SUSTAINABLE ENERGY FOR ALL

BOTSWANA:
Rapid Assessment and Gap Analysis

OBJECTIVE

The purpose of Rapid Assessment and Gap Analysis is to provide:

- A quick brief look of the energy situation in the country (Section 1) within the context of its economic and social development and poverty eradication
- A good review of where the country is in terms of the three SE4ALL goals (Section 2), and
- A good estimate of the main challenges and opportunities vis-à-vis the three goals of SE4ALL where the major investments, policies and enabling environments will be required (Section 3)
- A sound basis and background for an Action Plan that may follow as part of the SE4ALL activities in the country

EXECUTIVE SUMMARY

The UN Secretary General has launched a global initiative to achieve Sustainable Energy for All by the year 2030.The key objectives under this goal are: (a) ensuring universal access to modern energy services, (b) doubling the rate of improvements in energy efficiency and (C) doubling the share of renewable energy in the global energy mix. This document presents the situational analysis of the energy sector of Botswana, with special reference to the objectives of sustainable energy for all.

Summary of Key Findings and Conclusions

Energy Access

Botswana is highly dependent on imports to meet its energy demand. Internal electricity generation is not sufficient to meet demand and progress is being made to ensure security of supply through expansion of the country's thermal power station.Petroleum fuels are also imported in their refined form from South Africa. The challenge with importing petroleum fuels is limited supply routes which had led to periodic shortages in fuel supply. This is exacerbated by inadequate internal strategic storage capacity and the long distances travelled to supply all parts of the country.

Policy objectives with regards to energy access are ensuring improved security of supply and reliability of energy supply to all sectors of the economy. Government has set national electricity access target of 82 % by 2016 and 100% by 2030. Currently electrification in urban areas stands at 75 % and 57% in rural areas while national average electrification is 62%.

Modern Energy for Thermal Applications

LPG is widely used as a main energy source for cooking in urban areas by 70.7% of the households and 40.5 % in rural areas. LPG is supplied by the private sector with minimum interference from government. Private sector control of LPG supply and pricing has created a large market for LPG in the country. With regards to kerosene, its use as fuel for cooking is not significant for both urban and rural areas. Kerosene is partly subsidised by government with the intention to make it

affordable by the low income groups. Cooking with electricity is still at low levels as only 1% among rural households and 3% among urban poor households are using it as their principal energy source for cooking. And with the tariff continuing to increase, not many more consumers will use electricity for cooking.

The programme to promote uptake of coal is intended to encourage the substitution of fuel-wood, imported coal and petroleum products with local coal. Reliability of coal supply in Botswana remains poor in terms of both coverage and efficiency of delivery. Coal is anticipated to offer alternative energy supply solutions that can improve energy security. Some of the coal is already being promoted for use in households and institutions for cooking

Fuelwood is the main cooking fuel for rural households (53 % rural households and 13 % of urban households with a national average of 49.1 %).Efforts to promote the use of efficient wood stoves is on- going in the country, though commercial availability of improved stoves in Botswana is still low. There is need to set up a reliable supply chain of stoves coupled with local production of a variety of stoves in the country to ensure availability of the stoves.

1.1.2 Promoting Energy Efficiency

The Government of Botswana intends to achieve 10 % power savings by 2020 through energy efficiency and conservation initiatives. Currently there are no set energy efficiency appliance standards in place and the government plans to develop and enforce such standards. Botswana's energy intensity can be attributed to mining and construction sectors which rely heavily on energy for their processes. However, there are programmes being implemented to promote energy efficiency.

1.1.3 Share of Renewable Energy in the National Energy Mix

Renewable energy resources for Botswana are solar, wind, and various forms of bioenergy that include biofuels and biomass wastes. Lack of perennial rivers in the country has ruled out potential for hydro power. Botswana does not have a dedicated Renewable Energy Policy, however there is a Biomass Energy Strategy that specifies the biomass related projects that can implemented in the country to augment the power sector. The RE goal is to promote growth of a sustainable PV/SWH market through creation of financing schemes and integrating grid and non-grid electrification.

Main strengths with regards to the promotion of renewable energy in national energy mix;

Solar Energy

- Potential to tap solar energy.Botswana has direct normal irradiation (DNI) of 3000kwh/m2/year, which is among the highest in the world.

Biomass

- Widespread availability of fuelwood

Waste to Energy

- Potential for landfill gas and biogas from municipal solid waste, abattoir waste and animal waste.

Biofuels

- Potential for biodiesel production from jatropha and animal fat.

With regards to investment in the country, the investment promotion programs of Botswana are characterized by favourable exchange control for potential investors low cooperate tax (which is expected to be reduced) and relaxed labour laws to bring in skilled personnel. A Special Economic Zones Policy has already been passed by Cabinet where these tax and labour incentives will apply. Such policies can attract investment in the energy sector in the country.

The key gaps, barriers and additional requirements to achieve SE4All in thermal energy applications, power sector and modern energy for productive use are as follows;

- Adequate power supply to meet growing demand and expected access rates.
- Clear policy for energy access, EE/RE and productive use of energy.
- Assessment of RE/EE potential and capacities that can be achieved.
- Identification and costs and benefits of various technologies.
- Instituting appropriate regulatory frameworks e.g. for technology standards, incentives to reduce costs to consumers,
- Having dedicated institutions that push for the SEA4ALL agenda
- Dedicated financing mechanisms with reduced cost of finance to enable the poor to afford
- Government absorbing risk for energy producers to supply both grid ,mini grid and off-grid systems
- Awareness of end users on technologies and their costs and benefits
- Monitoring and evaluation of set targets for energy access, RE and EE
- Capacity of technology developers ,designers, installers and maintenance

Section I: Introduction

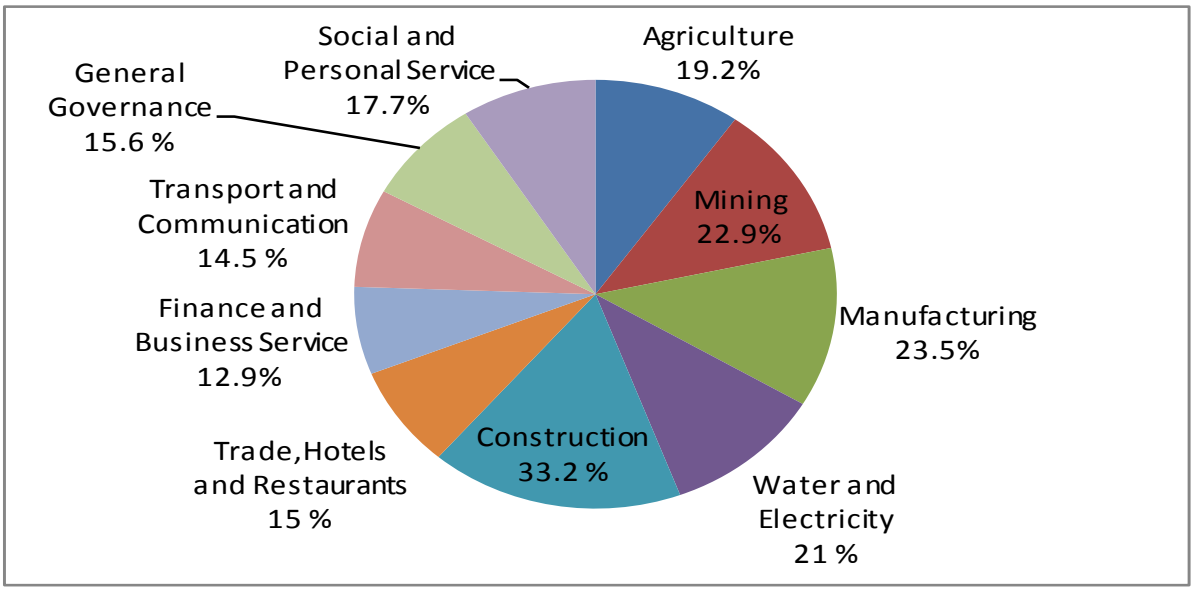
1.1 COUNTRY OVERVIEW

1.1.1 Basic socio-economic data: population, GDP/capita, key economic sectors, poverty rate (current and trend)

The 2001 population census reveals that Botswana had a population of 1,680,863 with 55% of the population residing in urban areas while the remaining 45% in rural areas. . The population is estimated to be growing at a rate of 1.2 % (2011 est.) .In 2011 the total population was estimated to be 2,065,398 (July 2011 est.)[1] and is projected to reach 2,334,836 by 2030.

Botswana has been experiencing a fast growing economy with an average real per capita GDP growth rate of 8.7 % per annum between 1996 and 2001 and 4.6 % between 2001 and 2006.Real gross domestic product increased by 1.4 % in the fourth quarter of 2011 from a decrease of 3.0 % in the same quarter of 2010 (CSO, 2012).

In terms of sectoral GDP shares, construction was the highest recording 33.2 %, followed by manufacturing and mining with 23.5 % and 22.9 % respectively (Figure 1). Electricity and water contributed 21% to the national GDP in 2011.



Source: (CSO, 2012)

Figure 1: Percentage real GDP by Economic Activity for the year 2011

The mining sector remains the main engine of growth in the country's economy despite recording a decrease in the year 2010.The current forecast is that diamond revenue will fall by 65 % by the end of NDP 11 in 2022 and will decline to zero by 2028. This suggest that diversification of the economy will be required during the next 20 years if GDP growth is to be sustained at past levels (BEST 2009).

[1] A census was carried out in 2011 but results are not yet official

Agriculture plays an important role to the socio –economy of Batswana though its contribution to GDP fell from 40 % at independence in 1996 to only 1.8% in 2006/07 and the sector stagnated during the period of National Development Plan (NDP) 9 (2002/3 to 2008/9). This is largely due to disease outbreaks and droughts (BEST 2009).

The Vision 2016 targets require that the proportion of people in income poverty be halved to 23 % by 2006 and to zero by 2016.Statistics from the 2002/03 Household Income and Expenditure Survey reveals a percentage decline in the number of households with incomes below the poverty datum line including the number of individual with incomes below the poverty datum line (Table 1).

Table 1: Successive poverty estimates (1985-86 to 2002-03)

Year of Survey	% of Households below PDL	% of individuals below PDL
1985/86	49 %	59 %
1993/94	38 %	47 %
2002/03	22 %	30 %

Source: HIES 1985/86; 1993/94; 2002/03

Botswana's Human development Index (HDI) value for 2011 was 0.633 in the medium human development category, positioning the country at 118 out of 187 countries and territories. Between 1980 and 2011, Botswana's HDI value increased from 0.446 to 0.633, an increase of 42 % or average annual increase of about 1.1 % (UN Human Development Report, 2011).

1.2 Energy Situation

1.2.1 Energy Supply

Botswana relies mainly on electricity, coal, fuelwood and petroleum for its energy demands. Total energy supply for the country in 2008[2] was 1604.10 ton-oil equivalent (toe) with petroleum being the major supplier at (895.83 toe) (54 %) followed by coal at (485.93 toe) (29%) and Electricity at (276.6 toe) (17%) respectively (Figure 2)[3].

