OPPORTUNITIES FOR DIRECT UTILIZATION OF GEOTHERMAL ENERGY IN EBURRU AREA, KENYA

Cornelius Ndetei
Environmental Scientist
Kenya Electricity Generating Co. Ltd

6th African Rift Geothermal Conference (ARGEO-C6)
United Nations Conference Centre – Addis Ababa, Ethiopia
3rd November, 2016
Outline

1 Introduction
2 Current Situation
3 Opportunities for direct utilization
4 Envisaged benefits
5 Recommendations
INTRODUCTION

Geothermal energy is natural heat energy from the earth’s interior

Transmitted:
   i) Conduction
   ii) Convection fluids via fractures and pores in the rocks
Geothermal Resource Utilization

1. Indirect utilization
   - Electricity generation

2. Direct utilization
   - Non-electric utilization
Electricity Generation

- High to medium enthalpy resource
- 24 countries worldwide
- Installed capacity 12.6GWe
GEOTHERMAL INSTALLED CAPACITY (IN MWe)

Total installed capacity (2015): 12,635MWe

Source: Bertani R., Proceedings WGC, 2015
Direct Utilization

- Oldest, most versatile & common form
- Medium to low enthalpy resource
- 82 countries worldwide
- Installed capacity 70,329 MWt

Fish drying in a geothermal tunnel dryer in Iceland
Greenhouse heating in Tunisia (~244 Ha)
Direct Energy - Installed vs Utilized

World-Wide Installed Capacity for Direct Uses
- Geothermal heat pumps: 70.95%
- Bathing & Swimming: 13.00%
- Space heating: 10.74%
- Greenhouse heating: 0.99%
- Aquaculture pond heating: 0.87%
- Industrial uses: 0.51%
- Cooling/Snow melting: 0.23%
- Agricultural drying: 0.11%
- Others: 0.00%

The 5 leading countries (2015): USA, China, Sweden, Germany & France

World-Wide Utilization of Geothermal Resource
- Geothermal heat pumps: 55.30%
- Bathing & Swimming: 20.31%
- Space heating: 15.01%
- Greenhouse heating: 4.54%
- Aquaculture pond heating: 1.78%
- Industrial uses: 0.35%
- Cooling/Snow melting: 0.25%
- Agricultural drying: 0.11%
- Others: 0.00%

The five leading countries (2015): China, USA, Sweden, Finland, Canada
Kenya’s geothermal potential in excess of 10GWe

Endowed within the Kenyan Rift

Over 23 geothermal fields/prospects

Installed capacity: 677 MWe

Direct utilization of geothermal in Kenya has been low (22.4MWt).
Direct Utilization – Oserian Greenhouse heating

- KenGen has leased well OW-101 (1.28MWe) to ODCL
- Geothermal used for greenhouse heating (50 Ha of roses)
- Controlled temp & humidity conditions
- Limit fungus growth
- CO₂ extracted to aid in photosynthesis
Direct Utilization – Bathing & Swimming

- Olkaria Geothermal Spa (Capacity: 4.4MW\textsubscript{t})
  - Promoted tourism at Hell’s Gate National Park
  - Increased revenue

- L. Bogoria Resort Hotel (0.4MW\textsubscript{t})
  - Water from a natural hot spring used in the swimming pool
Located within the Kenyan Rift

40km north of Olkaria at the foot of Mau escarpment

Potential of over 60MWe

- Only EW-01 was thermally productive.
- KenGen has put up a 2.4 MWe Plant (Jan, 2012)
- Plans to put up a 25 MWe plant
Current Situation in Eburru

- Geothermal potential is ~60 MWe
  - Only 2.4 MWe harnessed for power generation
  - ~1 MWt for direct use (agricultural drying)

- Water is scarce in the area
  - Steam condensed from fumaroles using traditional techniques

- Pyrethrum is the main cash crop grown;
  - No commercial factory exists for drying
  - Employ traditional techniques using geothermal
  - This is on small scale & uncoordinated
Great opportunities exist for direct uses of geothermal in Eburru

The proposed forms for direct uses include:
- Upgrading the steam harvesting system
- Drying & dehydration
- Pasteurization
- Poultry hatching
- Geothermal steam bath

Platform for KenGen to showcase direct uses of geothermal
(i) Upgraded Condensate Harvesting System

- Eburru local community condenses steam from naturally occurring fumaroles

- Two shallow steam wells drilled in 1950s used to provide potable water.

