Chapter 2 Overview of Botswana, Energy and Power Sector

Chapter 2 Overview of Botswana, Energy and Power Sector

2.1 Overview of the Country of Botswana

2.1.1 Political and Administrative Situation

After 80 years as a British Protectorate, Botswana became the independent Republic of Botswana on 30 September 1966.

The Constitution provides for a unicameral legislature, the National Assembly. Members are directly elected from 40 constituencies. The Presidential candidate, whose declared supporters form the majority of directly elected members of Parliament, takes office as President and selects his Ministers from among the National Assembly.

In addition to the National Assembly, there is a House of Chiefs with 15 members, which advises on matters affecting custom and tradition.
There is an independent judiciary with a High Court presided over by the Chief Justice.

The capital of Botswana is the City of Gaborone. The Central Government is represented in each of the Districts by the District Administration, headed by a District Commissioner. There are ten districts, and nine district councils.
Refer to Appendix 2, Section 2.1.1 on the community development structures.

Botswana is a member of various international organizations, including the United Nations, the Non-Aligned Movement, the Organizations of African Unity, the African, Caribbean and Pacific group of countries covered under the Lome Convention, Commonwealth, the World Bank, the International Monetary Bank, the African Bank, the Southern African Customs Union (SACU) and the African Development Community (SADC). The headquarters of SADC is in Gaborone.

2.1.2 Geographical Situation

(1) Physical Features

Botswana is a landlocked and straddles the Tropic of Capricorn in the center of the Southern African Plateau. The mean altitude above sea level is approximately 1,000 meters and the country total land area is 582,000 sq. km, which is about the size of Kenya or France.

The rest of Botswana is covered with thick sand layers of the Kalahari Desert. This accounts for more than two-thirds of Botswana's land area. The sand cover is up to 120 meters deep. The Kalahari supports a vegetation of scrub and grasses, but there is an almost complete absence of surface water.

(2) Climate

Botswana is situated close to the subtropical high pressure belt of the southern hemisphere. As a result, the country is largely arid or semi-arid. Mean rainfall ranges from over 650 mm in the extreme north-east to less than 250 mm in the extreme south-west.

(3) Natural Resources

Botswana's main natural resources are range and arable land, a large wildlife population, and a variety of known and promising occurrences of minerals. Arable land is scarce; it is estimated that less than 5% of Botswana's land area is cultivable. Capricious rainfall makes arable agriculture a precarious undertaking. Much of the best arable land is found in the freehold farming areas in the east. Much more of Botswana's land is suited to extensive beef production and this is reflected in the fact that cattle outnumber humans.

Copper-nickel is mined at Selebi-Phikwe and other potentially exploitable copper resources are known to exist. Mining of coal at Morupule is relatively small-scale at present, but reserves of billions of tons have been proven. Diamond mines at Orapa, Letlhakane and Jwaneng are in production.

(4) Communications

The single-track railway line between Ramatlabama in the south and Ramokgwebana in the north links Botswana with the South African and

Zimbabwean systems. The railway system carries a substantial portion of the total freight traffic within the country.

Regular air services connect Gaborone's Sir Seretse Khama Airport with major international airports at Johannesburg in South Africa, Windhoek in Namibia, Harare in Zimbabwe, and London in United Kingdom. Regular internal air, services are maintained between Gaborone, Francistown, Maun, and Kasane.

The road network has been greatly improved since Independence. The main highway and feeder roads to major district centers have also been tarmacked.

Botswana has international telecommunications links through an earth station at Gaborone as well as via South Africa. Microwave links have been established between Gaborone and Johannesburg in South Africa and between Francistown and Bulawayo in Zimbabwe. Internal telecommunications are good in main centers,; plans are in good hand to upgrade the telecommunications system in major villages and towns. In addition, Internet Services are gradually being developed.

2.1.3 People

(1) Ethnicity

Most of Botswana's citizens are members of Setswana-speaking ethnic groups, the official languages are Setswana and English, the latter being the main language in Government. All citizens have equal rights under the Constitutions.

(2) Main Population Characteristics

The main features of Botswana's population are that:

* it is small relative to the size of the country
* it is growing rapidly as a result of high fertility and declining mortality rates;
* there is, consequently, a high proportion of children and young people:
* infant mortality is declining and life expectancy is increasing; and
* the pattern of settlement is changing rapidly.

(3) Pattern of Settlement

There is rapid urbanization of the population. The five regions of concentration are settlements in the Gaborone, Serowe/Palapye, Francistown, Selebi-Phikwe and Maun catchment areas. In terms of urbanization, it was estimated that about 46% of the Botswana population was urban in 1991.

2.1.4 Economic Situation

At the time of Independence in 1966, Botswana was one of the poorest countries in Africa. An overwhelmingly rural population depended mainly on agriculture for a livelihood.

The 30 years since 1966 have seen a remarkable economic transformation.

