



WORLD BANK GROUP



ECREEE
TOWARDS SUSTAINABLE ENERGY

REGIONAL OFF-GRID ELECTRIFICATION PROJECT

Off-Grid Solar Market Assessment & Private Sector Support Facility Design

NIGERIA REPORT

JULY 2019



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ABBREVIATIONS & ACRONYMS

ABP	Anchor Borrowers' Programme
AFD	Agence Française de Développement (French Development Agency)
AfDB	African Development Bank
ASD	African Solar Designs
BDC	Business Development Company
BOA	Bank of Agriculture
BoI	Bank of Industry
BTG	Beyond the Grid
BVN	Bank Verification Number
C&I	Commercial & Industrial
CACS	Commercial Agriculture Credit Scheme
CAPEX	Capital Expenditure
CAR	Capital Adequacy Ratio
CBN	Central Bank of Nigeria
CEADIR	Climate Economic Analysis for Development, Investment, and Resilience
CFA	Communauté Financière Africaine (African Financial Community)
COD	Cash-on-Delivery
CRMS	Credit Risk Management System
DBN	Development Bank of Nigeria
DCA	Development Credit Authority
DisCos	Distribution Companies
DFI	Development Finance Institution
DFID	Department for International Development
DMB	Deposit Money Bank
DRE	Decentralized Renewable Energy
DRET	Decentralized Renewable Energy Taskforce
EBID	ECOWAS Bank for Investment and Development
ECA	Export Credit Agency
ECN	Energy Commission of Nigeria
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
ECOWREX	ECOWAS Observatory for Renewable Energy and Energy Efficiency
ECREEE	ECOWAS Center for Renewable Energy and Energy Efficiency
EEDC	Enugu Electricity Distribution Company
EFInA	Enhancing Financial Innovation and Access
EIB	European Investment Bank
ERERA	ECOWAS Regional Electricity Regulatory Authority
ERGP	Economic and Recovery Growth Plan
ESMAP	Energy Sector Management Assistance Program
ESRM	Environmental and Social Risk Management
EU	European Union
EUR	Euro
EVA	Energio Verda Africa
FAO	Food and Agriculture Organization of the United Nations
FBN	First Bank of Nigeria Limited
FCMB	First City Monument Bank
FEI	Facility for Energy Inclusion
FGD	Focus Group Discussion

FGN	Federal Government of Nigeria
FI	Financial Institution
FIRS	Federal Inland Revenue Service
FMBN	Federal Mortgage Bank of Nigeria
FME	Federal Ministry of Environment
FMITI	Ministry of Industry, Trade, and Investment
FMPWH	Federal Ministry of Power, Works and Housing
FX	Foreign Exchange
GCF	Green Climate Fund
GDP	Gross Domestic Product
GenCos	Generation Companies
GEF	Global Environment Facility
GIIN	Global Impact Investing Network
GIS	Geographic Information Data
GIZ	German Corporation for International Cooperation
GNI	Gross National Income
GOGLA	Global Off-Grid Lighting Association
GSMA	Global System for Mobile Communications / Groupe Spéciale Mobile Association
GVE	Green Village Electricity
HC	Health Center
HDI	Human Development Index
HH	Household
ICT	Information and Communications Technology
IDA	International Development Association
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IEDN	Independent Electricity Distribution Networks
IFC	International Finance Corporation
IMF	International Monetary Fund
IPP	Independent Power Producer
IRP	Independent Resource Plan
IRENA	International Renewable Energy Agency
JICA	Japan International Cooperation Agency
kW	Kilowatt
kWh	Kilowatt-hour
LTO	Lease-to-Own
MAN	Manufacturers Association of Nigeria
MFB	Microfinance Bank
MFI	Microfinance Institution
MIGA	Multilateral Investment Guarantee Agency
MMO	Mobile Money Operators
MNO	Mobile Network Operator
MOFI	Ministry of Finance Incorporated
MoU	Memorandum of Understanding
MPWH	Ministry of Power, Works and Housing
MSME	Micro, Small and Medium Enterprise
MSMEDF	Micro, Small and Medium Enterprise Development Fund
MTF	Multi-Tier Energy Access Framework
MW	Megawatt
MYTO	Multi-Year Tariff Order

NACCIMA	Nigerian Association of Chambers of Commerce, Mines & Industry
NAFDAC	National Agency for Food, Drugs, Administration & Control
NAPTIN	National Power Training Institute of Nigeria
NAQS	Nigerian Agricultural Quarantine Services
NBET	Nigeria Bulk Electricity Trader
NCC	Nigerian Communications Commission
NCIC	Nigeria Climate Innovation Center
NCS	Nigeria Customs Service
NDF	Nordic Development Fund
NDLEA	National Drug Law Enforcement Agency
NDPHC	Niger Delta Power Holding Company
NEAF	Nigeria Energy Access Fund
NEP	National Electrification Project
NERC	Nigerian Electricity Regulatory Commission
NESP	Nigerian Energy Support Programme
NEXIM	Nigerian Export-Import Bank
NFIS	National Financial Inclusion Strategy
NGN	Nigerian Naira
NGO	Non-Governmental Organization
NIBSS	Nigeria Inter-Bank Settlement System
NIDB	Nigerian Industrial Development Bank
NMIS	Nigeria MDG Information System
NPL	Non-Performing Loan
NREAP	National Renewable Energy Action Plan
O&M	Operations and Maintenance
OGS	Off-Grid Solar
OPIC	Overseas Private Investment Corporation
PAYG	Pay-As-You-Go
PCB	Private Credit Bureau
PFI	Participating Financial Institution
PHCN	Power Holding Company of Nigeria
POS	Point of Sale
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PSRP	Power Sector Recovery Plan
PTFN	Presidential Task Force on Power
PUE	Productive Use of Energy
PV	Photovoltaic
RE	Renewable Energy
REA	Rural Electrification Agency
REAN	Renewable Energy Association of Nigeria
REEEP	Renewable Energy and Energy Efficiency Program
REF	Rural Electrification Fund
REFOG	Rural Electrification Fund Operational Guidelines
RESIP	Rural Electrification Strategy and Implementation Plan
RISE	Regulatory Indicators for Sustainable Energy
ROA	Return on Assets
ROE	Return on Equity
ROGEP	Regional Off-Grid Electrification Project
RUWES	Rural Women Energy Security

SANEP	Shared Agent Network Expansion Program
SEF	Sustainable Energy Finance
SEFA	Sustainable Energy Fund for Africa
SEforALL	Sustainable Energy for All
SEPAN	Sustainable Energy Practitioners Association of Nigeria
SHS	Solar Home System
SIDA	Swedish International Development Cooperation Agency
SME	Small and Medium Enterprises
SOGE	Scaling Off-Grid Energy Grand Challenge for Development
SON	Standards Organization of Nigeria
SPV	Special Purpose Vehicle
SSA	Sub-Saharan Africa
STMAA	Secured Transactions in Movable Assets Act
SUNREF	Sustainable Use of Natural Resources and Energy Finance
TA	Technical Assistance
TCN	Transmission Company of Nigeria
TEM	Transitional Electricity Market
UBA	United Bank for Africa
UKEF	United Kingdom Export Finance
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USADF	United States Africa Development Foundation
USAID	United States Agency for International Development
USD	United States Dollar
WAPP	West African Power Pool
WB	World Bank
Wh	Watt-hour
Wp	Watt peak

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NOTE: The findings, analysis, conclusions and recommendations expressed in this report are those of the authors – they do not necessarily represent the views of ECREEE, the World Bank, or any of the individuals and organizations that contributed to this study.

KEY DEFINITIONS

ELECTRICITY ACCESS

For the purpose of this analysis, figures on national, urban and rural electrification rates are from the International Energy Agency (IEA) Energy Access Outlook Report, 2017.¹ Although local government authorities (energy ministries, rural electrification agencies, utilities etc.) may have different or more up-to-date electrification data, one single, uniformly-accepted source was necessary as a baseline to assess electricity access figures across all 19 of the countries analyzed under this regional market assessment.

There is no single internationally-accepted and internationally-adopted definition of modern energy access. The IEA defines energy access as “a household having reliable and affordable access to both clean cooking facilities and to electricity, which is enough to supply a basic bundle of energy services initially, and then an increasing level of electricity over time to reach the regional average.”² A “basic bundle of energy services” means, at a minimum, several lightbulbs, task lighting (such as a flashlight or lantern), phone charging and a radio. This definition of energy access serves as a benchmark to measure progress towards UN Sustainable Development Goal 7.³ The IEA electricity access statistics presented in this report include household connections, either from a grid connection or from a renewable energy-based off-grid source; the approach excludes illegal connections. The data is sourced wherever possible from governments, supplemented by data from multilateral development banks, various international organizations and other publicly available statistics.

The Multi-Tier Energy Access Framework (MTF) is also used as a key reference throughout this report. Rather than measuring electricity access as a household connection to an electricity grid, the MTF views electricity access along a continuum of service levels (tiers) and according to a series of indicators, including capacity, availability/duration of supply, reliability, quality, affordability, legality and health/safety.⁴

OFF-GRID / STAND-ALONE SOLAR

The term “off-grid” as it is widely used throughout this report (e.g. “off-grid sector”) refers to both mini-grids and stand-alone systems. When “off-grid solar” or its acronym “OGS” are used, this refers *only* to stand-alone solar systems and does not include mini-grids. The main focus of this market assessment is the stand-alone solar sector. While micro/mini-grids typically provide a small community with electricity, stand-alone solar systems are not connected to an electricity distribution system and typically include a battery, but may also be used in conjunction with a diesel generator, wind turbine etc. Stand-alone solar technology broadly includes the following:

- Pico solar/solar lanterns⁵
- Single module solar systems (DC)⁶
- Multiple module solar systems (AC)⁷
- Large solar systems (AC)⁸

In addition to providing electricity access, stand-alone solar products/systems also support a wide range of productive applications (e.g. solar water pumping, agricultural processing, milling equipment, refrigeration etc.).

¹ https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf

² <https://www.iea.org/energyaccess/methodology/>

³ <https://sustainabledevelopment.un.org/sdg7>

⁴ “Multi-Tier Framework for Measuring Energy Access,” World Bank ESMAP: <https://www.esmap.org/node/55526>

⁵ Typically less than 10 Wp; all-in-one lighting and/or phone charging; enables partial or full Tier 1 electricity access

⁶ Typically 11-100 Wp; capable of powering a few appliances (lights, mobile phone charging, TV, radio, fan etc.); often referred to as a “plug-and-play” solar home system when components are sold as a set; enables full Tier 1 or higher electricity access

⁷ Typically 101-500 Wp; capable of powering multiple appliances; requires small inverter

⁸ Typically greater than 500 Wp; most often used to power a large home; requires large inverter

Multi-tier Matrix for Measuring Access to Household Electricity Supply

		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5	
ATTRIBUTES	1. Peak Capacity	Power capacity ratings ²⁸ (in W or daily Wh)	Min 3 W	Min 50 W	Min 200 W	Min 800 W	Min 2 kW	
			Min 12 Wh	Min 200 Wh	Min 1.0 kWh	Min 3.4 kWh	Min 8.2 kWh	
		OR Services	Lighting of 1,000 lmhr/day	Electrical lighting, air circulation, television, and phone charging are possible				
	2. Availability (Duration)	Hours per day	Min 4 hrs	Min 4 hrs	Min 8 hrs	Min 16 hrs	Min 23 hrs	
		Hours per evening	Min 1 hr	Min 2 hrs	Min 3 hrs	Min 4 hrs	Min 4 hrs	
	3. Reliability						Max 14 disruptions per week	Max 3 disruptions per week of total duration <2 hrs
	4. Quality						Voltage problems do not affect the use of desired appliances	
5. Affordability						Cost of a standard consumption package of 365 kWh/year < 5% of household income		
6. Legality						Bill is paid to the utility, pre-paid card seller, or authorized representative		
7. Health & Safety						Absence of past accidents and perception of high risk in the future		

Source: World Bank Energy Sector Management Assistance Program (ESMAP)

WEST AFRICA AND THE SAHEL

The term “West Africa and the Sahel” as it is used to throughout this report refers to the 19 countries covered by the first phase of the Regional Off-Grid Electrification Project (ROGEP). The countries include the 15 member states of the Economic Community of West African States (ECOWAS) – Benin, Burkina Faso, Cabo Verde, Côte d’Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Sierra Leone, Senegal and Togo – plus Cameroon, Central African Republic, Chad and Mauritania.

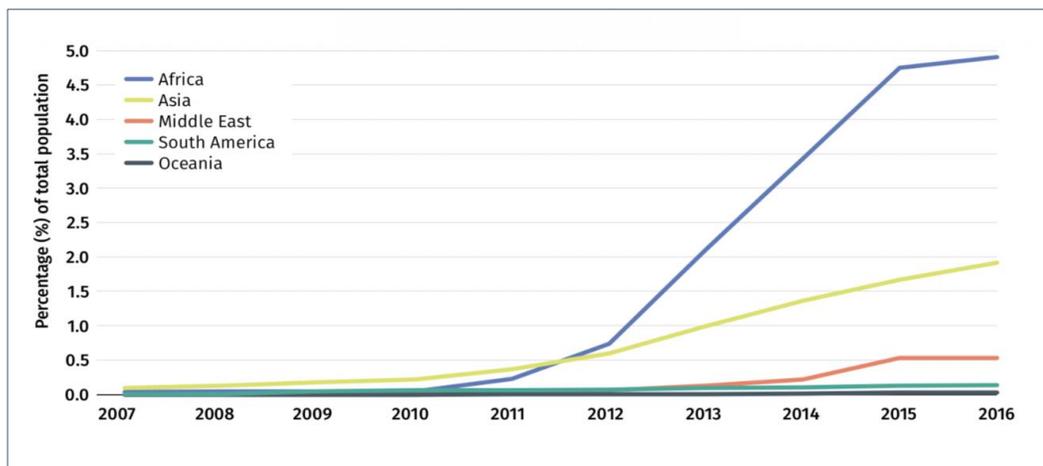


EXECUTIVE SUMMARY

I. INTRODUCTION

Access to electricity in Sub-Saharan Africa has improved significantly over the past decade. The number of people without access to electricity in the region stopped increasing for the first time in 2013 and has since declined.⁹ Although grid connections continue to be the primary method of electrification, access to electricity through off-grid renewable energy systems has grown considerably. The use of off-grid solar (OGS) power is notably on the rise, with African countries accounting for most of the sector’s growth over the last decade (**Figure ES-1**). The pace of solar electrification has accelerated more rapidly in Sub-Saharan Africa than anywhere in the world.¹⁰ In order to achieve universal electrification by 2030, the International Energy Agency (IEA) estimates that Sub-Saharan Africa will need more than half of new electricity access connections between 2017 and 2030 to be made through decentralized systems (mini-grids and stand-alone systems), with solar technologies representing nearly 60% of these connections.¹¹

Figure ES-1: Off-Grid Solar Access Rate by Region



Tier 1 access and above

Source: International Renewable Energy Agency

Despite this progress, government efforts to increase electricity access in Africa have struggled to keep pace with rapid population growth and increasing demand. Many countries across the region must navigate the interrelated challenges of energy poverty, energy security and climate change (among other sociopolitical, economic and development challenges), which collectively slow the adoption of renewable energy and the pace of off-grid market growth. Rates of energy access remain particularly low in rural areas, where the electrification rate is less than 25% across Sub-Saharan Africa.¹² In part, this is due to the gap between the power sector’s infrastructure needs and the availability of necessary resources to expand grid electrification. Extending the grid to rural areas can be challenging due to significant transmission distances and low population densities.

⁹ “Energy Access Outlook, 2017: From Poverty to Prosperity,” International Energy Agency, (2017):

https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf

¹⁰ “Tracking SDG7 – The Energy Access Report 2018,” The World Bank, IEA, IRENA, UN Statistics Division and the WHO, (2018):

<https://openknowledge.worldbank.org/handle/10986/29812>

¹¹ Tracking SDG7 – The Energy Access Report, 2018.

¹² IEA Energy Access Outlook, 2017.

As of 2016, over 200 million people in West Africa and the Sahel – more than half of the region’s population – lacked access to electricity. This figure represents nearly one-third of Africa’s total unelectrified population. Rates of urban and rural electrification vary widely across the region, with the average rate of access nearly three times higher in urban areas.¹³

Despite these access deficits, the region is generously endowed with renewable energy resources – including hydropower, solar, wind and bioenergy. These resources are largely untapped, however, as investments in the power sector remain high-risk due to market instability, as well as a variety of political and regulatory risks. Other energy sector challenges include *inter alia* limited institutional capacity, poor utility financial performance, a shortage of local technical expertise and a lack of support from local financial institutions (FIs).

Until recently, diesel generators largely served as the expensive alternative both for rural electrification and for urban and peri-urban “bad grid” areas, where electricity was unreliable or only available for part of the day. However, the advent of decentralized renewable energy technologies, particularly stand-alone solar and mini-grid systems, offers opportunities to deliver clean and cost-effective off-grid solutions. Accordingly, policymakers are increasingly utilizing these options in electrification planning as they offer a reliable, flexible and relatively affordable complement to grid extension initiatives.

Solar energy is the most promising technology in the off-grid space, with three key trends converging to drive the industry’s growth: first, continued reductions in hardware and balance of system costs (solar modules, batteries, inverters, appliances etc.); second, a digital revolution, with mobile communication technology facilitating payments and monitoring; and third, innovation in private sector business models, such as pay-as-you go (PAYG) and third-party ownership of solar home systems (SHS), which offer energy as a service and remove previously prohibitive up-front costs for households.¹⁴ As a result of these developments, the off-grid solar market is rapidly evolving and expanding.

In 2016, the OGS market reported global revenues of approximately USD 1 billion. This figure is expected to increase to USD 8 billion by 2022, with SHS representing the majority of this revenue growth and an increasing share of unit sales (**Figure ES-2**). Investments in the off-grid solar sector doubled annually between 2012 and 2016, increasing by 98% over this period. Between 2013 and 2017, East Africa represented 86% of the global PAYG market in terms of cumulative unit sales, followed by West Africa at 12% and Asia at 2%.¹⁵ As the East African market becomes more crowded and solar companies expand their operations into West Africa, the region will account for a larger geographic share of the burgeoning global OGS market. Although the sector’s investment trends remain volatile, there is some preliminary evidence to suggest that this transition is already underway: in 2016, West Africa accounted for 34% of total funds raised, up from 9% in 2015, while East Africa’s share of funding decreased from 77% to 47% over the same period.¹⁶

¹³ IEA Energy Access Outlook, 2017.

¹⁴ “Derisking Renewable Energy Investment: Off-Grid Electrification,” United Nations Development Programme (UNDP) and ETH Zurich, (December 2018):

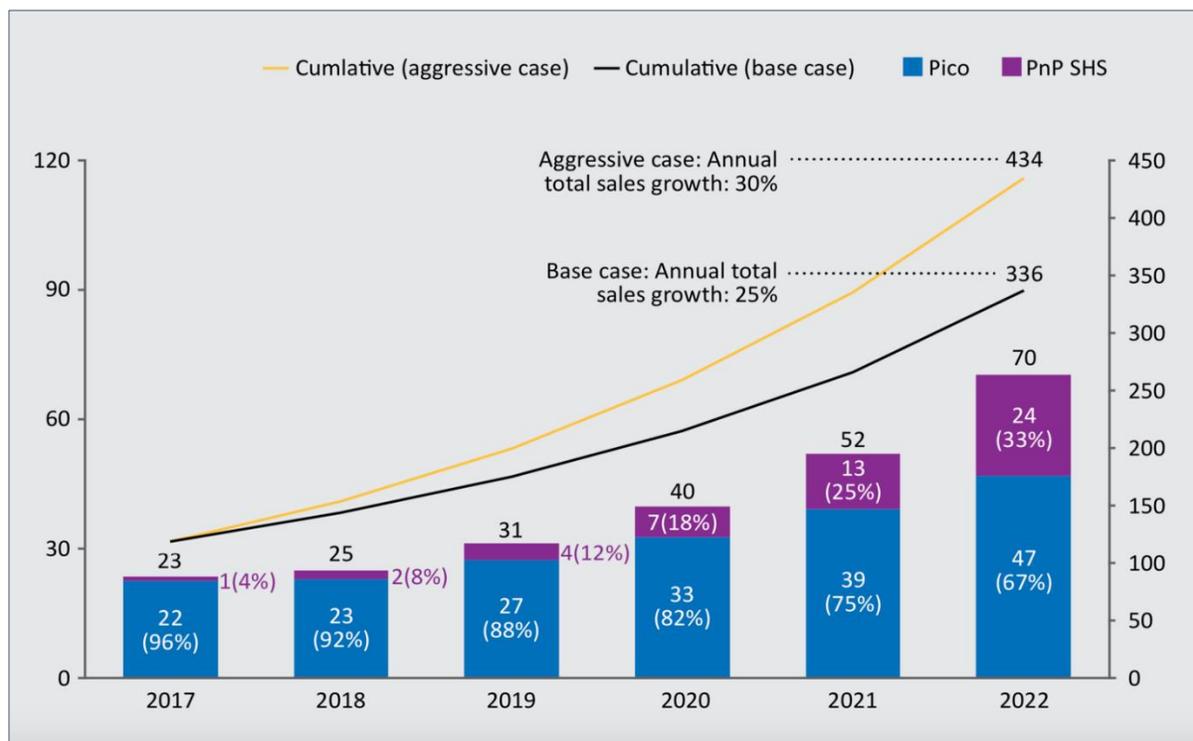
[https://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Strategies/DREI%20Off-Grid%20Electrification%20-%20Full%20Report%20\(20181210\).pdf](https://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Strategies/DREI%20Off-Grid%20Electrification%20-%20Full%20Report%20(20181210).pdf)

¹⁵ “Off-Grid Solar Market Trends Report 2018,” Dahlberg Advisors, Lighting Global, GOGLA and World Bank ESMAP, (January 2018):

https://www.lightingafrica.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf

¹⁶ Ibid.

Figure ES-2: Global Off-Grid Solar Market Forecast (million units sold)



NOTE: Left axis = annual sales volume; Right axis = cumulative sales volume; PnP SHS = Plug-and-Play Solar Home System

Source: Dahlberg Advisors, Lighting Global, GOGLA and World Bank ESMAP

Many international off-grid solar companies, including most of the industry’s leading players – BBOXX, Greenlight Planet, Azuri, d.light, Off-Grid Electric, M-KOPA Solar, Fenix International, and French utilities EDF and Engie among others – have recently entered markets in West Africa, joining international pioneers such as PEG and Lumos, which launched originally in Ghana and Nigeria, respectively, and both expanded into Côte d’Ivoire and Togo.¹⁷ While these large international companies are well capitalized, there is a dearth of financing for smaller, early-stage companies that operate in nascent markets across West Africa and the Sahel. In fact, the top 10 global off-grid solar companies have received nearly 90% of investment capital since 2012, while early-stage companies often struggle to raise the necessary capital to accelerate growth.¹⁸

In order to scale off-grid electrification, OGS companies will need to access large volumes of commercial debt financing. In the longer term, partnerships with local commercial banks and microfinance institutions (MFIs) will also be necessary in order to develop domestic, local-currency sources of financing and reduce foreign exchange risk.¹⁹ Partnerships with local FIs, whose understanding of the credit risk of local populations, may also reduce financing costs more rapidly compared to other methods (e.g. using debt from securitized receivables).²⁰ Although most financing currently comes from non-commercial sources (i.e. the

¹⁷ Bavier, J., “Off-grid power pioneers pour into West Africa,” Reuters, (February 20, 2018):

<https://www.reuters.com/article/us-africa-power-insight/off-grid-power-pioneers-pour-into-west-africa-idUSKCN1G41PE>

¹⁸ “Accelerating Energy Access: The Role of Patient Capital,” Acumen, (2018): <https://acumen.org/wp-content/uploads/Accelerating-Access-Role-of-Patient-Capital-Report.pdf>

¹⁹ UNDP and ETH Zurich, 2018.

²⁰ “How can Pay-As-You-Go Solar Be Financed?” Bloomberg New Energy Finance, (7 October 2016):

https://www.bbhuh.io/bnef/sites/4/2016/10/BNEF_WP_2016_10_07-Pay-as-you-go-solar.pdf

international development community), global capital markets have the size and depth necessary to meet this investment challenge. Nevertheless, small investment sizes and other early-stage market investment risks are currently holding back abundant and low-cost private capital flows to the off-grid sector.²¹

In order to mitigate risks and spur investment, the OGS sector requires substantial policy and regulatory support. It is therefore important that governments send a clear signal to the private sector by integrating off-grid technologies into national development programs, electrification plans and electricity access targets. Governments should also adopt favorable policies, laws and regulations to boost private sector participation, including procurement and tax incentives, grants and subsidies, concession schemes, streamlined licensing and permitting procedures, and quality standards for equipment. Additional measures include public awareness raising, encouraging inclusive gender participation, and building local capacity at all levels (e.g. solar PV vocational training and technical certification programs, training for FIs to address unfamiliarity of lenders with off-grid solar sector, corporate and consumer financing needs etc.).