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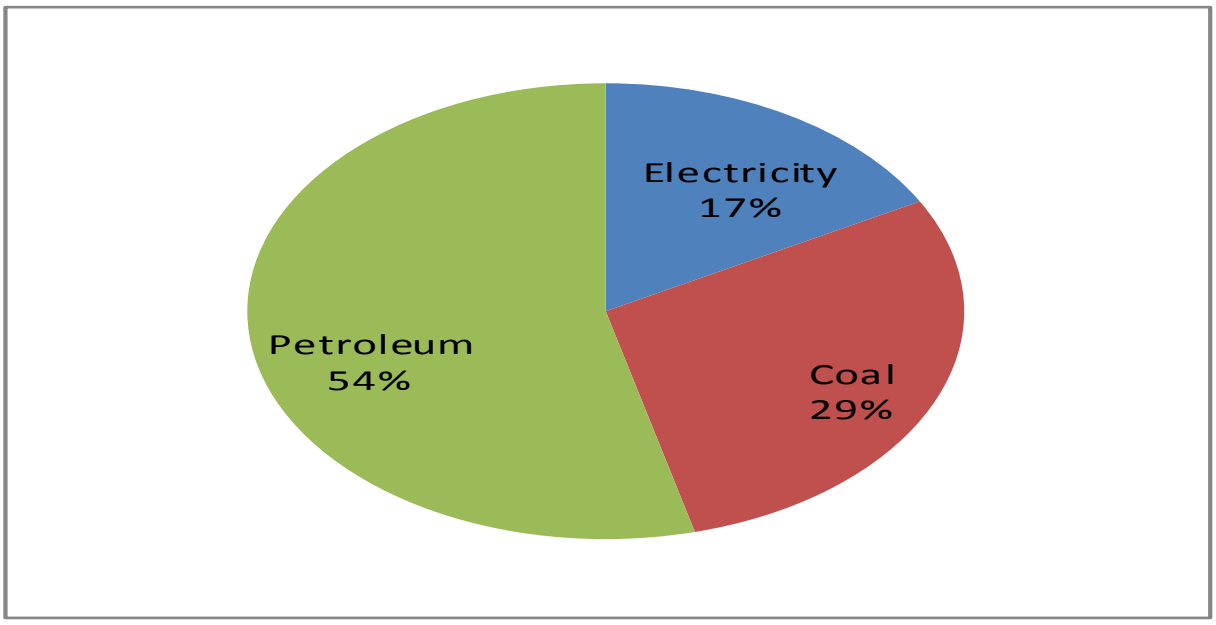
[2] This is the latest year with official energy statistics

[3] The latter energy balances stopped including fuelwood supply due to unreliability of data



Source: Energy Statistical Bulletin 2008

Figure 2: Primary Energy Supply

A review of the country's energy balances reveals an increase in energy supply over the years. Electricity supply rose from 4% in 2000 to 17 % in 2008. The growing transport sector has also perpetuated an increase in petroleum products consumption which in 2000 was at 32 % compared to 54 % in 2008.

The country does not have oil reserves and imports its petroleum products from South Africa and most recently the government has been making efforts to get supply through other routes e.g. ports in Mozambique and Namibia. Petroleum products consumption in the country has risen significantly, and the 2008 statistics shows that total consumption for petroleum was 895.83 tonnes in 2008 compared to 520.50 tonnes for 2007.

Botswana's energy resource base is dominated by huge coal reserves estimated at 212 billion tonnes. The coal consumption of Botswana is around one million tonnes per annum. More than 55% of that is used for electricity generation by Botswana Power Corporation (BPC).

The country's level of dependency on biomass energy is significantly lower than most other African countries, where biomass often accounts for 80-90% of primary energy consumption. Woody biomass is the major source of energy in Botswana's rural households, accounting for 30% of the country's primary energy supply and 38% of total final energy consumption. Data reveals that over 90% of this resource is consumed by households of which 75 % is consumed by rural households (BEST 2009).[4]

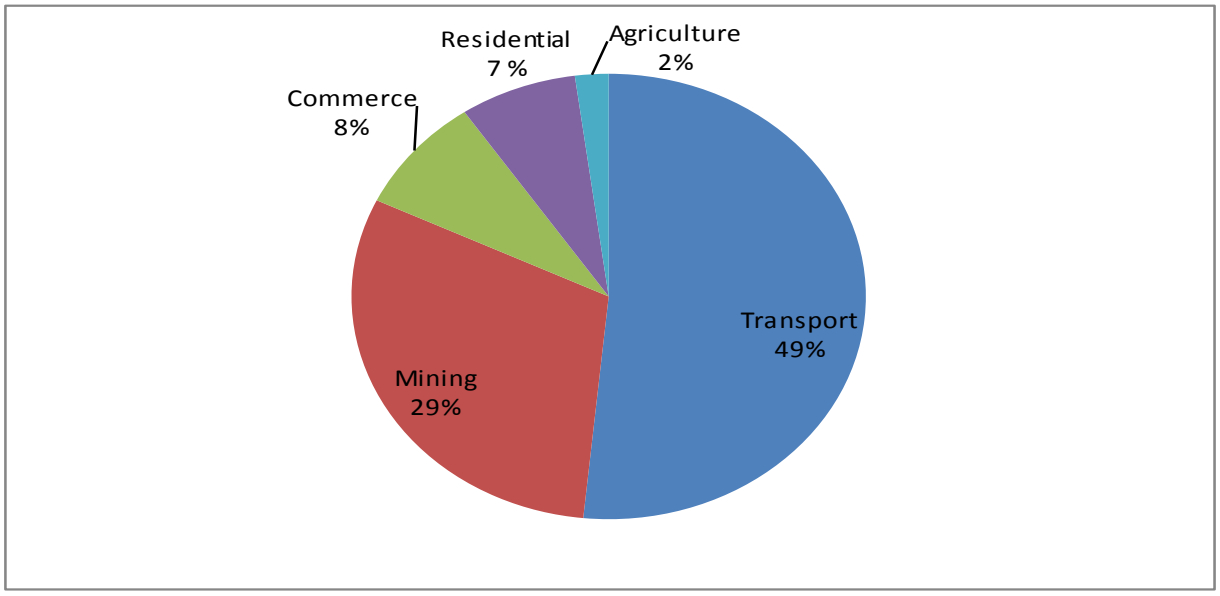
1.2.2 Energy demand

Botswana's energy sector has over the years relied heavily on imports, which account for 69.82 % of the total energy supply to meet the country's energy demands .South Africa, the major exporter of the electricity consumed in Botswana supplied about 410MW prior to 2008 which was later

[4] The supply side data is not reflected in energy balances

reduced to 150 MW in 2011. Currently Botswana's national electricity peak demand stands at 550MW.

The transport sector is the main consumer of energy accounting for a total of 49 % of final energy consumption. Consumption in the sector has risen from 27 % in 2000 to 49 % in 2008. The second major consumer is the mining sector at 29 %, followed by commerce, residential and agriculture at 8%, 7 % and 2 % respectively. The Energy Balance reveals that energy consumption in the residential sector has gone down significantly accounting for about 23 % of the final energy demand compared to 42 % in 2000. The household sector meets 90 % of its energy from fuelwood, 75 % of which is consumed by rural residents. The transport sector uses 63 % of all liquid fuels, of which 85 % goes to road transport. Figure 3 shows energy consumption by sector for the year 2008.



Source: Energy Statistical Bulletin 2008

Figure 3: Energy Consumption by Sector

Fuelwood supplies nearly 100 % of biomass energy in Botswana. In 2003, 1363 million t. of fuelwood were consumed of which the household sector consumed 95 % (74 % of this by rural households – (1.04 million t.) and 26 % by urban households- (0.373 million t.)

1.2.3 Energy and Economic Development

Energy sector contribution to GDP increased from 17.2 % in 2010 to 21% in 2011 (Statistical Brief, CSO.2012). Goals to increase energy sector contribution to economic growth are being pursued in NDP 10.

Imports contribute about 70 % to the country's total energy supply, while 33.53 % is from domestically produced sources[5].With regards to the power sector, energy imports accounted for 52 % of Botswana Power Corporation's total costs .Import power costs went up by 35 % bringing unit sales to 36 thebe against an average unit cost of 57 thebe per kWh (BPC, 2010). Total sales of 3150.6 (GWh) were made in all sectors with mining and commercial sectors being the highest consumers at 1,149.3 and 864.7 GWh.

[5] Energy Statistical Bulletin .2008

Development programmes in the country recognizes the importance of universal access to energy services for sustainable economic growth. Emphasis is being placed on rural electrification using both grid and solar energy to improve the livelihoods of rural areas. The government is promoting expansion of efficient support services. There is need to improve particularly the agricultural support services for biofuels production.

Studies done in the country reveals that biofuels production can enhance small micro enterprises, and in this case small-scale rural entrepreneurs. The Revised National Policy for Rural Development provides opportunities for enterprise building in rural areas availing productive resources, employment and other opportunities in rural areas to both male and female-headed households. Diversification from communal rain-fed agriculture based on current practices is being promoted to improve rural incomes and hence alleviate/eradicate poverty.

1.2.4 Energy Strategy and relevant targets

Morupule Power Station is the major generator of electricity in the country contributing about 17 % of current power .The thermal station has an installed capacity of 132 MW and is currently being expanded by an additional 600 MW. The first unit of this new plant is expected to start operating in 2012[6].Morupule Power Station consumes about 560 000-630 000 tons of coal per annum depending on the availability of the plant.

There is a diesel plant of 70MW at Matshelagabedi used for emergency purposes only and can operate for an average of 2 hours per day. Debswana has just commissioned a 90 MW power plant operating on diesel (and can also operate on gas) for its Mines. CIC Energy has embarked on a project to build a Power Plant with a capacity of 300 MW in Mookane.

The Draft Energy Policy of December 2010 stipulates a target of 25% peak electricity demand from renewable energy by 2030, 100% use of Cfl's by 2020, 10% biodiesel blending by 2020. The policy aims to maximize the potential of RE through decentralization to meet socio-economic needs in rural areas, creating a critical mass of expertise particularly among SMEs and integrating all viable rural electrification technologies.

Fuelwood is the most widely used form of bioenergy in Botswana. It is recognized that fuelwood scarcity is on the increase and is exacerbated by use of fuelwood for commercial purpose and in government institutions. Botswana has been participating in ProBEC initiatives where energy saving fuelwood cook stoves was introduced in the country. Dissemination of the stoves is being pursued by BPC Lesedi, which is a subsidiary of the Botswana Power Corporation.

[6] A Presentation on the Electricity Supply Situation in Botswana – Botswana Power Corporation

SECTION 2: CURRENT SITUATION WITH REGARD TO SE4ALL GOALS

2.1 ENERGY ACCESS vis-à-vis GOAL OF SE4ALL

1. Energy strategy and relevant targets (access, capacity, generation, energy security)

2.1.1 Overview and assessment

This section presents current situation on energy access in relation to the major end uses of thermal applications (cooking and heating), access to electricity and access to modern energy for productive uses.

2.1.2 Modern Energy for Thermal Applications

2. Modern energy for thermal applications (cooking, heating)

- Physical access: share of households without access to modern cooking/heating, industrial/agricultural use

Household Energy Use

Studies conducted in 2000 showed that households use multiple fuels, even for one end use, depending on the availability of both the fuel and financial resources. LPG is widely used in the country and it is prevalent in urban areas as the main energy source of cooking by 70 % of the households. Cooking with electricity is still at low levels as only 1% among rural households and 3 % among urban poor households are using it as their principal energy source for cooking. For heating purposes, wood is the most preferred source of fuel in rural areas. About 72.6 % of rural households use wood for water heating while kerosene is the principal fuel for heating in urban areas for 41.4 % of the households (BEST 2009).

Fuelwood is the main cooking fuel for rural households at 53 % compared to 13 % of urban households with a national average of 49.1 %. Most of the lowest income urban households are still largely dependent on fuelwood as their principal source of energy. Population growth, lack of effective local resources management and lack of regulation of commercial fuel wood collection has led to over harvesting of fuelwood in the country.

