Will a Transition to Renewable Energy Promote Energy Security Amid Energy Crisis in Nigeria?

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7.1 Introduction

The economic growth and industrial development of several countries have over century depended on energy resources, of which conventional energy such as oil, gas and coal primarily characterized early production and supply of such resources. This scenario of an overly dependence on conventional energy sources (CES) and its revenue is still a typical tendency of most countries in transition to economic prosperity today and can be seen well in African countries such as Nigeria. Although there are various efforts on the African continent to embrace clean energy, the anticipated increase in demand for fossil fuels to meet the estimated increase in population growth and boom in urbanization cannot be

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1 Dieter Helm, *Burn Out: The Endgame for Fossil Fuels* (Yale University Press 2017).

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There is, however, a growing shift from over-reliance on fossil fuels-oriented economies to very low-carbon economies as a remarkable development worldwide. This development recognized as energy transition and defined as a structural move from the production and use of predominant energy sources and technologies to more energy sources, is now at the mainstream national, regional and international policy agendas.

Essentially shaped by ‘socio-economic development, technological innovation, and policies’, energy transition has provided most countries with potential opportunities to promote energy security, mitigate climate change, and foster sustainability-related goals. Most of it all, it is perceived as a promising solution with pathways to fast-track fossil fuel decarbonization, using new regulation and policy-based new technologies and business models. Thus, if it is increasing decarbonization of the energy systems, and support for utilizing cleaner and affordable renewable energy sources (RES) such as wind, hydro, biomass and solar. Likewise, advancement in technologies has sufficed to support carbon capture, floating solar photovoltaic, electric cars, hydrogen fuels for refining oils, and bio-refineries for processing quality-based biofuels. The development is also accompanied by a paradigm transition in energy governance and has been mainly spurred by declining social and political acceptance of fossil fuels.

The idea of energy transition supporting energy security is beginning to attract attention and support in Nigeria. This is true given existing ambitious government policy objectives aimed at power generation from renewables. Nigeria’s renewable energy transition efforts are, however,
more transparent in principle rather than as a practical reality. The existence of untapped abundant renewables spotted in every part of the country is axiomatic of her dysfunctional renewables-based energy transition. Nevertheless, substantial progress can be seen in the exploitation of hydropower to support the national grid system. The reality, in any case, is that power generation in Nigeria is still at a trifling point, indicating a short capacity for the country. Therefore, it has become a critical issue of concern as to whether transitioning to renewable energy can promote energy security to abate Nigeria’s regular power crisis.

The primary aim of this chapter is to examine the potential of renewables for sustainable power generation in Nigeria. The rationale for it has arisen given the need for a transition from an overly reliance on fossil fuels to renewable-sourced electricity (RES-E), as a way of mitigating power crisis to ensure energy security in particular. The study, following an introduction, provides background information on Nigeria’s renewable energy-based transition. This understanding is followed by a discussion of renewable energy prospect for energy security in the country. The next section examines how renewables development challenges can be overcome, using inclusive and effective policy measures. Overall, a summary has been provided in the conclusion section.

7.2 Energy Security in Energy Transition Regime: The Case of Nigeria

The idea of energy security which has expanded from a mere supply of oil to a relatively broad range of global issues,\(^6\) underpinning various conditions from a technical and theoretical perspective,\(^7\) and embracing ‘availability, affordability, accessibility, and acceptability’\(^8\) is now typically

\(^6\)Daniel Yergin, ‘Ensuring Energy Security’ (2006) 85(2) Foreign Affairs, 69–82; Jonathan Elkind, ‘Energy Security: Call for a Broader Agenda’. In C. Pascual and J. Elkind (eds), Energy Security: Economics, Politics, Strategies, and Implications (Brookings Institution Press, 2009) 119.

\(^7\)Felix Ciuta, ‘Conceptual Notes on Energy Security: Total or Banal Security?’ (2010) 41(2) Security Dialogue, 123–144.

\(^8\)Alicia Altagracia Aponte (ed), A Quest for Energy Security in the 21st Century: Resources and Constraints (APERC 2007).
a global concern. However, in Nigeria, it is more a great, unique challenge cutting across upstream, midstream and downstream issues. The power sector has either been confronted by regular low performance or a complete failure to deliver desired capacity, mainly due to related economic and political barriers. This does not, in any sense, translate to having little or no energy resources in Nigeria. There are both abundant CES and renewables. The major problem remains that oil and gas are a dominant source of power generation and national income. The effect of which has been manifest in energy crisis and economic losses of different proportions. The condition of power crisis is characteristically now unsurprising a lifestyle to which many Nigerians are accustomed.

There are relative, differing accounts on power generation capacity in Nigeria. This divergence can be attributed to the typically dynamic nature of power itself, and most often generation-supply-connected technicalities. However, a most recent report from Nigerian Electricity Regulatory Commission (NERC) indicates that power generation, as at the third quarter of 2019 was 5093 MW at a peak per day, with an increase of the average generation up to 6709 MW during the same period. This figure is well below a hypothetically estimated daily requirement of roughly 180,000 MW of electricity. The current daily electricity generation has also been anecdotally confirmed to reflect last year’s average daily figure of the quarter in view. But gas alone accounted for 74.63% of the total generation, which implies its dominance in the

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9Gbeminiyi M. Sobamowo and Sunday J. Ojolo, ‘Techno-Economic Analysis of Biomass Energy Utilization through Gasification Technology for Sustainable Energy Production and Economic Development in Nigeria’ (2018) Journal of Energy, 1–16.

10Abubakar Sadiq Aliyu, Joseph O. Dada and Ibrahim Khalil Adam, ‘Current Status and Future Prospects of Renewable Energy in Nigeria’ (2015) 48 Renewable and Sustainable Energy Reviews, 336–346.

11Sunday Olayinka Oyedepo, ‘Energy and Sustainable Development in Nigeria: The Way Forward’ (2012) 15(2) Energy, Sustainability and Society, 1–17.

12Nigerian Electricity Regulatory Commission (NERC), Quarterly Report (Third Quarter, 2019) 24.

