Djibouti Geothermal Project

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Reykjavik Energy Invest
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Geothermal Energy for Sustainable Development
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Entebbe, Uganda
Reykjavik Energy

- Reykjavik Energy is the largest geothermal utility company in Iceland, and one of the largest geothermal companies in the world.
- The company provides electricity and hot and cold water to its customers.
- Currently the company produces 330 MW of electric power and 1000 MW of thermal power from geothermal sources.
- In the near future about 100 MW electric will be added annually.
Reykjavik Energy Invest

• Reykjavik Energy Invest (REI) is Reykjavik Energy’s international business development and investment arm.
• REI focuses on creating partnerships to develop geothermal areas.
Building of 50 MWe Power Plant at the Assal area in Djibouti.

Project status:
- Pre-feasibility study finished in May 2008
- The project is now in the feasibility study phase
- Presentation of EMP for the feasibility study in September 2009 – final report finalized
- Financing of feasibility study expected to be closed in the first quarter of 2009
- Negotiations with drilling companies in Iceland and China
Building of 50 MWe Power Plant at the Assal area in Djibouti.

Next steps:
• Civil work, drilling of shallow wells and other preparation
• Drilling of 3 deep wells at site

Time schedule
• Exploration drilling expected to be finished late 2009
• Designing and building of the Power Plant in 2009 to 2012
• Production of electricity expected to begin in late 2012
Pre-feasibility study: The Assal Area

- The Assal Area is a volcanic field in the Afar rift, the last eruption occurred in 1978
- A geothermal resource is demonstrated by fumaroles and hot springs
Previous studies

• Donor funded projects in the 1980s:
  – Limited surface exploration
  – Drilling of 6 deep wells
  – Well testing

• The reservoir fluid encountered is very saline brine, Cl level three times that of the sea

• Downhole temperature found in excess of 360°C
REI in Djibouti

• A contract granting a temporary exclusive license for geothermal utilization in the Assal Rift area between the Government of the Republic of Djibouti and Reykjavík Energy was signed on 29 February 2007.

• An exploration permit was issued by the Djibouti Minister of Energy and Natural Resources on May 23rd 2007.

• The concession area covers 750 km².
First stage of REI project

• Review of older studies (from 1970’s to 1980’s)

• Additional geo-scientific studies
  – Contractor: Iceland Geosurvey (ISOR)
  – Period: October 2007 to January 2008
  – Methods: Geology and geophysics
  – Results: Pre-feasibility report
Main fumarole area
Resistivity and seismicity W-E section
Heat mining: Lower salinity system?

Super saline sealed off systems
Findings of the study

- The well location is based on the first conceptual model
- The area of interest is within the Lava Lake
- The physical activities will be outside the Lava Lake
- Drilling targets will be reached by deviated drilling
ARGeo

• ARGeo initially consisted of six African countries, the World Bank and UNEP
• The aim is to promote geothermal development in Africa
• Djibouti and REI have applied for Risk Mitigation from ARGeo funds
• The Environmental Management Plan is prepared according to ARGeo requirements
• If Djibouti receives the ARGeo support it will be the first country to do so
From resource to geothermal power production in Djibouti

Financial issues

Kristjan B. Ólafsson
Presentation:

The steps needed to take a power plant project in Djibouti from resource to construction in a financially viable manner. This presentation discusses the likely cost of power in Djibouti and the competitiveness against other sources of power.

