CLIMATE
POLICY
INITIATIVE

Using Public Finance to Attract Private Investment in Geothermal: Olkaria III Case Study, Kenya

Valerio Micale
Chiara Trabacchi
Leonardo Boni

June 2015

San Giorgio Group Report

CLIMATE
INVESTMENT
FUNDS

Acknowledgements

The authors would like to thank the following organizations and professionals for their collaboration and input: Zhihong Zhang, Shaanti Kapila, Abhishek Bhaskar and Seth Walter Collins (Climate Investment Funds), Bjoern Rissmann (Deutsche Investitions- und Entwicklungsgesellschaft mbH), Paul Ngugi (Geothermal Development Company), Tom Harding-Newman (International Finance Corporation), Albert Mugo (Kenya Electricity Generating Company Limited), Federica Del Bono and Petal Jean Hackett (Multilateral Investment Guarantee Agency), Nachman Isaac (Ormat Technologies), Mary Mervenne and Stephen Morel (Overseas Private Investment Corporation), Mike Long (POWER Engineers), and Alejandro Moreno (World Bank).

Finally, the authors would like to acknowledge the contribution of Barbara Buchner, Martin Stadelmann, Gianleo Frisari, and Padraig Oliver, for their continuous support, advice and internal review, and to Ruby Barclay, Dan Storey, Maggie Young and Amira Hankin for their editing, useful comments and suggestions. This project would not have been possible without the generous technical and financial support of the Climate Investment Funds (CIF) as an effort to advance critical thinking under their knowledge management program. The findings, interpretations, and conclusions expressed in this report are those of the authors, and do not necessarily reflect the views of the CIF Administrative Unit or the CIF.

Descriptors

Sector	Geothermal, Renewable Energy, Climate Finance
Region	Kenya, Africa
Keywords	Geothermal; Finance; Exploration Risks; Binary, Drilling
Related CPI Reports	The Role of Public Finance in Deploying Geothermal: Background Paper
Contact	Valerio Micale: Valerio.micale@cpivenice.org

About CPI

Climate Policy Initiative is a team of analysts and advisors that works to improve the most important energy and land use policies around the world, with a particular focus on finance. An independent organization supported in part by a grant from the Open Society Foundations, CPI works in places that provide the most potential for policy impact including Brazil, China, Europe, India, Indonesia, and the United States.

Our work helps nations grow while addressing increasingly scarce resources and climate risk. This is a complex challenge in which policy plays a crucial role.

Executive Summary

Geothermal energy holds significant promise for the low-carbon energy systems of developing countries. As a renewable electricity source with the ability to both meet baseload power demand and backstop fluctuating supply from other renewable sources, it can be a vital component of low carbon electricity systems – where resources allow.

Kenya is one of the leading countries globally for geothermal development, with significant geothermal resources and a government already undertaking significant investment, including supporting scientific research, drilling and the generation of electricity.

The Government of Kenya recognizes the importance of geothermal as cost-effective option for reducing the country's reliance on expensive fossil fuel and weather-dependent hydro power generation as well as improving energy access. As a consequence, it has set the ambitious target of increasing its geothermal power capacity from 600 MW to 5,000 MW by 2030, taking the share of geothermal in the power mix from 15% to 27%.

The Kenyan government is seeking to accelerate geothermal development to meet ambitious deployment targets through a series of reforms.

Annual deployment rates have increased significantly following the introduction of financial and fiscal incentives by the Kenyan Government, including the coverage of upfront resource risks, with the aim to incentivize private investment in particular. However, the sector isn't attracting the level of investment necessary to achieve national deployment targets, mainly because of the long timeframe required to confirm a geothermal resource, high upfront risks related to exploration and the significant capital investment required (ESMAP, 2012; GDC, 2015b).

Private sector engagement in geothermal development in the Olkaria III geothermal plant

This case study analyzes the Olkaria III geothermal power plant in Kenya, as part of a research program carried out by Climate Policy Initiative on behalf of the Climate Investment Funds to help policymakers and donors, as well as private stakeholders, understand how to most effectively support geothermal development along the project lifecycle, and specifically which financing structures and instruments are most suited to attract private capital.

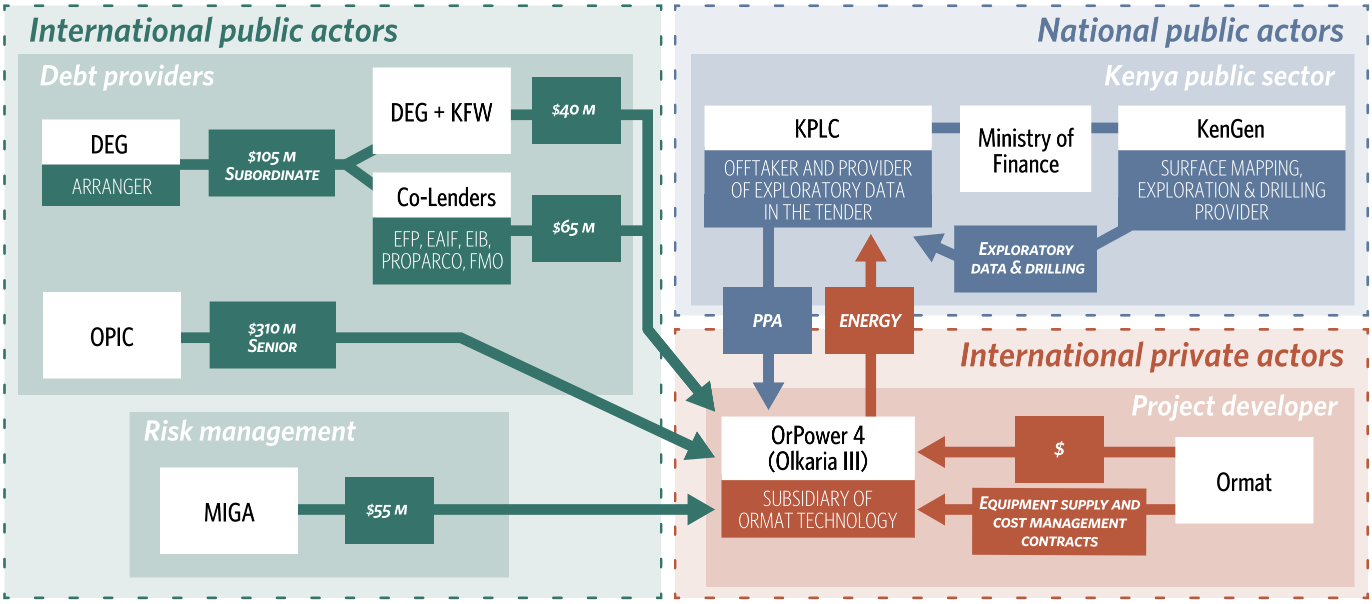
The Olkaria III project is the first privately funded and developed geothermal project in Africa. It was enabled by a phased development strategy, and a combination of public and private financing and risk mitigation instruments that ensured the viability of the project.

Olkaria III is a 110 MW binary geothermal power plant, whose resources were explored by the government before development was undertaken by private actor Ormat Technologies. Ormat used a modular, phase by phase expansion of its generation capacity, from an initial 8 MW to 110 MW, which allowed the progressive exploitation of the steam power generated by the geothermal reservoir and reduced investment exposure in the initial, more risky, years.

The project had a cost of USD 445 million. Initially financed by equity in the late 1990's, the project was able to attract debt needed for its expansion only in 2009 after renegotiation of the power purchase agreement (PPA) and the attachment of a government security package to back the payments to the off-taker, the utility Kenya Power and Lighting Company.

The private developer Ormat provided equity financing with an initial USD 40 million commitment in the years 1998-1999, which reached USD 150 million in 2006. Ormat had to extend its equity commitment for longer than originally expected, securing debt financing only 11 years from the inception of the project. The current project finance structure relies heavily on debt from Development Finance Institutions, which now accounts for 85% of overall investment costs. Germany's Deutsche Investitions- und Entwicklungsgesellschaft mbH (DEG), together with KFW Development Bank, headed a financing consortium that refinanced Ormat's equity in Phase I with a USD 105 million loan. The U.S.'s Overseas Private Investment Corporation (OPIC) provided a 19-year tenor senior loan of USD 310 million disbursed in three tranches used to finance Phase II and Phase III development and refinance part of the equity and debt provided earlier.

Figure ES1: Mapping Olkaria III stakeholders and their contributions to the project



Source: Ormat Technologies (2014); OPIC (2011). Ormat operates the plant through its wholly owned subsidiary Orpower 4 Inc. More details on the stakeholders of the project can be found in Annex I of this paper.

Lessons for policymakers and public international actors

Olkaria III demonstrates that the combination of national government support, in the form of an early-stage exploration and grant, a security package guaranteeing power purchase, a power purchase agreement addressing main operational risks, and international public finance, in the form of loans and Political Risk Insurance, can attract private investors in the geothermal sector in countries with significant perceived political risk.

Lessons for policymakers

Olkaria III delivered power at a lower cost than comparable projects in Kenya and East Africa with purely public development and finance models, suggesting that private investment and development in geothermal energy could be a cost-effective and promising way for the Kenyan government to meet its ambitious deployment targets. Olkaria III achieved a 13% lower LCOE than the average for similar geothermal projects in Kenya. Its private developer model with public sector support was important in keeping the costs low. Local and international public financial support lowered the cost per unit of geothermal power by 31%, keeping the tariff of the project competitive, ultimately lowering overall system generation costs.

In addition, to enable private investment in the project, the Kenyan government had to take on several risks:

1. **Kenya Power and Lighting Company (KPLC) signed a renegotiable 20-year PPA with Ormat Technologies to guarantee purchase of the energy produced by Olkaria III and provide the project's source of return.** We estimate a 16% internal rate of return (IRR) on the project's equity after tax, meeting investment expectations in the country, which generally range from 15% to 23% for geothermal projects (Ngugi, 2012b).
2. **The PPA also includes clauses that mitigate the impact of external risk factors on the profitability of the project, for example foreign exchange risks.** Risk mitigation clauses include partial adjustments to the Consumer Price Index to compensate for potential escalation of operation and maintenance costs, a relief formula ensuring capacity payments to address the risk of resource degradation due to force majeure, and, more importantly, a tariff pegged to the US dollar, which shields Ormat from currency exchange risk and a potential fall in equity returns.

3. **To ensure project viability the government had a key role in mitigating exploration and credit risk.**
    - Exploration risk was significantly mitigated by the government of Kenya thanks to previous exploration in the field performed by the public utility KenGen. KenGen provided data on the resource and donated 8MW of wells to Ormat Technologies. The provision of the wells was equivalent to a 13.5% equity share from the government in the first phase and reduced time between initial private investment commitment and returns. Without these actions expected returns for the whole project would have dropped to 13% from 16%, insufficient for the private developer to make the necessary equity investment without a 15% increase in the PPA tariff.
    - The support of the Government of Kenya was also critical in attracting long-term debt finance needed to develop the plant by backing off-taker payments with a security package including a letter of credit and a letter of comfort, which supported the creditworthiness of the off-taker.

Lessons for development finance institutions

DFIs covered political risk during the first phase of the project. MIGA's PRI offered coverage for the equity exposure, fundamental in the early years of project implementation (Phase I). MIGA's PRI is able to strongly mitigate political risk. Over the years, indeed, MIGA has successfully resolved more than 90 disputes that had the potential to develop into payable claims.

Low-cost, long-term financing from DFIs was also important to guarantee access to finance during the subsequent expansions and increase the attractiveness of the investment. DFIs refinanced Ormat Technologies' initial equity investment, freeing additional equity resources for the subsequent development phases of the project, and raising the internal rate of return on equity from 12% to 16%. The favorable conditions of the public debt ensured the financial viability of the project during Phase I, helping the project to generate returns in line with expectations for geothermal projects in Kenya. Returns improved particularly in Phase II and in Phase III once the resource was proven and the project reached maturity.

Project replicability

Until recently, public finance dominated geothermal development in Kenya, but going forward, private finance will be increasingly important to achieving the country's deployment goals.

Olkaria III is the only geothermal project in operation in the country with private participation from field development through to operation and maintenance so far. It represents the first step in a transition from publicly based geothermal development to a development model with increased private participation.

The establishment of the Geothermal Development Company (GDC) serves a valuable purpose as a proactive government mechanism to stimulate private sector investment. GDC carries out early stage exploration and then sells the proven steam resources to private power producers, shifting exploration risks away from investors.

Alternative project development models where the private sector takes a greater role in earlier stages of geothermal projects are also emerging in Kenya, but public support plays a significant role in covering the high risk of the exploration drilling phase and ensuring the creditworthiness of the off-taker.

Beyond Kenya, the potential of geothermal energy in East African countries on the Great Rift Valley is estimated at 14,000 MW. Olkaria III's experience shows that government financing in the resource exploration and appraisal phase plays an important role in attracting private investors. Moreover, it shows that a country's attractiveness to private investors does not only depend on proven resource availability. It also requires a combination of in-country skills, data availability, regulatory frameworks (including FiT) and a creditworthy off-taker.

It is also worth noting that attracting private investment in project development before exploration drilling could require governments to offer a higher tariff because of the risks that the project developer would be taking on, which could then be passed on to consumers' electricity bills. A desire to keep electricity bills low may then influence governments' choice of geothermal development models going forward.

CONTENTS

1. Introduction

Geothermal energy holds significant promise for the low-carbon energy systems of some developing countries. As a renewable electricity source with the ability to both meet baseload power demand and backstop fluctuating supply from other renewable sources, it can be a vital component of low carbon electricity systems – where resources allow.

Many developing countries in Southeast Asia, East Africa and Latin America have significant geothermal resources, situated as they are, near geological fault lines.[1] Endowed with significant geothermal resources, Kenya is one of the world's leading geothermal producers, with a government already undertaking substantial investments, including supporting scientific research, drilling and the generation of geothermal-sourced electricity.

Although touted for its high potential, geothermal resources have been very slowly developed due to low private sector participation. This is mainly due to the long timeframe required to confirm a geothermal resource, high upfront risks related to exploration, and significant capital investments for the development of power plants (ESMAP, 2012; GDC, 2015b).

This case study of the 110 MW Olkaria III geothermal power plant in Kenya is part of a research program carried out by Climate Policy Initiative on behalf of the Climate Investment Funds and follows the methodology of the San Giorgio Group, developed by CPI.[2] The overall objective of the program is to help policymakers and donors, as well as private sector stakeholders, understand how to most effectively support geothermal development along the project lifecycle, specifically which financing structures and instruments are most suited to attract private capital.

This analysis draws on three in-depth case studies,[3] examining the roles of multilateral development agencies, the private finance community, government representatives and project developers to identify how to best scale up deployment of geothermal electricity plants globally.

Olkaria III is an interesting case to study, as it was the first privately funded and developed geothermal project in Africa. Furthermore, the project represents an example of phased development strategy, and a good mix of financing and risk mitigation instruments made available by the public sector.

We examine the financing and deployment of the 110 MW Olkaria III geothermal power plant because it represents a new development model for Kenya for two key reasons:

Firstly, **the project is the first privately funded and developed geothermal project in Africa.** Ormat Technologies, the project developer, invested its own equity into the project and is the first geothermal independent power producer in Kenya. Before Olkaria III, the Kenyan government had a fully integrated single national public entity (KenGen) developing all stages of geothermal projects. In contrast, Olkaria III was developed on a field previously explored and proven by KenGen, but then transferred to Ormat Technologies when it was awarded the public tender for the development of the field (see Table 1).

