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SMALL HYDROPOWER (SHP) DEVELOPMENT IN NIGERIA: ISSUES, CHALLENGES AND PROSPECTS

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ABSTRACT

Nigeria as of today generates less than 4000MW of electricity but has the capability of increasing her generation through small hydropower (SHP) considering unharnessed potentials in the country. In other to increase the percentage contribution of hydroelectricity to the total energy mix and to extend electricity to rural and remote areas, considering the economic, social and environmental benefits, this paper presents verifiable data to show that generated power can be increased by over 80 percent if areas of SHP potentials in different states of the federation of Nigeria are properly harnessed.

KEYWORDS: Small hydro-power, potentials, harnessing, energy-mix

INTRODUCTION

Nigeria depends heavily on fossil fuel for electricity generation due to the vast deposits of crude oil and natural gas in the country. Notwithstanding the vast deposit of crude oil, Nigeria generates less than 4000MW of electricity with per capita consumption of 0.03kw (table I).This is the present situation despite the fact that the installed total capacity as far back as 1999 was put at 11,756MW (Oparaku, 2007).

In 2010, Ohunakin's study showed that hydropower was the only source of electrical power in Nigeria before the discovery of crude oil. The shift in attention to fossil fuels due to the vast deposit of fossil fuel in the country led to the decay in the hydropower sector development.

As a source of energy, the technology used in hydropower predates fossil fuels and (with more efficient design) continue to improve.

To date only about one quarter of the world's hydropower potential has been utilized, and experts note that it is currently impossible to develop every one of the remaining undeveloped resources because of the social and environmental problems of building large hydro-electric dams.

However, small-scale hydro projects which have the least social and environmental effect have continued to receive serious attention from many countries of the world including China, Italy, USA, etc.

China leads the world in small hydropower development, and has already developed some 58,000 smaller plants that provide in excess of 13,000MW capacity. Other countries seriously involved in the development of small hydro plants include France, Italy, the United States, and Sweden. Each of these countries has already developed over 1,200 small-scale hydro plants and each has plans for additions (Schwaller, 1996). The total installed capacity for European Union (EU) countries is put at 11000MW (Kucukali et al, 2009). The same source also puts the global total installed capacity at 138000MW.

From the existing, on-going and proposed power station projects, Nigeria has failed to utilize her small hydropower potentials in spite of the various rivers in the country with SHP potentials. (Table I, III, IV)

Large SHP potentials are also available in Nigeria considering her numerous rivers and dams which can be economically tapped in other to increase the percentage contribution of hydroelectricity to the total energy mix and to extend electricity to rural and remote areas.

If Nigeria should consider the present difficulties in power generation capacity and embark on SHP which is less costly to build and requires low rivers and have fewer environmental effects as compared to those with large dams; many communities in different states of the federation will enjoy good per capita consumption of electricity.

SMALL HYDROPOWER PLANTS (SHP)

Schwaller (1996) revealed that water power is one of the oldest sources used by humans for survival.

Olayinka et al. (2010), also opined that SHP has been in existence in Nigeria since 1923 i.e. 45 years before the commissioning of the country's first large hydropower in Kainji. Also, the Nigerian Electricity Supply Company (NESCO) was able to supply electricity to the old Benue-Plateau area from the mid forties to the eighties with hydropower from the kurra falls.

Small hydro power plants are defined and classified as micro, mini or small as shown in table V.

The definition of SHP and classification of capacity are dynamic and determined by indigenous development and growth in economy. For example, in China the definition of SHP capacity range has always

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been increasing. This is because the Chinese economy has been growing year after year as the rural energy consumption steadily increased. Indigenous development and growth in different countries economy has been the litmus test for definition and classification of SHP capacity. Hence most countries have different definition and classification for SHP (Essan, 2007).

SHP PROSPECTS IN NIGERIA

Olayinka et al (2010) evaluates the SHP technology to be at a very low level with the scheme operated in only three states of the federation. Nigeria has a large hydro potential of 14,750MW and has been able to utilize only 1, 930 MW of total installed grid connected electricity generation.

