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Solar Energy: A Source of Renewable Energy and a Disruptive Innovation Creating Business Opportunities in Nigeria

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Abstract

One of the limitations for entrepreneurs and businesses in Africa, including Nigeria, is having access to a stable energy source. The World Bank Group has encouraged off-grid power solutions to address this issue. Qualitative exploratory research of readily available literature was undertaken, supplemented by in-depth interviews. The findings were that an overhaul of existing systems needs to take place, and a huge market is available for exploitation by multinational corporations, small to medium enterprises, entrepreneurs, and investors. Finally, new business models are needed from entrepreneurs and businesses venturing into the power sector in order to disrupt the energy sector and alter the power supply, which was previously solely government owned. Privatization of the power supply by the government would bring more efficiency into the energy sector through disruptive solar technology.

Keywords: *Solar energy, disruptive innovation, business opportunities*

Introduction

Suanmali, Kokuenkan, Lohananthachai, Kumpong, and Suwatanapornchai (2018) indicated that electric power in the twenty-first century is a necessity for everyday life. From their Thai perspective, they held that energy supplied to the power grid using non-renewable generation technology is insufficient to meet demands, and eventually will lead to a search for renewable energy as an alternative. Paul and Uhomoibhi (2012, 2014) showed that most of the electricity provision in emerging economies over the past decades has been through non-renewable energy. It has not been equally distributed because it is still limited. The demand for electrical energy for technological use and sustainable development is on the rise in emerging economies on account of population increase, urbanization, and industrialization. Although electricity is held as a necessity for life, economic growth, and poverty elimination, Nigerians are still living without it. Presently, around 60% to 70% of Nigerians have no access to electricity, and thus government power diversification in the energy sector is required urgently through adopting new technologies, like solar energy, to increase access and reduce costs (Emodi & Ebele, 2016). A report on African energy industrial prospects (An African Energy Industry Report, 2018) stated that more than six hundred and twenty million people in Africa are without access to consistent electrical power. Nigeria, being one of the largest economies, faces an enormous energy challenge like many other African countries. The problem is that a steady commitment to enhance the use of alternative renewable sources of energy is still lagging (An African Energy Industry Report, 2018). The main purpose of this research is to highlight the energy situation in Nigeria and the market opportunities for increased use of solar energy technologies.

Review of Literature

Solar Energy as a Disruptive Innovation in the Nigerian Energy/Power Sector

Entrepreneurship was conceived by Schumpeter as a function of innovation (Schumpeter, 2017); he stated that entrepreneurial processes play a central role in economic development. According to Schumpeter's creative destruction concept, economic activity driven by entrepreneurs destroys the old and creates new structures, and this process tends to repeat itself over time. Thus, applied to the energy market, innovations induced by entrepreneurs should break the old conventional energy sector model, thereby facilitating economic development (Backhaus, 2006). The claim made here is

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that electricity provision can be disrupted by solar energy technology. To illustrate that solar energy technology could be a disruptive innovation in Africa, and Nigeria in particular, the impact of information and communication technology (ICT) has been used as an example in this research.

The developmental impact on ICT implementation in the continent of Africa over more than twenty years has shown that ICT generally has been a means of effecting changes in many sectors to achieve developmental goals (Paul & Uhomoibhi, 2012). According to these researchers, welcome ICT developments could also be replicated in the solar energy sector as a source of economic growth. The application of this technology in the continent would increase productivity and promote the achievement of a sustainable economy.

The Africa Partnership Forum viewed ICT as an instrument for cumulative efficiency gains that would create new opportunities, providing greater accessibility to new markets or services as well as improving governance, thereby giving equivalent opportunities to underprivileged people who are voicing their demands (Paul & Uhomoibhi (2012). Many developed and developing countries that have invested in ICT have seen increased sustainable economic development, as it plays a critical role in rapid economic growth and productivity, both in the private and public sectors of the economy (Schreyer, 2000; Indjikian & Siegel, 2005). However, unlike other developing countries such as China, India, Malaysia, Philippines, Thailand, and South Korea that have benefited from ICT investment, Nigeria is one of the African countries that has faced economic decline (Bloom & Sachs, 1998), inadequate energy supplies, and energy crises (United Nations Industrial Development Organization, 2009; OPEC Fund for International Development, 2010; Jimba, 2000). These outcomes are due to a lack of accessibility to electrical energy and new venture investments in technology. Market investment in solar energy technology in Nigeria represents a possible solution to this dilemma.