The use of energy efficient devices has been identified as an initiative in ensuring efficient use of fuelwood and also addressing health problems associated with the use of fuelwood. This also includes combating climate change by mitigating carbon dioxide emissions. The use of energy efficient devices such as solar cookers can result in tangible monetary savings, thus enabling families to divert funds to other uses.

Efforts to promote the use of efficient stoves in the country are on-going .Previous studies reveals that energy efficient wood stoves have been tried in Botswana since the mid-eighties but penetration has been low to non-existent, though an urban study conducted in 2000-2001 showed that there is considerable willingness (40-60%) to use these stoves(HIES 2002/03).

In 2007, Programme for Biomass Energy and Conservation (ProBEC) piloted the introduction of Energy Efficient Stoves in Botswana through RE Botswana. This collaboration has in part led to the formation of BPC Lesedi, whose objectives amongst other things is to promote Energy Efficient wood stove in Botswana with the possibility of exporting them into the region. As of November 2010, BPC Lesedi had sold 233 stove with the aim of reaching 55000 households in 10 years.

2.1.3 Access to Electricity

3. Access to electricity:

- Physical access: grid connection, urban/rural areas, target group: areas/category of population with minimum level of physical access [official statistics exist]
- Availability and reliability of supply: frequency/duration of black-outs, load shedding (if officially practiced)
- Affordability: tariffs, share of utility bills in household incomes, subsidies [data available for most countries via national household survey]
- Sustainability: share of renewable energy sources (RES) in power mix [official statistics exist]

Physical Access

Access to energy (particularly modern energy) is an essential input in the process of development and poverty alleviation. Grid rural electrification necessitates economic, social and environmental achievements that can result in improved livelihoods.

According to World Bank, about 24 % of the sub-Saharan Africa population has access to electricity versus 40 % in other low income countries. African manufacturing enterprises experience power outages that make the firms lose about 6% of sales revenues in the informal sector and where back up generation is limited, losses can be as high as 20 %. Power tariffs in most parts of the developing world fall in the range of US$0.04 to US$0.08 per kilowatt-hour, however, in Sub Saharan Africa, the average tariff is high at US$0.13 per kilowatt-hour. In countries dependent on diesel-based systems, tariffs are higher still. Given poor reliability, many firms operate their own diesel generators at two to three times the cost with attendant environmental costs.

In Botswana, electrification in urban areas stands at 75 % and 57% in rural areas while national average electrification is 62%[7].The target for national electricity access is 82% by 2016 and 100% by 2030 both from grid electricity and New and Renewable Sources of Energy (NRSE). According to Botswana Power Corporation, the number of new connections in 2010 totalled 15 555, an 11 % decline when compared to new connections of the previous year.

Biomass is a major source of energy and it is predominantly used for cooking and heating particularly by rural households in the country. Renewable energy based on off-grid energy can significantly contribute to poverty reduction and assist in addressing MDGs. And to achieve this, modern energy services should be provided for cooking, lighting and other small electric needs. This also includes for agriculture production and small scale businesses. Currently, solar is used by a small number of farmers for water pumping and a few households. Government and parastatal institutions constitute a major user of solar equipment both solar water heaters and solar PVs.

[7] Draft SADC Renewable Energy Strategy and figures provided by BPC 2011.

Availability and Reliability of Supply

Demand for the year 2010 was 553 MW, representing an increase of 9.9% from the previous year's maximum demand of 503 MW .Power supply in the country has over the recent years continued to be outstripped by demand, leading to load curtailment during peak periods. The phenomenon was however contained within tolerable levels through regional cooperation of the Southern African Power Pool utilities, which continued to offer both firm and non-firm supply. Currently, the country is working on expanding the thermal power station in order to increase security of supply from the current installed capacity of 132 MW and is being expanded to 732 MW.

Through Government subsidy and support construction of two emergency power facilities commenced during the year, with the 70MW in Matshelagabedi, 25 km east of Francistown commissioned in January 2010. And to reduce burden of mining sector consumption on national grid, Debswana also commissioned the 90MW generator in Orapa.

Various demand side management initiatives to educate and sensitize consumers on efficient use of electricity and load management are being carried out.

According to Botswana Power Corporation, high usage of electricity is during peak hours of the day (06:00 – 10:00 and 18:00 – 22:00). The most extreme demand occurs at these times during winter peak season of the year (June – August).Should load-shedding become necessary; the load-shedding schedule adheres to principles set by the Corporation. Load shedding on account of supply shortfall resulted in loss of 3.146GWh sales which is 47% of the previous' year load shedding (BPC 2010).

Affordability

Because of imports, electricity price in the country depends on import costs. Electricity dispatch from the grid is accounted for under three customer categories; mines, rural areas (Rural Business) as well as the urban and peri urban areas (Customer Services and Supply).
The unit costs of electricity 5 years ago compared to other fuels is presented in Table 2.

Table 2: Unit costs of energy sources/fuels

Energy source	Unit	Unit cost (Pula[8])	Lower Calorific Value (MJ/unit)	Cost per unit of energy (Pula/MJ)
Coal	kg	0.2	27	8
Fuelwood	Kg (based on pack[9])	1.7	17	10
Electricity	kWh	0.3	3.6	83
Paraffin	litres	4.8	44.3	135
LPG	kg	10.3	46.1	224
Gel fuel	litres	10	16.1	621
Bio oil	litres	27	20	1,350

Source: EECG, 2007

[8] Pula (P) is the national currency. currently P7.5 per US$. The prices presented have been determined in previous surveys.

The electricity tariffs are now P0.5386 up to 200kWh and P0.6883 for more than 200kWh consumption in the case of households. In order to have affordable and uniform connection cost across the country, Government approved the establishment of the National Electrification Standard Cost (NESC)[10] at P 5,000 per household connection in electrified villages, towns and cities in April, 2010. The Government charges P0.05/kWh as levy consumed to support the standard costing approach. Prior to that, consumers used to pay the full costs of connection although this would be shared by other consumers that would connect to the same line.

Sustainability

The share of renewable energy sources is still at low levels in the country though there is potential to exploit renewable energy technologies such as biogas digesters, village scale mini grids /hybrid system and solar to increase the share of RES in the energy mix. Botswana has direct normal irradiation (DNI) of 3000kwh/m2/year, which is among the highest in the world and using less than 1% of the country area could meet Botswana's current electricity.

Botswana's large coal resource base threatens the deployment of renewable energy; this is also evidenced by the current on-going expansion of the Morupule Thermal Power Station which is expected to be complete by 2012. Various initiatives on clean coal technologies are also being pursued.

3.1.6 Modern Energy for Sustainable Uses

Modern energy for productive uses:

- Energy needs and access: energy demand in productive sectors; share of enterprises, industrial/agricultural, with access to modern energy sources
- Availability: quality of local supply chain and availability of required technologies for productive applications
- Affordability and access to capital: fuel prices, cost/affordability of technological

Botswana relies mainly on electricity, coal, fuelwood and petroleum for its energy demands. Total energy supply for the country in 2008 was 1604.10 ton-oil equivalent (toe) with petroleum being the major supplier at (895.83 toe) (54 %) followed by coal at (485.93 toe) (29%) and Electricity at (276.6 toe) (17%). Morden use of fuelwood and other biomass is not yet established.

The bulk of Botswana coal is used by the thermal power station (Morupule Power Station).Coal accounts for more than 55% of Botswana' s electricity supply. Electricity is mainly consumed by the household and services sector with mining sector being the main consumer.

This is an area that is not adequately studied to be able to provide substantive information at this stage.

Tariffs have increased regularly since 2005 but by insufficient amounts to comply with financial targets. Table 3 present recently adjusted tariffs for the productive sector.

[10] http://www.gov.bw/en/Ministries--Authorities/Ministries/Ministry-of-Minerals-Energy-and-Water-Resources-MMWER/Tools--Services/News-and-Press-Releases/Implementation-of-NATIONAL-ELECTRICITY-STANDARD-CONNECTION-COST-NESC/

Table 3: Tariff Structure for productive sectors

	Energy Charge		Demand Charge
	B1 up to 200 KWh	B1 more than 500 KWh	
Small Business	0.6161	0.7878	
Medium Business	0.3978		111.6024
Large Business	0.3587		105.0504
Water Pumping	0.8034		

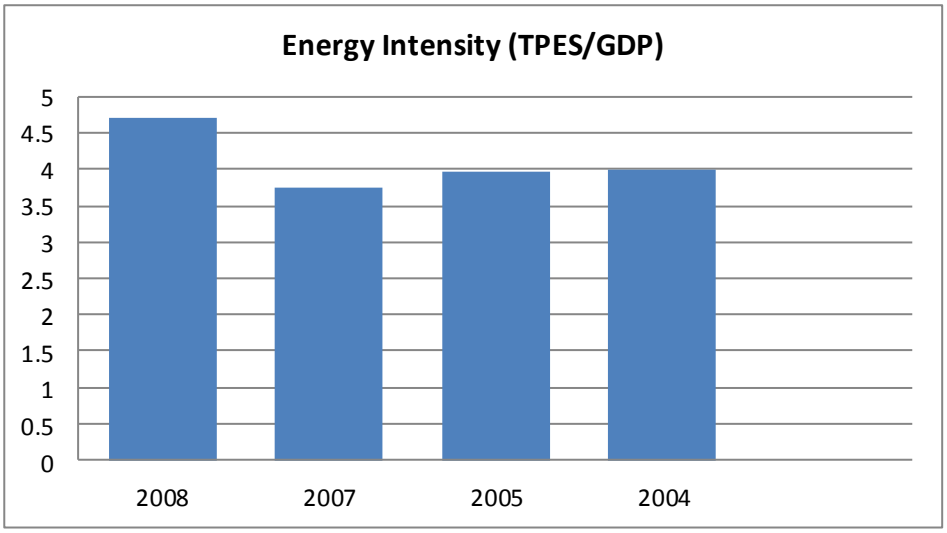
Source: BPC Annual Report.2010

2.2 ENERGY EFFICIENCY vis-à-vis GOAL OF SE4ALL

2.2.1 Overview and Assessment

Energy consumption has been on the rise in Botswana particularly electricity consumption which is the most preferred source in urban areas. Demand for fuelwood is also high especially in rural areas. Electricity demand for the year 2010 was 553 MW representing an increase of 9.9% from the previous year's maximum demand of 503 MW. It is anticipated that the implementation of energy efficiency and conservation initiatives will contribute to reduction in demand for energy.

Energy intensity for the sectors for the year 2008 was 4.7.Figure 4 shows energy intensity trend by year.