The very large SHP potential in Nigeria is vividly portrayed in Table IX. From the table it is clear that the tapping of these potentials in only two hundred and seventy-seven locations is capable of adding 734.2MW of electricity to the countries energy portfolio. Considering the fact that this is only for twelve states of the federation, the gigantic potentials of SHP in the thirty-six states could never be over-emphasized.

COSTS ASSOCIATED WITH HYDROPOWER

The costs associated with developing hydropower are very site-specific. Meeting environmental issues and the need to design the power plant to maximize its output vary from area to area. However, compared to other depletable and non-depletable energy sources, hydropower is among the least expensive of all the energy resources. Although the initial costs to develop and construct these facilities are not small, they have lower maintenance and operation costs. Taken together, the cost of electricity from hydroelectric plants ranges between 0.03 and 0.06 cents per kilowatt.hr. This makes these power plants attractive to meet the increasing need to supply electricity. The comparative costs of different sources of renewable energy are given in table XI (Schwaller, 1996).

According to Dudhani et al. (2006) an examination of the initial cost of some renewable energy sources as presented in table XII shows that SHP is the cheapest choice of the renewable sources in Nigeria. The table also reveals that the operating and investment cost is much lower in Nigeria than in some of the selected countries in Europe. The lower cost further supports SHP investments in Nigeria by individual, indigenous private and foreign organizations.

SOCIAL AND ENVIRONMENTAL COSTS ASSOCIATED WITH SHP

SHP projects are generally considered to be more environmentally friendly than both large hydro and fossil fuel powered plants because they do not involve serious deforestation and disturbance of aquatic life. Small-scale hydropower is economically competitive with small-scale fossil fuel/steam-electrical plants particularly if the hydro sites are located near electricity demand centers and are truly sustainable in the sense of being able to fully account for their environmental and social costs. The net cost savings resulting from the use of local materials and labour, standardized power plants and ease of local development of the technology make it a preferred choice for remote and off-grid applications (Dudhani et al; 2006).

The World Bank observed that a 2.5MW hydro scheme produces the same amount of electricity as a 2.5MW base line gas fired power plant. In Nigeria, the emission factor for gas-based heat and electricity generations is 670g C02 per Kwh. Hence, an assumed operating time of 7000 hours/year of hydro plant will result in annual savings of about 11,500 tons C02 emissions/year while an anticipated life time of 25 years will result in savings of approximately 290, 000 tons C02 emissions using the hydro plant. Thus the medical benefits that could be derived from SHPs are very attractive and life sustaining.

RENEWABLE ENERGY POLICY ON HYDROPOWER

In order to benefit from the huge SHP potentials in Nigeria a vibrant renewable energy portfolio standard has to be formulated along the following lines:

Policy:

- The nation shall fully harness the hydropower potential available in the country for electricity generation.
- The nation shall pay particular attention to the development of the mini and micro hydropower schemes.
- The exploitation of the hydro resources shall be done in environmentally sustainable manner.
- Private sector and indigenous participation in hydropower development shall be actively and generously promoted.

Objectives:

- To increase the percentage contribution of hydroelectricity to the total energy mix.
- To extend electricity to rural and remote areas, through the use of mini and micro hydropower schemes.
- To conserve non – renewable resources used in the generation of electricity.
- To diversify the energy resources base.
- To ensure minimum damage to the ecosystem arising from large hydropower development.
- To attract private sector investments into the hydropower sub-sector (Sambo, 2007).

SOCIAL AND ENVIRONMENTAL COSTS OF SHP PLANTS

One might think that hydroelectric energy is free from environmental problems. There is no waste, ‘no radioactivity, and no pollution. Nonetheless, hydroelectric plants have several major environmental problems to solve.

Ohunakin (2010) opined that social and environmental costs of hydropower are more prevalent for large-dam projects. Small-scale hydro projects have the least social and environmental effects.

Dudhani et al. (2006) SHP projects are generally considered to be more environmentally favourable than both large hydro and fossil fuel powered plants because they do not involve serious deforestation, rehabilitation and submergence.

http://en.wikipedia.org/wiki/Hydroelectricity state that since hydroelectric dams do not burn fossil fuels, they do not directly produce carbon dioxide (a green house gas). While some carbon dioxide is produce during manufacture and construction of the project, this is a tiny fraction of the operating emissions of equivalent fossil-fuel electricity generation.

