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Building Sustainability and Resilience in the Nigerian Power sector – A case study of the Rural Electrification Agency (REA)

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ABSTRACT

The Architecture Engineering Construction Operational (AECO) industry has experienced challenges following the recent recession and COVID-19. As a result, this sector experienced a massive reduction of construction and infrastructure projects as investors are more cautious with capital investments and disruptions to existing projects caused by the restrictions to the movement of people and goods.

With the increasing global population, more construction and infrastructure projects will be required to support the new normal's growing demands, especially in developing countries like Nigeria.

The Rural Electrification Agency (REA) is an organisation launched by the Federal Government of Nigeria to provide electricity to rural areas of the country. Having delivered numerous off-grid power stations that use renewable energy, the REA has launched several new initiatives, including the Economic Sustainability Plan (ESP), to support Nigeria's response to economic recovery following the COVID-19 pandemic. The ESP aims to build five million new solar-based connections in areas not connected to the national grid.

This paper will explore how three policies led to creating the REA and how the REA projects can create opportunities for the AECO industry in Nigeria.

Keywords: Sustainability, circular economy, climate change, built environment, and new normal

INTRODUCTION

Electricity is used extensively in all sectors of the economy to produce goods and services. A country's living and economic development standard is mainly linked to its electricity consumption (Monyei, Adewumi et al., 2018). Therefore, a country or region must have adequate energy availability and understand and meet the energy demand of the population (Trotter, McManus et al., 2017). Electricity is the most widely used form of energy. It is used predominantly in residential homes to provide power for refrigeration, lighting, and other household appliances and in commercial properties and industries for powering equipment in addition to the previously stated uses (IEA 2021). However, many developing countries, including Nigeria, are still unable to provide adequate and sustainable energy to their population, which is required to improve their living standards and drive economic growth (Agbo, Edet et al. 2021, Iyke 2015, Akpan 2015).

Nigeria's population has more than doubled between 1990 to 2020 from 95 million to 200 million (IEA 2020). This substantial increase in population has increased urbanisation and demand for electricity. Figure 1 shows that just under 60% of the country's total population is connected to the electricity grid. However, the electricity from the national grid is characterised by high unreliability and frequent power outages that can last for weeks or even months (Ayodele, Ogunjuyigbe et al., 2021). In addition, the high rate of urbanisation has resulted in increased energy consumption as demand for goods and services rise; therefore, the need for the construction of infrastructure to generate and supply electricity becomes crucial in creating a built environment with access to reliable, resilient, and sustainable electricity (Trotter, McManus et al. 2017).