GDP growth has averaged around 6% per annum in real terms over the entire post Independence period. Expressed in 1993/94 prices, annual per capita real GDP has grown from P1,682 in 1966 to P7,863 in 1994/95.

The altered structure of the economy is dominated by the emergence of the mineral sector.

Although the mining sector has dominated the economy since the early 1970s, there are signs that the economy is beginning to diversify. From a share of GDP of about 50% in the mid-1980s, the mining sector's estimated contribution to GDP in 1994/95 was about 34%. Other sectors like Government, Finance and Business Services, and Trade are beginning to make a significant contribution to the economy.

Formal sector employment has grown considerably over the years. At the same time, with rapid urbanization, informal sector activities have increased substantially. However, despite these achievements, unemployment (as well as associated poverty) still remains a problem.

2.1.5 Current Government Vision and Policies on the Development Program

The National Development Plan 8 (NDP 8), covering the six-year period from April 1997 to March 2003, was presented to Parliament in June 1997. It has the theme of *Sustainable Economic Diversification*, to be achieved primarily through accelerated

growth of the non-mining sectors of the economy, especially manufacturing, tourism and financial services.

The commencement of NDP 8 in 1997 followed the launching of the *Framework for a Long Term Vision* for Botswana in September 1996 by H.E. Sir Ketumile Masire, the then President of Botswana, on the occasion marking the country's thirty years of Independence. The framework was subsequently developed into a document: *"Long Term Vision for Botswana(Vision 2016):Towards Prosperity for All"*、which was published in September 1997. The long-term Vision runs to the 2016, when Botswana will have been independent nation for 50 years. It sets some goals for the nation for the year 2016, identifies major challenges in achieving them, proposes a set of strategies to meet those challenges.

(1) The Most Critical Issues

a. HIV/AIDS

The HIV/AIDS epidemic continues to pose a threat to the social and economic development of Botswana. The disease is not only a health problem but is also a social and economic problem, cutting across all groups in society and all sectors of the economy. On the economic front, it poses a threat to development by depleting the country's supply of labor, lowering productivity and increasing the dependency ratio. It should be noted, however, that the HIV/AIDS programs will have to be prioritized, in view of financial constraints.

b. Unemployment

Another major problem facing the nation is unemployment. The 1998 Demographic Survey estimated unemployment at 19.6% of the labor force. However, 19.6% rate of unemployment is still very high and unacceptable, and continues a major socio-economic problem for the country.

c. Poverty

The other major challenge facing the country is poverty. Poverty is calculated on the basis of the Household Income and Expenditure Survey (HIES) data, the latest being for 1993/94. According to the 1997 Study of Poverty and Poverty Alleviation in Botswana, 47% of Botswana individuals and 38% of household, were living in poverty in 1993/94. A

higher proportion, 50% of female-headed households were living in poverty compared to 44% of male-headed households. Furthermore, it was estimated that 62% of poor or very poor Botswana were living in rural areas, 24% in urban villages and 14% in urban areas.

d. Economic Diversification

Economic growth in Botswana over the last three decades has been driven chiefly by the growth of the mining sector, the mining of diamonds. This has been followed by the general Government sector. The call for sustainable economic diversification in both NDP 8 and Vision 2016 came out of the realization that high and stable growth of the economy in the long run, along with approaches towards full employment and eradication of absolute poverty, can only come through sustained growth and development of the other, i.e., non-mining and non-Government, sectors of the economy.

e. Public Sector Reform

Public sector reform is an encompassing term, which includes, among others: changes in the public procurement system, cost control and cost recovery, right-sizing of Government, productivity increases, privatization, improvement of implementation capacity in Government, etc.

f. Citizen Economic Empowerment

Citizen economic empowerment has recently become a topical issue.

2.2 Overview of Energy Sector

2.2.1 Overview of Botswana Energy Sector

Botswana is endowed with large reserves of coal and high level of solar insulation, but has no gas or oil and has, in general low rainfall over the country which limits hydro potential.

Large reserves of coal have not been exploited yet, due to the lack of sufficient demand.

(1) Botswana Primary Energy Supply

Primary Energy Supply (PES) is the total energy available for gross consumption. PES in 1997/98 is shown in Figure 2.2-1. This chart shows that the major sources of energy supplied were fuel wood and coal. For the past years, these sources were the most predominant. Although solar energy is becoming increasingly popular, especially in the field of water heating and lighting, its contribution to PES is still 0.034% and other renewable energy sources contributes only 0.002%.

