

Djibouti Potential Status and Prospectives in Geothermal Resources Development

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Keywords: Djibouti geothermal resources development

ABSTRACT : DJIBOUTI AT A GLANCE

The Republic of Djibouti is Located in the horn of Africa, at the junction of the Red Sea and Gulf of Aden (Indian Ocean).

The country's total area is 23,000 km²; it has a maritime desert climate, and is bordered by Ethiopia, Eritrea, and Somalia. Population is estimated at 750,000.

The Economy is based mainly in services that contributes up to 80% of GDP; Djibouti is 100% dependant for all its consumption needs, and has very few agricultural and industrial activities.

Due its geographical strategic location, the country acquires more and more international private investors with infrastructural, logistical or financial projects aiming to benefit from this strategic position of Gateway to the large market of East African countries.

1. INTRODUCTION: ENERGY DEMAND AND PROJECTIONS

100% of our electricity is produced by thermal diesel power plants with generators from 4 to 15 MW nominal; The 4 main interior cities are not connected to national are provided from Gasoil small Generators, with specific very high cost of fuel compared to HFO power generators.

Installed generation capacity is 100 MW. In 2009, it's assumed that only less than 2/3 of installed capacity can be made available. Over the past couple of years, very severe electricity shortages have existed.

Taking into account the available capacity and the actual residential and service demand there is a gap of 60-80 MW in 2008 and 2009.

Residential and Services Peak Demand is estimated to be 175 MW in 2011. That means a Gap of more than 120 MW for these sectors in very short term. The new Doraleh Terminal, the Free Zone and the Bulk Terminal have a 30-50 MW demand.

The integrated Development Lac Assal comprising the industrial salt exploitation, with the Ghoubet, multipurpos but primarily mineral terminal, and related economic activities will require a minimum of 40 MW.

Limestone exploitation, marble synthesis plant, and water in Ali Sabih require 20 to 30 MW.

A minimum estimate of the energy gap is 240 MW in 2011.

DJIBOUTI ENERGY DILEMMA

During these past few years, corresponding to the acceleration of the Globalization Era, Djibouti has acquired

more and more foreign investors, and direct foreign investment is now one the highest per capita in the world.

After a decade of deterioration in economical and social standards, the country has regained economic growth, with continuously increasing GDP and external financial investment. The priority of government politics is poverty alleviation through sustainable development programs.

Offering the larger number of population the equitable access to basic utilities, as electricity to facilitate them standard of living by electricity, that offers access to education, health, and sustainability through creation of economic and social activities by the an Affordable, Secure and Abundant of Electricity.

By giving you a glance to Djibouti current and programmed projects, you can measure the scope of hope that the country is promised to.

One current development project, the MADINAT AL NOUR PROJECT OF THE CENTURY, consists of the construction of twins cities on Yemeni's and Djiboutian's facing sides of the Red Sea, with a multipurpose railway and road bridge sponsored by a private investor, budget estimated of 300 billion USD.

For the presentation of this project, on a one day event; the promoter has gathered thousands of key leading companies representatives and more than 200 media representatives.

With a look at Djibouti economic facts through the past years, Djibouti seems to be promised to tremendous economic development in the near future.

Unfortunately, the country's energy production depend 100% on imported oil products; and the unique energy power plant is thermal HFO (Diesel) with production's costs prohibitive for social economical, business, and industrial activities.

We recently conducted a study that confirms that in existing energy availability/dependence the economy is at the mercy of any fluctuation on the oil and international markets.

Thus all serious state and other studies have stated the priority of research and development of alternatives, including sustainable and cheap abundant sources of energy.

1.1 Impacts of Imported Oil Products on Djibouti's Economy

As a concrete clear figure of the critical energy dilemma, the impact the oil price crises - excluding food price crisis; the long lasting severe drought in all the horn of Africa's populations shows the issue that we briefly described above.

Table 1. Oil products impact on Djibouti's economy with focus on electricity production

	2002 Ref	2003	2004	2005	2006	2007	2008
Fuel Cost	13,220	15,715	16,573	25,787	31,138	33,251	70,225
In \$Million		+18.9%	+25.4%	+95.06%	+135.5%	+151.5%	+114,294
GasOil							+35,380
Total Increase							149,674

Between 2004 and 2008, the price of kerosene has doubled, which is mainly used by households for cooking,.

Only for electricity generation oil prices crisis has absorbed 1/3 of total state budget and 1/5 of GDP.

Taking into account the Kerosene and the fuels for transportation the Financial Overcharge for the Economy is estimated in excess of 600 million USD

2. GEOTHERMAL RESOURCES

In this part we shall focus on the conventional resources of high enthalpy geothermal potential that have been intensively studied and explored for decades in Djibouti.

