GDC’S GEOTHERMAL DEVELOPMENT STRATEGY FOR KENYA: PROGRESS & OPPORTUNITIES

BY RUTH MUSEMBI
HEAD OF CORPORATE COMMUNICATION & MARKETING

DURING THE

POWER AFRICA-AFRICA UNION COMMISSION GEOTHERMAL ROADSHOW
SEPTEMBER - OCTOBER 2014
Introduction

- The provision of reliable and affordable electricity is indispensable to the social and economic development of any country.

- In Kenya, electricity is at the core of our national development agenda as enumerated by the Vision 2030.
GDC OVERVIEW

OWNERSHIP
- GDC is a special purpose Company wholly owned by the GoK, Incorporated on 2nd December 2008

MAIN OBJECTIVE
- To facilitate the development of 5000 MW by 2030

CORE ACTIVITIES
- Prospect for geothermal resources and develop them for steam sale

POWER GENERATION
- Through competitive bidding, Steam will be offered to local and international investors who will put up power plants
GDC Mandate

**Upfront Works**
- Remove upfront risks
- Reduce costs through infrastructural development, exploration works and production drilling

**Direct Use**
- Develop direct uses of geothermal

**Capacity Development**
- Develop human capacity
- Manage public resources such as rigs
- Provide consultancy services

**Funding**
- Support GoK in fund mobilization

**Power Plant**
- Support Private Sector entry
- Sell steam to power producers
Geothermal in Kenya (10,000MW)

- Suswa,
- Longonot,
- Olkaria,
- Eburru,
- Menengai,
- Arus-Bogoria,
- Lake Baringo,
- Korosi,
- Paka,
- Lake Magadi,
- Badlands,
- Silali,
- Emuruangogolak,
- Namarunu
- Barrier
- Mwananyamala
- Homa Hills
- Nyambene
- Chyulu Hills
# Kenya’s Current Power Mix

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>Installed Capacity (MW)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>816</td>
<td>40%</td>
</tr>
<tr>
<td>Thermal</td>
<td>651.4</td>
<td>31.5%</td>
</tr>
<tr>
<td>Geothermal</td>
<td>550.4</td>
<td>27%</td>
</tr>
<tr>
<td>Cogeneration</td>
<td>26</td>
<td>1.26%</td>
</tr>
<tr>
<td>Wind</td>
<td>5.3</td>
<td>0.27%</td>
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<tr>
<td>Isolated Grid</td>
<td>17</td>
<td>0.83%</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>2066.1</strong></td>
<td><strong>100%</strong></td>
</tr>
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</table>

The plan is to make geothermal the base load owing to its abundance and availability.
Electricity Landscape in Kenya

Installed Capacity

2,066 MW

High Cost

-~ KES 17.87

Peak Demand vs. Supply

Low Base-Load Capacity

Expensive Thermal Plants

Slow rate of addition of clean & stable geothermal
Kenya’s Vision 2030 Vs Demand

- National Target: 23,000MW required
- Why: To achieve a Newly industrialising Middle-Income status
- GDC’s Target: 5,000MW by 2030; 810MW by 2016
Why the Focus on Geothermal in Kenya?

• Climate change has made hydro power unreliable
• Geothermal is abundant – Kenya (10,000+MW)
• Green – no emissions
• Least cost source of power for Kenya
• Indigenous resource
• Not affected by adverse weather conditions
• High Availability (>95%)
• Cost of power can be predictable over the plant life
• Technology already successful in Kenya
Challenges of Developing Geothermal in Kenya -
Long Gestation Periods

- Started drilling in 1954
- **45 MW Olkaria I (KPLC/KenGen)**
  - Took **30 YEARS** from 1955 to 1985

- **105 MW Olkaria (KenGen)** - Started 1986
  - Unit 1 & 2 - 2003 (17 years)
  - Unit 3 - 2009 (23 years later)

- **280MW Olkaria IV & I (KenGen)** - started 1998
  - Commissioning – December 2014 (16 years)

- **100 MW Olkaria III (OrPower4)** – Started 1998
  - 48 MW Phase 1 - 2009 (11 years)
  - 72MW Phase 2 – 2014 (16 years)
CURRENT GEOTHERMAL DEVELOPMENT STATUS
GDC Geothermal Development Strategy

Reduce Cost & Time
> Use own rigs to drill
> Modular Power plants for early development revenue
> Competitive bidding

Reduce Upfront Risks
> Undertake detailed exploration
> Exploratory drilling
> Conduct Feasibility Studies

