
U.S. TRADE AND DEVELOPMENT AGENCY



EXECUTIVE SUMMARY

Feasibility Study of the Assal Geothermal Power Project Republic of Djibouti

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**Region: Africa/Middle East
Country: Djibouti
Sector: Thermal**

1.0 EXECUTIVE SUMMARY

Geothermal Development Associates ("GDA", the "Developer"), a private US corporation with over 20 years of geothermal resource and power project experience in the US and overseas, has exclusive rights for the development and operation of the Assal Geothermal Power Project ~"Project") in the Republic of Djibouti. GDA has sole responsibility for managing the Project including, without limitation, overseeing the design, engineering, procurement, construction, startup, commissioning, and commercial operation, formation of schedules, budgets and related fiscal matters, adoption of policies, all manner of personnel, negotiation and execution of agreements, documents, and instruments relating to the development and operation of the Project.

This Feasibility Study supports the potential commercial viability for a 30 MW Build-Own-Operate Project (wellfield and power plant) on a large, high-enthalpy resource which has been drilled and proven. The Assal site is 100 km by paved road west of Djibouti City.

Extensive geotechnical, drilling and well testing data has been obtained by the Government of Djibouti ("Government") over the periods 1970-1983 and 1989-1992 with support of the Governments of Italy and France, and multilateral and regional funding sources. The known geothermal resource covers an area of at least 120 square kilometers, with multiple wells recording temperatures in the 250' to 360'C range at depths from 1,100 to 2,100 in, with attendant high salinities. Well logs show strong evidence of a shallower reservoir between 400 and 600 m in depth with temperatures of 130' to 190'C, and a significantly lower salinity. Comprehensive field-testing will be completed to determine the most economic manner to mitigate the silica and heavy metal sulphide scaling. Drilling and flow-testing of up to three production size wells to test both the shallower and the deeper reservoirs will be completed during resource confirmation, prior to plant construction.

The Developer signed a Memorandum of Understanding with bectricit6 de Djibouti ("EdD"), the Government power utility, on May 13, 1999. The Developer will negotiate a Power Purchase Agreement with EdD, which has responsibility for development of the Assal Geothermal Power Project. An Implementation Agreement and Geothermal Resource Concession Agreement will be negotiated with the Government.

With a core of experienced geothermal specialists, GDA has allied itself with internationally recognized companies and experts having worldwide geothermal power project experience in resource development, power plant design and construction, legal, tax, and Arab/African affairs.

The Djibouti City metropolitan area, with over 300,000 inhabitants and almost the entire commercial and industrial infrastructure of the country, receives its power from largely aging diesel-fired generating units. For many years these units have been in a high state of disrepair, causing regular load shedding, frequent blackouts, and delivery of high cost electricity at well below market demand.

The Project is a top priority of the Government, enthusiastically supported by the President and Government of the Republic of Djibouti, as well as the private sector and the citizenry. This renewable energy resource will displace highly polluting diesel-fired units, and is the only viable baseload power alternative to fossil fuels. The Assal Project will deliver sustainable, significantly lower-cost power to the nation. Capacity expansions at Assal are anticipated to be up to 100 MW by the year 2015, according to 1999 Government planning estimates.

The Project is estimated to cost \$116,943,047, which amounts to \$3,544 per kilowatt of installed capacity. This amount covers all Project costs, including wellfield development, power plant construction, the construction of the transmission line and related system improvements, Project administration, financing costs, and contingency.

Financing for the Project has been assumed to be a combination of grants (5.3%), equity (33.3%), and debt (61.4%). Favorable terms for the debt are crucial for financial performance sufficient to attract the equity. For the purpose of this study, \$66,939,000 of senior debt on Project financing terms has been assumed at 570' for 25 years.

The inherent resource development risks that accompany geothermal power projects will be largely mitigated at Assal. Recognition that Djibouti is a new (1977), relatively poor country, even by African standards, and without appreciable natural resources, requires that the Feasibility Study focus on financial-related risks, such as currency convertibility and the Government's ability to sustain long-term repayment (via payment for electricity) of the Project debt, in terms acceptable to the funding entities.