In addition, solar companies increasingly rely on mobile money platforms to scale their business, as mobile payments allow them to offer low-income customers new ways to access and pay for electricity through innovative business models such as PAYG. Mobile money services, however, are only just beginning to be deployed in West Africa and the Sahel. Solar companies are therefore limited by low levels of penetration and in some cases by country-specific regulatory restrictions.²² Governments can take action to foster linkages between the off-grid solar, telecommunications and mobile money sectors to expedite the uptake of market-transforming technology platforms and business models.

Governments across West Africa and the Sahel have implemented a range of policies and approaches to support off-grid market development, including private concessions, Public Private Partnerships (PPPs), Rural Electrification Agencies (REAs) and Rural Electrification Funds (REFs), among other measures. Some countries like Senegal and Mali have adopted private concessions to scale up mini-grids in rural areas, while others, such as Nigeria and Ghana, have improved rural electrification largely through public investment.

To support these initiatives, the Economic Community of West African States (ECOWAS) adopted the ECOWAS Renewable Energy Policy (EREP) in 2013, which intends to achieve universal electricity access in the region by 2030. The EREP also aims to increase the share of the region's rural population served by decentralized renewable energy services (mini-grids and stand-alone systems) to 25% by 2030. The ECOWAS Center for Renewable Energy and Energy Efficiency (ECREEE) is working with member states to develop and implement national policies and strategies with electrification targets through 2030 in line with the EREP, including Sustainable Energy for All (SEforALL) Action Agendas and National Renewable Energy Action Plans (NREAP), among other programs in support of renewable energy and off-grid market development.²³

²¹ UNDP and ETH Zurich, 2018.

²² "Scaling Access to Energy in Africa: 20 Million Off-Grid Connections by 2030," Scaling Off-Grid Energy: A Grand Challenge for Development, USAID, UK DFID, Shell Foundation, (2018): https://static.globalinnovationexchange.org/s3fs-public/asset/document/SOGE%20YIR_FINAL.pdf?uwUDTyB3ghxOrV2gqvsO_r0L5OhWPZZb

²³ ECOWAS Renewable Energy Policy, 2013:

http://www.ecreee.org/sites/default/files/documents/ecowas_renewable_energy_policy.pdf

II. BACKGROUND AND CONTEXT OF THE ASSIGNMENT

In this context, with funding from the World Bank, ECREEE launched the Regional Off-Grid Electrification Project (ROGEP) in 19 countries in West Africa and the Sahel. The project aims to enhance shared capacity, institutions and knowledge in order to increase electricity access of households, businesses and public institutions using modern stand-alone solar systems through a harmonized regional approach. ROGEP has two main components/objectives:

✓ **Component 1: Accelerate development of a regional off-grid solar market:**

- (1A) Foster regional collaboration and promote a supportive enabling environment for the OGS sector;
- (1B) Provide entrepreneurship technical support to OGS companies at various stages of development (training to accelerate business growth and/or facilitate market entry);
- (1C) Provide entrepreneurship financial support to OGS companies at various stages of development (matching grants);
- (1D) Provide financing to remove barriers in challenging markets (market entry grants and performance grants to OGS companies operating in challenging markets)

✓ **Component 2: Facilitate access to financing for off-grid solar businesses:**

- (2A) Provide line of credit for OGS businesses via the West African Development Bank (Banque Ouest Africaine de Développement, BOAD) to be extended to local FIs for on-lending to local entrepreneurs (working capital for companies to finance equipment imports, receivables from PAYG schemes etc.)
- (2B) Implement contingent grant facility via BOAD to share risks with local FIs and encourage lending to OGS businesses.

In addition, the project intends to support a range of capacity building activities targeting public and private sector stakeholders to address existing policy, regulatory, institutional, financial, economic, business, technology and capacity related barriers. ECREEE will also assist each country with development and implementation of national programs and initiatives in the areas of renewable energy, rural electrification and energy access in line with the regional focus of the assignment.

Under the first phase of the project, an initial assessment of the off-grid solar market was undertaken in each of the 19 countries. The study focused exclusively on the stand-alone solar PV market and did not assess mini-grids (see **Key Definitions**). The scope of work was broadly divided into the following tasks:

- (1) Review the current enabling policy and market environment for the off-grid solar sector
- (2) Analyze the market for off-grid solar products and systems, including an estimate of demand from the household, institutional and productive use market segments and analysis of the supply chain;
- (3) Assess the willingness and capacity of national and regional financial institutions to provide commercial and/or consumer financing to the off-grid solar sector; and
- (4) Propose models to incentivize the private sector and financial institutions to support off-grid solar market development and to harmonize a regional market to achieve universal access.

Available geographic information system (GIS) data for each country supported the Task 1 and Task 2 analyses. A least-cost electrification analysis was undertaken utilizing geospatial mapping to assess the potential development of electricity access and grid coverage in each country through 2023 and 2030. The study estimated the total number of potential settlements, people and households electrified by on-grid, mini-grid or off-grid stand-alone solutions under each timeframe based on a series of indicators, including national electricity grid proximity, population density and nodes of economic growth. The assessment was

also performed for health facilities and education centers (although the analysis was limited by the availability and/or quality of GIS data for these market segments). The results of the analysis were used to estimate the share of the population suitable for off-grid stand-alone solar solutions over the analyzed periods and to assess corresponding potential demand from the household sector under the Task 2 market sizing.

Within the context of this assignment, a gender-focused analysis was also implemented in order to assess the level of female participation in each country’s off-grid energy sector. Each stage of the market study therefore analyzed inclusive participation and gender implications. A comprehensive gender profile is presented in **Annex 4**, including a summary of findings, as well as recommendations to improve gender equality and enhance women’s engagement in development of the off-grid sector.

To carry out these tasks, the project team utilized a combination of desk research, input from local country experts and feedback from engagement with a wide range of stakeholders at the country and regional levels. Interviews were conducted with policymakers, industry experts, and representatives from solar companies and financial institutions. Focus group discussions were also held in each country with key stakeholders from the four market segments analyzed under Task 2 (household, institutional, productive use and supplier). Focus group participants included representatives from government, the donor community, NGOs, solar companies, business and industry associations, academia, community groups, and women’s groups. In addition to the focus group meetings, surveys were administered in order to collect additional Task 2 market data, including (i) a survey of international solar companies to gauge their level of interest in the region; (ii) a survey of local solar companies and retail suppliers in each country to inform the supply chain analysis; and (iii) an assessment of an off-grid village in each country to better understand how solar is being utilized for productive uses. Under Task 3, a survey was administered to local and regional FIs to determine their level of capacity and interest in lending to the off-grid solar sector. A detailed description of the methodology used to carry out these tasks is presented in **Annexes 1-3**.

This report is organized into three sections that correspond to Tasks 1-3 described in the scope of work above (Task 4 was prepared in a separate report). **Section 1** covers the enabling policy and market environment for the OGS sector. This includes an overview of the status of the on-grid and off-grid markets, an analysis of off-grid energy policy and regulation and gaps in the existing framework, and a summary of off-grid development initiatives. The results of the least-cost electrification analysis are also included in this section.

Section 2 estimates the potential market for off-grid solar products and systems by assessing potential demand from the household, institutional and productive use market segments (**Figure ES-3**), followed by an analysis of the supply chain. The household market sizing utilizes results from the least-cost electrification analysis, along with data on household income and energy expenditure, in order to estimate potential demand based on the number of households able to afford various OGS systems. Both the cash and financed market potential were estimated for 2018, 2023 and 2030.

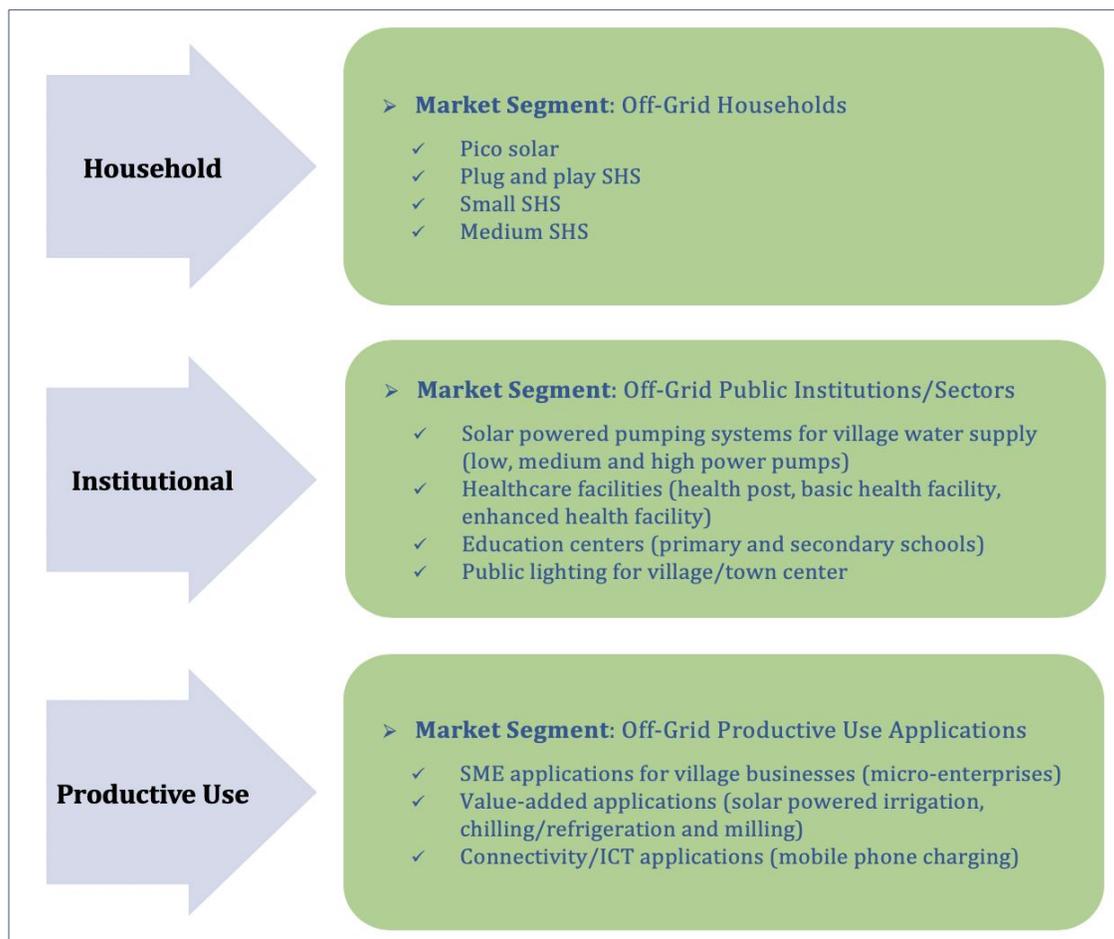
The institutional sector analysis combines available GIS data with secondary research to estimate potential demand based on assumptions about the electricity needs, usage patterns and associated costs of solar electrification of four public/institutional markets – water supply for off-grid communities, healthcare facilities, education centers (primary and secondary schools) and public lighting. Where GIS data was unavailable, per capita comparisons were made using data from similar countries to estimate off-grid solar demand by market segment (see **Annex 2** for country categorization). The productive use of energy (PUE) market sizing estimates potential off-grid solar demand for SME, value-added and connectivity applications. Feedback from stakeholder interviews and focus group discussions informed the analysis and

helped characterize each market segment’s consumer perceptions, interest, awareness, ability to pay and access to finance.

The Task 2 supply chain analysis presents an overview of key market actors, solar products and services, sales figures and business models, and includes a discussion of the role of informal market players and the impact of uncertified products. The analysis also addresses the capacity needs of the supply chain and describes specific areas of support where technical assistance is needed to accelerate market growth.

Section 3 assesses the willingness and capability of national and regional financial institutions (FIs) to provide commercial and/or consumer financing to the off-grid solar sector in each country. This section includes a summary of financial products for the off-grid sector, a comprehensive overview of each country’s financial market and commercial lending environment (including analysis of commercial banks, microfinance institutions and other non-bank financial institutions) and any programs supporting off-grid solar lending. This section also examines the scope of financial inclusion in each country and the impact of digital financial services and mobile money on access to finance. It concludes with the results of surveys that were administered to financial institutions in each country across the region.

Figure ES-3: Analyzed Off-Grid Market Segments



NOTE: SHS = Solar Home System; ICT = Information Communication Technology

III. EXECUTIVE SUMMARY

Nigeria is Africa's most populous nation and its largest economy. The population reached 190 million in 2017 and continues to grow steadily. Nigeria is Africa's biggest oil exporter and has the largest natural gas reserves on the Continent. The economy relies heavily on oil as its main source of government revenue, accounting for approximately 90% of export earnings. Economic growth has emerged from the 2016 recession and rates of growth in the near-term are promising.²⁴ While Nigeria has an abundance of natural resources, endemic corruption, lack of economic diversification, insecurity, and rapid population growth are all major challenges facing the economy. Poverty also remains widespread, particularly in rural areas. In response, the Federal Government of Nigeria (FGN) has initiated structural reforms aimed at diversifying the economy and setting the country on a path towards sustained and inclusive economic growth in the medium-to-long-term.

Access to electricity remains an ongoing challenge and is a key barrier to economic development. There is a huge gap between demand for electricity and available supply in Nigeria, which means that many Nigerian businesses and homes produce their own power for commercial, industrial and residential uses. Even where grid connections exist, power supply is often unreliable, with fewer than one-third of firms and households reporting reliable access to electricity when surveyed.²⁵ In 2016, approximately 40% of the population – an estimated 74 million people – lacked access to electricity, with a significant disparity in rates of access between urban (86%) and rural (34%) areas.²⁶ The FGN aims to increase the national electrification rate to 90% by 2030 and aims to achieve universal access by 2040.

Off-grid solar is advantageous in Nigeria, given that a significant share of the economy is already powered by small-scale generators and a huge part of the population has limited or no access to the grid. The result is that there is an urgent need to develop the country's off-grid sector, which the Government is prioritizing through a series of policies, regulations and financial interventions due to be implemented over the next five years. To date, the Government's efforts to establish a supportive policy and regulatory framework for the off-grid sector are progressing well, as evidenced by the country's 18-point improvement in its World Bank Regulatory Indicators for Sustainable Energy (RISE) energy access score between 2015 and 2017. Despite this improvement, in the 2017 RISE evaluation, Nigeria ranked 10th among countries in West Africa and the Sahel.²⁷

Several off-grid programs are in various stages of implementation by the FGN, managed by Nigeria's Rural Electrification Agency (REA), with funding and support from development partners. With support from ECREEE, the Government has outlined its commitments and initiatives to develop renewable energy and meet its electrification targets in its SEforALL National Renewable Energy Action Plan. Under the Rural Electrification Strategy and Implementation Plan (RESIP), which is currently under development, REA will administer a Rural Electrification Fund (REF) to provide developers with financial incentives to expand rural electricity access – rather than offering consumer-financing options to make access affordable. In addition to REA, various public authorities at the federal and state levels, along with private sector suppliers

²⁴ "Nigeria Economic Outlook," African Economic Outlook, African Development Bank, (2018):

<https://www.afdb.org/en/countries/west-africa/nigeria/nigeria-economic-outlook/>

²⁵ Blimpo, M., and Cosgrove-Davies, M., "Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact," AFD and World Bank, Africa Development Forum, (2019):

<https://openknowledge.worldbank.org/bitstream/handle/10986/31333/9781464813610.pdf?sequence=6&isAllowed=y>

²⁶ IEA Energy Access Outlook, 2017.

²⁷ "Policy Matters: Regulatory Indicators for Sustainable Energy," World Bank ESMAP, (2018):

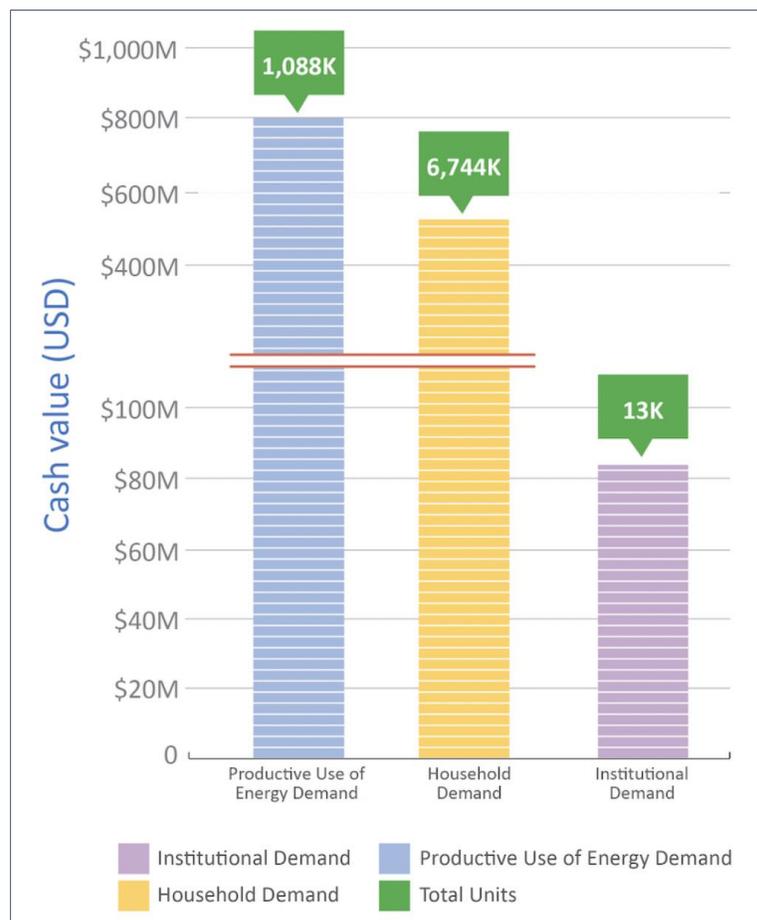
<http://documents.worldbank.org/curated/en/553071544206394642/pdf/132782-replacement-PUBLIC-RiseReport-HighRes.pdf>

and service providers will be involved in the sector’s development, increasing access through DisCos as well as other public and privately-funded initiatives.²⁸

The Nigeria Electrification Project (NEP) is another key initiative in the off-grid sector. The NEP is a USD 350 million program funded by the World Bank that aims to leverage private sector investments in solar mini-grids and stand-alone solar systems in order to provide electricity for 2.5 million people and 70,000 SMEs.²⁹ This project aims to develop a pipeline of local investments and financial incentives to catalyze off-grid market growth.

This report assesses the market opportunity for off-grid solar products and systems by estimating demand from the household, institutional, and productive use sectors in Nigeria (**Figure ES-4**). According to the assessment, there is a significant OGS market opportunity, with the annualized cash market potential in 2018 estimated to be USD 1.41 billion. The productive use sector (USD 800.3M) makes up the majority of estimated demand, followed by the household (USD 523.6M) and institutional (USD 83.6M) sectors.

Figure ES-4: Indicative Total Cash Market Potential for Off-Grid Solar Products in Nigeria, 2018



Source: African Solar Designs analysis

²⁸ “Rural Electrification Strategy and Implementation Plan,” Federal Ministry of Power, Works and Housing, Rural Electrification Agency, (2016): <http://rea.gov.ng/file/2017/09/RESIP.pdf>

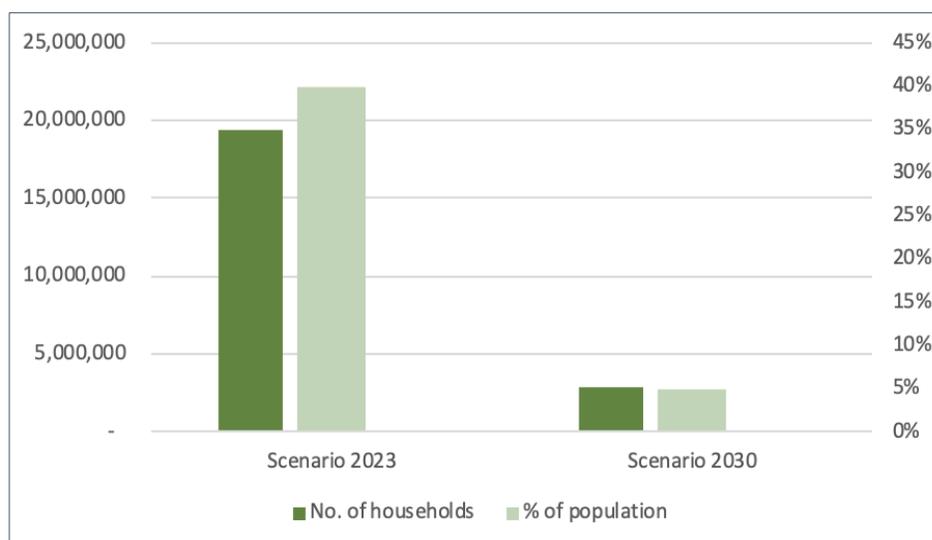
²⁹ “World Bank Approves \$350M for REA Off-Grid Projects,” REA, (2018): <http://rea.gov.ng/wbank-approves-350m-for-reas-solar-power-projects-in-schools-others/>

According to the least-cost electrification analysis, by 2023, 12,859 settlements across Nigeria (26,616,625 households) will be connected to the main grid, representing 54.8% of the population. By 2030, this figure will increase to 34,774 settlements (51,255,626 households), equivalent to 88.1% of the population. These estimates are based on the assumption that all planned grid extensions will be completed by 2030.

In the off-grid sector, the analysis identified 30,106 settlements (19,363,114 households) and 39.9% of the population in 2023 are suitable for off-grid stand-alone solutions, decreasing to 5,559 settlements (2,843,258 households) and 4.9% of the population in 2030.

While the total size of the off-grid solar market for households will decrease over time, it will also become more concentrated in certain regions. For example, by 2030, the OGS market in the south of the country will shrink significantly while the number of off-grid households will become more concentrated in the northern districts, particularly in Niger, Taraba, Borno and Bauchi. This trend has implications for long-term business models of the solar product market, which will need to consider broader distribution areas as the total number of off-grid households declines and becomes concentrated in areas far from urban centers.

Figure ES-5: Estimated Number of Households and Share of Population Suitable for OGS Systems in Nigeria, 2023 and 2030



Source: African Solar Designs analysis

According to the analysis, the annualized off-grid solar cash market potential for the household sector in 2018 is USD 523.6 million, with the estimated market value more than tripling in size to USD 1.4 billion with the addition of consumer financing (Figure ES-6). Consumer financing allows the poorest households to enter the market and those already in the market to afford larger systems.