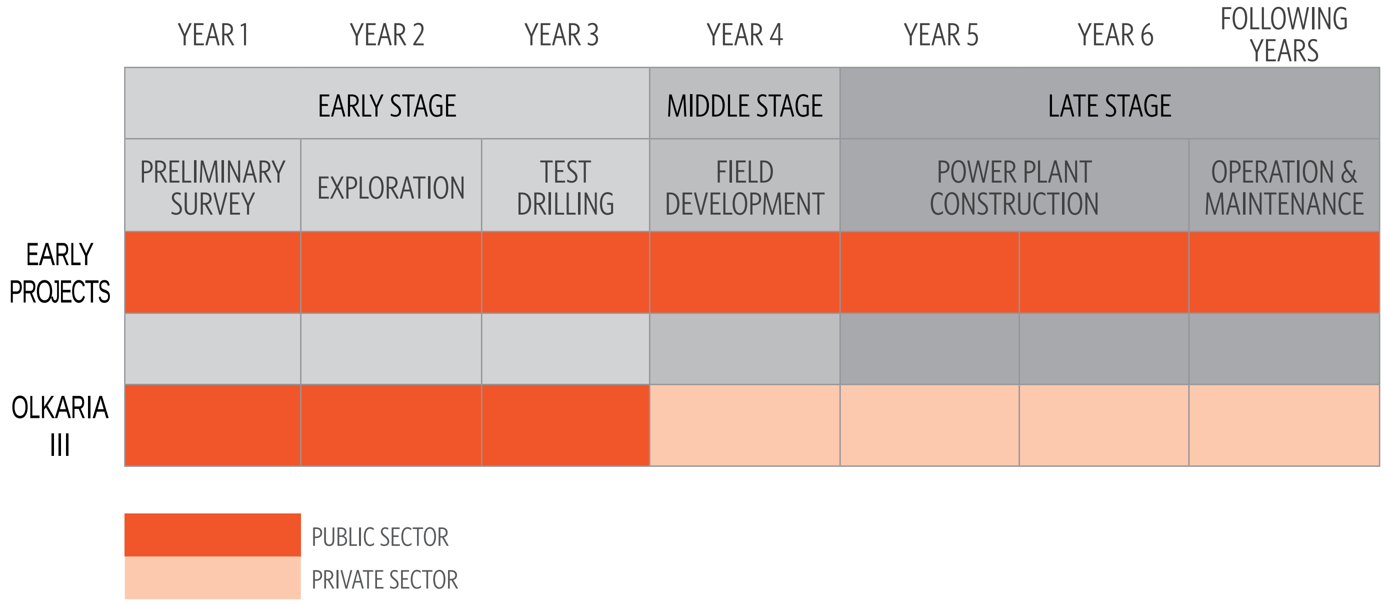
---

[1] See Micale et al. (2014) and ESMAP (2012). Fault lines in geology are cracks in the earth, more specifically intersections of a fault with the ground surface.

[2] The San Giorgio Group case study approach aims to systematically explore the role of project stakeholders, their investments and sources of return, the risks involved and arrangements to deal with them, and the lessons on how to replicate and scale-up best practices. It has been applied to a total of nine projects in solar, wind, energy efficiency, climate resilience, and forest conservation.

[3] The other case studies are the 13.2 MW Gümüşköy project in Turkey (see Oliver and Stadelmann, 2015) and the 3 x 110 MW Sarulla plant in Indonesia (see Rakhmadi and Sutiyono, 2015). For information on the events see http://climatepolicyinitiative.org .

Table 1: Olkaria III vs previous Kenyan geothermal project development model



	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	FOLLOWING YEARS
	EARLY STAGE			MIDDLE STAGE	LATE STAGE		
	PRELIMINARY SURVEY	EXPLORATION	TEST DRILLING	FIELD DEVELOPMENT	POWER PLANT CONSTRUCTION		OPERATION & MAINTENANCE
EARLY PROJECTS	🟥	🟥	🟥	🟥	🟥	🟥	🟥
OLKARIA III	🟥	🟥	🟥	🟧	🟧	🟧	🟧

🟥 PUBLIC SECTOR
🟧 PRIVATE SECTOR

Adapted from ESMAP (2012). Olkaria III is the name of the third power plant built in the Olkaria field, a geothermally active region located in the Great Rift Valley of Kenya

Secondly, **the project represents an example of a phased development strategy, combined public and private financing, and risk mitigation instruments which ensured the viability of the project.** Initially equity financed, the project was developed in phases to reduce the risk exposure of equity investment, particularly during the most risky early stages of development. Once de-risked and made viable in its early phase of development with the help of the public sector, the project was able to raise debt at favorable commercial terms from Deutsche Investitions- und Entwicklungsgesellschaft mbH (DEG), at the head of a financing consortium, and the Overseas Private Investment Company (OPIC) for an overall amount of USD 415m, a large part of which was used to refinance previous equity commitments.

The analysis in this case study will feed into the research program's overarching questions:

- How can public actors enhance private sector and private finance participation across the development lifecycle of geothermal projects, particularly during the early exploration and development stages?
- How do public finance, policy and regulatory frameworks stimulate private sector activity in geothermal investments?
- What are the risks, costs and benefits inherent in different models of geothermal development?
- How does geothermal add value to Kenya's electricity generation system, for example in terms of cost competitiveness and timely deployment of capacity?

Section 2 provides an overview of Kenya's electricity system and policy and regulatory framework. **Section 3** analyzes the project, its stakeholders, financial contributions, different cost components and the returns achieved. **Section 4** considers how risks were allocated and managed through the project development. **Section 5** reviews how the project finance and development model were effective, and the lessons for replication in Kenya and beyond. **Section 6** concludes.

2. Context

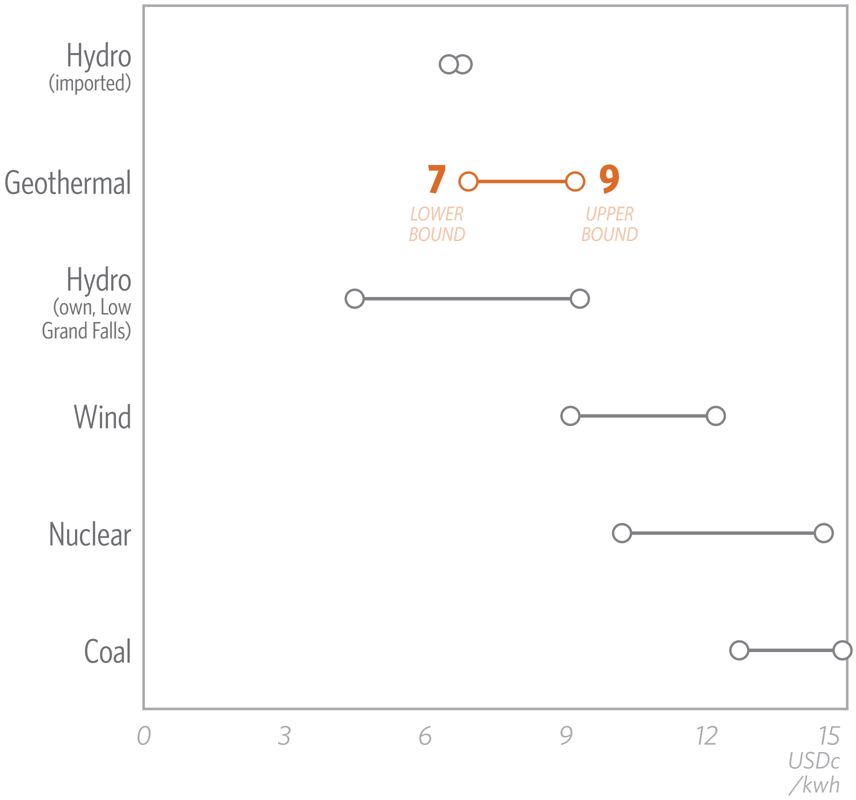
2.1 Kenya's energy market and the role of geothermal power

Kenya has set the ambitious target of increasing its geothermal power capacity from 600 MW to 5,000 MW by 2030, taking the share of geothermal energy in the power mix from 15% to 27%.[4]

With more than 14 high temperature potential sites along the Rift Valley, and an estimated potential of about 7,000 to 10,000 MW, geothermal energy offers a significant opportunity to help Kenya achieve its energy goals (ERC, 2015).

The Government of Kenya (GoK) recognizes the importance of geothermal energy as cost-effective option for reducing the country's reliance on expensive fossil fuel power and weather dependent hydro power generation.

Figure 1: Levelized Cost of Electricity (LCOE) comparison - geothermal versus other electricity sources in Kenya.



Source: Newell et al. (2014). LCOE ranges are based on 8-12% discount rates.

Geothermal energy is the lowest cost source of reliable electricity in Kenya and looks especially attractive when compared to coal power, which is almost two times more expensive (see Figure 1). Geothermal electricity is cost-competitive with most alternative sources of energy in Kenya, including wind, nuclear and coal. Only hydropower, mainly imported from Ethiopia, is cheaper than geothermal, but is vulnerable to extreme drought events, while geothermal can provide stable baseload generation, thus increasing the quality of energy delivered.

The GoK long-term development strategy Vision 2030 identifies a reliable and affordable energy supply as one of the critical enablers of the socio-economic transformation envisioned for the country (GoK, 2005). Geothermal energy was confirmed as the least cost option[5] to achieve the country's vision for power generation, addressing challenges such as:

- Low access to electricity, with nearly 80% of Kenyans living without it (2010-2014, WB, 2015). Electricity demand is projected to increase by over 300%, from 8,087 GWh in 2012/13 to 32,862 GWh in 2016/17 (GoK, 2014);
- Heavy dependence on increasingly unreliable hydropower,[6] which represents almost 50% of installed capacity (as of March) and has been the cause of several power outages;
- High electricity generation costs (USD¢ 11.30), with an end-user tariff of about USD¢ 19.78 per kilowatt hour for domestic customers (2014 data), in part dependent on short-term high-cost development of thermal generation to meet growing demand.

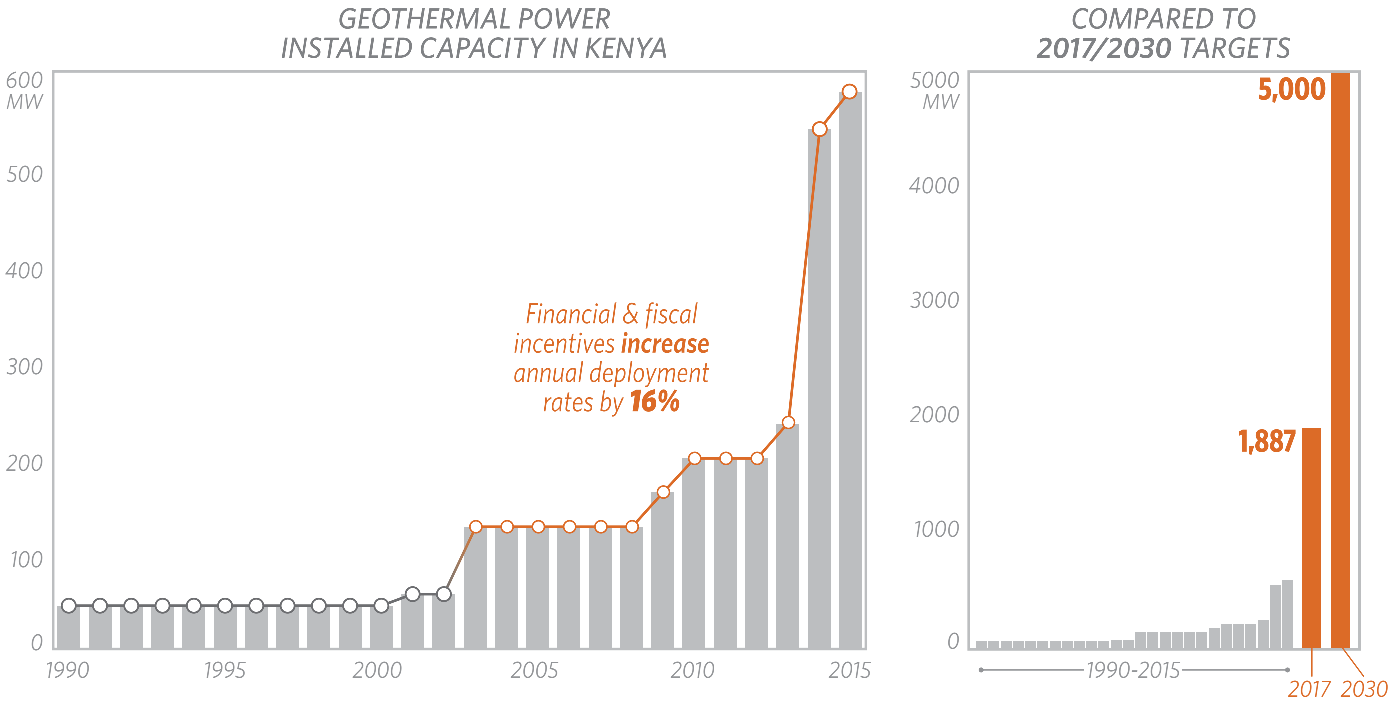
---

[4] KenGen (2015); KPLC (2014); GoK (2014), GoK (2014); REN21 (2015).

[5] See Ngugi (2012a); and Simiyu (2008).

[6] Recurrent droughts cycles have become a persistent feature in the region's power sector, as they induce reduction in hydropower generation.

Figure 2: Geothermal power installed capacity in Kenya from 1990 to present (GEA, 2014; KenGen, 2015)



Note: Geothermal exploration started in the 1960s, while generation begun in the early 80s with the commissioning of the 45 MW Olkaria I plant.

2.2 Deployment rates for geothermal power under Kenya's changing regulatory frameworks

Notwithstanding its significant potential role in the country's power mix, geothermal energy deployment has long been sluggish and restricted to public sector investment (see Figure 2). The state corporation Kenya Electricity Generating Company Limited (KenGen) has until recently led geothermal development in the country. It started geothermal exploration in the 1960s in the Olkaria field, and is now operating and developing about 460 MW of the 1,200 MW estimated potential in the field.[7] With the liberalization of the energy market in 1996 (Eberhard and Gratwick, 2005), participation has extended to include Independent Power Producers (IPPs) via an international competitive bidding process.

Annual deployment rates have increased significantly since 2009, following the introduction of financial and fiscal incentives by the Kenyan Government, including the coverage of upfront resource risks that aim to incentivize private investment.

Private sector participation is deemed essential to finance the country's Vision 2030 given the estimated USD 18 billion required for the development of the targeted 5,000 MW geothermal power by 2030 (Ngugi, 2012a).[8] To fast-track the development of geothermal energy and to attract private investors, the GoK introduced a number of policy measures including:

- The establishment in 2008 of a 100% state-owned and funded Geothermal Development Company (GDC) to spearhead the exploration, appraisal, and production drilling of geothermal resources. Through the GDC, the Government aims to address critical exploration drilling and appraisal risks by proving the availability and suitability of geothermal resources for power generation, thereby facilitating the entry of Independent Power Producers (IPPs) into the geothermal sector in field development and power plant construction phases;

---

[7] KenGen operates the existing 45 MW at Olkaria I and the 105 MW at Olkaria II. The company has commissioned and proposed for development additional capacity at Olkaria I, Olkaria IV and Olkaria V (KenGen, 2014).

[8] The USD 18 billion estimate excludes the additional distribution and transmission networks to evacuate and distribute the generated power.

- The introduction in 2008 (with revision in 2012) of a Feed-in-Tariff policy of USD¢/kWh 8.8, applying for 20 years from the date of the first commissioning of the geothermal power plant with a 35 MW minimum and 70 MW maximum power output capacity (GoK, 2012 and 2014);[9]
- The introduction in 2011 of a zero-rated (0%) import duty and removal of the Value-Added Tax (VAT) on renewable energy equipment and accessories (ERC, 2015; GoK, 2013).[10]

However, geothermal deployment rates remain below what is needed to achieve national targets due to the high risks during resource exploration and appraisal stages (Ngugi, 2012a) and high upfront capital investment requirements, which discourage private investors.

At present there are five IPPs licensed for geothermal power production, but just one, Orpower 4 Inc. (Ormat Technologies' subsidiary and developer and operator of Olkaria III), is currently generating power (GDC, 2015a). All other licensed IPP plants are still under development and expected to become operational over the next years: the 105 MW Menengai project, where GDC is drilling for the first phase of the estimated over 400 MW field; the 140 MW Longonot project; and the 70 MW Akiira project (Phase I).[11] Orpower 4 Inc. is operating the 110 MW Olkaria III geothermal power plants.

---

[9] Maximum cumulative power output capacity 500 MW.

[10] Prior to this year 2011, there was a 16% VAT on renewable energy materials.

[11] Sources: AfDB (2014); Standard Group (2014), GDC (2015a); UNFCCC (2014).

3. Project background, financing, and outcomes

Olkaria III is a 110 MW geothermal power plant located in Hell's Gate National Park, in Kenya's geothermal-rich Rift Valley.