Promote Direct Use
> Avail brine for heating
> Avail water
> Avail other products for Industrial uses

Sustainable geothermal Development
> Fundraising
> Manage the steam fields
> Capacity building
> Seek local financing option

5,000 MW by 2030
> At least 12 rigs in Kenya
> Drill at least 1,400 wells
GDC’s Role in Geothermal Development

KPLC (Off-Taker) → Off-Taker 2 → KenGen/IPP

Off-Taker 2 → Power Purchase Agreement → Off-Taker 3

KenGen/IPP → Geothermal Resource Exploration & Assessment

Geothermal Prospects:
- Olkaria
- Mene-ngai
- Paka
- Silali
- Bogoria

Geothermal Development Company*
GDC’s PUBLIC PRIVATE PARTNERSHIP - OPTIONS

VIABILITY ANALYSIS
- DETAILED SURFACE STUDIES
- INFRASTRUCTURE DEVELOPMENT
- EXPLORATION DRILLING
- APPRAISAL DRILLING
- FEASIBILITY STUDY

IMPLEMENTATION
- PRODUCTION DRILLING
- STEAM GATHERING
- POWER PLANT CONSTRUCTION

INCOME
- OPERATION AND MAINTENANCE
- STEAM FIELD MANAGEMENT

POWER GEN. OPTION
- JOINT STEAM DEV.
- PROD. DRILLING & POWER GEN
- STEAM DEV. & GEN.
- FULL CONCESSION

GDC
- IPP
- GDC
- IPP
- IPP
- IPP
- GDC

EQUITY FINANCE OR SOVEREIGN LOAN
- EQUITY & DEBT FINANCE
- REVENUE FINANCE
Development Model – Option I

MENENGAI 460MW

INFRASTRUCTURE AND EXPLORATION DRILLING

APPRAISAL DRILLING

FEASIBILITY STUDY

PRODUCTION DRILLING

STEAM GATHERING SYSTEM

CONSTRUCTION & OPERATION OF POWER PLANT

ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN

Sale of steam

GDC

EPC

IPP
Development Model – Option II

GDC

GDC (20-40%)

IPP

USAID is offering Technical Assistance for the Development of the JDA document

Joint Development partner (60%)

INFRASTRUCTURE DEVELOPMENT/EXPLORATION DRILLING

APPRAISAL DRILLING AND FEASIBILITY STUDY

PRODUCTION DRILLING

CONSTRUCTION AND MANAGEMENT OF STEAM GATHERING SYSTEM

CONSTRUCTION & OPERATION OF POWER PLANT

Sale of steam

ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN

GDC & JDP
Impact of the PPP options on tariffs

Example: A 50 MWe power plant

Scenario 1: IPPs Entering BEFORE Test Drilling 14 – 17 US cents per kWh

Investors prefer this option – RoI of approx. 25%, hence better returns

Scenario 2: IPPs entering after Test Drilling (GDC has removed most of the upfront risks 6.5 – 10.5 US cents per kWh

Scenario II lowers tariffs thus reduces the cost of business and living costs (an RoI – 18%– still good hence a win-win approach for investors and the country
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<thead>
<tr>
<th>NO</th>
<th>PARTNER</th>
<th>Amount (MUSD)</th>
<th>PURPOSE</th>
<th>Status</th>
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<tbody>
<tr>
<td>1</td>
<td>AFDB</td>
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<td>3 rigs, 90 wells materials, 1 wellhead, consultancies &amp; training</td>
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<td>2</td>
<td>SREP</td>
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<td>Drilling services</td>
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<tr>
<td>3</td>
<td>AFD</td>
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<td>2 rigs and business and strategic plan update</td>
<td>Rigs commissioned, business and strategic plans update ongoing</td>
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<td></td>
<td></td>
<td>100</td>
<td>Steam field, rig spares, drilling and pipeline consultancies</td>
<td>Pledged- Awaiting feasibility study report</td>
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<tr>
<td>4</td>
<td>World Bank</td>
<td>2</td>
<td>Feasibility study</td>
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<td>Amount (MUSD)</td>
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<tr>
<td>5</td>
<td>GRMF</td>
<td>6</td>
<td>Drilling of 2 wells</td>
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<tr>
<td>6</td>
<td>KfW</td>
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<td>Infrastructure development, Drilling services and consultancies</td>
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<td>11</td>
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<td>Capacity building, equipment, conceptual model for Silali</td>
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<tr>
<td>12</td>
<td>US Exim Bank</td>
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<td>Pledge</td>
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<tr>
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<td>Drilling services and materials, civil equipment</td>
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<td>EIB</td>
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<td>Financial management appraisal</td>
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<td>17</td>
<td>China Exim Bank</td>
<td>95.4</td>
<td>Drilling of 26 wells at Olkaria</td>
<td>Complete</td>
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</table>
## PROGRESS/SCORE CARD

