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Solar Energy as a Tool for Poverty Reduction and Economic Recovery in Nigeria – A Review

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Abstract: This paper examined the link between provision of solar energy and its impact on poverty reduction in Nigeria. Solar energy in the tropical countries is the most common and abundant form of all renewable energies and it is essential as an alternative to the present source of electricity in Nigeria as well as for the improvement of the living standards of both rural and urban dwellers in the area of job creations, provision of social amenities as well as boosting human and economic productivity. It enhances living conditions by providing better lighting for homes, alternative source of power for cooking, heating and even pumping of water for various use in agricultural production. This study found that, essential aspects of human welfare (leading to long and productive life, good health, access to knowledge and education opportunities, potential to earn sufficient income to supply ample nutrition, shelter and other materials and even to boost the economy) may improve only if an alternative source of energy to combat the present epileptic state of power supply is made available. The study also found that, solar energy can have major favourable effects in remote rural areas and as a very dependable form of renewable energy technologies, offer a key prospect in areas where the grid cannot reach. This paper is a contribution to a process towards the use of solar energy to be one of the instruments to reduce poverty in Nigeria.

Keywords: Solar energy, Renewable Energy, Poverty reduction, Technologies, Electricity

1. Introduction

Poverty is regarded as one of the world's most fundamental burning issues, which needs to be addressed through socio-economic development. It is conceptualized in material terms as not having access to adequate levels of food, water, clothing, shelter, sanitation, health care and education. This can be translated into people having insufficient income. A better life and an improved standard of living are fundamental aspirations. But for billions of people, a better life means getting access to basic needs such as food, health services, housing and clean water. None of these basic needs can arguably be provided without energy. Poverty as lack of access to basic needs/goods is essentially economic or consumption oriented. Thus, the poor are conceived as those individuals or households in a particular society, incapable of purchasing a specified basket of basic goods and services. Basic goods are nutrition, shelter/housing, water, and healthcare, access to productive resources including education, working skills and tools and political and civil rights to participate in decisions concerning socio-economic conditions (Streeten and Burki, 1978).

Global leaders at the World Summit for Social Development described poverty eradication as an ethical, political and economic imperative, and identified it as one of the three pillars of social development. Poverty eradication has since become the overarching objective of development, as reflected in the internationally agreed development goals, including the Millennium Development Goals (MDGs), which set the target of halving global extreme poverty by 2015 (Hussein and Filho, 2012)

However, energy is one of the most essential inputs into sustaining people's livelihoods, at the most basic level it is a precondition of cooked food, boiled water and warmth. Lack of access to clean and affordable energy is considered a core dimension of poverty. It has been well known for a long time that poor people tend to use biomass as their energy carrier. In many areas, there are increasing biomass supply shortages, which add to women's burden whose responsibility is to collect fuel.

Energy is crucial but in the search for solutions, it is important to understand that energy supply is not a goal in itself, but only a means through which peoples' needs can be met. People need heating, lighting, the ability to cook food and transportation, therefore, energy is a basic input into all human activities. At the most simplistic level: producing food requires energy inputs to prepare the land, for harvesting the crops, transporting, processing and cooking the food. The more complex the activities become, the more complex the energy inputs.

Looking at the statistics of the world's energy consumption, a significant proportion of the world's economy depends upon fossil fuels, this includes the various kinds of moving, transporting, heating or running electric devices, this all rely to a greater or less extent on usage and energy retrieval from oil, coal and gas, (Johannes, 2012). The continuous use of this energy entails an inherent risk.

The infrastructure, such as power plants, distribution networks and storages are vulnerable to both natural disasters and human acts of destruction. For example the Tsunami, which hit Japan in 2011, seriously damaged a nuclear power plant. The limited amount of fossil fuels available is also a threat; these are finite

resources and given the growing worldwide consumption, they are most likely to run out sooner rather than later.

To correct the impending danger lying on the continuous use of non-renewable energies, the use of renewable energies, such as wind energy, bio fuels, hydropower and solar energy must fall in the vision of the Nation. Among these renewable energy forms, solar energy in particular shows a high potential to satisfy future energy demands to a high extent (Johannes, 2012).