13Roseline Okere, ‘Nigerians Require 180,000 mw of ELECTRICITY’ The Guardian (20 September 2017), https://guardian.ng/energy/nigerians-require-180000mw-of-electricity/, accessed 20 April 2020.
power generation and supply mix.\textsuperscript{14} To put it in a more mathematical perspective, electricity generated from gas in the third quarter of 2019 was approximately 3801 MW of the total 5093 MW per day. The NERC, in effect, has expressed a concern that gas dominance in power generation heralds a grave security implication of energy supply for Nigeria. Gas prioritization is unsurprising because of its comparative efficiency and low-carbon emissions,\textsuperscript{15} richness and cost-effectiveness in terms of gas-fired power plants, but such dominance reveals a weakness in the power generation structure.\textsuperscript{16}

Though unsurprisingly, demand for power currently exceeds supply as the majority of Nigerians lack access to electricity, even amid predominant conventional energy resources exploitation. The United States Agency for International Development (USAID) in its fact sheet indicates that about 45\% of Nigerians have access to the national power grid, with a lack of unequal access among rural and urban dwellers.\textsuperscript{17} This population also faces persistent power outage in unequal real times. Besides, it has been shown that about 20 million people are unconnected to the national electricity grid.\textsuperscript{18} The increasing population growth in Nigeria, and the ongoing global coronavirus disease (COVID-19) pandemic\textsuperscript{19} are likely to impact her electricity generation efforts adversely to perceptible slower progress.

\textsuperscript{14}NERC Quarterly Report (n 11) 29.

\textsuperscript{15}Martin Lambert, ‘Decarbonization of Gas’ (2020) OIES Paper 121, at 29, Oxford University.

\textsuperscript{16}Chukwueyem S. Rapu and others, ‘Analysis of Energy Conditions in Nigeria’ (2015) CBN Occasional Paper No. 55, https://www.cbn.gov.ng/out/2017/rsd/analysis\%20of\%20energy.pdf, accessed 20 April 2020.

\textsuperscript{17}USAID, ‘Nigeria: Power Africa Fact Sheet’, https://www.usaid.gov/sites/default/files/documents/1860/Nigeria_-_November_2018_Country_Fact_Sheet.pdf, accessed 9 April 2020.

\textsuperscript{18}Ibid.

\textsuperscript{19}The usual practice by which Nigeria translates her crude oil into usable economic product focuses on exportation-re-importation cycle process. Therefore, Nigeria's electricity sector efforts are likely to be affected by the ongoing COVID-19 pandemic if the country is unable to export her crude oil for refinement and re-importation for local use due to containment lockdown measures of overseas governments or countries especially in countries where such refinement is usually done. Besides, production contracts and supply chain-related contracts in the energy or electricity sector are also likely to be impacted if performance is rendered impracticable, as either contracting party may raise a force majeure excuse. The impact may be short-term, depending on how long the pandemic lasts.
There have been different efforts made by Nigeria, and in some cases with international support for the renewable energy-based transition. The government, both present and past have, in different policy instruments acknowledged the increasing role of renewables especially in overcoming national power crisis and supporting global agendas such as climate change mitigation and sustainable development goals (SDGs). Through ambitious National Renewable Energy and Energy Efficiency Policy (NREEEP) and National Renewable Energy Action Plans (NREAP), both of which were approved in 2015 and 2016, respectively, Nigeria set robust objectives to diversify energy resources choices, achieve national energy security and energy efficiency, ensure ‘adequate, reliable, affordable, equitable and sustainable’ development and supply of renewables in an environmentally sound manner. The NERC has a target for at least 2000 MW of renewable electricity by the end of 2020, and in 2015 established a feed-in-tariff (FIT) mechanism.\(^{20}\) As part of international supports, the European Union (EU) and the German Federal Ministry for Economic Cooperation and Development (BMZ) co-financed Nigerian Energy Support Programme (NESP), launched in 2013 to support renewable energy investments.\(^{21}\) The World Bank, in addition, financed renewable-based rural electrification under the Power Sector Recovery Programme (PSRP).\(^{22}\) The government efforts also reflect in the international initiative, seeking to address equitable and affordable access to modern energy resources, particularly agenda 7 of the United Nations (UN) SDGs. A true reflection of which is the adoption of sustainable energy for all (SE4All) Action Agenda by the Nigeria National Council on Power (NACOP) in July 2016. These efforts have either shown little or no result. Thus, energy security issues in Nigeria

\(^{20}\)NERC, ‘Renewable Energy Sourced Electricity’, https://www.nerc.gov.ng/index.php/home/operators/renewable-energy, accessed 7 April 2020.

\(^{21}\)Déborah Giusy Londoño Londoño, ‘Human Security and Nigeria’s Energy Crisis’ (IAI Commentaries 18–49, September 2018), https://www.iai.it/sites/default/files/iaicom1849.pdf, accessed 20 April 2020.

\(^{22}\)World Bank, *Upscaling Mini-grids for Low Cost and Timely Access to Electricity. Energy Sector Management Assistance Program* (Washington: World Bank Group, 2017).
are primarily at the heart of availability, affordability, sustainability\textsuperscript{23} and acceptability. The SDG 7 on affordable and clean energy emphasizes the need to enhance energy access through equitable use of clean renewables. Thus, energy access is a correlative function of energy security because availability, affordability and sustainability create a condition for energy access, which is a major priority to be addressed at all levels\textsuperscript{24} just like energy security itself. Therefore, Nigeria lacks the bedrock for achieving SDG 7 on energy access, given its level of energy insecurity.

Nigeria’s intended nationally determined contribution (INDC) within the framework of the 2015 Paris Climate Change Agreement (PCCA) is centred on greenhouse gas emission reduction, of which 20\% reduction is unconditional and 45\% conditional with international support. The key measures for achieving which include efforts to end gas flaring well into 2030, promote 13 GW off-grid solar photovoltaic equivalent to 13,000 MW, and reinforce reforestation-based climate-smart agriculture. However, it is not clear how such contribution can be achieved in the face of heavy reliance on fossil fuels, and undue disregard to logical exploitation of modern energy resources. Thus, Nigeria’s INDC primary objective of promoting access to electricity for all, economic and social development, and standard of living is highly likely to be impacted by a lack of adequate deployment of renewable energy to support national energy mix. There is no doubt that actions taken to drive INDCs by nations such as Nigeria, will count as an all-first significant step towards a low-emissions trajectory.\textsuperscript{25}

\textsuperscript{23}Fubara Susan Amiesa, Omowumi Iledare and Onyije Israel, ‘Assessing the Economic Implication of Energy Insecurity in Nigeria’ (IAEE 40th International Conference, Singapore, June 2017).

\textsuperscript{24}Victoria R. Nalule, \textit{Energy Poverty and Access Challenges in Sub-Saharan Africa: The Role of Regionalism} (Palgrave Macmillan 2019)

\textsuperscript{25}Jim Herbertson, ‘The Oil and Gas Industry, Low-Emission Pathways, and the Energy Transition’ (2020) OIES Paper 121, at 9, Oxford University.
7.3 Forms and Prospects of Renewables for Energy Security in Nigeria

There are various forms of RES in Nigeria. The potentials of such resources have become a subject of great interest in several efforts and studies from both government and individual investigators. Though findings indicate axiomatic evidence of substantial share of RES, most of which have only made a tiny fraction of energy mix in the country, as represented in Fig. 7.1.