- Inefficiency: Substantial leakages of steam & condensed water.

- The water harvesting technique can be upgraded to allow for large scale harvesting.
KenGen has fabricated a condenser for watering wild animals at HGNP-Olkaria.

- Condensed steam: 4,500 litres per day.

Design & fabrication of condensers for Eburru in progress.

- 7 condensers each with estimated capacity of 6,000 Litres per day.
(ii) Geothermal Steam Bath

- Bathing & swimming, including balneology
- Used in over 70 countries
- Leading countries: China, Japan, Turkey, Brazil, Mexico
- Geothermal water used for therapeutic purposes
Cont’d Geothermal Steam Bath

- A steam sauna is proposed at Eburru to utilize the naturally occurring geothermal steam from the shallow steam wells.

- Besides being a great form of relaxation, steam bathing has a lot of health as well as beauty benefits.

- A steam bath relaxes overworked and stressed muscles, reducing aches and pains.
(iii) Pasteurization

- Quality of milk deteriorates rapidly due to enzyme activity & growth of micro-organisms

- Milk is processed using high-temperature treatments such as pasteurization or the ultra-high temp (UHT) process

- Eburru area has favorable conditions for dairy farming and hence developing techniques for milk preservation will benefit many.
Cont’d Pasteurization

- Milk pasteurized using hot geothermal water
- Involves applying heat exchange technology.
- Examples: Romania, New Zealand

Milk pasteurization using geothermal hot water
(iv) Chicken Hatchery & Brooders

- Incubators and brooders often result in higher hatch rates due to the ability to control both temperatures and humidity.

- The simplest incubators are insulated boxes with an adjustable heater, typically going up to 60°C - 65°C.

- Geothermal heat can be utilized to provide adequate and constant heat for such uses.

- The Eburru project will involve design and fabrication of a commercial hatchery.
(v) Agricultural Crop Drying

- Used in over 15 countries to dry vegetables, fruits & cereals
- Largest uses are in China, USA & Hungary
- Examples:
  - Seaweed (Iceland)
  - Onions (USA)
  - Fruits (El Salvador)
  - Wheat & other cereals (Serbia)
  - Lucerne (New Zealand)
Cont’d Agricultural Crop Drying

- Pyrethrum drying at Eburru using geothermal
  - Capacity: 1MWt

- However, this is uncoordinated and is on a very small scale.

- Propose to rehabilitate the drier
  - Opportunities for drying pyrethrum, fruits, vegetables & cereals
A cascaded use of geothermal energy at Eburru is proposed. The project will comprise of the following:

- Upgraded steam harvesting system
- Large scale agricultural drying
- Pasteurization
- Poultry hatching
- Geothermal steam bath

The proposed developments will promote research

Development used as a demonstration center to showcase direct utilizations of geothermal resource.
## Cost Estimates (USD)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Estimated Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical evaluation of the existing two wells at Ex-Peter (Depth, temp, fluid chemistry, energy potential)</td>
<td>5,000</td>
</tr>
<tr>
<td>Environmental/Social assessment, approvals &amp; permits</td>
<td>10,000</td>
</tr>
<tr>
<td>Repair and maintenance of the two existing wells at Ex-Peter</td>
<td>10,000</td>
</tr>
<tr>
<td>Upgrading steam harvesting system</td>
<td>10,000</td>
</tr>
<tr>
<td>Repair of existing drier at Ex-Peter</td>
<td>15,000</td>
</tr>
<tr>
<td>Geothermal steam bath facility</td>
<td>50,000</td>
</tr>
<tr>
<td>Pasteurization</td>
<td>10,000</td>
</tr>
<tr>
<td>Chicken hatchery and brooders</td>
<td>5,000</td>
</tr>
<tr>
<td><strong>Grand Total Cost</strong></td>
<td><strong>115,000</strong></td>
</tr>
</tbody>
</table>

Currency conversion: 1 $=KES 101
RECOMMENDATIONS

- Set up a cascaded use of geothermal energy near the Eburru drier community project.
- Need to evaluate the energy potential from the two existing shallow steam wells to establish optimum applications.
- Secure land for development of the proposed direct applications.
- Solicit for funds
Thank you