Exploration in the Olkaria field dates back to the 1960s and gained momentum with the support of the United Nations Development Programme (UNDP) between 1973 and 1980. It resulted in the construction of Africa's first geothermal power plant (the 45 MW Olkaria I) in 1981-85, and of the 70 MW Olkaria II in the Olkaria NE field in 2003 (Mariita, 2009; Mwangi, 2005).

The project developer, Ormat Technologies, developed Olkaria III using a modular approach, characterized by a phase by phase expansion of its generation capacity, from an initial 8 MW to 110 MW.

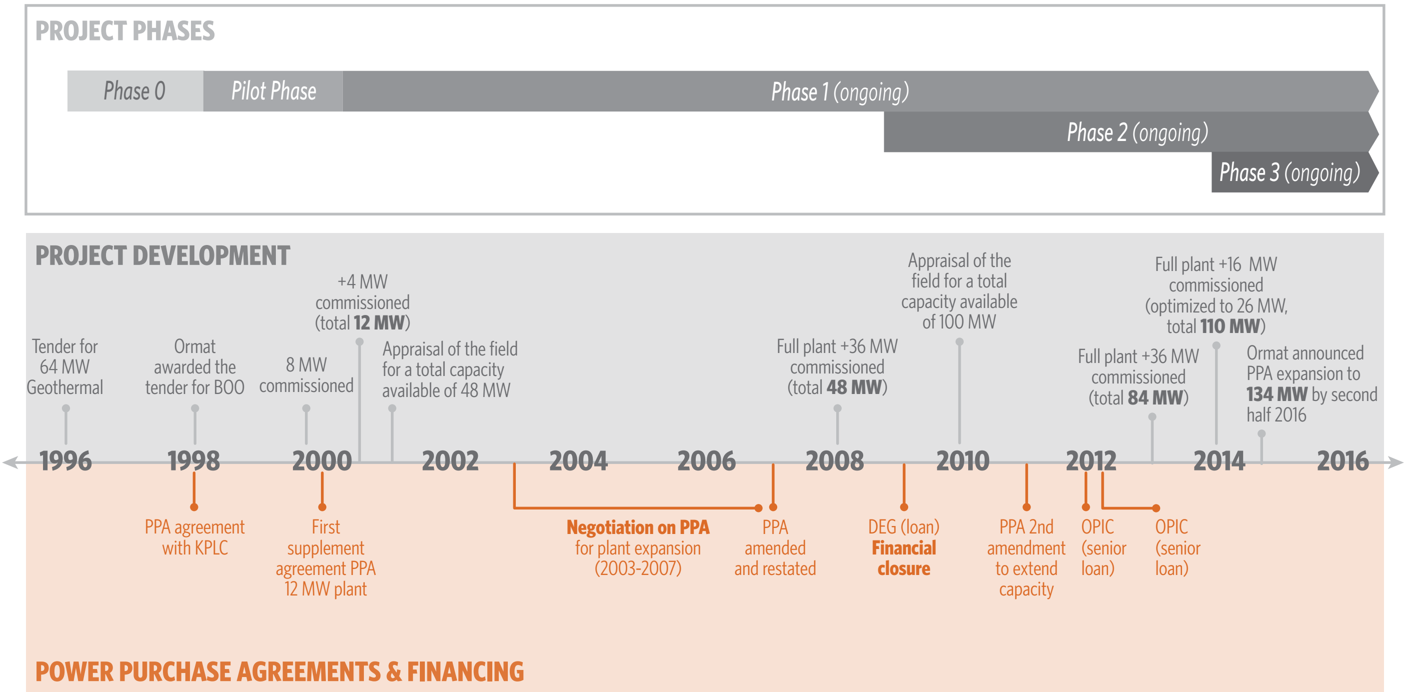
During the 1990s, Kenya Electricity Generating Company Limited (KenGen) performed initial exploratory and production drilling. In 1996, the Kenyan Government launched a 'Build, Own and Operate (BOO)' tender for the Olkaria III concession, which was awarded to Ormat Technologies in 1998 (WB, 2014).[12]

The initial pilot phase of the project (part of Phase I) included two existing wells drilled by KenGen with an estimated potential of 8 MW and subsequently extended by Ormat to 12 MW, which started operations in 2000. Reservoir conditions and close reservoir monitoring revealed substantial potential, so additional drilling activity was undertaken at various times to bring Olkaria III to 110 MW of total production capacity in February 2014, when the plant reached full commercial operation. Ormat has also announced an additional 24 MW expansion of the Olkaria complex, expected to come on line in the second half of 2016, bringing the complex's total capacity to 134 MW (Owens et al., 2015; Ormat, 2014b and 2014c).

The power generated is sold under a 20-year power purchase agreement (PPA), renegotiable with public company Kenya Power and Lighting Company Limited (KPLC).

The phase-by-phase approach allowed the progressive exploitation of the steam power generated by the geothermal reservoir, all in all, taking the plant 16 years to reach full capacity (see Figure 3).

Figure 3: Project timeline and key milestones



Sources: Ormat Technologies (2014a, 2014b and 2014c); UNFCCC (2013); World Bank, (2012a); World Bank (2014).

---

[12] The poor interconnection of Olkaria III's site with the other existing Olkaria I and II geothermal plants was one of the main reasons for the tender (Tole, 2015).

Timing was also influenced by **further field appraisals and lengthy negotiations on the PPA tariff, necessary for increased deployment:**

- The staged development strategy led to two separate appraisals of the field (2001 and 2010) to confirm the geothermal resource;
- The lengthy negotiation on the PPA tariff resulted in the amendment of the prior agreements and the restatement of the PPA in 2007 (World Bank, 2014).[13] The principal issue under negotiation was a Government of Kenya guarantee, through a security package covering payments due to Ormat by the public off-taker.

Table 2: Technical features of the Olkaria III geothermal power plant

TECHNICAL FEATURES	
TECHNOLOGY	Binary
NO. OF PRODUCTION WELLS	22 production wells: 14 in Phase I (2 of which donated by KenGen, for a total of 8MW), 8 in Phase II and III
DEPTH OF PRODUCTION WELLS	7,634 ft on average in 2000-2002; 5,723ft in 2011-2013
TEMPERATURE	HIGH: > 200° C
INSTALLED CAPACITY	110 MW
NET POWER GENERATED (POWER SOLD)	772 GWh per year over its lifetime (851 GWh in the years 2013-2014)

Sources: GEF (2001), Owens et al (2015), UNFCCC (2013), and KPLC (2015a).

Despite the high temperature of the geothermal field of Olkaria III,[14] **the plant uses Ormat's proprietary two-phase Organic Rankine-cycle (ORC) binary technology** (UNFCCC, 2013) – called Ormat Energy Converter (OEC). This technology is typically used in low enthalpy fields, allowing the generation of electricity from both geothermal steam and liquid phase streams (so-called brine) that are typically too low in temperature to be cost effectively converted into power by conventional technologies (Brasz and Bilbow, 2004). However, the technology also brings other benefits as it allows the reinjection of the waste water brine to replenish the aquifer which increases the reservoir lifetime, maintains the steam production rate, and reduces make up wells requirements (Gieré and Stille, 2004).[15]

An estimated 8,500 tCO2e (as of 2014) of non-condensable gases such as CO2 and CH4, generated yearly as a by-product of geothermal resource extraction, is sometimes piped to a neighboring farm for use in a greenhouse (Tole et al., 2009; WB, 2011). Such emissions are estimated to be more than compensated by the emissions reductions achieved by the project by displacing electricity generation from the country's power mix (see chapter 3.3).

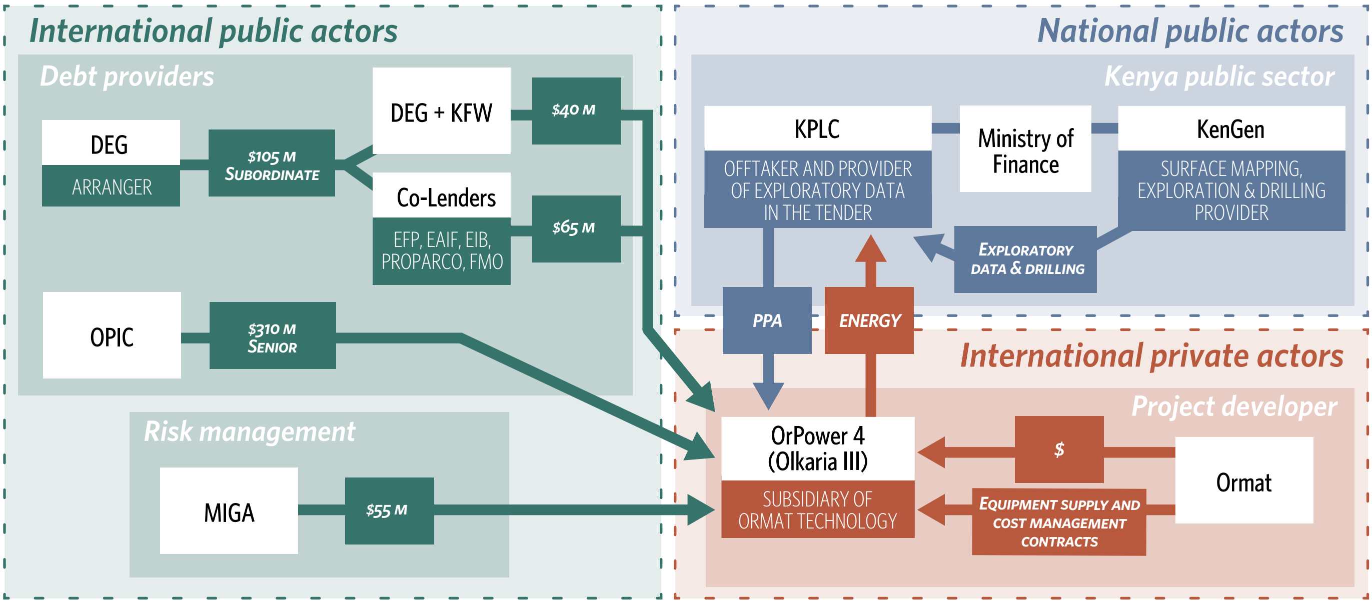
---

[13] The PPA was Amended and Reinstated first in January 2007, following tariff renegotiations, and then again in April 2011, in order to account for the planned expansion in capacity.

[14] Early exploration drilling by KenGen demonstrated only lower enthalpy. However, initial deep drilling in the year 2000 confirmed the presence of primary, high temperature, reservoir fluids in the center of the field (Owens et al., 2015; GEF, 2001).

[15] Make-up wells are production wells drilled to make up for declining capacity of wells and preserve the power capacity of the reservoir over time.

Figure 4: Mapping Olkaria III stakeholders and their contributions to the project



Source: Ormat Technologies (2014); OPIC (2011). Ormat operates the plant through its wholly owned subsidiary Orpower 4 Inc. More details on the stakeholders of the project can be found in Annex I of this paper.

3.1 Project Stakeholders and Finance Inputs

Several public and private stakeholders each with a specific role in financing the plant (see Figure 4 and Table 3) participated in Olkaria III.

The public company KenGen – the leading electric power generation in Kenya – carried out exploratory drilling activities, enabling the government to subsequently tender out the development of the resource (along with the donation of wells, including 8 MW capacity production wells[16] at an estimated value of USD 24 million[17]) to Ormat Technologies, to enable them to start the pilot phase.

The public company Kenya Power and Lighting Company (KPLC) - responsible for the transmission, distribution, and retail of electricity in Kenya - signed a renegotiable 20-year PPA with OrPower 4 to purchase the energy produced by Olkaria III, ensuring the financial viability of the project.

The first PPA was agreed in 1998 for the first 48 MW and subsequently amended and restated to account for the Phase II and Phase III expansions of the Olkaria III complex to 110 MW (World Bank, 2014). The PPA tariff comprises two main elements:

- Fixed monthly capacity payments,[18] and
- Floating energy payments[19] for the energy delivered.

---

[16] Eight wells were given in total, but only two were productive wells. The other wells were either nonproductive, used as reinjection wells, or failed observation wells (Ormat, 2014a).

[17] The grant associated with the donation has been estimated based on a cost of USD 3 million per well for each of the eight wells provided (GEF, 2001). The amount does not cover extra exploratory costs borne by Kengen (Tole, 2015; Ormat, 2014a; IPCC, 2011).

[18] The capacity charge is a fixed payment, typically based on the plant size that is paid each period for each kilowatt of available capacity. It covers fixed charges involved in the construction, operation, and maintenance of the power plant, including charges for: repayment of the principal and interest of the debt used to construct the facility, return on equity capital invested, fixed operation and maintenance (O&M) costs that are independent of the amount of energy generated (e.g., staffing costs, administrative expenses, operator fee, insurance premiums, etc.), possible fixed costs related to fuel supply and transportation, such as demand or through-put charges, or minimum take-or-pay obligations (Nehme, 2012).

[19] The energy charge is paid for each kilowatt hour of energy dispatched and delivered at the agreed delivery point during an agreed period. It includes variable costs involved in the generation of the energy delivered, including charges for: commodity charges for each unit of fuel used, including the cost of fuel and its transportation to the plant; variable operation and maintenance costs (e.g., spare parts, lubricants, and other consumables); a major maintenance sinking fund to cover the costs of required turbine maintenance based on usage (Nehme, 2012).

Table 3: Financial inputs at each phase of expansion (USD million)

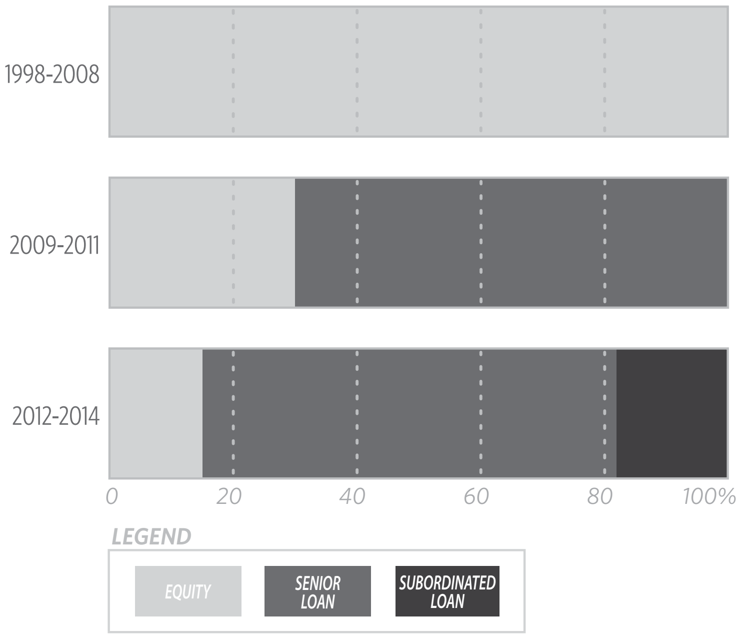
FINANCIAL SOURCES				PHASE OF EXPANSION (MW ADDED)				TOTAL FINANCIAL INPUTS	
ACTORS	TYPE	INSTRUMENT	YEARS DISBURSMENT	PHASE I		PHASE II	PHASE III	FINANCE MOBILIZED	PROJECT COSTS (EXCLUDING REFINANCING)
				12 MW	+36 MW	+36 MW	+16 MW (OPTIMIZED TO 26 MW)		
ORMAT	PRIVATE	EQUITY	1998 - 2014	40	110	43	27	**220**	**220**
DEG AND CO-LENDERS	PUBLIC	SENIOR (/ SUBORDINATED) LOAN (REFINANCING)	2009	105		---	---	**105**	**---**
OPIC	PUBLIC	SENIOR LOAN (REFINANCING)	2012	85		---	---	**85**	**---**
OPIC	PUBLIC	SENIOR LOAN	2012 - 2013	---		180	45	**225**	**225**
TOTAL								**635**	**445**

Sources: CPI estimates based on Climate Finance Options WB (2013); Ormat (2014a); OPIC (2011); SEC (2012c); World Bank (2000); World Bank (2014).

The PPA tariff is denominated in U.S. dollars and partially linked to the Consumer Price Index to compensate for the escalation of operation and related maintenance costs (Ormat, 2014a).