The foregoing evidence of low utilization of renewables lends credence to an earlier finding that natural gas dominates Nigeria’s power mix. This makes for an assumption to argue that government power generation efforts have focused on increasing investments in natural gas development and gas-fired plants increase. The government perhaps relies on gas as a convenient low-risk approach to energy security, especially as a growing market for liquefied natural gas (LNG) alongside technological improvement, has become a trend.\(^{26}\) This is despite potential investments and market demand opportunities for renewables in Nigeria.

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\(^{26}\) Occhiali Giovanni and Falchetta Giacomo, ‘The Changing Role of Natural Gas in Nigeria: A Policy Outlook for Energy Security and Sustainable Development’ (2018) Fondazione Eni
Ominously, over-reliance on gas-fired power, and as noted in page 4 by NERC does not only raise resource monopoly concern but also even intensifies energy insecurity. Therefore, ensuring a well-balanced sustainable national grid system operation, which fosters an acceptable degree of energy security requires a good deal of energy mix, including different forms of renewables. For Nigeria, renewable energy has a promising solution to the energy crisis for energy security, and such primary potential energy sources are examined hereunder.

7.3.1 Hydro Power

The location of Nigeria in Africa and on the world map offers good environmental conditions for harnessing sufficient hydropower. There exist several exploitable big and small rivers, including streams dispersed in most states.\(^27\) The most exciting thing is that the available rivers offer good sites for large and small hydropower projects, which are likely to serve urban dwellers and the most often isolated rural inhabitants.\(^28\) Nigeria is also typically characterized by regular incidences of significant natural rainfall. This can be harnessed with support from modern technology to generate electricity.

The potential of hydro sites in the country has attracted both policy and research attention. Existing research shows enormous opportunities in most states for unexploited small hydropower, with a predictable overall capacity of 3500 MW, of which only about 64.2 MW is currently exploited.\(^29\) The evidence further indicates that both rivers and streams in Nigeria have a potential to provide 70 micro dams, 126 mini dams and 86 small sites for generating an estimated capacity of 11,250 MW, but only about 17% is exploited under the prevailing energy regime.\(^30\)

\(^27\)Ismaila Haliru Zarma, ‘Hydro Power Resources in Nigeria’ (International Centre on Small Hydro Power 2nd Hydro Power for Today Conference, Hangzhou, 2006).

\(^28\)Ibid.

\(^29\)GET.invest, ‘Nigeria: Renewable Energy Potential’, https://www.get-invest.eu/market-information/nigeria/renewable-energy-potential/, accessed 5 April 2020.

\(^30\)Ibid.
total installed hydropower capacity is, nonetheless, around 2380 MW.\textsuperscript{31} Besides, one research evaluated hydro potential in Nigeria to be as much as 8824 MW, with a yearly electricity generation potential in excess of 36,000 GWh, of which large hydropower makes up 8000 MW and small hydro technology accounts for 824 MW.\textsuperscript{32} Electricity from hydro in the third quarter of 2019 accounted for about 25.37% of the total daily national power generated.\textsuperscript{33} Based on available statistics, about three major hydropower plants are currently in operation in Nigeria, as represented in Table 7.1.

There are yet different ongoing hydropower projects in Nigeria, apart from the represented hydropower stations currently in full operation. The Mambilla hydropower project, located in Kakara village in Taraba State with an estimated 3050 MW of electricity is in progress. This project is expected for completion in 2030, as Nigeria’s largest and one of Africa’s biggest hydropower stations. There also exists for completion, a Zungeru hydropower dam located on the Kaduna River in Niger State, which is projected to have a capacity of 700 MW. The Zungeru hydro project started in 2013 but has been adversely delayed for commissioning due to unaddressed social-legal issues, and a new date for commencement is expected in 2021. There are further under-developed Gurara I and Gurara II projects in Kaduna State, and Kashimbila in Taraba State. These hydropower projects have expected capacities of 30 MW, 360 MW, 40 MW and 40 MW, respectively.

\begin{table}[h]
\centering
\begin{tabular}{llll}
\hline
S/N & Name     & Installed capacity (MW) & Completion year & Location     \\
\hline
1   & Kainji Dam & 960            & 1968          & Niger State  \\
2   & Jebba Dam  & 540            & 1984          & Niger State  \\
3   & Shiroro    & 600            & 1990          & Niger State  \\
\hline
\end{tabular}
\caption{Current hydropower plants in operation}
\end{table}

\textit{Source} Constructed by the author

\textsuperscript{31}USAID (n 16).
\textsuperscript{32}John-Felix K. Akinbami, ‘Renewable Energy Resources and Technologies in Nigeria: Present Situation, Future Prospects and Policy Framework’ (2001) 6 Mitigation and Adaptation Strategies for Global Change, 155–182.
\textsuperscript{33}NERC Quarterly Report (n 11).
The history of power generation may see hydro to have contributed significantly to electricity supply in Nigeria. But in reality, hydro resource availability has not as possible been fully exploited as visible, especially when considering an increased demand for electricity in the country. Thus, much investment is needed in hydro technology, at least, small hydropower systems. The Federal Government of Nigeria is poised to continue to increase a share of power from hydro, with a target to generate roughly 6156 MW by the end of 2020.\footnote{IHA, ‘Nigeria: Nigeria Statistics’, https://www.hydropower.org/country-profiles/nigeria, accessed 9 April 2020.} This will require robust institutional, technological and financial commitments, in addition to addressing related critical investment barriers.

### 7.3.2 Solar Energy

The sun may be considered the world’s greatest sky-based natural power plant, especially for some countries well-positioned geographically. Though solar energy appears to be the oldest source of power,\footnote{UI Ndaceko and others, ‘Solar Energy Potential in Nigeria’ (2014) 5(10) International Journal of Scientific and Engineering Research, 594–598.} technology for harnessing it is not as old as the resource itself. Technology has only recently emerged to support solar energy utilization, and a wide range of it including photovoltaic, solar heating, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis provide humanity with a great opportunity to fully maximize solar potential. The sun, however, can be felt naturally on human health and livelihoods without any technological processes of capturing and conversion. This can also have wide natural implication for different agricultural purposes.\footnote{JK Yohanna and VI Umogbai, ‘Solar Energy Potentials and Utilisation in Nigeria Agriculture’ (2010) 2(3) Journal of Environmental Issues and Agriculture in Developing Countries, 10–21.}

There is the presence of radically aggressive sunlight in Nigeria, replete with the huge solar energy potential of relatively daily distributed radiation circa 19.8 MJ m\(^2\) on average.\footnote{GET.invest (n 25).} The average sunlight at interval
is 6 hours per day, and possible concentrated solar power and photovoltaic is roughly 427,000 MW. More evidence shows that Nigeria’s entire solar energy landmass coverage is 120,000 times electricity generated for consumption in the country in 2002. The use of solar modules or collectors to cover, at least, 1% would potentially generate $1850 \times 10^3$ GWh of solar energy yearly, a capacity which is 100 times electricity consumed currently in the country. The geography of Nigeria is generally solar promising, yet a function of seasonal weather as is relatively likely elsewhere. The country at large relatively experiences solar intensity. The northern part, for example, experiences the extreme intensity of the sun, with longer daily hours of sunlight. The following Fig. 7.2 shows Nigeria’s level of global horizon irradiation (GHI), which by critical analysis, offers substantial evidence of exploitable solar energy in the country.

