

# ASSESSMENT OF ENERGY DEMAND AND SUPPLY FRAMEWORK IN BOTSWANA

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**Abstract**— This paper gives a complete examination of the prospect of further development of energy sector in Botswana. As per word bank sources, it has been found that, only 53.2% of family units have access to electrical power in country territories of Botswana. Circulation of power is troublesome in light of the fact that little towns are spread out over an expansive desert. The expense of amassing electrical cables to remote towns is high, and the low energy utilization by the little and poor townships won't pay off the hypothesis. According to a study done the patterns in Botswana demonstrates that renewable energy sources e.g., solar based, biofuel, or wind power can give energy to provincial towns more economically than by association with a national electrical grid. The paper depends on different government and other related documentations investigations, site visits in the Botswana's vitality area and present status of awareness and supply. In this study, a PPP model is suggested which aims to increase the employment as well as to fulfill the demand for power and energy in the country. It is contemplated that, there is a need of appropriate policies, observing and arrangement making for the development, usage and establishment of integrated and hybrid renewable power based plants.

**Keywords**— PV, GDP, Biofuel, electricity, NDP, energy supply.

## INTRODUCTION-

Botswana is one of the fastest growing economies in Africa, because of its being the world's biggest maker of precious stones. Botswana is a sheltered nation, with a stable just government and a low wrongdoing rate, a significant part of the nation is secured by sandy soils. The eastern regions have slopes and seepage sorrows which encourage the Limpopo River. These soils are basically sandy top soils to sandy mud soils, with shallow skeletal soils where overwhelming, sporadic precipitation washes recently framed soil materials into low lying zones and down seepage lines. The soils are accordingly primarily alluvia. Water is gotten by penetrating boreholes to a profundity of around 200 m, where it is found in fossil, underground tanks. In a few regions in the amazing west boreholes dive as deep as 500 m. On the off chance that discussing the wellspring of energy and power, it has been commanded by an overdependence on coal as an essential source of energy, to a great extent in view of its plenitude and claimed cost-viability. Botswana has an expected 212.8 Billion metric huge amounts of coal stores found in different areas, albeit just the stores at Morupule are being mined for power era [12]. Morupule Power Station, close Palapye, represents 80% of Neighborhood generation. Botswana, similar to a few different nations in the Southern Africa sub district. Depends on modest, plenteous, and electric power from South Africa [11]. The greater part of Botswana's refined oil needs are supplied by South Africa, aside from a little supply toward the western part of the nation by Namibia country. Botswana is geographically level, with up to 70 percent of its domain being the Kalahari Desert. It covers an area range of 581730 km<sup>2</sup> between roughly 20° and 29° E and 18° and 27° S. The chief area spread is characteristic field, Shrubland and forest, a quarter of which is moderated in parks or holds. A significant part of the nation comprises of the Kalahari, an immeasurable, dry sandy range of inadequate populace however bottomless natural life. The wetlands of the Okavango Delta and Chobe River in the north are of global significance for the protection of biodiversity, as perceived under the RAMSAR Convention. The present populace of Botswana is 1.5 million, of which half live in provincial territories. The per capita GDP in 1994 was US\$ 2 800. Botswana is a creating nation, with a glad record of enduring change in the personal satisfaction of its kin, and a stable majority rule political framework. The economy depends on mining, (especially precious stones, additionally copper-nickel, coal and pop cinder), light assembling, tourism and domesticated animals. Commitments of the different segments to the GDP are: mining 35.7%, general government 15.6%, banks, protection and business 10.1%, exchange, lodgings and eateries 8.3%, development 6.5%, producing 4.6%, agribusiness 4.4%, transport and correspondence 3.7%, water and power 2.2%, and social and individual administrations 4.3%. Botswana just contributes around seven percent of Africa's aggregate nursery gas emanations while Africa itself contributes just around five percent of the worldwide aggregate. The nation is, in this way, a minor supporter to the issue of an unnatural weather change and environmental change. In any case, Botswana, in the same way as other of the creating nations, will be essentially affected by climatic change. The nation is not plentifully supplied with rich surface water assets so water lack is a