The first part of the paper, explores the implications of being poor on the present state of electricity supply in Nigeria and what effect electricity supply has on the poverty level, the gender dimensions of solar energy and poverty. The second part of the paper, examines the assumption that if income generation is the answer to poverty, then what is the role of solar energy in this process?

Poverty is a global challenge and its alleviation is among the international institutions overarching goals. The purpose of this study was to develop a methodology and approach that would enable a poverty reduction analysis of the solar energy projects, as well as to identify means to enhance their impact on poverty reduction. Methodology for the evaluation of both direct and indirect impacts of solar energy utilization on poverty alleviation and also the enhancement of such impacts in Nigeria was also developed.

2. Literature Review

Energy is considered an important input to achieving sustainable development, including the reduction of poverty. Although in the 1990s, policy makers and international organizations (most significantly, including the World Bank) let rural electrification and rural energy supply in general fall out of favour due to the problems of converting energy supply into a profit making business in times of economic reforms (IDS, 2003), the topic of energy for poverty reduction has now been placed back on the agenda (Barnes, 2007). The recognition of the contribution of energy to implementing the MDGs for sustainable development and/or national poverty reduction strategies is widespread (WSSD, 2002; DFID, 2002; UN, 2002; UNDP, 2005; IDA, 2005).

"Energy inputs such as electricity and fuels are essential to generate jobs, industrial activities, transportation, commerce, micro-enterprises and agriculture outputs." Research in the field of energy supply for income generation shows consensus on the fact that energy can improve opportunities for income generation, but that the evidence is often anecdotal (Fishbein, 2003; Ramani and Heijndermans, 2003) or measured by tracking use of energy before and after an intervention rather than the impact on poverty itself (Barnett, 2000). This lack of understanding of actual productive uses of energy is

also found in the field of renewable energy projects even though such projects often have a poverty reduction objective and claim to have impacts on income generation (Etcheverry, 2003).

Nigeria is located on the west coast of Africa. It is the continent's most populated country in Africa, with over 150 million people. According to the Nigerian Energy Policy report (2003), it is estimated that the population connected to the grid system is short of power supply over 60% of the time. Additionally, less than 40% of the population is even connected to the grid. On a fundamental level, there is simply not enough electricity generated to support the entire population. The grid is powered by hydropower and thermal, which itself is composed of fossil fuels. Within each of these sources there are structural problems that detract from the overall efficiency of the energy producing capacity of each type of infrastructure.

The energy crisis, which has engulfed Nigeria for almost two decades, has been enormous and has largely contributed to the incidence of poverty by paralyzing industrial and commercial activities during this period. The Council for Renewable Energy of Nigeria estimates that power outages brought about a loss of 126 billion naira (US\$ 984.38 million) annually (CREN, 2009). Apart from the huge income loss, it has also resulted in health hazards due to the exposure to carbon emissions caused by constant use of 'backyard generators' in different households and business enterprises, unemployment, and high cost of living leading to a deterioration of living conditions. Moreover, according to the Central Bank estimate, Nigeria consumed 8,771,863 tonnes of oil which is equivalent to about 180,000 barrels of oil per day (CBN, 2005). Since then, oil consumption in Nigeria has drastically increased. The effect of this increase on the economy relying solely on revenue from oil is tremendous. Also, the Department for Petroleum Resources (DPR, 2007) reported an amount of petroleum of more than 78% of the total energy consumption in Nigeria. In the present predicament as a nation, it is obvious that depending mainly on fossil fuel (petroleum) is not enough to meet the energy needs of the country. Since Nigeria is blessed with abundant renewable energy resources such as hydroelectric, solar, wind, tidal, and biomass, there is a need to harness these resources and chart a new energy future for Nigeria. In this regard, the government has a responsibility to make renewable energy available and affordable to all.

Many indigenous researchers have looked into the availability of renewable energy resources in Nigeria with a view to establishing their viability in the country. Onyebuchi (1989) estimated the technical potential of solar energy in Nigeria with a 5% device conversion efficiency put at 15.0×10^{14} kJ of useful energy annually. This equates to about 258.62 million barrels of oil equivalent annually, which corresponds

to the current national annual fossil fuel production in the country.