The use of solar for power generation is visibly slow in Nigeria, despite her proven solar energy potential. This situation, in addition to an overall poor power generation, has seen individuals struggling to adapt to off-grid solar power. Thus, more progress can be seen in the deployment of photovoltaic technology among some corporate institutions and households able to afford any associated costs. This scenario is a reflection of government’s unwinding political will and commitment.

The availability of exploitable solar in Nigeria, even amid government’s indifference has become a great subject of interest in several studies. Fagbenle assessed the desirability or otherwise of applying solar energy to air, road, sea, rail, including military transportations. The economic benefits of solar apart from power generation can be widely felt in several other sectors such as agriculture, engineering, medical sciences

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38 Ibid.
39 GENI, ‘How is 100% Renewable Energy Possible for Nigeria?’ , http://geni.org/globalenergy/research/renewable-energy-potential-of-nigeria/100-percent-renewable-energy-Nigeria.pdf, accessed 24 April 2020.
40 Chigasa C. Uzoma and others, ‘Renewable Energy Penetration in Nigeria: A Study of the South-East Zone’ (2011) 1(5) Continental J. Environmental Sciences, 1–5.
41 RL Fagbenle, ‘Prospects and problems of solarising transport technology’ (1991) 2(1) Nigerian Journal of Renewable Energy, 85–88; RL Fagbenle, ‘Estimation of Total Radiation in Nigeria Using Meteorological Data’ (1990) Nigerian Journal of Renewable Energy, 1–10.
42 Ibid.
One study conducted by Yohanna and Umogbai specifically assessed both solar energy potential and the extent of its application to Nigeria's agricultural sector. The authors demonstrated extensive, conventional use of solar energy for various agricultural purposes. There is an underlying argument that solar energy is a catalyst for economic development in Nigeria, and anchor-energy due to its support for

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43 OI Okoro and TC Madueme, ‘Solar Energy: A Necessary Investment in a Developing Economy’ (2004) 23(1) Nigerian Journal of Technology, 58–64.
44 Yohanna and Umogbai (n 32).
45 Okoro and Madueme (n 39).
tapping other renewables.  

A recent study demonstrates that a unit cost of electricity from stand-alone photovoltaic systems is less costly, as opposed to the cost of widely utilized imported diesel generators.

Therefore, economic viability exists for solar energy in Nigeria. This makes for an assumption that an effective harnessing of a substantial amount of disposable solar energy in the country can provide electricity to both urban and rural dwellers. This can be crucial for power decentralization and access localization. There is no doubt that deploying solar technology to support off-grid and on-grid electricity generation would make a significant impact on Nigeria’s economy and citizens’ well-being. This could be a reality with the government’s recent launch of $75 million in funds to generate electricity for her teeming population.  

The government will, nevertheless, need to show a clear political will to scale solar energy technology, and also address challenges to its investments.

### 7.3.3 Wind Energy

Technology has proven wind to be an economic power-based resource globally, which is relatively ubiquitous. The presence of wind can be naturally felt in every state of Nigeria. This sensation does not, in any sense mean wind viability for power generation in every state. The concern to evaluate wind potential coupled with unjustifiable regular short capacity made wind a great subject of interest, reflecting in efforts from both government and researchers, but little has been done to commercialize it. On a basic level, some analyses have only focused

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46 Ikponmwosa Oghogho and others, ‘Solar Energy Potential and its Development for Sustainable Energy Generation in Nigeria: A Road Map to Achieving this Feat’ (2014) 5(2) International Journal of Engineering and Management Sciences, 61–67.

47 Chiemeka Onyeka Okoye, Onur T aylan and Derek K. Baker, ‘Solar Energy Potentials in Strategically Located Cities in Nigeria: Review, Resource assessment and PV System Design’ (2016) 5(C), Renewable and Sustainable Energy Reviews, 550–566.

48 JP Casey, ‘Electrifying Nigeria: Could Solar Power One Million Households?’ (Power Technology, 20 January 2020), https://www.power-technology.com/features/electrifying-nigeria-could-solar-power-one-million-households/, accessed 14 April 2020.

49 Oluseyi O. Ajayi, ‘Assessment of Utilisation of Wind Energy Resources in Nigeria’ (2009) 37 Energy Policy, 750–753.
on wind characteristics in some states,\textsuperscript{50} while others assessed wind energy technology potential,\textsuperscript{51} challenges to, and solution for effective deployment of such technology.\textsuperscript{52}

The economic viability of wind energy at a core height of 65 metres up from a ground level with a yearly average wind speed of 5.36 m/s was conducted at Umudike, a semi-urban settlement in Ikwuano Local Government Area (LGA) of Abia State, based on a 10 year (1994–2003) wind speed data.\textsuperscript{53} Fadare, using Weibull distribution function and daily wind speed data from 1995 to 2004, performed a statistical assessment of wind energy potential in Ibadan, Oyo State capital, which shows an average wind speed of 2.943 m/s,\textsuperscript{54} while a study carried out by Adekoya and Adewale to assess wind speed using data from 30 states in Nigeria, reveals that annual average wind speed and power fluidity densities range from 1.5 to 4.1 m/s and 5.7 to 22.5 W/m\textsuperscript{2}.\textsuperscript{55} Fagbenle and Karayiannis earlier performed a 10-year data assessment from 1979 to 1988, which considered surface and upper wind, including the maximum guts.\textsuperscript{56} One study, unlike many others, focused on a review of research developments on onshore and offshore wind energy potentials as well as research for developing, designing, and applying small-scale wind energy turbines for electricity generation in Nigeria, and on the other hand, evaluated the