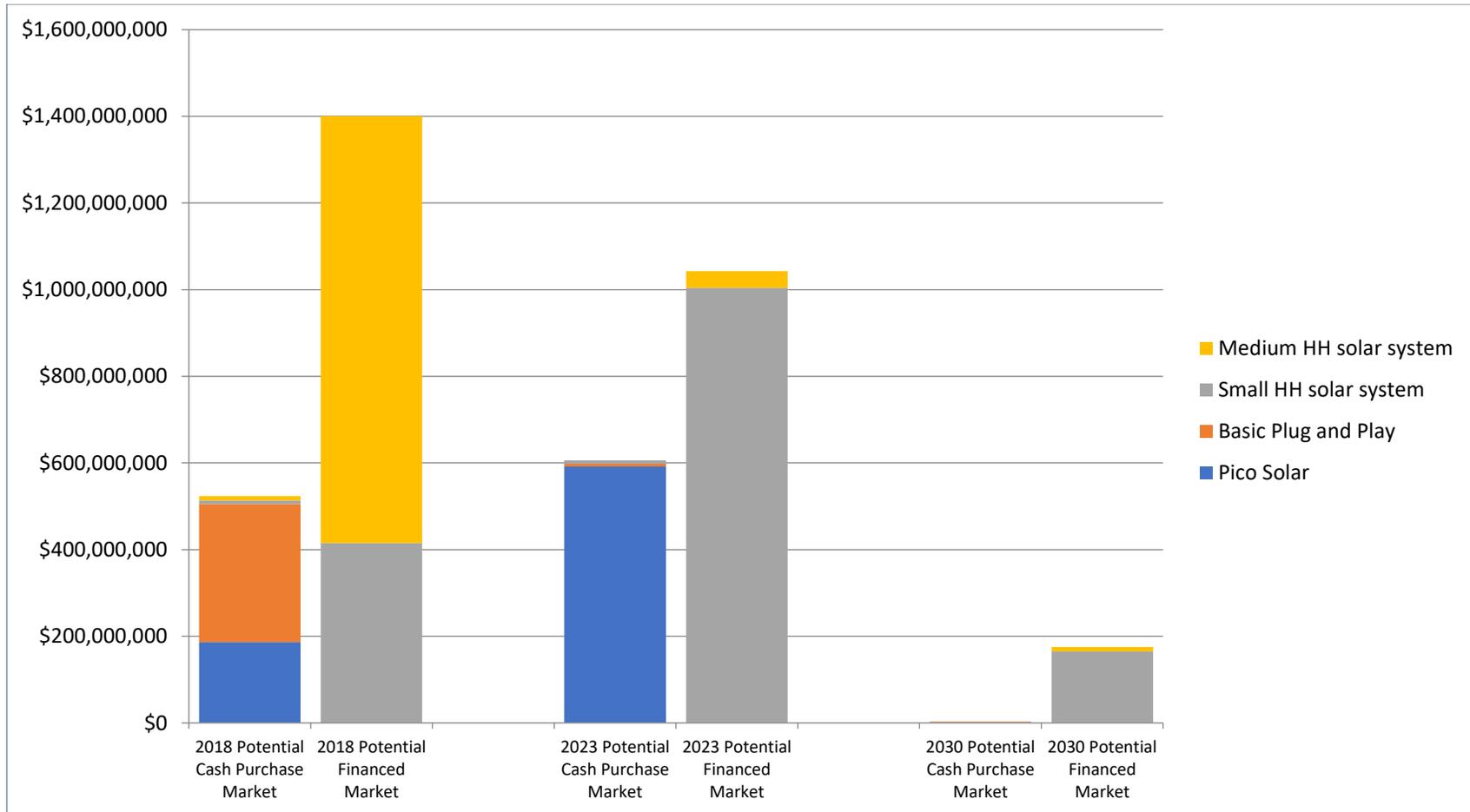
According to the assessment, the most common types of systems the market can afford on a cash basis are pico solar and small plug and play systems; however, this changes significantly with the introduction of financing (Figure ES-7). While affordability improves over time, households in the lowest income quintiles cannot afford any off-grid solar products without financing. Consumer financing will therefore prove critical for accelerating off-grid solar market growth and meeting electrification targets through 2030.

Figure ES-6: Estimated Off-Grid Solar Cash and Financed Market Potential for Household Sector



Source: African Solar Designs analysis

Figure ES-7: Estimated Off-Grid Solar Cash and Financed Market Potential for Household Sector by System Type



Source: African Solar Designs analysis

Figure ES-8: Estimated Off-Grid Solar Cash Market Potential for Institutional Sector

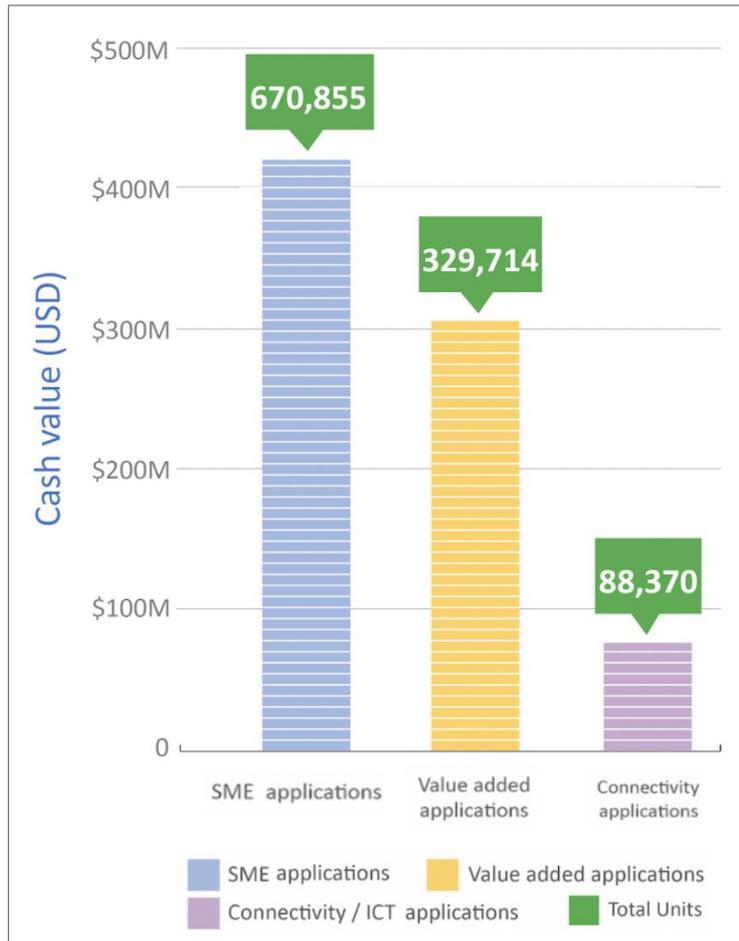


Source: African Solar Designs analysis

The estimated annualized cash market potential for Nigeria’s public/institutional sector in 2018 is USD 83.5 million (**Figure ES-8**). The institutional market segment with the largest potential is water supply (USD 72.6M), followed by healthcare (USD 4.8M), education (USD 4.6M) and public lighting (USD 1.5M). The water supply sector analysis identified off-grid water points such as boreholes and wells that could benefit from solar technology for water pumping. The healthcare sector analysis identified off-grid health facilities categorized by their size (from basic clinics to enhanced health facilities) that could be electrified by stand-alone systems. The education sector analysis identified primary and secondary schools that could be electrified by stand-alone systems. The public lighting analysis assessed the lighting needs for off-grid villages and market centers (excluding street lighting).

According to the analysis, the annualized off-grid solar cash market potential for the productive use sector in 2018 is USD 800.3 million (Figure ES-9). The estimated demand from SMEs represents most of the PUE market potential (USD 419.3M), followed by value-added applications (USD 304.8m) and connectivity applications (USD 76.2M).

Figure ES-9: Estimated Off-Grid Solar Cash Market Potential for Productive Use Sector



Source: African Solar Designs analysis

The calculation of the estimated off-grid solar market for SMEs focused only on barbering and tailoring appliances, which comprises a small portion of overall SME sector demand. These two microenterprises are indicative of the service-based SME off-grid solar market, as they benefit significantly from extended working hours and the use of modern appliances/machinery. The estimated demand for this market segment is therefore intended to provide a baseline for future research, as a more robust analysis would be necessary to assess realistic demand from all SMEs.

The value-added applications that were analyzed include solar pumping for agricultural irrigation, solar powered milling and solar powered refrigeration. The assessment utilized a series of inputs, including data from the UN’s Food and Agriculture Organization on national agricultural production, as well as applicable solar technologies to support income generation for small shareholder farmers (i.e. solar pumps, mills, and refrigeration systems). Access to energy for agriculture is critical for the country’s economic development, particularly given the sector’s importance to GDP.

Off-grid solar power supports a wide range of connectivity applications, including mobile phone charging, wi-fi servers, banks, mobile money kiosks, and telecommunications towers. Mobile phone and internet connectivity are also necessary pre-cursors to mobile money and PAYG solutions in the off-grid solar sector. The market sizing examined mobile phone network coverage as well as rates of mobile phone ownership and mobile internet penetration to estimate the market potential for mobile phone charging enterprises (stations/kiosks).

It should be noted that the Task 2 market sizing assesses the total *potential* demand for off-grid solar, as well as variables that affect demand, such as changes in population density, household income, expansion of national grids and access to finance, among other factors. This data will support policymakers and practitioners as they assess market potential over time. However, the quantitative demand estimate has not been revised to reflect *realistic* market potential. Many other factors and market failures will prevent the full realization of this total market potential, and these will vary by market segment.

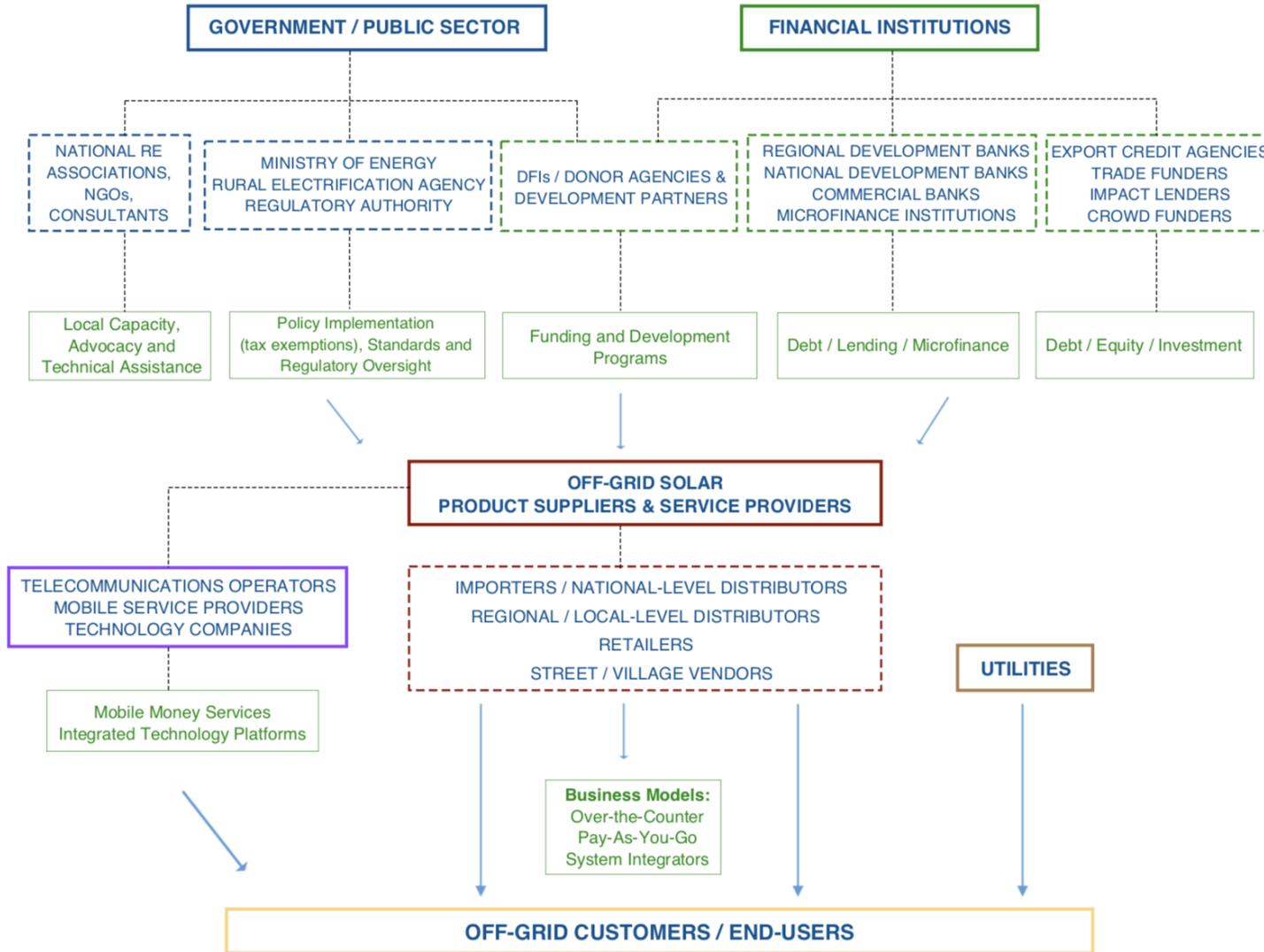
For household demand, the off-grid solar market is already tangible. Still, many factors will affect household demand for solar products, such as distribution realities, consumer education, competing economic priorities for households, financial shocks, etc. The institutional market will be affected largely by government and donor budget allocations along with the potential for community-based finance. The productive use market is perhaps the least concrete. Considered a relatively new market segment for the off-grid solar industry, productive use market dynamics are not yet well understood. The ability to realize potential productive use market demand will also be affected by many of the factors that commonly determine enterprise prospects in the country, including infrastructure, rural distribution, marketing, access to finance, insecurity, regulation, etc. The data presented in this report is intended to provide a baseline for future research.

Following the estimates of market demand, this report analyzes the supply chain for off-grid solar products and services in Nigeria, which includes a wide range of stakeholders, including importers, distributors, wholesalers, retailers and end-users (**Figure ES-10**). The solar supply chain is made up of both formal and informal companies that offer a variety of solar products and systems and deploy several business models. Rural households make up the main market for OGS products in the country, as the demand for lighting products and household electrical appliances is growing. Nevertheless, urban households, both electrified and non-electrified, are also a key consumer market, as they may have greater ability to afford solar products and systems. Nigeria has the largest off-grid solar market in the region. Figures published by GOGLA indicate that the country's off-grid solar market was the largest in West Africa during 2016-2017 in terms of sales volume and revenue.

The off-grid solar supply chain faces several barriers, including competition from the informal market. The widespread sale of low-quality, uncertified products undermines consumer confidence in solar equipment, undercuts the prices of sellers of quality-verified products and hinders overall OGS market growth. There are also a number of interrelated challenges and capacity building needs of the supply chain, including financial, capacity, awareness and regulatory challenges.

Nigeria's solar market is poised to grow if requisite technical assistance is provided to the supply chain. To operate effectively, companies need a significant amount of both local and international technical and financial expertise, as well as an ability to make practical decisions about their operations. Companies must manage a number of technical competency requirements, including the selection of business models, importation and distribution channels, solar PV technologies, as well as the design and implementation of associated marketing instruments and related initiatives.

Figure ES-10: Off-Grid Solar Market and Supply Chain Overview



Source: GreenMax Capital Advisors

Local industry and supply-chain stakeholders who participated in the Task 2 focus group discussions and surveys identified the following key barriers to and drivers of OGS market growth in Nigeria:

Key Barriers to Off-Grid Solar Market Growth
• Security concerns prevent companies from operating in certain regions
• Low consumer purchasing power and lack of consumer financing options
• Low levels of consumer awareness of solar solutions, particularly in rural areas
• Lack of financing for solar companies
• Informal sector competition and market spoilage
• Lack of local capacity/qualified technicians to maintain systems
• High transaction costs associated with equipment inventory, distribution, importation, taxation etc.
• Insufficient or fragmented market data on consumer electricity needs, usage or experience
Key Drivers of Off-Grid Solar Market Growth
• Strong off-grid electricity demand
• Government policy and action is supportive of the industry, which helps attract substantial/sustained investment to the market
• Growing penetration of mobile money services allows OGS companies to increasingly utilize integrated technology platforms and innovative business models to offer PAYG consumer financing solutions to the market
• Extensive private sector engagement in development of the off-grid sector, with companies adopting new business models and strategies to attract external investment and expand their operations
• Strong donor presence and support from the international development community provides confidence that the market will continue to receive financial, policy and technical support necessary to develop (e.g. CEADIR and SUNREF)

Source: Focus Group Discussions; Stakeholder interviews; African Solar Designs analysis

Access to financing is critical for off-grid solar market growth. Solar companies need financing for working capital needs, while off-grid solar consumers need financing for the purchase of systems. This report analyzes the willingness and capacity of national and regional financial institutions to provide financing to businesses and consumers in Nigeria and throughout the region to support development of the OGS sector. In addition to commercial banks and microfinance institutions, impact investors and crowd funders are also active in several markets across the region.

Financial inclusion in Nigeria remains an ongoing challenge. In 2017, 40% of Nigeria’s adult population had an account at a financial institution or with a mobile money service provider, up from 30% in 2011. While the rate of inclusion was above the regional average for West Africa and the Sahel (33%), it was slightly below the average for Sub-Saharan Africa (43%). Despite the country’s overall progress, Nigeria has one of the largest financial inclusion gender gaps in the world – 27% of women had an account at a financial institution or mobile money service compared to 51% of men, representing a 24% gender gap in access to financial services.³⁰

The growing availability and usage of digital financial services and mobile banking will be critical to improving the country’s financial inclusions challenges. Expanding digital financial services, especially mobile money, can create new opportunities to better serve women, the lower-income population, and other groups that are traditionally excluded from the formal financial system. Moreover, mobile money technology also plays a critical role in the application of off-grid solar solutions, particularly for PAYG systems that rely on the interoperability between digital financial services and stand-alone solar devices.

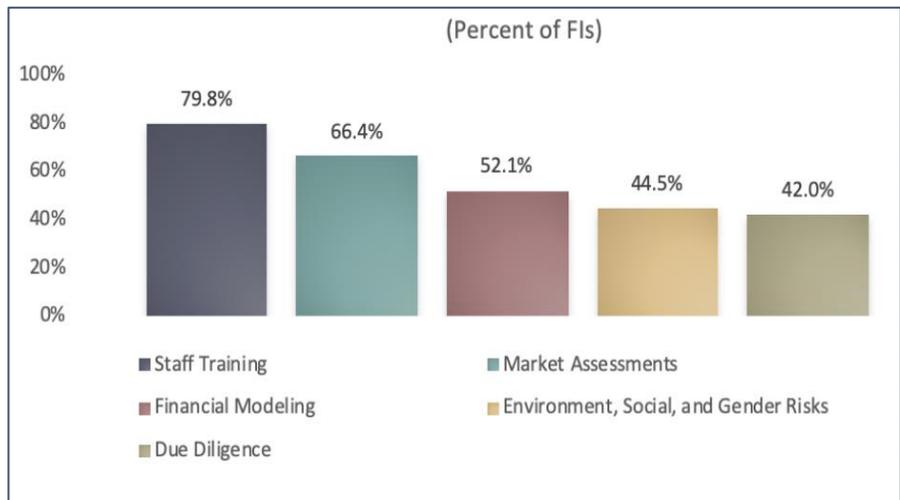
Local FIs and MFIs in Nigeria are increasingly becoming aware of opportunities in Nigeria’s off-grid market, while several have already engaged in lending to the clean energy and off-grid sectors under various

³⁰ Demircuc-Kunt, A., Klapper, L., Singer, D., Ansar, S., and Hess, J., “The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution,” World Bank, (2017): <http://documents.worldbank.org/curated/en/332881525873182837/pdf/126033-PUB-PUBLIC-pubdate-4-19-2018.pdf>

development programs. These include the aforementioned World Bank-funded NEP, IFC Lighting Africa, AFD’s Sustainable Use of Natural Resources and Energy Finance (SUNREF) West Africa program, the Nigerian Energy Support Programme (NESP) being administered by GIZ, and the efforts of USAID under its ongoing Beyond-the-Grid (BTG) program as well as the recently completed Climate Economic Analysis for Development, Investment, and Resilience (CEADIR) program.

According to the Task 3 survey of financial institutions in Nigeria and across the region,³¹ there is strong interest to provide financing to the off-grid solar sector. Respondents identified loan guarantees and credit lines as the most important measures to reduce market entry risks for lenders and stimulate FI engagement in the sector. Surveyed FIs also identified several areas of internal capacity that require improvement in order to lend (or increase lending) to the OGS sector (**Figure ES-11**). The most common need among FIs was training for bank staff, which includes *inter alia* assistance to originate deals and appropriately assess the credit risk of off-grid solar firms and projects, due diligence support to qualify products and approve vendors, and targeted support for new lenders to the sector with product structuring and development as well as building deal-flow. Technical assistance for solar enterprises (as is envisioned under Component 1B of ROGEP) will also be necessary, as entrepreneurs often do not have proper financial management and accounting systems in place, are unable to present quality financial models and lack the expertise required to structure their companies to take on debt obligations.

Figure ES-11: Financial Institution Needs to Increase Off-Grid Solar Lending



Source: Financial Institution survey; Stakeholder interviews; GreenMax Capital Advisors analysis

³¹ The results are based on feedback from a total of 121 FIs (including commercial banks, microfinance institutions and other non-bank FIs) that were interviewed across the 19 countries.

Gender inclusiveness is also a key component of this market assessment, and the key findings of the gender analysis are presented throughout this report. Given that the off-grid market is only beginning to emerge in Nigeria, women are not yet highly engaged in the sector. The overall lack of inclusive participation in the off-grid space is attributable to a wide range of factors. A 2018 survey conducted by IRENA found that nearly three-quarters of respondents cited cultural and social norms as the most common barrier to women's participation in expanding energy access, which reflects the need for gender mainstreaming (**Figure ES-12**). More than half of the women surveyed in Africa identified a lack of skills and training as the most critical barrier, compared to just one-third of respondents globally.³²

The same survey found that access to necessary technical, business or leadership skills development programs was the single most important measure that could be taken to improve women's engagement in energy access. Over half of survey respondents also highlighted the need to integrate gender perspectives in energy access programs, mainstream gender in energy policies and to enhance access to financing for women (**Figure ES-13**).³³

³² "Renewable Energy: A Gender Perspective," International Renewable Energy Agency, (2019): https://irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_Gender_perspective_2019.pdf

³³ Ibid.

Figure ES-12: Key Barriers to Women’s Participation in Energy Access

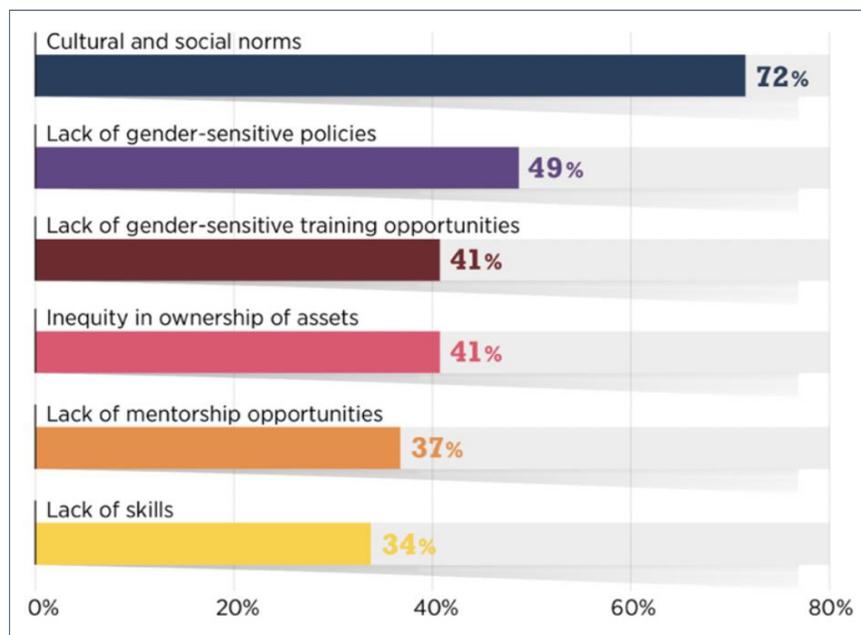
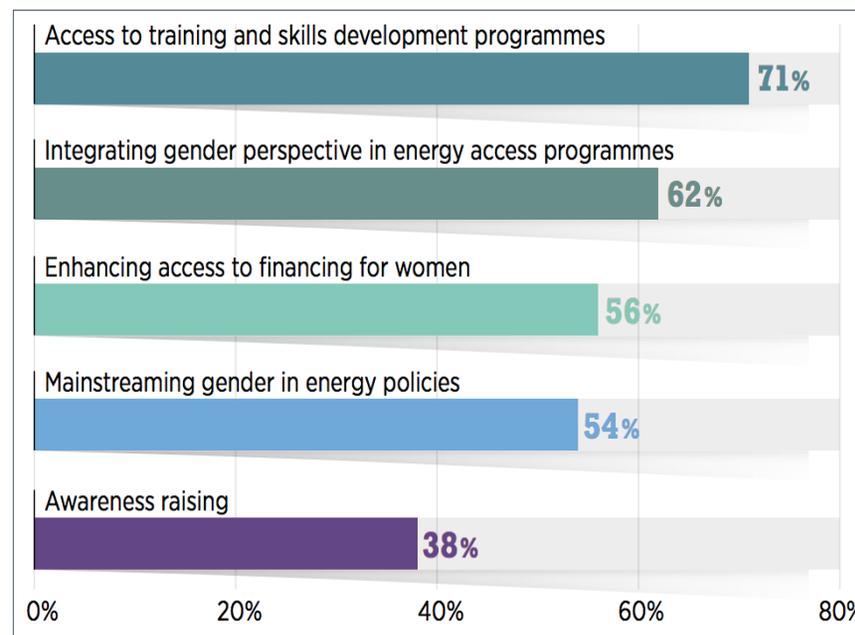


Figure ES-13: Measures to Improve Women’s Engagement in Energy Access



Source: International Renewable Energy Agency

The gender analysis undertaken in Nigeria corroborated many of these findings and revealed several interrelated challenges that women face in the off-grid sector, including lack of access to skills development, technical capacity building, and education/training; lack of access to capital, asset ownership, collateral and credit (e.g. to start a business); and low rates of financial literacy due to a lack of education and information available to women on access to financial resources.

