ENTERPRISE DEVELOPMENT CENTRE
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Nigeria Climate Innovation Center

GREEN ECONOMY ECOSYSTEM MAPPING:

RENEWABLE ENERGY IN NIGERIA

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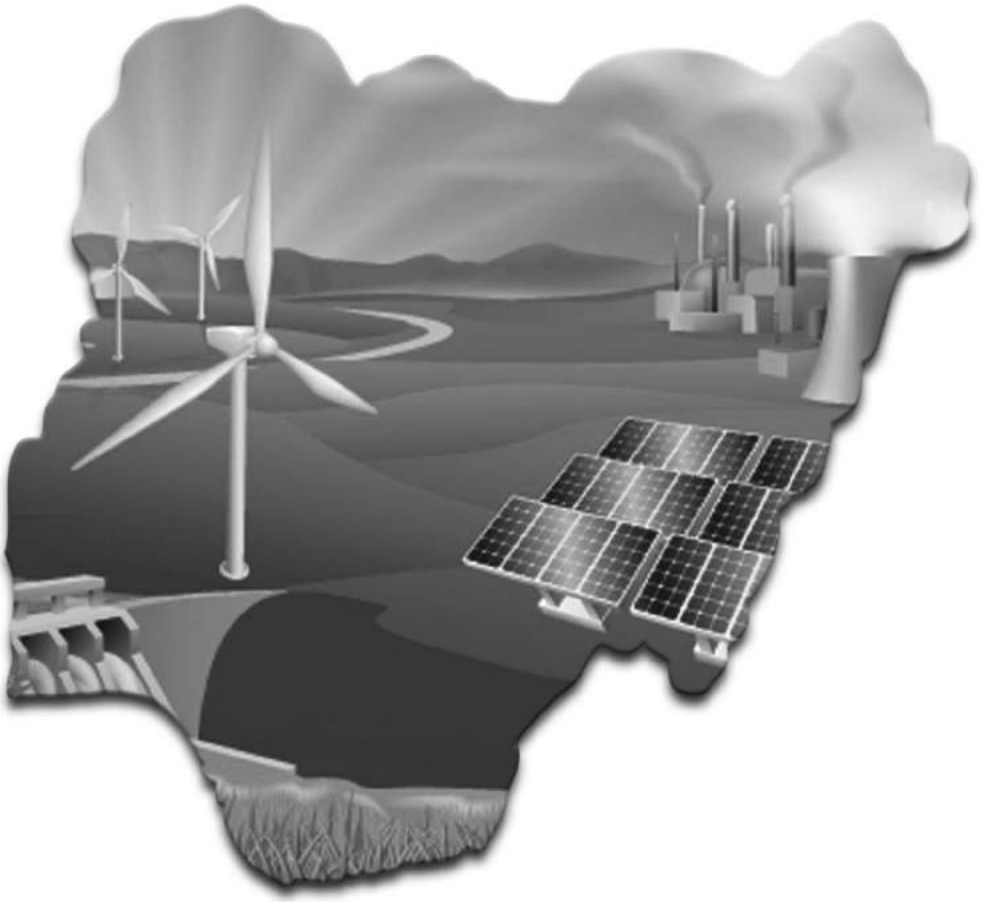

Green Economy Ecosystem Mapping: Renewable Energy in Nigeria.
Enterprise Development Centre, Pan-Atlantic University and Nigeria Climate Innovation Center, Nigeria.

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FOREWORD

I am delighted to present this mapping report on Nigeria's Green Economy Ecosystem, a partnership between Enterprise Development Centre, Pan-Atlantic University (EDC) and Nigeria Climate Innovation Centre (NCIC). This report 'Green Economy Ecosystem Mapping: Renewable Energy in Nigeria' is the first in the series of the ecosystem mapping. Other areas include Smart Agriculture, Water Solutions and Waste Management.

No doubt, the growing attention on the Green economy by both developed and emerging economies emphasizes the importance of the sector for sustainable development. Admittedly, the issue of 'going green' has not been adequately placed in the policy mainstream. Although various policies of the government are geared towards ensuring sustainable development, a clear understanding of what constitutes the Green space, the opportunities, challenges and policy implications will be of immense benefit to all stakeholders.

This report details results of desk research, ample and iterative engagements with major stakeholders supported by analytical appraisal from relevant data. Our expectation is that this study will provide information that is useful to every segment of the renewable energy ecosystem and industry stakeholders. It is hoped also that the recommendations in this report are a valuable contribution to the conversations within the ecosystem, encouraging Nigeria to maximize the many opportunities for profitable, sustainable and equitable socio-economic development.

Peter Bamkole
Director,
Enterprise Development Centre,
Pan-Atlantic University.

PREFACE

Nigeria which is unarguably Africa's largest economy has made great strides in positioning herself as a leader in green growth by exploring the adoption of a more circular and green approach in achieving economic growth and development. This has led notable development institutions, the academia, private sector and civil society, among other groups to partner with the Nigerian Government in building a robust green agenda with the primary aim of steering the country towards building resilience as it recovers from the Covid-19 pandemic.

The Nigerian green economy can be better understood through a well canvassed approach in identifying key green sectors and their players as well as stakeholders that make up the Nigerian Green Space in its entirety.

This document- Green Economy Ecosystem Mapping is a partnership between the Nigeria Climate Innovation Center (NCIC) and Enterprise Development Center (EDC) which seeks to provide key insights into the Nigerian Green Economy with Renewable Energy as an initial scope of study, while other sectors will be thoroughly mapped as well with the same objective in subsequent publications.

Furthermore, the mapping document will serve as a guiding tool and point of reference to new and existing players as well as industry enthusiasts who are constantly looking into ways of unlocking opportunities within the ecosystem, through reliable information carefully drawn from selected industry players, experts and resource persons. The expected outcome of this exercise would be to produce a more informed and disruptive Green Ecosystem that will birth sustainable innovation in driving green businesses while creating a cleaner and more sustainable country.

Bankole Oloruntoba
CEO,
Nigeria Climate Innovation Center

EXECUTIVE SUMMARY

The global green economy as at 2018 was worth roughly 4 trillion USD, overtaking the fossil fuel industry. Renewable energy, Waste Management, Water Solutions, and Smart Agriculture create value through multiple industry value chains, including agriculture, manufacturing, textiles, pharmaceuticals, hospitality, and so on. While past economic development has come at a great cost to environmental sustainability and social well-being, it has become obvious that economic and green development are not mutually exclusive.

The largest source of GreenHouse Gas (GHG) from human activities is from burning of fossil fuels for energy generation. Energy is utilized as electricity, heat and for transportation, powering all industries and daily life. This makes renewable energy a cornerstone in the green ecosystem. The global renewable energy market alone accounts for an estimated 928 billion USD. Innovation and technological development have made the cost of renewable energy (RE) generation by solar, wind, hydro and biofuels drop dramatically in the last decade, with the International Renewable Energy Agency (IREA) reporting an 82% decline in the global costs of solar photovoltaic equipment since 2010. This and other critical changes in global environmental policy means that clean energy has become more affordable and profitable than fossil fuels.

This mapping report provides critical information to aid stakeholders discern the optimal manner of conducting renewable energy businesses in Nigeria, through a succinct expository of the local conditions, regulatory environment, institutional frameworks and support systems that shape the business models of players in the ecosystem.

From the data collected and analysed, it is apparent that solar is the prevalent renewable energy resource utilized in Nigeria. Biofuels are on the rise, while hydro remains underutilized. The business models applicable for solar in Nigeria are explored in depth. Case studies are provided to give insight into the available opportunities for hydro and bio-fuel renewable energy businesses in Nigeria.

There is a global focus on investing in Nigeria's Green economy. This study identified the barriers to RE investments. The negative market perception of locally produced goods limits the market access of solar equipment assemblers. Skilled labour deficit limits the scaling feasibility. End user credit risks limit the financing opportunities of organizations who provide Green energy as a service, to reduce the upfront costs associated with installation of solar equipment. Policy risks including the competition from fossil fuel subsidy policies, unpredictable import policies, and other general national volatility contribute to making Nigeria a high-risk investment environment. This report outlines research based derisking instruments that may be applied by the government to cultivate a low-risk investment environment.

While advocates and associations work with the government to create infrastructures that establish stability and support the rapid growth of RE enterprises, all industry stakeholders can benefit from strategic partnerships for development. It is also critical to develop national and institutional indicator systems for monitoring and impact assessment of climate and RE policies, to contextualize the value of RE amongst policy makers, and incentivize long-term planning and investments.

Chapter 01

INTRODUCTION

INTRODUCTION

The United Nations Environment Programme (UNEP) defines a green economy as one that results in improved human well-being, and social equity, while significantly reducing environmental risks and ecological scarcity.[1] A major environmental risk faced globally is the increased concentration of heat-trapping greenhouse gases (GHG) in the atmosphere, which causes human-driven climate change; also known as global warming.[2] Beyond reducing carbon emissions, Resource-use efficiency and socially inclusive growth are significant aspects of the green economy.

Climate technologies are being developed to solve climate change challenges by mitigating GHG emissions, and creating mechanisms to cope with climate impacts. Various Green innovation facilitators[3] have been established globally, including the UNEP and World Bank supported Climate Innovation Centres. Climate Innovation Centres all around the world support the green economy, by facilitating research and development, advancing regulatory policy frameworks, supporting innovative green businesses by facilitating enterprise creation, enhancing access to financial support, and other business development services.[4]

The Nigeria Climate Innovation Centre (NCIC) provides support for Nigerian entrepreneurs that make up the national green economy. In the Nigerian context, the green economy ecosystem consists of ventures in Renewable Energy, Waste Management, Water Solutions, and Smart Agriculture. While technologies for Water Solutions and Smart Agriculture are meant to adapt to local climate change impacts, Renewable Energy and Waste Management technologies are targeted at mitigating GHG emissions and pollution.