Figure 1 shows the total electricity consumption in megawatts per hour and the various sectorial decompositions. Electricity utilization by the industrial sector has been fairly static because of the unreliable nature of the public electricity supply system in the country. Thus, many companies have resolved to provide their own power-generating sets as sources of electricity, leading to huge transfer costs on their products and services.

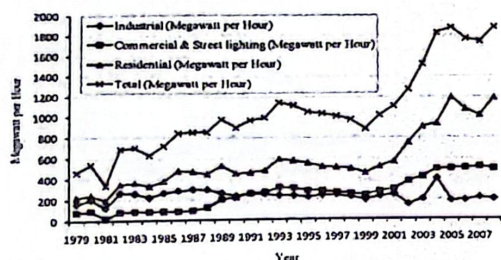


Figure 1: Electricity consumption pattern in Nigeria (Source: CBN,

2.1 The role of renewable energy technologies in sustainable development

Renewable energy has an important role to play in meeting the future energy needs in both rural and urban area. The development and utilization of renewable energy should be given a high priority, especially in the light of increased awareness of the adverse environmental impacts of fossil-based generation. The need for sustainable energy is rapidly increasing in the world.

Because renewable energies are constantly being replenished from natural resources, they have security of supply, unlike fossil fuels, which are negotiated on the international market and subject to international competition, sometimes even resulting in wars and shortages. They have important advantages, which could be stated by CBN (2007) as follows:

- ♦ Their rate of use does not affect their availability in the future; thus, they are inexhaustible.
- ♦ The resources are generally well distributed all over the world, even though wide spatial and temporal variations occur. Thus, all regions of the world have reasonable access to one or more forms of renewable energy supply.
- ♦ They are clean and pollution-free and are therefore a sustainable natural form of energy.
- ♦ They can be cheaply and continuously harvested and are therefore a sustainable source of energy.

2.2 Energy link with Poverty

There are still many people in the world who do not have access to electricity or other forms of modern

energy. In total, nearly 1.6 billion people out of the total population of 6.5 billion do not have electricity access, and 2.5 billion depend on biomass (OECD, 2006). All over the world, the people without access to modern forms of energy are typically the poor, and this lack of access to energy is one of the major factors making it difficult for them to improve their lives.

A substantial and influential body of policy makers believes that creating energy access will make it possible for the poor to improve their lives by creating an income, as the quotes below show: "Access to energy is central to poverty alleviation. Access to affordable energy services is critical for increasing agricultural productivity, encouraging economic activity, generating employment and income opportunities and improving the quality of life particularly for women and children." World Summit on Sustainable Development in 2002 (UN, 2002).

Clearly, energy for the sake of energy is not useful. Its utility lies in facilitating human development. The energy sector has strong links with poverty reduction through income, health, education, gender and the environment. These links suggest that the energy sector needs to focus increasingly on working with other sectors to ensure that the poor benefit as much as possible from greater access to energy supplies. So there should be a framework for analysing the role of the energy sector and role of energy services on poverty reduction. Figure 2 shows a framework for establishing development goals to guide the selection of policies and program to achieve specific target. Apparently, the paths through which energy could contribute to increasing incomes for the poor are diverse. From an economic growth perspective, energy use in industry is the driving force behind poverty reduction. More direct impacts of energy on poverty reduction can occur when energy is used by the poor to generate or increase their income through new or improved opportunities for small enterprises or for farming (Sen, 1999; Schulte Nordholt, 2004; Cabraal et al., 2005). Such uses of energy for income generation are often called productive uses of energy.

2.3 Solar energy as a tool for poverty reduction

Considering the health hazard and the green-house effect of the energy source in use (fossil fuels) and the abundant supply of solar energy, it is worthwhile, adopting solar energy as an alternative source of energy in Nigeria, especially in the area of electricity supply and poverty reduction. Replacing the present energy source with solar energy in Figure 1, various opportunities and advantages can be tapped from solar energy.