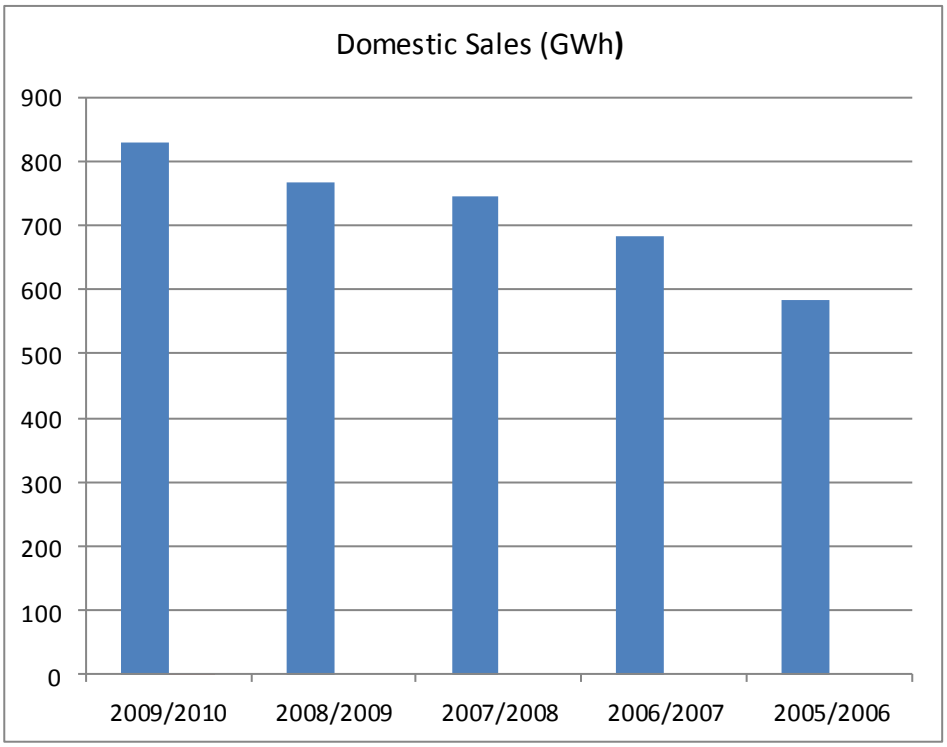


Source: Statistical Brief, CSO.2012

Figure 4: Energy Intensity TPES/GDP

The rise in electricity consumption in the domestic sector can be attributed to increased connections to the grid and change of lifestyle and it is expected that demand will continue to grow as more households get connected[11].Various initiatives to ensure efficient use of electricity

in the domestic sector have been identified and are being implemented. Figure 4 shows that domestic energy use/ capita for the year 2010 was 829.1 GWh, a 7.9 increase compared to 768.7 GWh for the previous year.



Source: BPC Annual Report, 2010

Figure 5: Domestic sales (GWh)

2.2.1 Energy intensity of national economy: TPES/GDP$, current situation and trend, is there a decoupling between energy use and GDP, sectoral breakdown into:

- Industrial energy use and potential for energy saving
- Household energy use and potential for energy saving

The Government of Botswana intends to achieve 10 % power savings by 2020 through energy efficiency and conservation initiatives. Based on the 2008 final consumption data, savings of 345.25 GWh can be achieved with the effective implementation of energy efficiency and conservation initiatives.

A target to achieve 100 % use of energy efficient lights by 2020 has also been set and this will be achieved through promoting the use of CFLs and LEDs.[12] Currently there are no set energy efficiency appliance standards in place and the government plans to develop and enforce such standards.

2.2.2 Some Initiatives on promotion of energy efficiency

There are programmes being implemented to promote energy efficiency. Efforts have been put towards training on energy efficiency at all levels of education, encouraging the use of solar water heaters instead of electric geysers, implementation of demand side management initiatives such as time-of-use tariffs and step tariffs, promotion of fuel saving measures in the transport sector and encouraging the use of improved cook stoves (wood and coal) to reduce fuel wood use.

[12]Draft Botswana Energy Policy.2010. BOBS is working with the Department of Energy on CFL standards

Some of the energy efficiency (EE) initiatives were done through external support. The DANIDA Energy Efficiency and Conservation in buildings, that lasted from 2005 to 2008, introduced energy audits, operation and maintenance manuals, energy management practices, energy efficiency guidelines and regulations. Other EE initiatives are to start in the industrial sector with UNIDO support but not much is happening yet in the commercial sector.

Developing Energy Efficiency and Energy Conservation in the Building Sector

In order to address policy objectives, building design guidelines were developed. The Guidelines are intended to be a resource that will help achieve the overall aim of improving energy efficiency and energy conservation in the building sector. The guidelines provide relevant information and guidance on key issues related to the stages in the life of a building from inception, procurement, design, construction, commissioning, and operation and decommissioning. It is expected that guidelines facilitate timely incorporation and consideration of energy efficiency aspects early in the design stage (Energy Efficiency Building Design Guidelines for Botswana, 2007).

A program to audit six government institutions was implemented. The energy audits consisted of a comprehensive assessment of electricity usage by the buildings. Audits included assessing overall efficiency, propose clear actions for improvement, calculating return on investment, timelines and advising on how best to achieve energy savings.

Promoting the use of CFL's

The energy efficiency in households' initiative has seen the achievement of 30 MW savings through BPC's 1 million CFL's project. Government also plans to phase out the import and commercialisation of incandescent light bulbs. With regards to activity on the domestic sector, BPC has distributed 850,000 compact fluorescent lamps (CFLs) for free to households realizing the annual energy saving of 30MW. The utility is looking at a number of ways to sustain CFL uptake among them banning incandescent lights and lobbying for removal of VAT on CFLs. CFLs that are currently being used are produced in Lesotho under a SAPP utilities initiative that agreed on set CFL standards. The disposal of CFLs is also another issue to be resolved and has currently been subcontracted to a private company because local councils do not have capacity to do so. This responsibility will be transferred to local councils in the long term as the current arrangement is not sustainable.

Hot Water Load Control

A hot Water load control[13] programme is also in place and it is anticipated that a saving of up to 40MW can be achieved. The main objective of the project is to manage customer hot water loads (geysers) as a way of controlling demand especially during peak periods. Since the inception of the programme, 20 MW savings has thus far been achieved.

In order to control the hot water load, the installed system will enable remote switching OFF of geysers for selected customer load groups (supplied from the same transformer). Geysers for customers in the same load groups will be switched OFF at the same time. It is anticipated that geysers are likely to be switched OFF during peak periods whenever demand exceeds supply.

Smart Meters

If switching OFF of geysers is not sufficient to address the supply deficiency, load curtailment can be done. The smart meters installed have a facility to be remotely configured to limit load to required levels. The level of load limit will be determined by the extent of supply constraint being experienced.

Remote disconnect/reconnect of supply to selected customer groups can also be done if the mentioned load curtailment initiative does not work. Switching off supply will only be implemented under extreme cases when severe supply constraints are being experienced.

Energy Efficiency Campaign

The Ministry of Minerals, Energy and Water Resources has collaborated with BPC on an EE campaign to effect behavioural change.

2.3 RENEWABLE ENERGY vis-à-vis GOAL OF SE4ALL

4. Overview and Assessment
5. On-grid and off-grid renewable energy
6. Use of renewable energy sources (RES) for thermal applications (cooking/heating)
7. Use of RES for productive activities

2.3.1 Overview and assessment

Renewable energy resources for Botswana are solar, wind, and various forms of bioenergy that include biofuels and biomass wastes .Botswana has no perennial rivers and large dams and therefore has no potential for hydro-power.

Solar Energy

Botswana has direct normal irradiation (DNI) of 3000kwh/m2/year, which is among the highest in the world. The area bordering Botswana, South Africa and Namibia is among the areas with the highest DNI. It is estimated that using less than 1% of the country area, Botswana could meet its current electricity consumption[14].

Basing on the PVGIS[15] data: High figures of global irradiation of 2350 KWh/m^2/year were identified on the western side of a place called Kang, in the western region of Botswana and around Kalahari Gemsbok National Park (Location: 23°10'50" South, 20°57'42" East, Elevation: 1240 m a.s.l) The lowest figures are on the north eastern side of Botswana west of Francistown (Figure 4).

[14] REFIT study 2011.
[15] Solar Radiation Database

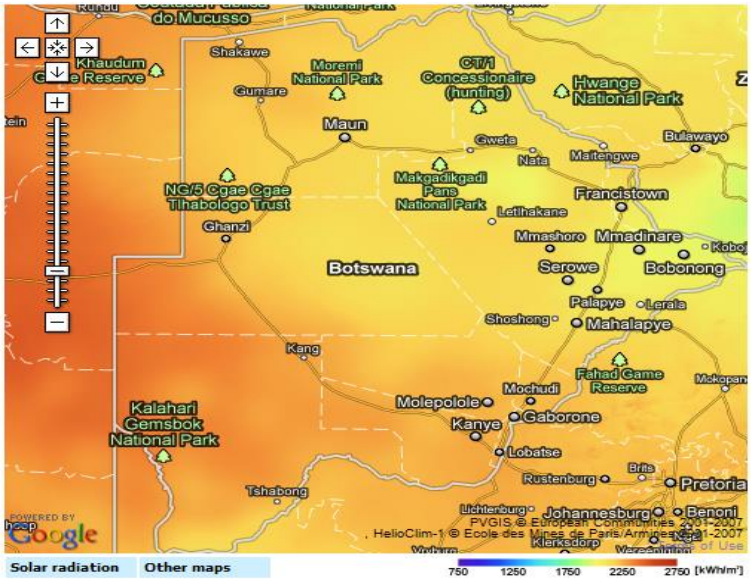


Figure 6: Detailed solar hotspots of global irradiation KWh/m^2 /year for Botswana

Solar generation is primarily during the day and yet peak times occur between 7pm and 9pm hence higher solar capacities may result in grid instability.

Wind

Wind speeds in Botswana are generally known to be below 4m/s and hence wind has previously been ruled out for power generation. There is exposition that wind speeds increase with altitude and previous wind resource potential measurements were at 9 sites in the country in 2003, of which 8 of them were measured at 10m above ground and 1 site at 25m above ground. Furthermore, the results indicated that wind speed at 25m is 20% higher than at 10m and a 20% increase in wind speed translates to a 60% increase in available energy[16]. The Southern Africa wind map Fig 2.2.1 shows that Botswana has potential for winds ranging between 5m/s to 7m/s at a height greater than 80m. However no measurements have so far been done at heights above 20m to authenticate this. This however suggests that wind potential for electricity generation can be explored further. The best hotspot for wind speed for Botswana was identified at Kwai Pan (Location: 21°15'56" East, 25°23'32" South) with wind speed in the range 6 to 9 m/s (Figure 5).

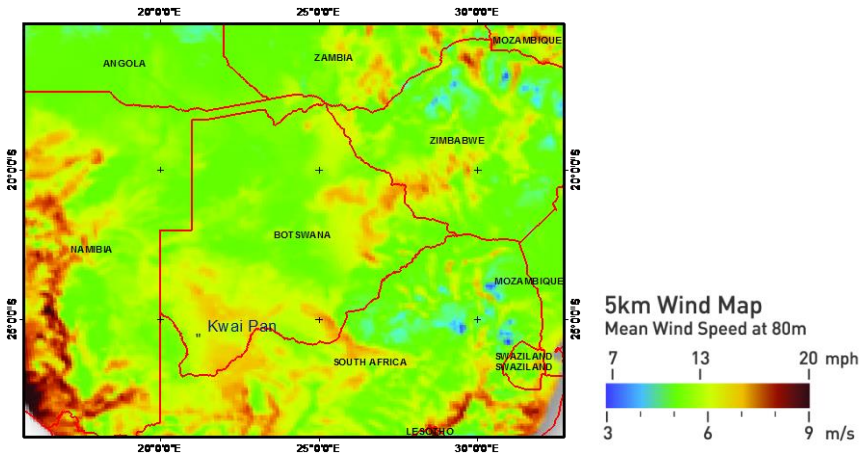


Figure 7: Detailed wind speed map for Botswana with hotspot identified at Kwai Pan (Location: 21°15'56" East, 25°23'32" South)

[16] Wind energy resource mapping in Botswana, March 2002. Foreign and Commonwealth Office. AEA Technology plc.

Biomass

Fuelwood is the most widely used form of bioenergy in Botswana. However the last comprehensive fuelwood surveys in the country was done between 2000 and 2004 and hence some of the demand data may be outdated. The supply side data are even scarcer and the most recent energy balances of Botswana do not indicate fuelwood supply as a primary energy source.