key concern. The accessibility and nature of water, which might turn out to be all the more genuinely influenced under the anticipated environmental change situations, are along these lines formative difficulties. Botswana's energy demand was about 3660 GWh in 2008 (peak load of 500MW), which is projected to grow at about 6% per annum reaching 5300 GWh by 2017 (peak load of 850MW) and 6890 GWh by 2026 (peak load of 1130MW). Botswana, like many African countries, has a consistent electricity deficit, which peaked in 2008 at 1174.83 Kilo-watts (KWh) per capita [2]. This is because of declining power era and a diligent increment in power utilization. Botswana has chiefly depended on imports to take care of its developing demand for power. In 2008 its top interest achieved 500MW and is anticipated to be around 600MW in 2012. However, the deepening energy crisis across the Southern Africa sub-region is a major impediment to Botswana's economic growth plans, posing a threat to stability and requiring a major concerted effort at the national and regional levels to address the energy challenge [7]. Figure 1 shows the Botswana-

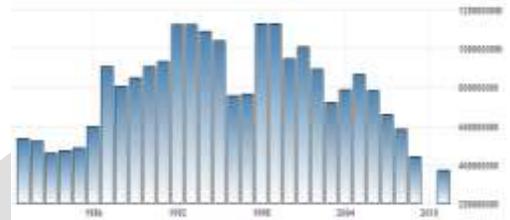


Fig.1- Botswana-electricity-production-kwh [6].

electricity-production-kwh during the period of 1986 to 2010.

## 2. Main sources of Energy:

Aside from alternate sources of energy in Botswana, the renewable power sources with the best potential are wood, biomass, wind and sun based energy. Wind and sun based energy (solar power) have been to a great extent undiscovered sources of energy in Botswana. Nearby energy assets thought to be in wealth in Botswana incorporate coal (200 billion tons), daylight (3,200 hrs. at 21MJ/m<sup>2</sup>), biogas (2.2 million cows, 3 kg compost/LSU/day) and fuel wood (200 tons/annum). Complete introduced power limit (2011) was 132 MW warm (for the most part coal). Botswana's energy sources comprise basically of power, fuel wood, and Liquefied petroleum gas (LPG), petrol, and diesel and aeronautics gas. Solar, biogas and biodiesel constitute a little extent, around 1%. Fuel wood utilization has been declining throughout the years while LPG and power utilization has been on the ascent [14]. This is mostly credited to the rising level of abundance and additionally the expanded access to power. Fuel wood keeps on assuming a critical part as an energy hotspot for some family units, particularly in provincial regions. It is the vital energy source utilized for cooking as a part of 46% of the family units broadly; and in 77% of families situated in provincial ranges. This speaks to a decrease from around 90% in 1981 yet at the same time sufficiently noteworthy to pull in arrangement consideration. Peak power demand is set to increase from 578 MW in 2012 to 902 MW by 2020, a 56% increase. Peak demand stands at 598 MW with current supply of 392 MW (excluding 200 MW emergency supply from Eskom), resulting in a shortfall of 206 MW [7].

Table-1 Latest BPC Electricity Tariffs showing the increment in rates from 1 April, 2015 [23].

| Type OF Consumption              | Fixed Charge |            | Energy Charge |                   |               |                   | Demand Charge |            |
|----------------------------------|--------------|------------|---------------|-------------------|---------------|-------------------|---------------|------------|
|                                  | Old Tariff   | New Tariff | Old Tariff    |                   | New Tariff    |                   | Old Tariff    | New Tariff |
| Domestic Customers (TOU 4)       |              |            | Up to 200 kWh | More than 200 kWh | Up to 200 kWh | More than 200 kWh |               |            |
|                                  | 21.98        | 21.98      | 0.6051        | 0.8025            | 0.6505        | 0.8828            | Nil           | Nil        |
|                                  |              |            | Up to 500 kWh | More than 500 kWh | Up to 500 kWh | More than 500 kWh |               |            |
| Small Business (TOU 6)           | 66.53        | 66.53      | 0.6993        | 0.9534            | 0.7693        | 1.1202            | Nil           | Nil        |
| Medium Businesses (TOU 7)        | 66.53        | 66.53      | 0.4814        |                   | 0.5656        |                   | 135.0389      | 158.6707   |
| Large Businesses (TOU 8)         | 66.53        | 66.53      | 0.4340        |                   | 0.5099        |                   | 127.111       | 149.3554   |
| Government water pumping (TOU 2) | 66.53        | 66.53      | 1.3481        |                   | 1.5840        |                   | Nil           | Nil        |