\textsuperscript{50}JO Ojosu and RI Salau, ‘A Survey of Wind Energy Potential in Nigeria’ (1990) 7(2–3) Solar & Wind Technology, 155–167.
\textsuperscript{51}NA Idris and others, ‘Nigeria’s Wind Energy Potentials: The Path to Diversified Energy Generation-Mix’ (2013) 2(4) International Journal of Modern Engineering Research, 2434–2437.
\textsuperscript{52}AA Oyedeji and others, ‘Wind Energy Technology in Nigeria: Prospect, Challenges and Solution’ (2018) 2(2) Covenant Journal of Engineering Technology, 52–58.
\textsuperscript{53}AD Asiegbu and GS Iwuoha, ‘Studies of Wind Resources in Umudike, South-East Nigeria: An Assessment of Economic Viability’ (2007) 2(10) Journal of Engineering and Applied Sciences, 1539–1541.
\textsuperscript{54}DA Fadare, ‘A Statistical Analysis of wind Energy Potential in Ibadan, Nigeria, Based on Weibull Distribution Function’ (2008) 9(1) Pacific Journal of Science and Technology, 110–119.
\textsuperscript{55}LO Adekoya and AA Adewale, ‘Wind Energy Potential of Nigeria’ (1992) 2(1) Renewable Energy, 35–39.
\textsuperscript{56}RL Fagbenle and TG Karayiannis, ‘On the Wind Energy Resource of Nigeria’ (1994) 18(5) International Journal of Energy Research, 493–508.
desirability of various geographical sites for onshore and offshore wind energy generation.\textsuperscript{57}

The wind potential in Sokoto State alone is as high as 97 MWh yearly.\textsuperscript{58} Besides, harvestable potential wind exists in offshore areas of Lagos, Ondo, Delta, Rivers, Bayelsa, and Akwa Ibom States in a year-round.\textsuperscript{59} Generally, annual wind speed at 10 m up from ground level varies from 2.3 to 2.4 m/s for seaside sites, and 3.0 to 3.9 m/s for semi-arid regions including high land areas with observed poor wind speeds in the southern part of Nigeria, except offshore and littoral regions.\textsuperscript{60} The northern hilly regions are branded with extremely strong wind, whereas fairly exploitable wind energy can be seen in the steep topographies of the middle belt and northern fringes.\textsuperscript{61} The wind speed values range from 1.4 to 3.0 m/s in the north and 4.0 to 5.12 m/s in the far northern part, at 10 m height.\textsuperscript{62} The months of April to August account for peak wind energy speed.\textsuperscript{63}

To a quite level of difference, another study indicates that wind speed in the northern and southern regions measures between 4.0–7.5 m/s and 3.0–3.5 m/s, respectively, and of 10 m above from ground level is significant to generate accessible power for a good number of the Nigerian population.\textsuperscript{64} Similarly, states within the sea lying areas have high wind speed sufficient for power generation.\textsuperscript{65} The north is considered one of the most strategic areas for wind technology\textsuperscript{66} because of its promising energy potential of about 8.70 m/s wind speed. Though initial studies

\textsuperscript{57}O Adedipe, MS Abolarin and RO Mamman, ‘A Review of Onshore and Offshore Wind Energy Potential in Nigeria’ (2018) 413 IOP Conference Series Materials Science and Engineering, 1–8.

\textsuperscript{58}GENI (n 35).

\textsuperscript{59}Oluseyi O. Ajayi, ‘The Potential for Wind Energy in Nigeria’ (2010) 34(3) Wind Engineering, 303–312.

\textsuperscript{60}GENI (n 35).

\textsuperscript{61}Ibid.

\textsuperscript{62}Ajayi (n 56).

\textsuperscript{63}GENI (n 35).

\textsuperscript{64}Ajayi (n 56).

\textsuperscript{65}JO Okeniyi, OS Ohunakin and ET Okeniyi, ‘Assessments of Wind-Energy Potential in Selected Sites from Three Geopolitical Zones in Nigeria: Implications for Renewable/Sustainable Rural Electrification’ (2015) 15 Scientific World Journal, 13.

\textsuperscript{66}GENI (n 35).
show that a real utilizable wind energy reserve at 10 m height may vary from 8 MWh to 51 MWh per year in Yola and Jos, respectively, and as high as 97 MWh yearly in Sokoto at 10 m height value increase. To a very relative extent, existing findings show evidence of possible exploitable wind energy in Nigeria. But no single evidence exists to show that wind energy is currently a source of power generation in the country. The first and only efforts to harness wind energy manifested in the 1960s, when a few stand-alone wind energy plants were installed in 5 northern states mainly to power water pumps and a 5 kW wind power conversion machine for power supply at Sayyan Gidan Gada, Sokoto State. \(^{67}\)

### 7.3.4 Biomass

The nature of biomass resources makes it a likely enviable RES globally. They are extremely low in carbon emissions and cost-effective, comparing it with other renewable technologies. Biomass can also make a large proportion of energy resources mix. Electricity, liquid biofuels and biogas from a variety of biomass feedstock depend on a wide assemblage of practices taken. \(^{68}\) There are a wide variety of biomass resources in Nigeria, making it a highly studied zone for biomass production potential. These resources can be grouped as ‘agricultural resources, crop resources, forestry resources, urban wastes and other wastes’. \(^{69}\) Urban wastes and other wastes could be industrial and non-industrial wastes as well as a large chunk of wastes from rural areas. The good news, however, is that wastes of any kind remain an important feedstock for clean energy generation. The daily biomass production in Nigeria is around 227,500 tons, which could possibly make up 6.8 million m\(^3\) of biogas. \(^{70}\) But in a

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\(^{67}\)CE Nnaji, CC Uzoma and JO Chukwu, ‘The Role of Renewable Energy Resources in Poverty Alleviation and Sustainable Development in Nigeria’ (2010) 3 Continental Journal of Social Sciences, 31–37.

\(^{68}\)Juliet Ben-Iwo, Vasilije Manovic and Philip Longhurst, ‘Biomass Resources and Biofuels Potential for the Production of Transportation Fuels in Nigeria’ (2016) 63 Renewable and Sustainable Energy Reviews, 172–192.

\(^{69}\)Ibid.