The Schumpeterian concept appears well-suited for the Nigerian economy. The concept proposes disruptive economic development that is spontaneous, and which encourages change of the status quo. According to Schumpeter's theory, change comes in different forms, which may involve the introduction of new products or services–or a new method of production–involving entrepreneurs (Haldar, 2019). For example, a young solar entrepreneur named Patrick Ngowi who founded the Helvetic Solar Contractors Company has installed nearly 6,000 solar power in small homes in Tanzania where his company is based, and his company is working with several other government and non-profit organizations around East Africa. The Helvetic Solar Contractors Company is said to be generating US$15 million revenue per annum, which indicates the potential business opportunities in the solar energy market across Africa (Iwuoha, 2013).

Yu and Hang (2010) have indicated the substantial nature of research findings concerning disruptive innovation. Anderson and Markides (2007) and Johnson (2007) indicated that Africa has different types of consumer clusters that may be amenable to disruptive innovation. One set of particular interest is represented by low-income groups in cities. The United Nations and World Resources Institute in 2015 have estimated that there are around 225 cities in Africa with populations over one million. Therefore, business opportunities exist for entrepreneurs, small to medium enterprises (SMEs), and multinational corporations (MNCs) in the form of solar energy provision as an alternative for the inadequate power grid. Solar energy represents a disruptive innovation which could provide access to millions of potential customers. The potential market demand they represent expands to billions of dollars if the supply of the energy was reliable and cost affordable.

Disruptive innovations may be thought of as technologies that provide different sources of value from those tapped by conventional technologies (Christensen, 2006), or as an innovation that has charted an entirely new market by providing a new type of product or service (Christensen & Bower, 1996). This appears to be the case with solar energy. A disruptive innovation as in product innovation, process innovation, or service innovation tends to provide a recognizable improvement in the value delivered to the customers (Wan, Williamson, & Yin, 2015). A new mixture of current and new technologies can be used to solve problems, whether in energy supply or other areas (Walsh & Linton, 2000). In meeting the challenges faced by consumers with different types of needs, most researchers tend to favor a research approach for solving the problems encountered and seek

a balance between disruptive innovation and sustainable development (Adegbile & Sarpong, 2018; Hemphill, 2010; Rivera-Santos, Rufin, & Kolk, 2012).

The Status of Electricity/Power Problems in Nigeria

According to Paul and Uhomoibhi (2012), the most important factor for sustainable development in emerging economies like Nigeria is a steady power supply. This is of equal importance to other such factors as land, capital, and labor. Electrical power has been a major source of social, environmental, and economic sustainable growth. Having noted the importance of electrical energy, Nigeria's energy is still largely provided by non-renewable sources of energy like oil and gas, which not only contribute to pollution, but are also unequally distributed. Power is required in emerging economies for industrial purposes, sustaining population growth, and for urbanization.

The installed power capacity in Nigeria today is at 12,522 megawatts from existing plants, but most days only around 4,000 MW is actually generated, which is insufficient. Electricity supply in Nigeria is far less than the demand. Therefore, to meet future power demands, it is predicted that Nigeria should be generating around 20,000 MW (Ezennaya, Isaac, Okolie & Ezeanyim, 2014). This reflects a wide market gap between electricity demand and supply in Nigeria. From the above information, less than half (50%) of Nigeria's population has access to a steady electricity supply.

Generating Electricity Using Non-renewable Sources

Many studies connected with electric power generation in emerging economies have found that non-renewable energy is the major source of energy available (Hasnain, Alawaji, & Elani, 1998). In Nigeria, most electrical power is supplied through dispersed, small diesel plants (Andrade, 2009). There is limited electricity availability, and since most of that supplied is being generated from diesel power plants, this means that the cost is high on account of the price of diesel and other fuels (Goldemberg, Rovere, & Coelho, 2004). In contrast, alternative non-renewable resources are sourced in other countries. For example, according to Garcia-Valverde, Miguel, Martinez-Bejar and Urbina (2009), 52.19% of the electricity in India was generated from gas in mid-2009. In South Africa, electricity generation from coal during 2001 was around 93% (Malzbender, 2005). Another study conducted in 2001 indicated that in South Africa electricity nationwide was limited, with 66% of demand being satisfied (Davidson & Mwakasonda, 2004).