Adaptation has tended to receive less attention than mitigation in global and national climate discussions alike, yet climate impacts are already evident and these trends are only likely to accelerate in the coming years. The NCIC supports climate change adaptation in Nigeria by facilitating innovation[4] for managing water stress through enhanced storage, conservation, and recycling, as well as for increasing the resilience of agricultural systems, including modified crops, improved cropping systems and practices, and land management.[5]

1. UNEP, Green Economy Reports: A Preview, 2010, p. 4-5
2. NASA's overview on Weather, Global Warming and Climate Change, accessed 09 Feb 2021. https://climate.nasa.gov/resources/global-warming-vs-climate-change/#:~:text=Climate%20change%20is%20a%20long,are%20synonymous%20with%20the%20term.
3. A 2010 report on Climate Innovation Centres reports up to 70 institutions have been established.
4. nigeriacic.org/our-events/
5. Climate Innovation Centres, infoDev, UNIDO and DFID, 2010 https://www.infodev.org/sites/default/files/climateinnovationcenters_fosterclimatetechnologies.pdf https://www.infodev.org/sites/default/files/climateinnovationcenters_fosterclimatetechnologies.pdf

Figure 1 Components of Sustainable Economies

The Green Business

The global green economy as at 2018 was worth roughly 4 trillion USD, overtaking the fossil fuel industry[6]. Renewable energy, Waste Management, Water Solutions, and Smart Agriculture create value through multiple industry value chains, including agriculture, manufacturing, textiles, pharmaceuticals, hospitality, and so on. While past economic development has come at a great cost to environmental sustainability and social well-being, it has become obvious that economic and green development are not mutually exclusive.

NCIC cohort Muhammed Salisu Abdullahi Co-Founder & Managing Director of eTrash2Cash, ethical computer and electronics recycling company, made the Forbes 30 under 30 list for 2019[7]. Furthermore, businesses like Tesla, make significant profits, utilizing climate technologies to create advanced technology vehicles, batteries and solar PV products. Tesla Inc was founded in 2003 by Elon Musk, and reported the first profit in the company's existence ten years later, in the first quarter of 2013, to the tune of 11 million USD[8]. Seven years later, by January 2020, Tesla was valued at 100 billion USD[9], and by January 2021, the company value had risen up to 773 billion USD[10]. The green business calls for long-term investment, but can bring amazing returns.

6. Green Economy Overtaking Fossil Fuel Industry - FTSE Russel Report, 2008; https://unfccc.int/news/green-economy-overtaking-fossil-fuel-industry-ftse-russel-report#:~:text=Presently%2C%20the%20green%20economy %20is,water%2C%20waste%20and%20pollution%20services.
7. https://nigeriacic.org/campaign-grid-view/#1600868047755-e17f6806-5154
8. https://www.reuters.com/article/autos-tesla-debt-idUSL2N0DY12C20130517
9. https://www.nytimes.com/2020/01/22/business/elon-musk-tesla-bonus.html
10. https://qz.com/1954423/tesla-founder-elon-musk-is-now-the-worlds-richest-human/

Government's funding and policy support were critical to the success of Tesla, with low-interest loans supporting the business in the early research and development phases. When the company was three years old, Tesla received a US$465 million loan from the United States Department of Energy. This funding was a small part of the US$25 billion Advanced Technology Vehicles Manufacturing Loan Program which other automobile companies benefited from. Investments into the industry, benefits all industry stakeholders, directly or indirectly.

With new global policies focused on meeting sustainable development goals, and recovering from the economic recession triggered by the COVID-19 pandemic, there is an opportunity for 'green economic recovery' (GER). GER calls for business and government tactics that re-grow the GDP while dematerializing and decarbonizing the economy. Cleaner air quality, healthier water, effective waste management, and enhanced biodiversity protection not only reduce the vulnerability of communities to pandemics and improve resilience, but have the potential to boost economic activity, generate income, create jobs, and reduce inequalities[11].

Some untapped opportunities for green business in Nigeria include the following; Advanced Technology Vehicles for water transportation, capitalizing on the large coastal line of Nigeria, can be applied to regional transportation of goods and persons, for trade and tourism[12]. Hybrid or solar powered boats have a viable market, not just in Nigeria, but globally.

The packaging market in Nigeria is estimated to be worth N10 billion. Plastic packaging is popular for its advantages, and the consumption of plastic in Nigeria in 2020 was estimated at 1.5 million tons. Recycling paper and plastic for sustainable or biodegradable packaging materials, is a business that has the potential to generate high returns.

The demand for packaging materials keeps rising, as consumers increasingly resort to e-commerce for purchases[13]. Moreover, government regulations standardizing the recycling practice for plastics were published in 2019, aiming to improve the production processes of plastics, making more plastic products recyclable[14]. The high volume of plastics consumption presents the opportunity to recycle plastic bottles into polyester for clothing. These are profitable ways to reduce plastic pollution in Nigeria.

Finally, with buildings emitting more energy-related carbon globally than the entire transport sector, experts say holistic adoption of green building standards in the housing industry would boost efficiency and lower construction costs. The rising population in Nigeria makes housing a growing industry, and smart buildings are a necessity as we aim to transition to more sustainable ways of life[15]. Several government incentives have been set in place to encourage energy efficiency, creating a profitable opportunity for older buildings to get "smarter". Energy efficiency consultation services will not only reduce building emissions for the environment, but will also reduce electricity related expenditures for the building-owners.

Figure 2 Components of Nigeria's Green Economic Ecosystem

11. http://www.oecd.org/coronavirus/en/themes/green-recovery
12. Coastal line in Nigeria is 853km long https://www.hydro-international.com/content/article/coastline-migration-in-nigeria#:~:text=The%20853km%20long%20Nigeria%20coastline,Rivers%20bordering%20the%20Atlantic%20Ocean.&text=The%20general%20dynamics%20of%20the,oceanic%20and%20climatic%20seasonal%20changes.
13. Items purchased online require additional shipping packaging
14. https://www.mordorintelligence.com/industry-reports/nigeria-packaging-market
15. https://guardian.ng/property/experts-list-hinderances-to-green-building-developments-in-nigeria/

RENEWABLE ENERGY

Energy supply is the backbone of every productive society. The largest source of GHG from human activities is from burning of fossil fuels for energy generation[16]. Energy is utilized as electricity, heat and for transportation, powering all industries and daily life. This makes renewable energy a cornerstone in the green ecosystem. The global renewable energy market alone accounts for an estimated 928 billion USD, roughly a quarter of the green economy[17], and this is with only a 28% share of global electricity generation[18].

Renewable energy may be generated through geothermal, biomass, wind, hydro and solar means, and are an outstanding alternative to fossil fuels. Renewable energy supply reduces GHG emissions significantly, are non-harmful to people and the environment, offer significant savings on fuel costs (wind, waves and sunlight are free), and are sustainable (unlike fossil fuels, natural forces cannot be depleted). The renewable energy industry tackles the vulnerability associated with fossil fuel dependence, where the state of the economy is linked to the price of oil and gas. Furthermore, improved energy efficiency contributes to increased global and individual competitiveness of any industry and company respectively[19].

UNDERSTANDING THE RENEWABLE ENERGY BUSINESS

The optimal manner of conducting any business can be determined through an understanding of the local conditions, regulatory environment, institutional frameworks and support systems in place.

Local Conditions

The energy generation capacity in Africa is generally underutilized, studies suggest that only 7% of Africa's geothermal and hydro-energy potential has been harnessed[20].

Energy poverty is most pervasive in Sub-Saharan Africa, with population growth out-stripping grid expansion. South Africa accounts for 45% of total electricity generated in Africa, while North Africa accounts for 30%, leaving 80% of Africa's population in the rest of Sub-Saharan Africa, generating and utilizing 24% of Africa's total electricity. That is a huge market opportunity. An estimated tenfold increase of the power sector in Africa from 2019 would be necessary to reach the unlikely target of providing universal access to electricity by 2030[21].

In Sub-Saharan Africa, the poor distribution of electricity through the conventional energy grid is generally attributed to low-capacity utilizations/availability, deficient maintenance, and high transmissions and distribution losses, alongside a host of other problems unique to each country. These lapses of the conventional system create a unique opportunity for off-grid solutions.

In Nigeria, the grid is powered by electricity generated using natural gas and hydro with a ratio 70-30% respectively. The grid serves only about 45% of the population, and only 15% have reported having more than 12 hours daily average power supply. The majority of Nigerians generate electricity using off-grid technologies. Popular off-grid technologies are; solar home systems[22], green mini-grids[23], and diesel generators. Less popular is the use of small hydropower (SHP) generators, however this has valuable potential. In 2010, National Electricity Supply Company (NESCO) had developed many SHP schemes around Jos Plateau, generating and supplying about 19 MW by a private sector operator (Ebhota and Tabakov, 2018). Even though studies have shown that solar power is cheaper than diesel, diesel generators are currently the most prevalent form of off-grid electricity used in Nigeria, with an estimated 8,000 – 14,000MW of installed capacity throughout the country as at 2019[24].