\(^{70}\)GET.invest (n 25).
more general perspective, it contributes roughly 78% to national energy consumption as primary energy.\textsuperscript{71}

The government’s interest in biofuels production from agricultural crops had only become manifest in 2007 when it introduced Bio-Fuel Policy and Incentives.\textsuperscript{72} There exist other research on biomass potential for electricity generation in Nigeria, despite a lack of interest from the government to harness its potential. Based on findings, Nigeria’s cultivable agricultural landmass covers about 71 million ha, which is about 77% of the country’s total area of 923,770 km\textsuperscript{2},\textsuperscript{73} of which 37.3% is arable land,\textsuperscript{74} with over 12.6 million active agriculturists.\textsuperscript{75} There is a massive potential for high energy content crops such as cassava, sugar-cane, sorghum and corn in Nigeria, due to a fair availability of water and cultivable arable lands.\textsuperscript{76} These crops are considered the most promising feedstock for biofuel production in the country.\textsuperscript{77} There are also other energy crops such as oil palm, wheat, soya beans, rice, groundnuts, beans grown in the country, including cost-effectively viable feedstock substrates for biogas like water lettuce, water hyacinth, dung, cassava leaves, sewage, etc.\textsuperscript{78}

Existing research shows evolving bio-refineries in Nigeria utilize unsustainable first-generation biomass feedstock from food crops, which

\textsuperscript{71}AA Sokan-Adeaga and GR Ana, ‘A Comprehensive Review of Biomass Resources and Biofuel Production in Nigeria: Potential and Prospects’ (2015) 30(3) Rev Environ Health, 143–162.

\textsuperscript{72}See, the Federal Republic of Nigeria, Official Gazette of the Nigerian Bio-Fuel Policy and Incentives 2007, http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/laws/1517.pdf, accessed 14 April 2020.

\textsuperscript{73}FAO, ‘AQUASTAT Country Profile 2016–Nigeria’, www.fao.org/3/i9807en/l9807EN.pdf, accessed 14 April 2020.

\textsuperscript{74}Ben-Iwo, Manovic and Longhurst (n 64).

\textsuperscript{75}FAO, ‘Country Fact Sheet 2016’, www.fao.org/nr/water/aquastat/data/cf/readPdf.html?f=NGA-CF_eng.pdf, accessed 14 April 2020.

\textsuperscript{76}Nelson Abila, ‘Biofuels Adoption in Nigeria: A Preliminary Review of Feedstock and Fuel Production Potentials’ (2010) 21 Management of Environmental Quality an International Journal, 785–795.

\textsuperscript{77}GET . invest (n 25).

\textsuperscript{78}John-Felix K. Akinbami and others, ‘Biogas Energy Use in Nigeria: Current Status, Future Prospects and Policy Implications’ (2001) 5 Renewable and Sustainable Energy Reviews, 97–112.
compete with food. The government needs non-food biomass feedstock to harness renewable energy, which is crucial for sustainable biofuel. This is also crucial to avoid counter-productive efforts that would adversely impact the agricultural sector, and lead to food insecurity, especially if we factor in the increasing impacts of climate change on agriculture. Crop residues, which could be on-farm burnt or leftover materials or industrial by-products from processed crops, are enormous in Nigeria. Their usefulness can vary in terms of density, moisture content, site and source of origin, a period of harvest, and harvesting technique. But whether field-based primary residues produced in the course of harvest or industrially processed as secondary residues, both have a potential for renewable energy generation. These resources have simply been underutilized. Local farmers in most cases, convert such residues into locally prepared organic manure in place of artificially produced fertilizer.

Economically, forestry as a source of biomass can substantially contribute to a country’s power source. There is revealing evidence from research that about 9.5% of Nigeria’s total land is covered by forest. The southern part of the country is characterized by tropical rainforest forest, while Sahel savannah exists in the north. The rain forest produces greater woody biomass, unlike savannah forest that mainly produces crop residues. Throughout Nigeria, the forest is seen, and a larger part of it is under government reserve, but is not always adequately protected and conserved. Forest residues remain under-exploited in Nigeria, but most

79 Ben-Iwo, Manovic and Longhurst (n 64).
80 Ibid.
81 Ibid.
82 Moses Hensley Duku, Sai Gu and Essel Ben Hagan, ‘A Comprehensive Review of Biomass Resources and Biofuels Potential in Ghana’ (2011) 15 Renewable and Sustainable Energy Reviews, 404–415.
83 Osakue Jessy Osaghae, ‘Potential Biomass-Based Electricity Generation in a Rural Community in Nigeria’ (Masters thesis, Luleå University of Technology 2009)
84 KJ Simonyan and O Fasina, ‘Biomass Resources and Bioenergy Potentials in Nigeria’ (2013) 8(40) African Journal of Agricultural, 4975–4989.
85 Yekini Suberu Mohammed and others, ‘Renewable Energy Resources for Distributed POWER Generation in Nigeria: A Review of the Potential’ (2013) 22 Renewable and Sustainable Energy Reviews, 257–268.
86 Ben-Iwo, Manovic and Longhurst (n 64).
local communities instead use much of her biomass resources such as firewood or charcoal for lighting, cooking, heating and meeting related-households needs in unsustainable practices. There is a lack of knowledge among rural people about the health implication of local practices of utilizing forest residues. The government needs to prioritize the forest as a means of economic revenue and clean power generation. This must be supported with clear legal and regulatory frameworks and strong institutions that foster government objectives and enhance forestry knowledge amount the citizens, especially the local people.

Technologically, waste-to-energy (WTE) conversion has become an increasing approach to power generation, especially for countries with a significant amount of wastes. There is a large chunk of wastes or biomass in Nigeria, which can be found in larger expanse in major cities where households consumption and industrial and commercial activities are regularly, increasingly higher. The government’s approach of getting rid of such wastes by open burning has been a major state practice instead of utilizing it for biofuel generation. Such practice is pointedly anti-climate and environmentally unsound in terms of pollution or emission of greenhouse gases. The production of biogas from wastes is known to bring immediate benefit. This benefit can be extensive as biogas is characterized by adaptable technology likely to be scaled at household, industry and community levels. Thus, tapping Nigeria’s enormous wastes by employing modern technology for WTE could bring tremendous social and economic benefits. This will not only contribute significantly to power generation but also offer crucial by-products such as fertilizer for supporting and enhancing agricultural productivity, as well as ensuring effective sanitary practice.

There is no gainsaying as to whether biomass remains an overlooked energy resource in Nigeria. The truth is simple. There is a lack of interest among states and national governments to utilize such resources. For instance, a 5.5 MW biomass gasifier power plant owned by United Nations Industrial Development Organization (UNIDO), and formally

87Mofoluwake M. Ishola and others, ‘Biofuels in Nigeria: A Critical Strategic Evaluation’ (2013) 55 Renewable Energy, 554–560.
88Ibid.
located at UNIDO Mini-industrial cluster in Ekwashi Ngbo in Ebonyi State, which was acquired by Ebonyi State government in 2016, but has no place of siting much less of being utilized is clearly an illustration of a lack of government’s interest in biomass utilization.