Small dams and micro hydro facilities create less risk, but can form continuing hazards even after they have been decommissioned. For example, the Small Kelly Barnes Dam failed in 1967, causing 39 deaths with the Toccoa Flood, ten years after its power plant was decommissioned in 1957.

ECONOMICS OF SHP

The major advantage of hydroelectricity is elimination of fuel cost. The cost of operating a hydroelectric plant is nearly immune to increases in the cost of fossil fuels such as oil, natural gas or coal, and no imports are needed, hence it is rarely affected by global economic and political changes.

It is also worthy of note that hydroelectric plants also tend to have longer economic lives than fossil-fuel-fired plants. Operating/ labour costs are also usually low, as plants are automated and have few personnel on site during normal operation.

Small hydro projects generally do not require the protracted economic, engineering and environmental studies associated with large projects, and often can be completed in a few months. A small hydro development may be installed along with a project for flood control, irrigation or other purposes, providing extra revenue for project costs.

It is also a fact that small hydro units in the range of 1MW to 30MW are often available from multiple manufacturers and that using standardized "water to wire" packages, a single contractor can provide all the major mechanical and electrical equipment (turbine, generator, ancilliary switchgears), selecting from several standard designs to fit the site conditions.

RIVERS TO POWER PROPOSAL

From Table IX, it was shown that SHP potentials in two hundred and seventy-seven locations in the country could contribute approximately 734MW of electricity to the national grid. Hence, it is the author's view that a 'Rivers to power project' be made to be part of the national power plan. By this plan, a blue-print of SHP potentials in the whole country should be commissioned and made an integral part of the independent power project (IPP). The horizon should be to have not less than 3000 locations of SHP all over the country contributing a minimum of 10,000MW to the national energy portfolio. The greatest attraction in this is that the SHPs could easily be used as off-grid power centres for industrial, zonal or regional power needs.

CONCLUSION

The potentials of SHP in Nigeria has been explored and certified to be very huge considering the many sites already assessed by experts to have the natural features for such projects. It has been shown that the exploitation of SHP potentials in twelve states could raise the available megawatts by more than 20 percent and also improve the energy mix. In order to be able to do this, a vibrant renewable energy policy with SHP development as its arrow head should be put in place.

Nigeria as a developing country has a lot to gain from SHP and very little to lose considering the minimal environmental hazards associated with this type of power generation.

Table I: Country Statistics of Electricity Generation and per capita consumption.

Continent	Country	Population (million)	Generating capacity(MW)	Per capita consumption (kw)
Africa	Nigeria	140	>4000	0.03
	Egypt	67.9	18,000	0.27
	South Africa	44.3	45,000	1.02

Source: National Centre for Energy Research and Development (NCERD).

Table II: Existing Power Station Projects

Existing power station
Egbin thermal, Lagos state (1320MW)
Afam thermal, Rivers state (969.6MW)
Sapele thermal, Delta state (1020MW)
Ijora thermal, Lagos state (40MW)
Kainji Hydro, Niger state (760MW)
Jebba Hydro, Niger state (578.4MW)
Shiroro Hydro, Niger state (600MW)
Total: 6200w

Source: National Centre for Energy Research and Development (NCERD).

Table III: On-going Power Station Projects

On-going Projects
Geregu Thermal, Kogi state (414MW)
Omotosho thermal, Ondo state (335MW)
Papa Lanto Thermal, Ogun state (335MW)
Alaoji thermal, Abia state (504MW)
Total: 1588MW

Source: National Centre for Energy Research and Development (NCERD).

Table IV: Proposed Power Station Projects

S/N	Proposed Projects
1	Omoku thermal, rivers state (100MW)
2	Gbarian/Ubie thermal, Delta state (250MW)
3	Sapele thermal, delta state (500mw)
4	Ikot Abasi thermal, Akwa Ibom state (300MW)
5	Eyaen thermal, Edo state (500MW)
6	Egbema thermal, Imo state (350MW)
7	Calabar Thermal, Cross River (500MW)
Total	2500MW

Source: National Centre for Energy Research and Development (NCERD).