16. https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#:~:text=The%20largest%20source%20of%20greenhouse,Greenhouse%20Gas%20Emissions%20and%20Sinks.
17. https://www.prnewswire.com/in/news-releases/renewable-energy-market-size-is-expected-to-reach-usd-1-512-3-billion-by-2025-valuates-reports-814260258.html#:~:text=The%20global%20renewable%20energy%20market,CAGR%20from%202018%20to%202025.
18. https://www.iea.org/reports/global-energy-review-2020/renewables
19. https://www.adb.org/sites/default/files/publication/161889/business-models-renewable-energy-gms.pdf
20. Geothermal energy potential in Kenya stands at 9000MW but only 60MW is exploited https://sustainabledevelopment.un.org/content/documents/nepadkarekezi.pdf
21. https://www.sciencedirect.com/science/article/pii/S1364032118307925
22. SHS offers up to 5kW of power via solar equipment and a battery.
23. Mini-grids provide power to multiple homes or businesses through an independent electricity distribution network using integrated renewable or hybrid energy systems.
24. Excluding few exceptions https://reader.elsevier.com/reader/sd/pii/S1364032118307925?token=EBC4C2B1BF21784370515BBD352E4C34B1C12B7308E78539C4A34B1F88F2F46FFDE18DE38E338E61F1261649F51791BF

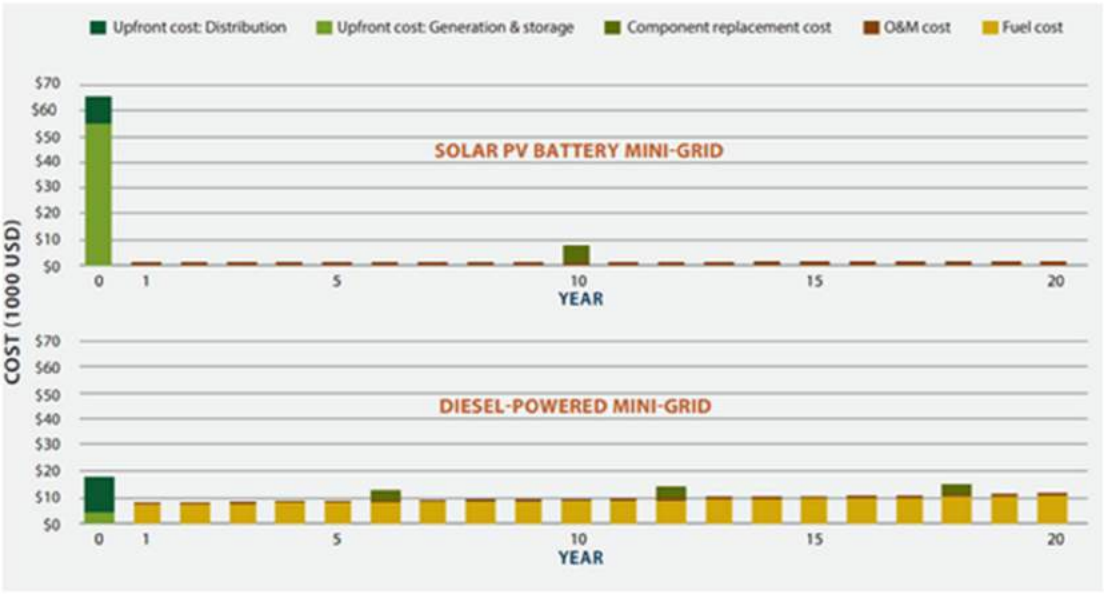


Figure 3: The different capital costs of electricity generation from solar-PV battery mini-grid and diesel-powered mini-grid (UNDP & ETH Zürich, 2018)

The predisposition to using oil and gas derivatives for power generation may be in part because Nigeria ranks in the world's top 10 for proven reserves of oil and gas[25]. This leaves businesses and communities vulnerable to financial shocks due to fluctuating oil prices that lead to irregular subsidy policies and increasing on-grid tariffs. The popularity of generators also creates noise and air pollution that negatively affects the quality of life.
Nigeria is rich in solar irradiation; the natural resource necessary for solar power generation, making solar energy the most promising renewable energy technology for large-scale off-grid electricity distribution[26]. Conveniently, the Nigerian population currently underserved by the conventional grid supply is the prime location for high solar irradiation[27]. There is an ample market of consumers for mini-grids and SHS in Nigeria and Sub-Saharan Africa[28].

The solar power market is growing rapidly, as new technology emerges, the costs of installing solar photovoltaic systems falls, and the population increases. The global solar energy market is expected to reach 422 billion USD in 2022, in comparison to 86 billion USD in 2015, an almost five-fold increase[29]. REA values the short terms market opportunity for solar energy in Nigeria, at 9.2 billion USD[30]. As the solar market grows, there are increased opportunities for employment, investment and business in various sectors of the ecosystem.

“The global solar energy market is expected to reach 422 billion USD in 2022, in comparison to 86 billion USD in 2015, an almost five-fold increase. REA values the short terms market opportunity for solar energy in Nigeria, at 9.2 billion USD”

25. Nigeria Investment Guide, January 2020 – Nigerian Investment Promotion Commission (nipc.gov.ng)
26. Nigeria Power Sector Program Off-Grid Sector Assessment, March 2019, p7, 'Map of Solar Irradiation in Nigeria'
27. https://nigeria.thesolarfuture.com/news-source
28. 'Communities' refers to locations densely populated enough to optimize the mini-grid infrastructure power supply capacity. Low density areas are better served by SHS.
29. https://www.statista.com/statistics/217177/global-projected-growth-of-solar-power-by-2020/#:~:text=The%20global%20solar%20energy%20market,deployed%20than%20traditional%20energy%20sources.
30. https://rea.gov.ng/rea-nigerias-annual-mini-grid-electricity-investment-opportunities-reach-9-2bn/

POLICIES AND REGULATIONS

Business models are significantly influenced by the government and regulatory environment, as this shapes the institutional frameworks and support structures. The social impact of renewable energy investment creates a strong case for public sector support and the government has put in place some incentives. An overview of the policies and regulations that apply to the green energy sector in Nigeria is the first step in understanding the renewable energy business.

The National Renewable Energy and Energy Efficiency Policy (NREEEP)[31] approved by the Nigerian Federal Executive Council (FEC) for the electricity sector in 2015 defines renewable energy as 'energy obtained from energy sources whose utilization does not result in the depletion of earth's resources or has minimal environmental impacts'. According to the NREEEP, incentives to encourage the development of RE sectors have been made available. These incentives include;

- Carbon credit scheme; Renewable energy businesses may procure carbon credit through the Federal Ministry of Environment. Where a limit on emissions is enforced, climate change organizations who have been approved to sell legitimate carbon credits, and organizations with emissions below the limits, may sell these credits to companies who emit above the limits. This creates a premium on GHG emission. Furthermore, revenue made from such trades are exempted from income tax or duty[32].

- Tax holiday; Manufacturers and investors into the renewable energy sector enjoy a five-year tax-holiday on revenue and dividends from domestic renewable energy sources, respectively.
- Free custom duty; importers of renewable energy equipment and materials are to enjoy duty free trade for two years.
- Funding; in the form of soft loans and special low interest loans from the Power Sector Development Fund for renewable energy supply projects, and other federal budgetary considerations.

The 'Nigeria Feed-in Tariff for Renewable Energy Sourced Electricity' policy document[33] goes in further detail on the regulations and incentives for Renewable Independent Power Producers (IPPs) as outlined in the NREEEP. In summary the Federal Government of Nigeria wishes to improve private sector participation in on-Grid power generation, with focus on green energy, by providing investment security and market stability.
Renewable IPPs which qualify for these incentives are Solar PV energy generators with capacity between 1MW to 5MW, Wind Energy generating up to 10MW, and Small Hydro Plants generating up to 30MW. Renewable energy plants generating under 1MW are liable to waive energy generation licensing. However, licensed renewable energy generators, producing electricity to the set capacity per technology, who are operating as part of the grid, may receive the following benefits;
- Guaranteed Market; Identified off-takers are encouraged by the policy to treat electricity generated by renewables under the set limits as 'must-take', meaning DISCOs and other off-takers are strongly encouraged to buy the electricity offered to the market at rates determined by the NERC.
- Simplified licensing; The regulator provides a template and concessional fee structure to allow ease of access to licensing.
- Land and site access; The Federal Ministry of Power is set to collaborate with State or Local Governments to assist investors in the acquisition of land rights.

The 'Mini-Grid Regulations' policy document[34] specifies the regulations and incentives for isolated (off-grid) or interconnected independent electricity generation. Within this Regulation, the term Mini-Grid is used for any Isolated or Interconnected Mini-Grid generating between 0kW and 1MW of

31. https://rea.gov.ng/rea-nigerias-annual-mini-grid-electricity-investment-opportunities-reach-9-2bn/
32. http://admin.theiguides.org/Media/Documents/NREEE%20POLICY%202015-%20FEC%20APPROVED%20COPY.pdf
32. However, no national implementation of carbon limits and credits has been enforced yet.
33. https://www.nbet.com.ng/wp-content/uploads/2018/05/REGULATIONSONFEEDINTARIFFFORRENEWABLEENERGYSOURCEDELECTRICITYINNIGERIA.pdf accessed 19 March 2021
https://www.iea.org/policies/5974-nigeria-feed-in-tariff-for-renewable-energy-sourced-electricity
34. http://rea.gov.ng/wp-content/uploads/2018/07/NERC-Mini-Grid-Regulation.pdf

of Generation Capacity. Qualified operators run one or more systems of less than 100kW of Distributed Power per site having gone through a Mini-Grid Registration procedure with the Commission successfully.

