

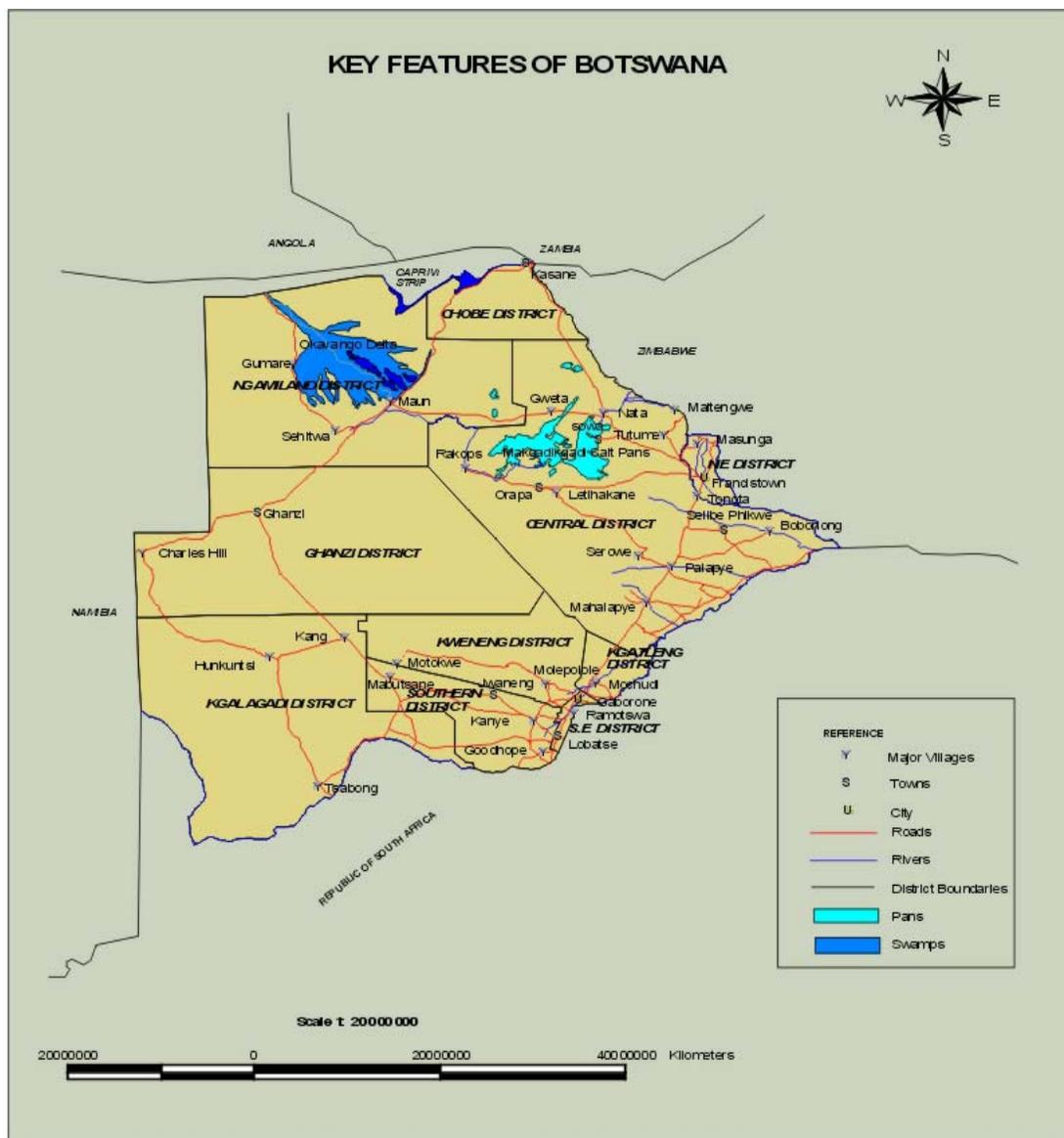
**MORUPULE POWER STATION  
GENERATION EXPANSION PROJECT  
PALAPYE, BOTSWANA**

**INVESTMENT MEMORANDUM  
FOR THE  
INVESTMENT COMMITTEE**

# Country information

## Geography and geology

Botswana is a landlocked country in southern Africa that neighbours Zimbabwe, South Africa, Namibia and Zambia (Figure below). The total land area is 581 730 km<sup>2</sup>, between 20 and 29.4°E and 17.8 and 26.8°S. The country lies entirely within the shallow basin formed by the high-lying interior plateau of southern Africa. Three-quarters of the land surface is covered by the Kalahari sands. The land surface is nearly flat, with a mean altitude of 1 000 m above sea level. The lowest point in Botswana is at the confluence of the Limpopo and Shashe rivers at an altitude of 537m. The highest point is found at the Ootse Hill in the south east, at 1 491 m (Pers. Comm. Department of Surveys and Mapping, 2000; National Development Plan 8; CSO 2000).



## **Economic overview**

Botswana was one of the poorest countries when she attained her political independence in 1966 with a per capita income of about US\$80. Beef was the only source of foreign exchange. The poverty situation was worsened by several years of drought which led to one third of the national cattle herd dying. Gross Domestic Product (GDP) in current prices was estimated at P36.9 million in the 1966/67 fiscal year.

By the beginning of the 1980s, diamonds had well overtaken beef as the country's leading foreign exchange earner. By the year 1999/2000, real GDP had constantly increased. This growth was due mainly to the significant increase in mining sector output, following the expansion of the Orapa diamond mine

The diversification in exports markets has continued over the years leading to the economic growth of the country. The performance of the economy has enabled Government to increase resources for its development budget. This has been translated into development in the form of infrastructure as well as improvement in the standard of living of Botswana. This resulted in Botswana graduating from a low income country to a middle income country. The Botswana currency (Botswana Pula – BWP) faces risk of exposure to hard currency exchange rate fluctuations. The current rate stand at: BWP1 = US\$ 0.1785.