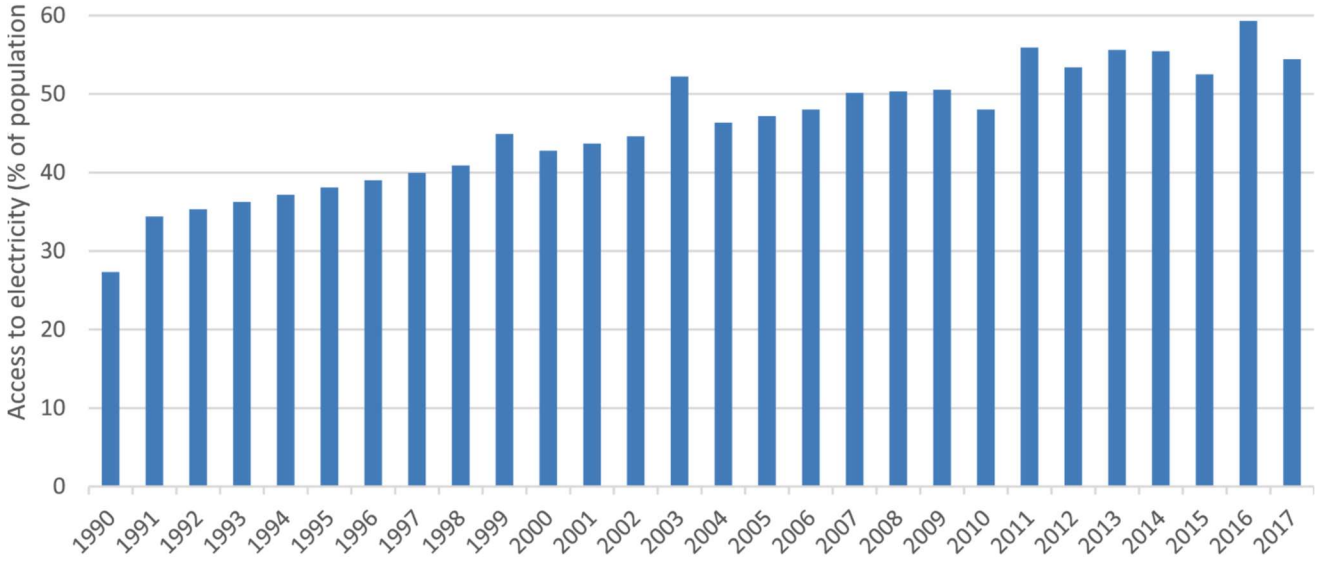

Figure 1 Access to electricity (% of the population) (Ayodele, Ogunjuyigbe et al. 2021)

COVID-19 has increased the need for electricity as certain vaccines need to be stored under specific temperatures, and electricity is needed to do this. Furthermore, the pandemic has also caused a change in people's behaviour as many people had to work and study remotely during the lockdown. Therefore, an increased effort must be channelled to generation and transmission expansion projects to assess if the objectives of construction projects will yield the intended outcome based on the new normal's demands to avoid wasting capital and effort.

Generation Expansion Planning (GEP) and Transmission Expansion Planning (TEP) are the two common types of power system expansion planning. GEP and TEP help assess the feasibility of obtaining the desired outputs from building new generation power plants or new transmission facilities due to the high capital investments required for these types of projects (Hemmati, Hooshmand et al. 2013, R. Bent, G. L. Toole 2012).

GEP has always attracted more focus from investors and consumers due to the high investment required to increase energy production. The investment planning in GEP

should consider the following factors: timeframe, new generation units technology, size, investment recovery, risks to ensure that the investors have a good return on their capital and that the end consumers are satisfied. The main objective in GEP is increasing the present power system to fulfil increased future demand by achieving the reliability criteria (Hemmati, Hooshmand et al., 2013).

Bent R., Toole G. L. 2012, Jinxiang Zhu, Mo-yuen Chow 1997 have acknowledged the benefits of conducting a combined transmission and generation expansion planning. Historically, TEP and GEP were conducted independently due to computational challenges in jointly solving both simultaneously. However, with the current situation in Nigeria and the cost of implementing TEPs, it is recommended that more focus is placed on off-grid electrification projects while the more complex TEPs are in progress to provide electricity to the communities that are currently not served by the national grid.

This paper will explore the impacts of nine electricity policies in Nigeria between 2001 and 2020 to determine their contributions to electricity generation and supply. It will also explore how three of these policies led to the creation of the REA, which launched several initiatives, including the Economic Sustainability Plan (ESP), to support Nigeria's response to economic recovery following the COVID-19 pandemic. The ESP aims to build five million resilient new solar-based connections in areas not connected to the national grid. This creates an opportunity for the Nigerian AECO companies as more infrastructure will be required to support this initiative.

The Rural Electrification Agency (REA) and Economic Sustainability Plan (ESP)

The REA was launched in 2005 to provide electricity to rural areas and communities not currently served by the national grid as stated in the following three policies: the National Energy Policy (NEP) 2003, the Electric Power Sector Reform Act (EPSRA) 2005, and the Rural Electrification Strategy and Implementation Plan (RESIP) 2016 (REA 2021).

Figure 2: REA's achievement as of 31 May 2021 (REA.gov.ng)

Since the inception of the REA, it has completed many electrification projects, including deploying seven mini-grids and over 6,000 Standalone Solar Home Systems (REA 2021), as shown in Figure 2. Furthermore, most of the power stations built by the REA utilise renewal energy sources, thereby demonstrating resilience and sustainability. In addition,

the REA has several ongoing programmes funded by the World Bank and the African Development Bank AfDB (REA 2021).