The PPA tariff also includes risk mitigation clauses that are described more in detail in Chapter 4.

Figure 5. Evolution of financing structure of Olkaria III over time (net of refinancing)

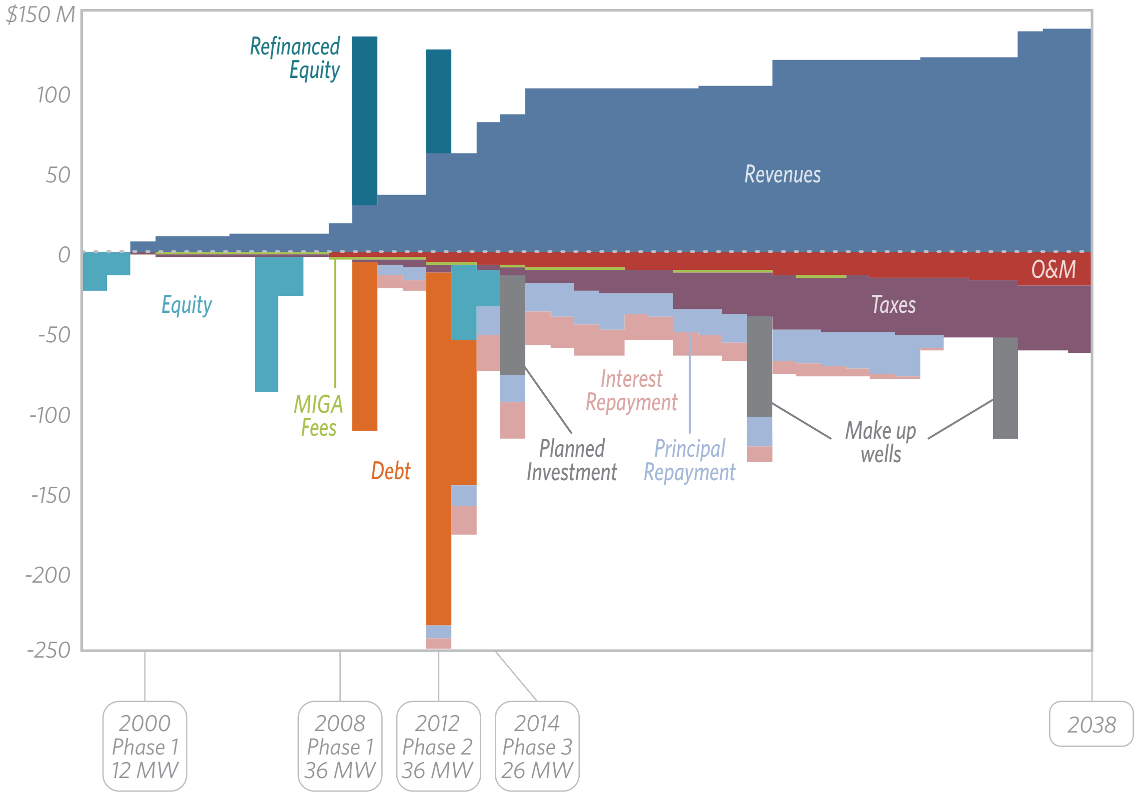


The Olkaria III power plant cost USD 445 million, mobilizing USD 635 million in investment overall including refinancing. The project financing structure has evolved over the different phases of its development (see Figure 5).

Ormat had to extend the equity commitment for longer than originally expected, securing debt financing only 11 years after the project's inception in 1998, after the successful renegotiation of the PPA tariff and the GoK release of a security package covering the payments of the off-taker KPLC. The current structure relies strongly on debt, which accounts for 85% of overall investment costs.

Ormat Technologies invested a total of USD 220 million in equity to finance the phased expansion of the Olkaria III plants, USD 150 million of which entirely financed Phase I (48 MW). The project developer also took out Political Risk Insurance (PRI) with the World Bank Group's Multilateral Investment Guarantee Agency (MIGA) to protect the investment against political risks, including transfer restriction, war and civil disturbance, and expropriation at a cost of around 2% of annual premium.

Figure 6: Project cash flow



Source: CPI elaboration. Planned investments for which financing structure is not known is here represented in grey.

DFIs provided the long-term financing and refinancing needed to enable the full development of the plant. Germany's DEG, together with KFW Development Bank, headed a financing consortium that refinanced Ormat's equity in Phase I.[20] The U.S.'s OPIC provided a 19-year tenor senior loan of USD 310 million disbursed in three tranches to finance Phase II and Phase III, and to refinance the equity invested in Phase I by Ormat and part of the previous debt, which became subordinated.[21] Olkaria III was the first geothermal project financed by OPIC, which was attracted by a supportive regulatory framework for geothermal, the expertise of the local public sector, the environmental sustainability of the project's approach, and the reliability of the project developer (OPIC, 2011 and 2014).

3.2 Project profitability for the private sector

Figure 6 represents costs and revenues across the different phases of development of the project.[22]

Revenues depend on the agreed PPA, partially adjusted to fluctuations in the Consumer Price Index, but also on the availability of geothermal resource.

Revenues of the project are mainly influenced by the degradation of the resource and wells and the drilling of make-up wells to compensate for the degradation, as well as by the partial adjustment of the PPA to the Consumer Price Index to compensate for nominal increases in operation and maintenance costs.

Public support from the Government of Kenya and low-cost, long-term financing from DFIs enabled the project to achieve returns in line with the average investment expectations in the country.

---

[20] The refinancing strategy does not necessarily reflect the actual use of the DFI funds involved in the deal. It reflects the long involvement of the facilities in the process of achieving bankability of the project as well as the latest construction stage only taking place recently.

[21] For the refinancing OPIC provided USD 85 million: 65 USD million were used to refinance the equity of Ormat Technologies, the remaining USD 20 million was instead used to repay part of the loan arranged by DEG (SEC, 2013b). The loan arranged by DEG was originally a secured senior loan. In connection with the OPIC financing, the collateral was released and the claims subordinated to that of the OPIC loan (in exchange for a guarantee).

[22] We built a cash flow model to analyze the project's performances (revenues, liabilities and profitability and, ultimately, its levelised cost of electricity). We assume 40 years lifetime of the plant, compatible with the license provided by the Kenyan government to Ormat for the exclusive rights of use and possession of the geothermal resource, expiring in 2029, but extendable for two additional five-year terms (SEC, 2012c).

Table 4: Effect of the different forms of public financial support on the profitability of the Olkaria III plant with a focus on Phase I

EQUITY IRR	ENTIRE PROJECT (110 MW)	FOCUS ON PHASE I	
		12 MW	36 MW
PROJECT CASE	16%	14%	16%
W/O IN-KIND	13%	8%	16%
W/O REFINANCING	14%	13%	11%
W/O FAVORABLE COMMERCIAL TERMS OF THE LOANS	12%	13%	12%
W/O ANY OF THE ABOVE	**10%**	**8%**	**11%**

Source: CPI internal assessment based on independently sourced data. overall system generation costs.

We estimate that the equity internal rate of return (IRR) of the project (16%) meets the minimum expectations of investments in the country, generally ranging from 15% to 23% for geothermal projects (Ngugi, 2012b).[23]

Low-cost, long-term financing from DFIs and additional public support was important to increase the attractiveness of the investment by maintaining adequate returns through the different phases of development.

Without financial support, the IRR of the project would go down to 10%, way below private expectations. We explored in particular the effect of the following forms of public support on the profitability levels of the project in its different phases:

- The early stage in-kind donation of wells with 8 MW capacity by the public actor, KenGen;
- DFIs' refinancing of the equity invested by the private investor, Ormat Technologies;
- The favorable commercial terms of the long-term loans provided by the DFIs.

KenGen's donation of 8MW of wells to Ormat Technologies significantly increased the profitability of the project at its critical inception phase (Phase I).

The in-kind donation of wells with 8 MW capacity by public utility KenGen saved Ormat Technologies an estimated USD 24m (see paragraph 3.1) and increased the equity IRR from 13% to 16% over the entire lifetime of the project.

The donation was particularly significant when we look at the development of Phase I. The after tax equity IRR of this phase would have fallen almost by half (from 14% to 8%) if Ormat Technologies had instead covered these costs through equity investment.[24] The provision of the wells was equivalent to a 13.5% equity share from the government in the first phase of the project.

DFIs refinancing of Ormat Technologies' initial equity investment freed additional equity resources for the subsequent development phases of the project, and reduced project costs during Phase I. Nevertheless, delays in refinancing diminished its potential impact on profitability.

USD 190 million of the loan provided by DEG and OPIC refinanced the equity invested by Ormat Technologies during Phase I enabling subsequent investment during the Phase II and Phase III expansions of the plant. In addition, refinancing improved the profitability of the investment as it allowed the project to benefit from tax-deductible interest costs. We estimate that refinancing reduced total tax expenses by 10%,[25] increasing after-tax equity IRR from 14% to 16% along the entire project life. The benefits of refinancing were concentrated in the second part of Phase I of the plant's development (Phase I – 36 MW added), where tax savings were more than 20%, increasing the phase's IRR from 11% to 16%. Benefits of refinancing were instead limited (from 13% to 14%) for the first part of Phase I development (Phase I – 12 MW added), where refinancing occurred much later than the related investment.

---

[23] In general, returns higher than 20% are expected when private investors bear full exploratory risks (ESMAP, 2012).

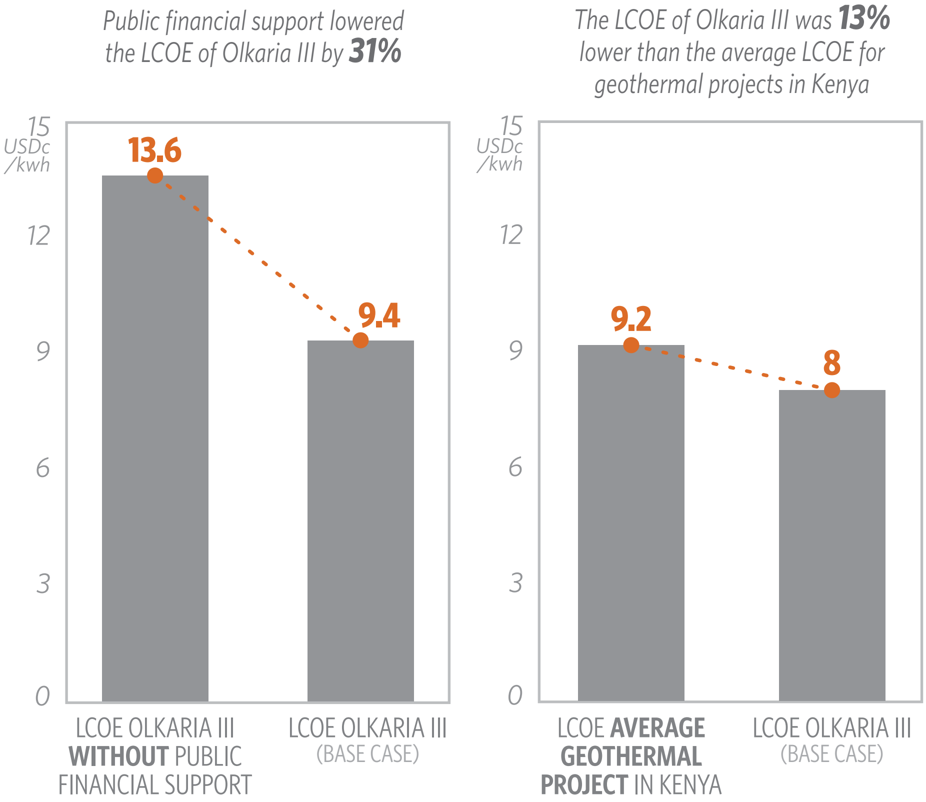
[24] As a counterfactual, we assume that the investment costs for the initial wells were entirely borne as equity investments by the private developer, considering that a geothermal plant usually requires five years from the exploration phase for its development (CPI, 2014).

[25] From 1.62 USD/kWh to 1.45 USD/kWh (based on LCOE calculation).

Long-term public debt ensured the financial viability of the project as a whole, improving returns, particularly in Phase II and in Phase III of its development.

10 to 19 year tenors and an estimated 6.2% interest rate on average for loans provided and arranged by development finance institutions (see Annex I for more information) are unmatched in the local commercial market in Kenya. At the time when loans were provided, average commercial rates for infrastructure investment in Kenya were around 15%, and tenors no longer than five years (Central Bank of Kenya, 2015, Shendy et al., 2011). The shorter term of the loans available are a particularly poor match with the development timelines of a geothermal plant which would not be able to generate enough revenues to pay back loans without revising tariffs upward. Our analysis shows that returns are significantly affected if market rates and tenors are used,[26] with overall after tax equity IRR falling from 16% to 12%, and more significant reductions in Phase II and in Phase III. Expected returns for geothermal projects in Kenya range from 15% to 23% (Ngugi, 2012b). Olkaria III would not have provided this level of return at the tariff agreed without low-cost, long-term public debt.

Figure 7: LCOE of Olkaria III with and without public support and compared with cost of geothermal in Kenya



Source: Newell et al. (2014) and CPI elaboration. LCOEs of Olkaria are discounted at different rates to allow for comparability. To compare project LCOE with the LCOE of other geothermal projects in Kenya we used a discount factor of 12% (applied by Newell et al., 2014). To assess the impact of public resources on the current project LCOE (estimated as 9.37 USDc/kwh) we used the 16% equity IRR currently estimated for the project based on our model.

3.3 Project Outcomes for the Public Sector

As mentioned in Section 2.1 geothermal is the lowest cost source of reliable electricity in Kenya and especially attractive when compared to coal power, which is almost two times more expensive. Olkaria III brings the following environmental, social and economic benefits to Kenya:

Olkaria III generates power at lower cost than similar geothermal projects developed in Kenya, demonstrating that a public-private development model can deliver affordable power in line with policymakers' objectives regarding the tariff.

Our cash flow model (see figure 7) estimates an LCOE 13% lower than the average expected costs for similar geothermal projects in Kenya.

A private developer model with public sector support has been important in keeping the costs low. We estimate that local and international public financial support through the in-kind grant, and loans, lowered the cost per unit of geothermal by 31%, keeping the tariff of the project competitive, ultimately lowering overall system generation costs.

---

[26] We assume that Ormat would use its own balance sheet to make the debt service payments that the project is temporarily unable to cover on its own under this scenario.

Olkaria III is helping Kenya meet growing energy demand, lower end-user tariffs, and improve the reliability of Kenya's power system.

Olkaria III has helped address clear constraints of Kenya's energy sector during a time of significant energy shortages (Dalberg, 2012) and reduced the country's dependency on increasingly unreliable rain-fed hydropower. Additionally, it reduced power generation costs, resulting in foreign exchange savings from fuel imports and contributed to making end-users' electricity bills more affordable. Electricity bills have already been reduced by 30% in Kenya due to the deployment of geothermal power in the country and could fall further by 48% (GDC, 2015a; CNBC, 2015; Coastweek, 2015).

Olkaria III will reduce the emissions of Kenya's power sector by 3 to 4%.

We estimate that the 110 MW Olkaria III will generate an average 772 GWh of grid-based electricity per year over its lifetime. This would result in annual carbon emissions reductions of about 450,000 tCO_2e net savings per year through to 2038 by replacing electricity generated by fossil fuel powered plants. This is around 3 to 4% of Kenyan power sector emissions in 2012. [27]

The project, which is registered under the UNFCCC CDM,[28] is reported to have had a positive impact both in terms of jobs for the local community and technology transfer from Ormat to its counterparts (GRC, 2007).

---

[27] Considers electricity generated and emissions saved from 2000 to 2038; the country's 2012 emissions are based on EIA data. Average yearly emissions reductions in the years 2000-2015 corresponded instead to 188,000 tCO2e.We calculated gross emission reductions based on the electricity supplied by the geothermal plant, considering a country emission factor of 0.6 tCO2/MWh (UNFCCC, 2013). Net emissions reductions are calculated as the difference between the gross emission reductions and project emissions, the latter being the emissions released by the geothermal site due to project activities and estimated based on UNFCCC (2013) and Tole (2011) data.

[28] Only phase 2 of the Olkaria III project is registered under the CDM, with an estimated amount of annual average GHG emission reductions of 250,970 tCO2e.

