OVERVIEW OF GEOTHERMAL RESOURCE UTILIZATION AND POTENTIAL IN EAST AFRICAN RIFT SYSTEM

Meseret Teklemariam

The First International Conference on geothermal Energy in the East African Rift Region
November 24-26, 2006
Addis Ababa, Ethiopia
Hottest Known Geothermal Regions
THE EAST AFRICAN RIFT SYSTEM
THE EAST AFRICAN RIFT SYSTEM GEOTHERMAL POTENTIAL
THE EAST AFRICAN RIFT
GEOTHERMAL POTENTIAL

E. G. R.P = 7000 MWe
• Most of the EA countries are dependent on TBF= 70-90%: Causes Deforestation & Environmental degradation

• East African Countries are committed to investigate and further develop GE due to:
  - Strong growth in electricity demand in the countries
  - Hydro proven unreliable as a base load source due to Recent effects of drought
  - Volatile nature of petroleum fuels etc..

• RE sources (hydro, geothermal, solar) represent a small portion of TEP averaging 2%.
African Countries Using Or Having Carried Out Research On Geothermal Resources

- Djibouti
- Eritrea
- Ethiopia*
- Kenya*
- Malawi
- Tanzania
- Uganda
- Zambia

*Plant installed
DJIBOUTI

Afar Triangle

TIC= 85 Mwe (Thermal)
GEOTHERMAL PROSPECT AREAS
OF THE REPUBLIC
OF DJIBOUTI
STATUS OF GEOTHERMAL EXPLORATION

- Exp. Began in the Assal Area (1970-83) funded by French Govt.
- Geo-scientific studies including drilling of six wells in Assal
- Exp. in Hanle-Gaggade area (1984-92) funded by Ital Gov+ADB+OPIC+UNDP and WB
- Scaling and Corrosion Study of deep brines of the Assal area (1989) by the Icelandic company
- Devt. & Prod. of the deep Assal resource funded by Ita. Govt. and WB.
- With the support of USTDA, GDA completed a feasibility study for the devt. of 30 MW plant in the Lake Assal region
ASAL GEOTHERMAL FIELD

MAIN AREAS OF FOCUS

ASAL 1 & 3
ASAL 2
ASAL 4
ASAL 5
ASAL 6
**PROPOSED GEOTHERMAL PROGRAM**

- Plan to drill additional wells and develop 30 MW Geothermal Plant in the Lake Assal Region

- Government of Djibouti is committed to diversify the primary energy resource particularly use of RE resources (Geothermal).
ERITREA

TIC = 130 MWe; Thermal

- Asmara-Massawa HW Sp.
- Red Sea Coast
- Gulf of Zula
- Acfat Group
MAIN AREAS OF FOCUS
SURFACE THERMAL MANIFESTATIONS IN ERITREA
Status of Geothermal Exploration

- In 1973, UNDP identified significant Geothermal Resources.
- In 1995, USAID financed USGS to explore possible use of geothermal resources for power generation in Eritrea, and gave priority to Alid V.C.
- Geological and Geochemical including isotopes were carried out in the Alid Volcanic Area.
- Results indicate:
  - Occurrence of magmatic chamber (heat source)
  - Gas geothermometer = T > 250°C
  - Presence of Fractured Permeability
  - Favourable for power generation
PROPOSED GEOTHERMAL PROGRAM

Further Exploration and Analysis in the Alid.V.Area These include:

- Upgrading of Geological, Geochemical and Geophysical information
- Selecting of target Areas for TG wells
- Exploratory drilling, well testing & installation of a pilot power plant at Alid.
- Reconnaissance Survey in the eastern lowlands of Eritrea.
ETHIOPIA

- Located in the H. of Africa
- Largest Geothermal Resources in Africa
  (E.G.P: > 1000 MWe)
TIC= 790 MWe
Hydro= 678 MWe
Thermal= 112 MWe

• 17% of the Population have access to E

• PLANNED TO REACH TO 50% BY 2010

Others- traditional Biomass
Exploration began in 1969 (UNDP & EG)

About 18 Geothermal Prospect areas were identified in the whole ERV (covers 13% of the country)

Much larger are for direct uses (agriculture, agro-industry etc)
ONLY TWO AREAS ARE SUBJECTED TO DRILLING

- ALUTO-LANGANO (LD-AREA)
  200 KM S. OF A.A

- TENDAHO (N.AFAR)- 650 KM NE OF A.A
8 Deep wells with maximum depth of 2.5 Km.