## **Political stability**

Botswana became independent from the British Protectorate in 30 September, 1966. The Constitution of Botswana established a nonracial democracy which maintains freedom of speech, freedom of the press and freedom of association, and affords all citizens equal rights. Since independence in 1966 the Republic of Botswana operates on the governing principle of democracy and in this regard Botswana has had three changes of President since independence in 1966. The same political party, the Botswana Democratic Party (BDP) has been in power since independence. Elections occur every 5 years with ten to fifteen parties competing for power. All changes in power have been peaceful and democratic and have followed the guiding principles of the Botswana constitution.

## **Energy**

The profile of Botswana's energy supply is similar to most developing countries, particularly the Southern African Development Community (SADC) countries, and is dominated by fuelwood which contributes 58% to the total primary energy supplied. The fuelwood is mainly collected by hand, by individual households, resulting in local depletion. At a national scale, the supply due to tree growth is greater than the harvest.

Fuelwood is used in the residential sector, government institutions and in small to medium commercial enterprises, especially in rural areas. There is considerable support for the Expanded Coal Utilisation Programme (CUP) which promotes the use of coal rather than fuelwood from the natural wood lands. Liquid petroleum gas (LPG) and electricity are used in medium and high-income households. LPG is steadily gaining in popularity in the low-income households because of convenience, and because of localised fuelwood scarcity.

Most of the electricity is supplied by Botswana Power Corporation, especially in urban areas. In the remainder of the country diesel generators are estimated to supply over 20 MW of energy to villages, rural schools, hospitals, police stations and prisons. Solar photovoltaic and wind-generated electricity contribute a fraction of one percent to the total energy supply, but occupy an important position in satisfying needs in remote areas, and are promoted by the national energy policy. Solar and photovoltaic technologies are used in schools, for rural street lighting, and in some homes and government buildings. In 1994, 75.1% of the electricity supply in Botswana was generated in the country, and 24.9% was imported from the Southern African Power Pool (CSO, 2000).