4. Risk Allocation

The risk of exploratory drilling failing to locate a resource suitable for power generation, the amount of time it takes to explore and develop the resource, and the level of investment required in the early stages of geothermal projects, make the exploration phase the riskiest in geothermal project development (ESMAP 2012; Micale et al., 2014). However, other risks related to financing, policy, or technology performance may also occur at later stages in the project.

4.1 Risk identification and assessment

To systematically identify the main risks faced by the stakeholders participating in Olkaria III, this section assesses risks based on their probability of occurrence (low/moderate/high), and their impact on the plant's financial and non-financial objectives (again from low/moderate/high). The main risks identified are the following:

4.1.1 HIGH RISK EVENTS

Resource drilling risk during exploration and construction: The proving of the geothermal resource is typically one of the major areas of risk for geothermal development. The risk relates to the probability of hitting dry wells during the exploratory and appraisal drilling, resulting in delays and cost overruns. Drilling risk is higher for unexplored fields but remains significant even for fields with confirmed resources: success rates for exploration drilling for the initial wells are estimated to be 50-59% on average worldwide, and increase to around 70-80% when the resource is confirmed (IFC, 2013).

Financing risk/ Loan repayment: The ability of the project to raise debt financing, was indirectly impacted by political risk: government energy policy required the power off-taker KPLC to provide power to consumers at a social rate, undermining its financial profile, while the Government of Kenya proved unable and/or unwilling to provide coverage of off-taker risks (UNFCCC, 2013; Ormat, 2014a). This resulted in Ormat being initially unable to attract debt financing either from private actors or DFIs, despite significant reduction of exploratory risk and the presence of a MIGA guarantee covering equity - usually able to indirectly enhance the creditworthiness of a project (Frisari and Micale, 2015). As a consequence, Ormat initially financed the project with its own equity, thus bearing the full financing risk at the early stage of the project implementation.

Political risk: Despite a policy framework that is generally supportive for geothermal development, political risk remains a disincentive to investment in the country. At the time of Ormat's investment, Kenya's business climate was weak with a limited GDP compound annual growth (1.73% in 1990-2000) and falling Foreign Direct Investment (Eberhard, 2005).

Currency risk: Over the course of the 1990s, when investment was made, the country had seen its currency depreciate more than 300% (from Ksh 22.9 = 1 USD in 1990 to Ksh 75.9 = 1 USD in 2003), which highlighted a substantial currency risk for project developers in general. After a phase of appreciation in the years 2004-2011 the country is now again experiencing significant depreciation, with currency exchange reaching an all-time high of 105.75 Kenyan Shillings (Ksh) to one US Dollar in October 2011 (Eberhard, 2005; Trading Economics, 2015).

4.1.2 MODERATE TO HIGH RISK EVENTS

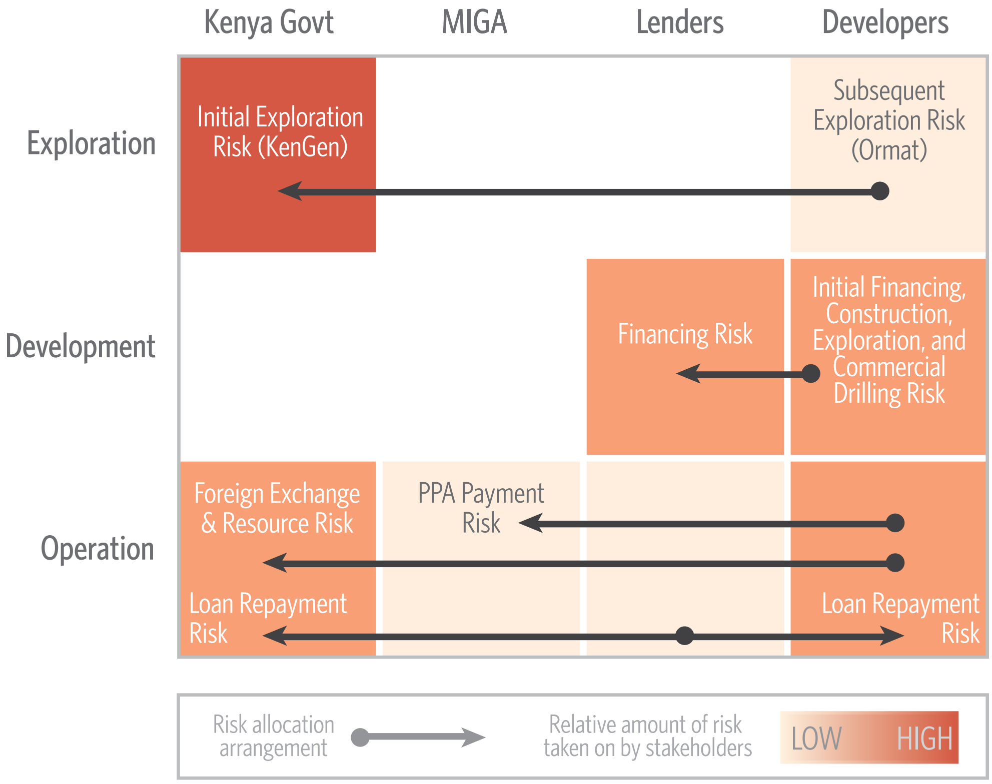
Resource degradation due to reservoir and mechanical issues and remaining resource uncertainty: In Olkaria III (as in other plants) the geothermal resource is subject to a degradation factor that reduces energy generation. In this case, energy generation is projected to decrease by 0.5% to 1% on average every year.[29] Most of the degradation derives from the cooling and loss of enthalpy of the overall underground natural reservoir, while the rest can mainly be attributed to a decrease in the efficiency of the plant's machines (Ormat, 2014a). In addition, even with the best exploration and production drilling program, some degree of uncertainty remains about the performance of the reservoir over time, and the success of operations to re-inject fluids back into the geothermal field.

Construction risk: projects in the geothermal sector, as with other infrastructure projects, are sometimes exposed to potential losses related to cost and schedule overruns.

---

[29] For comparison, the Olkaria I field, which is very similar to the Olkaria III field, has experienced variable regimes of annual steam decline from an initial 5-6% to the near zero decline registered in 2008 (Ouma, 2008).

Figure 8: Olkaria III risk allocation matrix



4.1.3 RISK ANALYSIS, ALLOCATION AND MITIGATION

In the risk matrix in Figure 8, we illustrate the main risks across the different development phases of the project and map how key risks were transferred from the investors initially bearing the risk to different project stakeholders. The rest of this section presents the main risk transfer mechanisms used in the project.

Exploration risk was significantly mitigated by the Government of Kenya thanks to its previous exploration of the field and the in-kind donation of exploration wells with 8 MW capacity drilled by KenGen, which increased remaining drilling success probability (to be borne by Ormat) from 50% to 80%, increasing expected returns from 13% to 16%.

Kenya has long recognized the risks associated with initial geothermal exploration, drilling and the assessment of the resource as being a disincentive to private sector investment. To address this barrier the government financed pre-development activities jointly with the utility KenGen prior to the liberalization of the power generation sector in 1996 (AFREPREN/FWD, 2008). Thanks to the results of earlier exploration activities in the Olkaria III field, drilling success probability for the remaining exploration was estimated at 80% in 2011,[30] up from the average 50-59% expected for initial stage geothermal drilling. The resource was 100% confirmed by subsequent production drilling activities (GEF, 2001; Mwangi, 2005; Ormat, 2014a). We estimate that, had Ormat carried out exploration activities of the Olkaria III field without previous drilling activities of KenGen, the expected returns would have been 13%, insufficient for the private developer to make the necessary equity investment without a 15% tariff increase.[31]

Construction and commercial drilling risks were mitigated by the power producer by reducing its equity exposure recurring to a phase-based expansion strategy.

Phased “well by well” plant development is practice in the geothermal landscape, considered more effective than building a geothermal, centrally located power plant, as it allows to better manage equity risk exposure and better understand resource characteristics before financial commitment (OPIC, 2014). In the case of Olkaria III, the phased approach enabled the implementation of a preliminary pilot phase (UNFCCC, 2013) at a time when resource risk was still considered significant. While for the private developer the

---

[30] This assessment was consistent with the overall Olkaria III field experience up to then, and with experiences of developing the Olkaria field in general and of Olkaria I project in particular. At the time of assessment, Olkaria I had been operating with high reliability for 20 years, and presented strong similarities with Olkaria III, even though it is geologically separate (GEF, 2001)

[31] We calculated the impact of exploration risk on the returns for the private developer and the tariff by projecting the expected number of wells to be drilled by the developer based on ex-ante expected drilling success rates of the geothermal field, the historic learning curve for geothermal (IFC, 2013), and average wells sizes and costs for each of the Olkaria III development phases (GEF, 2011 and IFC, 2013).

benefits of a phased approach outweigh costs,[32] this approach may be a disadvantage under a public sector perspective aiming at quick deployment of capacity.

Resource degradation risk is mainly borne by the private developer in the absence of a dedicated risk mitigation mechanism. The project developer plans to manage it by building make-up wells to compensate for productivity losses and guarantee stable returns.

Ormat plans to recover losses in productivity due to the degradation of the geothermal resource by drilling 2 to 3 make-up wells (each with an average size of 7 MW[33]) every 10 years to sustain the capacity of the plant.

Make-up wells allow the project to generate additional revenues for the equity investor, however they are not always feasible and they are a costly solution that requires additional capital commitment[34] in the absence, to date, of insurance mechanisms that cover the gradual natural decline in the performance (Ormat, 2014a).

Part of the resource degradation risk was transferred to KPLC through a relief formula in the PPA which treats resource degradation as a "force majeure", allowing for a deviation from contracted capacity.

Ordinarily, if the plant did not provide power capacity specified in the PPA,[35] Ormat would receive no capacity payments for the underperforming portion. Instead, the relief formula obliges KPLC to transfer 90% of capacity payments to Ormat for capacity that is unavailable as a result of "force majeure" whenever production goes below construction requirement due to an unexpected degradation of a geothermal reservoir (SEC, 2007a; Nehme, 2012; Ormat, 2014a).

Political risks to the project developer were mitigated by Political Risk Insurance (PRI) provided by the Multilateral Investment Guarantee Agency (MIGA).

To protect equity holders from political risks including transfer restriction, war and civil disturbance, and expropriation, Ormat signed a MIGA PRI, at a cost of around 2% of annual premium.[36] Coverage has been renegotiated to optimize changes in the equity amount used in the project, and adjust the coverage to the actual equity exposure of the project (Ormat, 2014a).[37] The PRI has not been called to date.[38]

---

[32] Staged-investments may present both benefits and costs for private investors (Krohmer et al., 2007): on the one hand, this approach may lead to myopic view of the investment, focusing on mid-term results instead of considering the long-term view (Cornelli and Yosha, 2003); on the other hand, positive results in each stage of finance encourage the investor to advance the project, enhancing the monitoring of activities and increasing the likelihood of positive outcomes (Gompers, 1995).

[33] Production wells in the plant are currently estimated around 8-10 MW each, bigger than the 3-4 MW ones usually drilled by KenGen (Ormat, 2014a).

[34] Furthermore, this method does not always fully recover productivity losses related to the degradation of the resource (Ormat, 2014a): for example, if the level of the fluid in the reservoir diminishes, the drilling of make-up wells may not be enough to recover capacity losses (Ormat, 2014a).

[35] The capacity contracted is the gross capacity, corresponding to the capacity measured at the generator terminal before deduction of self-consumption; a correction curve is then used to translate actual performance to contractual commitment (Ormat, 2014a). The tender mechanism provides for an initial assessment of the reservoir before the estimation of the PPA. Ormat provided a report with the help of GeothermeEx third party certification (Ormat, 2014a). Resource assessments of the geothermal fields initially identified 58 MW of proven geothermal reserves, the amount required for a plant of 48 MW's capacity. Now the assessment process is carried out by the public entity, the Geothermal Development Company (Eberhard, 2005).

[36] This excludes the cost for the standby premium, an option for additional coverage. Every six months it is possible to ask MIGA to transform the standby amount in current amount which will be the new coverage. The advantage of the standby amount is the possibility to pay only 1/3 of the premium rather than the entire amount.

[37] Coverage has been adjusted to the actual equity exposure at the different stages of the project's development. The total present exposure of MIGA guarantee is USD 79m, with USD 55m being the amount "on current" today. MIGA's coverage was renegotiated several times starting in 2000 with an exposure of USD 43.3 million, to the most recent renegotiation in 2012 which brought guaranteed amount from USD 134 million to USD 79 million (see annex I for more details). Coverage may increase if new investments are made (e.g. new make-up wells).

[38] A MIGA delegation was however sent to ascertain the facts when OrPower4 was pressured by both the government and KPLC to reduce its tariff, but the guarantee was never officially invoked. Although pressure from KPLC continued after the MIGA visit, pressure from the government subsided (Eberhard et al., 2011).

Credit risks to the project, especially during the initial development phases, were strongly dependent on the creditworthiness of the off-taker. The developer undertook some measures to mitigate credit risk,[39] but only guarantees later provided by the Government of Kenya for the PPA addressed this risk enough to finally unlock debt financing.

After witnessing the financial troubles of KPLC in 1999,[40] Ormat requested a supplemental PPA, accompanied by a **security package** (Eberhard, 2005). However, KPLC and the Ministry of Energy were unable to provide such support until eight years later, eventually enabling financial closure for the syndicated loan arranged by DEG. The main elements of the security package are:

- Letter of credit (LC) from KPLC - Based on the Security Agreement, KPLC issued stand-by LCs for each plant (as plants have different expiry dates). According to the Security Agreement defined in 2007, LCs must have a duration of more than 12 months, covering no less than 4 months of payments for each respective plant, and can be amended when PPAs are revised. In the case of continuing payment default, OrPower 4 is entitled to make demand under the Letter of Credit for an amount no greater than the amount of the Secured Liabilities then due but unpaid. The LCs are established and maintained by the identified LC bank, while fees are borne and paid by KPLC (SEC, 2007b; Ormat, 2014a). [41]
- Letter of comfort from the Government of Kenya – The letter, also included in the security agreements, does not create any legal obligation on the part of government, but reassures the project developer that the government will use all means within its power to ensure KPLC issues its payments under the PPA agreement.

The security package may be substituted with an International Development Association (IDA)-backed LC in the future, covering KPLC's ongoing payment obligations under the PPA and GoK's ongoing payment obligation under its letter of support (Nehme, 2012; Ormat Technologies, 2014d).

Foreign exchange risk is transferred from the power producer to KPLC and eventually passed on to consumers by ensuring PPA payments in USD.

This PPA tariff shielded the power producer from currency exchange fluctuations, increasing equity returns from 15% to 16%, and avoiding what could have been USD 22 million of foreign exchange losses alone in the period 2000-2014.[42]

There is a limited foreign exchange risk for Ormat. According to the PPA, KPLC undertook to pay capacity and energy payments pegged on the US dollar (Nehme, 2012; Ormat, 2014a). Foreign currency risk then falls onto KPLC, with devaluation in the local currency making it more expensive for the off-taker to meet its payments. The cost of foreign exchange losses is assessed on a monthly basis by KPLC and is eventually fully billed to the consumers on a pass through basis (Ngugi, 2012b; World Bank, 2014). This may slightly weaken the benefits on electricity cost reductions discussed in section 3.3. Furthermore, if consumers are unable to pay their electricity bills, this increases the off-taker's risk of a default under the PPA.

---

[39] To mitigate credit risk for debt holders Ormat standard practices include establishing a loan reserve: out of the loan, an amount equal to six months of upcoming debt service is deposited in a collateral account to be used under extreme circumstances (Ormat, 2014a). In addition, company policy is to procure risk coverage if the country credit rating in a particular investment destination is below a certain level (Ormat, 2014a).

[40] Although KPLC's financial situation proved negative from 1999-2003, the firm did report profits again, starting in 2003-2004 (Eberhard, 2005).

[41] OrPower 4, however, reimburses KPLC for such costs up to the total aggregate amount of 1% (one percentage) per annum of the then prevailing face value of the Letter of Credit (SEC, 2007b).

[42] We looked at historical variations in the KES / USD change rate from 2000 onward (Oanda, 2015). Forecasts for the period 2015-2038 are calculated using a 5-year moving trend.