Five wells are Potentially Productive with a Max. temperature of 350 °C
One of the Discharging Wells At Aluto, LA-6

- Estimated Capacity of the field = 30 MWe for 30 Years (Feasibility Study, 1986)

- In 1995, the field handed over to EEPCO for Development
TENDAHO GEOTHERMAL FIELD
• 3 DEEP (2100 m) & 3 SHALLOW WELLS (500m)

• MAXIMUM TEMP = 260°C

• PRODUCTION TEST & GEOCHEMICAL MONITORING

• ITALIAN TECHNO ECONOMIC STUDY INDICATED SHALLOW PRODUCTIVE WELLS CAN POWER 3-5 MW e

• ESTIMATED CAPACITY OF THE FIELD FROM THE DEEP WELLS IS ABOUT 20 MW e.
One of the Discharging wells, TD-5
PROSPECTS

AT

ADVANCED EXPLORATION STAGE
Fig. 1 Location Map of the Geothermal Prospect Areas within the Ethiopian Rift Valley
Fig. 1 Location Map of the Geothermal Prospect Areas within the Ethiopian Rift Valley
CURRENT ACTIVITY

RESERVOIR ENGINEERING & GEOSCIENTIFIC STUDIES OF THE TENDAHO GEOTHERMAL FIELD

REPORT COMPILATION OF THE DETAILED GEOSCIENTIFIC STUDIES OF THE DOFAN-FANATEL GEOTHERMAL PROSPECT AREA

PROBLEM IDENTIFICATION AND REHABILITATION OF THE ALUTO-LANGANO GEOTHERMAL PILOT POWER PLANT
DURING THE THREE DECADES THAT GEOTHERMAL RESOURCE EXPLORATION WAS CARRIED OUT

• GOOD INFORMATION BASE

• GOOD DEGREE OF EXPLORATION AND HUMAN CAPACITY

• BASIC INSTITUTIONAL AND INFRASTRUCTURE HAVE DEVELOPED.
FUTURE GEOTHERMAL PROGRAMME

- FURTHER GEOSCIENTIFIC AND RESERVOIR ENGINEERING STUDIES (INCLUDING MT SURVEY BY “BGR”) 

- FEASIBILITY STUDY (US-TDA) FOR INSTALLATION OF A PILOT PLANT OF 2-5 MWe AND FURTHER DEVELOP THE TENDAHOO GEOTHERMAL FIELD

- REHABILITATION, FURTHER DEVELOPMENT AND EXPANSION OF ALUTO-LANGANO GEOTHERMAL FIELD

- RESOURCE ASSESMENT ON 5 SELECTED GPA & DETAILED STUDIES AND DEVT. AT THE TWO IDENTIFIED GEOTHERMAL PROSPECT AREAS.
KENYA

TIC = 1059 MWe

Thermal = 346 MWe

Hydro = 584 MWe

Geothermal = 129 MWe
LOCATION OF GEOTHERMAL PROSPECTS
THE KENYAN RIFT

E. R. Potential: >1000 MWe

Main Areas of Focus:
Olkaria fields
Longonant
Eburu
Menengai
• Exploration started in Olkaria region in 1950’s

• In 1970’s More exp. Wells were drilled funded by UNDP and Kenya govt.

• Todate, a total of 105 wells were drilled in Kenya to depths ranging from 503m-2800m.

• Exploration ongoing at Lake Magadi, Longonat, Menengai and Suswa Sites.
Kenya’s use of Geothermal Energy

• 1ST African country to use Geothermal energy for E. power generation

• 45 MW (Olkaria I plant) Operating in Hells Gate National Park since Early ’80’s > 98% Availability

• 70 MW Power station (OLkaria II) owned by KENGEN was commissioned in 2003

• In 1997, Ormat International received a license to generate 64-100 MW in BOO agreement, 13 MW commissioned so far (Olkaria III)

• Olkaria IV (DOMES)- Exploartion with three Exploartion wells drilled. Further DEW drilling is under preparation

• Total installed capacity is about 129MW
The Greater Olkaria Geothermal Area, Kenya
Location of Geothermal Wells in the Eburru Geothermal Field, Kenya
PROPOSED GEOTHERMAL PROGRAM

- Appraisal drilling including six additional deep wells in south of Olkaria Domes (Olkaria IV)
- Addition of a 35 MW Unit in Olkaria II to take advantage of excess steam in Olkaria I & II
- Building a Geothermal Pilot plant at Eburru
- Plans for additional 576 MW by 2019
- GoK is planning to further explore and develop other geothermal prospects
KENYA:

- Has acquired considerable expertise in geothermal related earth sciences and engineering.