## **Technology Needs Assessment Report**

This project for Botswana on Technology Needs Assessment was being undertaken in the context of the United Nations Framework Convention on Climate Change (UNFCCC).

The main objective of the study was to identify and assess environmentally sound technologies that have synergy between reducing impacts of climate change and rate of GHG emissions in Botswana with national development objectives. This was done building on Botswana's past activities under the UNFCCC as provided in the Botswana Initial National Communication (BINC).

The study identified technologies in energy, water and agriculture and these technologies were prioritised with the assistance of the stakeholders.

The following are the major findings:

1. Botswana has significant potential for environmentally sound technology (EST) application in coal, coal bed methane (CBM), biogas and biofuels.
2. With the abundance of solar energy in Botswana, there is potential for solar pumping, solar water heating, passive solar designs, solar PV and solar cooling.
3. Application of wind, and other biomass (elephant grass) is limited in scope.
4. Energy efficiency and demand side management activities have not been fully exploited in Botswana and yet there is potential in various sectors. Potential was recognised in the following technologies: compact fluorescent lighting, passive solar design and energy management systems
5. There is abundant wastewater being generated in Botswana but not currently fully utilised. Technologies identified included the activated sludge treatment plant for municipal wastewater. The study also identified that a high percentage (64.6%) of respondents were willing to reuse treated grey water
6. Treatment of brackish water to potable quality is expensive. Technologies identified are: Reverse osmosis, de-mineralisation and evaporation stills which can be used for small scale water treatment facilities
7. Agricultural technologies for methane abatement are not well known in Botswana, however several technologies were identified as follows: Livestock

number reduction, breeding of low methane emitter animals, introduction of antibiotics that can reduce methane emissions from animals

The major recommendations are:

1. Support for the following activities is required in order to realize the prioritised technologies in each of the energy sector
  - a. For the coal bed methane, there is a need to establish resource base and potential market for CBM use.
  - b. On the policy side, Government would have to liberalize the energy market to allow other players that might provide CBM based energy services.
  - c. Research and capacity building in relation to exploitation and utilization CBM technologies ought to be pursued.
  - d. In relation to coal beneficiation, the feasibility for coal washing coal should be completed and results disseminated to attract potential entrepreneurs and energise the market. The potential benefits in the power sector, industry and household sectors need to be explored.
  - e. On the policy side, Government can support promising entrepreneurs with funding from funding sources such as CEDA, BDC and NDB.
  - f. On biofuels, there is a need to identify biofuels and related crops that can be produced in Botswana and undertake pilot projects to produce those biofuels.
  - g. Government can encourage through policy the use of biofuels and infuse the policy into the Botswana Energy Master Plan.
  
2. In relation to Energy Efficiency, further work is required to assess potential of energy efficiency, establish and demonstrate energy efficiency practices and technologies in industry, households, commercial buildings and the power sector. This can be done through promoting institutional framework for providing
  - a. Energy audit and management services
  - b. Awareness creation to potential beneficiaries.
  - c. Government may have to provide incentives for uptake of energy efficient measures to potential beneficiaries.
  - d. On wastewater the Government create an environment that will ensure that the resource is exploited for various end uses. This could include the following:
    - e. Create awareness in terms of scarcity of water and safety of treated wastewater
    - f. Develop infrastructure for the distribution of treated wastewater
    - g. Complete and enforce wastewater treatment standards
  
3. On treatment of brackish water the government should provide subsidies for the adoption of reverse osmosis technology.
  