5. Potential for replication and scale-up

Kenya has ambitious targets to scale up geothermal power. Attracting private investment will be critical to achieving these targets, particularly considering that, until recently, public finance dominated geothermal development in the country. The development model adopted in Olkaria III represents the first private-led geothermal development in Kenya and it offers several useful lessons for future scale up. Kenya has also recently introduced several other promising models to attract private investment in geothermal that could offer potential for the country to reach its targets.

5.1 Replication potential and lessons learned from Olkaria III

Under Kenya's Vision 2030, the GoK aims to increase its geothermal power capacity from about 600 MW to 5,000 MW by 2030, thereby increasing the share of geothermal power in the electricity generation mix from 19.8% in 2012/2013 to close to 30%.[43] To achieve this target, public and private geothermal investment will need to reach an estimated USD 18 billion.[44]

Until recently, public finance has dominated in geothermal development, but going forward, private finance will be increasingly important to achieving the country's goal.[45]

Olkaria III demonstrated, for the first time in Kenya, a private-led geothermal development model from field development through to operation and maintenance.

Earlier geothermal facilities built in the country (Olkaria I 45 MW and Olkaria II 70 MW) were fully developed and financed by the public power generation company KenGen with the support of more than USD 300 million from DFIs (Mugo, 2015).

Olkaria III is the only generating geothermal plant in Kenya that is primarily financed by private actors, from field development through to operation and maintenance (Table 5), representing the first major step in a transition from publicly based geothermal development to a development model with increased private participation.

It would be difficult to scale up all the elements of Olkaria III's model in Kenya, as the model has been strongly influenced by project-specific circumstances, such as:

- The relative maturity of the geothermal field at the time of the bidding (Olkaria was the first field explored in the country), due to previous exploration;
- The lack of a formalized approach on the role of public sector in the mitigation of resource risk, which led previous exploration to be treated as a sunk cost by the government and included as an in-kind grant into the tender.

With that context, however, the model adopted in Olkaria III still offers several useful lessons on the role of public sector in addressing barriers to private investment:

- Olkaria III demonstrates how the public sector can reduce information barriers: The GoK, through KenGen, has helped to reduce the risks associated to the availability of the resource by carrying out initial resource appraisal as well as exploratory and initial production drilling;
- The model also provides an example of how the public sector can reduce viability gaps: the development of green field geothermal power plants remains very capital intensive[46] and financing can be difficult to source in markets like Kenya. The 20 year PPA, renegotiable, backed by the GoK's security package ensuring the creditworthiness of the off-taker played a role in attracting long-term debt finance needed to enable the full development of the plant.

---

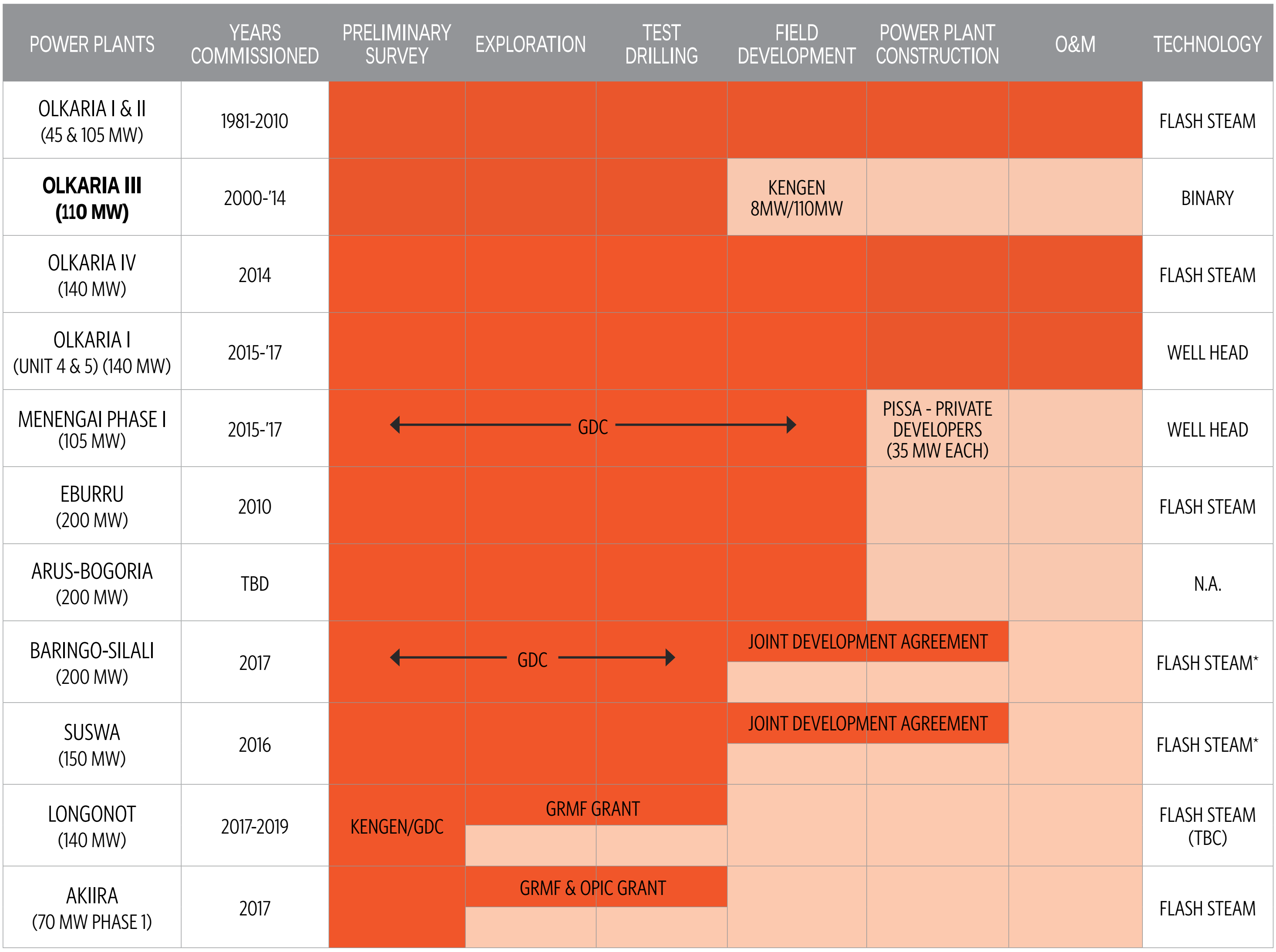
[43] Based on Ngugi (2012a); GoK (2013); GoK (2014); REN21 (2015).

[44] This estimate excludes the investment costs for the additional transmission and distribution networks (Ngugi, 2012).

[45] See Ngugi (2012a); Falzon et al. (2014); KenGen (2015).

[46] According to Ngugi (2012), green field development requires about USD 100 million in Kenya for exploration, resource appraisal, feasibility study, access roads and to set up the water system.

Table 5: Geothermal development models for existing and prospective plants in Kenya



POWER PLANTS	YEARS COMMISSIONED	PRELIMINARY SURVEY	EXPLORATION	TEST DRILLING	FIELD DEVELOPMENT	POWER PLANT CONSTRUCTION	O&M	TECHNOLOGY
OLKARIA I & II (45 & 105 MW)	1981-2010	🟥	🟥	🟥	🟥	🟥	🟥	FLASH STEAM
OLKARIA III (110 MW)	2000-'14	🟥	🟥	🟥	🟧 KENGEN 8MW/110MW	🟧	🟧	BINARY
OLKARIA IV (140 MW)	2014	🟥	🟥	🟥	🟥	🟥	🟥	FLASH STEAM
OLKARIA I (UNIT 4 & 5) (140 MW)	2015-'17	🟥	🟥	🟥	🟥	🟥	🟥	WELL HEAD
MENENGAI PHASE I (105 MW)	2015-'17	🟥 ←	🟥 GDC	🟥	🟥 →	🟧 PISSA - PRIVATE DEVELOPERS (35 MW EACH)	🟧	WELL HEAD
EBURRU (200 MW)	2010	🟥	🟥	🟥	🟥	🟧	🟧	FLASH STEAM
ARUS-BOGORIA (200 MW)	TBD	🟥	🟥	🟥	🟥	🟧	🟧	N.A.
BARINGO-SILALI (200 MW)	2017	🟥 ←	🟥 GDC	🟥 →	🟥 JOINT DEVELOPMENT AGREEMENT 🟧	🟥 🟧	🟧	FLASH STEAM*
SUSWA (150 MW)	2016	🟥	🟥	🟥	🟥 JOINT DEVELOPMENT AGREEMENT 🟧	🟥 🟧	🟧	FLASH STEAM*
LONGONOT (140 MW)	2017-2019	🟥 KENGEN/GDC	🟥 GRMF GRANT 🟧	🟥 🟧	🟧	🟧	🟧	FLASH STEAM (TBC)
AKIIRA (70 MW PHASE 1)	2017	🟥	🟥 GRMF & OPIC GRANT 🟧	🟥 🟧	🟧	🟧	🟧	FLASH STEAM

🟥	PUBLIC SECTOR
🟧	PRIVATE SECTOR

Note: Eburru is currently generating 2.5 MW but field potential is estimated to be >=60 MW. PISSA = Project Implementation and Steam Supply Agreement. GRMF = Geothermal Risk Mitigation Facility. Sources: GDC (2015a); GDC web site; Ormat web site; Kengen web site; Lonsdale (2015); AfDB (2011); GoK (2011); UNFCCC (2012); UNFCCC (2014). (*) Subject to resource characteristics.

- The developer's multi-stage strategy helped to further mitigate resource risk, and reduce equity exposure of the private investor as well as lenders' credit risk.[47] This approach had several advantages, but could also be considered a disadvantage under a public sector perspective, in countries aiming at quick deployment of capacity as it may slow down full commercial operations of the site.

We discuss these lessons in greater detail in previous sections (3 and 4).

5.2 The path forward for scaling up geothermal in Kenya

With the creation of a company dedicated to geothermal exploration and drilling for steam, the GoK has taken a decisive step to encourage private investment by assuming the upfront risks associated with resource assessment.

Resource risk remains a major barrier to private sector involvement in geothermal energy development, but it varies depending on the maturity of the field.

To address this hurdle, through KenGen, the GoK has undertaken detailed surface studies of most of the prospects in Kenya (Simiyu, 2008). In 2008, it established a 100% state-owned and funded Geothermal Development Company (GDC) to absorb the initial resource exploration and development risks. Under the 'GDC model,' GDC conducts surface studies, exploration drilling, feasibility studies and production drilling. Then it sells the steam through competitive tendering to power generating companies, which can be both KenGen and private Independent Power Producers (IPPs), which will open up opportunities for both public and private financiers in the consequent phases (World Bank, 2010; CIF, 2011 and ESMAP, 2012).[48]

This approach, called Project Implementation and Steam Supply Agreement (PISSA), has been recently adopted for the development of the Menengai field.[49] GDC developed the field (green field) and tendered the steam to private IPPs that are responsible for financing the building, construction, and operation of the power plant.[50] GDC also guarantees the steam supply over the plant life, and maintains a coordinating and oversight role on the management of the reservoir. The advantage of this model compared to Olkaria III is that GDC's steam supply obligations help to reduce project risk, the overall financing cost of the investment, and facilitate financial closure (Ngugi, 2012a; AfDB, 2014).

More recently for the development of the Baringo-Silali and Suswa complex, GDC started exploring the so-called Joint Development Agreement model. This is an alternative to the PISSA model that still sees substantial public participation in the exploration and development of the geothermal field. The responsibilities of this agreement are yet to be defined, but the desired situation is to involve IPPs to contribute 60-80% of the investment in the drilling of production wells and the development of the steam field, and then 100% in the construction and operation phase (see Table 5).[51]

Alternative project development models where the private sector takes a greater role in earlier stages of geothermal projects are emerging in Kenya, but public support plays a significant role in covering the high risk of the exploration drilling phase and ensuring the creditworthiness of the off-taker.

Private developers are having a greater role in early stages of geothermal projects in Kenya. Private developers have already been licensed at the Akiira and Longonot fields, and received grant funding from the Geothermal Risk Mitigation Facility (GRMF) to begin exploration drilling. Akiira also received grant funding from OPIC Africa Clean Energy Finance program to support project preparation activities. These projects are also expected to pilot a drilling insurance from Munich Re (Londsale, 2015).

---

[47] The phased-approach allows to progressively but gradually exploiting the geothermal reservoir resources enhancing the developers' ability to verify the geothermal reservoir in the earlier development stage of the project and to make available quality data on the reservoir potential, as well as lenders' ability to assess the potential for the expansion of the plant, and its debt repayment capacity

[48] GDC is satisfied with a financial IRR of 8.3% which won't be acceptable for private investors in the drilling stage. Private investors would expect returns on equity ranging between 25-35% for exploration (AfDB, 2011).

[49] See GDC.co.ke, 2014

[50] GDC awarded the development of the first phase of 105 MW to three IPPs in February 2012, each of which each of these companies will install a 35 MW power plant (GDC, 2014). GDC constructed roads, drilling pads and the water system needed to harness the potential of the Menengai field, which is in one of the most rugged and complex volcanic calderas in the country.

[51] GDC would carry out initial surface studies as well as appraisal and exploratory drilling, but then tenders the concession to the IPP who could co-finance the production drilling phase and the construction and management of steam gathering system (Musembi, 2014).

Like with Olkaria III, the timely signature of the PPA as well as guarantees on the creditworthiness of the off-taker prove to be important to attract the long-term debt finance necessary for development of the plants.[52]

It is also worth noting that attracting private investment in project development before exploration drilling could require the Government of Kenya to offer a higher tariff because of the risks that the project developer would be taking on, which could then be passed on to consumers.

Early private participation may not increase actual costs of geothermal project development, but it reveals them in the tariff. Olkaria III benefitted from the early exploration carried on by KenGen and the donation of eight wells without which expected returns for the project would have dropped to 13% from 16%. We estimate that this would have been insufficient for the private developer to make the necessary equity investment without a 15% increase in the PPA tariff.[53]

Similarly, the 'GDC model' may require an increase in the tariff on offer. GDC wants to sell rather than donate the steam to power generating companies through competitive tendering, thus project developers may demand a higher tariff to compensate for the cost of buying the steam from GDC. Higher tariffs, however, do not match with policymakers' priorities (GDC, 2015a). One may argue that the achievement of policy goals may then influence the choice of the country's geothermal development models going forward.

5.3 Taking Olkaria III and the Kenyan experience to neighboring regions

Beyond Kenya, the potential of geothermal energy in East African countries on the Great Rift Valley is estimated at 14,000 MW. Accelerating geothermal development in Kenya's resource-rich neighboring countries, therefore, is a key priority to fill the region's electricity deficit.

Kenya's geothermal experience shows that government financing in the resource exploration and appraisal phase plays an important role in attracting private investors. Moreover, it shows that a country's attractiveness to private investors does not only depend on proven resource availability. But, it is a combination of in-country skills, data availability, regulatory frameworks (including FiT) and creditworthy off-taker.

Kenya's experience therefore, offers lessons to geothermal-rich neighboring countries such as Ethiopia, Rwanda, Tanzania and Djibouti seeking to harness their geothermal potential. Key enablers of private sector involvement in geothermal development are:

- **The investment climate:** the development of a legal, regulatory and institutional framework for geothermal, including clear targets, concession tendering process and development requirements, as well as technical capacity within institutions
- **The risk/reward ratio** of individual geothermal projects, which can be improved by
  - » Ensuring stable revenues through, for instance, production subsidies (FiT), well-established PPAs with fair tariffs
  - » Sharing, or reducing, costs and risks, during the riskiest phases of project development, such as exploration phase, but also by offering tax breaks, guarantees, grants or low-cost loans able to help the project meet return requirements and improve their overall financial viability.

Some countries in the region (e.g. Djibouti) are currently seeking to develop, or have already developed (e.g. Tanzania) the Kenyan 'GDC model' to speed up geothermal development reducing risks to private investors.[54] The 'GDC model', however, requires significant in-house capacity to develop and manage steam fields. Therefore, in countries with relatively low potential such as Tanzania (~650-680 MW), it may not represent an efficient use of public resources (Londsale, 2015). Furthermore, to ensure efficiency, the GDC-led model should evolve along with the relatively maturity of geothermal fields in the country. Thus, targeting with public resources fields where little exploration has taken place.