Table 1 shows the latest BPC Electricity Tariffs the increment in rates from 1 April, 2015. As per the Annual report of BPC 2014, Total operating expenditure for the year amounted to P3.642 billion compared to P3.660 billion in the prior year, reflecting 0.5% reduction (P17 million). The total loss for the year amounted to P1.373 billion compared to P2.125 billion loss reported in 2013 [28].

Africa will thus have to increase its energy consumption if the continent is to emerge from its current state of underdevelopment, to address the need for improving living standards for its people [24].

### 3. Present Scenario in Botswana-

At present Ghanzi is supplied through a 132 kV line from Namibia. Shakawe by a 33 kV line also from Namibia. Pandamatenga by a 33 kV line from Zimbabwe and Kasane by a 66 kV line from Zambia. [31]. BPC Annual Report, 2013 [16] says that Utilization of petroleum items had, in 2007, surpassed 1,500 million m<sup>3</sup> however began to diminish amid the fuel value treks of 2008 to 800 million m<sup>3</sup> and settled at just around 900 million m<sup>3</sup>. As per the World Bank, Electricity creation (kWh) in Botswana was last measured at 372000000 in 2011. At present sources of energy and electrical power are Fuel wood, Coal Fired Thermal Power Plants, Diesel Generators, Solar, Biogas, Natural gas (in the form of coal bed methane), while ESKOM, Zimbabwe Electricity Supply Authority, Namibia, Zambia electricity authority are other providers. Botswana's energy sources comprise fundamentally of power, fuel wood, Liquefied Petroleum Gas (LPG), petrol, diesel and aeronautics gas. Sun based, biogas and biodiesel constitute a little extent, around 1 %. LPG and all the petroleum based powers are foreign made. Fuel wood utilization has been declining throughout the years while LPG and power. Utilization has been on the ascent. Botswana has huge stores of coal evaluated at more than 200 billion tons. There is broad woody biomass from 3 to 10t/hectare. Most electric force is produced thermally in establishments keep running by the Botswana Power Corporation, an open endeavor set up in 1970. Electric creating limit comprises of the 132 MW Morupole coal-terminated plant. The 60 MW coal-let go plant at Selebi-Phikwe has been shut. Absolute limit in 2002 remained at 132 MW. Creation of power in that same year totaled 930 GWh. Fossil fills were utilized only. Utilization of power totaled 1.989 TWh. Coal creation in 2002 comprised altogether of the bituminous sort and totaled 992,000 tons. Coal is mined exclusively at Morupule Colliery by Debswana, for the most part for the era of power. The legislature is considering developing a coal-let go power plant at the same coal field, which would be intended to fare energy to South Africa. Further coal-to power stations are under thought. A few organizations are prospecting for oil, yet none had been found starting 2002. Be that as it may, Amoco (now BP) has examined the likelihood of coal bed methane extraction. The Botswana Energy Master Plan (BEMP, 2004) highlights the linkages in the middle of energy and the accomplishment of the financial and natural objectives set out in Vision 2016 and NDP 9. BEMP recognizes issues for incorporated energy arranging, the interest segments, supply areas (power, oil and gas, biomass, coal and new and renewable wellsprings of energy), energy proficiency, cross-cutting issues, administration and regulation in the energy division. Execution of improvement projects is embraced in accordance with the NDP. The arrangement is likewise adjusted to the long haul destinations set out in the national vision arranging report and might likewise incorporate improvement benchmarks taking into account globally concurred targets, for example, the Millennium Development Goals.

