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## Impact of small hydropower developments on rural transformation in Nigeria

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# Impact of small hydropower developments on rural transformation in Nigeria

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**Abstract.** Rural transformation in Nigeria constitutes a major problem. Over the years rural development has not been given priority attention and this is where about seventy percent of the estimated Nigeria population of 180 million resides. The problem has largely been identified as government non-sustainable policy action towards rural transformation. However, the recent Economic Recovery and Growth Plan (2017 – 2020) of the Nigerian administration seem to address this imbalance by directing governance largely towards the rural dwellers. The paper highlights the importance of small hydropower technology in driving rural economy thereby reducing rural-urban migration.

## 1. Introduction

Hydropower is the most widely used renewable energy (worldwide), due to its significant advantages over other renewable resources; high energy density, low cost and reliability. These plants are used for rural electrification in many countries and have high potential to be integrated into the agriculture value chain in those locations. At the Colorado State University, USA for instance and located in mountainous area, 7 percent of the Colorado's irrigated farm land has a pressurization potential to produce a total of 30mw of hydropower [1].

It is common knowledge that most Nigerians who live in the rural areas (about 75% of them) are, by virtue of the circumstances of their habitat subjected to serious handicaps as stated below [2].

### 1.1 The Status of Most Rural Communities in Nigeria

- Inadequate functional motor able roads. Where roads exist, there are characterized by numerous pot holes.
- Inadequate supply of potable water- both for drinking and various household chores.
- Inadequate number of hospitals or basic health centers
- Inadequate number functional schools
- Inadequate source of electricity or reliable electricity supply to boost commercial agriculture.

To address the issue of irregular power supply which is our main area of focus and given the need for economic development of rural areas, the government is to give top priority to complimentary source of power, particularly small hydro in our local communities. Power availability will improve food security, increase industrial raw materials, increase employment and youth empowerment, wealth creation and poverty alleviation, greater contribution to GDP, foreign exchange earnings and government revenue.



Small hydropower projects have the capacity to enhance the quality and reliability of the power system, as they are located close to the load centers.

## 2. National Renewable Energy and Energy Efficiency Policy (NREEEP)

In 2015, the Federal Executive Council approved the National Renewable Energy and Energy Efficiency Policy (NREEEP). The policy was developed in line with the objectives of the National Energy Policy, Rural Electrification Strategy and Plan, Millennium Development Goals and the National Economic and development strategy [3].

The National policy is established to remove key barriers that put renewable energy and energy efficiency at economic, regulatory or institution disadvantages relative to other forms of energy in Nigeria. The lack of access to power has had a negative on economic growth in Nigeria by placing significant constraints on the productive capacity of Micro-entrepreneurs and rural supply chains.

The policy classifies hydropower as follows:

- Pico Hydropower: Pico < 100kW
- Micro Hydropower:  $100\text{kW} \leq \text{Micro} < 500\text{kW}$
- Mini Hydropower:  $500\text{kW} \leq \text{Mini} < 1\text{MW}$
- Small Hydropower:  $1\text{MW} \leq \text{Small} < 30\text{MW}$
- Medium Hydropower:  $30\text{MW} \leq \text{Medium} < 100\text{MW}$
- Large Hydropower: Large > 100MW

Hydraulic structures of small hydropower are much less complex than large hydroelectric plants. During recent years, small and mini hydro has gained momentum and traction due to inherent advantage on smaller investment, short gestation period, grid isolated power solution and less conflict with social issues.

## 3. SHP China experience

China is now the global leader in solar, wind, and hydro energy capacity, investing more in renewable energy each year than the U.S. and EU combined. This is to avoid smoggy skies experienced recently. China increased this commitment by pledging to invest an additional \$360 billion in renewable energy prior to 2020, and, according to a recent report by the Institute for Energy Economics and Financial Analysis (IEEFA), last year alone China pumped over \$44 billion into increasing its renewable energy reach.

The Economist cites that China has hydroelectric energy potential with a likely 300 gigawatts of untapped energy potential. Hydropower is an important asset for Chinese economic growth [8].