In 2020, the Federal Government of Nigeria (FGN) launched the Economic Sustainability Plan (ESP) to drive economic recovery following the COVID-19 pandemic. The ESP aims to roll out five million new solar-based connections to rural communities and areas not grid-connected under the Solar Power Naija initiative. The program is projected to create a seven billion naira increase in tax revenues annually and USD10 million in yearly import substitution (REA 2021).

Key outputs of the ESP's Solar Power Naija project include:

I. Provide electricity via Solar Home Systems (SHS) to twenty-five million individuals / five million homes, or via connection to a mini-grid

II. Encourage the growth of the local manufacturing industry by assisting the off-grid solar value chain

III. Facilitate the establishment of two hundred and fifty thousand new jobs in the energy sector

The REA is also working on a specific Covid 19 recovery initiative. This project is part of the World Bank-funded Nigeria Electrification Programme Solar Hybrid Mini-Grid Component (REA 2021). The intended outputs of the REA's Covid 19 recovery project include:

I. The provision of suitable power supply for equipment needed for testing and treating COVID-19 related cases such as ventilators, cooling systems, etc. via the provision of electricity to provide sustainable and clean energy power
II. A functional modular design to provide essential services for emergency operations
III. Stable supply of water via solar water pump systems for the designated facilities
IV. Increase energy efficiency by retrofitting electrical appliances in the selected facilities to more energy-efficient appliances to minimise power consumption.

These initiatives will increase electricity access to unconnected areas in Nigeria and provide opportunities for the AECO projects to build the supporting infrastructure.

METHOD

A mixed-method (Qualitative-Quantitative) methodology was adopted to include a combination of literature review and research surveys while using both quantitative and qualitative approaches to analyse the data collected to validate the findings from the different sources (Weinberg 2002). Mixed-method research has been defined as a philosophically underpinned model of inquiry combining qualitative and quantitative research models so that evidence may be mixed and knowledge is increased in a more meaningful manner than either model could achieve alone (Creswell 2014). Following a

comprehensive review of the literature and Nigerian electricity policies, several Subject Matter Experts from the Nigerian Power Industry were identified through purposive sampling to participate in the survey. As a result, 78 experts participated in the survey with experience and knowledge of the Nigerian Power Industry, such as researchers, energy service providers, policymakers, financiers, and modellers.

The questionnaire survey was designed to validate, prioritise, and perform further analyses on the statements. The first part of this research involved a critical literature review of nine existing Nigerian Government policies on electricity to determine how they had contributed to national electrification. Past and current issues in electricity generation and supply were identified and critically examined. In the study of nine Electricity policies developed between 2001 and 2020 in Nigeria, respondents from the Nigerian electricity industry were asked to identify which policy(s) contributed to an increased electricity generation and supply in the country.
Participants were also asked to rank nine policies based on how they increased electricity generation or supply in Nigeria. The results of these questions were analysed using quantitative methods.

The survey participants were further asked to explain how the policies contributed to the power sector and their recommendations of how future policies can be improved. Finally, the results from these questions were coded and analysed using qualitative methods. The electricity policies within the scope of this study are briefly described below:

National Electric Power Policy (NEPP), 2001
This marks the first step in the electricity sector reform. The NEPP defined three stages of achieving the reformation of the power sector. The first step was the privatisation of NEPA and the introduction of the Integrated Power Producers (IPPs) of electricity (Emodi, Ebele 2016).
National Energy Policy (NEP), 2003
The policy's primary goal is to create energy security through a robust combination of energy sources, thus resulting in sustainable development and environmental conservation. The NEP also promotes off-grid and standalone systems to supply electricity to remote areas of the country, thus improving rural electrification. (Emodi, Ebele 2016).
National Power Sector Reform Act (EPSRA), 2005
This act was established to liberalise the Nigerian power sector by providing a new legal and regulatory framework resulting in the unbundling and privatisation of the power sector. It was intended to introduce competition in the electricity market, enhance rural electrification, develop performance standards and protect consumer rights (Emodi, Ebele 2016).
Renewable Energy Master Plan (REMP) 2005
This plan sets out a road map for increasing the use of renewable energy in achieving sustainable development in Nigeria and points out the need to incorporate renewables in

buildings, electricity, and off-grid electrical systems. Furthermore, it emphasises the significance of solar power in the country's energy mix (Emodi, Ebele 2016).