Nigeria, like most of the countries in Africa, is blessed with an enormous amount of non-renewable electrical energy resources. These include natural gas, petroleum, uranium, and coal. Estimates of the reserves available indicate that most electrical energy demands can be supplied from these resources for a couple of decades to come (United Nations Industrial Development Organization, 2009). Despite this, shortages in the power supply are unprecedented. Many African countries including Nigeria face enormous energy supply problems that include poor quality of power supply and services, together with an inability of governments to show their full commitment that will help stimulate and encourage more private investment into the energy sector (Mkhwanazi, 2003; Frederick & Selase, 2014). In Sub-Saharan Africa, the United Nations Industrial Development Organization (2009), estimated that around 26%–or five hundred and forty-seven million people–are either facing a problem of inadequate electricity supply from the grid, or do not have access to it. According to the report, Africa has the lowest electrification rate of all continents.

Mwahiva and Mbise (2003) have pointed out that supplying electricity to remote areas is problematic in Africa. This is due principally to the fact that there is no viable demand for electricity because of the poor income levels of potential users. But that is not the case in Nigeria, where there are high energy demands on account of it being one of the biggest economies in Africa. The supply of an uninterrupted energy supply is highly sought after, particularly when it is affordable and in a technologically advanced format such as solar energy. Meeting these provisions would make it a readily marketable commodity.

Generating Electricity Using a Renewable Source, Solar Energy

Nigeria, like most of the African countries, is close to the equator, making solar energy an attractive development. In fact, the World Bank is investing around 350 million dollars in Nigeria

through the rural electrification agency (Rural Electrification Agency, 2018). The implementing agency for the project has been working with the World Bank team to develop a robust solar energy project that, when developed, will be the largest off-grid electrification project in West Africa.

For the research reported here, the main focus has been on the type of solar energy panels that are normally installed on the top of building roofs to generate power for individual households and businesses.

Nigeria Off-Grid Market Opportunities and Potential for New Business

Renewable energy, particularly solar energy, could become a trillion-dollar market in Africa (Iwuoha, 2017). Nigeria is currently facing a lack of government investment and the political commitment needed to connect the entire country to a reliable power grid. The country needs an alternative source that is decentralized, readily available, cheap, easy to install, and effective enough to provide power to millions of potential customers in the shortest possible time. This is where disruptive innovation should do well. There are a number of renewable alternatives available for Africa: i.e. biogas, wind, water, and sun. Solar power is free and most abundant because many African countries are located on or near the equator. Therefore, solar power is one of the best options in the energy market today. Solar power in Nigeria is gaining market momentum although it is relatively new (Figure 1). Only forward-looking businesses and capable entrepreneurs have been able to identify and capture the business opportunities. Entry into this market may be as a wholesale supplier, retailer, or as an installation service contractor.