Table V: definition/classification of SHP plants.

Micro hydropower plants	Below 100kw
Mini hydropower plants	100 – 1000kw
Small hydropower plants	1 – 30MW

Source: Anthony E. Schwaller – Energy Technology: sources of power, thamson learning, 1996.

Table VI: Definition and classification in some countries and organizations

Country/organization	Micro (kw)	Mini(kw)	Small (kw)
IN-SHP	<100	101 – 500	501 – 10,000
UNIDO	<100	101 – 2000	2001 – 10000
ESHA	-	-	<15000
OLADE	<50	51 – 500	501 – 5000
China	<100	101 – 500	501 – 25000
Philippines	-	51 – 500	<15000
Sweden	-	-	101 – 15000
US	<500	501 – 2000	1<15000
India	<100	<2000	-
Nepal	<50	<500	<5000
Panama	<100	101 – 1000	1001 – 10000
Former USSR	-	-	<30000
Vietnam	<50	51 – 500	501 – 5000
Japan	-	-	<10000
Nigeria	? 500	501 – 1000	1001 – 10000
France	<500	501 – 2000	-
New Zealand	-	<10000	<5000
Indonesia	-	-	5000
Zimbabwe	5 – 500	501 – 500	-
Norway	-	-	<1000
U.K.	<1000	-	-
Swaziland	<300	301 – 2000	-
Canada	-	<1000	1001 – 1500
Argentina	-	<1000	-

Source: Tong Jiandong, (2004).

Table VII: Existing SHP in Nigeria

State	River	Installed Capacity(MW)
Oyo	Ikere	6
Kano	Tiga	6
Plateau	Lere I & II	8
Sokoto	Bakalori	3
Plateau	Bagel I & II	3
Plateau	Ouree	2
Plateau	Kurra	8
Total		36

Source: Energy Commission of Nigeria (2004) Guide book on Small Hydro power Development in Nigeria; Planning, Policy and Financing issues.

Table VIII: Growth in the world' SHP capacity.

2000	37,000
2005	46,000
2010	55,000

Source: Kucukali S. & Baris K: Assessment of SHP development in Turkey, Energy Policy 2009.

Table IX: Small hydro Potential in Surveyed States of Nigeria

River Basin	State	Capacity (Mw)	Unit Location.
Lower basin	Benue	69.2	19
Chad	Borno	20.8	28
Upper Benue	Bauchi	42.6	20
Upper Benue	Gongola	162.7	38
Lower Benue	Plateau	110.4	32
Niger	Kaduna	59.2	19
Niger	Niger	117.6	30
Cross river	Rivers	258.1	18
Hadeija – Jamaare	Kano	46.2	28
Niger	Kwara	38.8	12
Sokoto – Rima	Katsina	8.0	11
Sokoto – Rima	Sokoto	30.6	22
TOTAL		734.2	277

Source: Energy Commission of Nigeria: Renewable Energy Master Plan (REMP)

Table X: Investigated SHP Sites in Nigeria

Town	Water Head/m	Potential capacity(MW)
Jibia	18.0	31.3
Dutsinma	19.8	71.3
Iddo	15.0	0.24
Funtua 1 & 2	20.0	60
Ajiwa	12.5	30.0

Source: Energy Commission of Nigeria: Guide book on Small Hydro power Development in Nigeria; Planning, Policy and Financing issues (2004).

Table XI: Comparative Costs of Different Sources of Renewable Energy

Power source	Average cost (cents/kwh)
Micro-hydropower	20 – 30
PV panels	90
Small wind sets	40 – 90
Gas turbine	3 - 6

Source: National Centre for Energy Research and Development (NCERD).

Table XII: Initial capital costs of electricity generating systems

Technology	Size (kw)	Initial capital cost ($/kw)
Micro hydro	10 – 20	1,000 – 2,400
Photovoltaic (PV)	0.07	11,200
Photovoltaic (PV)	0.09	8,400
Wind turbine	0.025	5,500
Wind turbine	4	3,900
Wind turbine	10	2,800

Sources: Energy Commission of Nigeria: Renewable Energy Master Plan (REMP), Abuja (2005)

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