Renewable Electricity Policy Guidelines (REPG), 2006

This policy mandated the FGN to expand electricity generation in the country from renewable energy sources to at least 5% of the total electricity generated and a minimum of 5 TWh of the electricity generation in the country by 2016 (Emodi, Ebele 2016). RE is considered to extend electricity services to areas not yet connected to supply sources and presents the government's plans, policies, strategies, and goals for promoting renewables in the Nigerian power sector (Emodi, Ebele 2016).

Multi-Year Tariff Order (MYTO I), 2008

The MYTO 1 was developed as a fifteen-year roadmap towards cost-reflective tariffs. The first two stages, 2008-2011 and 2012-2017 were intended to retain low consumer prices through a gradual price increase. The final regime is intended to deliver the necessary incentives to operate and maintain electricity infrastructure for power producers and investors (Emodi, Ebele 2016).

Multi-Year Tariff Order (MYTO II), 2012

The MYTO 2 included some enhancements and was intended to review the retail tariff in MYTO 2 bi-annually. As a result, amendments may be made for all electricity generated at wholesale contract prices, adjusted for the Nigerian inflation rate, daily generation capacity, US$ exchange rate, and accompanying actual CapEx and OpEx requirements that will change from those used in the previous tariff calculation (IEA 2017, Emodi, Ebele 2016).

Nigerian Electricity Regulatory Commission Mini-Grid Regulation, 2016

The Mini-Grid regulation was adopted in 2016 to regulate a mini-grids sector and design a suitable environment for further investments to speed up the nation's electrification process. In this document, a mini-grid is described as a system capable of generating electricity with a generation capacity between 0 kW and 1MW and supplying power to more than one customer (IEA 2017).

Rural Electrification Strategy and Implementation Plan (RESIP), 2016

The RESIP defines a roadmap for expanding access to electricity rapidly and cost-effectively to rural areas of the country. It considers utilising on-grid, off-grid and standalone systems for electricity supply with subsidies focused on expanding access rather than on consumption (Emodi, Ebele 2016).

The results of the survey and their implications are discussed in the next section of this paper.

RESULTS AND DISCUSSION

The availability of stable and sustainable electricity remains an issue in Nigeria. It is estimated that the Federal Government of Nigeria (FGN) committed an enormous USD16 billion investment for restoring the electricity sector from 1999 to 2017 (Akuru, Onukwube et al., 2017). In addition, there are several initiatives in progress to increase Nigeria's electricity generation and expand the national grid.

The results of the surveys showed the Nigerian Electricity Regulatory Commission Mini-Grid Regulation 2016, the Rural Electrification Strategy and Implementation Plan (RESIP) 2016, the National Power Sector Reform Act (EPSRA), 2005 contributed the most to an increased electricity generation and supply in Nigeria between 2001 and 2020 as shown in Figure 3.