A number of initiatives exist that seek to address some of these challenges and help improve gender inclusion in the country’s energy and off-grid sectors. For example, in 2018, ECREEE partnered with AfDB to launch a regional workshop to advance the participation of women in the renewable energy sector. The program intends to address the lack of female inclusion in the energy value chain, as women represent only 2% of energy sector entrepreneurs in West Africa. The joint initiative ultimately seeks to develop a pipeline of investment-ready, women-owned energy businesses across the region, including in Nigeria.³⁴

³⁴ “Feasibility study promotes women’s participation in energy transition,” ESI Africa, (7 May 2018): <https://www.esi-africa.com/feasibility-study-promotes-womens-participation-in-energy-transition/>

I. STATE OF ENERGY ACCESS AND ENABLING MARKET ENVIRONMENT

This section begins with a brief introduction of key macroeconomic and social indicators in Nigeria (**Section 1.1**). This is followed by an overview of the country’s existing energy sector (**Section 1.2**), with a focus on the status of energy access, including an assessment of both the on-grid and off-grid markets, a least-cost electrification analysis and a review of gender policies. **Section 1.3** examines national energy policy and regulation vis-à-vis the off-grid solar market, including detailed analysis of the existing framework for stand-alone systems³⁵ in Nigeria as well as gaps in the framework. **Section 1.4** is a summary of all relevant national and donor-funded development initiatives in the off-grid sector. **Annex 1** provides an overview of the Task 1 methodology.

1.1 Country Overview

Nigeria is Africa’s most populous nation and its largest economy. The population reached 190 million in 2017 and continues to grow steadily. Nigeria is Africa’s biggest oil exporter and has the largest natural gas reserves on the Continent. The economy relies heavily on oil as its main source of government revenue, accounting for approximately 90% of export earnings. GDP growth emerged from the 2016 recession to reach an estimated 0.8% in 2017; the outlook beyond is positive, with growth projected at 2.1% in 2018 and 2.5% in 2019.³⁶

While Nigeria has an abundance of natural resources, endemic corruption, lack of economic diversification, insecurity, and rapid population growth are all major challenges facing the economy. Poverty also remains widespread, particularly in rural areas. In response, the Federal Government of Nigeria (FGN or “the Government”) has initiated structural reforms aimed at diversifying the economy and setting the country on a path towards sustained and inclusive economic growth in the medium-to-long-term.

Table 1: Macroeconomic and Social Indicators

Population	190.8 million ³⁷
Urban Population	49.4%
GDP	USD 376 billion
GDP growth rate	0.8%
GNI per capita*	USD 2,100
Unemployment rate	7.04% (2016)
Poverty rate	46% (2009)
Urban	34.1%
Rural	52.8%
Currency	Naira (NGN)
Official language	English
Natural resources	Hydrocarbons (coal, oil, gas); ores (gold, gypsum, lead/zinc, copper, manganese, phosphate, limestone, salt, marble, bitumen)



* World Bank Atlas method (current USD)³⁸

All figures from 2017 unless otherwise indicated

Source: AfDB and World Bank

³⁵ NOTE: The term “off-grid” as it is widely used throughout this report (e.g. “off-grid sector”) refers to both mini-grids and stand-alone systems. When “off-grid solar” or its acronym “OGS” are used, this refers *only* to stand-alone systems and does not include mini-grids

³⁶ “Nigeria Economic Outlook,” African Economic Outlook, African Development Bank, (2018):

<https://www.afdb.org/en/countries/west-africa/nigeria/nigeria-economic-outlook/>

³⁷ 50.7% male/49.3% female

³⁸ “World Bank Open Data: Nigeria,” World Bank, (2017): <https://data.worldbank.org/country/nigeria>

1.2 Energy Market

1.2.1 Energy Sector Overview

In 2001, the Government released its initial reform agenda, the National Electric Power Policy, which aimed to liberalize the electricity market. Throughout the early 2000s, many other policies and regulations, such as the Electricity Power Sector Reform Act of 2005, guided Nigeria through a slow privatization and deregulation process.³⁹ Since 2013, the distribution and generation sectors have been liberalized, while the FGN has retained transmission assets, although there are also plans to liberalize this sector. This liberalization has caused more operators to enter the market as Generation and Distribution Companies (GenCos and DisCos). In its long-term energy sector planning, the Government aims to continue the country’s transition away from the existing centrally-managed, publicly-funded framework to a demand-driven, market-based system. However, Nigeria’s energy market transformation is yet to impact the off-grid sector. Based on energy sector liberalization policies, many government agencies, regulators and private sector actors have been introduced to the sector as presented in **Table 2**.

Table 2: Institutional and Market Actors in the Energy Sector

Institution / Company	Role in the Energy Sector
Ministry of Power, Works and Housing (MPWH)	Ministry responsible for implementing broad policies and programs geared towards the development and promotion of electricity generation, transmission, distribution, and supply from all energy sources
Presidential Task Force on Power (PTFN)	Task force responsible for overseeing the restructuring of the Nigerian Power Sector into its current form
Nigerian Electricity Regulatory Commission (NERC)	Independent regulatory body responsible for ensuring proper implementation of electricity regulation and creates laws and policies that protect electricity consumers’ interests. NERC also issues licenses for on and off-grid power generation, as well as for distribution of electricity and manages price regulation through the Multi-Year Tariff Order (MYTO)
Nigerian Rural Electrification Agency (REA)	Agency responsible for overseeing all rural and peri-urban electrification and for administering the Rural Electrification Fund
Energy Commission of Nigeria (ECN)	Commission, under the arm of the FGN, with the statutory mandate to support strategic planning and coordination of national policies in the energy sector
Federal Ministry of Environment (FME)	Ministry responsible for assessing Environmental and Social Impact Assessments submitted by power project developers
Transmission Company of Nigeria (TCN)	Private company responsible for overall administration of the electricity market, including managing the planning, dispatch and operation of the transmission system
Nigeria Bulk Electricity Trader (NBET)	Bulk purchaser and seller of electricity from generating companies to distribution companies (DisCos); manages existing Power Purchase Agreements and new procurement of power in the Transitional Electricity Market (TEM)
National Power Training Institute of Nigeria (NAPTIN)	FGN institution responsible for advising the MPWH on policy to build capacity in the power sector; operates regional training centers across the country
Standards Organization of Nigeria (SON)	Federal organization within the Ministry of Industry, Trade, and Investment (FMITI) that ensures product quality through standards and certification. SON oversees the importation of off-grid products
Distribution Companies (DisCos)	Private companies responsible for electricity distribution
Generation Companies (GenCos)	Private companies responsible for power generation

Source: ECOWAS Center for Renewable Energy and Energy Efficiency

³⁹ “Improving Access to Electricity Through Decentralized Renewable Energy,” Dahlberg Advisors, (May 2017): <https://www.dalberg.com/system/files/2017-08/off-grid%20policy.pdf>

1.2.2 Electricity Access: *Grid and Off-Grid*

Like many countries in Sub-Saharan Africa, Nigeria is struggling to provide sufficient power generation capacity to meet rising demand. Energy access in Nigeria is a key constraint for economic development and remains a major challenge. Approximately 40% of the population – an estimated 74 million people – do not have access to electricity, with a significant disparity in rates of access between urban (86%) and rural (34%) areas.⁴⁰ The FGN aims to increase the national electrification rate to 90% of the total population by 2030; in the long term, the FGN aims to achieve universal access by 2040.⁴¹

1.2.2.1 Off-Grid Market Overview

In order to achieve its energy access targets, Nigeria will need to provide electricity to more than 1 million households per year and add roughly 25 GW to its power generation capacity. This will require the Government to utilize a range of solutions beyond grid extension. The FGN is currently administering several policies to manage the country’s growing off-grid sector and is looking to expand opportunities for the development of mini-grids and the stand-alone solar market throughout the country.⁴²

Nigeria’s off-grid market is like no other due to the enormous deficit of centrally-generated power vis-à-vis actual demand. The increase in installed capacity and generation in recent years falls well short of the growth in the population’s demand for power.⁴³ In 2016, an estimated 60 million Nigerians owned power generating sets for their electricity needs, while the same number of people spent USD 13.8 billion (**Figure 1**) to fuel them annually. Consequently, Nigeria’s focus on off-grid solutions is not only aimed at rural electrification but also at addressing those grid-connected customers in urban and peri-urban areas that receive very unreliable centrally-generated power.

In this context, the economics for off-grid solar are extremely advantageous in Nigeria, as a significant share of the economy is already powered by small-scale generators (10-15 GW) and nearly half of the population has limited or no access to the grid. It is estimated that off-grid alternatives to complement the grid would create a USD 9.2 billion/year market opportunity for mini-grids and solar home systems that will save USD 6 billion/year for Nigerian homes and businesses (**Figure 2**). Nigeria is therefore prioritizing off-grid solutions as part of the country’s overall power sector strategic plan with a series of policies, regulations, and financial interventions to be implemented by the FGN over the next five years.⁴⁴

The FGN has instituted numerous policies and actions plans related to renewable energy and off-grid market development, which has resulted in an incoherent policy and institutional framework with often overlapping actors and mandates.⁴⁵ In an attempt to synchronize efforts, an Independent Resource Plan (IRP) was developed to drive implementation of several key policies, including the National Renewable Energy and Energy Efficiency Policy (NREEEP, 2015), the National Renewable Energy Action Plan (NREAP, 2016), and Nigeria’s Sustainable Energy for All (SEforALL) Action Agenda, in an effort to clarify the off-grid components of each plan.

⁴⁰ “Energy Access Outlook, 2017: From Poverty to Prosperity,” International Energy Agency, (2017):

https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf

⁴¹ “Rural Electrification Strategy and Implementation Plan,” Federal Ministry of Power, Works and Housing, Rural Electrification Agency, (2016): <http://rea.gov.ng/file/2017/09/RESIP.pdf>

⁴² “Upscaling mini grids for low-cost & timely access to electricity,” ESMAP, (2017):

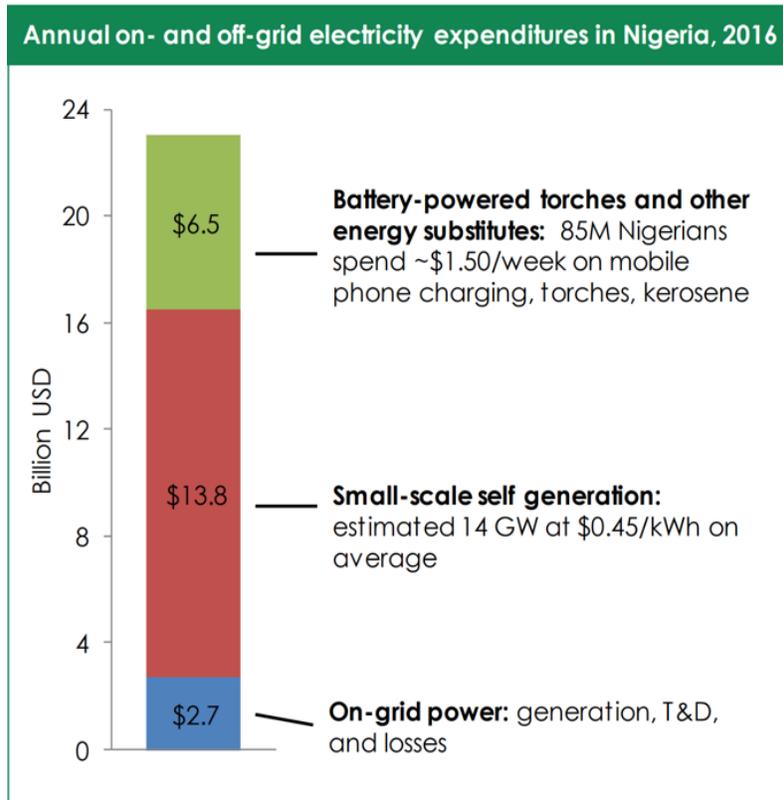
<http://documents.worldbank.org/curated/en/851271512391124096/pdf/121831-ESM-Nigeriabriefingbookv-PUBLIC.pdf>

⁴³ “Mini Grids in Nigeria,” World Bank, (2017): <https://openknowledge.worldbank.org/bitstream/handle/10986/29016/121827-ESM-dNigeriaMiniGridsCaseStudyConfEd-PUBLIC.pdf?sequence=1&isAllowed=y>

⁴⁴ Ibid.

⁴⁵ “Nigeria Sustainable Energy for All Country Action Agenda,” SEforALL, (July 2016): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/NIGERIA_SE4ALL_ACTION_AGENDA_FINAL.pdf

Figure 1: Electricity Expenditures in Nigeria, 2016⁴⁶



Source: Rural Electrification Agency

Figure 2: Estimated Annual Off-Grid Market Size by Technology, 2017⁴⁷



Source: Rural Electrification Agency

⁴⁶ "The Off-Grid Opportunity in Nigeria," Rural Electrification Agency, (2017):

https://www.esmap.org/sites/default/files/Presentations/REA_Damilola-Off-Grid%20Opportunity_03122017_web.pdf

⁴⁷ **NOTE:** Assumes 50% adoption of solar home systems and 75% adoption of mini-grids by small-scale self-generation; does not assume growth in electricity use.

Another important entity is the Rural Electrification Agency (REA), which is responsible for mobilizing the resources necessary to support rural electrification of the country’s six geopolitical zones, including implementation of a Rural Electrification Fund (REF) under the mandate of the Rural Electrification Strategy and Implementation Plan (RESIP, 2016). Both the REF and RESIP are currently under review and preparation. The plan is for the REA / REF to provide subsidies to developers to expand access rather than offering consumer-financing options to make access affordable. In addition to REA, various public authorities at the federal and state levels, along with private sector suppliers and service providers will be involved in the sector’s development, increasing access through DisCos as well as other public and privately-funded initiatives. RESIP promotes a range of electrification options, including on-grid, mini-grid and stand-alone solutions from both thermal and renewable sources.⁴⁸

To date, the country’s off-grid market has received significant interest from both the donor community as well as from the private sector. As of 2015, 53 companies had installed 115 MW of off-grid solar photovoltaic (PV) capacity through mini-grid and standalone systems. Some innovative pay-as-you-go (PAYG) business models have experienced recent fundraising successes that could enable future growth. Yet overall, the off-grid sector remains nascent.⁴⁹

The Nigeria Electrification Project (NEP) is another key initiative in the off-grid sector. NEP is a USD 350 million program funded by the World Bank and administered by REA that aims to leverage private sector investments in solar mini-grids and stand-alone solar systems in order to provide electricity for 2.5 million people and 70,000 Small and Medium Enterprises (SMEs).⁵⁰ The project will provide a pipeline of local investments and financial incentives to catalyze the off-grid market through the provision of detailed market data, grant funding, and technical assistance (TA). The NEP is divided into four components including solar hybrid mini-grids, stand-alone solar systems, an educational program, and TA. The TA component will deliver institutional support for REA, develop an investment pipeline and carry out a financial needs assessment.⁵¹ The project is also providing electricity to seven universities across the country.

Figure 3: Nigeria Electrification Project Overview



Source: Rural Electrification Agency

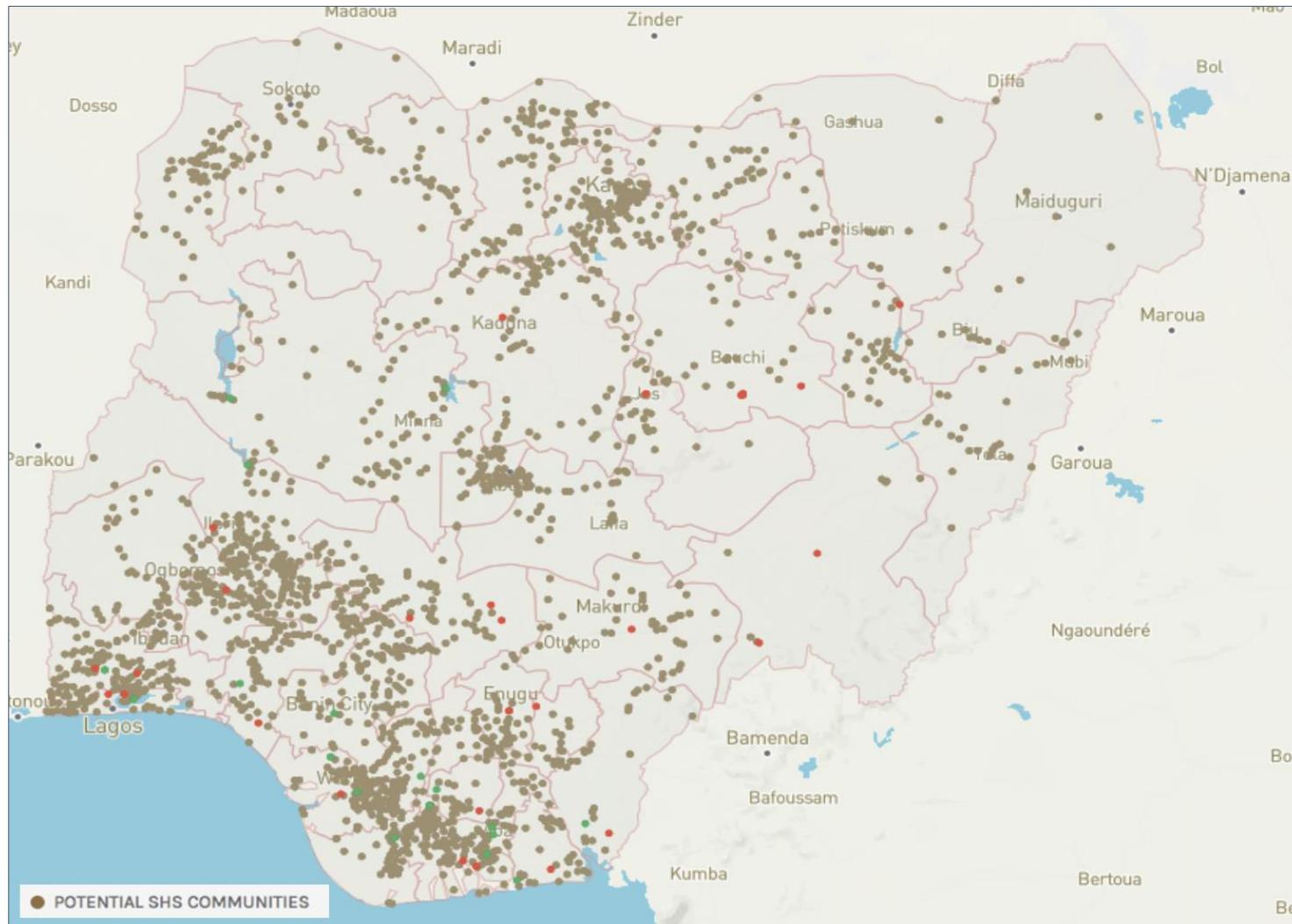
⁴⁸ “The Nigerian Energy Sector,” GIZ, (2015): <https://www.giz.de/en/downloads/giz2015-en-nigerian-energy-sector.pdf>

⁴⁹ “Improving Access to Electricity Through Decentralized Renewable Energy,” Dahlberg Advisors, (May 2017): <https://www.dalberg.com/system/files/2017-08/off-grid%20policy.pdf>

⁵⁰ “World Bank Approves \$350M for REA Off-Grid Projects,” REA, (2018): <http://rea.gov.ng/wbank-approves-350m-for-reas-solar-power-projects-in-schools-others/>

⁵¹ “The Nigeria Electrification Project,” REA, (2018): <http://rea.gov.ng/nigeria-electrification-project-nep/>

Figure 4: Potential Off-Grid Communities to be Electrified by Stand-alone Systems⁵²



Source: Rural Electrification Agency

⁵² REA: <http://database.rea.gov.ng/>

1.2.2.2 Demand and Supply/Generation Mix

Table 3: Electricity Sector Indicators, 2017⁵³

As of 2017, Nigeria had an installed capacity of 12.5 GW. Almost half of installed capacity is not operational as a result of poor grid infrastructure and a lack of maintenance of power stations. Due to a range of issues such as unavailability of gas, breakdowns, water shortages, grid constraints and liquidity issues, only around 4 GW of electricity are actually transmitted through the network, a quantity of power vastly insufficient to meet demand from the population and economy.⁵⁴ More than 80% of installed capacity comes from thermal generation with most of the remaining balance coming from hydropower.

Installed Capacity	12,522 MW
Thermal	10,142 MW
Hydropower	2,362 MW
Renewable (non-hydro)	18 MW
National electrification rate (2016)	61%
Urban electrification rate	86%
Rural electrification rate	34%
Population without access	74.4 million
Households without access	16.2 million
Electrification target	90% by 2030; 100% by 2040

Source: Ministry of Power, IEA and World Bank

Since the beginning of the 21st century, Nigerian electricity consumption has doubled. To meet increased demand and achieve energy access targets, current federal policies identify three major goals: (i) construction of new gas-powered generation nationwide, (ii) rural electrification driven by small-scale and off-grid renewables projects and (iii) energy efficiency initiatives in all sectors. Recent reform in electricity tariff pricing structures is also playing a role in shaping a more effective and resilient electricity sector.

The FGN is relying heavily on the private sector to bridge the enormous gap between electricity generation capacity and demand. The privatized Power Holding Company of Nigeria (PHCN) generation companies are contractually obligated to steadily increase generation over the next five years, while the government estimates the privatized Niger Delta Power Holding Company (NDPHC) plants will generate an additional 5,445 MW. An additional 2,000 MW increase will come from investments made by new Independent Power Producers (IPPs) entering the market.

The penetration of renewable energy in Nigeria’s generation mix is still in its early stages – the most substantial source of RE remains large hydropower, while grid-connected solar PV has been relatively limited, with an installed capacity of 15 MW. With energy policies and initiatives currently under development, wind and solar energy generation projects are gradually being deployed throughout the country. As a result, private investment in the off-grid sector is expected to grow in the coming years.⁵⁵

The Nigerian Electricity Regulatory Commission (NERC) sets tariffs based on a formula agreed to with the DisCos. This has resulted in the creation of a 15-year tariff plan with bi-annual reviews based on a short list of indicators; major tariff reviews are conducted every five years.⁵⁶ NERC’s Multi-Year Tariff Order (MYTO) is designed to protect consumers against exorbitant pricing and is based on the new entrant cost profile for generation companies. When DisCos took over assets from the PHCN in 2013, they committed to increase the number of new grid connections and to upgrade Nigeria’s metering infrastructure to address commercial losses. However, the DisCos ultimately incurred an average revenue loss of 46% on electricity

⁵³ See Section 2.1 for more details on households/population without access to electricity.

⁵⁴ Nigeria Power Africa Fact Sheet,” USAID, (2018): <https://www.usaid.gov/powerafrica/nigeria>

⁵⁵ “Nigeria Renewable Energy Master Plan,” International Energy Agency, 2013

⁵⁶ “Electricity Tariff in in Nigerian Electricity Supply Industry,” Nigeria Energy Regulatory Commission, NERC, (2018): <http://www.nercng.org/index.php/home/myto>

delivered to customers, primarily due to commercial and collection losses, which NERC has ruled cannot be passed on to customers through tariffs.⁵⁷

Tariffs vary between DisCos and among consumer types (retail, small business, Commercial & Industrial (C&I), etc.) but they are generally lower than tariffs in other less-developed West African nations. However, off-grid generation using medium-sized generators (50-500 kW) is typically much more expensive than grid electricity. Small businesses and families, the primary users of these generators, are spending an average of \$21.8 billion annually on diesel and petrol due to the unreliability of the national grid.⁵⁸

1.2.2.3 Transmission and Distribution Network

The Transmission Company of Nigeria (TCN) currently oversees the country's power transmission (**Figure 5**), while distribution is handled by DisCos. Since the 2013 split of the government from the PHCN, the work of the PHCN was divided into eleven distribution companies and six generation companies. There are also three large-scale IPPs in Nigeria that account for approximately 25% of overall generation.

Overall, a significant gap exists between the infrastructure needs of the power sector and the resources available to invest in grid maintenance and extension to rural areas. It is estimated that between 20-30% of generated electricity is lost as a result of poor transmission.⁵⁹ This has resulted in unstable and unreliable electricity supply, as power outages are extremely common among both firms and households (**Figure 6** and **Figure 7**).