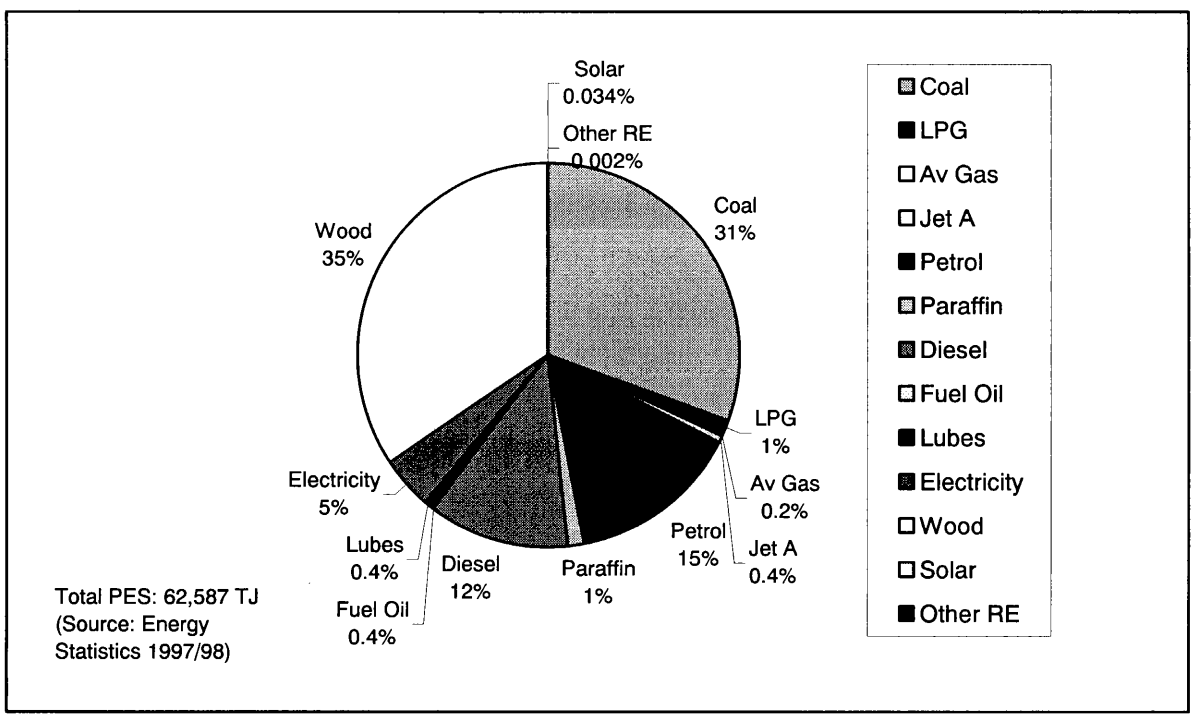


Figure 2.2-1 Botswana Primary Energy Supply 1997/98

(2) Botswana Final Energy Demand

Figure 2.2-2 shows Final Energy Demand (FED) in 1997/98, the total energy consumed by end users for various purposes. The major consumers were residential (consuming mostly fuel wood), transport (mainly petrol) and industry (mostly coal and electricity) respectively.