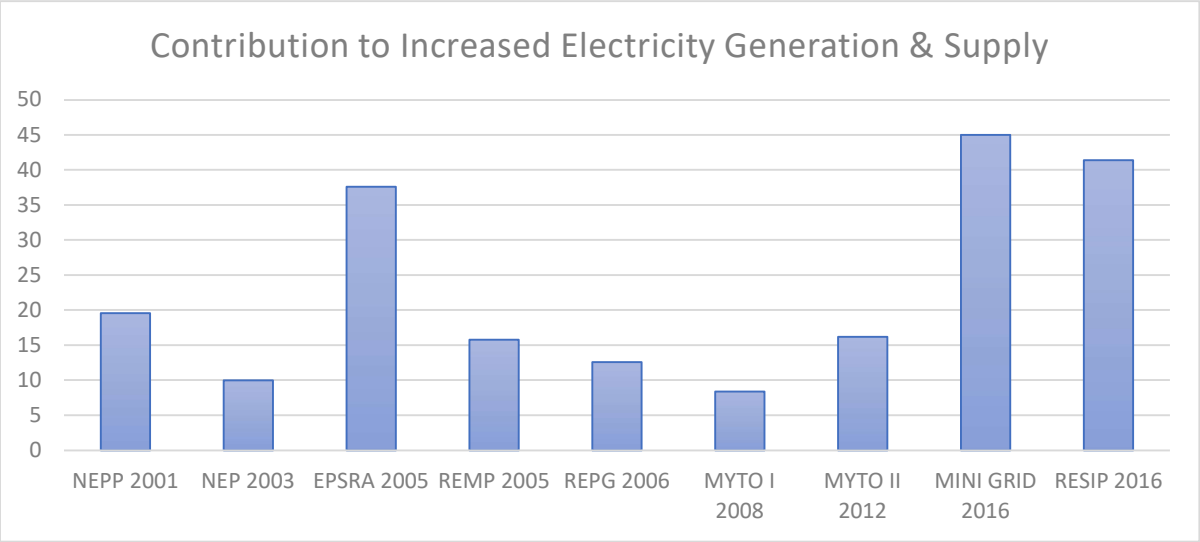

Figure 3: Nigerian Electricity Policy that has contributions to increased electricity generation and supply between 2001 and 2020

Further examinations showed that they were ranked for the following reasons shown in Figure 4, with an increase in rural and off-grid electrification scoring the highest.

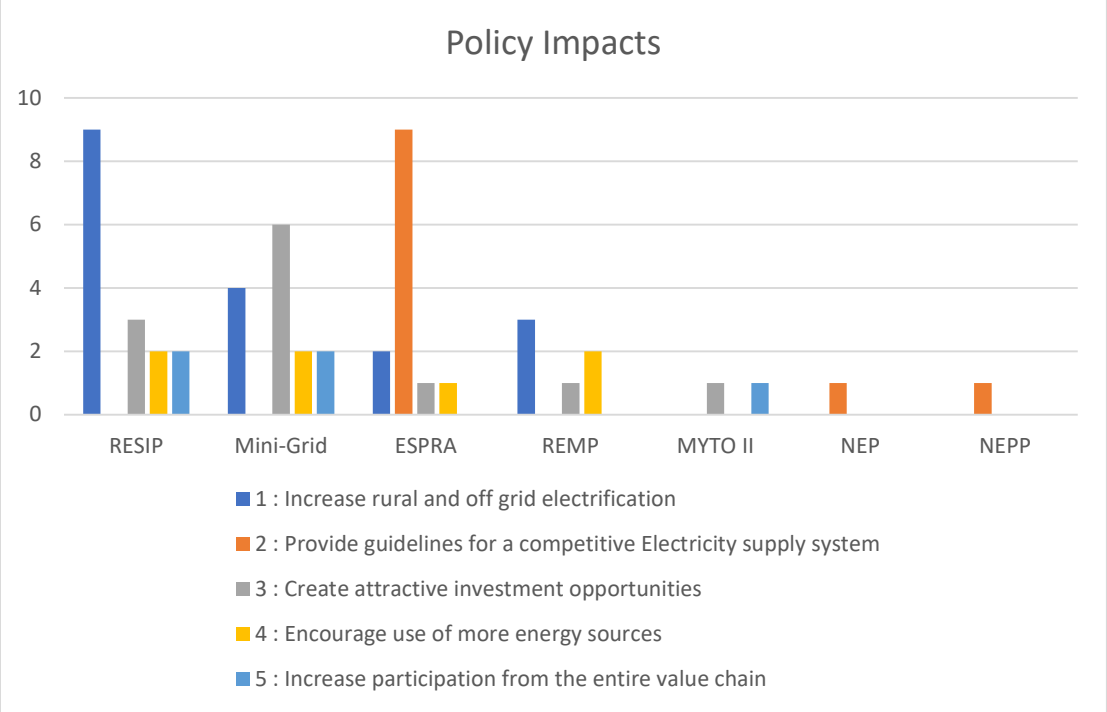

Figure 4 How nine policies have contributed to increased electricity generation and supply

This implies that the policymakers and the government should encourage more forms of electricity generation independent of the current grid or continue with the current grid expansion programs to support 100% electrification of the country. Findings from the study have recommended that the Nigerian electricity sector policy and decision-makers improve electricity generation and supply by creating more attractive investment opportunities, involving subject matter experts and participants from the entire value chain, encouraging the implementation of current policies, supporting the enhancement of the regulation of the power sector, increasing rural and off-grid electrification, localising policy designs, utilising more energy sources, and developing local skills to build a more sustainable and resilient electricity sector as shown in Figure 5.