While Mini-Grid operators do not require licenses. Limitations on access are placed on operators with generating capacities of over 100kW, to locations that fall into the intended expansion area of licensed distributors. These limitations apply provided the Mini-Grid operations interfere with grid activities. Furthermore, such operators with over100kW capacity are required to adopt tariffs based on the MYTO and approved by the NERC. Complying to these regulations is necessary, in order to obtain a legal permit to operate. Mini-Grid operators with capacities under 100kW are required to register with the NERC but may not need to obtain operation permits.

National Environmental Standards and Regulation Enforcement Agency (NESREA) Act[35] 2007 Section 27 prohibits, without lawful authority, the discharge of hazardous substances (solid, liquid or gas, as defined by the regulations) into the environment. This offence is punishable under this section, with a fine not exceeding, N1,000,000 (One Million Naira) and an imprisonment term of 5 years. In the case of a company, there is an additional fine of N50,000, for every day the offence persists. Section 7 provides authority to ensure compliance with environmental laws, local and international, on environmental sanitation and pollution prevention and control through monitory and regulatory measures.

Section 8 (1)(K)[36] empowers the Agency to make and review regulations on air and water quality, effluent limitations, control of harmful substances and other forms of environmental pollution and sanitation. Current regulations are available in the Federal Environmental Protection Agency Act 1992[37], Part II.

Environmental and Social Review Procedures[38] are an international standard protocol necessary to implement measures to mitigate or correct project impacts/risks on the environment and society, including occupational health and safety. There are Environmental Health and Safety Guidelines that set technical and industry-specific standards for Pollution Prevention and Abatement etc. The International Finance Corporation (IFC), a member of the World Bank Group, is fundamentally committed to sustainable development, and has set up a sustainability framework (SF) with a globally recognized risk management system and Environment, Social and Governance Department, supporting IFC investment activities. E&S review is particularly important to projects with international sponsors or partners.

Institutional Frameworks and Support Systems

The Renewable Energy Ecosystem in Nigeria is made up of policy makers/regulatory bodies, international stakeholders, climate advocacy groups, industry financers, industry players, and the value chain.
Policy makers/regulatory bodies in Nigeria include; the Nigerian Electricity Regulatory Commission (NERC), Rural Electrification Agency (REA), Federal Ministry of Environment, Lagos State Ministry of Environment and Water, ECOWAS, the Lagos State Environmental Protection Agency (LASEPA), and others. Policy makers have a high impact on the entire ecosystem, and are primarily influenced by foreign stakeholders and advocacy groups.

Foreign stakeholders with impact on the renewable energy ecosystem in Nigeria include; the United Nations Development Program (UNDP), World Bank, United States Agency for International Development (USAID), UKaid, African Development Bank (AfDB), UK's Foreign, Commonwealth and Development office (formerly DFID), Germany's Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Africa Clean Energy (ACE), and others. These organizations collaborate with, or establish advocacy

35. http://extwprlegs1.fao.org/docs/pdf/nig120569.pdf
36. In 2018, amendments have been made to the original Act as found on the NESREA website https://www.nesrea.gov.ng/wp-content/uploads/2020/04/NESREA_Ammended_Act_2018.pdf
37. https://lawsofnigeria.placng.org/laws/F10.pdf
38. https://www.ifc.org/wps/wcm/connect/6f3c3893-c196-43b4-aa16-f0b4c82c326e/ESRP_Oct2016.pdf?MOD=AJPERES&CVID=lRwoQFr

to support climate innovation, influence policies, and offer donor support, funding grants, research projects and development programs.

Climate advocacy organizations and green economy drivers in Nigeria include; the Nigeria Climate Innovation Centre (NCIC), All On, Nigerian Environmental Society, and Friends of the Environment. Advocacy organizations are a critical part of the ecosystem, as they connect to every part of the ecosystem. Advocacy groups lobby for sustainable policies, partner with international stakeholders on research backed development projects, and identify investment opportunities for financiers and industry players. They also provide support and knowledge to the value chain, educating industry stakeholders on the latest innovations of the green economy. The strength of the advocacy groups impacts the strength of the entire ecosystem.

Industry financers include financial institutions, government agencies and independent/impact investors. Funding is typically provided in form of loans, equity or grants to industry players.

Industry players drive the green economy forward. They include innovators, entrepreneurs and developers, creating technologies and solutions to the challenges associated with climate change and adaptation. Industry players are connected with almost every aspect of the ecosystem chain, but have a particularly strong impact on the value chain, as the industry players serve as a major link between the value chain and the rest of the ecosystem.

The value chain consists of various subsystems that create products and services, including; green technology traders, and service providers. The primary activities of a value chain according to Michael Porter are inbound logistics, operations, outbound logistics, marketing/sales and service[39]. The value chain activities are geared towards generating profits. The value chain is the primary connection between the ecosystem and the consumers/communities. The value chain is most important in shifting public perception of the green ecosystem through organic community interactions.

Therefore, the links between the value chain and advocacy groups is critical, as a widespread understanding of the value offered by a green economy is best communicated by the value chain.

BUSINESS MODELS FOR RENEWABLE ENERGY BUSINESSES IN NIGERIA

Business models are adaptable to the financial environment, local conditions and risk profiles of the proposed project; however, they may be broadly categorized into two classes;

- Ownership models, which address financing and risk mitigation concerns
- Service models, which focus on meeting the needs of consumers, determined by their local conditions.

In reality, businesses do not strictly adhere to either of these models, but adapt the approaches of the both models to be as profitable as possible. RE businesses however will lean towards an ownership or service model, depending on the product and service considerations, the scale of the project, consumer demographics, and the regulatory environment.

Ownership Business Models

For renewable energy generation projects, with a medium- to large-scale, supplying energy to communities, the most appropriate ownership business model is frequently a public-private partnership (PPP), implemented as a form of build-own-operate-transfer (BOOT) or multi-party ownership. On the other hand, smaller scale projects frequently involve lease or hire purchase and dealer credit sale models. These ownership models are further explored below;

Ownership Business Models for Medium- to Large-scale Projects

Public-Private Partnerships (Case Study)

A great example of a PPP is illustrated by the small hydro power plant project executed by the United Nations in the Sardauna Local Government Area of

39. https://www.isc.hbs.edu/strategy/business-strategy/Pages/the-value-chain.aspx

Taraba state[40]. Sardauna is a remote LGA in the far southeast of Taraba, bordering Cameroon. By 2002, poverty, unemployment, and clashes over land and mineral resources displaced 38,000 Nigerians in the region to Cameroon. By 2005, most of these refugees returned to Taraba, facilitated by the interventions of the United Nations High Commissioner for Refugees (UNCHR). To prevent a recurrence of conflicts and create a suitable environment for communities to resettle, UNCHR Nigeria, the United Nations Industrial Development Organization (UNIDO), the UN Food and Agriculture Organizations (FAO) and several other UN agencies launched a joint program.

UNIDO initiated a project to install a small hydro-power plant at the Tunga Dam, to provide renewable energy to a population of about 50,000, covering five communities on the Mambilla plateau, namely Kakara, Kusuku, Galadima, Nguroje and Furmi. These communities' main economic activity is the cultivation and production of tea. The Mambilla Beverages company produces Highland Tea in Kakara and runs plantations of about 6,000 farms. Because this is the sole industry in the area, with a hiring capacity of just about 500, unemployment remained a major problem in the area. The use of diesel generators and wood fuelled driers drained the factory economically, limiting expansion potential.

"In order to revive existing economic activities and create additional income generating opportunities for local communities, it was necessary to focus on providing reliable and cost-effective electricity for the area," - Patrick Kormawa, UNIDO Representative to Nigeria. In 2013, with the support from the Taraba State Government and funding from UNCHR, the International Centre for Small Hydro Power (ICSHP) in China collaborated with UNIDO to supply and install electro-mechanical equipment with an operating capacity of 400kW. The ownership of the facility was transferred to the State Government, while operations and management were transferred to the Mambilla Beverages company, the major industrial benefactor of the project.

The project has had a positive impact on some 6,000 families, the tea factory and the environment, in the following ways;

- Labour savings (from not having to collect wood)
- Reduced deforestation (from less reliance on fuel wood and charcoal)
- Health benefits from reduced indoor air pollution and improved water (electrically powered pumps)
- Education benefits (from improved lighting in schools and residencies, contributing to improved study conditions)
- Reduced poverty (from agricultural and industrial productivity improvements)

These benefits would be difficult to reflect in electricity tariffs, and the tariffs would cover the cost of supply at most. These unaccounted benefits need to be publicly recognized, to encourage the involvement of impact investors. Depending on how a PPP contract is structured, the cost of using the service can be borne by the users exclusively, by the government, or by both, in a blended approach. The government may support the project by providing land or similar assets, in addition to providing revenue subsidies, and the regulatory stipulated tax holidays.

The UNIDO SHP project is a good example of the BOOT model, where the operation and maintenance of the facilities is transferred to the beverages company and the majority equity is transferred to the State Government. Other common models of PPP are the build-own-operate (BOO) model and the build-own-transfer (BOT) model. Typically, these business models involve high government participation due to the scale of the project. A special-purpose company (SPC) may be created by the government to work as a central administrative entity, handling contracts to acquire funding (from equity and debt investors) and managing operation and management contracts. SPCs minimize risks to the government, re-allocating those risks to the parties best able to manage them.

In the case above, UNIDO and ICSHP collectively operated as the SPC, liaising with the government and managing contracts. One disadvantage of this One disadvantage of this model is that it can be highly complex, and if risks are misallocated, it can be costly to the involved parties. The best-fit partners are required for the success of BOOT model PPPs.