At a regional level, Nigeria is a member of the West African Power Pool (WAPP). The WAPP, in conjunction with the ECOWAS Regional Electricity Regulatory Authority (ERERA), launched a regional electricity market in 2018 in which Nigeria will begin trading electricity (it already engages in bilateral trade) to hedge against transmission line risks in the future.⁶⁰ The WAPP also announced plans to start construction of the Nigerian component of the core transmission line in northern Nigeria that will bolster the connection that is already in place with Benin, Niger, and Burkina Faso.⁶¹

⁵⁷ "Multi-Year Tariff Order for 2015-2018," NERC, (2015): <https://www.nigeriaelectricityhub.com/download/myto-2-1-multi-year-tariff-order-for-2015-2018/>

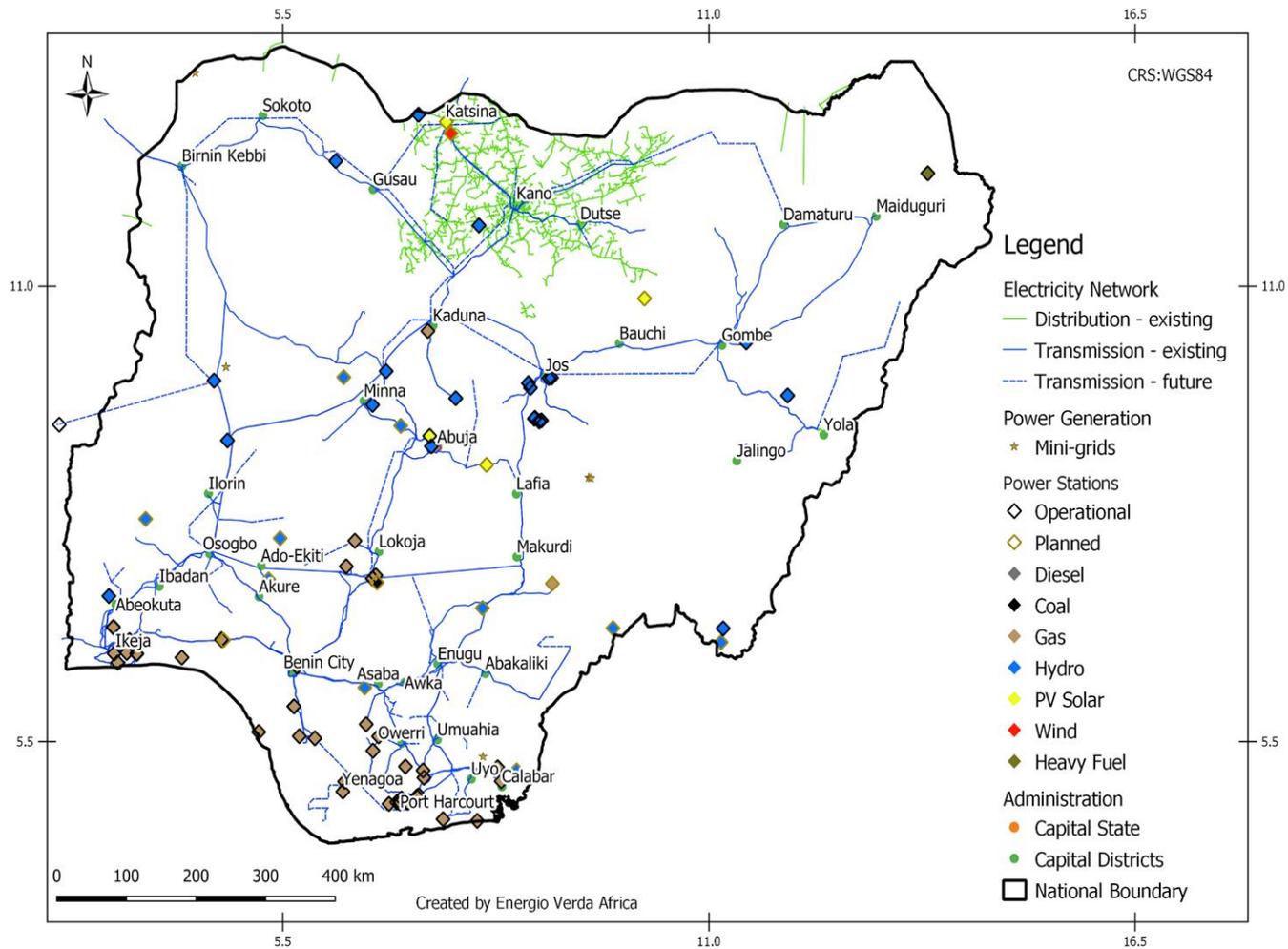
⁵⁸ "Program for Results Information Document No.PIDC0122348: Power Sector Recovery Performance-Based Loan," World Bank, (2017): <http://documents.worldbank.org/curated/en/266341497992825758/pdf/Nigeria-Power-Sector-Recovery-P4R-Concept-Stage-PID-8-3-2017.pdf>

⁵⁹ Stakeholder interviews; GreenMax Capital Advisors analysis

⁶⁰ "Nigeria to begin electricity trading with neighboring countries," ESI-Africa, (9 April 2018): <https://www.esi-africa.com/nigeria-to-begin-electricity-trading-to-other-neighbouring-countries/>

⁶¹ "Construction of transmission lines to connect Nigeria, other West African nations to commence," Pulse New Agency, (2018): <https://www.pulse.ng/news/local/wapp-start-constructing-transmission-lines-to-connect-nigeria-id8207745.html>

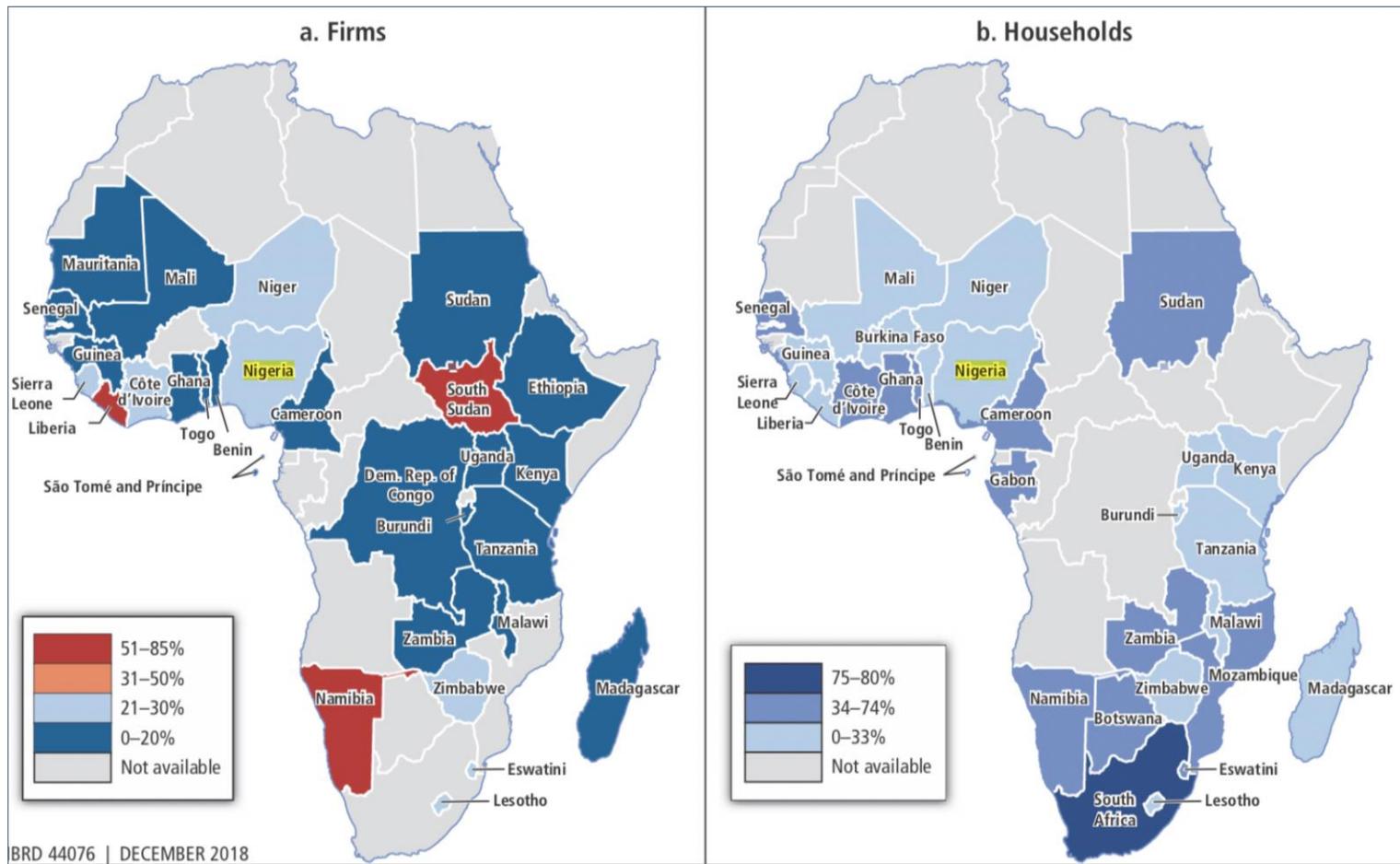
Figure 5: Electricity Transmission and Distribution Network⁶²



Source: Energo Verda Africa GIS analysis

⁶² See Annex 1 for more details, including data sources.

Figure 6: Access to Reliable Electricity by Firms and Households in Africa⁶³

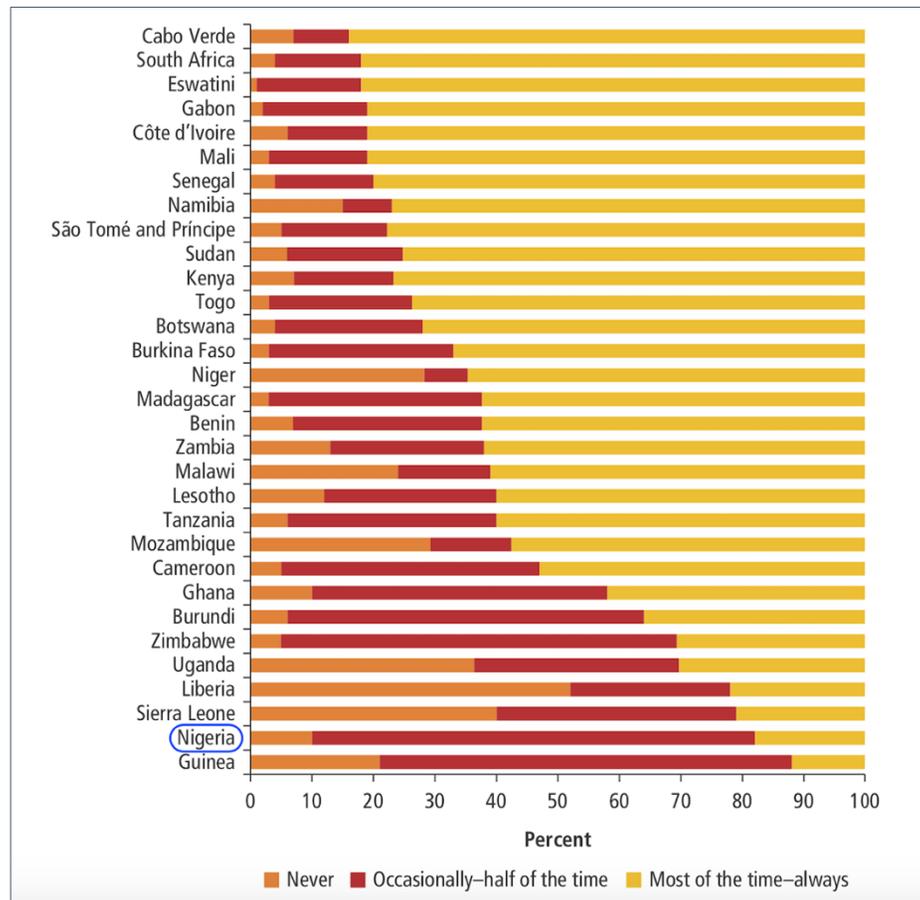


Source: World Bank Enterprise Surveys, 2013-2017 and Afrobarometer Household Surveys, 2014-2015

The maps in **Figure 6** illustrate the share of firms (Panel a) and households (Panel b) reporting access to a reliable supply of electricity across Africa. In Nigeria, fewer than one-third of surveyed firms and households reported having reliable access to electricity.

⁶³ Blimpo, M., and Cosgrove-Davies, M., "Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact," AFD and World Bank, Africa Development Forum, (2019): <https://openknowledge.worldbank.org/bitstream/handle/10986/31333/9781464813610.pdf?sequence=6&isAllowed=y>

Figure 7: Reliability of Grid Electricity in Connected Households in Africa⁶⁴



Source: Afrobarometer Household Surveys, 2014-2015

Figure 7 shows the variation in the reliability of grid electricity for connected households across Africa. In Nigeria, fewer than 20% of households reported receiving electricity supply at least most of the time, while more than half of surveyed households indicated having electricity only occasionally.

⁶⁴ Blimpo, M., and Cosgrove-Davies, M., "Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact," AFD and World Bank, Africa Development Forum, (2019): <https://openknowledge.worldbank.org/bitstream/handle/10986/31333/9781464813610.pdf?sequence=6&isAllowed=y>

1.2.2.4 Least-Cost Electrification Analysis

A least-cost electrification analysis has been performed to assess the potential development of electricity access in Nigeria through 2023 and through 2030 (“Scenario 2023” and “Scenario 2030”).⁶⁵ The analysis identifies the scale of market opportunities for off-grid stand-alone solar electrification. A brief summary of the approach and methods used, main assumptions and key results of the analysis in Nigeria are outlined below. Additional geographic information system (GIS) information, including categorizations, key definitions, and datasets are included in **Annex 1**.

➤ Methodology

This analysis used geospatial techniques to determine the least-cost electrification options for settlements across Nigeria based on their proximity to electrical infrastructure, population density or nodes of economic growth.

For the scenario 2023 analysis, it is assumed that widespread densification of the existing electrical grid will enable settlements within 5 km of existing grid lines to connect to the grid – according to West African Power Pool (WAPP) densification plans.⁶⁶ Beyond the 5 km distance, the likely candidates for electrification by mini-grid systems are settlements that are relatively dense (above 350 people/km²) and have active local economies, evidenced by the presence of social facilities and by their proximity to other settlements already with electricity access (i.e. within 15 km of night-lights areas). All remaining settlements – those in areas of lower population density (below 350 people/km²) or far from the national grid – are considered candidates for off-grid stand-alone systems.

For the scenario 2030 analysis, it is assumed that the grid and the reach of grid densification efforts will extend far beyond the existing network. Hence, settlements that are within 15 km of current lines (average densification distance announced by utilities across West Africa in a 10-year timeline in personal interviews) and 5 km of future planned line extensions are assumed to be connected (planned low- and medium voltage lines were not available for the analysis). For mini-grids, future economic development – which will allow new settlements to grow sufficiently to become candidates for mini-grids – is assumed to occur in settlements within 1 km of mini-grid settlements (average distance of mini-grid coverage of different developers) identified in the five-year analysis, as well as within 15 km of economic growth centers – airports, mines and urban areas. All other settlements are considered candidates for off-grid stand-alone systems.

Given the lack of low and medium voltage distribution line data, it is necessary to approximate areas where un-electrified settlements in close proximity to the grid exist. The analysis therefore focuses on settlements that are within 5 km of the high and medium voltage network, but that are located beyond 15 km of areas with night-time light emissions (indicative of electrification). Settlements in areas of low population density (below 350 people per km²) that met the above criteria are identified as both being currently un-electrified and unlikely to be electrified within the five-year scenario.⁶⁷ Additional analysis was undertaken to estimate the population within each settlement. The current annual national population growth rate of 2.6%⁶⁸ was applied to the geospatial analysis to project population figures for the scenario 2023 and 2030 analyses.⁶⁹ **Figure 8** shows population density across the country, which served as the basis for this analysis.

⁶⁵ NOTE: Rather than presenting a 10-year projection through 2028, the analysis conforms to FGN electrification targets for 2030

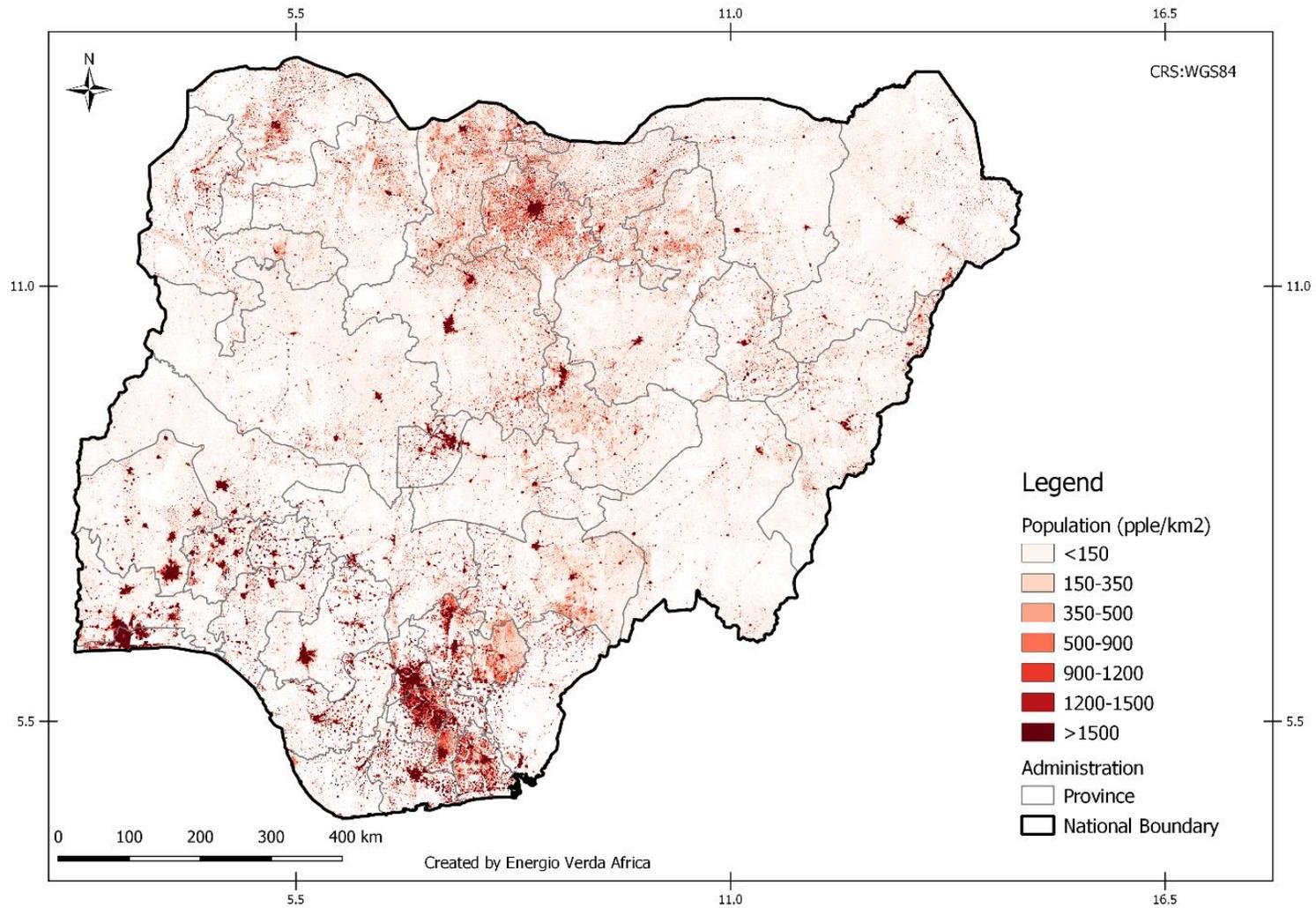
⁶⁶ NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)

⁶⁷ Note that this analysis was performed for the scenario 2023 but not for the scenario 2030 due to uncertainties regarding population densities being too high over such a long timeframe

⁶⁸ “Population Growth (annual %),” the World Bank, (2017): <https://data.worldbank.org/indicator/SP.POP.GROW?locations=NG>

⁶⁹ See **Annex 1** for more details on the approach and methods used

Figure 8: Population Density, 2015⁷⁰



Source: Energio Verda Africa GIS analysis

⁷⁰ See Annex 1 for more details, including data sources.

➤ **Results**

Table 4 summarizes the results of the least cost electrification analysis. **Figure 9** and **Figure 10** illustrate the distribution of settlements according to least-cost electrification options under scenarios 2023 and 2030, respectively. The number of households was estimated by using the average household size for the country (4.6 persons/household).⁷¹

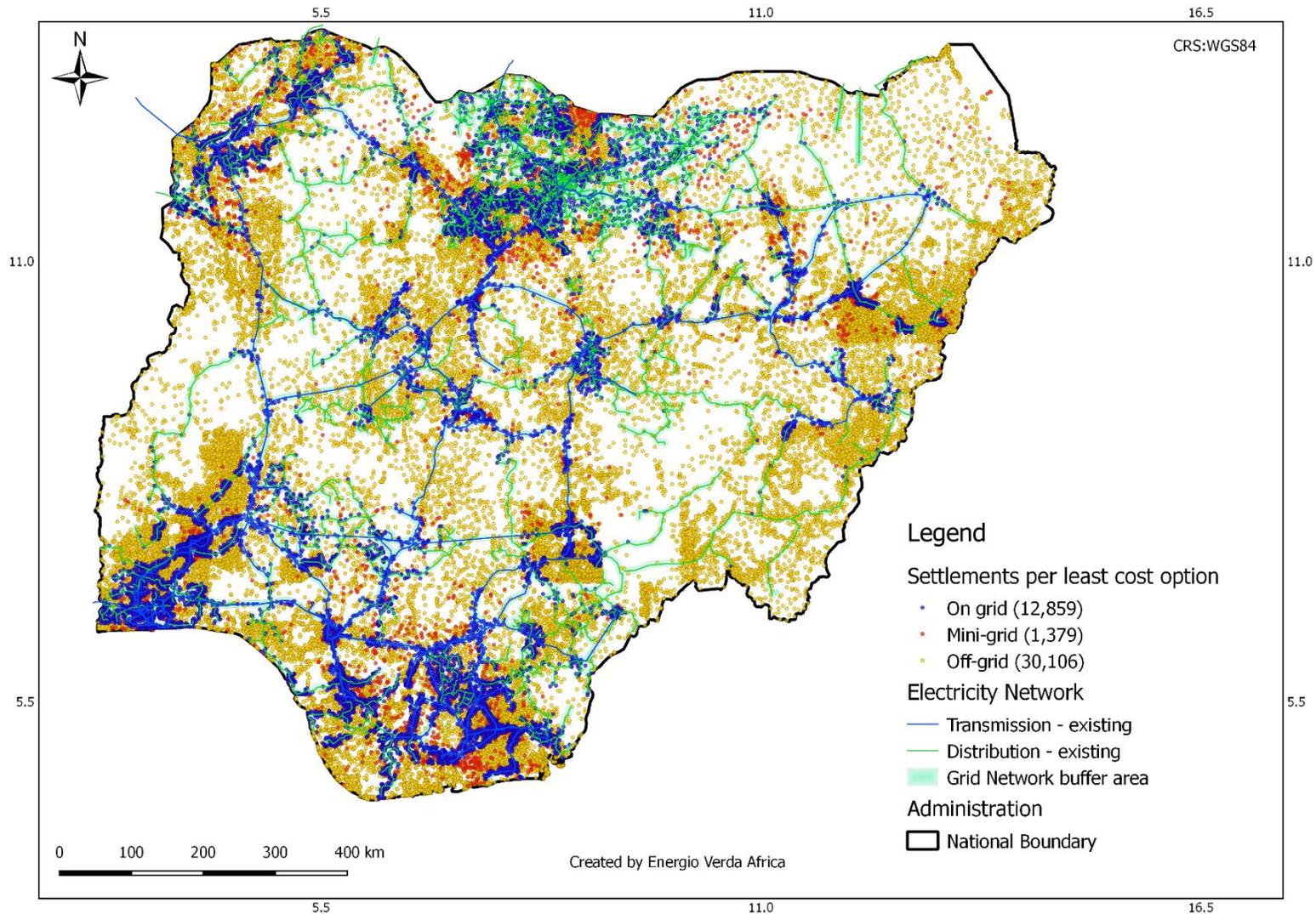
Table 4: Results of Least-Cost Electrification Analysis