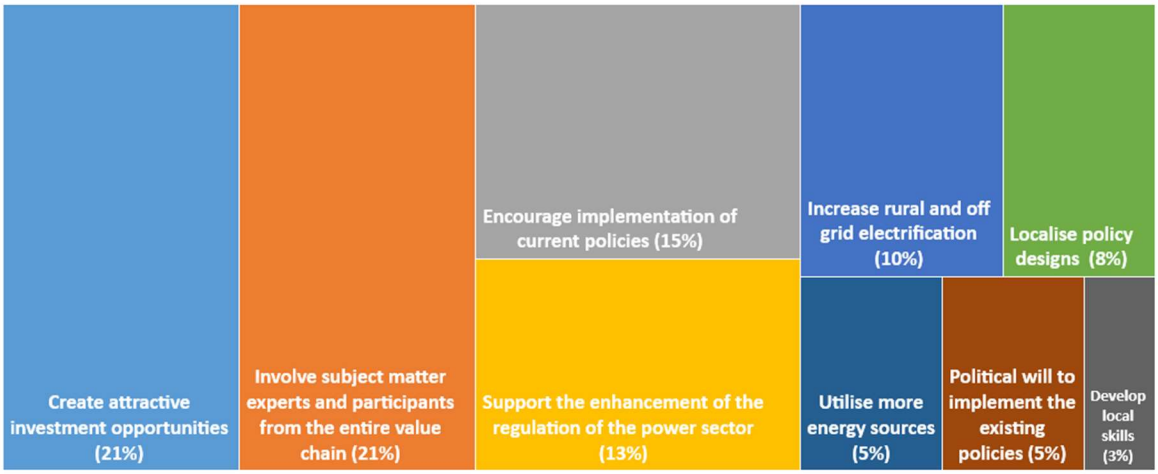

Figure 5 Recommendations of future policies to improve electricity and supply in Nigeria

CONCLUSIONS

Nigeria's electrical grid supplies about 60% of the population, which is inconsistent and inadequate. As a result, most households in Nigeria use generators or solar panels to generate electricity. However, they still require more reliable, affordable, resilient, and sustainable sources of electricity.

With off-grid solar electricity, households can access direct electricity and transition into cleaner and renewable energy sources. Developing countries like Nigeria must have sufficient electricity to drive economic growth and meet the growing population's demands. With climate change and global warming, it is advised that policy and decision-makers in Nigeria consider using more renewable energy sources in the development of future electricity generation to drive sustainability and resilience in the sector.

This paper reviewed the impacts of nine electricity policies in Nigeria between 2001 and 2020 to determine their contributions to electricity generation and supply. The RESIP and the Mini-grid policies came out as the top-performing policies. Finding from the survey of

the policies found that the nine policies contributed to the electricity generation and supply in Nigeria by (a) increasing rural and off-grid electrification, (b) providing guidelines for a competitive Electricity supply system, (c) creating attractive investment opportunities, (d) encouraging the use of more energy sources, (e) increasing the participation from the entire value chain. However, despite the effort of the Nigerian government, sufficient electricity supply remains a challenge in the country.

The RESIP is one of the policies that led to creating the Rural Electrification Agency (REA). Since its inception, the REA has launched several initiatives, including the Economic Sustainability Plan (ESP), to support Nigeria's response to economic recovery following the COVID-19 pandemic. The ESP aims to build five million new solar-based connections in areas not connected to the national grid. This creates an opportunity for the Nigerian AECO companies as more infrastructure will support this initiative.

It is anticipated that the findings from this paper can help the Nigerian electricity sector policy and decision-makers to create attractive investment opportunities, involve subject matter experts and participants from the entire value chain, encourage implementation of current policies, support the enhancement of the regulation of the power sector, increase rural and off-grid electrification, localise policy designs, utilise more energy sources, and develop local skills to build a more sustainable and resilient electricity sector.

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