Djibouti benefits from a unique geological situation, located at the junction of three active tectonic structures:

- the great African Rift Valley which extends at 15-20mm/year
- The Red Sea Oceanic Rift
- The Arabian Rift plate

This unique geographical situation and the surfaces manifestation of hot springs and fumaroles indicate the potential of exploitable geothermal resources.

Exploration, with some deep drillings wells have been conducted in many sites. The results of these exploration campaign are very promising.

In the region, Kenya is the leading country and has gained undisputed experience and knowledge in research, exploration and exploitation of geothermal resources, with a total installed capacity of 127MWe covering 10% of its 1200MW energy consumption and planning to add 575MW till 2017 to cover 25% of its electricity demand.

Ethiopia has engaged programs to develop its geothermal resources as an alternate to hydroelectricity too dependent of seasonal rainfalls availability.

One binary pilot plant of 8MW capacity – 3MW functional- is installed in Lungano.

Two exploration drillings have been done in Tendaho; near Djibouti's border.

3. GEOTHERMAL EXPLORATION

A brief technical description of up to date geothermal activities – surface prospection; analysis; exploration; etc...- undertaken on the territory of Djibouti are stated here after.

3.1 Assal Rift Site

On the Assal site six deep drilling exploration wells have been realized between 1100m and 2100m. Results:

- 3 wells productive (Assal 1, Assal 3 et Assal 6), with Average T° = 260°C.
- 3 wells non productive, due no permeability (Assal 2, Assal 4 et Assal 5) but with very high temperature of abouts 360°C.

3.2 Hanle Zone

The Hanle Area was the second zone were significant explorations were conducted.

Geological, geo-chemical and geophysics were conducted with the advice of scientifically board of ISERST; in the 80's; with a program of exploration gradient drilling.

Unfortunately the results didn't meet the scientists expectations with low temperatures (72°C at 1420m and 124°C at 2020m). And this zone was not more been considered since.

3.3 Obock Zone

Near Obock were identified three hot springs and one fumaroles on the coastal area.

Surface survey and prospection need to be completed using more adapted geophysical methods- EM , MT-.

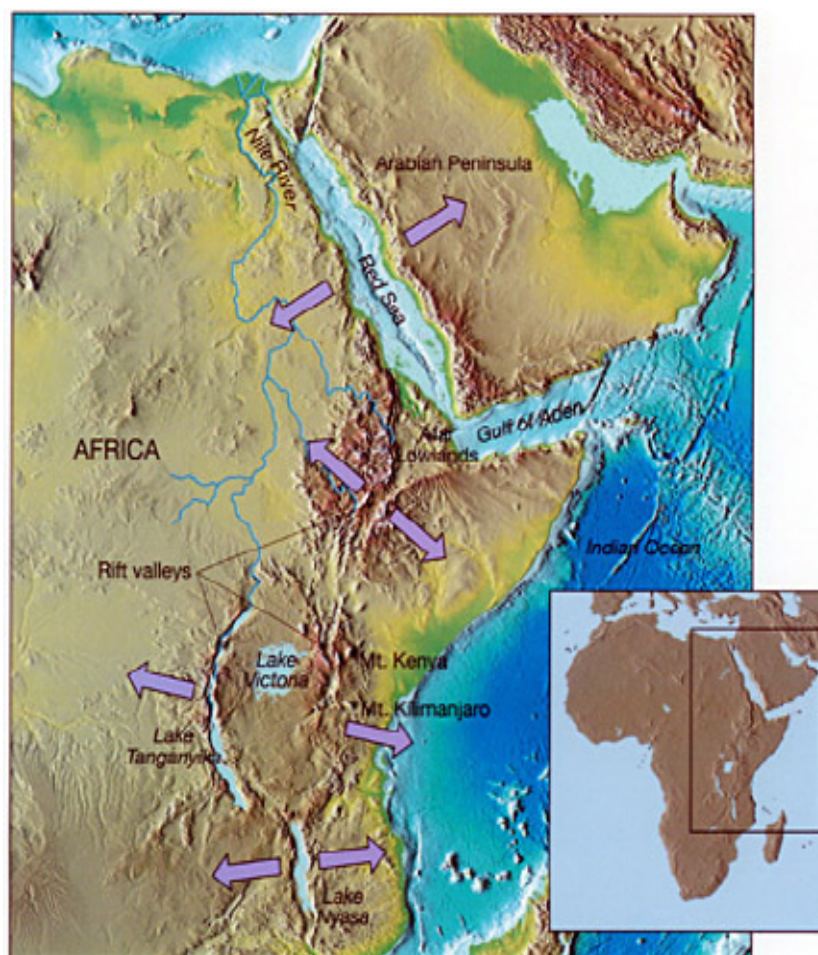


Fig.1. Active hottest tectonic zones in the world and Djibouti in African Great Rift Valley