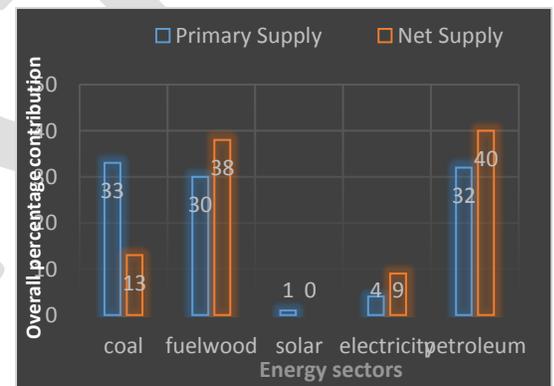


Fig. 2 - Energy Supply statistics [15].

### 4. Coal and Wood fuel -

In Botswana, Wood is as of now a broadly utilized as the renewable energy source. Country has shown stores of somewhere in the range of 212 billion tons of coal. As of now, Morupule mine is the main store mined, supplying Morupule Power Station, BCL Smelter and Botswana Ash. Most by far of Botswana's coal assets stay undeveloped.. Botswana has noteworthy coal assets assessed at 212 billion tons. The greater part of this coal is relied upon to be mined, with some of it utilized as a part of coal plants in Morupule and Mmamabula coal plant refineries to create the nation's required energy. The nation's economy will be helped by the coal fares to these Nations sought after. More cash will be gotten in the national banks, all the sufficiently more to fabricate bases and put resources into small undertakings in around the nation. The nation will likewise profit by Power and energy delivered from the force plants with all accessible organizations up and running subsequently adding to the country's economy. Concerning the abundance coal mined, the vast majority of it is required to be traded to China and India through the Trans-Kalahari Railway and Wavis sound, Namibia.

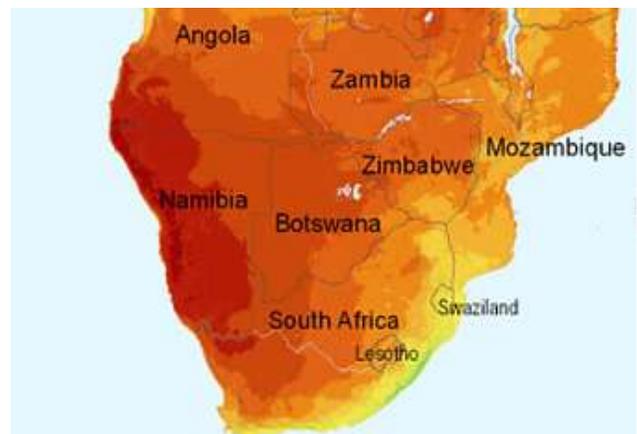
**Table 2-** Coalfields of Botswana [12]

| Coalfields in Botswana |                 |                             |                 |                                       |
|------------------------|-----------------|-----------------------------|-----------------|---------------------------------------|
| Coalfield              | Tones           | Published resources         |                 | Location                              |
|                        | (Mt)<br>(1998)# | Resources<br>M/Ind/Inf      | Figures<br>(Mt) |                                       |
| Dukwe                  | 1,604           | 1,969                       |                 | Sowa/Dukwe                            |
|                        |                 | -1,500 Exploration target   |                 |                                       |
| Foley                  | 6,860           | 3,377+860                   |                 | Sese/Mabesekwa                        |
|                        |                 | 3-6,000 Exploration target  |                 |                                       |
| Serule                 | 9,685           | 915                         |                 | Lechana/Tshimoyapula                  |
|                        |                 | -3,900 Exploration target   |                 |                                       |
| Bobonong               | 179             | None declared               |                 | Poorly Explored                       |
| Morupule               | 18,072          | 190                         |                 | MCL                                   |
|                        |                 | 7,234                       |                 | Kgaswe                                |
|                        |                 | 2,400                       |                 | Morupule South                        |
| Moijabana              | 3,539           | 1,460                       |                 | Mijabana                              |
|                        |                 | +5,000 Exploration target   |                 | Kweneng                               |
| Mmamabula              | 23,213          | 2,925+442+2,512+3,144+2,493 |                 | MME/MMNC/MMS/MMW                      |
| Mmamantswe             | 2,898           | 1,300                       |                 | MmaMantswe                            |
| Lethakeng              | 70,353          | 4,230+2,654                 |                 | Takatokwane remainder poorly explored |
| Dutlwe                 | 71,740          | None declared               |                 | Poorly explored                       |
| Ncojane                | 4,725           | None declared               |                 | Poorly explored                       |
| <b>Total</b>           | <b>212,868</b>  | <b>60,021(28%)</b>          |                 |                                       |

5.