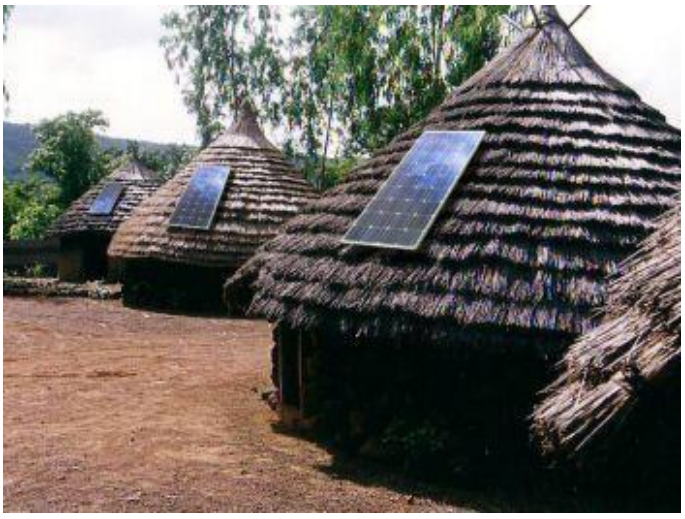

Figure 1. Solar Energy in Rural Areas in Africa

There is abundant sunlight for 325 days per year on average in equatorial areas (Duffie & Beckman, 2013). Paksoy (2010) estimated that an hour of sunshine can provide the needed solar energy demands of the world population. Solar energy is the second most sought-after renewable source in providing energy demands (Stritih, Osterman, Evliya, Butala, & Paksoy, 2013; Stritih, Paksoy, Turgut, Osterman, Evliya, & Butala, 2015). Businesses and entrepreneurs in Nigeria with foresight need to exploit this huge gap between electricity demand and supply and utilize this next big market opportunity (Cao, Liu, & Cao, 2014). Exploitation of solar energy in Nigeria could potentially resolve supply issues in the troubled power sector that are hindering economic progress. The ability of an entrepreneur or manager to identify a business opportunity requires foresight to facilitate entry into the solar energy business. In order to make such an entry easier, it is imperative to portray the market potential of solar energy technologies in Nigeria.

There is an estimated market opportunity of 10 billion dollars per year for mini-grids and solar home systems in Nigeria (Rural Electrification Agency, 2018). Today's off-grid and under-served annual market size in Nigeria is illustrated in Figure 2.

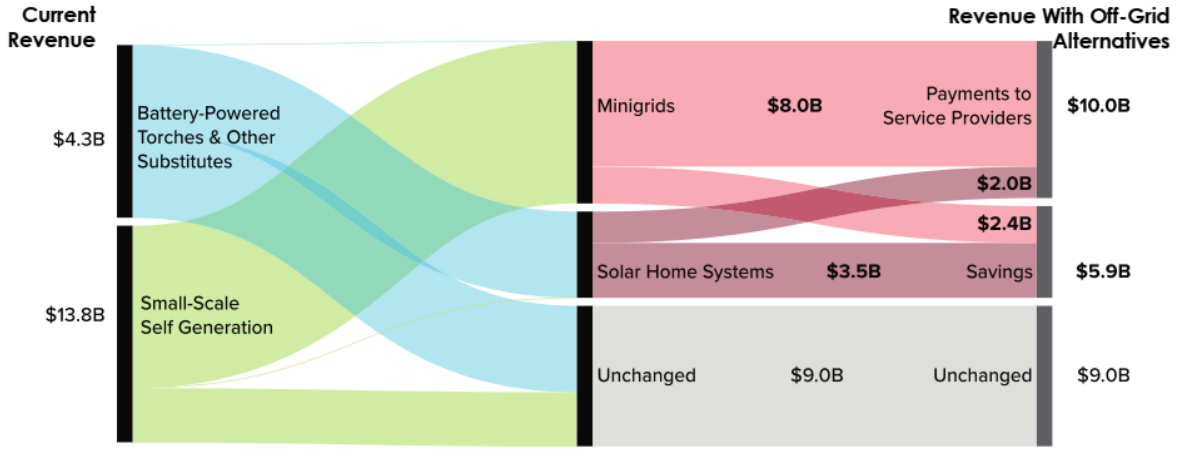

Figure 2. Today's Off-grid and Under-served Annual Market Size in Nigeria by Off-grid Technology (Rural Electrification Agency, 2018)

The off-grid market opportunity breakdown in the present Nigerian market is estimated as follows, based on current market expenditures. It is understood that customers may pay more for superior services.

1. $10 billion annual market opportunity to supply off-grid and under-served customers with mini-grids and solar home systems.
2. The market would boost economic growth 8% by the 2030s, adding an additional $670 billion value to the economy.
3. The shift from expensive methods of generating power would save Nigerians customers about $6 billion per year over current energy costs, and supply would be more efficient.