It is recognized that fuelwood scarcity is on the increase and is exacerbated by use of fuelwood for commercial purpose and in government institutions. Efforts by Government to prevent institutions from using fuelwood instead of alternative fuels have been hampered by budgetary constraints since budgets for such alternative energy fuels/sources allocated through the Ministry of Local Government only last for the first 3 months in a year. Political interference on use of fuelwood is also still a hindrance when trying to restrict the use of fuelwood where opportunities for alternative energy sources can be used.

Both land fill gas from Municipal Solid Waste (MSW) and biogas from various forms of biomass waste that include chicken manure, municipal liquid waste (MLW), abattoir waste, and animal waste in feedlots offer great potential. However, appropriate technology to exploit these resources needs to be advanced to the various generators of the waste and potential end users of the energy.

There is experience with biogas plants using Municipal Liquid Waste at the two cities of Gaborone and Francistown where part of the generated biogas is used to maintain digesters temperatures and the rest is flared. There are a number of planned CDM project activities that are looking at waste to energy using both MSW and other wastes or a combination of wastes. The Finish support for Renewable Energy and Environment Partnership Programme (EEP) is also supporting a number of biogas plant initiatives, which are still under feasibility study stage.

Biofuels

Botswana has undertaken Biofuels Feasibility study in 2007[17] for the production and use of biofuels in Botswana and subsequently produced Investor guidelines in 2009. The country is also utilizing the SADC Decision Making Tools and Sustainability guidelines in which member states develop their own Sustainability Guidelines based on the Regional guidelines.

From the Feasibility Study, the country identified land that could be suitable for growing jatropha to produce biodiesel as part of the resource potential assessment. Further work has been delayed by the need to identify a suitable jatropha species that can grow in Botswana yielding reasonable amount of seed oil. Research on a jatropha species that is suitable for the local climate with high oil yields is now being initiated through the support of JICA. The research is expected to last until 2016 after which jatropha growing will be rolled out and further guidelines prepared for the cultivation and production of the selected jatropha species.

A feasibility study on the potential to produce biodiesel from animal fat has also been done but the project was deemed to be unviable at current fuel prices. The Draft Energy Policy Botswana is aiming for B10 biodiesel blending by 2020.

[17] The Feasibility Study of Production and Use of Biofuels in Botswana, 2007. Department of Energy. Botswana

2.3.2 Grid and Off-grid systems

Off grid systems

Solar energy is currently primarily used for solar water heating and small scales solar PV, in households, government and mining institutions in the country. The national PV Rural Electrification Programme (NPVREP) was initiated to promote PV systems and during its implementation, PV contractors in the country doubled from 5 to 10 due the demand for PV. The PV uptake was 312 systems (43kWp) installed over a period of 3 years between 1997 and 2000. The impact of the project for income generation was limited to 17 PV systems bought for productive uses by business enterprises (i.e. 3 poultry farms and 14 shops and bars) while the remaining 285 were home systems. The systems were installed in 86 villages in 8 districts out of 10 districts posing challenges of effectively and timely servicing the clients. NPVREP also contributed in the setting of standards for PV systems/equipment and installations which if enforced should ensure installation of good quality systems.

Grid systems

Possibilities of solar PV and CSP for electricity generation are being investigated. The Botswana Government has done a pre-feasibility study for a 200MW CSP with the support of the World Bank and the African Development Bank. As a follow-up the Government intends to do a bankable feasibility study, which it intends to hand over to the private sector for implementation. However, given the fact that Botswana's national grid is relatively small, further expansion of solar CSP beyond the 200MW to feed into the grid may need adaption of the existing grid network. A 1MW solar PV plant for grid connection is also being investigated with support from the Japanese International Cooperation Agency (JICA).

2.3.3 Use of renewable energy sources for thermal applications and productive use

The use of RES for cooking and heating in Botswana is quite low and biomass remains the most preferred fuel. The use of RES for productive use is also still low in the country. In the past, some initiatives were implemented to use biogas for water pumping but this was not sustainable .Currently the use of solar for water pumping is still on-going though at low levels, and this is due to the high costs of solar systems.

8. Consolidated Summary: problem statements with regard to energy access, energy efficiency and renewable energy

Energy access	Energy efficiency	Renewable energy
Access to energy is largely given for electricity sector but not for cooking/heating and productive uses	Data on how many industries/enterprises and households using energy efficient appliances are lacking.	Potential for electricity that can be generated from renewable energy for both grid and off-grid is not comprehensively derived
Targets are also set for electricity but not for thermal and productive uses	There hasn't been a practice to derive energy intensity of GDP in the country	Application of RE to thermal and productive uses are not quantified or reliable estimated.
Data for planning energy access are limited	Data on potential fuelwood savings in cooking/heating are also lacking	Renewable energy has largely been applied to some domestic end uses such as lighting with limited application to productive uses.
	Full potential of energy efficiency in the economic demand sectors and domestic sector needs to be estimated to show value of EE and avoided costs of investments.	

2.4 SE4All goals

9. Goals

- Energy access
- Energy efficiency
- Renewable energy

Goals would ideally be formulate and if so, should be based on problem statement and can relate to improved physical access, as well as its reliability, affordability and sustainability for the whole country and/or targeted consumers' groups, i.e. households or productive users. It would be good to use quantitative indicators/targets when formulating national goals to enable their aggregation at the global level (i.e. XXX mln people with approved access to electricity and YYY mln people with access to modern energy for cooking, etc). Milestones to 2015, 2020 and 2030 would be ideal.

The following are targets set by government to ensure sustainable energy for all;

4.1 Energy Access

- Improved security of supply and reliability of energy supply to all sectors of the economy (82 % national electricity access target by 2016) and 100% by 2030 which is the same target for SE4ALL.

4.2 Energy Efficiency

- Improved energy efficiency and conservation for all energy sources in all sectors of the economy
- 10 % power savings by 2020 through energy efficiency initiatives
- Development of policy and legislation for demand-side management
- Sustainable exploitation of energy resources
- 100 % use of energy efficient lights by 2020,this will be achieved through promoting the use of CFL's and LED's

  This will need to be viewed in relation to energy (GJ)/GDP in 2012 and then 2030 to be able to measure the target of doubling energy efficiency by 2030.

4.3 Increased share of new and renewable sources of energy in the energy supply mix of the country

- 25% peak electricity demand from renewable energy by 2030
- Biodiesel to contribute 10% to energy mix by 2020

The current renewable energy mix is about 1% and if this target reaches 25% by 2030 that will be a significant stride in the case of Botswana.
The challenge is to see how these targets can be met in the light of the slow pace that has been experienced in the past.

SECTION 3: CHALLENGES AND OPPORTUNITIES FOR ACHIEVING SE4ALL GOALS

3.1 Institutional and policy framework

This section should focus only on those institutional and policy frameworks which have direct relevance to identified goals and the degree to which there is, or not, coordination among the various relevant ministries and/or whether there is an institution which coordinates the energy sector activities within the context of economic and social development in the country.

This section indicates the policy framework that that is in place and how the institutional framework is organized at the moment. This is viewed in the context of whether they can adequately support achievement of SE4ALL goals.

3.1.1 Energy Institutional Framework

The Ministry of Minerals, Energy and Water Resources (MMEWR) coordinates development and operational activities for the whole energy sector. The Ministry shares the energy portfolio responsibility with other ministries, private companies, parastatals and nongovernmental organisations.

The Department of Energy Affairs in MMEWR is tasked with the formulation, direction and coordination of the national energy policy. The Department was established in 1984 as the focal point of all energy related matters. The overall policy goal for the energy sector is to provide affordable, environmentally friendly and sustainable energy services in order to promote social and economic development.

In order to efficiently and effectively achieve its policy objectives the Department of Energy Affairs is comprised of ten units which are tasked to carry out the following:

Coal:
Improving accessibility and quality of Botswana coal.

Electricity:
Increasing accessibility, reducing connection costs and availing easy/affordable payment terms.

Solar Energy:
Increasing accessibility, reliability, affordability and acceptability

Biomass:
Protecting the environment by promoting sustainable use of biomass energy resources; woody biomass, residues, wet biomass and energy crops and by ensuring successful adoption of modern biomass energy technologies.

Petroleum Products: Increasing accessibility, reliability of supply and price stability of the products, and ensuring operational safety in the handling, storage and distribution of the products.

Efficiency and Conservation: Reducing energy wastages and costs through energy efficiency measures, and encouraging least cost mix practices.

Planning and Documentation: Developing and using efficient and effective planning tools for energy planning.

Communications Division: Is tasked with managing and implementing the communication function for the department and dissemination of information on energy policy and issues, energy development programs and projects.

Administration Division: Comprises of support staff responsible for daily administration duties, staff welfare and success of the division

Botswana Power Corporation (BPC) is a parastatal utility responsible for the generation, transmission and distribution of electricity within Botswana to areas approved by the Ministry of Minerals, Energy and Water Resources. The utility's main goal is to provide efficient, reliable, safe and environmentally sensitive electricity services to Botswana.

The Corporation has within the forty-one years of its existence, developed from a small, oil-fired power station in Gaborone which was commissioned in 1970 and dismantled in 1989 to the current 132MW thermal power station at Morupule.

BPC Lesedi

BPC Lesedi[18] provides clean and modern energy services to the rural and peri urban communities of Botswana. The company assists local entrepreneurs who are interested in starting businesses and improving people's lives through supply of lighting and cooking products (rechargeable lanterns, solar PV systems, improved wood stoves, solar cookers and heat retention devices). The plan is to offer customers these products on a retail or fee-for- service basis.

The Rural Industries Innovation Centre (RIIC) is a Research and Technology Organization (RTO) responsible for developing, testing and dissemination of renewable energy technologies.

The Botswana Technology Centre (BOTEC) another RTO, undertakes research and development and information dissemination on solar energy.

The Ministry of Environment, Wildlife and Tourism (MEWT): It is responsible for forestry and environmental conservation, long term research on fuel wood, productivity of natural woodlands and promotion and implementation of fuel wood programmes;

The Ministries of Local Government (MLG) and Education and Skills Development (MoESD); for off-grid power supply, and installation and maintenance of solar energy equipment in government institutions in rural and urban areas

All these institutions have tended to operate in an uncoordinated manner and this has to change for effective planning of the energy sector. This is particularly so with regard to renewable energy, where there is also a dimension of cross-sectoral linkages e.g. forestry with biomass energy, agriculture with biofuels production etc.

[18] a brain child of BPC formed under a GEF Barrier Removal project

3.1.1 Energy and Development

10. Energy and development:

- Energy in national development and poverty reduction strategies and plans

Access to energy services is recognized to play an important role in the sustainable economic growth and there is evidence of a strong and positive correlation between Gross National Product (GNP) per capita and modern energy use per capita. The energy sector contribution to GDP in the country increased from 1.4 per cent to 1.9 percent during NDP 9. In order to ensure increased sector contribution to economic growth, the following goals are being pursued in NDP 10;

- To deliver an adequate supply of reliable energy
- To exploit sustainable energy resources
- To facilitate economic efficiency
- To improve access and affordability of energy services
- To ensure security of supply and diversified supply sources

The Botswana Energy Master Plan 2004[19] emphasizes Rural Electrification using both grid and solar energy to improve the livelihoods of rural areas.

Other development policies to consider in the context of energy and development are the Industrial Development Policy, the Revised Rural Development Policy, the National Master Plan on Arable Agriculture and Dairy Development (NAMPAADD), the National Water Master Plan and National Master Plan on Wastewater and Sanitation and the Forestry Policy.

The Industrial Development Policy promotes expansion of efficient support services and component manufacturers in the SMEs category including small-scale rural entrepreneurs. The Revised National Policy for Rural Development provides for exploiting opportunities for enterprise building in rural areas availing productive resources, employment and other opportunities in rural areas to both male and female-headed households. Diversification from communal rain-fed agriculture based on current practices is promoted to improve rural incomes and hence alleviate/eradicate poverty.