### 3.1. *Why China has succeeded in Small Hydropower*

- Regulatory Perspective- China has a centralized authority to regulate development. The Chinese Hydropower Sector has in recent decades has made installations exceeding 2000mw per year thereby setting a record in international hydropower development. The regulatory environment is favourable both locally and nationally.
- Due to large initial investment associated with hydropower infrastructure-both energy, money, regulation, distribution, the country is concentrating more in micro scale hydropower which are viable. Small hydros has already proven to make positive economic impacts in local Chinese economic interest.

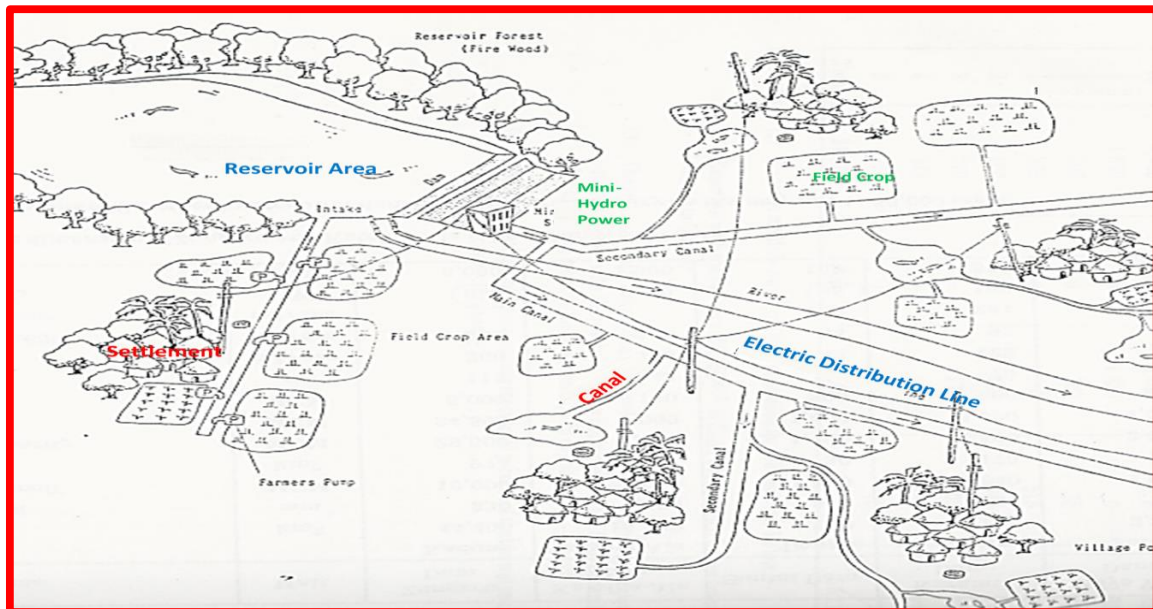
### 3.2. *Small Hydropower-The Nigerian Setting*

On the other hand, not much is done since the 60s and early 70s in small hydropower development. Very few SHPs are developed as already mentioned. To encourage the sector as in China experience, government must incorporate subsidies, feed-in tariffs and framework for Price Purchase Agreement (PPA) into the policies as well as encourage favourable regulatory environment. This will attract both indigenous and foreign investments.

As at 2010, the number of SHPs operational in Europe was about 21,800 and Germany had the highest number installed SHP of over 7,500 near 81.5% of this number were concentrated in 6 countries namely: - Germany, Austria, Italy, France, Sweden and Czech Republic [10].

### 4. **JICA study on small Hydropower Plant**

In 1995, JICA carried out a study on the National Water Resources Master Plan (NWRMP). The study also recommended the implementation of small dams with hydropower component in remote areas of the countries. Below in fig 1 is a perspective of such projects. However, implementation of such projects will be proceeded with studies. Such studies include survey, collection of hydrological data, geotechnical studies etc.