40. https://www.unido.org/news/small-hydro-power-plant-nigerias-taraba-state-offers-sustainable-energy-tea-factory-and-improves-lives-local-communities

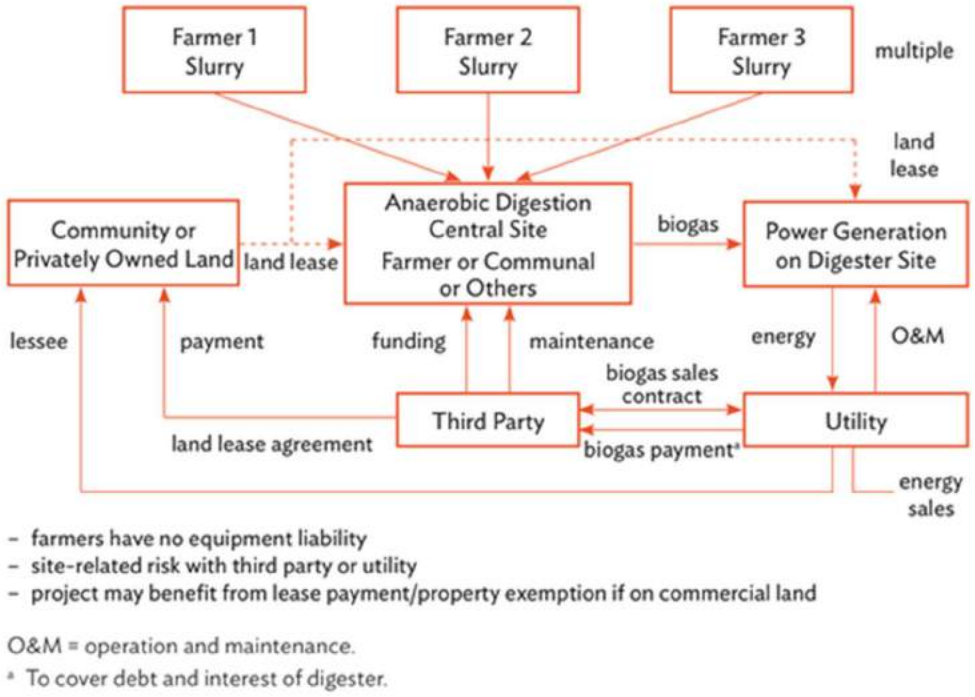


Figure 4: Community Digester System Relationship Diagram (ADB, 2015)

Multiparty Ownership

Multiparty Ownership projects, involve the public sector, as large-scale projects generating over 1MW up to the respective limits for renewable energy technologies[41], are required to partner with public sector/grid off-takers. However, these partnerships are often private driven and private parties maintain ownership of the project. Multiple parties that may be involved in such a project are user cooperatives, energy service companies and financiers, amongst others. The power-generating equipment may be funded and installed by private financers and RE service companies, the equipment may be owned and maintained by the user cooperative and the service company, and the off-takers (target consumers) pay the standardized tariffs for the electricity generated.

Regulations set to increase the share of renewable energy generation in the national grid, ensure a stable market. However, there is a high level of complexity in executing these projects, as good synergy and good business practices between all parties is necessary for success. Taking the local environment into consideration is also critical, if companies do not connect adequately with the communities, that leads to an added risk.

An example of such a model in action would be a community-based biogas digester project, where community farmer cooperatives supply the agricultural wastes that fuel the biogas digester, and one or more bio-energy service companies source finance (from rural electrification donor funds and private investors) to operate and maintain the digesters and biofuel electricity generators, that in turn supply electricity to the grid, as illustrated in the figure below.

The bio-digesters used to produce bio-fuels, may also produce other by-products that will create value for the farming community, such as fertilizers. Likewise, the farmer cooperative profits from sales of the agricultural waste to the bio-digester company; leading to reduced poverty in the community. The low costs of biofuels for the electricity generators, compared to fossil fuels, makes it profitable for the RE GENCO to make electricity sales to off-takers at the standard tariffs. Finally, the increased energy supply to the DISCOs translates to a boost in community grid-power supply, and this ultimately translates to increased revenue for the DISCOs and increased community development.

41. As specified under “Regulatory Environment”

Multiple revenue streams reduce individual risks, and create avenues for synergistic Green growth and improvement. In this Multiparty Ownership scenario, the farmers' cooperative may own equity with the biogas digester energy service company or through a contractual agreement, maintain that the digester sources raw materials from the

community first, and by-products such as fertilizers are sold to the farmers at a competitive price. The biofuel electricity generator may be run by another specialized renewable energy service company, in partnership with the biogas digester company, and the public sector. The bio-energy organization may supply energy (under 1MW) directly to the biogas digester organization, the farmers and other agro-industries in the community, through a mini or micro grid. The mini-grid may be provided to the biodigester energy service company on a lease or hire purchase model, or on a dealer credit sale model, as described below.

Ownership Business Models for Small-scale Projects

Lease or Hire Purchase Model

This model allows users to purchase equipment in instalments. A leasing company or equipment supplier provides RE equipment to the end user for a contracted period of time in exchange for regular payments. The leasing company is responsible for sourcing, installing and maintaining the equipment until the end of the contract. Depending on the arrangement, at the end of the contract, the equipment may remain with the leasing company or be transferred to the user (sometimes for an additional amount). This model is suitable for residential, and industrial facility Solar PV Systems, and increases market share by overcoming the problem of high initial costs for the purchase and installation of these systems.

Dealer Credit Business Model

This variant of the ownership model operates with the equipment supplier providing initial credit for the system, as well as the equipment. Simply put, the equipment and its associated costs are provided as a non-fiscal loan. Monthly payment installments finance the loan, and the equipment itself, in addition to an initial down payment, serves as capital collateral that can be recovered in case of default. However, unlike the hire purchase model, ownership of the system is transferred to consumers at the end of the loan repayment period. This combines the promotion of simple and standardized energy products with micro-loans.

The model addresses the issues of access to finance for both RE service companies and consumers, especially when a two-hand form of the model is applied. In the two-hand form, a microfinance institution (MFI) forms a long-term partnership with a technology company, however they operate as separate entities, managing their specialized aspects of the business. This allows for diversification and customization of energy products, to meet a wider range of consumer needs.

However, a partnership with an RE tech company may pose an additional risk to the MFI, if the technology company fails to take adequate insurance measures to guarantee product performance for the moratorium of the loan, or fails to deliver services that are essential for loan repayment. In such a case, the MFI may need to take over the project, converting it to a one-hand form of the model. In a one-hand form, the credit and the equipment are provided by the same institution. This model is well suited for supplying solar systems to MSMEs that need stable electricity supply for successful business operation.

Service Business Models

The service-based business model focuses on providing a product or service directly to the end user. The products and services offered under this model may be broadly categorized into two, namely; energy supply and energy efficiency. End users may pay tariffs for electricity supplied by an
off-grid solar or hydro mini-grid, or purchase solar home systems. The service model covers systems maintenance and energy efficiency consultations that create energy savings against a predefined baseline. This service model also includes battery recycling and refurbishing, as batteries are the backbone of many renewable energy grids.

"This service model also includes battery recycling and refurbishing, as batteries are the backbone of many renewable energy grids."

Chapter 02

METHODOLOGY

METHODOLOGY

The study adopted a mixed research approach, involving the use of both quantitative and qualitative data collection and analysis methods. The quantitative approach was implemented through a sample survey of the population. The qualitative aspect was implemented through an in-depth interview survey of purposely selected key informants aimed at collecting rich in-depth information about issues and variables of focus in the study.

Desktop research

This aspect involves literature/document review with emphasis on key variables in the study. This was useful to create context and shape the design of the instruments for the other methods of enquiry.

Focus group discussions and key informant interviews

These data collection methods helped get an in-depth understanding on the needs and concerns of the Renewable Energy (RE) stakeholders across Nigeria. The focus group discussion yielded rich qualitative information for gaining deeper insight and understanding of the contexts of the variables of the study. Such insights assisted the interpretation of results from the analyses of the quantitative data. There were ethical considerations including consent, full disclosure, confidentiality and security of information etc. in collecting data from the respondents. The interviews were recorded and transcribed manually by writing out the responses to identify common themes across the interviews. There were twenty (20) focus group participants and six (6) key informants.

Surveys

Preliminary engagements with some key industry stakeholders of the RE ecosystem in Nigeria for an initial scoping of the socio-demographic information helped guide the design of the instrument for ease of data collection. The questions in the survey were based on the lines of enquiry deemed relevant based on literature review. They were aimed to obtain data on the socio-demographic characteristics of RE entrepreneurs/investors in Nigeria, including their business history, access to finance, and needs evaluation. The surveys also explored the business models of RE entrepreneurs in Nigeria.

The sampling method used was purposive sampling. The respondents were drawn from the database of NCIC. Surveys were administered digitally. Fifty-nine (59) total responses were collected.

Limitations of Data Collection

There is limited specific data available on the Renewable Energy Ecosystem in Nigeria, due to a lack of a functional labour market information system (LMIS). This creates a gap in information on the occupational trends of Nigerians. Likewise, irregular censuses leave us with outdated data on employment, unemployment, education and training. It is therefore difficult to give a comprehensive mapping, stating accurately the number of RE entrepreneurs in Nigeria and their geographical distribution. The methods of data collection are limited to the network and access available at the time of the study.

> **“There were twenty (20) focus group participants and six (6) key informants. Surveys were administered digitally. Fifty-nine (59) total responses were collected.”**

Chapter 03

KEY FINDINGS

KEY FINDINGS

The RE business respondents are split almost evenly between production, installation and trading of equipment. The majority of the respondents (39.5%) are engaged in assembling renewable energy systems locally and installation (32.6%), with materials that are predominantly imported. Of the RE businesses surveyed, 52.4% of respondents exclusively import and 28.6% use both imported and local raw materials. The minority are engaged in trading and other value adding services such as consultations, training and business advisory. Additionally, there is a niche in the market that focuses on critical aspects of the value chain that are commonly overlooked, such as, battery recycling and refurbishing.