The Business Opportunity and Market Potential

Identification of a business opportunity by an entrepreneur or SME involves the processes of finding, assessing, and exploiting opportunities (Theyel, Theyel, & Garnsey, 2013). The market and business potential in Africa have recently started to attract the attention of entrepreneurs and business leaders, as well as scholars (George, Corbishley, Khayesi, Haas, & Tihanyi, 2016). According to the International Monetary Fund, five of the world's fastest growing economies are in Sub-Saharan Africa (Adegbile & Sarpong, 2018). Recognizing business opportunities and the market potential of the African continent has dominated the thinking of international businesses in recent times (Simanis, Hart, & Duke, 2008). The issues associated with reorganizing the economic dynamics to encourage the exploitation of opportunities and to encourage economic activities has also attracted scholarly research. This has focused on how businesses (entrepreneurs, SMEs & MNCs) can grasp the opportunities and capitalize on them to create value from this unserved market segment by enhancing capabilities that often have been neglected (Adner, 2006; Charitou & Markides, 2003; Danneels, 2004; Prahalad & Hart, 2002; Prahalad & Hammond, 2002). Christensen and Bower (1996) have indicated that, even as there are enormous challenges such as bad management on the part of the government regimes, resulting in inadequate infrastructure and under-developed distribution systems, for new businesses to capitalize on the market potential and make profits requires an innovative approach/technologies, and a strategic plan to fully unlock market possibilities.

Research Methods

Two main sources of information were used for this research: namely, documentary evidence, and the application of a qualitative research method.

Population and Samples

A purposive random sampling method was adopted for a qualitative research study. The population used for this study was the Managing Director/CEO of the Rural Electrification Agency, the Head of the Project Management Unit of the Nigeria Electrification Project, 11 prospective market players representing big companies (i.e., MTN, D.light, AWANGO, Rensource, Greenlight

Planet, Arnergy, Azuri, SOLAR SISTER, OAS BBOXX, Barefoot Power, LAPO Microfinance Bank), a representative of the World Bank, and selected entrepreneurs/ potential investors from around the world who participated in the August 2018 exhibition at the Nigeria electrification project/event held at Lagos, Nigeria. This exhibition was on the issue of developing a robust plan that, when implemented, would be the largest off-grid electrification project in West Africa.

Research Tools

Documentary evidence was accessed by a review of the available literature on solar energy business opportunities that was found in Scopus-indexed academic journals/articles, Google scholar, news, websites, and the World Bank website. On the other hand, the qualitative method was applied through using in-depth interviews. Participants, as identified in the previous section, were asked to explain the problems of energy supply and the major causes of persistent energy crises in Nigeria. They were also asked: What are the market potentials of renewable energy particularly solar energy in Nigeria? What are the main reasons why renewable energy, particularly solar energy, is not making a greater impact in Nigeria? What has been done to attract investors to this industry?

Research Findings

Q1. Explain the problems of energy supply and the major causes of the persistent energy crises in Nigeria.

Answers from 11 Business representatives, some selected Entrepreneurs, and Investors:

1. Government's inconsistent policy in the energy sector.
2. High levels of corruption in the energy sector.
3. Lack of or inadequate technical know-how.
4. Insurgency, with militants vandalizing the pipeline and disrupting the energy sector, since most non-renewable energy in Nigeria comes from natural gas.

Answers from the Managing Director/CEO of the Rural Electrification Agency and the Head of Project Management Unit for the Nigeria Electrification Project:

1. Both respondents acknowledged the roles of inconsistency and corruption but reaffirmed the commitment of the Federal Government of Nigeria's (FGN) objective to improve the sector through privatization.
2. They also acknowledged the roles of insurgency, pipeline vandalization, and the lack of competent technicians. They held that gender inclusion in the Nigeria power sector – together with economic growth, especially in agriculture business due to steady power availability – would help create more jobs and business opportunities, which would help to moderate these problems.

Q2. What is the market potential of renewable energy – particularly solar energy – in Nigeria?

Answers from the FGN agency, big players, entrepreneurs, and potential investors are similar in this regard:

1. Abundant sources of renewable energy are available in a region, for there is up to 8 hours of sunlight in a day.
2. Inadequate or unstable power supply currently experienced from on-grid sources makes room for an off-grid supply, such as via solar energy.
3. New government directives and objectives on policy accommodate off-grid energy business opportunities.
4. Increasing market share for renewable energy exists in Nigeria, especially as advances in technology reduce solar energy supply costs.
5. Excess energy generated can also be sold to the nation's grid or to high energy users.
6. Lack of local solar energy technology manufacturers in Nigeria presents a huge market opportunity for foreign investors who attended the electrification exhibition held in Nigeria.

