KENYA COUNTRY UPDATE

PEKETSA MANGI & DR. PETER OMENDA

ARCEO C6, 2ND – 6TH NOV 2016
Kenya In Africa

44 MILLION PEOPLE

LOCATION: Eastern part of Africa

INSTALLED CAPACITY: 2.3GW

POWER OUTPUT: 8,840 GWh

TOTAL GEOTHERMAL INSTALLED CAPACITY: 676.8 MW (30%)

GEOTHERMAL POTENTIAL: > 10,000MW
Power Sector Overview

Electricity sub sector unbundled

- GDC – steam developer
- IPPs
- KenGen
- Imports
- REA
- KETRACO – Transmission operator
- KPLC – Distribution/Supply
- Customers

Ministry of Energy and Petroleum

Energy Tribunal

ERC
Demand and Supply for the Country

Peak demand estimated to reach 7,000 MW by 2025, requiring 8,100 MW generation capacity at a 15% reserve margin

900 MW excess contracted capacity expected by 2025 with 15% reserve margin – speed will be key to deliver projected plan

Capacity increases significantly as Lamu (960 MW) and Kitui (960 MW) coal plants come online

SOURCE: Team analysis; KPLC PPA list of projects, interviews with most developers, KenGen, ERC Kenya ten year power sector expansion report
Geothermal Sites in Kenya

• 23 prospects
• Located within the Kenya rift which is part of the continental East African Rift system
• Three (3) fields are currently under development, namely, (a) Olkaria [KenGen, OrPower, AKIIRA], (b) Eburru [KenGen], and (c) Menengai [GDC]
• Other prospects are at exploration stage
History of Geothermal Development in Kenya


- Discovery well was drilled in 1975 (OW-2)

- Appraisal and production wells drilled at Olkaria between 1975-1981

- 1st geothermal power plant commissioned in stages: 1981-1985 (45MW)
• Testing of well OW-X2 at Olkaria on 8\textsuperscript{th} September 1971
• 1\textsuperscript{st} geothermal well to discharge high pressure steam in Kenya
### Geothermal generation

#### Public Sector
- KenGen
- GDC

#### Current Private Investments
- OrPower4 Inc. (Ormat) (139MW)
- Oserian Development Company (4.3MW)

#### Coming soon:
- AGIL
- Marine Power (AkiiraOne)
Global Geothermal Development

- First African country to develop commercial Geothermal Energy utilization
- One of the fastest growing geothermal markets in the World
- World’s seventh largest geothermal power producer
- Current installed interconnected capacity= 676.8 MWe

Modified from GEA, 2013: Geothermal Power International Market overview report
DRILLING AT OLKARIA GEOTHERMAL FIELD, NET ORPOWER AND AKIIRA WELLS

287 DRILLED WELLS
## TOTAL GEOTHERMAL INSTALLED CAPACITY 2016

<table>
<thead>
<tr>
<th>Project</th>
<th>Series</th>
<th>Year</th>
<th>Status</th>
<th>Type</th>
<th>Capacity</th>
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<tr>
<td>Menengai</td>
<td>Menengai</td>
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<td>3</td>
<td>Construction Ongoing</td>
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<td>Silali</td>
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<td>2017**</td>
<td>NYD</td>
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<td>Longonot</td>
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<td>&quot;</td>
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<td>&quot;</td>
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<td>Eburru</td>
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<td>&quot;</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
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<td>676.8</td>
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</table>

Key: 1F- Single Flash. B- Binary
# Direct Uses in Kenya

<table>
<thead>
<tr>
<th>Use</th>
<th>Installed Capacity $^1$</th>
<th>Annual Energy Use $^2$</th>
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<tbody>
<tr>
<td></td>
<td>(MWt)</td>
<td>(TJ/yr = $10^{12}$ J/yr)</td>
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<tr>
<td>Individual Space Heating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>District Heating</td>
<td></td>
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</tr>
<tr>
<td>Air Conditioning (Cooling)</td>
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<td>Greenhouse Heating</td>
<td>16</td>
<td>126</td>
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<tr>
<td>Fish Farming</td>
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<tr>
<td>Animal Farming</td>
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<td>Agricultural Drying</td>
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<td>10</td>
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<tr>
<td>Industrial Process Heat</td>
<td></td>
<td></td>
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<tr>
<td>Snow Melting</td>
<td></td>
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<tr>
<td>Bathing and Swimming</td>
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<td>46</td>
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<tr>
<td><strong>Subtotal</strong></td>
<td><strong>22.4</strong></td>
<td><strong>182</strong></td>
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<tr>
<td>Geothermal Heat Pumps</td>
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<td><strong>TOTAL</strong></td>
<td><strong>22.4</strong></td>
<td><strong>182</strong></td>
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Geothermal utilization

Orpower4 - 1998-2016 (139MW)

Greenhouse heating

Panoramic view of the Olkaria Geothermal Spa
45 MW Olkaria I Power Plant
105 MW Olkaria II Power Plant
150 MW Olkaria IV
Olkaria I Units 4 and 5 (150MW)
5MW Wellhead Unit at Olkaria
(i) Cut Roses Greenhouse Heating (50 acres), (ii) Fumigation of soils and sterilization of liquid recycled plant fertilizers, (iii) carbon dioxide enrichment
Eburru Geothermal field
Geothermal Outlook: 2015-2017
Geothermal Growth Projections for Kenya