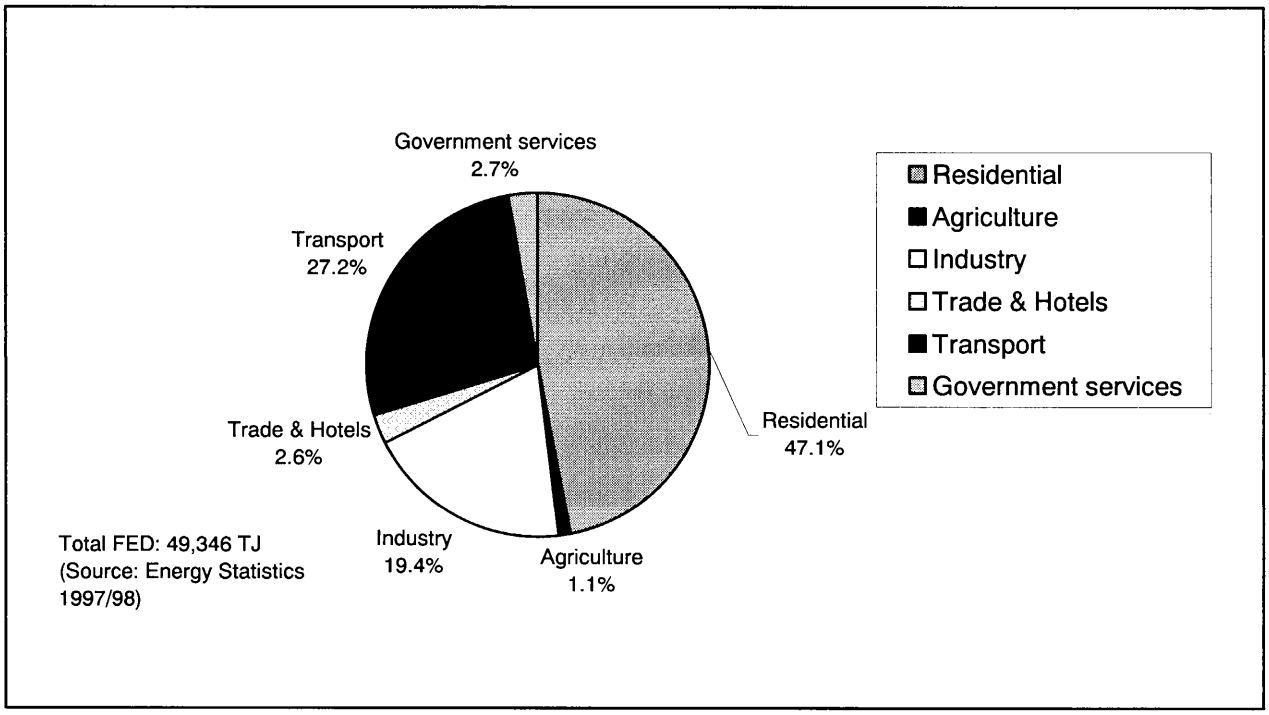


Figure 2.2-2 Final Energy Demand in 1997/98

2.2.2 Energy Policy

Energy policy is an extension of national policy. Presently Botswana energy sector is governed under the following hierarchy of national policy.

(1) Long Term Vision in Context with Energy Policy and Rural Development

The Botswana Government set forth "Long Term Vision 2016" and shaped the vision and strategies.

The Long Term Vision presents, among others, "Building an Educated, Informed Nation", "Building a Prosperous, Productive and Innovative Nation" and "Building a compassionate, Just and Caring Nation". In order to accomplish such vision, the following strategies, among others, are raised:

* The improvement of all level of schooling by the proper equipping of primary and secondary schools with electricity, especially in remote areas.
* Economic growth in rural areas creating employment with the full utilization of solar power abundant in Botswana.

(2) National Development Plan in Context with Energy Policy and Rural Development

The main theme of the Eighth National Development Plan (NDP8) is sustainable economic diversification. In NDP8, energy sector policy and strategy are raised.

(3) Energy Master Plan

The Ministry of Minerals, Energy and Water Resources (MMEWR) has been responsible to coordinate development and operational activities in the energy, water and minerals sector. According to Botswana Energy Master Plan drafted under the Energy Affair Division (EAD) of MMEWR in June 1996, Botswana has an explicit commitment to equalizing the distribution of economic benefits between all parts of Botswana society. Energy is a basic need for household such as education and health services. For the long-term success of the Botswana economy and Botswana society, access to basic energy services (cooking, heating and lighting) is essential. Although the mandate to achieve economic efficiency makes the policy of "price being cost reflective" a major objective of the government, the calculation of costs and the mechanisms for recovering costs can vary widely, particularly in the supply of basic energy services to poor households. In such a case appropriate methods of risk analysis, billing mechanisms and funding and financing arrangements need to be applied in order to provide supply and ensure the financial viability of the utility.

According to the basic policy above mentioned, Energy Master Plan dictates access to electricity, both connected to the national grid, off-grid and photovoltaic (PV) to all those households where it makes economic and social sense, and improving the affordability of electricity to households. It also identified the following factors:

1) At present no institution takes final responsibility for the overall planning and coordination of electrification potentially resulting in inappropriate planning and resource wastage.
2) Electrification planning should be integrated with other development planning.

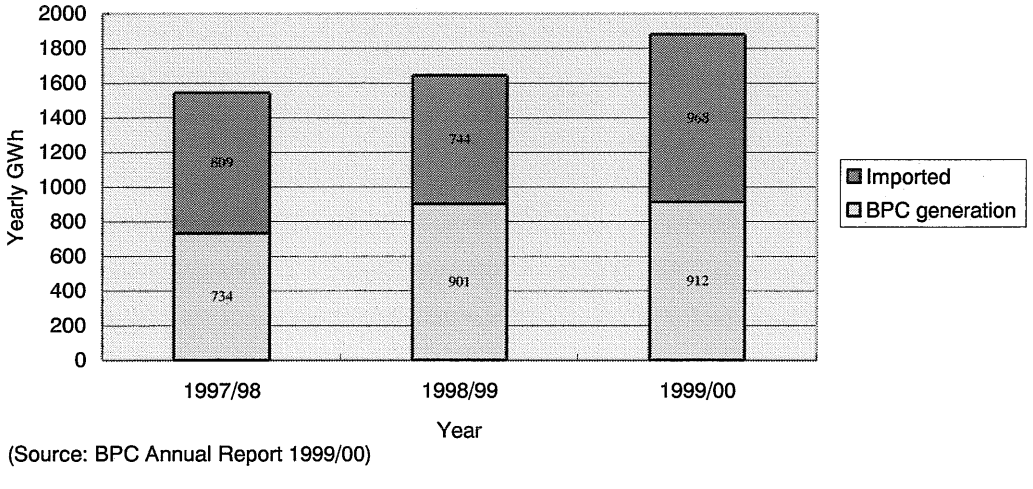
3) Rural electrification needs to be regarded as part of the national electrification program but as having very different objectives and requirement to urban electrification.