4. In agriculture the following is recommended:

- a. Animal breeding for methane abatement is currently not being done however, some work on high productivity animals is being carried out by DAR. It is recommended therefore that DAR should disseminate research results to farmers.
- b. It is recommended that the Botswana Agricultural Union take an active part and farmers to reduce their livestock number to optimise pastures. It should be emphasized that there are added benefits of higher productivity with reduced high quality livestock.
- c. Conservation tillage is being tried in the country namely by Masedi Farms in Pandamatenge, NAMPAADD in Barolong Farms and RIPCO (B) in association with MODIMP of the Republic of South Africa. It is therefore recommended that NAMPAADD disseminate reduced tillage methods and include its advantage as part of the purpose for implementation.

#### General Recommendations

- a. Many of the technologies identified need to be adapted to be compatible with social, cultural, economic and environmental priorities of Botswana.
- b. The role of the private sector will be vital in the identification and adoption of environmentally sound technologies and therefore should continue to be engaged in future TNA activities.
- c. Technology needs will continue to change and Government should ensure that this TNA report is frequently updated and new action plans developed for implementation.
- d. There should be training for organizations, which will manage technologies and conduct the environmental impact and risk assessments.
- e. General stakeholder participation should be ensured in the technology transfer process.
- f. Endogenous capacities should be developed because an exclusive dependence on imports can prove harmful in the future.
- g. There is a need to undertake project life cycle confirmation studies to determine methane mitigation potential for each technology identified.

### **Botswana Power Corporation (BPC)**

The Government of the Republic of Botswana wholly owns Botswana Power Corporation, which was established by an Act of Parliament. BPC is responsible for the generation, transmission and distribution of electricity in Botswana. It is the sole utility over the entire country that has a mandate of supplying the country with power. BPC owns and operates Morupule Power Station, a coal-fired and dry cooled power plant with an installed capacity of 132MW (4x33MW units)

BPC operates a significant network of transmission and distribution lines to transport electricity from the power station, or point of import to consumers. The Corporation supports a customer base in the region of 136,000. The Corporation also acts as the implementation agency of the rural electrification projects on behalf of the Government.

## Project background information – Generation Expansion at Morupule Power Station

Morupule is a mine-mouth power station situated near Palapye in the Central District of Botswana. The coal is supplied by Morupule Colliery (Ltd). Currently, Morupule Power Station produces about 30% of the country's electrical energy requirements. The balance is met through imports, mainly from Eskom (RSA). BPC has a power purchase agreement with Eskom, which expires in December 2007, and this agreement is for firm imports up to 410MW. The current BPC system peak demand is 434MW, satisfied through internal generation at Morupule and imports).

Table below reflects power statistics

	2001	2002	2003	2004
Total Unit Sales (GWh)	1,843	1,955	2,150	2,366
Total Sales Growth (%)	10.3	6.1	10.0	10.1
Power Imports (GWh)	1,123.1	1,241.6	1,605.7	1,915.2
Total Generation (sent out) & Import (GWh)	2,043	2,170	2,435	2,642
Total Consumers	86,165	96,961	108,985	122,625
System Maximum Demand (MW)	316	337	360	394
<b>Average Selling Price (Thebe/kWh)</b>	<b>22.4</b>	<b>21.9</b>	<b>23.6</b>	<b>23.6</b>
Average Selling Price (USD/kWh)	0.046	0.044	0.047	0.047

The Southern African region is faced with diminishing surplus generation capacity, which is expected to be exhausted by 2007/10. Therefore, in order to counter this, BPC commissioned a generation expansion feasibility study in 2003. The feasibility study recommended that 6x100 MW units be installed in progressive stages; 400 MW immediately (2009-10), 100 MW (2018), and finally 100 MW (2023).

As part of the feasibility study, a coal mine plan was developed for a period of 25 years to assess the sustainability of the coal supply to the project and the existing power station. Based on the resource blocks investigated, a resource in the order of 150 Million tones of coal is estimated. Furthermore, Morupule Colliery Limited is going to undertake a coal exploration to increase the confidence level in the available quantity and quality of the coal resources. The nature of the coal is sub-bituminous and the sulphur content averages 1.5 % with 21 % ash content with an average calorific value of 23 MJ/kg, moisture free basis.