UNDP has approved PDF-B grant funds of \$287,000 to support the completion of the principal Project agreements, including a Power Purchase Agreement. Through UNDP, GEF has approved funds of approximately \$3,000,000 for drilling and related field activities during resource confirmation, and may also consider supporting other issues that contribute to mitigating in-country risks that affect Djibouti's chances of securing private investment. USDOE is also fully cognizant of the Project and has expressed its willingness to provide support for the resource confirmation. IFC has been highly supportive and has expressed keen interest in possibly providing funding toward Project implementation. A number of regional African and Arab funding sources have also indicated their interest in the Project. Support from these entities, together with private funding sources, is anticipated.

2.0 PROJECT DESCRIPTION

2.1 Introduction

Important Project parameters for this Feasibility Study are based on the Memorandum of Understanding between the Republic of Djibouti and Geothermal Development Associates signed on May 13, 1999, and the results of 20 years of geotechnical surveys and exploration drilling and well testing in the Assal geothermal area. Study of the Assal resource records, and taking into account the country's power requirements as expressed by the Government, the Developer's approach to development of the Assal geothermal resource will consider a number of options-some of the most important of these are stated below. The final development path will largely depend upon the geotechnical and drilling results of the resource confirmation phase.

2.2 Location and Access

The Assal Geothermal Power Project area is located in the Republic of Djibouti in East Africa at the confluence of the Red Sea and the Gulf of Aden (Figure 2.2a).

The Assal Geothermal Project Concession Area (yellow outline, Figure 2.2b), described in the MOU, Section 2.2, (Appendix G) for which GDA has the exclusive development rights, extends as a continuous belt from the Tadjoura Gulf eastward through Lake Assal, and continues 35 kilometers further inland in a northeasterly direction.

The primary focus of the geothermal development within this geothermal resource concession area is located 100 km due west of the Djibouti City, being a land mass of roughly 12 by 10 km which separates Lake Assal on the west, and the Ghoubbet el KharAb, an extension of the Gulf of Aden, on the east (Figure 2.2c). Access to the Assal Project site from the Djibouti City is via a paved highway-about 75 minutes drive. Within the Assal resource area, topographic relief is low to moderate, vegetation is sparse, and vehicular travel in the drilled area is uncomplicated (Figure 2.2d).

2.3 Participants

2.3.1 Project Administration: Geothermal Development Associates

The Developer, Geothermal Development Associates ("GDA"), is a private company incorporated in the State of Nevada, USA. The firm has a permanent core management and staff of geotechnical and engineering professionals. GDA's management complements its staff with Associates who have a similar reputation for integrity, knowledge, and experience. These Associates provide complementary disciplines and services to meet Project needs, under the coordinated planning and direction of GDA's management.

GDA has over 20 years of corporate expertise and experience in geothermal power projects, and management with 30 years in the geothermal industry. The company has been active in all phases of the development of medium- and small-scale geothermal power projects in the United States, Philippines, Indonesia, and other countries worldwide.

Together, GDA and its Associates cover the full range of principal disciplines in resource exploration and development; power plant design, construction and operation; and permitting and regulatory affairs. GDA's skills in project management, project economic evaluation, and risk assessment and mitigation, are also essential. GDA endeavors to utilize the services of financial, legal, tax, engineering, construction, and environmental firms familiar with geothermal power projects and Africa operations. See Appendix A for a more complete history of the key officers, company expertise, and experience. The contact person is:

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GDA, as the Developer, having extensive geothermal power project management experience, will have sole responsibility, without limitation, for managing the Project including: overseeing the design, engineering, procurement, construction, startup, commissioning, and commercial operation; formation of schedules, budgets and related fiscal matters; adoption of policies; engaging all manner of personnel; negotiation and execution of agreements, documents, and instruments relating to the development and operation of the Project (EdD-GDA MOU, May 13, 1999).