As for policies relating to the PV, Energy Master Plan sets forth the policy to include electrification using PV systems in national electrification planning. Planning of PV electrification needs to take cognizance of grid expansion plans, and should be funded under the same principle that justifies grid rural electrification.

2.2.3 Overview of the Power Sector in Botswana

(1) The Structure of the Power Sector

Botswana Power Corporation (BPC), which is a wholly government owned public power corporation, has an overall power generating capacity of 132 MW at Morupule, and produced approximately 48.5% of Botswana's total power and 51.5% was imported through Southern African Power Pool (SAPP). Refer to Figure 2.2-3.



(Source: BPC Annual Report 1999/00)

Figure 2.2-3 BPC's Electricity Generation and Purchase

BPC made the preliminary evaluation for a generation expansion at Morupule for Government approval. Preliminary assessments indicate that this

expansion should be commissioned between 2004 and 2007 depending on the regional growth, Power Pool tariffs as well as the self-sufficiency aspect, given that by 2007 imports will be supplying 70% of the total energy requirements. The initial cost estimate for the 250 MW expansion to the existing 132 MW station at Morupule is approximately P1.3 billion. BPC's plan is to fund at least 50% of the expansion internally.

In addition to power generation, BPC also has a monopoly on power transmission and distribution. The government is currently implementing a policy to promote restructuring and privatization of every sector in Botswana, but it is said that the power sector is an exception to this policy and the priority for its restructuring and privatization will be low.

Department of Electrical and Mechanical Services (DEMS) of Ministry of Works, Transport and Communications (MWTC) has constructed diesel power plants for the governmental and public facilities in the area where grid is not extended and has supplied surplus electricity to households in the vicinity of the facilities.

Photovoltaic electricity generation has been significantly developed in various fields such as in telecommunication, water pumping, lighting of public facilities, and railway signals. Non-grid rural electrification started from the pilot project in Manyana Village in 1991.

(2) Generated Power

Table 2.2-1 shows the contribution of the sources of the power generated by each of the BPC and DEMS power station facilities.

Table 2.2-1 Generated Power by Power Station Facilities

Generation facility	1997/98 (GWh)
Coal-fired (BPC)	835
Diesel Power Plants (BPC)	4
Diesel Power Plants (DEMS)	22
Self generation	86
Total	947

Source: Energy Statistics 1997/98

(3) Demand Growth and Demand Disposition

BPC has continued high growth in the demand for power supplies. BPC's sales increased by 11.1% from the previous year. BPC's sales disposition in 1999/2000 is shown in Figure 2.2-4. Demand for mining is predominant (46%). Sales growths in each demand disposition are shown in Table 2.2-2.