**Potential and utilization of Solar Photovoltaic-**

Botswana has one of the most elevated sun based insolation on the planet. Botswana was one of the principal nations to advance the utilization of solar powered in Southern African region using solar water heaters in government lodging improvements. Botswana is near the sub-tropical high weight belt of the southern half of the globe. The atmosphere is driven by two unmistakable atmosphere zones with the dominant part falling under the Zaire Air Boundary atmosphere zone toward the north. There are without further ado 3 vast lattice associated frameworks in Botswana. One single substantial scale 1300 kW sun powered homestead in Phakalane toward the north of Gaborone; an as of late developed, yet not yet operational, 20 kW EU-supported UB research framework introduced in Mokolodi town, only south of Gaborone; and a 34 kW framework, claimed by Scales Associates and situated in the Broadhurst area of Gaborone close to the Western Bypass. There are various other little scale establishments with comparative setups, i.e. matrix associated yet simply utilizing the network as reinforcement, that have been introduced on homes in Gaborone and environment. Solar energy in Botswana adds up to more than 3,200 hours/annum with a quality of 22Mega Joules for every hour (MJ/hr) speaking to one of the most noteworthy sunlight based qualities on the planet. Normal sun based radiation is phenomenal at 6.1 KWh/m2 every day. Various photovoltaic pilot ventures have been begun in Botswana since 1990. The first was the Manyana PV project which began in 1992. The JICA PV sun powered pilot venture in Botswana, propelling in 2003 at Kudumatse, Motlhabaneng, and Lorolwana towns. The essential goal of every one of these ventures was to get to the feasibility and supportability of solar based innovation as an option energy source, particularly for country based groups. Contingent upon the discoveries, such ventures were likewise planned to be imitated in different parts of the nation. Regardless of generous endeavors by the administration of Botswana and benefactor offices, the utilization of PV solar systems for power generation in Botswana, especially inside disengaged groups, stays low.



**Fig.3-** Global Irradiation map of Botswana [32]

Botswana has incredible sun powered conditions, with a normal of 320 clear, sunny days every year and an average global irradiation of 21 MJ m<sup>-2</sup>/day all through the nation. Sunlight hours in Botswana are between 9.9 hrs in summer to 8.2 hrs in winter. With 3,200 hours of daylight a year, sun power is seen as a characteristic answer for the force deficiencies of the nation and district. The spearheading concentrating sunlight based thermal power station venture in Jwaneng would deliver 100 MW. The sun oriented warm power industry is still at an early phase of business arrangement. The Government is included in the development of a 1.3 MW photovoltaic power plant in Phakalane, financed through a Japanese grant of P90 million. The plant was allotted in August of 2012. It is visualized that such photovoltaic force plants will in the end be recreated somewhere else in the nation. Government proceeds with its non-network provincial charge plan utilizing photovoltaic power which was kicked begun in 2006 by the Government and the UN.

## 6. Biomass & Bioenergy-

The Botswana National Development Plan 10 (NDP 10) communicates that there is potential for biofuel creation in Botswana using sweet sorghum and Jatropha as food stocks. The Government is starting now focusing on the formation of biodiesel. The draft national imperativeness approach communicates that by 2020, adjacent making of biodiesel will speak to 10% of the supply of diesel in the country [1]. There is an exploration venture in view of "Jatrofa" is additionally running under faculty of engineering & technology at University of Botswana. Jatropha flowers all year round, except in winter, producing seeds that contain up to 40 percent oil [30]. Biomass and Biofuel can be sub separated into taking after classifications-