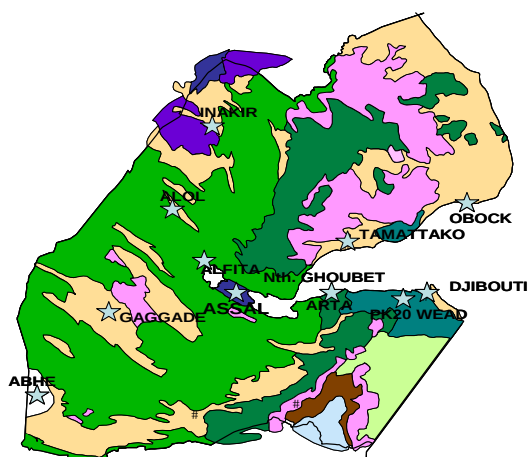


Fig 2. Identified geothermal sites

3.4 Gaggade

Two Geophysical Prospection surveys using gravimetric and electrical methods have shown:

One intermediary underground location with temperatures between 100 and 180°C and a deep underground system with high temperatures between 300 and 350°C.

3.5 Nord Goubhet Zone

North Goubhet presents a promising potential and has already benefited of geophysical and geochemical prospections and analysis indicated an intermediary geothermal reservoir.

3.6 Arta

Geochemical analysis by 'Géothermica' in 1982 of fumaroles indicates a potential geothermal reservoir with temperatures of 170 to 220°C.

3.7 Lac Abbe Zone

Zero prospection till know. Scientific research due to begin with a Private Promoter.

Very important fumarols and hot springs, mainly alcalyn chlorade (Na-Cl) are visible in a large area of more than 100 square km. Temperatures stand at 90°C plus, with many spots with 100-105°C.

3.8 Dorra; Sak Alol, Kalou, Wead and others

Very few geochemical analysis of surface manifestations show common geothermal 'anomalies' that are generally linked with geothermal potential.

Instead of boring you of technical data of detailed prospections and drillings conducted since the 70's mainly in Assal zone, we have opted for a presentation:

- a synthesis of historical geothermal activities till 20009 will better give a figure of Djibouti particular steps in the past.
- After this synthesis a presentation of the current Geothermal projects and the overall Governmental's multipurpose

initiative, likely a master plan, to promote and develop the geothermal resources in relation with the identified energy resources major obstacle to Social and Economic development of Djibouti Republic.

Table 2: Geothermal prospection and exploration in different sites

Site	Geophysical	Geochemistry	Well Logs	Deep Drillings	Surface Manifestations	Comments
Lac Abbé						
Arta						
Assal						Deep Reservoir with Technical Limitations Identified Intermediary Reservoir.
Gaggadé						AMT et EM to be done
Obock						AMT et EM to be done
North Goubhet						Geophysical Survey to complete
Others sites						Survey needed

4. GEOTHERMAL PROJECTS IN PROGRESS

4.1 Lac Assal Project

Agreements for Development of Geothermal Generating Power Plant was granted to an Icelandic company – Reykjavic Energy Invest-.

Prefeasibility was completed

Second phase: the feasibility, comprising deep drillings is pending.

Total Cost of the project is estimated around 170millions USD for a 50MW Geothermal Plant; extensible to 150MW.

4.2 Lac Abhe Project

A development License have been granted to an Indian based Company specialized primarily in Petroleum exploration/production.

The linking road is engaged by Government.

Surface prospection, environmental assessment, and logistic setting for exploration activities are scheduled to start end 2009.

The promoter; initially has signed for a 50MW extendable to 150MW, seems for now to go directly for a 150MW prospect.

The particularity of this field is the utilization of medium reservoir 400-600m deep with Binary technology.

Total Coast is estimated to 300Millions USD an completion scheduled in 3 Years maximum.

5. BINARY GEOTHERMAL PROSPECTS

5.1 Binary Resources Development Program

We have engaged a voluntary program for the promotion and development of Medium or/ and Low temperature/Enthalpy Geothermal Resources

Lot of drillings have been done on the all parties of Djibouti territory in different programs of water research.

To Solve very taff problem we have to look for and privilege uncommon (edge standing) or very original inovatives solutions.

On the allowed space for this paper, I cannot present the principle of Binary Geothermal Power Generation; thus all IGA members are certainly for now awared of.

Due to the exceptional geographical situation Djibouti is literally seating on a Volcano. And it is not surprising to get water at 40-60°C qt 100m deep for water drilling.

In Arta and Obock Prospects, we have formulated a project appraisal for a 3 to 10MW Binary Geothermal Project for each of ones.