7.4 Overcoming Renewable Energy Development Challenges in Nigeria

Though Nigeria has enormous renewables, translating such resources into a meaningful, sustainable economic wealth and power have proved unrealistic. This scenario can be attributed to critical multi-dimensional constraints, in addition to a lack of genuine political will, weak and corrupt institutions, and overly reliance on fossil fuels. The current energy market is monopoly-driven, and as such, remains one greatest barrier to the energy transition process and energy security pathway in Nigeria. There are government policies to support renewable energy deployment, yet none is effective because such policies support mere objectives not regulated under any known legal framework. The electricity generation and supply sectors have not adequately been open to competition, and energy investors have continued to enjoy a significant degree of monopoly over them. The predominant tendency of the Nigerian government in overhauling the power sector has focused on privatization, an entirely different unbundling energy policy concept, which in reality does not create desired competition.

There are different impediments to RES-E development. Pueyo and others have provided useful insights into barriers to RES-E, especially in developing regions like Nigeria. The authors have grouped such barriers as economic and financial, regulatory and political and technical,

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89 Tamara Posibi, ‘Biomass in Nigeria: An Overview’ (BioEnergy Consult, 11 March 2020), https://www.bioenergyconsult.com/biomass-energy-in-nigeria/, accessed 14 April 2020.
90 Hugo Lucas, Pablo del Rio and Mohamed Youba Sokona, ‘Design and Assessment of Renewable Electricity Auctions in Sub-Saharan Africa’ (2017) 48(5–6) IDS Bulletin, 79–100.
91 A Pueyo and others, ‘Green Growth Diagnostics for Africa: Literature Review and Scoping Study’ (2015) IDS Working Paper 455, https://opendocs.ids.ac.uk/handle/20.500.12413/6168, accessed 20 April 2020
which are argued to be more severe in developing countries. Though unsurprisingly, RES-E development projects in developing countries have inherent challenges, which include:

- a higher capital cost which can be intensified by cost discrepancies in funding,
- perceivable higher risks likely to raise the cost of financing and equity share in a project’s funding arrangement,
- lack of suitably domestic equity finance and debt finance maturity, in particular, of private equity, and
- overall, low prices of generated RES-E, which can constrain cost recapture.

There are other several studies that have identified detailed constraints to RES-E. Traditionally, power project is always capital-intensive. Therefore, for the government, it is an unbearable financial burden, especially on budgets. The risks extend to other different types of interlaced constraints involving:

- construction, operation, foreign exchange and country risks,
- off-taker risk.

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92Ibid.
93Ibid.
94Rainer Quitzow and others, ‘The Future of Africa’s Energy Supply: Potentials and Development Options for Renewable Energy (2016) IASS, https://publications.iass-potsdam.2016.008, accessed 20 April 2020.
95Antonio Castellano and others, ‘Electric Power and Natural Gas: Brighter Africa: The Growth Potential of the Sub-Saharan Electricity Sector’ (2015) McKinsey and Company, https://www.mckinsey.com/~/media/Mckinsey/~/mckinseydotcom/client_service/EPNG/PDFs/Brighter_Africa-The_growth_potential_of_the_sub-Saharan_electricity_sector.ashx, accessed 20 April 2020.
96Quitzow and others (n 90).
97Anton Eberhard and others, Independent Power Projects in Sub-Saharan Africa: Lessons from Five Key Countries (Washington, DC: World Bank 2016).
electricity sector structure often controlled by single, state-owned utilities accountable for a sizable share of generation, transmission and distribution,98
weak grids induced technical limitations,99 and finally,
low tariffs and a large volume of required investments.100

Essentially, any country desirous of deploying a sizable amount of renewables must address these risks through appropriate energy policy and market strategy-based incentives. For Nigeria, appropriate energy policy would need to focus on a redesigned, fully liberalized competitive power market, one that considers competitors in both generation and supply sectors, in addition to remedying critical barriers highlighted above through various incentives. The liberalization process will create an entry point for scaling energy transition regime and overcoming challenges hampering effective renewable energy deployment in Nigeria, and as a process will remove monopoly right and introduce competition and choice of energy providers at competitive prices for energy consumers. The choice of energy itself and the availability of different energy sources is an underlying characteristic of the energy transition. The whole aim of liberalization, however, may not initially focus on price minimization, but at least to encourage new entrants or investors, and or to generate additional funds for investments, since Nigeria does not have existing sufficient capacity to meet demand.

The introduction of competition into the power market is, by implication, an invitation to investors. But investors indeed need an acceptable level of regulatory and political certainty or are otherwise interested in understanding what regulatory and political risks exist in, or characterize a particular energy market. Currently, Nigeria lacks an affirmative legal framework supporting the implementation of government objectives on energy mix. This, coupled with energy-related political instability and rights-based social malady, serves as one of the challenges to renewable

98Climatescope, ‘The Clean Energy Country Competitiveness Index’ (Bloomberg New Energy Finance, 2017), http://2017.global-climatescope.org/en/download/insights/climatescope-2017-energy-transition.pdf, accessed 18 April 2020.
99Eberhard and others (n 93); Quitzow and others (n 90)
100Lucas, del Rio and Sokona (n 86)
energy development in the country. For this challenge to be overcome, a well-crafted, robust, stable and transparent legal framework must be put in place to address certain market conditions and risks as well as investments into renewables. The provisions of any legal framework can only become effective if an interaction exists between such framework and strong institutions. There is a need for policy consistencies across a range of institutions manned with the role of energy resources management and regulation, and to make clear government’s renewable energy strategy and targets, price outlook and processes for contracts standards. By political and policy implication, lending support to investors by the government is key to effective and viable renewable energy investments. This should be augmented through axiomatic government’s Ease of Doing Business (EDB). The World Bank’s 2020 EDB report\(^\text{101}\) shows progress for Nigeria, but a significant gap exists. Therefore, much is needed by the government to improve on its global ranking.

The relative new growth of renewable energy technologies, excluding hydro, is seriously considered a constraint to their deployment. The viability of some renewable technologies is still technically unproven, and as such, attracts risks uncertainty. This means investor’s intrinsic risk perception of particular technologies depends on renewable deployment or maturity.\(^\text{102}\) Renewable energy technologies deployed at a scale in long term and of different backgrounds, tend to show an acceptable degree of certainty.\(^\text{103}\) To overcome this challenge, it has been suggested that wide deployment of relative renewable technologies be undertaken simultaneously to enable operational testing within different operational environments, and under some conditions of operation so as to provide strong reliability, availability and equipment lifespan information. There are many RES available in different parts of Nigeria, which can be relatively deployed. Accordingly, some renewable technologies such as hydro, solar, biogas, onshore wind, offshore wind and biomass have been argued

\(^{101}\)World Bank Group, ‘Doing Business 2020: Comparing Business Regulation in 190 Economies’, https://openknowledge.worldbank.org/bitstream/handle/10986/32436/9781464814402.pdf, accessed 4 May 2020.

\(^{102}\)Pueyo and others (n 87).