**Table-3** availability of Biomass and their types in

| Biomass                             | Type  |
|-------------------------------------|---|
| <b>Straightforward Wood biomass</b> | Taken to mean fuel wood, given that charcoal is an unimportant energy source in Botswana.   |
| <b>Wet biomass-</b>                 | Municipal slime and creature waste.   |
| <b>Buildups</b>                     | Agricultural, ranger service and urban squanders, including essential deposits as fallen trees, confined Poultry waste, optional deposits e.g. sawmill waste and tertiary deposits e.g. metropolitan strong waste). |
| <b>Crops</b>                        | Tree and rural products delivering biofuels such as biodiesel, ethanol and subordinantes.   |

Biomass energy contributes essentially to Botswana's energy regulation and is assessed to represent 30% of the nation's essential energy supply and 38% of aggregate last energy utilization. More than 90% of this energy is devoured by family units, of which 75% is represented by country families. Thus, 90% of family biomass utilization is as fuel wood. Fuel wood is the most noteworthy woody biomass energy utilized as a part of nation, for family unit utilization, and particularly for families in country regions. Botswana's level of reliance on biomass power is essentially lower than most other African nations, where biomass regularly represents 80-90% of essential energy utilization. With a bovine masses of 2,220,000 in 2008 (Statistics Botswana, 2012), the volume of dairy creatures excrement may be adequate to run different stand-alone power-plants in creamer game-plan with sun arranged residences. The widespread use of biomass energy in the domestic sector nevertheless suggests that biomass, even in its traditional form, plays an important role in Botswana's socio-economy [EAD, 2006]. Right now, there are 15 known biogas plants in Botswana. Two of these plants are utilized for examination, 2 at wastewater treatment plants, and the rest are utilized for cooking and lighting at lodging and family unit scales. The feedstock utilized are

sustenance, agro-waste and sewage slurry.

## 7. Wind

In this region, Wind speed is generally low, at around 4-5 km/hr, for the majority of the year, with the exception of preceding neighborhood rainstorms. The twist for the most part originates from the east to north-east in the late spring however veers essentially toward the west to south west. From 1984 BRET venture report add up to yearly information from nine locales all through the nation were broke down for month to month and yearly normal wind speeds. The yearly normal wind speed shifted somewhere around 2.4 and 3.6 meters for every second. The utilization of wind energy power in Botswana is inclined toward pumping of water for watering system because of low normal wind speeds. According to [9] the wind speeds in the observation site at Kweneng district of Botswana is observed to be normal no less than 6m/s at a stature of 80m over the ground. These wind velocities are sufficient to drive cutting edge wind turbines that traverse statures of 50-100m. The undertaking will use 50 x 2MW huge wind turbines giving an introduced limit of 100MW. With the limit element of 0.24, the undertaking will deliver 210 GWh of power for each year.

## 8. Challenge in-front of Botswana –

Botswana does not have a devoted arrangement to react to energy sector and environmental change. Amid the 2013 money related year, BPC brought about a 37% (P989 million) increment in the expense of supply to P3.7 billion, from P2.7 billion in the earlier year.