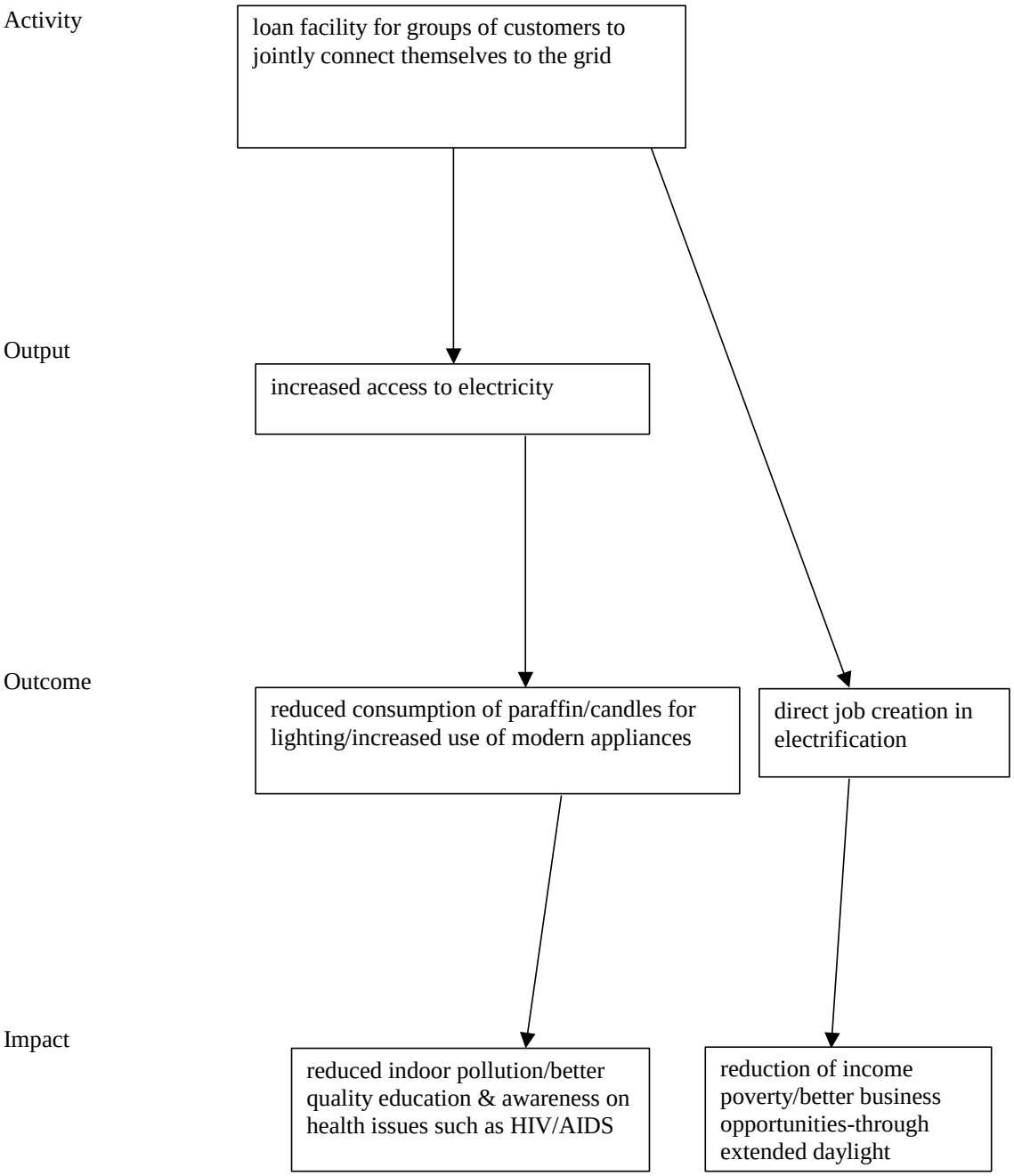
NAMPAADD introduces a business-oriented scheme for agriculture compared to past schemes that were welfare oriented. Large farms of 150-1000 ha which can utilize mechanized equipment and new technologies are being proposed for the plan.

The challenge is to understand how energy affects economic development and communities, in this case the poor and what decision makers such as government officials should do to ensure energy needs of the poor are met.

A case study to gauge development that could be linked to grid rural electrification was carried out in 2006.The causal chain between energy and development that was developed for this case study is presented in Fig 8 below. The causal chain consists of the activity or intervention itself, then the output (i.e. access to electricity), the outcomes (i.e. quality lighting, increased use of modern appliances e.g. for communication, health facilities, entertainment, education, offices) and then the impact which links up with development indicators e.g. improved health, improved education quality, productivity, high incomes, informed nation e.g. on HIV/AIDS etc.

[19] The most recent Energy Master Plan in use.

Bostwana: Rural electrification collective scheme



Source: Development and Energy in Africa- Botswana Report, 2006

Figure 8: Causal chain between energy and development

3.1.2 Energy policies and strategies

Botswana's Energy Master Plan was developed in 1985 and has guided the country's energy developments and strategies over the years. The Plan was reviewed in 1996 and 2004 to take cognizance of regional and local challenges. A lot has evolved within the energy sector since then, which will need to be addressed by future energy policy and NDP 10. In the past two decades, policy has centered on low cost energy provision from RSA, which has benefited from the low costs of hydro and coal fired energy, and from economies of scale. Global and regional shortages

of electrical energy mean that the policy has run into difficulties. *There is a need to shift energy policy and investment to more sustainable, local sources of supply*. The Energy Master Plan 2004's goal on renewable energy is to promote growth of a sustainable PV/SWH market through creation of financing schemes and integrating grid and non-grid electrification.

The draft energy policy aims to maximize the potential of RE through decentralization to meet socio-economic needs in rural areas, creating a critical mass of expertise particularly among SMEs and integrating all viable rural electrification technologies.
The policy objectives that are linked to access to energy are;

- To improve access and affordability of energy services
- To ensure security of supply and diversified supply sources
- To ensure environmental sustainability
- To improve governance within the energy sector

3.1.3 Energy Applications

Modern Energy for Thermal Applications

11. Thermal energy for households:

- Relevant targets, policies, strategies, plans

On thermal applications, Botswana is focussing on a number of energy initiatives and fuels, among them LPG, kerosene, electricity, coal and biomass energy.

Liquid Petroleum Gas (LPG)

LPG is generally more expensive than wood but it's now widely used as a main energy source for cooking in urban areas by 70.7% of the households. The use of LPG is also significant in rural households as 40.5% of them use it as the principal energy source for cooking up from 4% in 1996. LPG is supplied by the private sector with minimum interference from government. Pricing is not controlled by government but government interest is on safety and relating LPG cylinder conditions and installations. The price has skyrocketed in recent years-more than double in the last 10 year. Supply is however not a constraint in the country although all the LPG is imported through South Africa. This model of leaving promoting of LPG in the hands of the private sector has created a large market for LPG in Botswana and it is considered a success story. What may be important to do from the government side is to ensure that private sector does not overcharge and that competition for supply is increased.

Kerosene

The use of kerosene as principal fuel for cooking is not significant for both rural and urban households with shares of 4.5% and 13.1% respectively. The greater use in urban areas reflects the use by the poor who cannot afford LPG or electricity and have limited access to fuelwood. Kerosene is partly subsidized by government with the intention to make it affordable by the low income groups. There are now more efficient kerosene stoves on the market that are also safe to use and are less polluting. Such stoves could be introduced in the market for consumers to use.

Electricity

Cooking with electricity is still at low levels as only 1% among rural households and 3% among urban poor households are using it as their principal energy source for cooking. Perhaps with the tariff continuing to increase, not many more consumers will use electricity for cooking. Electricity stoves, similar to CFLs could be initially supplied with house wiring to start up would be users of electricity for cooking. The policy of Basic electricity allowance to the poor that South Africa is practicing up to a certain amount of consumption (kWh), would also give a better change for people to use electricity for cooking.

Coal

The programme to promote uptake of coal has been underway since the mid-1980s and is intended to encourage the substitution of fuel-wood, imported coal and petroleum products with local coal. The Expanded Coal Utilization Project was initiated with Technical assistance from Germany (GTZ) as far back as 1987 and the project considered introduction of upgraded coal in public institutions such as hospitals, schools etc and the household sector.

The project recommended establishment of a distribution and marketing network for upgraded coal and the introduction of suitable coal stoves. A market for 100,000 tonnes of beneficiated coal was estimated for industry and public institutions excluding households. What was to be addressed is availing the upgraded coal suitable stoves and making potential users aware of the potential dangers- health and environmental that could result from using coal.

Only a few types of coal stoves/appliances have been designed and are being promoted on the market, e.g. through coal depots, but aggressive marketing is needed and other varieties of stove designs and quality are required.

On the supply side, coal beneficiation is now being taken up and two coal distributors have been created through Government support operating in the large cities of Gaborone and Francistown. There are a few minor ones operating but are limited in coverage and efficiency. Reliability of coal supply in Botswana remains poor in terms of both coverage and efficiency of delivery. Government has completed a feasibility study on coal beneficiation and the coalmine is taking up the project to beneficiate the coal. This may improve coal uptake in the future.

Coal is anticipated to offer alternative energy supply solutions that can improve energy security. Some of the coal is already being promoted for use in households and institutions for cooking. Coal is however one of the most damaging sources of environment pollution and it is important considering its sustainable exploitation and clean coal technologies.

In order to deliver SEA4ALL goals the following will be considered

- Establishment of infrastructure geared towards the promotion of local coal utilisation in all districts to enhance availability and reliability,
- Further expansion and development of the infrastructure for coal beneficiation,
- Development of efficient and safe utilisation devices for coal utilisation (mainly cooking) at household and institutional level.

- Assessment of socio-economic and environmental implications of adopting clean coal technologies, such as coal gasification, exploitation of coal bed methane and the use of the resulting products in all sectors.

The Department of Energy Affairs is continuing coordinating coal utilisation in the country. The Department's mandate with regards to exploitation of coal is to improving accessibility and quality of Botswana coal. This will be carried out under direct supervision by the Ministry of Minerals, Energy and Water Resources. The Department can work with other institutions such as RIIC, BOTEC towards that end.

Efficient Wood Stoves

Fuelwood is the main cooking fuel for rural households as already demonstrated by extent of use (53 % rural households and 13 % of urban households with a national average of 49.1 %).Most rural households prefers using woodfuel since it is readily available and cheap unlike other sources of fuel. The use of energy efficient devices has been identified as a good initiative in ensuring efficient use of fuelwood and also addressing health problems associated with use of fuelwood. This also includes combating climate change by mitigating carbon dioxide emissions. The use of energy efficient devices such as solar cookers can result in tangible monetary savings, thus enabling families to divert funds to other uses in their households.

The NDP 9 energy policy for the fuelwood subsector was to ensure sustainable use of fuelwood and invetorise and monitor woody biomass resources. This was to be achieved through establishing a biomass database, monitoring and controlling fuelwood use by government institutions, introducing efficient fuelwood stoves and promoting community based natural resource management.

The Botswana Energy Master Plan focuses on the sustainable use and harvesting of biomass energy resources and the need to engage with key stakeholders in developing policies and legislation that can support community based fuelwood management.

Previous studies reveal that energy efficient wood stoves have been tried in Botswana since the mid-eighties but penetration has been low to non-existent. Programmes to promote improved stoves did not perform well due to high cost of the improved stoves compared to the traditional stoves, limited consumer research, stove design, market development and long-term financing and business growth.