---

[52] Africa Geothermal International Kenya Ltd's (AGIL) signed a 25-year PPA with KPLC for the purchase of power from the 140 MW Longonot geothermal plant (Think Geoenergy, 2013). Commercial operation is scheduled to begin with plant commissioning in 2018 (Agil web site).

[53] As discussed in section 4, IRR of Olkaria III would need to increase by 23% to ensure adequate returns to the investor to cover exploration risk. Musembi (2014), for instance, highlighted that the required rate of return on equity (RoE) could be 25% higher and, tariff requirements for a 50 MW plant would be USDc 14-17/KWh. By providing the early stage high risk equity, GDC aims to reduce IPPs' premium. However, there is concern that the 20-40% investment in early stage drilling is not enough to allow the overall project to meet private developer financial return rates at the current USDc/kwh 8.8 FIT.

[54] The GoT recently created the Tanzanian Geothermal Development Corporation (TGDC), which will be in charge of geothermal development in the country Lonsdale (2015).

6. Conclusions

Olkaria III is delivering power at a lower cost than comparable projects in Kenya and East Africa with purely public development and finance models. This suggests that private investment and development could be a cost-effective and promising way for the Kenyan government to meet its ambitious deployment targets.

Its risk mitigation approach provides an example for project development models which aim at encouraging private sector participation at earlier stages of geothermal development.

Olkaria III demonstrates that the combination of national government support, in the form of early-stage exploration and a grant, a package to guarantee that the power off-taker can pay the agreed tariff, international public finance with longer terms and lower costs than locally available, and Political Risk Insurance from the World Bank Group, can attract private investment in geothermal in countries with significant perceived political risk.

Public support from the Government of Kenya and financing from DFIs, combined with a multi-stage approach for project development, enabled the project to achieve returns in line with average infrastructure investment expectations in the country.

Public support allowed for returns in the different phases of development of the project, ensuring financial viability at its inception, and higher returns once the resource was proven and the project reached maturity:

KenGen's donation of 8MW of wells to Ormat Technologies significantly increased the profitability of the project in its inception phase (Phase I).

DFIs refinancing of Ormat Technologies' initial equity investment freed additional equity resources for the subsequent development phases of the project, and reduced project costs during Phase I.

DFIs ensured the financial viability of the project as a whole, with solid returns particularly in Phase II and in Phase III by providing longer-term, lower-cost debt than was publically available.

The 20-year PPA contract enabled project developer to obtain stable and predictable returns while addressing risks related to the operational phase of the project.

To ensure the viability of the project, the developer signed a 20 years PPA with the off-taker for the energy produced by Olkaria III. Clauses in the PPA include:

- Partial adjustments to the Consumer Price Index to compensate the escalation of operation costs and related maintenance costs;
- A relief formula ensuring capacity payments to address the risk of resource degradation due to force majeure;
- A tariff pegged on the US dollar, to shield power producer from currency exchange risk.

The project also benefited from a set of risk mitigation solutions for exploration and credit risk.

Exploration risk was significantly mitigated by the Government of Kenya thanks to previous exploration in the field – which allowed for collection and transfer of data on the resource. The Government of Kenya's decision to guarantee the creditworthiness of the off-taker by backing off-taker payments with a security package including a letter of credit and a letter of comfort was critical and meant that DFIs were willing to provide the public debt mentioned above. Political risk was instead mitigated by the public sector with the coverage of the equity exposure through PRI, fundamental especially in the early years of project implementation (Phase I).

Olkaria III is so far the only geothermal project in operation in the country with private participation from field development through to operation and maintenance, and is inspiring similar models in Kenya that aim to encourage an early participation of the private sector.

The establishment of the Geothermal Development Company (GDC) serves a valuable purpose as a proactive government mechanism to stimulate private sector investments. GDC carries out early stage exploration and then sells the proven steam resources to private power producers, shifting exploration risks away from investors. Private development models are therefore beginning to establish themselves in the country, but public support remains critical to cover the high risk exploration drilling phase.

Annex - Olkaria III stakeholders' description and financing role

STAKEHOLDER DESCRIPTION		PROJECT ROLE	FINANCING ROLE
Project Developer	Ormat Technologies Inc.	Through OrPower 4, a Special Purpose Vehicle ad hoc set up, designed, constructed and operate Olkaria III on a BOO basis.	Provided USD 220m in equity to Orpower 4 of which USD 150 million to entirely financed Phase I
National Government and Public Bodies	Ministry of Finance (MOF)	In 1996, the MOF issued an international tender for the development of a 64 MW geothermal plant on a Build-Own-Operate (BOO) basis in the resource area of Olkaria III	
	Kenya Power and Light Company (KPLC)	Buys, transmits, distributes and sells the electricity produced by Olkaria III in Kenya under a 20 years PPA.	Signed a first 20-year PPA amendment with OrPower4 to purchase energy from Olkaria III plant in 1998. This was amended and restated in March 2011 to allow for a further 52 MW expansion of the complex (undertaken in Phase II and Phase III) (World Bank, 2014).
	KenGen	Kenya Electricity Generating Company Limited, KenGen is the leading electric power generation company in Kenya, producing about 80 percent of electricity consumed in the country.	Donated 8 wells to Ormat Technologies in 1998 with a value of USD 24 million (CPI Calculations based on Tole, 2015; Ormat, 2014a; IPCC, 2011) after carrying out exploratory drilling on the Olkaria site in the 1990s and discovering that Olkaria III's wells were poorly interconnected with its existing geothermal plants, Olkaria I and Olkaria II.
International Organizations	Overseas Private Investment Company (OPIC)	Provided a USD 310 million senior loan to Ormat Technologies divided in three tranches, each with a 19-year tenor to refinance Phase I and finance the subsequent expansions (Phase II and Phase III).	Provided first tranche (USD 85 million) in November 2012. This tranche of the loan was repaid by July 2013 with a variable interest rate Provided second tranche (USD 180 million) in two instalments: USD 135 million in November 2012 and USD 45 million in February 2013. The interest rate formula for both instalments was the same as tranche I. Provided third tranche (USD 45 million) in November 2013 with a fixed annual interest (SEC, 2012c)
	DEG - Deutsche investitions- und entwicklungsgesellschaft mbH	Arranged a 10 years USD 105 million loan to refinance Phase I (46 MW). Currently involved as with a shareholder loan.	In 2008, with KfW, provided USD 40 million and raised USD 65 million from 13 European Development Finance Institutions[*] (Climate Finance Option WB, 2013). The loan was disbursed in two instalments: 1. 1st of USD 90 million in March 2008, of which: • USD 13 million to be repaid every 6 months a variable interest rate composed of 6-months LIBOR + 400 base points • USD 77 million to be repaid at an annual fixed interest of 6.9%. 2. 2nd USD 15 million in July 2008, to be repaid every 6 months at a variable interest rate composed of 6-months LIBOR + 400 base points (SEC, 2012c).
	World Bank Group Multilateral Investment Guarantee Agency (MIGA)	Issued Political Risk Insurance (PRI) coverage to guarantee Ormat Technologies' equity investments in OrPower 4. The guarantees, issued in 2000 (USD 43.3 million exposure for a 13 MW plant) and extended in 2007 (USD 88.3 million exposure for USD 98.1 million equity investment to increase the plant capacity to 48MW - phase II) and in 2012 (USD 134 million for Phase III - 26 MW, later reduced to US$79M) cover Ormat's equity investments against the risks of transfer restriction, expropriation, war and civil disturbance for a 15-year tenor.	As of December 2014, PRI total gross coverage of USD 79m million

Sources: SEC (2012c); OPIC (2011); Ormat Technologies (2014a); Climate Finance Options WB (2013); World Bank (2000) and World Bank (2014).

[*] The loan was provided by a group of European Development Finance Institutions (EDFIs) arranged by DEG. The lender group includes: Société de Promotion et de Participation pour la Coopération Economique, Emerging Africa Infrastructure Fund Limited and Nederlandse Financierings Maatschappij Voor Ontwekkelingslanden N.V. Furthermore, a portion of the funds provided for the loans will come from KfW Entwicklungsbank (KfW Development Bank) and from the European Financing Partners, a financing vehicle of 13 European Development Finance Institutions and the European Investment Bank (EIB). DEG will also act as global agent for the lender group (SEC, 2009)

References

AfDB. 2014. "AfDB eases investor risk in large African geothermal project". African Development Bank. Available at: http://www.afdb.org/en/news-and-events/article/afdb-eases-investor-risk-in-large-african-geothermal-project-13652/

AfDB. 2011. "Menengai Geothermal Development Project - Project Appraisal Report – SREP Supplementary Document". African Development Bank. Available at: http://www.climateinvestmentfunds.org/cifnet/sites/default/files/Kenya%20Menegai%20Geothermal%20Development%20Project%20Supplementary%20Doc%20-%20Approved.pdf

AFREPREN/FWD. 2008. "Success Story – Geothermal Power Generation in Kenya". Energy, Environment and Development Network for Africa, Nairobi, Kenya. Available at: http://climateparl.net/cpcontent/pdfs/081024%20East%20Africa%20Geothermal%20Toolkit.pdf

Agil. 2015 (access). "Logonot Geothermal Power Project – Development phases". Available at: http://www.africa-geothermal.com/longonot-project/development-phases/

Audinet P. 2013. "Global Geothermal Development Plan" presentation at the GGDP Roundtable, The Hague, November 2013.

Brasz Lars J., Bilbow, William M., 2004. Ranking Of Working Fluids For Organic Rankine Cycle Applications. In: International Refrigeration and Air Conditioning Conference, Purdue, pp. 722–729.

Climate Finance Option, World Bank. 2013. "DEG/KfW Olkaria III Geothermal Power Station (Kenya)". Climate Finance Option, Washington DC, USA. Available at: http://www.climatefinanceoptions.org/cfo/node/67

Climate Investment Funds (CIF). 2011. "SREP Investment Plan for Kenya". Climate Investment Funds, Washington DC, USA. Available at: http://www.climateinvestmentfunds.org/cif/sites/climateinvestmentfunds.org/files/Kenya%20IP_0.pdf.

CNBC Africa. 2015. "Kenya's Electricity Costs Take A Dip". CNBC Africa, Nairobi, Kenya. Available at: http://www.cnbcafrica.com/news/east-africa/2015/02/23/kenya-electricity-cost/

Coastweek. 2014. "Kenya plans to axe electricity price by 47 per cent in three years". Coastweek Newspapers Limited, Thika, Kenya. Available at: http://www.coastweek.com/3732-latest-news-Kenya-plans-to-axe-electricity-price-by-47-per-cent-in-three-years.htm

Collins. 2012. "Nuclear Energy For Industrialization, A Case Study Of Kenya's Vision 2030". International Atomic Energy Agency, Vienna, Austria. Available at: https://www.iaea.org/INPRO/5th_Dialogue_Forum/Tuesday,_28.08.2012/1400-1530(National_Perspective)/6._Collins_Gordon_Juma_Kenya_0828.pdf

Cornelli, F. and Yosha, O. 2003. "Stage Financing and the Role of Convertible Securities". London Business School, London, UK. Available at: http://www.francescacornelli.uk/images/reports/venture02.pdf

DEG. 2015. "Financing opportunities - shaping development" Deutsche Investitions- und Entwicklungsgesellschaft, Koln, Germany. Avaiable at: https://www.deginvest.de/International-financing/DEG/Die-DEG/Was-wir-tun

Dalberg. 2012. EDFI Join Evaluation on EFP Energy Infrastructure Projects – Summary Document. March 30, 2012. Available at: https://www.deginvest.de/DEG-Englische-Dokumente/About-DEG/Our-Mandate/EDFI-Joint-Evaluation-on-EFP-Energy-Infrastructure-Projects.pdf.

Deloitte. 2014. "International Tax: Kenya Highlights 2014". Deloitte Touche Tohmatsu Limited. Available at: http://www2.deloitte.com/content/dam/Deloitte/global/Documents/Tax/dttl-tax-kenya-highlights-2014.pdf

Eberhard, A., and K.N. Gratwick. 2005. "The Kenyan IPP Experience". Stanford University, Stanford CA. Available at: http://iis-db.stanford.edu/pubs/20976/Kenya_IPP_Experience_.pdf

Eberhard, A., and K.N. Gratwick. 2011. "IPPs in Sub-Saharan Africa: Determinants of success". In Energy Policy 39. pp. 5541–5549. Available at: http://www.gsb.uct.ac.za/files/IPPSinSubSaharaEnergyPolicyPaper.pdf

ERC. 2015 (access). "Functions of the Renewable Energy Department". Energy Regulatory Commission. Available at: http://erc.go.ke/index.php?option=com_content&view=article&id=106:-functions-of-the-renewable-energy-department&-catid=87:services.

ESMAP. 2012. "Geothermal Handbook: Planning and Financing Power Generation". Energy Sector Management Assistance Program – World Bank, Washington D.C. Available at: http://www.esmap.org/sites/esmap.org/files/DocumentLibrary/FINAL_Geothermal%20Handbook_TR002-12_Reduced.pdf

Falzon J. Pols D. King'uyu S., Wang'ombe E. 2014. Nationally Appropriate Mitigation Action (NAMA) to Accelerate Geothermal Power: Lessons from Kenya. Available at: http://cdkn.org/wp-content/uploads/2014/12/Kenya-IS4.pdf.

Frisari, G. and V. Micale. 2015 (Forthcoming). "Risk Mitigation Instruments: Risk arrangements in the Bujagali Hydropower Project" Climate Policy Initiative, Venice, Italy.

GDC. 2014 (access). "Steaming ahead- now IPPs move to Menengai". Geothermal Development Company, Kenya. Available at: http://www.gdc.co.ke/index.php?option=com_content&view=category&id=48&layout=blog&Itemid=210

GDC. 2015a. Conversations with Paul Ngugi from the Geothermal Development Company (GDC) on 24th October, 2014 and February, 2015.

GDC. 2015b (access). "Why invest in Geothermal?". Geothermal Development Company, Kenya. Available at: http://www.gdc.co.ke/index.php?option=com_content&view=article&id=193&Itemid=165

GEF. 2001. "Kenya: Olkaria III Geothermal Power Development". Global Environmental Facility. Available at: http://www.thegef.org/gef/sites/thegef.org/files/gef_prj_docs/GEFProjectDocuments/Climate%20Change/Kenya%20Olkaria%20III%20Geothermal%20Power%20Development/Project%20Document%20for%20WP%20(Revised).pdf

GEG. 2014. Conversation with David Hunter from Green Energy Group (GEG), on 20th November 2014.

GENI. 2015 (access). "Geothermal Energy in Kenya". Global Energy Network Institute. Available at: http://www.geni.org/globalenergy/library/renewable-energy-resources/world/africa/geo-africa/geo-kenya.shtml

Gieré R., P.Stille. 2004. "Energy, Waste and the Environment: A Geochemical Perspective (Geological Society Special Publication)". Available at: here.

GoK. 2012. "Feed-in-Tariffs Policy on wind, Biomass, Small-Hydro, Geothermal, Biogas and Solar Resource Generated Electricity". Government of Kenya. Available at: http://www.energy.go.ke/downloads/FiT%20Policy,%202012.pdf

GoK. 2013. "Vision 2030. Updated Least Cost Power Development Plan Study Period 2013-2033". Government of Kenya. Available at: http://erc.go.ke/images/docs/Least_Cost_Power_Development_Plan_2013-2033.pdf.

GoK. 2014. "Draft - National Energy Policy". Government of Kenya, Ministry of Energy and Petroleum. Available at: http://www.kengen.co.ke/documents/National%20Energy%20Policy%20-%20Final%20Draft%20-%2027%20Feb%202014.pdf

Gompers, P. A. 1995."Optimal investment, monitoring, and the staging of venture capital". Available at: http://www.jstor.org/discover/10.2307/2329323?sid=21105735076303&uid=2&uid=4&uid=3738296

ICPAK. 2009. "Kenya Sme Limited Annual Report And Financial Statements For The Year Ended 31st December 2009". Available at: http://www.icpak.com/download.php?a_id=65&download=129

IFC. 2013. "Success of Geothermal Wells: A Global Study". The International Finance Corporation, Washington D.C. Available at: http://www.ifc.org/wps/wcm/connect/7e5eb-4804fe24994b118ff23ff966f85/ifc-drilling-success-report-final.pdf?MOD=AJPERES

IPCC. 2011."IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation", Intergovernmental Panel on Climate Change, Geneva.