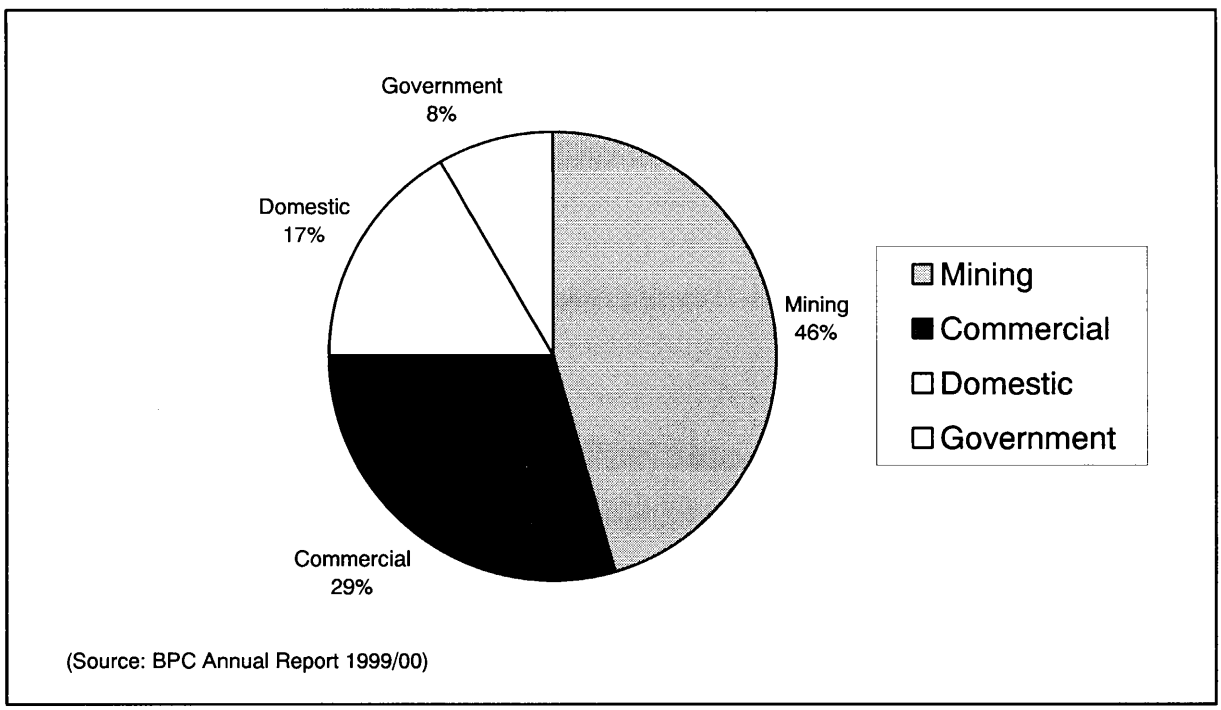


Figure 2.2-4 BPC's Sales Disposition

Table 2.2-2 Sales Growth (%)

Sales Growth	1999/00	1998/99	1997/98	1996/97
Mining	0.9	5.3	7.0	7.9
Commercial	17.4	9.5	0.6	12.1
Domestic	26.0	17.0	9.4	8.3
Government	30.3	17.7	6.3	8.1

Source: BPC Annual Report 1999/00

Although domestic sales growth stayed low by 1997/98, high increase of sales has been attained in recent two years.

(4) Tariffs

BPC customers are categorized into six classes based on the use and size of supply taken. The tariffs for domestic customer are P7/m for fixed charge and P0.2523/kWh for energy charge. Customers pay a security deposit of P200. For remote area customers such as those of 72 villages grid extension project, P7/m of fixed charge is exempted.

A tariff increase of 5% was effected in February 1999. This was the first increase since October 1993. Accumulated inflation for the period March 1994 to March 1999 was 53%, versus the accumulated increase in tariff over the same period of 2%.

2.2.4 Overview of Grid and Diesel Mini-grid Rural Electrification

(1) Extension of Transmission and Distribution Lines by BPC

BPC's power supply had been continuously expanded to rural villages, approximately at the pace of 15 villages every year in accordance with NDP7 and NDP8. Then, 72 villages electrification project to start in 2000 and to be completed in two years was announced. At present, BPC completed it in September 2001.
New grid-extension proposed for NDP9 has been elaborated by BPC and is subject to government deliberations.

Although the grid has been extended rapidly, the number of households connected to the extended grid has not increased as a satisfactory rate, due to the policy of recovering the costs for connections from the end-users. Botswana Power Corporation (BPC) has planned a long-term loan program, the Rural Electrification Collective Scheme (RCS), to alleviate the burden of users' connection fees. However, the down payment and monthly payment were not in the affordable range for average rural households, according to the evaluation of RCS made by EAD in 1999. Following the evaluation, since April 2000, measures to decrease by half the amount required as down payment, and to lengthen the term for payment to 15 years from 10 years were adopted. Since then, the increase in the rate of connection has picked up steeply.
RCS credit scheme are shown in Table 2.2-3

