. Feasibility study & ESIA
6. Production drilling
7. Power plant design, construction and commissioning
8. Reservoir, steam field management and further development
9. Power plant operations
10. Plant decommissioning

Source: Modified from Ngugi, 2008
Olkaria IV Development Phases
Olkaria IV Development Phases

- Olkaria IV was co-financed by the Government of Kenya (GoK) through KenGen and by a series of development partners, including World Bank (IDA), Japan International Cooperation Agency (JICA), European Investment Bank (EIB), Kreditanstalt Für Wiederaufbau (KfW) and Agence Francaise de Development (AFD).

- This power station has two Units with a design rating of 74.9MW but contracted capacity of 70MW each. This station cost about $ 107M (exclusive of steam field and transmission) and was designed to have a typical lifetime of 25 years.
Client: KenGen
Consultant: Jacobs/ Previously SKM
Contractor: Toyota Tshusho and Hyundai Engineering Company
Photo: Olkaria IV geothermal power plant aerial view
Olkaria IV Development Phases

Resource Exploration - Detailed geo-scientific work for Olkaria Domes field commenced in 1992 and was completed in 1997. Three exploratory wells namely OW-901, OW-902 and OW-903 were drilled between 1998 and 1999.

Resource Assessment - Six appraisal wells were sited in 2007. Well testing of these wells was conducted concurrently with the drilling processes. The pre-feasibility study report was availed in 2009 by West Japan Engineering Consultants. In 2010, Gibb Africa Consultants conducted the Environmental and Social Impact Assessment (ESIA).
Olkaria IV Development Phases

- **Plant Construction** - Roughly, 30 production wells had been drilled at the Olkaria Domes field at the end of 2011.

<table>
<thead>
<tr>
<th>Task Name</th>
<th>Start Date</th>
<th>End Date</th>
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<tbody>
<tr>
<td>Contract Signing</td>
<td>7th November 2011</td>
<td></td>
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<tr>
<td>Performance Certificate</td>
<td>2nd September 2014</td>
<td></td>
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<tr>
<td>Steam Field</td>
<td></td>
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<tr>
<td>Construction and Commissioning</td>
<td>July 2012</td>
<td>April 2014</td>
</tr>
<tr>
<td>Power Stations</td>
<td></td>
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<tr>
<td>Construction</td>
<td>January 2012</td>
<td>June 2014</td>
</tr>
<tr>
<td>Commissioning (Both Units)</td>
<td></td>
<td>September 2014</td>
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- Prior to handing over, performance and reliability tests were done by the Contractor. The reliability run tests also included 72 hours continuous operation at not less than 95% of the unit rated capacity.
Olkaria IV Project Development Timelines
Challenges Faced and Solutions Offered
Challenges Faced

- Progress can be hampered by lack of public funding, institutional, regulatory and legal constraints, a lack of technical and human capacity, as well as economic, financial barriers among others.

- Olkaria IV was developed in approximately 22 years and faced challenges such as access to funding, stakeholder management and commissioning bottle-necks.
Challenges Faced and Solutions

- **Access to financing** - Success in geothermal project development in Kenya has relied on various financial partners e.g. government incentives, concessional funds, private equity, long term debts among others.

- Due to the complex and risky nature of geothermal projects, financiers conduct financial analysis so as to confirm project viability in terms of generating enough income to meet their initial investment.
Challenges Faced and Solutions

- In 1996, donors introduced energy sector reforms in Kenya some of which became conditional to further funding for the construction phase. Funding was approved in 1998.

- Further drilling of Olkaria IV wells did not commence until 2007 leading to an 8 year break. KenGen focused on construction of Olkaria II power plant in the year 2000 and commissioned it in 2003.

- GoK has been committed and involved making it a lot easier to attract foreign cash inflows in the later project stages where results had been proved.
Challenges Faced and Solutions

- **Land acquisition** - project site was on privately owned land belonging to Kedong Ranch. There were Maasai settlements within the land area. During community consultations it was clear that there was conflict of land ownership.

- Kedong Ranch had a leasehold title for a term of 999 years but the local community wanted entitlement to this land by adverse possession of over 12 years which is applicable under Laws of Kenya, Limitation of Actions Act, section 8.
Challenges Faced and Solutions

- KenGen acquired 3610 acres for project area thus necessitating involuntary resettlement of the local community.

- However, ahead of the General Election in 2013, local politicians encouraged residents to claim the land as a way of campaigning.

- KenGen was entangled in court battles which delayed the project. After government intervention and following several court cases, it was ruled that the local community had no legal right to occupy the land.
Challenges Faced and Solutions

- Other issues such as way leaves for power evacuation affected the commissioning of this plant. With no connection available (to Suswa), a scheme was devised that provided temporary 220kV connections to enable back-feed power from Olkaria II power station.

- KenGen therefore conducted public consultation and disclosure of intention to set up a power plant via consultative meetings at district and local levels included discussions with the provincial administration, village elders, KenGen staff, specialists and key informants.
Challenges Faced and Solutions

- Expropriation and compensation of Project Affected Persons (PAPs) - PAPs expressed fears of KenGen’s ability to expropriate people given previous experience where the local community were forcibly removed from the land without due consideration of the historical problems they had faced. They also expressed fears on embezzlement of funds meant for the exercise.

- Various community consultative and public meetings were organized so as to initiate project buy in by the communities.
Challenges Faced and Solutions

- Due to the sheer size of the project, expropriation and compensation was governed by information collected via participatory rural appraisals. However, considerable time was lost before the PAPs and KenGen agreed on the number and the quality of the resettlement facilities.

- KenGen was guided by the principle objectives that the affected people had their former living standards which had to be restored or improved.
Challenges Faced and Solutions

- 1,700 acres of land located about 5 kilometres from Olkaria IV project area was purchased for this resettlement. A resettlement and compensation plan was developed and it involved conducting a valuation of existing assets such as schools, churches, manyattas and land within the proposed project area.

- This action was carried out in accordance with land administration Laws of Kenya and World Bank Policies.
Challenges Faced and Solutions

- Glass reinforced polyester pipes - In December 2013, heavy downpour resulted in surface flooding of part of the site. Normally, this would have been unlikely to be a problem, but the installation of the backfill of the Unit 2 glass reinforced polyester piping was incomplete. The flood water infiltrated the backfill around the pipe causing it to float out of the trench.

- Repairs took approximately 3 months hence extending the expected completion date further. Repairs involved excavation, filling bed material and lamination.
Challenges Faced and Solutions

- **Underperformance of Steam Turbine Generator** - The plant provisional performance test gave a net power output of 66.8 MW which was significantly below the requirement. There was excessive pressure drop through the main steam strainers and turbine first stage nozzles.
- **New strainers were installed and the desired net power output of 70MW was obtained.** However, the turbine efficiency or steam rate did not meet contract requirements. This led to modification of the first stage nozzles which extended the project timescale by a month after which all other Units were then modified by the OEM accordingly.
Challenges Faced

- **Steam Scrubber Internal Faults** - Unusual reverberations in the steam scrubber revealed that the vortex tube and smoothing sleeve weld seam had failed. This was after complete installation of the steam scrubbers.

- A comprehensive repair methodology was adopted in conjunction with the OEM thus affecting the total project duration.
Experiences with geothermal development worldwide show that developing a geothermal industry can be slow. These studies indicate that different projects have their distinct fair share of challenges.

This project was developed in approximately 22 years from 1992 to 2014. Part of the critical success factors for KenGen success is government’s commitment and involvement in research in the geothermal sector.
References


Thank you

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www.thearge.org/C7