The renewable energy industry has made many significant strides towards solving identified challenges to growing in Nigeria. There are established associations, such as the Renewable Energy Association of Nigeria (REAN) and others in the alliance, who provide support for RE businesses and a community for their members. These associations are effective in providing growth and collaboration opportunities. These associations have taken decisive action towards RE friendly policy implementations, and campaigned for the import duty on solar panels and components to be reduced to zero.

The majority of renewable energy businesses import their materials, and this is a source of risk due to currency volatility, delays on delivery caused by customs inefficiencies, and lack of supply chain for spare parts, however this challenge is being resolved through the presence of several local assembly plants. These plants produce high quality hardware and create a supply of spare parts for device maintenance and customization.

Africa Clean Energy (ACE) in collaboration with REAN and UKaid published an importation guide for solar PV products and technologies in Nigeria (2019)[42] with relevant information on navigating importation. There is 5% duty applicable on solar panels. However, there is an exemption on solar cells and other components used in manufacture or assembly of solar modules.

This is one of the efforts to encourage the local assembly and production of solar PV technologies. A local supply of equipment is critical to the industry. In September 2020, All On awarded $1.5 million in debt and equity funding to an established local assembly company, to expand capacity and possibly begin local production of some components.

The establishment of the Rural Electrification Agency, with the interactive website showing good geospatial data of areas on and off the grid, helps the development of projects for rural electrification, however there is no comprehensive map of energy demand across the nation available. It is necessary for research to be conducted prior to any RE project, in order to allow contextualization of business models, risk assessment/mitigation and feasibility studies.

There is a tax relief incentive provided by the FIRS for research and development activities available to organizations who wish to take advantage, provided that such R&D activities are carried out in Nigeria and connected with the tax-paying business. Companies may be entitled to tax relief of an amount equal to 10% of the total profits of the company or 20% investment tax credit on their qualifying expenditure, depending on the nature of the research.

From the data, it appears that males lead the industry, with 70% male and 30% female respondents. It is necessary to encourage gender balance in the industry, as a key to being sustainable is eradicating inequalities.

Applied Business Models

The Renewable Energy ecosystem in Nigeria is largely Solar, with 58% of respondents working in the Solar Sector. It is worthy to note that there is a rise in biofuel renewables (25% of respondents), with more entrepreneurs embracing circularity and turning waste to fuel. Beyond the fact that there is a readily available resource of solar irradiation and wastes in Nigeria, the RE sector is predominantly privately owned, with limited public participation, and this in addition to the high capital requirements associated with hydro-energy generation limits the use of

42. https://www.ace-taf.org/wp-content/uploads/2020/01/ACE-NIGERIAN-IMPORTATION-GUIDE-2019122001.pdf

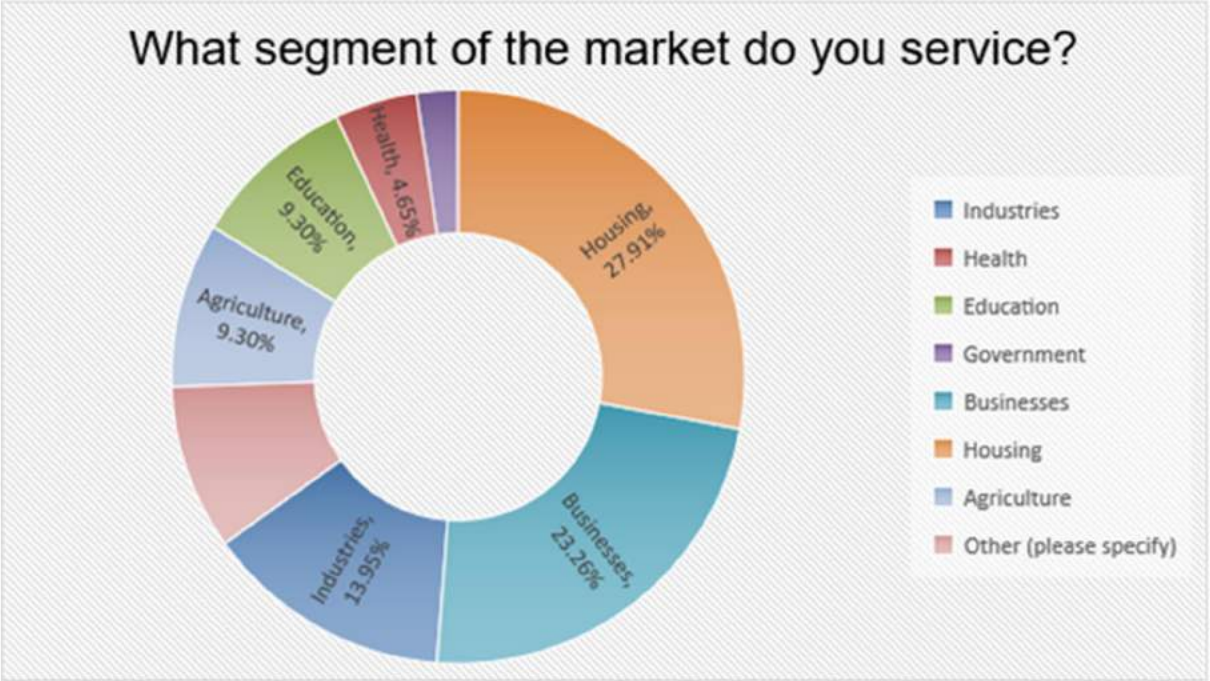


Figure 5 Segments of the market serviced by renewable energy entrepreneurs in Nigeria (2021)

of Nigeria's abundant hydro resources. Only 4.2% of respondents are in the hydro sector.
The RE innovators in Nigeria majorly create Green energy access for Agric, Manufacturing, Healthcare, Education, Banking, MSMEs and Homes. Due to the high population of Nigeria and poor grid power supply, solar home systems are the most popular renewable energy product, with more than half of respondents deploying them for use by homes and MSMEs.

The mode of operation varies significantly between the urban, peri-urban and rural parts of Nigeria. The Nigerian rural electrification agenda mandates the creation of access to energy for off-grid communities, and there are government funds and other grants to facilitate that. The current incentives for rural electrification address the issues of capital for distribution assets, but do not address the issue of low/unpredictable power consumption by rural settlers. While a PPP can be an ideal business model to overcome the various challenges associated with operating in rural regions, the level of direct involvement of the government impacts the scale of feasible rural electrification projects.

Despite the challenges associated with rural development, the rural communities are exceedingly compatible with green energy technology, and have seen a rise in solar mini-grids over the years. Mini-grids are usually the most cost-efficient option for people who live in communities so far from the main grid that extension costs are higher than installing local generation and storage capacity. Unlike other off-grid energy solutions, such as most solar home systems currently on the market, mini grids have the added advantage of supporting both residential and institutional energy needs (e.g., lighting and small appliances) and productive energy uses (e.g., milling, irrigation, and light manufacturing). This translates to the flexibility to meet different settlement needs.
Urban settlements are on-grid, but NED off-grid power supply to supplement unstable power supply, or reduce costs of electricity. The service model is predominant in urban settlements, with individuals and corporations who can afford to, buying solar home systems. As a way to overcome the challenge of price-point inaccessibility, small-scale ownership models have been applied, however increasingly, a hybrid of the service model and ownership model called the 'Power-Purchase Model' is being used.

The power purchase model involves an agreement between an independent power plant (such as a solar mini-grid) and an "off-taker" where the off-taker pays for power supply, without any prior financial commitments for equipment purchase and installation. The power-purchase agreement may have a transfer clause, depending on the agreements with the off-taker. Where a transfer clause is included, the power generation assets may be possessed by the client after a predetermined period of time, in a similar manner to the dealer credit business model. The off-taker may be private (residential area, corporation or DISCO) or public, and a business might cater to both.

The power purchase model is most suitable for various projects and user groups in Nigeria, because this model is a good fit where projected revenues are uncertain, there's competition from subsidized fossil fuels, and purchasers require security of supply[43]. This model minimizes risks to the consumer, therefore adequate insurance is necessary for service providers to mitigate the risks of operating the power plant. Biogas generators may be employed as a back-up for these power-purchase mini-grids, turning them from solar mini-grids to green mini-grids. This is necessitated in areas underserved by the grid, and areas with heavy rainfall or lower irradiation. It is particularly beneficial when the community can supply raw materials for the bio-fuel.

Financing

Recent years have seen increased investments into SHS, and innovative business financial models that make solar power more accessible to the market. Off-grid renewable energy operators can typically access a range of financing types, depending on the maturity of the company. Early stage off-grid renewable energy start-ups typically rely on self-financing and seek out grants RE MSMEs under five (5) years old, reported high levels of difficulty in accessing finance and the majority have not received any grants, debt or equity finance. Some of these younger businesses employ short term and small-scale loans to finance their business needs. It is necessary for businesses to build a good credit rating over time through short term loans, and show investment readiness through good business practices and consistency, in order to attract large and long-term funding.

More mature companies rely on equity and (occasionally) debt from actors such as impact investors, and development finance institutions. As firms expand, their requirement for working capital or short tenor loans to finance ongoing expenses increases. For smaller off-grid assets such as solar lanterns and smaller SHSs, using ownership models, this requirement can be met to some extent through consumer financing by micro-finance institutions and/or local banks.