**Figure 1.** A perspective of SHP in a community setting

### 5. **Site screening study to assess SHP potential in Nigeria**

In 2008, the Federal Ministry of Power (through the Project Management Unit of PHCN) in collaboration with NovaTech International Inc., Great Falls Virginia, USA in partnership with UNIDO Regional Center for small hydropower in Africa carried out a comprehensive study of small hydropower.

About 200 sites were screened for priority and potential costing for project implementation. Field trips were undertaken with Environment Impact Assessment (EIA). Some of the sites visited for which construction works eventually commenced as are follows:

- Oyan Dam (Ogun State)
- Ikpoba Dam (Edo state)

- Ezioha Mgbowo SHP (Enugu State)
- Kurra power station, intake works, dam, and reservoir (Plateau State)
- Ankwil I power station, dam, and reservoir (Plateau State)
- Waya dam (Bauchi State)

The recommendations, based on the site screening study are as follows:

- There are some 90 universities and technical colleges in Nigeria and a number of these institutions offer good potential for hydropower development. Such a development would also provide an opportunity for the engineering faculties to incorporate SHP training into their curricula while supplying trained manpower.
- Developing numerous run-of-river micro hydropower projects with an installed capacity less than 500 kW for rural electrification can be an important tool for poverty alleviation. In Nigeria, there are a number of fast perennial streams where hydropower can be harnessed at very low cost.
- Some of the strategies for SHP implementation is via -River Basin Development Authorities; in the area of studies, data acquisition, agricultural development and climate resilience/mitigation projects.
- For the longer-term success in SHP, the Nigerian government should provide comprehensive research and development facilities such as those related to the: Investigations on hydrology and geology of sites (including use of GIS). Turbine, generator and auxiliary systems. Investigation of watersheds, catchments area and ecology related to micro-and mini hydro resources. Exploring the use of innovative hydropower technologies that do not require dams or impoundment.

## 6. SOME UNIDO SHP programs in 10 sites and 10 countries

UNIDO has worked tremendously in Nigeria and in other countries by promoting SHP development. The effort which should be sustained were highlighted in table 1.

**Table 1.** UNIDO Small Hydro- Power Programs in some Selected Countries

S/N	Country	Name of site	Capacity	Status
1	Rwanda	Nyamyotsi	75 x 100kW	Operating
2	Kenya	Kibae	1 x 1kW	Operating
3	Indonesia	Wias Island	40kW	Operating
4	Nigeria	Waya dam	2 x 75kW	Finished but have problems due to environment issues
5	Tanzania	Kinko	10kW	Finished but have problems due to limited site condition
6	Rwanda	Gatube	200kW	Under construction
7	Mali	Sirakorobougou	3kW	Construction suspended. Government reluctant to finance the civil engineering work
8	Uganda	Bwindi	50kW	Studies underway
9	Sierra Leone	Port Loko	1mW	Studies underway
10	Zambia	Shiwanigende	1mW	Studies underway

Note: Status of these projects would have changed as at 2019

### 6.1. Advantages and Disadvantages of Hydropower Plant in Agriculture

Some Advantages of SHP:

- Nigeria has large SHP potentials that are underutilized and adequate development of these potentials will not only improve the power supply but also boost economic impacts on fish industry, agriculture, tourism and provision of low-cost electricity for rural and urban development.
- Consumers are often poor and their electricity consumption low.
- Social issues are also limited.

Disadvantages of SHP:

- High upfront investment
- Potential environmental threats
- Hydropower growth is limited by the existence of rivers and water sources to generate power.

## 7. Conclusion

- The development of small hydro's is recommended for a small community or rural industry in remote areas away from the grid. There is an urgent need now to develop small and medium hydro in Nigeria.
- Amongst others, the RBDAs will be better suited to implement these hydropower schemes and to help remove millions of Nigerians from poverty.
- Among various types of energies, hydropower has the highest Energy Payback Ratio (EPR). The EPR of a power plant is defined as the total energy produced over the lifetime of the plant divided by energy needed to build, operate, fuel and decommission it.

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