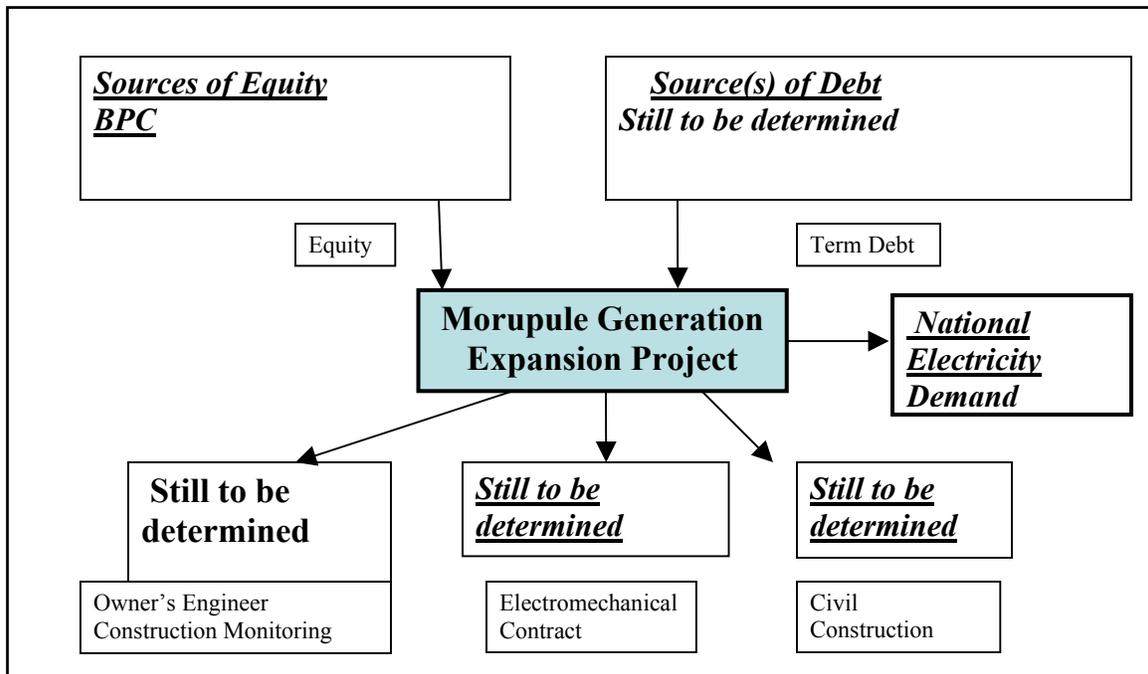
## **Project description**

BPC is in the process of developing, immediately, a 400 MW coal-fired power plant at Morupule. The Project will increase Botswana's internal generating capacity in order to reduce dependency on imported power. The proposed project is part of an initiative to fulfill the objectives of the country's energy policies as contained in Botswana's National Development Plans and Energy Master Plan.

The study recommendations were based on conventional steam power technologies being employed for the expansion, that is, conventional pulverized coal-fired boilers with electrostatic precipitators for particulate removal. In order to improve the environmental performance of the project, the project could make use of cleaner coal technologies, which might include reducing the quantities of nitrogen oxides (NO<sub>x</sub>), sulphur dioxide (SO<sub>2</sub>), and particulate emissions to the atmosphere and also increasing the efficiency of converting coal into electricity so that less NO<sub>x</sub>, SO<sub>2</sub>, carbon dioxide (CO<sub>2</sub>) and particulates are produced for each unit of electricity. However, arising out of cost, access to these technologies is a barrier. The expansion will be accommodated within the existing property at Morupule.