IRENA. 2015. "Renewable Power Generation Costs In 2014". International Renewable Energy Agency, Abu Dhabi, United Arab Emirates. Available at: http://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Power_Costs_2014_report.pdf

KenGen. 2014. Expression of interest (EOI) for consultancy services for 140mw Olkaria v geothermal power project implementation kgn-grd-55-2014. Available at: http://www.kengen.co.ke/documents/TenderBrief/KGN%20GRD%2055%20 2014%20EOI%20ADVERT%20Olkaria%20 V%20EoI.pdf.

KenGen. 2015. "Energy Industry and Legislation". Kenya Electricity Generating Company Limited, Nairobi, Kenya. Available at: http://www.kengen.co.ke/index.php?page=aboutus&subpage=energy

KPLC. 2015a (access). "Annual Reports (Archives)". The Kenya Power and Lighting Company Limited, Nairobi, Kenya. Available at: http://www.kplc.co.ke/content/item/40/Annual-Reports-Archives

KPLC. 2015b. "Who we are – Website". The Kenya Power and Lighting Company Limited, Nairobi, Kenya. Available at: http://www.kplc.co.ke/content/item/14/Who-We-Are

Krohmer P., R. Lauterbach, V. Calanog. 2007. "The Bright and Dark Side of Staging: Investment Performance and the Varying Motivations of Private Equity Firms". Goethe Universität Frankfurt, Finance Department. Available at: http://www.ecb.europa.eu/events/pdf/conferences/ecbcfs_conf9/Krohmer.pdf?a7e540a9b3d437732d2b66d87e32a214

Lonsdale A. 2015 (forthcoming)." Multi-Donor Strategy for Geothermal Development in East Africa" Power Africa.

Mariita. 2009. "Exploration history of Olkaria geothermal field by use of geophysics". Kenya Electricity Generating Company, Naivasha, Kenya. Available at: http://www.os.is/gogn/unu-gtp-sc/UNU-GTP-SC-10-0407.pdf

Micale, V., P. Oliver, and F. Messent. 2014. "The Role of Public Finance in Deploying Geothermal: Background Paper". Climate Policy Initiative, Venice, Italy. Available at: http://climatepolicyinitiative.org/wp-content/uploads/2014/10/Geothermal-Background-Final.pdf

Ministry of Energy and Petroleum. 2014. "National Energy Policy". Ministry of Energy and Petroleum, Nairobi, Kenya. Available at: http://www.energy.go.ke/downloads/National%20Energy%20 Policy%20-%20Final%20Draft.pdf

Mizuho Information & Research Institute. 2015. "Joint Credit Mechanism Feasibility Study on Introduction of Small-scale Geothermal Power Generation Unit to the Republic of Kenya – Report". Ministry of Economy, Trade and Industry, Japan. Available at: http://www.meti.go.jp/meti_lib/report/2015fy/000021.pdf

Mugo A. 2015. "Kenya's Geothermal Journey". Presentation Delivered on February 2015 at the Second Geothermal Dialogue. Available at: http://climatepolicyinitiative.org/event/second-geothermal-dialogue/

Musembi R. 2014. GDC's Geothermal Development Strategy For Kenya: Progress & Opportunities. Available at: http://www.geothermal.org/Annual_Meeting/PDFs/Musembi_Presentation.pdf

Mwangi, M. 2005. "Country Update Report for Kenya 2000-2005". Kenya Electricity Generating Company, Naivasha, Kenya. Available at: http://www.geothermal-energy.org/pdf/IGAstandard/WGC/2005/0174.pdf

Ncube, M., C. Lufumpa, L. Ndikumana. 2010. "Infrastructure Deficit and Opportunities in Africa" African Development Bank, Tunis-Belvedère, Tunisia. Available at: http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/ECON%20Brief_Infrastructure%20Deficit%20 and%20Opportunities%20in%20Africa_Vol%20 1%20Issue%202.pdf

Nehme, B.A. 2012. "Renewable Energy Training Program Financing Renewable Energy Projects - PPAs and Tariff Design". Presented at ESMAP Renewable Energy Training October 9, 2012. Available at: https://www.esmap.org/sites/esmap.org/files/ESMAP%20IFC%20Re%20Training%20 World%20Bank%20Nehme.pdf

Newell P., J. Phillips and A. Pueyo with E. Kirumba, N. Ozo, K. Urama. 2014. "The Political Economy of Low Carbon Energy in Kenya" Institute of Development Studies, University of Sussex, Brighton, East Sussex, UK. Available at: http://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/4049/Wp445.pdf?sequence=5

Ngugi, P. 2012a. "Financing The Kenya Geothermal Vision". Geothermal Development Company Ltd, Nairobi, Kenya. Available at: http://www.os.is/gogn/unu-gtp-sc/UNU-GTP-SC-14-14.pdf.

Ngugi, P. 2012b. "What does geothermal cost? The Kenya Experience". Geothermal Development Company Ltd, Nairobi, Kenya. Available at: http://www.os.is/gogn/unu-gtp-sc/UNU-GTP-SC-15-1201.pdf

Oliver, P, and M. Stadelmann. 2015. "Public Finance and Private Exploration in Geothermal: Gümüşköy Case Study, Turkey." Climate Policy Initiative, Venice, Italy. Available at: http://climatepolicy-initiative.org/wp-content/uploads/2015/03/SGG-Report_Public-Finance-and-Private-Exploration-in-Geothermal_Gumuskoy-Turkey1.pdf

OPIC. 2011. "OPIC Board Approves $310 Million for Geothermal Project in Kenya". Overseas Private Investment Corporation, Washington DC, USA. Available at: http://www.opic.gov/press-releases/2011/opic-board-approves-310-million-geothermal-project-kenya

OPIC. 2014. Conversation with Mary Marvenne and Stephane Morel from the Overseas Private Investment Corporation on 7th October 2014

OPIC. 2015. "Homepage". Overseas Private Investment Corporation, Washington, DC, USA. Available at: http://www.opic.gov/

Ormat. 2014a. Conversations with Nachmann Isaac from Ormat Technologies on 25th October 2014, 18th November 2014, 1st and 3rd December 2014.

Ormat. 2014b. "Olkaria III Geothermal Complex in Kenya Reaches 110 MW with Commercial Operation of Plant 3". Ormat Technologies Inc, Reno, NV, USA. Available at: http://www.ormat.com/news/latest-items/olkaria-iii-geothermal-complex-kenya-reaches-110-mw-commercial-operation-plant-3

Ormat. 2014c. "Ormat to Expand Olkaria III Geothermal Complex in Kenya by 24 MW". Ormat Technologies Inc, Reno, NV, USA. Available at: http://www.ormat.com/news/latest-items/ormat-expand-olkaria-iii-geothermal-complex-kenya-24-mw

Ormat. 2015. "Technology". Ormat Technologies Inc, Reno, NV, USA. Available at: http://www.ormat.com/technology

Ouma, P. A. 2008. "Geothermal Exploration and Development of the Olkaria Geothermal Field". Kenya Electricity Generating Company, Naivasha, Kenya. Available at: http://www.os.is/gogn/unu-gtp-sc/UNU-GTP-SC-07-52.pdf

Owens L., E. Porras, P. Spielman and P. Walsh. 2015. "Updated Geologic and Geochemical Assessment of the Olkaria III Field Following Recent Expansion to 110MW" Ormat, 6225 Neil Road, Reno NV. Available at: https://pangea.stanford.edu/ERE/db/GeoConf/papers/SGW/2015/Owens.pdf

Rakhmadi, R and G. Sutiyono. 2015 (forthcoming). "Using private finance to accelerate geothermal deployment: Sarulla Geothermal Power Plant, Indonesia." Climate Policy Initiative, Venice, Italy.

REN21. 2015. "Renewables Interactive Map Country Profile: Kenya", Renewable Energy Policy Network for the 21st Century, Paris, France. Retreived on: 01/16/2015. Available at: http://www.map.ren21.net/Kenya_Renewables_Profile.

Rissmann, B. 2015. Conversation with Bjorne Rissmann (e-mail) on 24th April 2015.

SEC. 2007a. "Amended and Restated Power Purchase Agreement for Olkaria III Geothermal Plant".United States Securities and Exchange Commission, Washington DC, USA. Available at: http://www.sec.gov/Archives/edgar/data/1296445/000095013607001557/file2.htm

SEC. 2007b. "Olkaria III Project Security Agreement". United States Securities and Exchange Commission, Washington DC, USA. Available at: http://www.sec.gov/Archives/edgar/data/1296445/000095013607001557/file3.htm

SEC. 2009. "Form 8-K – Ormat Technologies - Form 8-K Current Report Pursuant To Section 13 Or 15(D) Of The Securities Exchange Act Of 1934 Date Of Report: January 8, 2009" Available at: United States Securities and Exchange Commission, Washington DC, USA. Available at: http://www.sec.gov/Archives/edgar/data/1296445/000119312512372014/d402817d8k.htmhttp://secfilings.nyse.com/filing.php?doc=1&attach=ON&ipage=6064016&rid=23

SEC. 2012a.. "Form 8-K – Ormat Technologies – Current Report Pursuant to Section 13 OR 15(d) of the Securities Exchange Act of 1934 – Date of Report: August 28, 2012". United States Securities and Exchange Commission, Washington DC, USA. Available at: http://www.sec.gov/Archives/edgar/data/1296445/000119312512372014/d402817d8k.htm

SEC. 2012b. "Form 8-K – Ormat Technologies – Current Report Pursuant to Section 13 OR 15(d) of the Securities Exchange Act of 1934 – Date of Report: November 9, 2012" United States Securities and Exchange Commission", Washington DC, USA. Available at: http://www.sec.gov/Archives/edgar/data/1296445/000119312512467790/d438418d8k.htm

SEC. 2012c. "Form 10-K – Ormat Technologies - Annual Report Pursuant To Section 13 Or 15(D) Of The Securities Exchange Act Of 1934 – Date of Report: December 31, 2012"

Think Geoenergy. 2013. "Kenya Power and private developer sign PPA for Longonot project". Available at: http://thinkgeoenergy.naturallygeothermal.is/archives/15136

United States Securities and Exchange Commission", Washington DC, USA. Available at: http://www.sec.gov/Archives/edgar/data/1296445/000119312513100991/d449824d10k.htm#toc449824_19

SEC. 2013a. "Form 8-K – Ormat Technologies – Current Report Pursuant to Section 13 OR 15(d) of the Securities Exchange Act of 1934 – Date of Report: November 25, 2013" United States Securities and Exchange Commission, Washington DC, USA. Available at: http://www.sec.gov/Archives/edgar/data/1296445/000143774913015309/ora20131126_8k.htm

SEC,. 2013b. "Form 10-K – Ormat Technologies – Annual Report Pursuant to Section 13 OR 15(d) of the Securities Exchange Act of 1934 - For the fiscal year ended December 31, 2013" United States Securities and Exchange Commission, Washington DC, USA. Available at: http://www.sec.gov/Archives/edgar/data/1296445/000143774914003113/ora20131231_10k.htm

Shendy R., Z. Kaplan, P. Mousley. 2011. "Towards Better Infrastructure Towards Better Infrastructure Conditions, Constraints, and Opportunities in Financing Public-Private Partnerships - Evidence from Cameroon, Côte d'Ivoire, Ghana, Kenya, Nigeria, and Senegal" World Bank, Washington, DC, USA. Available at: http://www.ppiaf.org/sites/ppiaf.org/files/publication/PPP_Ghana_Book_FINAL.pdf

Simiyu Silar M. 2008. "Status of Geothermal Exploration In Kenya And Future Plans For its Development." Available at: http://theargeo.org/home/files/Kenya/Status%20of%20Geothermal%20Exploration%20in%20Kenya%20and%20Future%20Plans%20for%20Its%20Developmen_Status_Kenya.pdf.

Standard Group. 2015. "Menengai geothermal to save nation Ksh 13 billion". The Standard Group. Available at: http://www.standardmedia.co.ke/thecounties/article/2000147012/menengai-geothermal-to-save-nation-ksh-13-billion

Tole, M. 2015. Conversation with Mwakio Tole on 30th January 2015.

UNFCCC. 2012. "Project Design Document Form for CDM Project Activities (F-CDM-PDD) – Longonot Phase I Geothermal Power Project". United Nations Framework Convention for Climate Change, Bonn, Germany.

UNFCCC. 2013. "Project Design Document form for the CDM activities - Olkaria III Phase 2 Geothermal Expansion Project in Kenya". United Nations Framework Convention for Climate Change, Bonn, Germany.

UNFCCC. 2014. "Component Project Activities Design Document - Akiira I 35 MW Geothermal Project (CPA 001)". United Nations Framework Convention for Climate Change, Bonn, Germany.

U.S. Bureau of Labor Statistics. 2014. "The Puget Sound Economic Forecaster". Prepared by Conway Pedersen Economics, Inc. Washington, DC, USA. Available at: http://www.seattle.gov/financedepartment/cpi/documents/US_CPI_Forecast_--_Annual.pdf

World Bank. 2000. "OrPower 4 Inc. – Project Brief". Washington DC, USA. Available at: http://www.miga.org/projects/index.cfm?pid=331

World Bank. 2002. "OrPower 4 Inc. – Project Brief". Washington DC, USA. Available at: http://www.miga.org/projects/index.cfm?pid=504

World Bank. 2008. "OrPower 4 Inc. – Project Brief". Washington DC, USA. Available at: http://www.miga.org/projects/index.cfm?pid=732

World Bank. 2010. Kenya Electricity Expansion Project. Project Appraisal Document. Washington, DC, February. Retrieved May 3, 2010, from http://documents.worldbank.org/curated/en/2010/05/12217930/kenya-electricity-expansion-project.

World Bank. 2011. "Environmental Audit Report Olkaria III Geothermal Power Plant". Available at: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/01/13/000461832_20140113113240/Rendered/INDEX/E27880V40REV0P00Box382119B00PUBLIC0.txt.

World Bank. 2012a. "Project Appraisal Document on a proposed series of IDA Partial Risk Guarantees in the aggregate amount equivalent to USD 166 million in support of Think Power Limited, Triumph Power Generating Company Limited, Gulf Power Limited, OrPower 4 Inc., for the private sector power generation support project in the Republic of Kenya". World Bank, Washington DC, USA. Available at: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2012/02/09/000386194_20120209002434/Rendered/PDF/663630PAD0P1220Official0Use0Only090.pdf

World Bank. 2012b. "Project Information Document (Pid) Appraisal Stage" World Bank, Washington, DC, USA. Available at: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/AFR/2012/08/10/77A8978CC7F2D61385257A560030DEF1/1_0/Rendered/PDF/PID0Appraisal00102012013445888278 44.pdf

World Bank. 2014. "Addendum to Project Appraisal Document on the private sector power generation support project for a proposed partial risk guarantee in the amount equivalent to USD 5 million in support of sub-project 4b OrPower 4 Geothermal Expansion (plant 3) in the Republic of Kenya". World Bank, Washington DC, USA. Available at: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/03/17/000333037_20140317102751/Rendered/INDEX/839230PAD0IDA0010Box382166B00OUO090.txt

WEBSITES

Central Bank of Kenya. 2015 (access). "Interest rates - Commercial banks weighted average rates". https://www.centralbank.go.ke/images/docs/Research/CSV/Nov2014/CormercialbanksWeightedAverageRates.csv

GDC. 2015 (access). Geothermal Development Company. Available at: http://www.gdc.co.ke/

KenGen. 2015 (access). Kenya Electricity Generating Company Limited, Nairobi, Kenya. Available at: http://www.kengen.co.ke/

Oanda. 2015 (access). "Historical Exchange Rates". Available at: http://www.oanda.com/currency/historical-rates/

Ormat. 2015 (access). Ormat Technologies Inc, Reno, NV, USA. Available at: http://www.ormat.com/

Trading Economics. 2015 (access). "Kenyan Shilling 1993-2015". Available at: http://www.tradingeconomics.com/kenya/currency