Scenario	Indicator	Least-Cost Electrification Option			Grid Vicinity		
		Grid extension	Mini-grid	Off-grid stand-alone systems	Under-grid un-served	Total under-grid	Total outside grid vicinity
Scenario 2023	Number of settlements	12,859	1,379	30,106	7,046	19,905	24,439
	% of settlements	29.0%	3.1%	67.9%	35.4%	44.9%	55.1%
	Total population	122,436,476	11,986,727	89,070,325	26,621,631	149,058,107	74,435,421
	% of population	54.8%	5.4%	39.9%	17.9%	66.7%	33.3%
	Number of households	26,616,625	2,605,810	19,363,114	5,787,311	32,403,936	16,181,613
Scenario 2030	Number of settlements	34,774	4,011	5,559	Not calculated	34,774	9,570
	% of settlements	78.4%	9.0%	12.5%	Not calculated	78.4%	21.6%
	Total population	235,775,878	18,628,313	13,078,988	Not calculated	235,775,878	31,707,302
	% of population	88.1%	7.0%	4.9%	Not calculated	88.1%	11.9%
	Number of households	51,255,626	4,049,633	2,843,258	Not calculated	51,255,626	6,892,892

Source: Energo Verda Africa GIS analysis

⁷¹ “Household Size and Composition Around the World,” United Nations, (2017): http://www.un.org/en/development/desa/population/publications/pdf/ageing/household_size_and_composition_around_the_world_2017_data_booklet.pdf

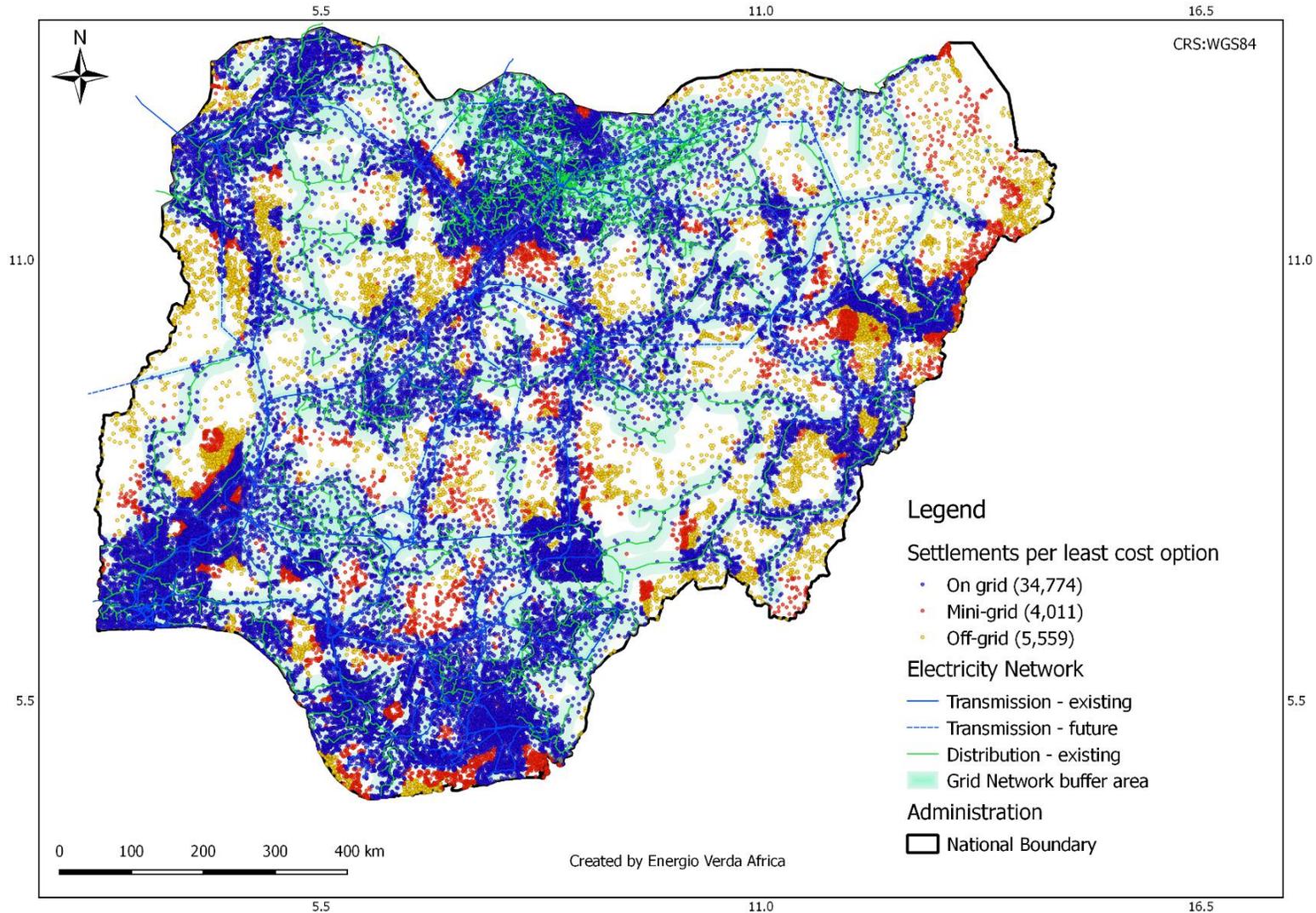
Figure 9: Distribution of Settlements by Least-Cost Electrification Option, 2023⁷²



Source: Energio Verda Africa GIS analysis

⁷² Displaying identified settlements with known location (given coordinates) only; see **Annex 1** for more details, including data sources.

Figure 10: Distribution of Settlements by Least-Cost Electrification Option, 2030⁷³



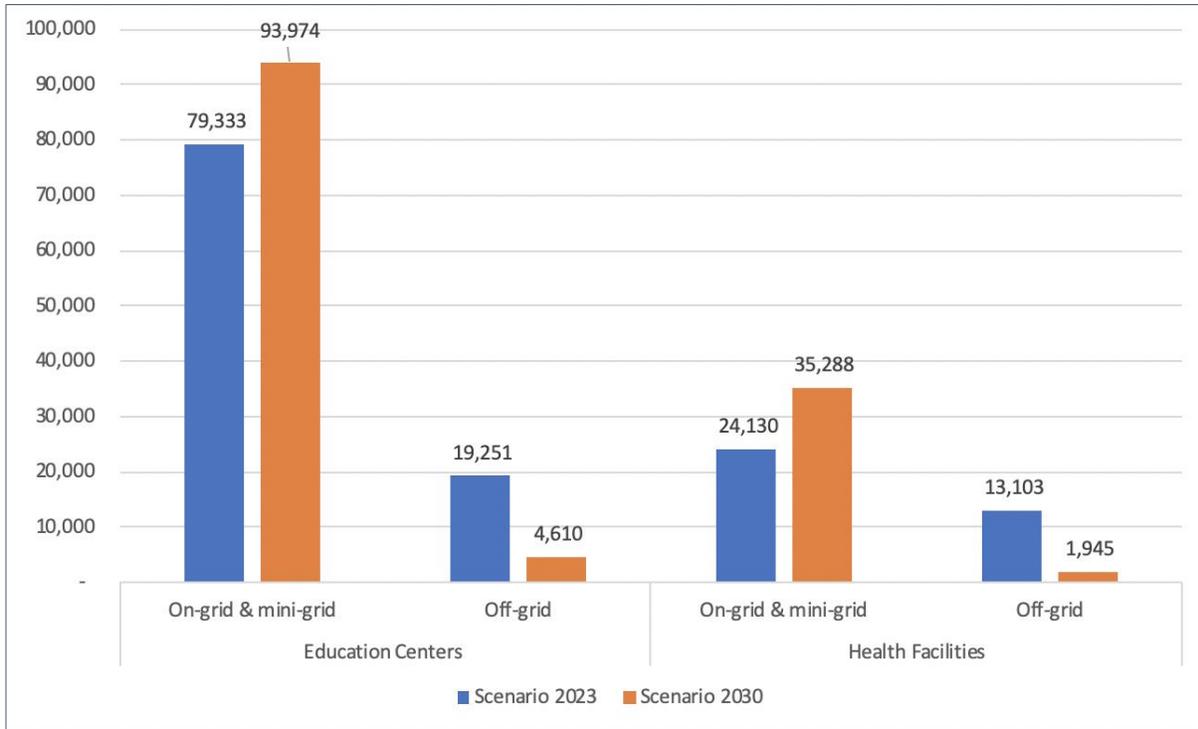
Source: Energio Verda Africa GIS analysis

⁷³ Displaying identified settlements with known location (given coordinates) only; see **Annex 1** for more details, including data sources.

The analysis also covered the education centers and health facilities that will remain in off-grid areas during the analyzed timeframes., The identified facilities were collected from the Nigeria MDG Information System (NMIS) between 2009 and 2014 to build a nation-wide inventory of education and health facilities.

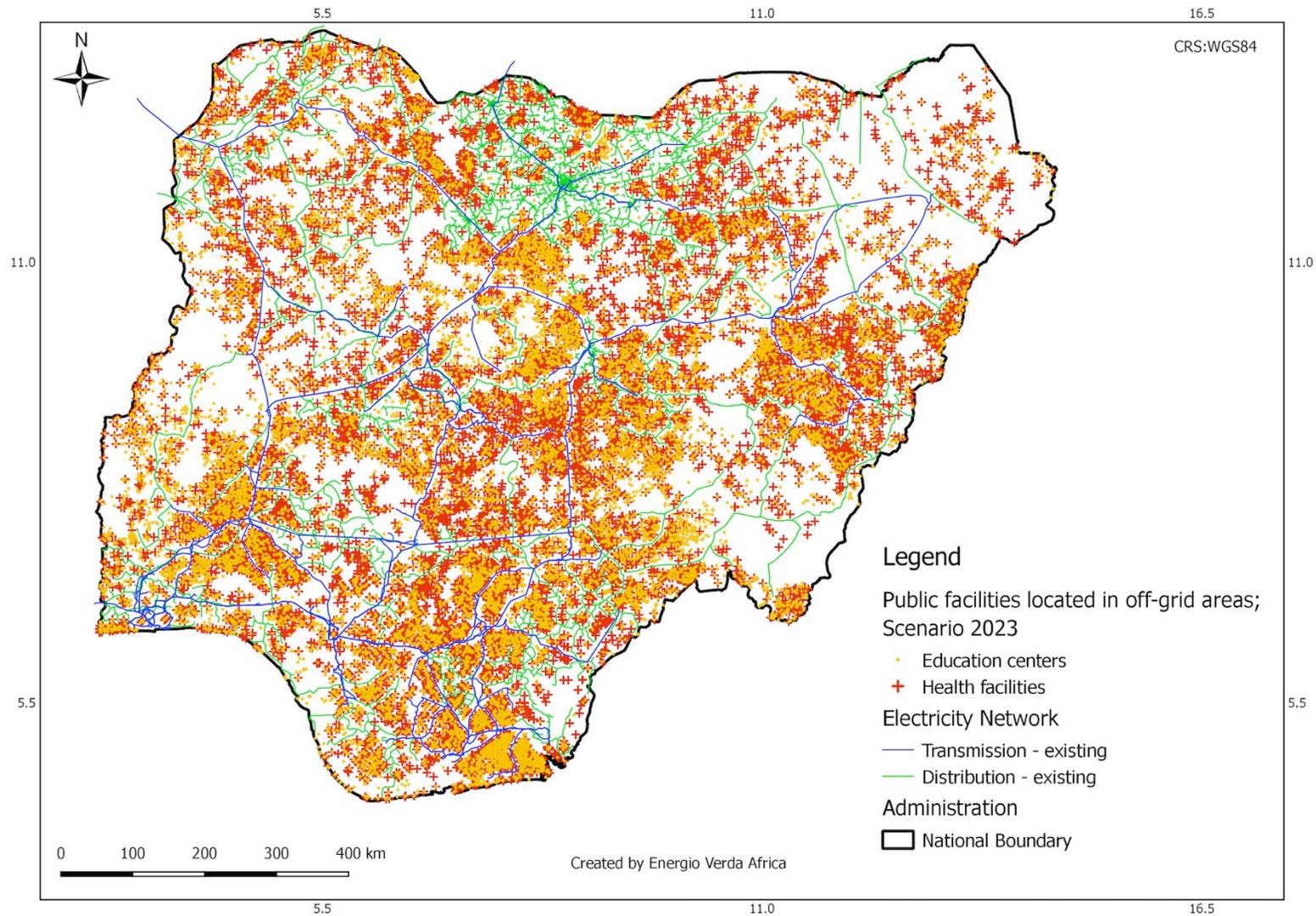
Figure 11 summarizes the number of education centers and health facilities that may be electrified (on-grid and mini-grid) or suitable for off-grid stand-alone solutions in scenarios 2023 and 2030. **Figure 12** illustrates the distribution of potential off-grid facilities across the country under the two scenarios.

Figure 11: Identified Social Facilities for On-Grid, Mini-Grid and Stand-alone Solutions, 2023 and 2030



Source: Energio Verda Africa GIS Analysis

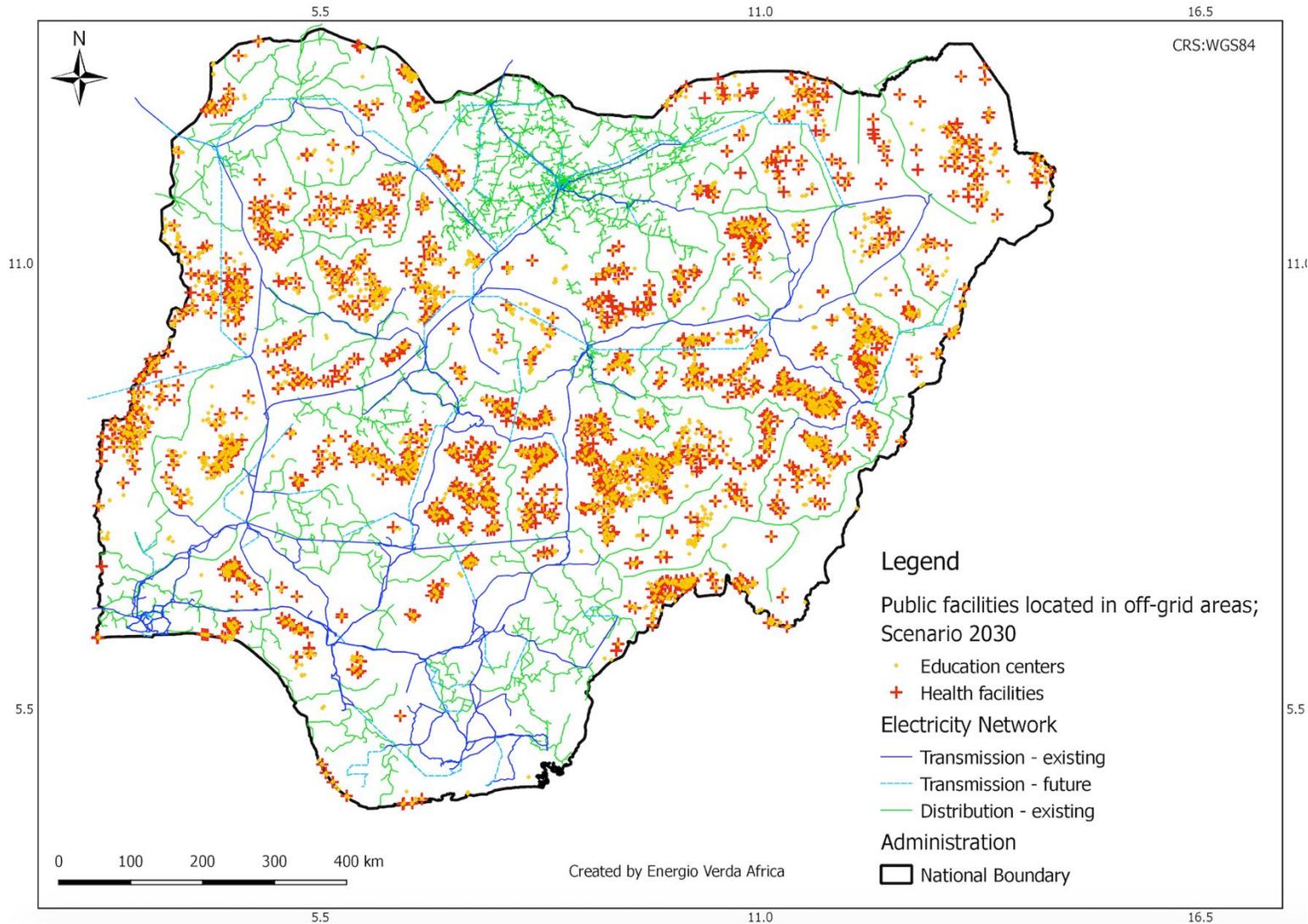
Figure 12: Distribution of Potential Off-Grid Social Facilities, 2023⁷⁴



Source: Energio Verda Africa GIS analysis

⁷⁴ Displaying identified facilities with known location (given coordinates) only; see **Annex 1** for more details, including data sources.

Figure 13: Distribution of Potential Off-Grid Social Facilities, 2030⁷⁵



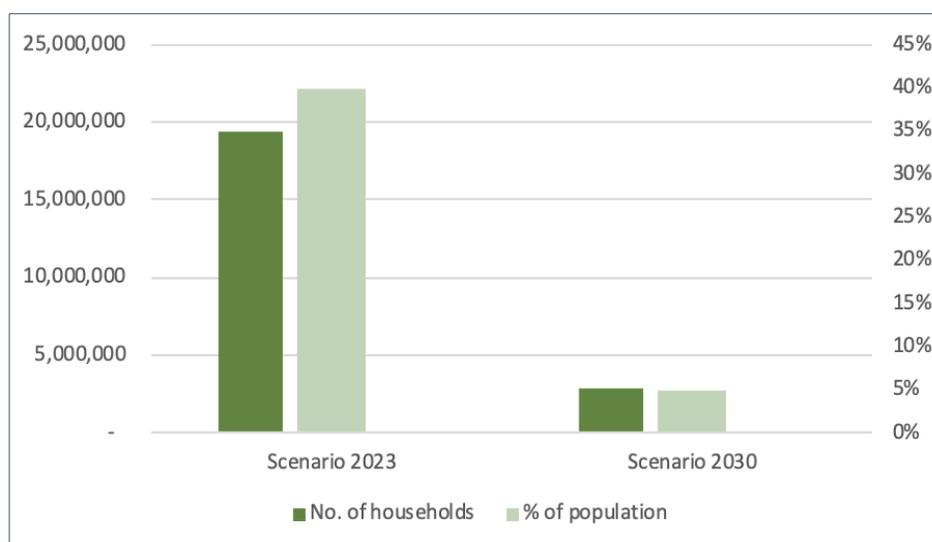
Source: Energio Verda Africa GIS analysis

⁷⁵ Displaying identified facilities with known location (given coordinates) only; see Annex 1 for more details, including data sources.

According to the geospatial analysis (Table 4), by 2023, 12,859 settlements across Nigeria (26,616,625 households) will be connected to the main grid, representing 54.8% of the population. By 2030, this figure will increase to 34,774 settlements (51,255,626 households), equivalent to 88.1% of the population. These estimates are based on the assumption that all planned grid extensions will be completed by 2030. Not all settlements in close proximity to electricity lines will connect to the main grid, largely due to the low density of these areas (dispersed settlements with a density below 350 people/km²). By 2023, an estimated 7,046 settlements located under the grid will meet these criteria (or 35.4% of the settlements located within 5 km of the grid).

Outside of the main grid areas, settlements with higher economic growth potential and higher population density can optimally be electrified by mini-grids. By 2023, this represents an estimated 1,379 settlements (2,605,810 households), or 5.4% of the population, increasing to 4,011 settlements (4,049,633 households), or 7.0% of the population by 2030. The remaining more dispersed settlements (further from centers of economic activity) can optimally be served by off-grid stand-alone systems. This comprises 30,106 settlements (19,363,114 households) and 39.9% of the population in 2023, decreasing to 5,559 settlements (2,843,258 households) and 4.9% of the population in 2030 (Figure 14).

Figure 14: Estimated Number of Households and Share of Population Suitable for OGS Systems, 2023 and 2030



Source: Energio Verda Africa GIS analysis

The analysis indicates that the off-grid stand-alone market has the potential to grow significantly. The off-grid market has even greater potential. According to figures published by the Global Off-Grid Lighting Association (GOGLA), an estimated 493,826 off-grid stand-alone solar PV products (pico solar and solar home systems (SHSs)) worth over USD 10M have been sold in Nigeria as of the end of 2017 (see Section 2.4.3).⁷⁶ The least-cost analysis estimates that more than 23 million households in 2023 are suitable for stand-alone solutions to meet electrification needs.

⁷⁶ “Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data,” GOGLA, Lighting Global and World Bank, (July – December 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth2-2017_def20180424_web_opt.pdf; and

“Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data,” GOGLA, Lighting Global and World Bank, (January – June 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth12017_def.pdf; and

In its SEforALL National Renewable Energy Action Plan, the FGN envisions a significant share of the population will gain electricity access through off-grid solutions (**Table 5**). While these targets appear to be generally in line with the findings of the least-cost analysis through 2030, the FGN may need to consider increasing the utilization of stand-alone solutions in its electrification planning in order to achieve its energy access targets.

Table 5: Estimated Share of Population Served by Off-Grid Systems⁷⁷

Estimated share of rural population with access to off-grid renewable energy electricity services (%)	2020 (target)	2030 (target)
Mini-grids + stand-alone systems	25%	40%
Stand-alone systems	4.7%	5%

Source: SEforALL National Renewable Energy Action Plan

1.2.2.5 Inclusive Participation⁷⁸

Inclusive participation in Nigeria remains an ongoing challenge. Gender inequality persists, as women are under-educated and generally have a lower socio-economic status, with inadequate access to basic social services and reduced economic opportunities compared to men. Nigeria performs poorly in the United Nations Development Programme (UNDP) Gender Inequality Index, which measures several indicators to assess levels of gender inequality in the areas of health, access to education, economic status and empowerment.⁷⁹ Access to education and enrollment rates for Nigerian women are particularly low, which has troubling implications given the relationship between education and poverty. While the education gap between boys and girls in primary school has improved, gaps still exist in higher levels of education (**Figure 15**). Men average 25% more years of schooling than women, have higher rates of employment and earn higher rates of income.⁸⁰ This trend is also reflected in higher levels of government, where women hold only 5.8% of the country’s seats in parliament.⁸¹

⁷⁷ “Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data,” GOGLA, Lighting Global and World Bank, (July – December 2016): https://www.gogla.org/sites/default/files/recource_docs/final_sales-and-impact-report_h22016_full_public.pdf; and

“Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data,” GOGLA, Lighting Global and World Bank, (January – June 2016): https://www.gogla.org/sites/default/files/recource_docs/global_off-grid_solar_market_report_jan-june_2016_public.pdf

⁷⁸ “Nigeria Sustainable Energy for All National Renewable Energy Action Plan,” SEforAll, (2016): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_PANER/Nigeria_National_Renewable_Energy_Action_Plans_.pdf

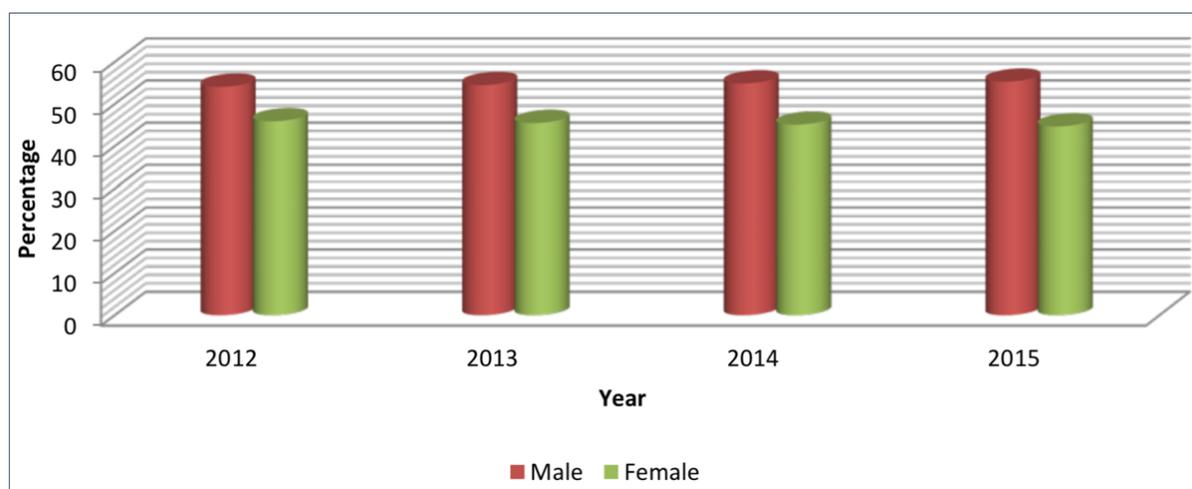
⁷⁹ See **Annex 4** for more details

⁸⁰ “Gender Inequality Index,” UNDP, (2015): <http://hdr.undp.org/en/composite/GII>

⁸¹ “Enhancing Financial Inclusion for Women in Nigeria,” CGAP, (March 2016): <http://www.cgap.org/blog/enhancing-financial-inclusion-women-nigeria>

⁸² “UN Human Development Indicators: Nigeria,” UN Development Programme, (2018): <http://hdr.undp.org/en/countries/profiles/NGA>

Figure 15: Percentage of Nigerian Population Completing Tertiary Education, 2012-2015⁸²



Source: National Bureau of Statistics

The Government has adopted both national and international policies, covenants and declarations to promote gender equality and women’s rights. The National Gender Policy adopted in 2008 and implemented by the Federal Ministry of Women Affairs, promoted the welfare and rights of Nigerian women and children in all aspects of life – political, social and economic. A National Gender Resource Center was also established through the National Center for Women's Development Agency of the Federal Ministry of Women's Affairs. Nigeria’s National Energy Master Plan also outlines a wide range of activities in coordination with the Federal Ministry of Women that aim to raise awareness, provide training, and other technical and financial support to help women access clean energy.