### Wells Drilled
- Olkaria – 59 wells
- Menengai – 25 wells

### Steam available
- Olkaria – 409MW
- Menengai – 90MW

### Drilling rigs
- 3 drilling rigs hired and have drilled at Olkaria
- 7 GDC owned drilling rigs procured.

### Funds raised (MUSD)
- **Committed**
  - GoK-445
  - Development Partners-512

- **Pledges**
  - Development Partners-754

### 5 yrs (2009 – 2014)

<table>
<thead>
<tr>
<th>Wells</th>
<th>MW</th>
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</thead>
<tbody>
<tr>
<td>Planned: 206</td>
<td>Planned: 280</td>
</tr>
<tr>
<td>Current: 83</td>
<td>Current: 480</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Rigs</th>
<th>Funding (MUSD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned: 12</td>
<td>Planned: 1,357</td>
</tr>
<tr>
<td>Current: 7</td>
<td>Current: 957</td>
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</tbody>
</table>
## Planned Projects to Harness 810MW Plan

<table>
<thead>
<tr>
<th>Project</th>
<th>Size</th>
<th>Commissioning</th>
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</thead>
<tbody>
<tr>
<td>460MW MENENGAI</td>
<td>100MW</td>
<td>Dec 2014</td>
</tr>
<tr>
<td></td>
<td>60MW</td>
<td>June 2015</td>
</tr>
<tr>
<td></td>
<td>100MW</td>
<td>Dec 2015</td>
</tr>
<tr>
<td></td>
<td>100MW</td>
<td>June 2016</td>
</tr>
<tr>
<td></td>
<td>100MW</td>
<td>Dec 2016</td>
</tr>
<tr>
<td>150MW SUSWA</td>
<td>100MW</td>
<td>June 2016</td>
</tr>
<tr>
<td></td>
<td>100MW</td>
<td>Dec 2016</td>
</tr>
<tr>
<td>200MW BARINGO-SILALI</td>
<td>100MW</td>
<td>June 2016</td>
</tr>
<tr>
<td></td>
<td>100MW</td>
<td>Oct 2016</td>
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</table>
100MW MENENGAI PROJECT

• 3 IPP’s already contracted to finance, procure and operate three modular power plants, on a build-own-operate basis, to be commissioned in Sept. 2015
  o Ormat International
  o Quantum Power EA
  o Sosian Energy

• PSSAs and PPAs submitted to ERC

• 2 IPPs have applied for generation licence from ERC
60MW MENENGAI PROJECT (30MW x 2)

- To be commissioned in Dec 2015
- Approval from PPP Secretariat obtained
- Tendering for 60MW closed
<table>
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<th>NO.</th>
<th>FIRM</th>
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<tr>
<td>1</td>
<td>Trans century Limited</td>
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<td>2</td>
<td>Power Machines OJSC</td>
<td>Russia</td>
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<td>3</td>
<td>SOSIAN ENERGY CONSORTIUM</td>
<td>Kenya</td>
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<tr>
<td>4</td>
<td>Allan Dick &amp;Co East Africa Ltd And Arabian Bemco Contracting Company Limited</td>
<td>Kenya/Saudi Arabia</td>
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<td>5</td>
<td>Toyota Tsusho Corporation</td>
<td>Japan</td>
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<tr>
<td>6</td>
<td>Daewoo International</td>
<td>Korea</td>
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<tr>
<td>7</td>
<td>Lantech (Africa) Ltd/China National Cable Engineering Corporation</td>
<td>Kenya/China</td>
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<td>8</td>
<td>Shandong Zhongkai Heavy Industry Group Co. Ltd</td>
<td>China</td>
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<td>The Mirambo Energy Consortium</td>
<td>Tanzania</td>
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<tr>
<td>No.</td>
<td>Firm</td>
<td>Country of Origin</td>
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<td>10</td>
<td>International Power S.A, Dubai Branch</td>
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<td>Kenya/China</td>
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<td>Usa</td>
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<tr>
<td>17</td>
<td>East Gate Power Limited</td>
<td>Kenya</td>
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<td>18</td>
<td>Consortium Of Africon Limited, Punj Lloyd Limited, Oserian Development Company Limited</td>
<td>Kenya</td>
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</tbody>
</table>
Potential – 750MW