Era, Transmission and Distribution costs constituted just about 93% of the aggregate working expense for 03, 2012. Throughout the years, Botswana has been accepting a steadily expanding power and diminishing recurrence in precipitation this is as per the Botswana water report arranged for UNECA in March 2005. Which demonstrates that environmental change exists and influences the measure of water the nation gets. Sporadic precipitation prompts low product yields, with the exception of where harvests are developed on subsiding overwhelmed zones. Water from profound Kalahari boreholes is frequently excessively salty for watering system. Agriculturists in the remote zones have not very many offices, for example, transport and phones, and supplies and advertising expenses are restrictively high. As per BPC annual report, 13 BPC gives a sample of the expense of coal era being at least BWP 1 for every kWh, while the purchaser pays BWP 0.43 per kWh, which implies the Government is required to give an appropriation of BWP 0, 57 for each kWh [16]. As per the Annual report of BPC 2014 [28], the total revenue increased by 14% to P2. 260 billion in 2014, compared to P1.984 billion in 2013 and the total loss for the year amounted to P1.373 billion compared to P2.125 billion loss reported in 2013. The level of utilization of petroleum items speaks to a noteworthy energy challenge for Botswana. The testing to control transport vehicles is all the more profound established as it touches on the estimation of fares versus imports and the unpredictability of the oil costs which has gigantic ramifications on the nation's import bill. Interrelated components adding to the high utilization of petrol and diesel, essentially by the vehicle segment. Coal power plants have additionally demonstrated to discharge unsafe nursery gasses which add to the atmospheres change Botswana is looking towards an intense circumstance because of it's drying out dams, little precipitation, little revive on surface water assets. Botswana additionally has its western geography secured by Sandoval bringing about little groundwater. In 1990 as per a water report, Groundwater bolstered 64% of the water utilization. Be that as it may, this time the utilization incorporates expanded mine operations and populace. Transport is the most noteworthy purchaser of petroleum items, particularly petrol and diesel. Non-Motorized Transport and the more extensive transport arrangement plan harbor further open doors for Botswana's Green Economy. The insights on proportion of autos to aggregate number of vehicles and the levels of utilization of petrol are an indication of an unsustainable advancement way. If there should arise an occurrence of biomass, the across the board utilization of fuel wood by poor family units, both country and urban, together with an ineffectively managed reaping administration, is required to bring about developing exhaustion of forests and to unfavorably influence rural efficiency [13].

### 9. Contribution & Strategies Framework-

There are mainly three strategy goals for New and Renewable Sources of Energy in Botswana. First to advance expanded utilization of photovoltaic (PV) charge in a methodical route with satisfactory coordination institutional, financing and technical standards. Secondly to advance utilization of solar based water heating system where appropriate and thirdly o exploit provincial and worldwide advancements in innovative research work (Republic of Botswana, 1997, p, 222). Botswana is likewise signatory to local endeavors, in the Southern African Development Community (SADC), to grow naturally amicable energy innovations. The nation's investment in the pilot Industrial Energy Conservation and the Industrial Energy Management ventures exhibits its readiness to helpfully investigate methods for using renewable energy sources economical. Botswana, has expanded quickly in light of populace and monetary development.