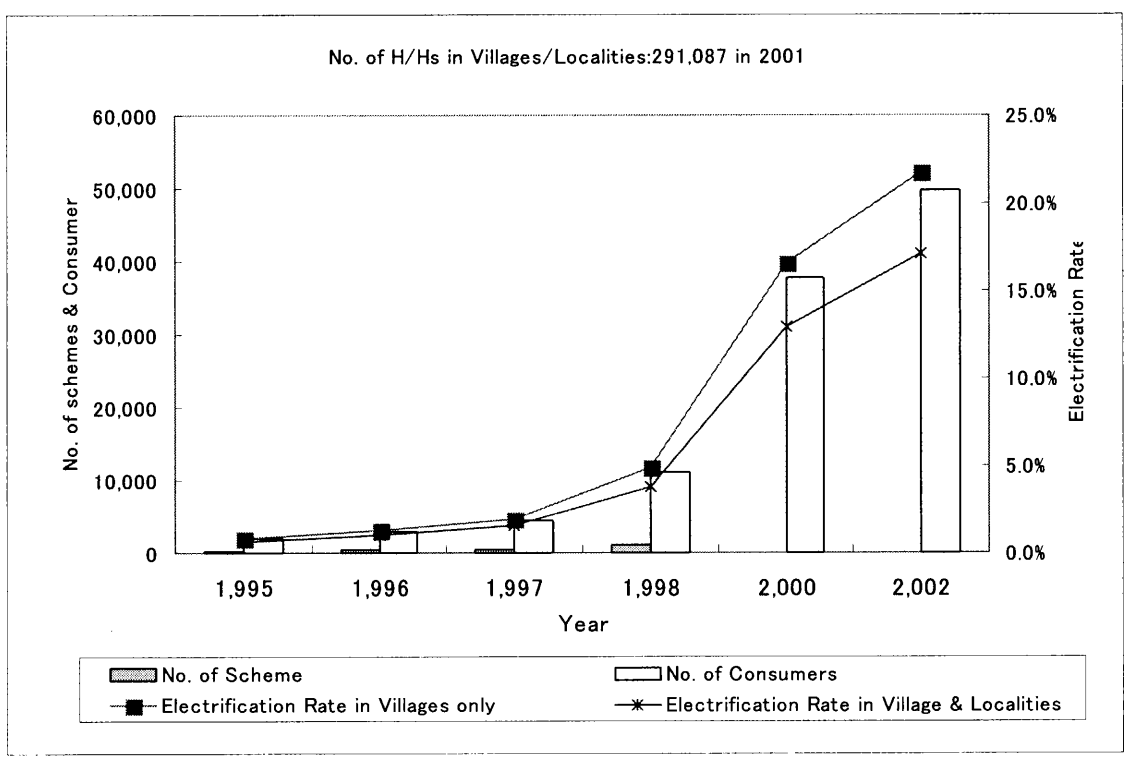
Table 2.2-3 Credit Scheme of RCS

	Down payment	Repayment	
		Interest	Repayment period
Commencement of RCS	40%	Prime Rate	10 years
Year of 1995	10%	9%	10 years
Year of 2000	5%	Prime Rate	15 years

Note: Prime Rate to be referred to Figure 11.1-2.

The movement of number of connections to the grids in recent years is referred in Figure 2.2-5.

This indicates steep increase of connections in recent two years is due to mainly improvement of RCS credit scheme. Number of connections increased by about 600 in one month from August to September, 2000. In case this increase remains, about 7,200 consumers will be newly grid-electrified in the rural villages in a year.



(Source: BPC)

Figure 2.2-5 Movement of RCS Electrification Rate

As a result of revision of the RCS, 49,170 households in urban area (43.3% of urban households 113,619) and about 50,000 households in rural villages

(17.1% of rural village households) have been connected to the grid. Of all households in Botswana (rural villages and urban cities and towns excluding the localities) 24.5% were electrified in September 2000.

As indicated in Table 7.4-1 of Chapter 7, grid was extended to 195 villages by the end of 2001. Total number of households in these villages is estimated as 191,800. Therefore, average electrification rate in the grid-connected villages reaches to 26% in 2002, taking 50,000 households into account as grid-connected. BPC's target grid-connection rate is 12% increase per year to the previous year. If such target is accomplished, average electrification rate in the grid-connected villages exceeds 80% after 10 years.

According to the post-revision of RCS, the average monthly payment for the connection fee is P38/m and the total monthly payment including BPC's tariff for electric consumption for average rural households is estimated to be average P47 to P50/m. The rural households who can afford the monthly payment of more than P50/m account for about 40% of total households in the rural villages, utilizing Figure 6.2-11 which is derived from the ability to pay for SHS application as discussed in Chapter 6.

The willingness and ability to pay for grid-connection will be higher than shown in Figure 6.2-11, taking into consideration more merits in case of grid-connected users. The electrification rate will be more than 40%.

Judging from the above mentioned discussion, the average grid-connection rate in the villages where the grid is extended is projected to reach about 60% within 10 years.

(2) Electrification by DEMS

DEMS constructs diesel power plants in the area where grid is not extended and it supplies electricity to governmental and public facilities, and it supplies surplus electricity to households in the vicinity of the diesel plant.

2.2.5 Overview of PV Rural Electrification

The overall energy policy of the Government of Botswana is to provide least cost mix of energy supply, which reflects total life costs and externalities. One of the specific objectives on new and renewable sources of energy is to promote increased usage of PV in an orderly way with adequate coordination and institutional support.

Since the National Development Plan 7 (NDP 7) the government has initiated Programs to promote the use of renewable energy sources. In 1991 the Energy Affairs Division (EAD) of the Ministry of Minerals, Energy and Water Resources (MMEWR) initiated a pilot project to install, monitor and evaluate solar energy technologies in Manyana Village. The objective was to assess the socio-economic viability of solar energy technologies in a village environment, with a view to replicate them in other parts of the country should they prove viable.

Following the positive outcome of the pilot project the National PV Rural Electrification Program (NPV-REP) was initiated in 1997. This Program was implemented by Rural Industries Innovation Center (RIIC) and offered loans to individual households and small businesses to purchase PV home systems repayable over a period of 4 years. Despite the existence of financing mechanism for PV dissemination the uptake remained low with only 300 systems disseminated over a period of 4 years.

The Department of Water Affairs, which is responsible for water supply development in rural areas, promotes PV water pumping and has installed about 35 PV pumps in rural areas, some of which belong to the Department of Wildlife and National Parks. A significant number of these installations have suffered from lack of maintenance, vandalism and theft of PV panels.