The total number of stoves in use both at households and institutional level are not well known. Recent efforts to promote efficient stoves were made under the ProBEC project. As of November 2010, BPC Lesedi had sold 233 stove with the aim of reaching 55000 households in 10 years. BPC Lesedi has the objective to promote Energy Efficient wood stove in Botswana and to export into the region.

Gap Analysis

Commercial availability of improved stoves in Botswana is still low, there is need to set up a reliable supply chain of stove coupled with local production of a variety of stoves in the country to ensure availability of the stoves.

The key issues and gaps to be addressed under Botswana's SE4ALL Action Plan are identified and summarised as follows:

- Promoting technical research and development on suitable efficient stoves for various end uses.
- Awareness raising and consumer research on benefits of using efficient stoves
- Creating innovative financing mechanisms that can target subsidies and grants for both domestic and productive uses.
- Enhance local and national institutional capacity to promote advanced biomass stoves
- Encourage the establishment of energy funds that enable financial institutions to effectively administer support to promote efficient stoves

Power Sector

The main challenge has been the overemphasis on grid connections without paying much attention to the off-grid systems. This however changed after placing off-grid mandate under the electricity utility.

The introduction of the Rural Electrification Scheme, a financial policy to assist consumers with upfront costs has yielded a significant benefit as the rural access rate has increased tremendously from 4% in 1996 to 57% in 2011. The increases in connection have continued although rate is slowed somewhat. The introduction of the standard costing for connection to the grid will also enhance rate of connections.

The power sector is however currently constrained by the limited power in both Botswana and the region but this is expected to be addressed by 2014 with the emergence of additional capacity of 600MW.

The power sector has a potential to be augmented by implementation of energy efficiency (avoiding costs of investment in new capacity) and also connecting renewable energy plants to the grid.

Policy target is 10 % power savings by 2020 through energy efficiency and conservation initiatives. A target to achieve 100 % use of energy efficient lights by 2020 has also been set and will be achieved through promoting the use of CFLs, LEDs. Botswana does not have energy efficiency standards in place and the government plans to develop and enforce such standards.

In relation to energy efficiency the challenges include;

- Lack of fiscal and financial incentives to encourage the use of energy efficient appliances and technology
- Limited outreach of institutions to extend services to districts and rural communities
- Lack of relevant regulations for energy efficiency
- Inadequate statistical data to evaluate rate of energy efficiency and conservation nationwide

In order to deliver SEA4ALL goals the following, policy has considered the following;

- Creating awareness among the general public on energy efficiency and conservation practices through addressing District Council meetings, workshops and seminars, the media
- Creating a regulatory/legal framework that makes energy audits mandatory

- Carrying out energy audits in public institutions and large electricity consumers such as mines.
- Creating incentives that will encourage energy efficiency practices.
- Development of guidelines for energy efficient building design. A chapter on energy efficiency has been included in the new building regulations
- Development of an energy efficiency curriculum and compendium for engineering courses at University of Botswana and the Advanced Diploma courses of the Department of Vocational Education and Training

With respect to renewable energy, Botswana is currently working on a national Energy Policy but has no dedicated Renewable Energy Policy. There is however a Biomass Energy Strategy which was drafted in 2009 with the assistance of GTZ that specifies the biomass related projects that can be implemented in Botswana to argument the power sector as well (in addition to thermal applications, transport and productive uses).

The Botswana Energy Master Plan 2004 has both RE and EE goals. The RE goal is to promote growth of a sustainable PV/SWH market through creation of financing schemes and integrating grid and non-grid electrification. The EE goal is to improve information campaigns and capacity and coordination of EE activities in the country.

In 2010, Botswana introduced a Renewable Energy Feed-In Tariff (REFIT) for biomass, biogas land fill gas based generation and solar PV and CSP ranging from 5kW to 5MW. Generation capacity above the upper threshold of 5MW will negotiate for tariffs. The REFIT is now drawn up for period from 2011 to 2014 with cumulative capacity limit reaching 43.5MW by 2014 (Table 3).

RE Technology	Levelised costs	Cumulative capacity limits (MW)			
	BWP/kWh	2011	2012	2013	2014
Biomass	.7765	0.5MW	4.0 MW	8.0MW	12.0MW
Biogas	.797	1.0MW	3.5MW	6.0MW	8.5MW
Landfill gas	0.611	0.25MW	1.0MW	2.0MW	3.0MW
Solar PV 5Kw to 25KW	3.459	0.4MW	0.8MW	1.4MW	2.0MW
Solar PV/CSP 25KW to 1MW	2.718	1MW	6MW	12MW	18MW
Solar PV/CSP 1MW to 2MW	2.595				
Solar PV/CSP 2MW to 3MW	2.469				
Solar PV/CSP 3MW to 4MW	2.343				
Solar PV/CSP 4MW to 5MW	2.217				
Total Cumulative installed RE capacity		3.15 MW	15.3 MW	29.4 MW	43.5MW

Source: A renewable Energy Feed in tariff for Botswana Draft Final Report V3.

Table 8: Proposed Tariffs and capacity limits for Botswana REFIT

A financial mechanism to raise the revenue to pay for Power Purchase Agreements (PPAs) under the REFIT program is being worked on and a number of options are being considered, which include among them:-

- Passing the cost directly to the consumer/burden sharing
- Government fiscus (general or taxes)
- Green electricity sales
- Donors/bilateral feed in tariffs support (grants or on-going tariff)
- Global feed in tariff, and
- Carbon finance.

Putting levy on tariff may not be viable considering that BPC is already raising tariffs regularly to meet operational costs.

The gaps/challenges related to renewable energy as it relates to grid and off-grid subsectors are summarized in the Table 4 below.

Table 9: Summarized gaps for the Renewable energy.

Technical	Information	Social	Economic	Financial	Institutional	Capacity	Regulatory	Affordability
	Uncertainty on how PV works	Low confidence in some RE technologies	High cost of services and labour costs	Not easy to secure investment finance	Decision makers not full convinced to support RE	Poor capacity to plan, design and service RE technologies	Lack of mandatory standards for RE technologies	Upfront costs still high particularly for PV and SWHs
PV performance not verified	Poor statistics on product range	Potential consumers have been told that RE don't work	Small size of economy preventing manufacturing base	Financing of EE also a constraint	Weakly supported associations e.g. for solar and biofuels		Watchdog for regulation lacking on product quality	Cost of project feasibility not readily available
Weak manufacturing base for SWHs Non-existent manufacturing base for other technologies e.g. solar PV		Low entrepreneurial mind-set			Fragmented institutional coordination; BOTEC,EAD,BPC,BPC Lesedi,RIIC		SADC and SACU protocols should allow regional trade in RE products	

Modern Energy for productive Use

This title is a bit misplaced as it has tended to isolate productive uses only for probably small scale types decoupling it from the other modern energy sources, such as power and thermal energy and yet the source of energy is the same.

The power sector and thermal applications can also be major sources of energy for productive uses. The various grid and off-grid systems do provide the needed energy for productive use e.g. lighting for chicken runs, water pumping, grinding mills. Thermal energy has provided energy for cooking meals for sale and restaurants. In Botswana, use of LPG for cooking meals for sale is prevalent. Water pumping is still largely done using diesel gensets and the water is for livestock watering. Income few commercial farms is the water used for crop irrigation e.g. at the Tuli Block and around the major dams.

3.1.4 Monitoring and evaluation

The following matrix (Table 10) presents the indicators that will be monitored to assess to what extent the se4all goals are meeting energy services for thermal applications, power and productive use.

Table 10. Matrix of indicators for monitoring and evaluation

Needs	Thermal Applications	Power	Productive Uses
Energy Access	No of efficient appliances in use at household and institutional level	National/urban, rural electricity access %	No of SMEs and agricultural enterprises having access to electricity and other fuels for productive uses
	Types and consumption per household/per capita and per institution	Grid connected, mini grid and off grid connections access %	Grid, mini grid and off-grid systems and types for productive uses
	Perception on convenience of energy services	Per capita consumption KWh/capita	Increase in productivity
Energy Efficiency	Fuel/energy savings due to use of efficient appliances e.g. fuelwood	Electricity savings achieved %	Comparative energy savings with old/traditional systems
	Perceptions on quality of energy service	Electricity/GDP	Energy/GDP by sector
Renewable Energy	Types and quantities of re energy sources in use for thermal purpose e.g.	Capacity installed for electricity of, solar, wind, biomass/biogas etc	Systems and types in use for productive use

	Number of SWH installed for households	Number of PV systems disseminated for HH, institutions, businesses etc	

Data, gaps and capacity needs

Table 11 summarizes the needs under thermal, power and productive uses.

Table 11. Data, capacity and other gaps

Needs	Thermal applications	Power	Productive uses
Data	Statistics of efficient cooking/heating appliances in use	Capacity of off-grid systems to date	No of systems in use or energy use for various productive use
		Inadequate statistical data to evaluate rate of energy efficiency and conservation nationwide	
Capacity	Supply of efficient cooking/heating appliances limited	Limited capacity for small scale/affordable installation and maintenance of off grid systems	Limited application of modern energy systems for productive uses
	Limited local and institutional capacity for promotion of efficient stoves		
Other gaps	No clear policy /incentives to promote the variety of efficient appliances e.g. rebates for SWHs	No dedicated policies/incentives/regulatory and institutional frameworks for energy efficiency and renewable energy systems-grid and off-grid. REFIT in place but not yet applied and only covers <5MW capacity	Limited knowledge/awareness on application of modern energy for productive use at small scale
	Need for research and development of acceptable cooking/heating appliances	No clear benefits of RE/EE documented and cost and benefit of local manufacture of RE/EE appliances	Lack of incentives, training and financing mechanisms suitable for productive use
	Awareness and consumer research on benefits of using efficient stoves	Fiscal and financial incentives to encourage the use of energy efficient appliances and technology	

3.2Programs and Financing

3.2.1 Power Sector: Programs to Improve Access, Efficiency and Use of RES for Power Supply

National Electricity Standard Cost

In order to ensure affordable and uniform connection cost across the country, Government approved the establishment of the National Electrification Standard Cost (NESC) at P5, 000 per household connection in electrified villages, towns, and cities. This has been a significant change from the cost recovery policy where consumers including households would pay for the full costs of connection to the grid. Other customers apart from households however continue to pay actual costs. To sustain the NESC initiative, a National Electrification Fund was established which derives its proceeds from the electricity levy on consumption at 5 thebe per unit.

Rural Electrification Programme

The Government initiated the Rural Electrification Program in 1975 with financial assistance from the Swedish International Development Agency (SIDA). The rural electrification policy has since 1995 envisaged electrifying 14 villages annually but in 1999 electrification was accelerated to 72 villages over two years ,September 1999 to December 2001.The plan in the National Development Plan 9 outlined that by the end of the five year plan there should be an additional 105 new villages electrified.

In 2006, the Government arranged with the Swedish and Norwegian Banks to fund the electrification of 100 villages through a loan. In addition to these villages, 30 villages were electrified through the national Development budget during 2007/08 financial year. Since the roll-out of the rural electrification programme, about 42 % of the rural community is now connected to the grid (Botswana Power Corporation, 2012).

Rural Electrification Collective Scheme (RCS)

The RCS is a financing policy that assists rural customers in the form of a loan to reduce the burden of up-front costs of connecting to the electricity grid. Potential consumers form groups of 4 or more customers when applying for connection to benefit from economies of scale i.e. share the cost of extending the grid closer to their premises. This loan scheme requires potential grid electricity consumers to pay a deposit and make repayments over a period. The Scheme began in 1988 and has undergone several phases and modification with regard to deposits, repayment periods and loan interest rates (Table 12).