Project Sponsors:

– REI: Reykjavik Energy Invest
  • Gunnar Hjartarson and Kristjan B. Olafsson
– IFC: International Finance Corporation (World Bank Group)
  • Tom Butler
# Geothermal project phases, investment and probability of success

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<tbody>
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<td>Exploration phase</td>
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<td>Design &amp; construction</td>
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<td>Operation &amp; maintenance</td>
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## Cumulative investment million US$:

<table>
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<tr>
<th>Phase</th>
<th>Cost</th>
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<tbody>
<tr>
<td>1. Seed capital</td>
<td>$1.5 mn</td>
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<td>2. Venture capital</td>
<td>$20-25 mn</td>
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<tr>
<td>3. Project financing</td>
<td>150 mn</td>
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## Probability of success:

<table>
<thead>
<tr>
<th>Phase</th>
<th>Probability</th>
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<tbody>
<tr>
<td>1. Exploration phase</td>
<td></td>
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<tr>
<td>2. Pre-feasibility</td>
<td>85%</td>
</tr>
<tr>
<td>3. Feasibility Study</td>
<td></td>
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<tr>
<td>4. Design &amp; construction</td>
<td>100%</td>
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<tr>
<td>5. Operation &amp; maintenance</td>
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Basic parameters and tariff calculation for a typical 50 MW geothermal power plant with high saline content of geothermal fluids (NB: not Djibouti figures)

1. Construction cost up to US$ 3 million per MW.
2. Operation and maintenance cost per year 4% of construction cost, including make-up of wells.
3. Lifetime +/- 30 years.
4. Return on Equity 20-25%.
5. Equity 30% of total finance.
6. Long term interest rate 8-11%.
7. Tax credit or no tax first years.
8. Using cash-flow model (NPV, IRR, Pay-back):
   Calculated tariff ca. 9,20 US$ cent/kwh.
Estimated construction cost

Construction cost US$ 3 million per MW x 50 = 150 mn.

- Drilling: 29%
- Steam Collection System and Re-injection: 16%
- Plant Buildings: 9%
- Piping, equipment and control system: 28%
- Groundwater supply: 8%
- Overhead, facilities onsite, etc.: 10%
Calculated tariff vs generating cost with oil in Djibouti.

$0.25 / kwh
Calculated difference for Djibouti per year in US$ million

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<td>Calculated tariff from geothermal</td>
<td>9,20</td>
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<tr>
<td>power plant</td>
<td></td>
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<tr>
<td>Transmission cost</td>
<td>1,80</td>
</tr>
<tr>
<td>Total</td>
<td>11,00</td>
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<tr>
<td>Generating cost with oil</td>
<td>30,00</td>
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<tr>
<td>Difference for Djibouti</td>
<td>19,00</td>
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</table>

- Calculated tariff from geothermal power plant: 9,20 US$ million
- Transmission cost: 1,80 US$ million
- Total: 11,00 US$ million
- Generating cost with oil: 30,00 US$ million
- Difference for Djibouti: 19,00 US$ million

Total difference: 118.3 - 74.9 = 43.4 US$ million
For the Djibouti Project

**Strengths:**

1. Financial strength of Reykjavik Energy
2. Geothermal expertise and technically experienced sponsor
3. Knowledge do deal with high saline content of the geothermal fluids
4. Site-specific knowledge
5. Expected cost-competitiveness of the Project
6. Strong demand for new generation capacity
7. Good opportunity to co-develop a renewable energy project
8. Good prospects for reasonable economic and financial returns
9. Balanced head of terms for a PPA and PA
10. Support of the World Bank and the Government in Djibouti

**Risk:**

1. Exploration/resource risk
2. High saline content of the geothermal fluids
3. Regulatory and political risk
4. Market and off taker risk
5. Experience with Djiboutian law
6. Price risk from regional electricity market integration
7. Seismic Activity
8. Global financial system in crisis and economy in downturn
9. Difficult to finance Feasibility Study in geothermal projects

**Other issues:**

1. Carbon credit future revenue
2. Side projects: Water production
3. ARGeo Mitigation
Standard IPP Project Structure

(IPP: Independent Power Producer)

Sponsor(s) → Funding → Project Company

Assal Geothermal Power

Lender(s) → Financing → PPA

Government Guarantee

PPA → Power off-taker

EPC Contract → Contractor

O&M Agreement → Operator

Conclusion

If the exploration drilling will discover a resource that can be exploited in a sustainable manner, then the project can be economically feasible and with many benefits for Djibouti and investors.
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Thank you