- Estimated Potential = 10,000MW
- Installed capacity – 676.8 MWe
- Target by 2017: 1,967MWe
- Target by 2030: 5,000MWe
- Direct use energy growth from current installed capacity of 22.4MW_t to > 200MW_t by 2020

<table>
<thead>
<tr>
<th>Year</th>
<th>MWe</th>
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<td>2012</td>
<td>267</td>
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<tr>
<td>2013</td>
<td>267</td>
</tr>
<tr>
<td>2014</td>
<td>630</td>
</tr>
<tr>
<td>2015</td>
<td>735</td>
</tr>
<tr>
<td>2016</td>
<td>1967</td>
</tr>
<tr>
<td>2017</td>
<td>5000</td>
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Additional Power plants at Olkaria

- 140 MW Olkaria V – Ground breaking: December 2016
- Expected commissioning 2018
- 70 MW Olkaria 1 AU 6 by 2018/2019

- 140 MW PPP Project Expected commissioning: 2018/2019
Additional capacity at Olkaria

46.3 MW Modular power plants (Package 1 & 2)

Advertised 22nd Sep 2016. Closing: 22nd December 2016 Expected commissioning 2018
Menengai Geothermal field: 105MW Phase 1

- Drilling ongoing for 105MW power plants
- 7 drill rigs being used
- Power plant commissioning expected in 2017/18
- Additional 60MW plant expected by 2019
Menengai Geothermal Field

- 30 wells so far drilled within caldera floor
- Maximum temp ~400°C at 2.3km depth – hottest well in Kenya!
- Well output of up to 32MWe
- Dry and wet wells present
Drilling Rig at Menengai Field

Photo of one of the 7 rigs currently drilling at Menengai field
Baringo-Silali Geothermal Prospect

• Comprise Baringo, Korosi, Paka and Silali prospects
• Planned for 200MWe Phase 1 development
• Road and water works under construction
• Drilling expected to commence in 2017
• Financing from KfW, UNEP, JICA and Government of Kenya
Other Geothermal Projects

- AGIL, Inc. to start exploration drilling at Longonot prospect in 2017. Target 70MWe by 2019

- GDC to develop Menengai Phase 2 - 60MWe by 2019


- GDC is planning to undertake exploration drilling in Suswa in 2017 (150MWe).
## Total Investments in Geothermal in 2014

<table>
<thead>
<tr>
<th>Period</th>
<th>Research &amp; Development Incl. Surface Exploration &amp; Exploration Drilling</th>
<th>Field Development Including Production Drilling &amp; Surface Equipment</th>
<th>Utilization</th>
<th>Funding Type</th>
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<tbody>
<tr>
<td></td>
<td>Million US$</td>
<td>Million US$</td>
<td>Million US$</td>
<td>Million US$</td>
</tr>
<tr>
<td>1995-1999</td>
<td>9</td>
<td>5</td>
<td>0</td>
<td>14</td>
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<tr>
<td>2000-2004</td>
<td>0.1</td>
<td>20</td>
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<td>194</td>
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<td>2005-2009</td>
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<td>186</td>
<td>0</td>
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<td>2010-2014</td>
<td>17</td>
<td>1,004</td>
<td>1</td>
<td>1,137</td>
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Olkaria Model

KenGen

SURFACE EXPLORATION

EXPLORATION, APPRAISAL AND PRODUCTION DRILLING

FEASIBILITY STUDY

CONSTRUCTION AND MANAGEMENT OF STEAM GATHERING SYSTEM

CONSTRUCTION & OPERATION OF POWER PLANT

ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN
GDC Model 1

SURFACE EXPLORATION

EXPLORATION, APPRAISAL AND PRODUCTION DRILLING

FEASIBILITY STUDY

CONSTRUCTION AND MANAGEMENT OF STEAM GATHERING SYSTEM

Sale of steam

CONSTRUCTION & OPERATION OF POWER PLANT

PRIVATE ENTITY

GDC & PRIVATE PLAYER

ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN
GDC Model 2

GDC & Private Sector

SURFACE EXPLORATION AND EXPLORATION DRILLING

EXPLORATION, APPRAISAL AND PRODUCTION DRILLING

FEASIBILITY STUDY

CONSTRUCTION AND MANAGEMENT OF STEAM GATHERING SYSTEM

CONSTRUCTION & OPERATION OF POWER PLANT

Sale of steam

ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN

GDC

EPC

PRIVATE ENTITY

GDC & PRIVATE PLAYER
Conclusions

Kenya is the new global investment hub for geothermal development.

Opportunities include the following:
- Supply of steamfield and power plant equipment
- Supply of drilling materials and services
- Engineering and scientific consultancies
- EPC contracts
- IPP
GROWTH CATALYSTS

- Resource availability
- Bilateral partners support
- Regulatory framework – Both Public and Private sector participation
- Government commitment
- Expertise and equipment
- Environmental management - mitigation of geothermal dev impacts
THANK YOU