Table 12. Evolutions of the RCS

Year	Deposit (%)	Balance (%)	Repayment Period (years)	Interest rate %
1990	40	60	10	8
1995	10	90	10	9
1997 (standard costing introduced)	10	90	10	9
2000	5	95	15	Prime+0.5

Source: Development and Energy in Africa- Botswana Report (2006)

Rural electrification started acceleration after the 2000 policy adjustments to overtake the rate of urban electrification. The 2010 statistics reveals that the total number of customers connected through this scheme was 8,903 bringing the total rural customer base connected through this scheme to 123,248 (BPC).

3.2.2 Financing

Botswana like other SADC countries have tapped into donor supported programmes such as the EEP initiative financed by the Governments of Finland and Austria. EEP supports RE and EE projects and has created interests in developing RE and EE projects. Additional funding for the project may be provided through DFID (i.e. the Department for International Development – UK).

The country has also benefited from GEF/UNDP support to promote uptake of Renewable energy in the country, SIDA for rural electrification and JICA support for PV projects and Jatropha research.

African Development Bank recognises the need to harness clean energy particularly hydro, solar, wind biomass and geothermal energy and it also places emphasis on energy efficiency.AFD is financing a Feasibility Study for a 200 MW Concentrating Solar Power Plant in the country and also co-financing the Morupule 'B' Power Project.

The Danish International Development Agency has previously offered Botswana financial assistance for Energy Efficiency and Conservation Projects .DANIDA has offered support for the Energy Efficiency Project that had the following components; Energy Competition in Schools, Development of Energy Efficiency Building Guidelines and Energy Audits in Government Buildings. [i]

3.3 Private Investment and Enabling Business Environment

This section shall identify critical gaps and barriers to private investment in energy access, energy efficiency and renewable energy, as perceived by local and international business community in a country. The main purpose is to identify key private sector stakeholders, opportunities and preconditions for scaling up their engagement and investment in support of national SE4ALL goals. It is advisable that this section is written based on contributions solicited from private companies.

12. Thermal energy for households:

- Private sector actors involved in supply chain (energy supply companies, technology providers, financiers)
- Barriers to private investment in modern energy supplies and technologies for cooking and other thermal applications

13. Power sector

- Private sector actors involved in supply chain (power generation and distribution companies, Independent Power Producers (IPPs), financiers, technology providers)
- Barriers to private investment in new on-grid and off-grid power generation capacity (especially for RES), grid extension/maintenance, demand-side management (DSM) and energy efficiency

14. Modern energy for productive sectors:

- Private sector actors on the demand and supply side (SMEs/agricultural enterprises, technology providers, financiers)
- Barriers to private investment in modern energy for productive and socio-economic uses with a focus on energy efficient and renewable energy technologies and solutions

The investment promotion programs of Botswana are characterized by favourable exchange control for potential investors low cooperate tax (which is expected to be reduced) and relaxed labour laws to bring in skilled personnel. A Special Economic Zones Policy has already been passed by Cabinet where these tax and labour incentives will apply. Such policies can attract investment in RE for the country.

REFIT is considered an important instrument to incentivize investment and uptake of RE in the country and it also allows various small and large scale players to participate, though large projects can be promoted on negotiated tariffs. The modality of raising revenue for PPAs is however still to be agreed upon.

Carbon financing has not received much support as the revenue is considered to be very small compared to the effort needed to register a project so as to access that funding. The process to realize the carbon financing is considered to be time consuming, cumbersome and requiring expertise that most project proponents would not have. The carbon financing may be beneficiary where projects are large enough to generate significant revenue to justify the required effort and investment. Technology producers also would not benefit from RE technology deployment as end users of the technologies would claim revenue for the Emission Reductions (ERs) unless in instances where the technology producer is improving product efficiency.

There are however opportunities for RE technology deployment in Botswana considering the increasing electricity tariff that has gone up from BWP 0.47 to 0.58 to .98 BWP in less than 3 years. This tariff increase and newly introduced REFIT therefore improves the project viability of RE technologies in Botswana.

Botswana is in the process of establishing an Energy and Water Regulator, which is expected to play a role in setting and enforcement of commercially viable tariffs.

The Electricity Supply Act of 1973, amended in 2007 allows participation of independent power producers (IPPs) in the electricity sector and does not require licensing for electricity producers below 25kW. The Act does not allow for independent distributors and does not cater for off-grid IPPs. The Electricity Supply (Licensing) Regulations (1993) are appropriate for large power generators but simplified regulations will be required for small scale producers.

3.4GAPS AND BARRIERS

Based on the outcome of analysis in previous section, this section shall identify critical gaps and barriers to achievement of national goals, both with regard to financing and policies, institutions and capacities. Further details on financing requirements will be presented in Annex 1, Table 1.2. The main purpose of this section is to already begin to identify the main areas needing attention and possible candidates for additional support.

15. Thermal energy for households:

- Governance (institutions, policies, enforcement capacities)
- Supply chain (access to capital, technologies and know-how)
- Households (capacities and access to capital/affordability)

16. Power sector:

- Governance (existence of enabling regulatory framework for investment, enforcement capacities)
- Supply chain (access to grid, capital, technologies, and know-how)
- End-users (affordability and access to capital)

17. Modern energy for productive sectors:

- Governance (existence of enabling regulatory framework for investment, enforcement capacities)
- Supply chain (access to capital, technologies, and know-how)
- End-users, agricultural and industrial enterprises, SME (capacities and access to capital)

Table 14 . Gaps and Barriers

SE4ALL Goal	Governance	Supply Chain	Households/ End users
Thermal energy for household Applications	No established institution for promoting thermal energy applications	No variety of appliances and no supply chain established and no local manufacturing	No financing for households to acquire appliances Not convinced about utility of appliances
	No government enforcement of fuelwood harvesting		Appliances may not be adapted enough to meet cultural requirements
Power Sector	No standard power purchase agreement	Capacity of grid to connect RE not established	No innovative financing for RE/EE at end user level
	RE feed in Tariffs only cater	High landed costs of	Connection to grid by

	for small capacities<5MW	RE/EE appliances	consumers still unaffordable for the low income groups
	No mandatory framework for energy audits and management	No local manufacturing of RE technologies	
	No dedicated RE/EE institutions- tendency for uncoordinated planning	Low appreciation of RE/EE benefits both from long terms cost benefits and clean energy	
Modern Energy for Productive use	Potential demand not well established to warrant policy	No well established technology suppliers, designers, installers and maintenance capacity	No focused credit financing for productive uses
	No institutional support for focussing on productive use of modern energy	High landed costs and no local manufacturing of some systems	High upfront costs
		Credible quality of technologies	Cost and benefits not well communicated
		Awareness on various technology performance and production outputs	Small systems and high transaction costs

18. Summary: key gaps, barriers and additional requirements

The key additional requirements to achieve SE4All in thermal energy applications, power sector and modern energy for productive use are as follows;

1. Adequate power supply to meet growing demand and expected access rates.
2. Clear policy for energy access, EE/RE and productive use of energy.
3. Assessment of EE/RE potential and capacities that can be achieved.
4. Identification and costs and benefits of various technologies
5. Instituting appropriate regulatory frameworks e.g. for technology standards, incentives to reduce costs to consumers,
6. Having dedicated institutions that push for the SE4ALL agenda
7. Dedicated financing mechanisms with reduced cost of finance to enable the poor to afford
8. Government absorbing risk for energy producers to supply both grid, mini grid and off-grid systems
9. Awareness of end users on technologies and their costs and benefits
10. Monitoring and Evaluation of set targets for energy access, RE and EE
11. Capacity of technology developers, designers, installers and maintenance.
12. Identification and costs and benefits of various technologies

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Annex 1 –Matrix of existing programs and required financing for achievement of SE4ALL goals

1.1 On-going initiatives by the Government and development partners

Title	Lead Agency	Financier	Relevant SE4ALL Goal(s) (Access/Efficiency/Renewable Energy)	Brief description and time frame	Value, US$
Rural Electrification Program	Botswana Power Corporation	Swedish and Norwegian Banks, Government of Botswana	Energy access	1979-2030	
Rural Electrification Collective Scheme	Department of Energy Affairs	Government of Botswana	Energy access	A financing policy that assists rural customers in the form of a loan to reduce the burden of up-front costs of connecting to the electricity grid.	
Power Capacity Additions	Botswana Power Corporation	World Bank, Government of Botswana	Energy access	Expansion of Morupule Thermal Power Station to 600 MW by 2014	
Coal Beneficiation	Department of Energy Affairs	Government of Botswana	Energy Access	Encourage the substitution of fuel-wood, imported coal and petroleum products with local coal. And improve efficiency and reliability of supply. Timeframe 1975-2016	
Promoting the Use of CFL's	Botswana Power Corporation	Government of Botswana	Energy efficiency	Encourage the use of energy efficient lights. Target is to ensure 100 % utilisation by 2020	
Hot Water Load Control	Botswana Power Corporation	Government of Botswana	Energy efficiency	The main objective of the project is to manage customer hot water loads (geysers) as a way of controlling demand especially during peak periods. Time frame 2010-2020	
Energy Efficiency Awareness Campaign	Department of Energy Affairs and Botswana Power Corporation	Government of Botswana	Energy efficiency	2010-2012	
Promote Use of Efficient Stoves	BPC-Lesedi	ProBEC,BPC	Energy Efficiency	2010 -2020,	

Biofuels Production	Department of Energy Affairs	JICA,Government of Botswana	Renewable Energy	2009-2020	
Solar PV and CSP For Electricity Generation	Department of Energy Affairs	World Bank, Development Bank JICA, Government of Botswana	Renewable Energy		
Renewable Energy Feed in Tariffs	Department of Energy Affairs	Government of Botswana	Renewable Energy	Tariff (REFIT) for biomass, biogas land fill gas based generation and solar PV and CSP ranging from 5kW to 5MW. Timeframe is 2011 to 2014 with cumulative capacity limit reaching 43.5MW by 2014	

1.2 An estimate and order of magnitude, if available, of the costs and investment requirements for making progress on the three goals of SE4ALL. It is understood that these are only rough estimates and using available data. A more detailed analysis would follow during the phase of preparation of the Action Plan for SE4ALL

Annex 2 - Initiating a Sustainable Energy for All initiative in Countries: Some suggested steps

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- **RC – as convener and facilitator of the SE4ALL initiative in the country makes initial contact with Government authorities to ascertain interest and commitment to engage**
- **Decision to engage on the SE4ALL initiative as an instrument/platform for ramping up action in selected energy areas of interest for the country and with a view to achieving universal energy access for all by 2030 is received by Government**
- **Decision to undertake assessment and analysis to mobilize action at country level (Rapid Assessment/ Gap Analysis) and design of process to undertake them – with expert support (national or international) with an all inclusive approach and in consultation with stakeholders to ensure proper feedback, adequate coverage of data, and proper buy-in from the start**
- **Designation of national focal point/institution to lead the process and to coordinate with relevant ministries and stakeholders including private sector and civil society**
- **With the support of the UN Resident Coordinator office or other support under SE4ALL if and when necessary, organization of stakeholder consultations with key stakeholders in each of the key potential partners (private sector, donor community, civil society) to enrich process mentioned immediately above while Rapid Assessment is being prepared**
- **Finalization of Draft Rapid Assessment and presentation to large stakeholder consultation**
- **Finalization of Rapid Assessment taking into account the inputs from the stakeholder consultation**
- **Presentation of report to institutions made responsible to act as focal point for SE4ALL in the country with the facilitation of the Resident Coordinator**

- **Plan of Implementation with detailed prospective partners and roles (EU, US, WB, Regional Development Banks, E+ of Norway, UNDP, UNIDO, others)**

[i] Government of Botswana. Energy Affairs Department