While finance is critical for the advancement of the sector, the cost of these high return investments trickles down to the end consumers, limiting company access to markets. Additionally, the high costs of finance constrict research and development budgets. As profits are poured into paying off debts, the growth of the sector is stunted, causing a negative feedback loop. While Development Finance Institutions (DFIs) and impact investors tend to look for comparatively lower returns, they also tend to invest in already established companies.

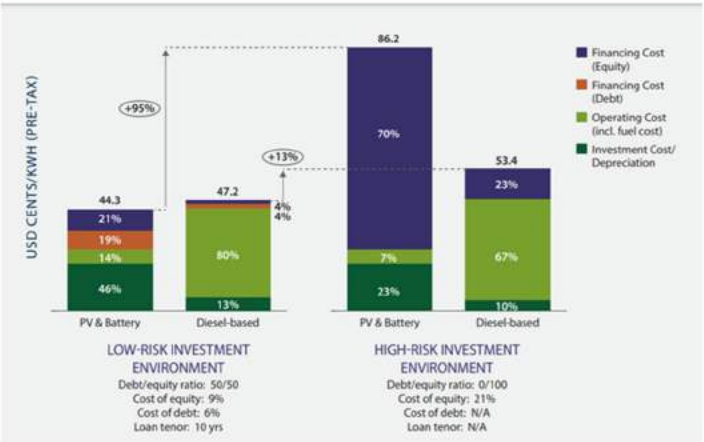


Figure 6 Impacts of Financing Costs on Solar and Diesel Mini-Grid Energy Generation Costs (UNDP and ETH Zürich, 2018)

There is a need to cultivate a low-risk investment environment if the national electrification goals for 2040 are to be met. Funds have been made available through impact investors and DFI's who have conducted research and identified the potential in the Nigerian market. But there is a gap, it is difficult for enterprises and innovators to access available funds, and investors to disburse them.

43. https://ppp.worldbank.org/public-private-partnership/sector/energy/energy-power-agreements/power-purchase-agreements

In order to minimize the risks, funders evaluate businesses thoroughly and this translates to bureaucracy for the businesses interested. The process is made to ensure that only those who need the funds apply for them, and only those that are qualified access them, however, the protocol may discourage businesses that are in the best position to benefit. There is also a miscommunication of expectations between parties, business owners often feel uninformed of the expectations of funders during the application process and while funders communicate requirements for funding, not every business that meets requirements are approved, due to other unspoken factors.

Higher financing costs for solar projects in developing countries reflect a number of perceived and actual investment risks (Malhotra et al., 2017). Some risks relate to renewable energy in general, some specifically to off-grid applications. Other risks reflect the broader investment environment in Nigeria, such as currency devaluation and rising poverty. Private investors seek to be compensated for higher risks with higher returns. Higher risks result in higher financing costs or – if the risks are too high – in investors completely refraining from investing. This can explain the absence of typically conservative commercial debt financing in many current off-grid renewable energy investments.

Barriers to Business

Market Perception/Access: Renewable energy and energy efficiency businesses and investments generate benefits to society in ways that cannot be measured solely through profits. In addition to environmental impacts which may seem abstract, these initiatives create economic impacts like job and revenue creation, and also reduce the financial burdens associated with fuel-based electricity generation. These impacts are generally long term. Risk arises from the lack of awareness and resistance to renewable energy and mini-grids in communities, and from resistance to incumbent businesses. Furthermore, there is a negative perception around locally produced technologies, discouraging local RE businesses from patronizing local assemblers and manufacturers of solar technologies.

Policy Risks: There is a lack of certainty regarding national targets for renewable energy electrification, and lack of clarity on the electrification plans. The lack of national plans and policy discontinuity with change in leadership, confers risks on long term investments and limits the available long-term funding. Long term funding is critical to the growth of the sector, as the initial costs for renewable energy facilities installations such as mini-grids and hydro-power plants are comparatively high. The competition from subsidized fossil fuels, and other strong policies supporting the oil and gas industry, with no emissions tax, limits the market access of renewable energy businesses. Furthermore, the lack of clear plans leads to changes in policies whenever there is a change in office. Import duty has been increased without warning or reason in the past, causing market shortages. Border closures significantly impacted the access to predominantly imported equipment, this is in part, a ripple effect of the COVID pandemic.

Skilled Labour Deficit: There is a lack of competitive labour market of educated, skilled and qualified potential employees to develop, design, construct, operate and maintain mini-grids and other renewable energy generation plants, leading to higher costs (added costs for training) and suboptimal performance of the ecosystem. Additionally, renewable energy business developers have minimal specialized training and may lack the necessary expertise, and (rural) community specific capabilities to formulate financially viable projects and contextualize business models.

End-User Credit Risks: General bad practice in the grid electricity industry, complicated by low customer collections, and the market's inability to enforce existing Vesting Contracts –which govern DISCO remittances to the NBET based on cash collected – leads DISCOs to exercise their own discretion on the proportion of market collections they remit to both NBET (for energy and capacity) and the Market Operator (for service provider fees). Furthermore, there is a lack of end-user credit data available, and incidences of electricity theft are commonplace in Nigeria. There is a widespread perception in Nigeria that power is a public good that should be provided

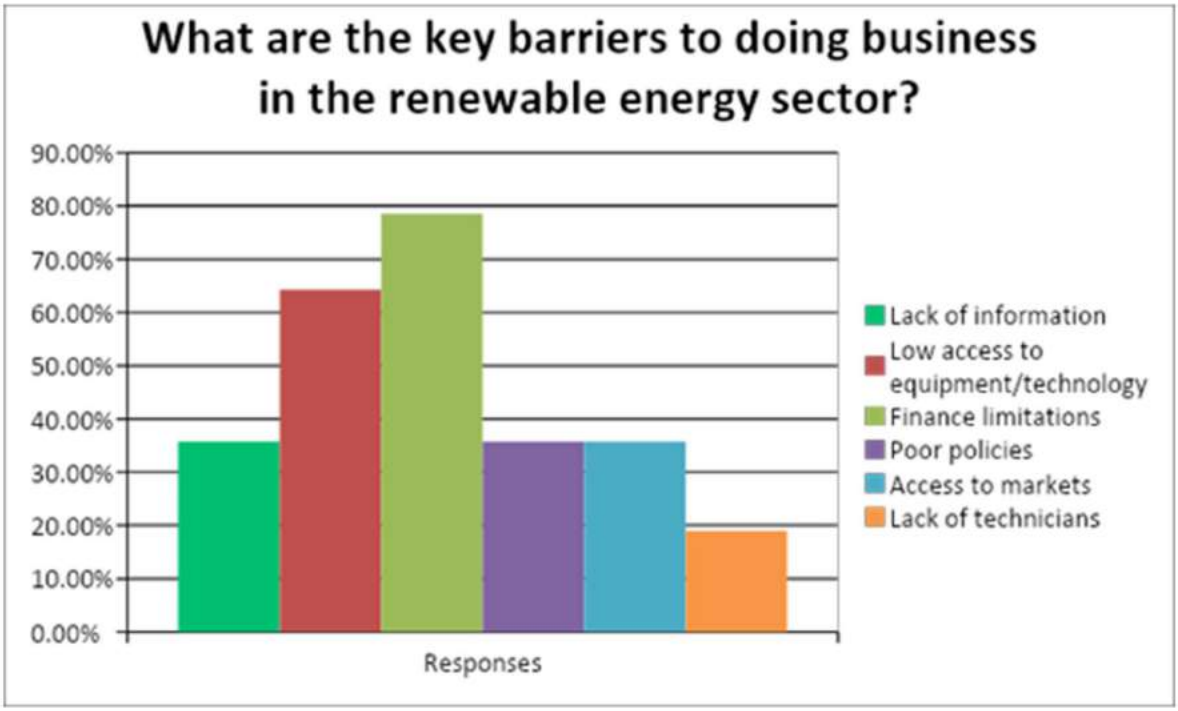


Figure 7 Top Barriers to Business in the RE Sector in Nigeria

by FGN at no cost. This is a necessary risk factor to consider when putting together power purchase business plans, either targeting consumers directly or targeting DISCOs, and the perceived risks may impair access to affordable loans.

Finally, the uncertainty related to conflict, political instability, economic performance, legal governance, ease of doing business, crime and law enforcement, land tenure and infrastructure are further uncertainties that impair the structured growth of the sector.

Chapter 04

CONCLUSION & RECOMMENDATIONS

CONCLUSIONS & RECOMMENDATIONS

Green businesses are positioned to take the lead in the transformation of the Nigerian economy, by improving power supply, economic sustainability and efficiency. It is important for green businesses to apply sustainable practices at every decision point throughout their operations. They might do this by implementing socially inclusive company policies, improving resource efficiency, going paperless, managing production waste in an environmentally friendly manner, reducing GHG emissions and improving energy efficiency.

The Renewable Energy Ecosystem is on an upward trajectory, with significant strides being made in every aspect of the value chain, in spite of the persisting challenges that limit all businesses in the country, and the added risks associated with implementing ground-breaking technologies.