\(^{103}\)Ibid.
to have low and medium technical risks. Nigeria has a significant amount of some of these renewables and can be effectively deployed.

The identified different barriers to RES-E undertaking can be justified by the choice of different energy mix policies.\textsuperscript{104} There are different policy tools identifiable to address such barriers.\textsuperscript{105} The most often applied option, in particular, for economic and financial barriers are FITs and feed-in-premiums (FIPs).\textsuperscript{106} The mechanism of FITs allows for a complete payment per MWh of generated RES-E by way of guaranteed prices, and as a combination of a procurement requirement by the utilities.\textsuperscript{107} FIPs are usually a payment granted on the wholesale market price of electricity per kWh.\textsuperscript{108} The former has been used in a number of African countries such as Ghana, South Africa, Kenya,\textsuperscript{109} although mixed feelings indicate that it only provided a small fraction of investments in these countries, remarkably, renewable energy auction has emerged as a very increasingly important mechanism to foster electricity generation from renewable sources.\textsuperscript{110} Most countries are now adopting it as an appealing option to address barriers to RES-E investments, given its success in South Africa and beyond.\textsuperscript{111} Defined as a ‘process in which a good or several goods are offered up for bidding’, the auction offers a procurement mechanism by which an auctioneer buys a ‘good’, in this context, RES-E from bidders offering the best bid such as least support level.\textsuperscript{112} There is an underlying argument that auction is advantageous over some kinds of administrative set-support mechanisms such as FITs.\textsuperscript{113} For example, the auction offers a higher level of transparency for support levels- market prices and limits support to

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\textsuperscript{104}Lucas, del Rio and Sokona (n 86) \\
\textsuperscript{105}Pueyo and others (n 87). \\
\textsuperscript{106}Lucas, del Rio and Sokona (n 86). \\
\textsuperscript{107}Ibid. \\
\textsuperscript{108}Ibid. \\
\textsuperscript{109}Ibid. \\
\textsuperscript{110}IRENA, \textit{Renewable Energy Auctions: Cases from Sub-Saharan Africa} (Abu Dhabi: IRENA 2018) \\
\textsuperscript{111}Lucas, del Rio and Sokona (n 86). \\
\textsuperscript{112}AURES, ‘About Auctions’, \url{http://auresproject.eu/about-auctions}, accessed 18 April 2020. \\
\textsuperscript{113}Lucas, del Rio and Sokona (n 86).
\end{flushright}
those granted in the auction. Furthermore, it reduces problem associated with information unevenness when remuneration levels are being set and are especially appropriate for the efficiency of allocation, cost control, expansion and technology mix.\textsuperscript{115}

The working condition of auction allows project developers to apply only when a call is made, as opposed to FITs in which application can be made anytime given its long-term open window.\textsuperscript{116} The efficiency level of the auction makes it the best alternative for the promotion of RES-E,\textsuperscript{117} a feature that has led to its massive adoption in over 67 countries globally.\textsuperscript{118} Given its convenience in developing countries, especially with regard to budget constraint,\textsuperscript{119} auction may prove to be useful in overcoming constraints to RES-E development in Nigeria, in addition to FITs and FIPs. The desirability of the auction, in particular, may, however, depend on specific renewable energy technologies, say photovoltaic due to its attractive features, as opposed biomass, and is likely to appeal to potential investors and decision-makers. But its success may depend on the design elements and supports offered to it by other policies.\textsuperscript{120}

The use of tax incentives could be extremely useful in driving renewable energy investments in Nigeria. Thus, certain renewables can receive tax grandfathering, or investors granted tax holiday. The USA has typically used tax incentives to support investments in renewables and boost returns.\textsuperscript{121} There is no doubt that tax incentive tool could be attractive for renewable energy projects, especially for the development of off-grid electricity in many remote parts of the country, where different renewables are scattered.

\textsuperscript{114}Ibid.
\textsuperscript{115}Marie-Christin Haufe and Karl-Martin Ehrhart, ‘Assessment of Auction Types Suitable for RES-E’ (2016) AURES Report D3.1
\textsuperscript{116}Lucas, del Rio and Sokona (n 86).
\textsuperscript{117}Ibid.
\textsuperscript{118}IRENA, \textit{Renewable Energy Auctions: Analysing 2016} (Abu Dhabi: IRENA, 2017).
\textsuperscript{119}S Stratt and others, ‘From Growth to Green Investment Diagnostics’ (2016) IDS Working Paper 472, https://www.ids.ac.uk/publications/from-growth-to-green-investment-diagnosicst accessed 30 April 2020.
\textsuperscript{120}Lucas, del Rio and Sokona (n 86).
\textsuperscript{121}Pueyo and others (n 87).
The resultant effect of unaddressed constraints—economic and financial, regulatory and political and technology would likely result in a lack of interest among investors. The rising of such behavioural disposition is remarkable, as an emerging constraint to renewable deployment. Therefore, behavioural constraint depends on whether or not other constraints have been addressed by the government. Basically, a good degree of confidence in policy and regulatory framework would suffice to assuage investor’s fear.

### 7.5 Conclusion

Logically, energy resources are the biggest gifts of nature to Nigeria. There are rich CES and RES, with renewables dispersed in every part of the country. The country’s renewables have only been relatively, marginally exploited. This is despite a lot of potential market opportunities and supportive government policies for renewable energy deployment. Today, it is clear to note that Nigeria is experiencing a resource curse, short capacity country notwithstanding her abundant energy resources. This scenario can be attributed to a handful of issues inherent in her current energy regime. There is no visible legal framework supporting government policy objectives for the effective renewable regime in Nigeria. As a matter of concern, a lack of effective renewable energy deployment questions her commitment to promoting SDGs and combating global climate change under the Paris Agreement.

The world is moving fast-forward to the energy transition that supports modern energy utilization, at least, for promoting energy security and access. The integration of renewable energy into the national grid system and mainstreaming of small-scale off-grid renewable energy technologies is critical for energy security, green economy and sustainable economic development in Nigeria. This will also offer numerous environmental co-benefits such as improvement in air quality, as well as create decent jobs for the citizens. The use of renewable energy technologies, at best, ensures energy efficiency and reduces greenhouse gas

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122 Pueyo and others (n 87).
emission. This cannot be realized by mere government policy objectives on renewable development without any robust legal framework supporting such objectives. The role of law and strong institutions are consequently critical to maintain an effective renewable energy regime. Legal framework is an important instrument to address critical issues of investor-state concerns, but especially for investors since the whole aim will be to attract new investments or create access for additional funds for investments in the power sector. The appropriate market strategy, and or policy will focus on incentives-liberalization within the role of a supportive regulatory framework.

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