The project activities will include the detailed engineering design, civil works, electromechanical, switchyard and new transmission lines for power evacuation, development of water source and water treatment, coal transport, coal handling plant and coal preparation including pulverisers, and solid waste handling and disposal.

The process of appointing owners engineer (for project management) and financial advisor (to put together the financing strategy) has been initiated, and the first phase of the project is projected to achieve commercial operations in 2009. BPC will own and operate the project and will provide equity finance to the project and the balance obtained through debt and/or grants from international financing institutions.



The lifetime economic cost (Net Present Value) of expansion is significantly lower than continued importing the balance of power requirement.

## Need for Power in Country

Morupule Power Station, which is currently operating as a base load station, generating about 30% of the country's electrical energy requirements. This is a complete reversal of the 1994 circumstance when about 70% of the power needs were generated internally. In order to minimize the risk of exposure to the external price risk associated with extensive purchases from Eskom, BPC has to implement Morupule generation expansion project.

## Infrastructure for Plant Construction

The project is situated next to the access road connecting Serowe and Palapye in the Central District, with a rail link to the adjacent Morupule Colliery. The existing Morupule Power Plant gets coal from this mine via an overland conveyor belt. The access road is in good condition and suitable for transportation of construction materials and equipments. The existence of the access road and rail link is a major plus for the Project, since the cost of constructing access to the site will be quite small.

## Project Land

The 400 hectare land on which the Project will be built is utilized by BPC under a lease agreement with the Department of Lands (Government of Botswana). An environmental scoping study has been undertaken, and has indicated some issues of concern and these will be investigated further during the EIA phase of the project.

## **Project Technical Parameters**

The project technical details are still to be determined after detailed project design is completed. The process of the Environmental Impact Assessment study has been initiated with the scoping phase already completed. Already, the scoping study has identified issues of importance to be considered further during the EIA process. As a way to improve the environmental acceptability of the project, cleaner coal technologies, such as technologies that reduce the quantities of emissions (low-NO<sub>x</sub> burners, Scrubbers/Flue-Gas Desulphurisation and Electrostatic Precipitators) and technologies within power generation with better efficiencies (subcritical pulverised fuel and atmospheric fluidised bed or advanced technologies- pressurised fluidised bed combustion, supercritical pulverised fuel), could be employed. The technical specifications will be determined once the decision on the technologies to be adopted is made.

The overall conclusion of Morupule Generation Expansion Project analysis is that the conventional project with Electrostatic Precipitators is feasible from a technical standpoint.

## **Engineering, Procurement and Construction Contracts**

The contracts for Engineering, Procurement and Construction are not yet in place. The process of appointing Owners' Engineer is progress.

## **Project Economic Cost**

The total Project cost is estimated to be US\$600 million (2004 prices) for the first 400 MW. The unit cost are estimated at US\$ 1,500 per kW and this cost estimate includes capital costs and all soft costs, that is, owners engineering and project management costs, pre-financial close, legal costs, as well as interest during construction. If high efficiency boilers/ or other cleaner coal technologies are installed at Morupule, the project costs could be in the range of US\$ 800- 1000 million for 600 MW (100MW x 6) capacity.

## **Project Financing**

This is still to be determined once the Financial Advisor for BPC is appointed. The current legislative framework does not accommodate direct equity participation in the project. BPC has set aside some finances for the generation expansion at Morupule and, in addition to this equity other sources of finance are debt and grants from international financing institutions. With the intent to improve on the environmental acceptability of the project, the Corporation is willing to consider cleaner coal technologies to reduce the total emissions (low NO<sub>x</sub> burners, scrubbers etc and /or higher efficiency coal to electricity conversion technologies). As already indicated, adoption of these technologies as part of the base case has cost as a barrier.

BPC borrows from international lending institutions and is exposed to currency risk. Currency exposure is managed primarily by holding deposits in foreign banks in the currencies of the borrowings. Borrowings from international agencies are secured by guarantees issued by the Government of the Republic of Botswana.