In the energy sector, efforts have been made to implement measures under the regional framework, ECOWAS Policy for Gender Mainstreaming in Energy Access, and at the national level. Gender mainstreaming in the country’s energy policy requires capacity building of staff and the implementation of gender management systems at the institutional level to provide guidance on gender responsive leadership and decision making. As part of this process, the Government has established a gender focal point at the Ministry of Energy to promote inclusive participation for women in the energy sector.

Energy linkages also exist in the National Gender Policy and the FGN has conducted a ‘gender audit’ of the energy sector. In 2018, under the NEP, REA developed a framework for Environmental and Social Risk Management (ESRM) framework that includes key gender provisions. With support from the World Bank, REA is also working to incorporate gender considerations into its operations, marketing and community outreach activities and training programs that will be delivered at various levels.⁸³

⁸² “Statistical Report on Women and Men in Nigeria: 2015,” National Bureau of Statistics, (November 2016).

⁸³ “Environmental and Social Management Framework,” REA, (2018): <http://rea.gov.ng/inc/uploads/2018/03/Draft-NEP-Environmental-and-Social-Management-Framework-ESMF-for-Consultation-March-2018-2.pdf>

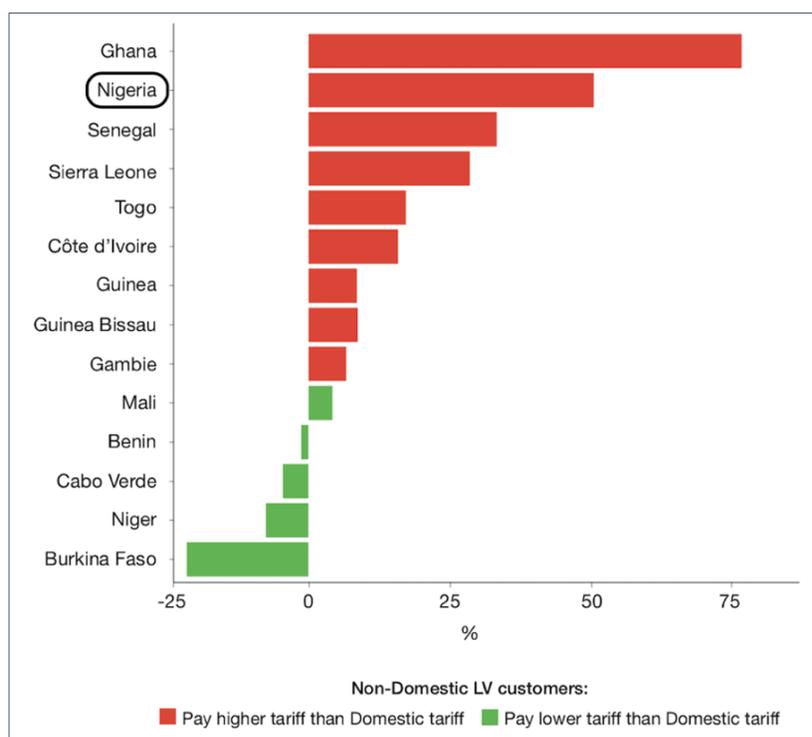
1.2.3 Key Challenges

Some of the key energy sector challenges facing Nigeria include (but are not limited to) the following:

- **Limited Grid Capacity and Grid Infrastructure:** Rapid economic and population growth, and the corresponding increases in electricity demand will continue to put pressure on power supply. The huge mismatch between demand and supply in the electricity sector will continue to burden the electricity transmission and distribution networks, which contributes to continued unreliable and irregular electricity service for customers (**Figures 6-7**). The country's limited generation capacity and unstable supply has led to prolonged periods of power outages, which significantly constrains economic growth. The Government urgently needs to engage GenCos and IPPs to increase supply, while the network needs maintenance and continued investment to reduce losses and expand access.
- **Electricity Tariffs:** Nigeria subsidizes electricity tariffs for low-income consumers, providing electricity to poorer households below the cost of supply through residential and commercial consumers who pay higher electricity rates. While this subsidization scheme has made power affordable for most residential consumers (particularly low-income households), commercial users/SMEs pay one of the highest electricity tariffs in the region – approximately 55% higher than residential tariffs (**Figure 16**).⁸⁴
- **Utility Financial Performance:** Without cost-reflective tariffs in place, TCN and Nigerian DisCos do not generate enough revenue to invest sufficiently in network extensions or in the maintenance of infrastructure. As a result, Nigeria's power sector remains largely dependent upon foreign assistance, while the overall quality of electricity service is extremely poor. Moreover, electricity users are not being charged accurately, with just seven million households registered as electricity customers out of 190 million citizens. Proper consumer auditing could help DisCos increase revenue without increasing tariff prices. A related issue that is hampering the utility's financial performance is the relatively weak state of the local currency and the associated currency risk that arises from this (Power Purchase Agreements (PPAs) are paid in USD, while electricity is sold at fixed rates in naira).
- **Imbalanced Energy Mix:** The country's power mix is overly reliant on natural gas and oil, which are susceptible to price volatility and are more carbon intensive than renewable alternatives. While private investment continues to support natural gas projects, there is comparatively little investment in non-hydro renewable energy, which cannot compete with cheaper fossil fuel power without significant policy and regulatory support from the FGN.

⁸⁴ "Electricity Tariffs in ECOWAS Region," African Development Bank Group, Energy Policy, Regulation and Statistics Division, (September 2018): http://www.ecowrex.org/sites/default/files/pesr1_-_energy_statistics_bulletin_september_2018.pdf

Figure 16: Commercial Tariff in Excess of Residential Tariff in ECOWAS Countries, 2018



NOTE: Liberia is excluded from the analysis; the disparity in electricity tariffs between commercial and residential consumers is an indication of the existence of a subsidization or cross-subsidization scheme that typically favors low-income residential consumers.

Source: ECOWAS Regional Electricity Regulatory Authority

- Market Barriers:** The FGN recently instituted a new policy increasing the import duty and VAT of imported solar components and accessories. Additionally, off-grid solar projects in Nigeria are often stymied due to a range of factors including the lack of technical knowledge in the private sector, a challenging regulatory framework, resistance from existing market players, and lack of access to competitive financing. The Government also continues to subsidize diesel fuel, keeping retail prices low compared to clean renewable energy alternatives. Policies such as these increase costs and create barriers to off-grid market growth.⁸⁵
- Local Financial Institutions:**⁸⁶ With the exception of a few banks active in the energy sector (e.g. Ecobank⁸⁷ and the Bank of Industry⁸⁸), experience in energy sector investment remains generally low for local financial institutions (FIs) and microfinance institutions (MFIs), who lack sufficient internal capacity and credit appetite to invest in this space. This challenge is complicated as it arises mainly from the risk perceptions of FIs, which influence whether efforts should be made to develop strategies and customize financial products to target a nascent market, where there is often limited knowledge of technologies, market characteristics and historical data on portfolio credit performance. There are also likely misperceptions about the potential size of these markets as well as doubts about the profitability

⁸⁵ "Off-grid Solar Nigeria: Enablers and Hurdles," Nigeria Electricity Hub, (2018).

⁸⁶ The role of FIs is examined in further detail in **Section 3**.

⁸⁷ Ecobank has received partial credit guarantees from the USAID Development Credit Authority to promote energy sector lending

⁸⁸ The Bank of Industry lends and invests the fund's capital on favorable, concessionary terms to qualified businesses installing mobile pay-go and other forms of off-grid solar energy systems and services across the country

of offering financial products in rural off-grid areas, where the creditworthiness of potential clients may be an issue. The renewable energy/off-grid space is particularly complicated given relatively high transaction costs and a comparatively unfavorable regulatory environment that exists in the country.⁸⁹

- **Other Challenges:** Successful development of the off-grid sector will require more than just a financial support mechanism – the Government and its supporting agencies will also need to develop and implement a range of measures to expedite growth of the market, including a robust technical assistance (TA) platform to supplement ROGEP’s objectives. This platform should address *inter alia* (i) awareness raising, education and training for consumers, including organization of appropriate community management structures; (ii) solar PV system supply chain and operations and maintenance (O&M) services, including training of local technicians to ensure that the cost of maintenance is affordable and sustainable; and (iii) standards for equipment and service providers (i.e. installers, technicians) to guide customers to companies providing the best value for their money. These measures should be part of a national rural electrification sector strategy to inform decision-making of key stakeholders surrounding development and regulation of the country’s stand-alone solar PV market.

⁸⁹ One notable exception to this is the commercial and industrial (C&I) market segment, where systems are larger and off-takers are often companies with large enough balance sheets to borrow. This has been one of the stand-alone market segments where there has been some lending to date in Africa (e.g. AFD’s Sunref program)

1.3 National Policy and Regulation

1.3.1 National Electricity/Electrification Policy

Over the past two decades, the energy sector has undergone reforms based on a few key policies, namely the National Electric Power Policy (2001), the National Energy Policy (2003), the Rural Electrification Policy Paper (2009), and the Roadmap for Power Sector Reforms (2010).⁹⁰ As a result of the variety of challenges facing the power sector and the lack of clear policies to address them, the Power Sector Recovery Plan (PSRP) was adopted in 2017 in partnership with the World Bank⁹¹ and the African Development Bank (AfDB). The PSRP includes a set of key interventions to be implemented over five years (2017-2022) that include (i) restoring financial viability; (ii) improving reliability to meet demand; (iii) strengthening the sector's institutional framework and increasing transparency; (iv) implementing clear policies that promote and encourage investor confidence in the sector; and (v) establishing a contract-based electricity market. Under this plan, the REA has created the Off-grid Electrification Strategy to increase electricity access to rural and underserved population and enhance the development of the Nigeria's off-grid power market.⁹²

In terms of renewable energy and energy efficiency action plans, the Government has adopted the NREEEP (2015), amended and complemented by the NREAP (2016), which focuses mainly on grid-connected renewable energy (RE). The primary targets are to increase energy access to 90% and to achieve 30% of renewables in the energy mix by 2030. For the off-grid sector, a national goal laid out in the 2015 NREAP of 40% of the rural population of Nigeria being served with off-grid renewable electricity services, and over 8,000 MW of off-grid capacity identified as part of the 2030 plan.

1.3.2 Integrated National Electrification Plan

Rural electrification is governed by the RESIP. The RESIP was prepared by the REA and approved in July 2016, but it still has not been fully implemented.⁹³ To achieve the RESIP targets of 95% urban electrification and 60% rural electrification rate by 2020, it is estimated that more than 10 million rural households will need to be connected (with an average of 7 people per household) and 6,000 MW added to the installed supply. These figures represent more than Nigeria's entire generating capacity in 2016. To this end, Nigeria requires an investment of Nigeria Naira (NGN) 1,440 billion (USD 9 billion). In addition to the creation of the Rural Electrification Fund, RESIP lays out a rural electrification strategy that seeks to shift from a centralized decision-making approach to a decentralized approach for rural electrification in the country, strengthening the role of states in managing off-grid development. This will enable a simplified and straightforward licensing framework to build electricity generation capacity (not exceeding 1 MW) as well as distribution capacity (not exceeding 100 kW). In addition to the RESIP, there is also the National Renewable Energy and Energy Efficiency Policy with the accompanying Vision 30:30:30 which aims at achieving 30,000MW of electricity by the year 2030 with renewable energy contributing 30 per cent of the energy mix.

Under the NREEEP and RESIP policies, NERC established more specific legislation in 2017 that includes details on license issuance and mini-grid and off-grid provisions. One of the main objectives outlined in the NERC guidelines include the installation of 180 MW of mini-grids generation capacity by 2020 and 5.3

⁹⁰ "Nigeria Sustainable Energy for All Country Action Agenda," SEforAll, (July 2016): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/NIGERIA_SE4ALL_ACTION_AGENDA_FINAL.pdf

⁹¹ "Nigeria - Power Sector Recovery Program," The World Bank, (2017): <http://documents.worldbank.org/curated/en/115731517496257028/Nigeria-Power-Sector-Recovery-Program>

⁹² "The Off-grid Opportunity in Nigeria," REA, (2017): http://rea.gov.ng/inc/uploads/2017/12/REA-Presentation-Off-Grid-Opportunity_africa2017.pdf

⁹³ "Rural Electrification Strategy and Implementation Plan (RESIP)," Federal Ministry of Power, Works and Housing / Government of Nigeria, (2016): <http://rea.gov.ng/inc/uploads/2017/09/RESIP.pdf>

GW by 2030, targeting 4,000 potential mini-grids to be developed by private operators and benefiting 13 million people living off-grid with 1.8 GW of new capacity. To reinforce the RESIP objectives, NERC states that while projects between 100kW and 1MW require a license those below 100 kW do not require a license but still need to register with NERC. For off-grid development, an agreement must be reached between the private generation operator and the community where the installation will be located. If a license is required, the distribution operator must pay the mini-grid owner 100% of the depreciated asset value or capital expenditure (CAPEX) plus one year of revenue.⁹⁴

1.3.3 Energy and Electricity Law

Nigeria launched an electricity sector legal reform program in 2001 that ultimately resulted in the unbundling and privatization of generation and distribution companies in 2013. Two key laws that were adopted include (i) the National Electric Power Policy (NEPP, 2001), which set the broad outlines of the reform agenda, and (ii) the Electricity Power Reform Act (2005), which effectively transformed the sector removing the monopoly of the vertically integrated utility.

This process also led to the unbundling of the sector into six generation companies (GenCos), 11 distribution companies (DisCos) and a transmission company (TCN), while simultaneously creating the Nigerian Electricity Regulatory Commission (NERC). The 2014 Rural Electrification Strategy and Plan (RESP) gives the NERC the mandate to regulate over the rural electrification sector. In 2015, the NERC passed the Regulation for Independent Electricity Distribution Networks (IEDN), which covers isolated generation and distribution operators requiring a license to develop off-grid areas.

1.3.4 Framework for Stand-alone Systems

Figure 17 is an overview of the key national policies, programs, laws, and regulations pertaining to Nigeria’s framework for stand-alone systems. The gaps in this framework are addressed in **Section 1.3.5**.

To date, the Government’s efforts to establish a supportive policy and regulatory framework for the off-grid sector are progressing well, as evidenced by the country’s 22-point improvement in its World Bank Regulatory Indicators for Sustainable Energy (RISE) energy access score between 2015 and 2017. Despite this improvement, in the 2017 RISE evaluation, Nigeria ranked 10th among countries in West Africa and the Sahel (**Figure 18**).

⁹⁴ “Nigeria mini-grid regulation,” Climatescope, Bloomberg New Energy Finance, (2017): <http://global-climatescope.org/en/policies/#/policy/5319>

Figure 17: Policy and Regulatory Framework for Stand-alone Systems

NIGERIA		
	World Bank RISE 2017 Energy Access Score: 40 World Bank RISE 2015 Energy Access Score: 22	2017 ranking among West Africa and the Sahel (ROGEP) countries: 10 th
Policy/Regulatory Support and Financial Incentives	Specific national policies, laws and programs	
	National electrification policy with off-grid provisions	√ National Energy Policy
	Integrated national electrification plan	[] RESIP ⁹⁵
	Energy/electricity law with off-grid provisions	√ IEDN
	National programs promoting off-grid market development	√ Nigeria Electrification Project (NEP)
	Specific target for rural electrification	√ 90% by 2030; 100% by 2040
	Financial incentives	
	Subsidies, tax exemptions or related incentives for solar equipment/stand-alone systems	[] REF
	Standards and quality	
	Government-adopted international quality standards for stand-alone systems	√ Standards Organization of Nigeria (SON)
	Government-certified program for solar equipment installers	x
	Consumer awareness/education programs	√ Nigeria Electrification Project
	Concession Contracts and Schemes	
[] RESIP		
Business Model Regulation		
x		

√ = existing/implemented provisions in the current regulatory framework

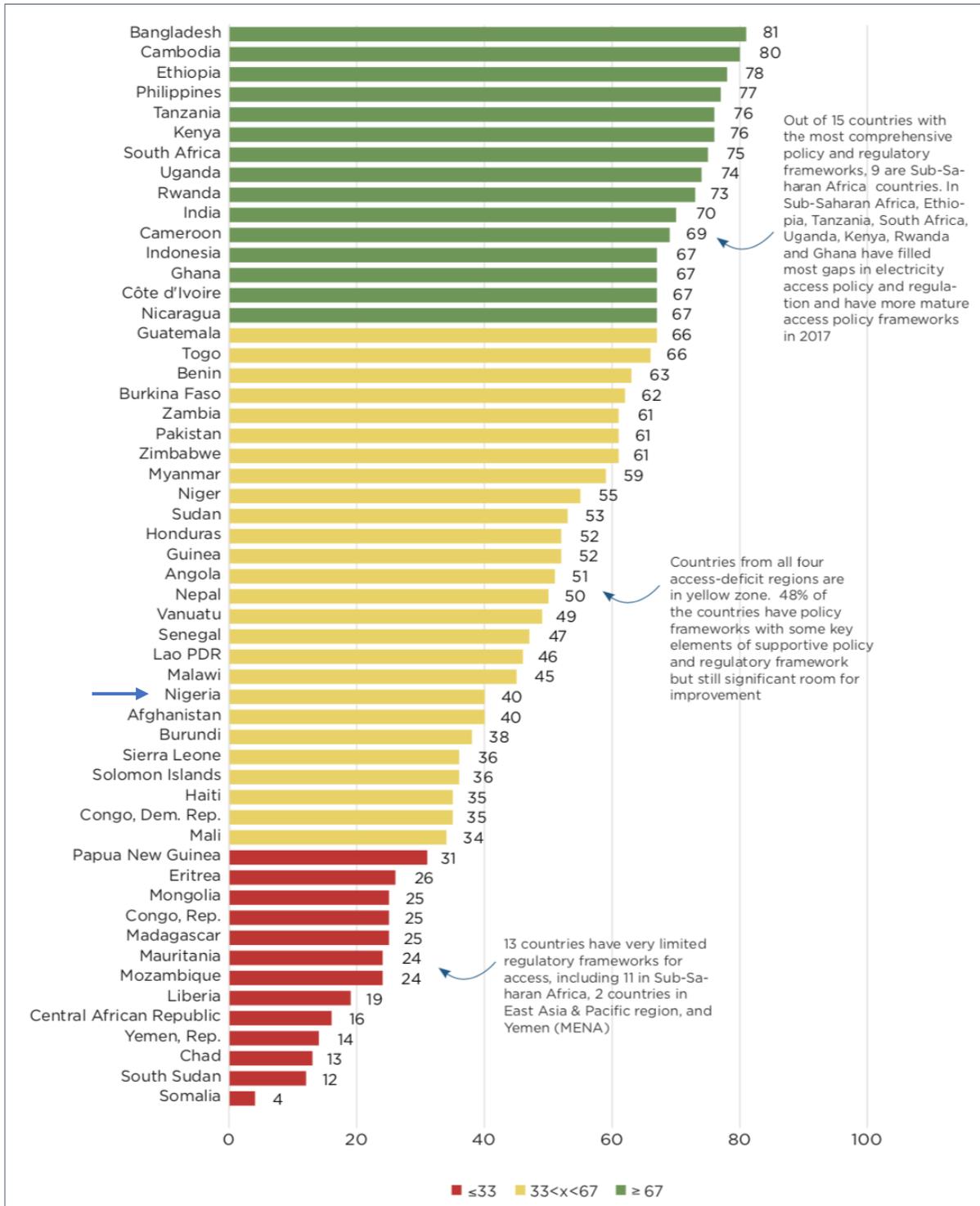
x = no existing provisions

[] = planned/under development

Source: World Bank RISE; Stakeholder interviews; GreenMax Capital Advisors analysis

⁹⁵ The Rural Electrification Strategy and Implementation Plan (RESIP), which includes plans/provisions to address many of the existing gaps in the policy and regulatory framework, was still under development as of early 2019.

Figure 18: Distribution of RISE Electricity Access Scores in Access-Deficit Countries, 2017⁹⁶



Source: World Bank Regulatory Indicators for Sustainable Energy

⁹⁶ "Policy Matters: Regulatory Indicators for Sustainable Energy," World Bank ESMAP, (2018): <http://documents.worldbank.org/curated/en/553071544206394642/pdf/132782-replacement-PUBLIC-RiseReport-HighRes.pdf>

1.3.4.1 Existence of Specific National Programs

The FGN has adopted a number of programs and policies that aim to electrify rural areas of the country. The most prominent initiative is the Nigeria Electrification Project, while the RESIP is a more comprehensive national plan and regulatory framework specifically for the off-grid sector, covering stand-alone solar products and services as well as mini-grids.⁹⁷ Nigeria’s SEforALL Country Action Agenda emphasizes the importance of off-grid solar technology in achieving the country’s rural electrification objectives, calling for 8 GW of off-grid generation capacity by 2030. The Action Agenda also highlights Nigeria’s 2014 Operation Light-Up Rural Nigeria as a pilot program that REA could learn from.⁹⁸

1.3.4.2 Financial Incentives

Nigeria currently lacks a clear policy framework with financial incentives for the stand-alone solar sector. Under RESIP, there are provisions for REA to establish a Rural Electrification Fund (REF) to help finance rural electrification expansion in the country. The REF aims to improve the affordability of power in off-grid areas by providing subsidies towards initial capital costs associated with establishing RE schemes in an effort to lower the economic barriers to enter the market in Nigeria. These subsidies will be offered by the REF as a capital grant based on a competitive allocation method directed to legal persons, corporate and other stakeholders interested in executing rural electrification.⁹⁹ The REA will also advocate for tax incentives, investment capital allowances, and low-interest loans for producers and retailers of RE equipment and materials and reduce taxes on imported solar goods.

1.3.4.3 Standards and Quality

The FGN, through the Standards Organization of Nigeria (SON), can take steps to establish a set of technical criteria and required standards for the off-grid sector. Measures can also be taken to improve the process for importing solar products, as suppliers currently face many hurdles that cause delays and increase transaction costs. The existing processes are unnecessarily onerous and are not fully aligned with global standards (e.g., International Electrotechnical Commission (IEC) /ISO).¹⁰⁰

1.3.4.4 Concession Contracts and Schemes

Interactions between private sector developers and the Government do not exist yet in Nigeria’s off-grid sector. While the framework is missing, RESIP defines a clear approach to rural electrification that combines the Government’s centralized method with a “bottom-up” de-centralized approach, whereby the REA/REF will support development of off-grid rural electrification through disbursement of funding for suitable off-grid projects and will collaborate with the private sector, local communities, distribution companies, and business groups to drive a collaborative environment for programs and projects financing.¹⁰¹

⁹⁷ “Off-grid Solar Market Trends Report,” Dalberg and Lighting Global, (2018): https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf

⁹⁸ “Nigeria Sustainable Energy for All Country Action Agenda,” SEforAll, (July 2016): https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/NIGERIA_SE4ALL_ACTION_AGENDA_FINAL.pdf

⁹⁹ Ibid.