- Has led to a development of the institutional structure necessary for geothermal resource E, D & U.
TANZANIA

TIC= 785 MWe
Hydro= 561 MWe (70%)
Thermal= 202 MWe (30%)
LOCATION OF PROPOSED GEOTHERMAL PROJECT SITES IN TANZANIA

E. G.R Potential

230-460 MWe
STATUS OF GEOTHERMAL EXPLORATION


- Two potential targets, Arusha & Mbeya region, were singled out for further Geothermal Exploration

- Detail Exploration in Mbeya region funded by UNDP in 1983

- FEC, T. company, did exploration studies and research on the economic feasibility in Rufiji (Luhoi) region (1998-2002)

- Results indicate:
  Existence of geothermal resources for power generation in Arusha, Mbeya and Luhoi area (T= 220-270ºC).
PROPOSED GEOTHERMAL PROGRAM

• Further Exploration and Analysis of selected geothermal Prospects (Arusha & Mbeya)

• The company develop plans for a 6 MW G. power plant in Luhoi and looking for an international partner.

• The prospect is located 20 km from a MG and 90 Km from the National Power Grid

• Govt. is committed to participate in a private sector led initiative
UGANDA

- Located in the western branch of the EAS
- TIC = 300 MWe (hydro) reduced to 135 MWe (2006)
- E.R. Potential: 450 MWe
- Main Areas of Focus: Western Part of Uganda
Figure 2: Location of the three main geothermal prospects of Uganda and the Estimated geothermal potential of East Africa.
STATUS OF GEOTHERMAL EXPLORATION

- 1st phase of Geoth. Exploration (GEP I) took place in 1993-94 with assistance from UNDP, OPEC and Govt. of Iceland

- Three Geothermal Areas were selected (Katwe, Buranga and Kibiro), all located on the W. branch of the EARS.

- ADB with UAERA conducted research at the katwe and Buranga fields

- ICEIDA financed geological and geophysical surveys at Kibiro & complete the work of UAERA.

- BGR is carrying out Microseismic survey at Buranga

- Drilling of TG wells (200-300m) is currently in progress at Katwe. 6 wells drilled at Kibiro.

- Govt. Provide Counterpart Support for successful Implementation
PROPOSED GEOTHERMAL PROGRAM

• Deep exploratory drilling at Kibiro & Katwe (is located 35 Km from the Terminus of a 132 KV transmission line).

• Feasibility study, if successful, development of 30MW geothermal power plant by an IPP.

• Govt’s policy framework is strongly private sector oriented for power generation
STATUS OF GEOTHERMAL EXPLORATION

- Since 1950, ZGS examined various springs during routine R. mapping exercises.

- In 1986, the ZGS together with I. company studied various HS and to date, development has been considered on two prospects (i) Kapsiya and (ii) Chinyunyu HS projects.

- Pilot Plant (nominal capacity of 200 kW) located in Kapsiya (Sumbu) was built with funding from the Ital. govt.

- The plant never became operational.

- KENGEN- Refurbishing & carry out further studies for expansion.
Govt. of Zambia is exploring options for expansion of the Kapsiya geothermal field.

Train local personnel in the maintenance & operation of the plant

JICA with ZGS planning Construction of a geothermal power plant to provide electric power to the local community at chinyunyu Hs (50 km east of Lusaka)
MAIN OBSERVATIONS

• A substantial Potential of G. E. Resource exist within the African Continent (EARS)

• Geothermal resources are indigenous, reliable, environmental friendly & cost effective alternative energy resource.

• Devt. of Geothermal Resources are constrained by
  - Risks associated with resource E&D
  - Financial risks associated with investment in PD projects
  - Lack of appropriate investment and institutional settings in many EA countries

• Diversified use of energy augments energy supply from HP plants and improve the Generation Mix (Avoid vulnerability to drought and oil P. fluctuations)
STRATEGIES FOR DEVELOPMENT

• Establish long term conducive policies and incentives that attract private investment

• A Regional Network of Geothermal agencies should be set-up to ensure the promotion and use of geothermal expertise in the region

• Establish a Risk Guarantee fund for exploratory and appraisal drilling of projects in the region

• Look for loans and grants from IO to finance the projects for further EX. & Development.

• Alternative is look for PS participation and financing from developers, investors, equipment suppliers and development banks.
UPCOMING PROJECT
Multi and Bi-lateral Agreements
ARGEÔ

• Eastern African Regional Geothermal Programme

• P. Objective – Techn. Ass & RMF for exploration

• Kenya, Ethiopia, Djibouti, Eritrea, Uganda and Tanzania

• The project approved by the GEF Council in June, 2006.

• Executive and Implementing agents are: World bank and UNEP.
THE FIRST EAST AFRICAN RIFT GEOTHERMAL CONFERENCE-ARGeo-C1

GEOTHERMAL ENERGY: AN INDIGENOUS, ENVIRONMENTALLY BENIGN & RENEWABLE ENERGY RESOURCE
24 -29 NOVEMBER, 2006
UNITED NATIONS CONFERENCE CENTER
ADDIS ABEBA, ETHIOPIA
Organized by
Geological Survey of Ethiopia

EEPCO, EEA, EPA, EREPDC, IGA