District Councils, which fall under the Ministry of Local Government, provide PV electricity to remote schools, clinics and health Centers in areas without access to grid-based electricity. The Ministry of Education provides PV in remote areas for their village reading rooms. The rooms are intended for reading purposes at night by students and the community. This is part of government efforts to improve literacy in rural areas.

The Botswana Telecommunication Corporation and the Botswana Police have installed substantial capacity for powering their communication equipment. Botswana Railways has also installed PV equipment for powering traffic signaling equipment. These installations have also faced extensive problems of theft of panels as most of the installations are unmanned and located in remote sites.

These individual efforts have been going on for some time without an overall guiding framework.

PV Rural electrification projects in Botswana are enumerated in Table 2.2-4.

Table 2.2-4 PV Rural Electrification Projects in Botswana

NR	Time	Project	Execution Body	Target Area	Objectives	Project Scheme	Payment Conditions	Evaluation
1.	92-95: Pilot phase, 95-97: Commer-cial. phase	Manyana PV Project	EAD/ RIPCO/RIIC	Manyana /Southern Ngwakatse	-determine social economic viability, -test performance, -aquire data to formulate policy, -for awareness and teaching device	42: SHS 1: Lighting and refrigenation In the clinic 6: PV street lights 6: Solar water heating system	Purchase with loan (2 years) 2 light: P28 (8.75$)/m 6 light: P100 (31.25$)/m	
2.	97 -2001	NPV-REP	EAD/ RIPCO-RIIC Operation: District council	Whole Botswana	-make PV affordable through financing mechanism, -for those who cannot afford grid electricity and need small loads applications	SHS 237 Households/year targetted	purchase with loan, 15% downpayment and 4 years repayment at prime rate 50Wp: downpayment;P600, repayment; P100/m 100Wp:P900, P150/m	Refer attched table
3.	98		EAD/ Botec Operation: District council	Motshegaletau /Central Serowe/Palapye	-Pilot for centralized PV system	DC 5.5 kW (AC4.5kW) Mini grid for 14 households, school, clinic, kgotla Mini grid: 240V-2km, total investment:P433,000 PV: 250Wp solar pannel	ESCO: Prepaid card the same price system as BPC (25 T/kWh)	Refer attched table
4.	99	Khakhia Solar PV Pilot Project	BPC	Khakhia /Southern Ngwakatse		SHS ① 24:72 Wh/day; P40/m ② 36:186 Wh/day; P60/m ③ 31:320 Wh/day; P100/m	ESCO ① P40/m ② P60/m ③ P100/m	Canceled

(1) Manyana PV Pilot Project

The project was started in 1992 as the first pilot project in Botswana to determine social economic viability, to test PV performance and to enquire data to formulate policy. The project was shifted into commercial phase and operated from 1995 to 1997 by RIIC. Scheme of payment was to purchase system with 2 years loan. Concerning recovery of loans, almost all households (total 42 SHS) paid within two years and it was evaluated that users were satisfactory with the results.

(2) National PV Rural Electrification Program (NPV-REP)

Following the satisfactory results obtained in Manyana pilot project, NPV-REP was planned by EAD to disseminate SHS nationwide and implementation was entrusted to RIIC. The objective of the project was to make PV affordable through financing mechanism. The project scheme was to purchase with loan, 15% down payment and 4 years repayment at prime rate of interest.

In case of 50Wp user, down payment was P600 and repayment was P100/m.

The project has been implemented since 1997 and by the end of 2001 only about 300 clients were gotten, despite the initial target was 237 households per year.

The issues related to NPV-REP are pointed out as follows:

1) Many customers fail to make installment payment;
2) It is very difficult to fix PV systems in trouble which are scattered in the whole country, because of the shortage of maintenance staff;
3) There is no same system as consumers needs at their house;
4) There is no inspection list and no program to check the system regularly;
5) The accounting system also is imperfect;
6) The whole system cost increases more than 50 percent over the original price;
7) It takes long time for applicants to receive cost estimates; and
8) The loan becomes six times the monthly income of the average applicant.

(3) Centralized PV system by BoTeC

The centralized PV system with capacity of 5.5kW(DC) started commercial operation in August 1998 in Motshegaletau Village. In June 1999, an inauguration ceremony was held in the presence of the President of Botswana. The system has two inverters and the AC output is 4.5 kW. It is the mini independent system which supplies electricity to 14 customers through the 240 V distribution line of about 2 km. Most electricity is supplied to a school, a clinic, Kgotla and households. Two TVs, which are donated by a firm, are installed in the school and the clinic. The rest of energy is supplied to streetlights.

Refer to the Appendix 2 for the detailed studies on the subjects related to Chapter 2 including lessons learned in PV rural electrification in the various developing countries.