With preliminary surveys, analysis on different part of the country, a first estimation of the capacity that can be

generated by Binary Medium Enthalpy Geothermal Power Generation is ranged from 50 to 100MW.

5.2 Binary Technology

Few Companies have large experience in the utilization and development of adequate machinery for Low and Medium Temperature Binary Geothermal Power or Heat Generation.

The system utilized is Organic Rankine Cycle or Kalina Cycle.

In the Chena Springs Binary Geothermal Unit; in Alaska, the source temperature is only 74°C. But a cold river of 10°C near side.

The temperature, but also the pressure, the flow are crucial for unit design.

Most of systems use the Refrigeration Process in a Reverse Cycle.

In Djibouti identified exploitable hot springs the Air Cooling scheme is needed



Fig 3. 2 photos of Binary Geothermal units of 50KVA and 280KVA

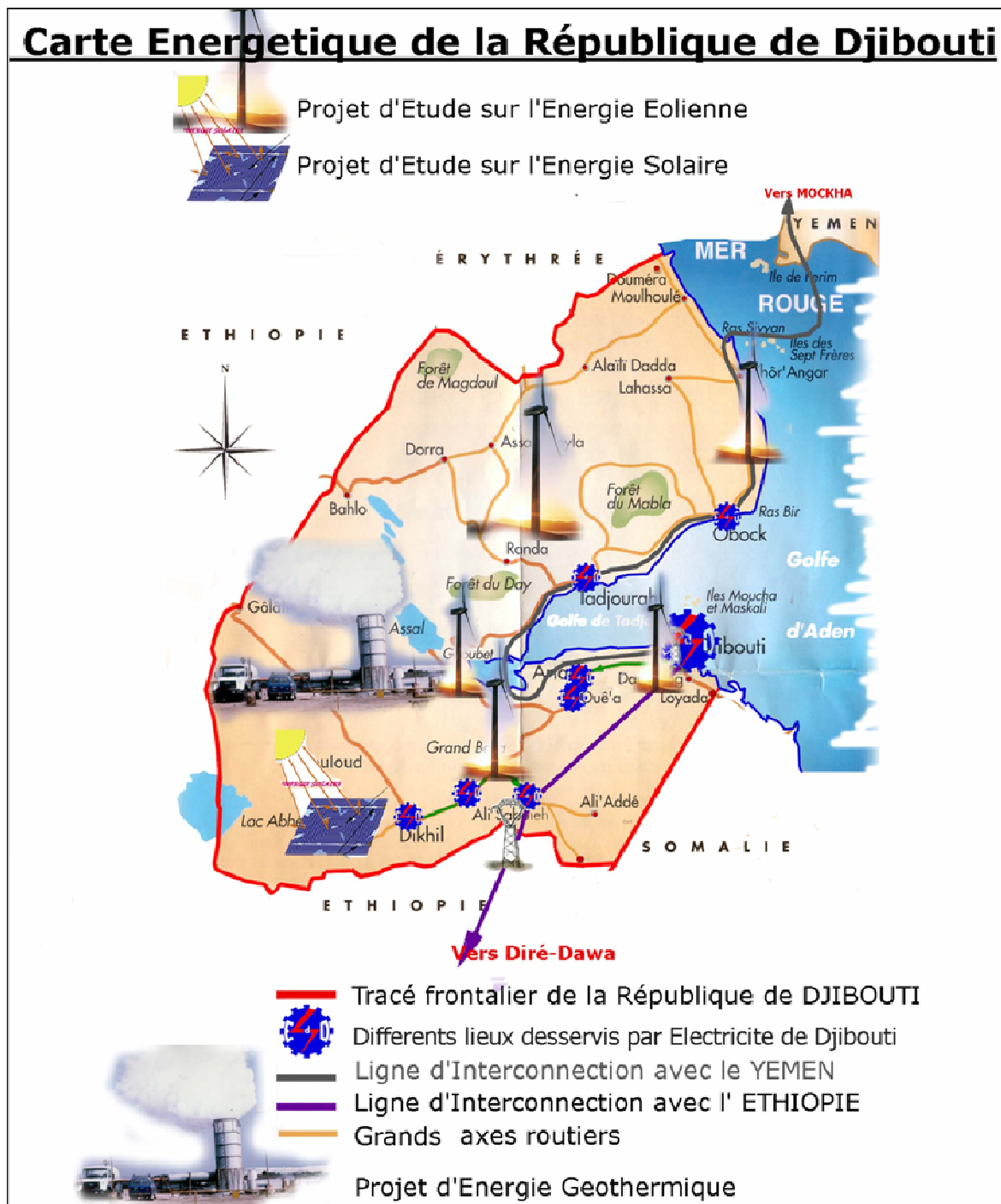


Fig 4. Djibouti Electricity Map

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