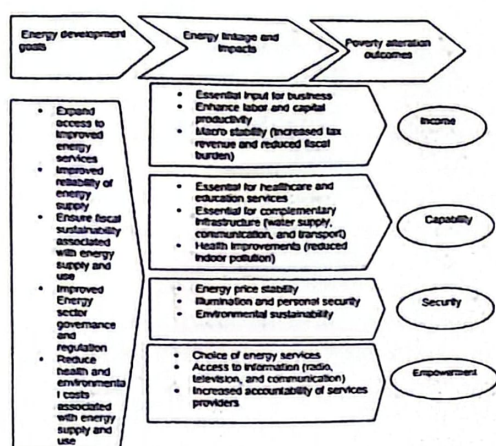


Figure 2: The energy-poverty framework (Source: Addison, 2007)

2.3.1 Solar energy versus income growth

Perhaps the most important way the energy sector can improve the lives of poor people around the world is by helping to increase their meagre income. To begin with, modern energy can greatly increase their productivity. Petroleum fuels power motorized transport that speeds the movement of goods between outlying areas and markets; and power agricultural activities that help expand crop production. Electricity enables poor households to engage in activities that generate income - by providing lighting that extends the workday and powering machines that increase output and it raises the productivity of small businesses and shops and powers telecommunications. All this is reflected in the strong correlation between energy consumption and national income. Most economic activity would be impossible without energy, even the small and medium-scale enterprises that are the main source of jobs for the poor. The kind of economic growth that creates jobs and raises incomes depends on greater and more efficient use of energy which provision of solar energy will greatly have a significant improvement on.

2.3.2 Solar energy versus education

For poor people everywhere, access to modern energy services frees time for education-time that would otherwise be spent collecting traditional fuels or in other menial work. It also frees children to attend school, by boosting productivity and thus allowing adult labour to substitute for child labour. For both adults and children, electric lighting in homes enables them to study after their daytime activities. And in rural areas, modern energy helps retain teachers by improving their quality of life. A survey in Nicaragua illustrates the relationship between education and household electricity use. It was found that the percentage of a family's children that attend school

is highly correlated with the availability of electricity. Among rural households in Nicaragua, 72% of children living in a household with electricity attend school, compared to 50% of those living in a household without electricity (Hussein and Filho, 2012).

2.3.3 Solar energy versus health

Solar energy helps improve health in many ways. By powering equipment for pumping and treating raw water, it helps ensure a clean water supply, reducing the incidence of waterborne diseases, especially in slums. By boosting agricultural production and household incomes, it helps reduce the malnutrition that is such a big factor in child mortality. And by allowing households to switch to kerosene or liquefied petroleum gas (LPG), it enables the poor to avoid cooking with biomass fuels like wood and dung, whose emissions cause respiratory ailments that are the fourth leading health risk in developing countries (WHO, 2002). Solar energy also helps improve health indirectly. Electricity enables health clinics to refrigerate vaccines, operate medical equipment, and provide treatment after sunset. It allows the use of modern tools of mass communication needed to fight the spread of HIV/AIDS and other preventable diseases. And through its benefits for education, it leads to higher literacy among women, which translates into better health for children.

2.3.4 Solar energy versus agriculture

The struggle against the malnutrition and food crisis in developing country requires an increase of agricultural productivity. Energy access within agricultural activities has for its part an important impact on agricultural yield's improvement (Singh, 1999). Because solar energy access in this sector facilitates irrigation, harvesting, and post-harvesting activities which lead to more mechanization of agricultural process which could increase food yields (Lee, 2005). Moreover the relationship between energy access and hunger is represented by the fact that energy in the form of heat represents 95% of the basis staple foods that form the human nutrition (UNDP, 2005).