- Development of 150MW by 2016
- ESIA in progress
- Community engagement ongoing
- Joint equity investors already invited to express interest for Joint development
# 300MW SUSWA JDA EOI SHORTLIST

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<tr>
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<th>Company</th>
<th>Country</th>
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<td>1</td>
<td>GLOBELEQ</td>
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<tr>
<td>2</td>
<td>MAYIRA LTD/ PATH FINDER/ HARBEL ELETTRIC</td>
<td>Kenya</td>
</tr>
<tr>
<td>3</td>
<td>FUJIAN INVESTMENTS</td>
<td>China</td>
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<tr>
<td>4</td>
<td>BIXIAN COAL LTD</td>
<td>China</td>
</tr>
<tr>
<td>5</td>
<td>RAM ENERGY</td>
<td>USA</td>
</tr>
<tr>
<td>6</td>
<td>INTERNATIONAL POWER S.SA-GDF SUEZ</td>
<td>Belgium</td>
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<td>7</td>
<td>MARUBENI CORPORATION</td>
<td>Japan</td>
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<td>ENEL GREEN POWER S.P.A</td>
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<td>SALWAN K LTD</td>
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<td>TOYOTA TSUSHO CORP</td>
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<td>Russia</td>
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<td>British Virgin Islands</td>
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<td>18</td>
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<td>ORMAT INTERNATIONAL INC.</td>
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<td>CHINA STATE CONSTRUCTION ENGINEERING LTD</td>
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<td>Russia</td>
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<td>Kenya</td>
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</table>
BARINGO-SILALI PROJECT

Potential – 3000MW

- 200MW to be developed by December 2016
- Environmental License and Land approval obtained
- Community engagement framework established
- GDC has advertised for equity investors to jointly develop the steam field with GDC
# 800MW Baringo-Silali JDA Shortlist

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<td>6</td>
<td>TRANSCENTURY LTD</td>
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Capacity Building

• Carried out through Internal training, on- the job training, assistance by international geothermal institutions, consultancies and collaboration with well established geothermal companies for on-job training.

• GDC has received support from the following institutions and partners in providing capacity building to its staff:
  • USTDA (USA)
  • UNU-GTP (Iceland)
  • University of Auckland (New Zealand)
  • University of Kyushu (Japan)
  • BGR (Germany)
  • NDF (Norway)
  • AFD (France)
  • AfDB
UNU Fellows in Iceland 1979-2012

GDC has more than half of the UNU-trained technical officers in Kenya.
Our technical staff have obtained specialized training at various institutions:

a) Institute for Geothermal Research, Pisa –Italy (Volcanology)
b) University of Kyushu, Japan (Resource Utilization)
c) University of Auckland, New Zealand (Theory)
d) US Universities (Duke –NC, Stanford, Rice -TX Berkley, Reno, Utah, Elpaso-TX) AfdB, WB Support
e) Internal drilling technology, Petro-Canada, Petroskill, Weatherford (Local)
f) UNU-GTP, Iceland (All round applied course)
g) UNU-GTP/GDC/KenGen Short Course in Kenya
Additional investment opportunities - direct use

Geothermal Resources

Steam
- Electric power generation
- Industry
- Dyeing
- Production of H₂SO₄ for scale prevention
- Agriculture and forestry
- Live stock
- Therapeutics
- Public welfare
- Hotel and sightseeing
- Production of H₂ for fuel cell
- Extraction of chemical materials
  - Na, K (Mexico) → fertilizer
  - Zinc (USA)
  - Silica, Li (Japan)
  - Boron (Japan, Turkey)

Hot Water

Conventional Electric Generation
- Refrigeration by ammonia absorption
- Digestion in paper pulp
- Drying of fish meal
- Alumina via Bayer's process
- Canning of food
- Evaporation in sugar refining
- Evaporation
- Drying and curing of cement blocks
- Drying of agricultural products
- Drying of stock fish
- Space heating (buildings and greenhouses)
- Cold storage
- Air conditioning
- Animal husbandry
- Soil warming
- Fishing pools, de-icing
- Fish farming

Binary fluid Electric Generation
- Space heating With heat pumps

Saturated steam
- Temp. °C
- 200
- 180
- 160
- 140
- 120
- 100
- 80
- 60
- 40
- 20
- 0

Hot water
THANK YOU