Q3. What (is) are the main reasons why renewable energy, particularly solar energy, is not making an impact in Nigeria, and what has been done to attract investors to this industry?

Answers from the Managing Director/CEO of Rural Electrification Agency, the Head of the Project Management Unit for the Nigeria Electrification Project, big players, entrepreneurs, and potential investors:

1. Heavy import duties have hindered the entry of more investors into the solar energy business.
2. Low or substandard solar energy panels have been supplied that do not serve the needs of customers. This might be one reason that has reduced the readiness to adopt solar technology.
3. Technical capabilities for installation and maintenance are inadequate, which are sources that have inhibited development. These represent areas in need of investors to capitalize on business opportunities.

Discussion

Solar energy is a readily available source of power waiting to be fully tapped in Nigeria. According to Schumpeter's concept of innovation, change induced by entrepreneurs and investors should break the static conventional energy sector, thereby opening new ways of business that foster robust economic development (Backhaus, 2006). Such changes already have been evident for the past twenty years in Africa in many sectors as a consequence of the information and communication technology revolution. The achievements in this sector in helping organizations reach their developmental goals can also be imitated in the solar energy sector as a source of economic development. The importance of steady power supply in the continent of Africa is undeniable. Even successful information and communication technology enterprises can be enhanced through the provision of a more efficient and effective power supply sector. In the continent, such moves would not only increase productivity but also steer the entire continent towards a more sustainable economy.

The present research, through in-depth interviews, confirmed the major causes of the persistent energy crises and the reality of business opportunities in solar energy in Nigeria. The conclusions reached from the interviews on the failure to exploit fully solar energy for electricity generation were confirmed in the literature review. The following reasons for exploitation failure were forwarded. First, there is a lack of expert solar technicians. This deficiency might lead to customer disappointment and system failures, and lead to the development of strong negative perceptions about solar technology, especially when the high installation costs are considered (Nieuwenhout, de Villers, Mate, & Aguilera, 2004; Chaurey & Kandpal, 2009). Second, there is inadequate market information and established business models (Chaurey & Kandpal, 2009; Martinot, Cabraal & Mathur, 2001; Martinot, Chaurey, Lew, Moreira, & Wamukonya, 2002). Third, renewable energy education is still limited, and the awareness of alternative technologies is inadequate (Nieuwenhout et al., 2004; Chaurey & Kandpal, 2009). Hasnain, Alawaji and Elani (1998) found that most emerging economies have been designed along traditional lines using non-renewable energy. Uncertainty and the high cost of the technology has cast doubts in many minds about the future of renewable energy, such as solar energy investment (Ma, Oxley, Gibson & Li, 2010; Chaurey & Kandpal, 2009; Martinot et al., 2001). All these inadequacies in the energy sector exist in Nigeria, which is reinforced through the educational system. These represent roadblocks to some. However, to the more enlightened they represent a new market potential for business, especially for solar energy. Business opportunities exist in wholesale supply, in retail, and in installation. There is a huge market potential to be exploited and capitalized upon. A disruptive innovation approach would provide access to millions of potential customers. These customers have potential market demands ranging in billions of dollars if the supply of the energy was efficient and cost affordable.

Conclusion

In order to realize their economic potential, a steady, available, and more affordable electricity energy supply is needed in emerging economies like Nigeria, so as to enable them to experience the benefits of prosperity in all sectors of the economy (Paul & Uhomoibhi, 2012). The research reported here highlights the potential for entrepreneurs and businesses to develop disruptive innovation in the emerging economies of Africa, especially in Nigeria. There are considerable market opportunities for solar energy, which appears to represent the best option currently available to tackle the problems of power shortages and to accelerate a more sustainable economic development, as well as reducing dependability on the government's inadequate grid power supply. Innovation in solar energy off-grid power in Nigeria would be facilitated if entrepreneurs and businesses had access to reliable market analyses and business models. The provision of well-trained technicians and the imposition of low government import taxes would assist in technology uptake. The government needs to approach the issues of inadequate power supply in Nigeria as one of the basic needs for improving daily lives and strengthening business success. This article promotes the idea of disruptive innovation creating business opportunities in Nigeria. Exploiting solar energy business opportunities appear to be the vehicle through which such a disruptive approach might succeed in Nigeria and elsewhere in the African continent.

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