2.3.5 Solar energy versus gender

Increasing access to energy brings disproportionate benefits for women - in health, education and productive activities - since in many parts of the world, it is they who spend more time than men cooking and collecting water and fuel. Modern cooking fuels free women from the burden of collecting and carrying large loads of fuel-wood and from exposure to smoke from primitive cooking stoves and Modern energy for lighting. Hussein and Filho (2012) survey of women's time use in rural areas shows how access to electricity can benefit women. The probability that a woman will read is strongly related to whether the home has electricity. Indeed,

regardless of income level, virtually no reading takes place in households without electricity. About 11% of the sample reported spending some time reading on the day of the survey - and these women reported doing so for about an hour a day on average. Averaging this time across all the households shows that higher-income women spend more time reading than lower-income women. But among lower-income women, those in households with electricity have a much greater likelihood of reading than those in households without electricity. Moreover, lower-income women have a lower literacy rate than higher-income women and so would have a lower possibility of reading. Thus, the high-quality lighting made possible by electricity appears to make it more likely that women will read in the evening regardless of their income level, how much more, when there is a more stable and readily available solar energy for electricity generation. Table 1 shows the impact that the adoption of Solar energy can have on better living and how it affect the environment, human health, gender equity, education and social activities.

Table 1: Impacts of Solar energy adoption to better living

Environment	
•	Lowering of pollution emission
•	Decreasing a biomass consumption
•	Improvement in vegetation cover
Health	
•	Reduction of respiratory problems
•	Reduction of infant mortality
Equity	
•	Time gain for female population, following a reduction in time collecting wood for energy use
Education	
•	Increasing of day length via night lighting
•	Time gain for children
Social	
•	Creation of social ties (nighttime discussion)

2.4 Solar energy as a contributor to essential human service

Reliable and affordable energy supplies are absolutely required to meet even the most basic human daily needs of the world's poor people. Solar energy in its own capacity can provide these basic needs which include:

- i. **Cooking:** Energy for cooking (and heating in cold climate) is one of the life's most basic needs. It is estimated that approximately 95% of staple foods (such as rice, grains, green bananas, etc.) need cooking before they can be eaten.
- ii. **Safe drinking water:** Supplying safe water would not be possible without energy for

pumping and clean fuels for boiling water. Without energy for pumping and/or boiling ware, people would be often forced to rely on water from streams polluted by cattle or human effluent.

- iii. **Lighting:** Energy for lighting allows people to study and/or carry out income-generating activities at night.
- iv. **Healthcare:** Energy is needed for powering vital equipment in rural health centers such as refrigeration for vaccines and other medicines, sterilization of equipment, and lighting, as well as transport facilities.
- v. **Education:** Energy is needed to provide lighting in schools, allowing extended classes and power modern learning equipment such as overhead projectors and computers.
- vi. **Communication:** Electricity supply is required for powering radio and/or TV sets, as well as information and communication technology (ICT), that are necessary for households, farmers, schools and others living in remote areas to access critical information.
- vii. **Agricultural needs:** Crops need to undergo some form of processing to improve the quality or to change the form or characteristics of crop. Processing operations also add value to the crop after production, prepare the crop for utilization or preservation. Such processing operations include cleaning, drying and milling. There are provisions for many solar powered mechanical equipment which can enormously reduce time consumption, almost back-breaking task, particularly for women and girl children.

3. Conclusion

For people living in poverty, the most pressing priority is the satisfaction of basic human needs, which includes access to food, shelter, water supply and sanitation and other services that will improve their standard of living, such as healthcare, education and better transport. But it is generally recognized that although energy is not a basic need, it is required as a crucial input for providing other essential human needs. The satisfaction of the basic needs and poverty alleviation efforts cannot be achieved without improving access to better energy services.

The sustainable use of Solar energy can contribute directly to poverty reduction by improving the quality of life through better lighting, access to cleaner source of power for cooking and pumping safe drinking water, improving effective delivery of social services through lighting, refrigeration of vaccines and other medicines, sterilization of equipment in health centres as well as providing lighting to schools thereby allowing students to study

at night and improving their employment prospect, generates income, creates jobs, helps the management of a country's balance of payments, contributes to lower CO₂ emissions, hence adapting to a lower carbon society and helping fight global climate change.

Agricultural production can also be enhanced through solar energy by powering some crop processing and storage equipment by solar energy which is always in abundance e.g. solar dryer, pumping water for irrigation purposes which will improve agricultural productivity and subsequently contribute to poverty reduction.

Although, the high initial cost might be a hindering factor to achieve its deployment but Renewable energy technologies (RETs) have the potential to help improve access to energy services for poor people living in urban and rural areas in Nigeria and the entire sub-Sahara Africa.

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