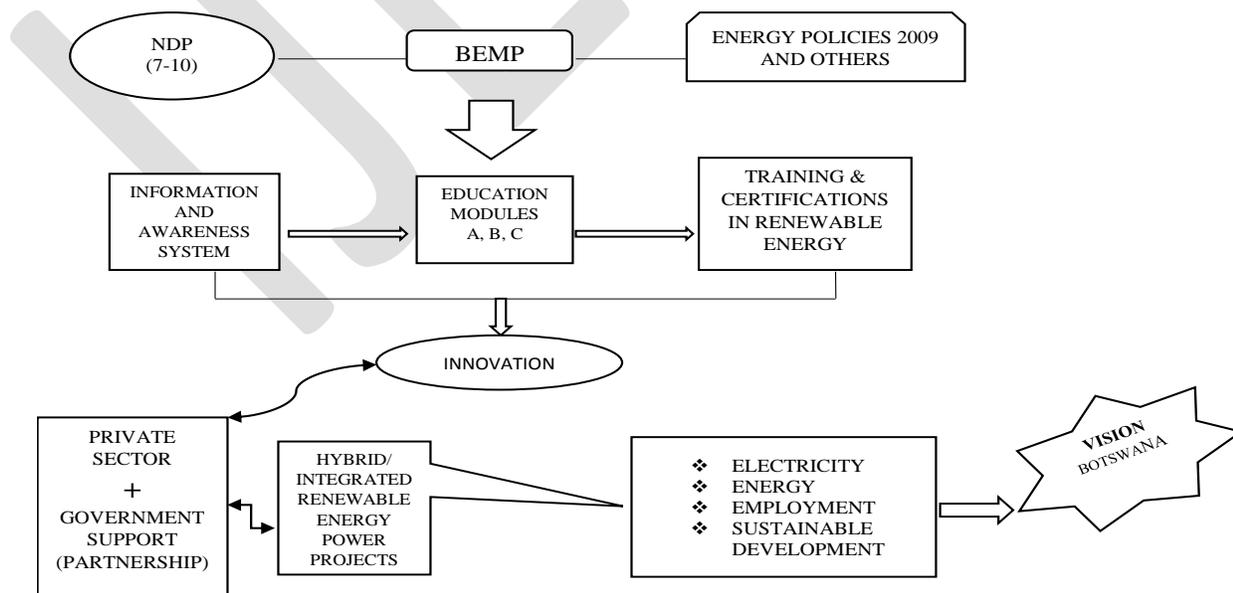


Fig.4- Suggested strategy towards vision Botswana

Despite the fact that, just like the case in whatever remains of sub-Saharan Africa, energy strategies in Botswana don't appoint satisfactory hugeness to renewable forms of energy at present, renewable energy contributes just around 1% to aggregate energy sector utilization. All NDPs Energy Sector Policy and Strategy, the Integrated Energy Planning additionally underscore that policy execution adequacy. Government organizations as Botswana Power Corporation, Energy Units in the Ministry of Mineral Resources and Water Affairs and so forth are included in data spread in the field of energy. Botswana's Energy Master Plan in any case contains approaches to manage the energies area towards accomplishing national social and financial objectives, it likewise suggests the advancement of proficient utilization of energy, the expansion of energy supplies, and the incorporation of social and ecological expenses in the cost of energy.

Figure 4 above clearly shows the strategy towards vision Botswana. Suggested education modules A, B & C stands for specially designed primary, secondary and upper level training course structures in academic curriculum focused on renewable energy sources. This approach will motivate the upcoming talents and produce a path towards the need, implementation and utilization of new and renewable sources of energy.

## 10. Conclusion-

At present, our current demand for electricity is 681 MW. Mmamabula power plant project is suspended and Marupule A is under refurbishment situation. Only Marupule B is in working condition [31]. Marope and Matshelagabedi are two main diesel power plants used in emergency situation. So, Botswana needs to tap its broad renewable potential to upgrade the nation's future energy security and movement. During 2005-14, UNDP and the Botswana government executed a GEF-financed project named renewable energy based rural electrification program for Botswana by BPC Lesedi (Pty) Ltd which was a joint endeavor between Botswana Power Corporation and the French energy organization, EDF International.

Another PV-biogas smaller than usual project was built up in Sekhutlane Village in Southern Botswana worked by BPC Lesedi. This experience can be used as an example for the advancement of the PPP model under this renewable project. There is proceeded with requirement for impartial dispersion of assets including clean energy. The declining expenses of renewables gives a chance to accomplish these destinations in a cost productive manner. There is deficient learning among different partners Government, privately owned businesses, ranchers, customer groups about the advantages of renewable energy sources and the accessible advancements. There is a misinterpretation of about cost and benefits of these resources. Better understanding, long term sustainable policies, and safe industrial and technological development with implementation in present policies are required to enhance the sector. Private-sector companies seeking Public Private Partnerships; PPPs should be encouraged. Such public and private partnership will increase the employment as well as fulfill the demand of power and energy in country. There is a need of regulated structures set up to permit partners to tackle joint obligation and the advancement of innovation. Without sponsorship no matter how you look at it at the national, locale and town level, the effective execution of plans prone to be unsuccessful.

## ACRONYMS-

|       |  |
|-------|--|
| GDP   | - Gross Domestic Product                       |
| EU/EC | - European Union- European Commission          |
| UN    | - United Nations                               |
| UNDP  | - United Nations Development Program           |
| JICA  | - Japan International Cooperation Agency       |
| KWp   | - kilo watt peak                               |
| PV    | - Photovoltaic                                 |
| BPC   | - Botswana Power Corporation                   |
| NDP   | - National development program                 |
| BEMP  | - Botswana Energy Master Plan                  |
| LPG   | - Liquid Petroleum Gas                         |
| UNECA | -United Nations Economic Commission for Africa |
| GEF   | - Global environment facility                  |
| WB    | - World Bank                                   |

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