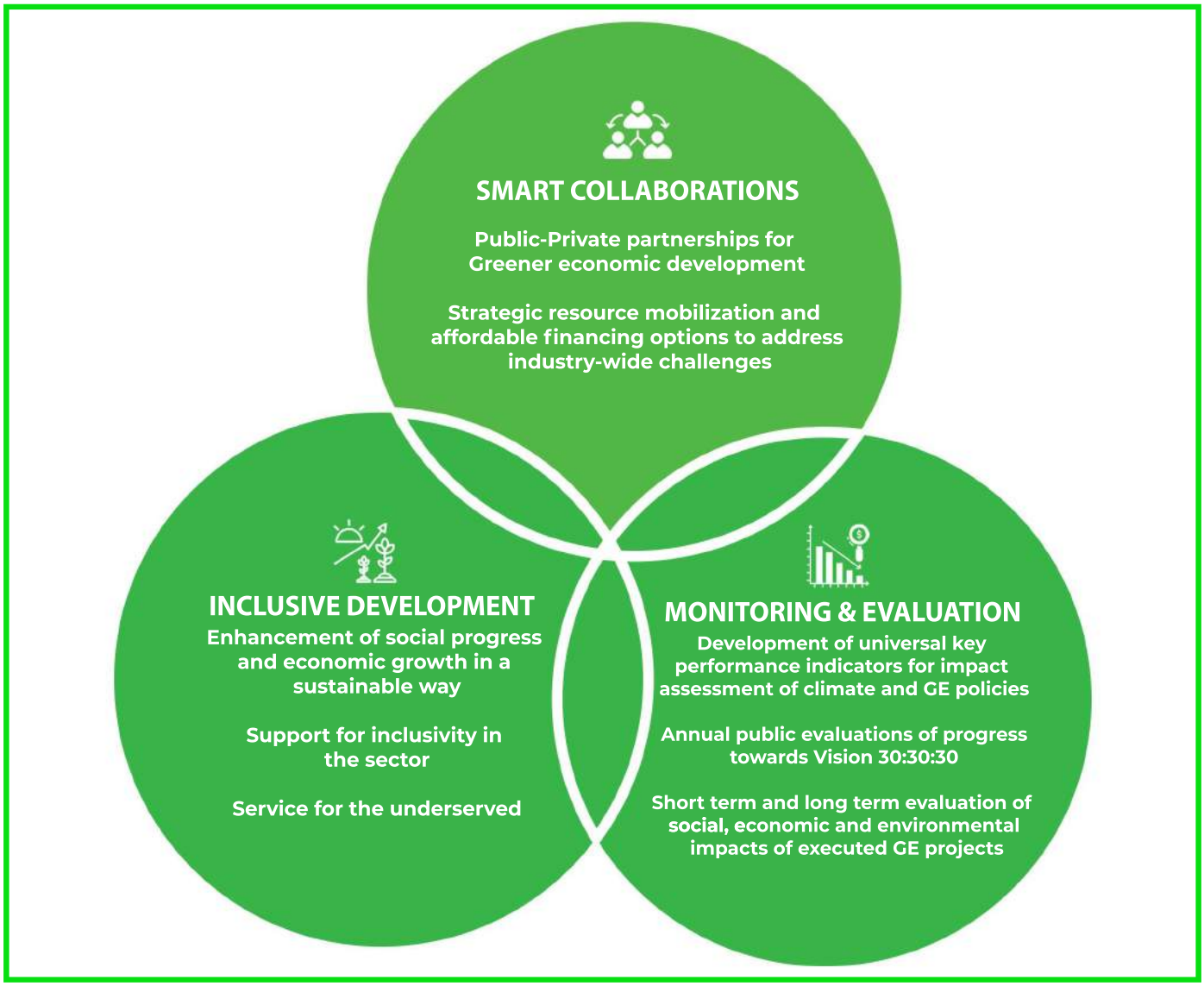
Ecosystem Support

There are several support systems available for innovators in the space to take advantage of. While finance seems to be a pressing concern for young businesses, better understanding of the sector and the business of renewables is necessary to access available funds, and to create scale-able businesses with clear paths to returns on investments. Organizations like the NCIC, SMEFUNDS Capital, Nigerian Energy Support Programme, Nigeria Power Sector Program, Energy Training Centre (ETC), All On, ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) and others provide financial support, business development services, and trainings. REAN also organizes training and development programs for her members regularly.
Government can cultivate a low-risk environment by using policy derisking instruments and financial de-risking instruments, and showing public support/advocacy for the sector. Policy instruments address the barriers that are the root cause of an investment risk. These types of instruments are typically policy and programmatic interventions that reduce the probability of a bad outcome for investors. An example of a policy derisking instrument to mitigate the risk of grid expansion forcing mini-grid operators out of business, is to establish good and transparent grid planning, including public reports on plans for off-grid service areas, in which mini-grid operators are unlikely to be affected by grid extension.

On the other hand, financial de-risking instruments do not directly address the underlying barriers but instead work by transferring financial losses, in the event of an unfavourable outcome, to a third party, such as a development bank. These instruments are typically public loans, credit lines or guarantees of some sort. A financial de-risking instrument to address the risk of grid-extension described above is the establishment of a compensation scheme, which can reimburse mini-grid operators for their losses in case the grid is extended to their service area.

Recognizing that all risks cannot be reduced through policy derisking or transferred through financial derisking, a third group of public instruments can be used to compensates investors for continued exposure to risks with higher returns. These direct financial incentives can take a number of different forms including capital subsidies, tax breaks and proceeds from carbon offsets. Government efforts and their national impact can be regularly evaluated for accountability and to incentivize measurable progress.

In addition to public instruments, the private sector addresses risks through business model design, good management practices, investment diversification, and contractual arrangements. For example, end-user credit risks can be mitigated through in-house assessment of credit worthiness and risk modelling using other indicators (e.g., employment, family members etc) or initial connection fees. Furthermore, the use of smart meters discourages electricity theft, due to accurate and standardized billing systems that incentivize payment. Proper staff training can also mitigate general operation risks. These approaches, combined with investment into



businesses operating different models in different communities, reduces the likelihood of damaging investment risks materializing. In Nigeria's early-stage markets, where many initial barriers exist, private sector derisking measures play a crucial role (Agenbroad et al., 2017; Blodgett et al., 2017).

Towards sustainable Renewables

Clean energy keeps getting cheaper. On the generation side, SHS costs have decreased by more than 99% in the last 40 years. Battery technologies are evolving and similarly becoming more efficient, moving from lead-acid to lithium-ion, and lithium-ion battery cell costs have fallen by 79% since 2010 (BNEF, 2017). There is an estimated 25 percent increase globally in the manufacturing of rechargeable batteries each year. On the demand side, an important development has been recent improvements in energy efficient appliances, overall energy waste is reducing and RE capacity is increasing. Closely related to new business models around 'energy as a service', businesses now offer newly built households an entire hardware package, including energy efficient appliances, solar systems/mini-grid supply, installation and maintenance. (Kavlak et al., 2016; Kittner et al., 2017).
While these changes confer growth in the industry, there is a risk arising from the lack of policies and planning regarding disposal of hardware including batteries and end-of-life mini-grids. Because these grids have longer life-spans, it is an aspect of development that is yet to be addressed directly.

However, it is important to invest in renewable energy businesses that address recycling of batteries and end of life grid equipment, innovating to find potential circularity opportunities, where RE wastes can be converted to raw materials for other industries. Beyond innovations to improve battery life, there have been new discoveries in improving the battery recycling process. Recently, researchers in Finland have discovered that electrodes in lithium batteries containing cobalt can be reused following a special process. In comparison to traditional recycling, which typically extracts metals from crushed batteries by melting or dissolving them, the new process—which newly saturates the electrodes with lithium—saves valuable raw materials, and likely also energy[44]. Many raw materials used in the batteries, such as cobalt, may soon be in short supply. The European Commission is preparing a new battery decree, which would require the recycling of 95 percent of the cobalt in batteries, but such policies are lacking in Nigeria, to the detriment of the economy and the environment.

Opportunities for Investments

Digitalisation has revolutionised operational models for off-grid energy services. Mobile communications have facilitated new payment models (mobile money, allowed for remote shut-off in case of non-payments, and real-time monitoring of hardware performance for maintenance purposes). New software allows for smart meters, and differentiated tariffs. Fintech solutions, often related to mobile money, have transformed approaches to end-user credit assessment (SDFA, 2018). The end result of these technological advancements is that private electrification entrepreneurs provide better service while managing their customers at lower cost.

There has been tremendous innovation in terms of private sector business models. The solar home system sector has seen significant innovation, with third party ownership models where SHS companies offer rent-to-own or perpetual lease services. These service offerings combine technology and financing, and have the advantage of eliminating up-front costs for households. In solar mini-grids, there are a variety of different ownership models, market strategies and approaches. An important area for solar mini-grids are opportunities around aggregation and modular approaches, where power purchase agreements are tailored for the market needs on a case-by-case basis, allowing for business flexibility and improved market access. Biofuels support for solar off-grid technology is an important aspect to explore, particularly in rural areas, to boost local demand for electricity and economic activities in farming communities. Biofuel generator technology is even younger than solar, and as such receives limited support due to perceived risks, however, in a continent where the majority of the labour force is employed in agriculture, biofuels are not only a source of clean energy, but are also a potential export good.

Industry collaborations, as were seen during the pandemic where grants were made available for the installation of solar systems in healthcare facilities, are the future of the industry. The Education, Agriculture and Healthcare sectors appear to be underserved by RE entrepreneurs, from the results of the study. Renewable energy businesses catering to these sectors stand to expand not only their market share, but also to access affordable funding provided for businesses in those sectors. Collaborations make the entire economy greener, reducing national emissions.

In summary, the renewable energy ecosystem in Nigeria is on the right track, however a low-risk investment environment must be developed for fast returns on investments to materialize. Future studies should analyse in-depth the political obstacles and opportunities for de-risking and develop recommendations that enable its fast and comprehensive implementation.

“...it is important to invest in renewable energy businesses that address recycling of batteries and end of life grid equipment, innovating to find potential circularity opportunities, where RE wastes can be converted to raw materials for other industries.”

44. https://www.goodnewsnetwork.org/battery-parts-recycled-without-crushing-melting-aalto/

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