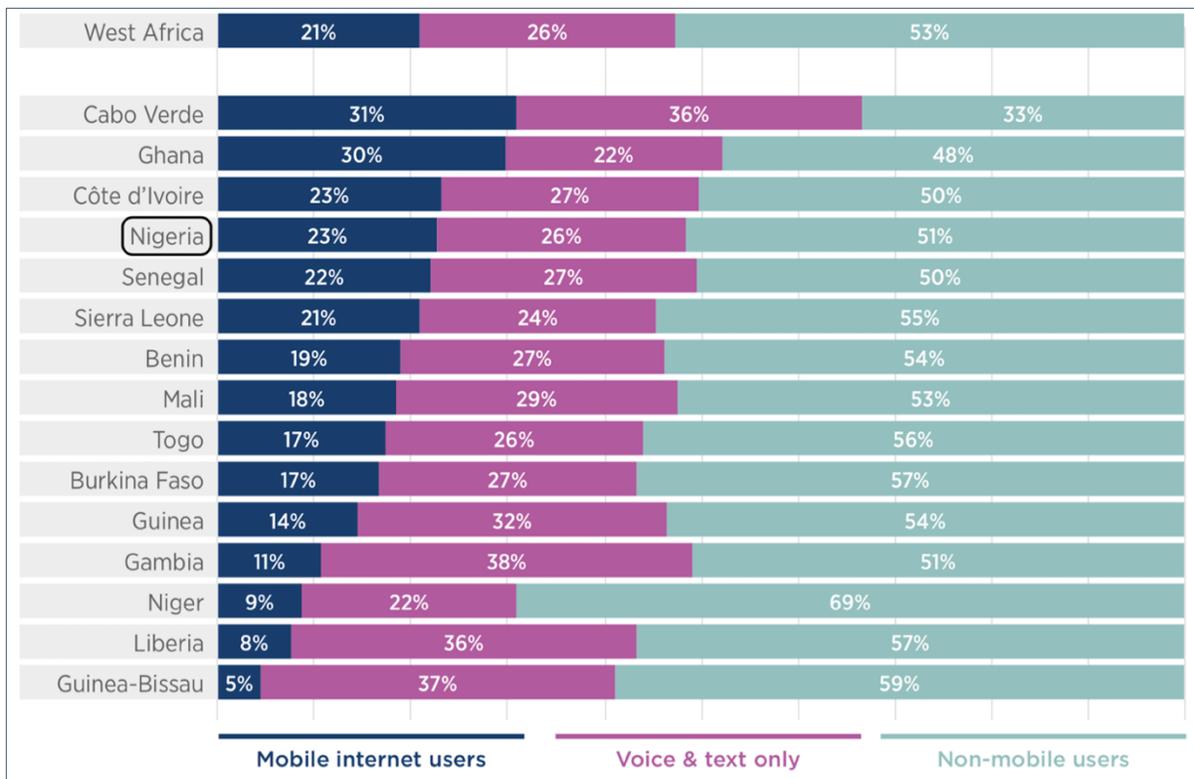
¹⁰⁰ “Improving Access to Electricity Through Decentralized Renewable Energy,” Dahlberg Advisors, (May 2017): <https://www.dalberg.com/system/files/2017-08/off-grid%20policy.pdf>

¹⁰¹ “Rural Electrification Strategy and Implementation Plan,” Federal Ministry of Power, Works and Housing, Rural Electrification Agency, (2016): <http://rea.gov.ng/file/2017/09/RESIP.pdf>

1.3.4.5 Specific Business Model Regulation

No specific business model regulations exist for stand-alone systems in Nigeria. NERC regulations approved in 2016 cover the registration, permitting, operations, and grid interactivity for mini-grids, with unique regulations for isolated mini-grids in areas unserved by national grid and DisCos and interconnected mini-grids in areas underserved by DisCos. The regulations do not address SHS and pico-solar (stand-alone systems). The Government can take measures to support PAYG business models that have already been deployed by private solar companies engaged in the market. As was demonstrated in East Africa in recent years, the proliferation of mobile money platforms can rapidly facilitate energy access. Recent data suggests that there is an opportunity for the FGN to bring together key stakeholders in the off-grid sector (solar providers, telecommunications companies etc.) to take advantage of the country’s growing mobile internet usage (**Figure 19**) and high rates of mobile phone ownership in rural areas (**Figure 20**). Moreover, a transition to mobile broadband networks is gaining rapid momentum,¹⁰² with Nigeria accounting for the largest share of new subscribers across West Africa.¹⁰³

Figure 19: West Africa Mobile Internet Penetration Rates, 2017



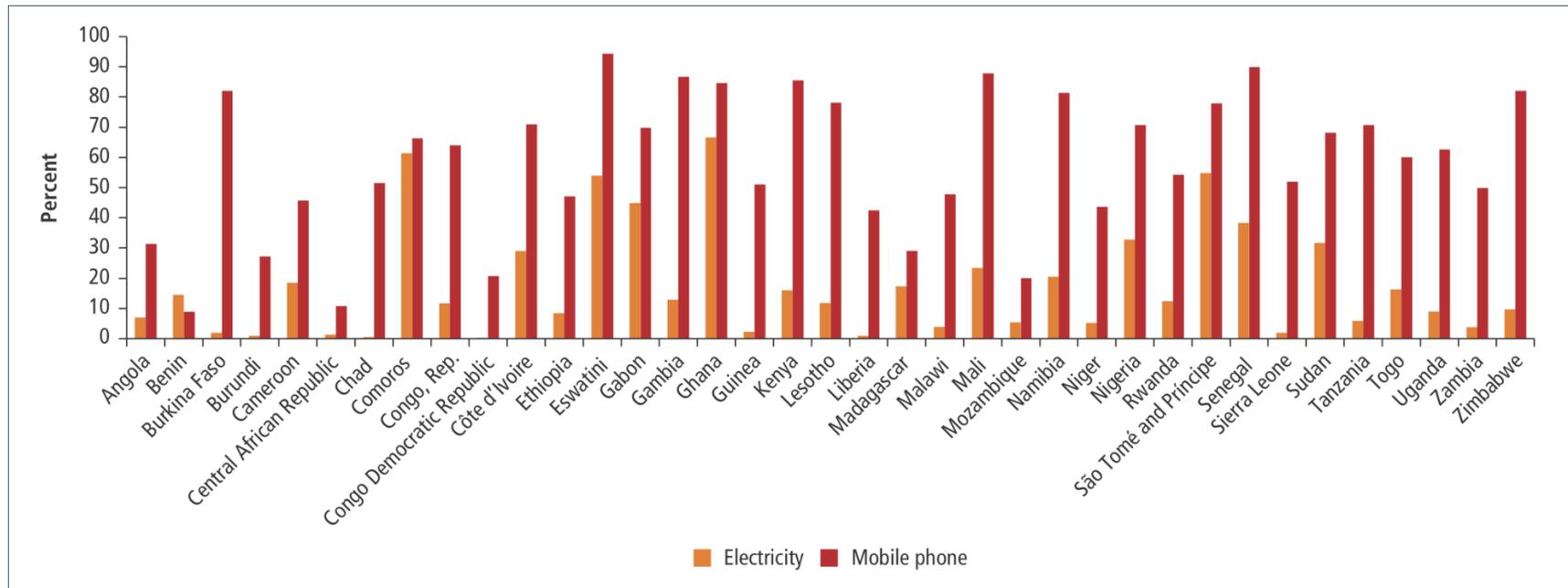
Source: GSMA Intelligence

¹⁰² Airtel Nigeria launched its LTE service in February 2018

¹⁰³ "The Mobile Economy: West Africa 2018," GSMA Intelligence, (2018):

<https://www.gsmaintelligence.com/research/?file=e568fe9e710ec776d82c04e9f6760adb&download>

Figure 20: Electricity Access and Mobile Phone Ownership in Sub-Saharan Africa, 2016 (% of rural households)¹⁰⁴



Source: World Bank

¹⁰⁴ Blimpo, M., and Cosgrove-Davies, M., "Electricity Access in Sub-Saharan Africa: Uptake Reliability and Complementary Factors for Economic Impact," AFD and World Bank, (2019): <https://openknowledge.worldbank.org/bitstream/handle/10986/31333/9781464813610.pdf?sequence=6&isAllowed=y>

1.3.5 Capacity Building and Technical Assistance

To overcome the challenges surrounding rural electrification, a range of technical and financial resources from both the public and private sector must come together. At the institutional level, the REA and the electricity market regulator, NERC, among others, will play key roles in establishing a supportive policy and regulatory framework. Additional reforms to the power sector may be required to provide the incentives necessary to increase private sector participation. Local FIs and MFIs will need incentives and support to develop and implement new financial products and administrative procedures to lend to the off-grid sector. International and local solar companies will need policy and financial support. Local technical capacity of the solar sector will need to be developed to ensure long-term O&M services are available and sustainable. Above all, financing and TA will be critical for all market actors – government, financial institutions, end-users, suppliers and service providers – in order to accelerate growth.

Though some of the major multilateral projects that are ongoing such as the Nigeria Electrification Project or EU Support to the Nigerian Energy Sector include capacity building and TA, further ongoing support that goes beyond broad-based economic restructuring is needed. RESIP also identifies TA and financial capacity building as crucial next steps to driving off-grid development. In addition, as part of the World Bank’s NEP project, an allocation of USD 20 million will be provided directly to the technical assistance component including institutional support for REA, investment pipeline development, financing needs assessment, regulatory support, pre-investment support to mini-grid developers, ecosystem development for SHS and environmental and social safeguards.

Table 6 identifies some of the policy/regulatory challenges facing off-grid market development in Nigeria and proposed TA interventions to address them.

Table 6: Gaps in the Off-Grid Policy and Regulatory Framework¹⁰⁵

Indicator	Policy/Regulatory/Market Gaps	Recommended TA Intervention
1. Specific National Policies, Laws and Programs	A. Insufficient National Electricity / Electrification Policy	a. Help Government analyze where fossil fuel subsidies serve as an impediment to development of safe, clean energy access alternatives ¹⁰⁶
	B. Lack of Integrated National Electrification Plan	a. Help Government develop a comprehensive, least cost, integrated plan for all rural electrification options (grid, mini-grid and off-grid) with clear and consistent targets and policies (RESIP) ¹⁰⁷ b. Help Government improve the planning framework to encourage private participation in mini-grid and stand-alone solar system options, including <i>inter alia</i> preparation of guidelines to enhance collaboration between Government and private companies, industry associations, and other relevant stakeholders to coordinate development of effective policy that is flexible and responsive to the needs of the market
	C. Insufficient Energy and Electricity Law	a. Help Government structure legal framework ¹⁰⁸ to ensure that it is flexible and helps create appropriate incentives for private sector participation in off-grid market development
	D. Insufficient national policies, laws, programs and/or action plans targeting off-grid market development	a. Help Government improve policy and regulatory framework to create appropriate incentives for private sector participation to expedite off-grid solar market growth, including <i>inter alia</i> preparation of procurement schemes and financing mechanisms designed to encourage PPP engagement in the off-grid sector ¹⁰⁹
2. Financial Incentives (import duties, taxes, etc.)	A. Insufficiently supportive financial incentives / tax regime	a. Help Government develop appropriate policies to reduce import duties and tariffs on the entire off-grid / stand-alone solar product supply chain (including batteries, inverters or other system components) that would provide necessary support to the industry ¹¹⁰

¹⁰⁵ “Government” as it is used throughout this table refers to the main public institutions, officials and policymakers responsible for planning, management and regulation of the energy sector in Nigeria (Table 2), including the Ministry of Power, Works and Housing (MPWH), the Presidential Task Force on Power (PTFN), the Rural Electrification Agency (REA), The Energy Commission of Nigeria (ECN), the Nigerian Electricity Regulatory Commission (NERC), and the National Power Training Institute of Nigeria (NAPTIN) among other national and local authorities.

¹⁰⁶ Although the FGN removed fossil fuel subsidies from the power sector in 2016, diesel gasoline/petrol continues to be subsidized to support individuals, households and business that require assistance to meet their fuel needs – this subsidy was identified by focus group participants, suppliers and dozens of interviewed stakeholders as the most important barrier to growth of the country’s solar sector

¹⁰⁷ The Rural Electrification Strategy and Implementation Plan (RESIP) remains under development as of mid-2018

¹⁰⁸ Electricity Industry Enforcement Regulations / Regulation for Independent Electricity Distribution Networks (IEDN)

¹⁰⁹ In this context, efforts should focus on improving the self-sufficiency / solvency of regional DisCos

¹¹⁰ Under the RESIP, the REA plans to include tax incentives, investment capital allowances, and low-interest loans for producers and retailers of RE equipment and to reduce taxes on imported solar goods

		<ul style="list-style-type: none"> b. Help Government establish a Special Task Force to (i) mitigate potential difficulties in customs clearance and import logistics, and (ii) oversee implementation of tax exemptions by coordinating with all agencies and regulatory bodies involved – Customs Authorities, National Revenue Authority, Standards Organization of Nigeria (SON) c. Help Government introduce appropriate grant and subsidy schemes which require private funding matches and are predictable and not overly bureaucratic (e.g. through implementation of the planned Rural Electrification Fund) d. Help Government create PPP schemes to share high project development and market entry costs particularly with developers in remote areas (e.g. through planned RESIP Rural Electrification Fund) e. Help Government analyze where subsidies or exemptions for non-renewable energy sources provide unfair advantage for fossil-fuels and impede development of clean energy solutions
3. Standards and Quality	A. Insufficient Market Data	<ul style="list-style-type: none"> a. Help Government establish a Special Task Force (e.g. within REA) responsible for collaborating with the private sector to compile and regularly update a database of critical off-grid market data (including inter alia solar product imports, costs, sales volumes, resource potential etc., GIS data and other key demographic and socioeconomic indicators) that can be (i) utilized by policymakers to make informed electrification planning decisions based on accurate/updated market information, and (ii) made easily accessible to interested off-grid developers, investors and other key industry stakeholders
	B. Unclear / lack of quality standards	<ul style="list-style-type: none"> a. Help Government improve upon existing framework to align with international quality standards for off-grid stand-alone solar products, including minimum technical standards (IEC Technical Specifications), warranties, required availability of and cost guidelines for post-sale services/O&M, etc. (through the Standards Organization of Nigeria, SON)¹¹¹ b. Help Government integrate standards with appropriate oversight agencies (e.g. REA, SON) to ensure quality-verification procedures are in place to ensure the safety and reputation of licensed products and to in turn mitigate the detrimental impact of the counterfeit / inferior product market¹¹² c. Help Government implement a legal framework that provides protections for consumers and suppliers, including inter alia regulations that (i) require licensing for the sale and installation of solar equipment; (ii) prohibit the sale of certain brands or models; and (iii) enable companies or public authorities to prosecute those caught distributing counterfeit / inferior products that are not up to promulgated standards

¹¹¹ These standards can be readily developed for the DC plug-and-play systems and solar lanterns. For component-based systems, the FGN, with support from the World Bank, is defining a quality verification framework for companies whose products are not certifiable by Lighting Global (AC systems and/or >350W DC systems); it is expected that Lighting Global will expand the scope of its system to include these in the future at which point they should become adopted by the SON

¹¹² The growth of the Black market / presence of poor quality, sub-standard products has resulted in reduced profit margin for the genuine licensed players in the industry

	<p>C. Lack of capacity of local technical sector (solar PV technicians, installers, services providers etc.)</p>	<p>a. Support establishment of technical certification and vocational training programs through government, private sector, and/or academia for installation and maintenance of stand-alone solar systems (e.g. by building on training and rural development initiatives of NAPTIN)¹¹³</p> <p>b. Support development of database of best practices / information sharing services to ensure skills transfer from international, local and regional initiatives (e.g. through NAPTIN or REA)</p>
	<p>D. Insufficient attention of private companies to environmental/social standards and community engagement</p>	<p>a. Assist private sector and/or civil society organizations to ensure environmental/social standards are in place</p> <p>b. Assist in development of strategies encouraging inclusive gender participation</p> <p>c. Support with the implementation of a repair and recycling framework for off-grid solar systems and equipment</p>
	<p>E. Insufficient public awareness</p>	<p>a. Support Government, trade associations and civic society organizations to develop and implement consumer awareness/marketing/education programs on the benefits of off-grid solar products and the existence of related national programs¹¹⁴</p> <p>b. Support development and implementation of programs to educate consumers, retailers and distributors on the benefits of quality certified solar products vs. counterfeit products</p>
<p>4. Concession Contracts and Schemes</p>	<p>A. Lack of clear and transparent licensing and permitting procedures</p> <p>a. Unclear procedures</p> <p>b. Insufficient communication and streamlining</p>	<p>a. Help Government (NERC) develop clear licensing and permitting procedures</p> <p>b. Help Government develop improved systems for sharing and disseminating information to project developers and key stakeholders, including establishment of a “one-stop-shop” for national level permits and approvals and expediting of local permits (e.g. through REA or NAPTIN)</p>
	<p>B. Lack of understanding of emerging concession and energy services schemes for off-grid providers</p> <p>a. Need for understanding of different SHS concession schemes</p>	<p>a. Help Government understand all options and models for possibilities of granting geographic concessions to private operators of SHS¹¹⁵</p>

¹¹³ One way that support will be channeled for this purpose is through the recently established Nigeria Climate Innovation Center (NCIC)

¹¹⁴ The Nigeria Electrification Project (NEP) includes an awareness raising component; Lighting Nigeria has been funding a private sector driven awareness raising activity for eligible products and the goal is to continue to support that under NEP TA.

¹¹⁵ Different models used to grant geographic concessions to SHS providers can yield wide-ranging results; while some observers have lauded the approaches being used in Rwanda, Togo and DRC as successful, there has been criticism of the approach deployed in Senegal.

	<ul style="list-style-type: none"> b. Need for understanding of emerging models for 'Integrated Private Utilities' or 'Energy Companies of the Future' c. Public procurement or public finance/budget laws that hamper deployment of energy services models for public facilities d. Lack of standardized contracts for energy services provided by private system operators to public facilities e. Insufficient protection for stranded investments 	<ul style="list-style-type: none"> b. Help Government to understand and develop approaches to facilitate pilots of 'Integrated Private Utility' or 'Energy Company of the Future' schemes.¹¹⁶ c. Help Government develop procurement and public finance laws that will facilitate stand-alone solar system investment for public facilities (schools, health care facilities, etc.) d. Help Government trade associations or civic society organizations develop model bilateral PPA and Energy Services Contracts for small scale IPPs and ESCOs to sell power or deliver energy services to public facilities (i.e. schools, health care facilities) or deliver solar street lighting services to municipalities e. Help Government develop proper procedures and guidelines to protect against stranded investments from competition among all on-grid and off-grid rural electrification approaches¹¹⁷
<p>5. Business Model Regulation</p>	<p>A. Lack of understanding about different pricing schemes and business models offered by stand-alone solar system developers</p>	<ul style="list-style-type: none"> a. Support capacity building regulators, Government, and non-Government stakeholders about different pricing schemes offered by stand-alone solar system providers to improve understanding and help avoid unnecessary interventions to regulate¹¹⁸ b. Support regulators and off-grid enterprises to collaborate specifically on developing pricing schemes for productive use market segment¹¹⁹ c. Support off-grid entrepreneurs and telecommunications companies in building the capacity of and fostering linkages between telecommunications companies / mobile money providers and off-grid solar companies to help roll out technology platforms and PAYG business models¹²⁰

Source: Focus Group Discussions; Stakeholder interviews; GreenMax Capital Advisors analysis

¹¹⁶ Innovative models are emerging for entire geographic areas to be concessioned to integrated private energy services operators who may offer an appropriate mix of solutions within their franchised area (i.e. a mix of SHS, rooftop solar, specialized systems for productive use, mini-grids and micro-grids). This is being piloted by the Shell Foundation in several countries.

¹¹⁷ As the off-grid sector becomes populated by a variety of different approaches, all private operators are subject to potential stranded investments "when the grid arrives" and even SHS providers can have their assets and revenues threatened when the mini-grid arrives.

¹¹⁸ The term "pricing schemes" used in this context refers to pricing options offered by standalone solar system providers for SHS, productive use, rooftop solar for public facilities, solar street lighting, etc. that are new, innovative and may be difficult for stakeholders to initially well understand. Whether these are PAYG, Lease to Own, electricity sales, commodity-based pricing, time of use or block pricing, the lack of understanding can often cause stakeholders to ask Government to intervene to "protect consumers" where such regulation of the market could in fact be misguided and unwarranted.

¹¹⁹ The productive use segment is brand new with SHS providers, mini-grid operators and vendors specialized on a single type of SME or agricultural productive use (i.e. grain mills, water pumps, cocoa processing etc.) all grappling to arrive at attractive approaches to billing for energy services. This is a particular area where TA support is much needed to help all stakeholders sort out fair and practical approaches.

¹²⁰ In Nigeria, Lumos has played a particularly transformative role in hastening development of the PAYG business model through a solution marketed, distributed and sold by MTN Nigeria as the MTN mobile electricity service, whereby customers can top up their electricity account using their MTN airtime. The use of airtime as credit varies by jurisdiction, as airtime is not considered a currency; as a result, airtime integration and usage for solar payments happen on a case-by-case basis.

1.4 Development Initiatives

1.4.1 National Government Initiatives

The FDN has instituted several key strategic plans and roadmaps to address rural electrification and development of the off-grid sector. These initiatives have been accompanied by a series of other plans funded by a variety of international donors (**Table 7**).

Table 7: National Government Off-Grid Development Programs

Project/Program	Timeline	Market Segment(s)	Description
Rural Electrification Strategy and Implementation Plan (RESIP)	2016 – ongoing	Off-grid, mini-grid, solar home systems	<ul style="list-style-type: none"> The primary sector plan governing Nigeria’s rural electrification. Overall strategy identifies off-grid electrification as vital to achieving energy access goals rural locations, focusing in particular on the cost-effectiveness of off-grid solutions. Identifies the need to coordinate grid expansion plans with off-grid development to avoid redundancies and to utilize the REF to drive off-grid market growth. Guiding policy for the REA that targets 75% electrification by 2020, with an estimated total cost of USD 1.9-3.3 billion.
National Renewable Energy and Energy Efficiency Policy	2015	RE On-Grid / Off-grid	<ul style="list-style-type: none"> Among other RE priorities, NREEEP sets policy priorities for the use of RE for on- and off-grid applications.
National Renewable Energy Action Plan	2016	RE On-Grid / Off-grid	<ul style="list-style-type: none"> Includes targets for off-grid development and provides for the removal of barriers to off-grid market development in accordance with the groundwork laid by Nigeria’s SEforAll priorities.
Vision 20:2020	2009 - present	Small-scale and off-grid	<ul style="list-style-type: none"> Among many other critical development initiatives, the Vision 20:2020 economic growth plan recognizes climate change as a critical threat to sustainable development.¹²¹ Among other related policy directives, the policy plan identifies a general decentralization policy in the power sector as crucial to Nigeria’s growth and development. The plan seeks to support policy initiatives that promote universal energy access with an emphasis on rural areas. By decentralizing control over parts of the power sector to the states, it aims to create a locally and regionally bifurcated economy for small-scale and off-grid renewable products.¹²²
Energizing Economies Initiative	2018 - ongoing	Solar kits for small businesses	<ul style="list-style-type: none"> The REA has partnered with Rensource Energy to provide solar kits for thousands of businesses in Sabon Gari Market in Kano, Nigeria in response to multiple large fires in public markets that occurred due to unsafe generator use. Rensource Energy is deploying solar energy kits to over 500 shops in the first phase of the project. Later phases of this project will see additional solar kits supplied to the remaining 12,000 shops in the market. The FGN has an overarching goal to make all public markets generator-free.¹²³

¹²¹ “INDC of Nigeria,” UNFCCC,

http://www4.unfccc.int/Submissions/INDC/Published%20Documents/Nigeria/1/Approved%20Nigeria's%20INDC_271115.pdf

¹²² “Vision 20: 2020”, Federal Government of Nigeria, (2009): <http://www.nationalplanning.gov.ng/images/docs/NationalPlans/nigeria-vision-20-20-20.pdf>

¹²³ “REA electrifies markets with solar power,” The Punch, (2018): <http://punchng.com/rea-electrifies-major-markets-with-solar-power/>

1.4.2 DFI and Donor Programs

Development Finance Institutions (DFIs) and donor-funded programs in Nigeria’s energy sector have been largely directed towards grid-connected power generation and transmission projects. A summary of relevant DFI/donor programs and initiatives supporting development of the off-grid sector are presented in **Table 8** and **Figure 21**.

Table 8: DFI and Donor-Funded Off-Grid Development Programs

Project/Program	Funding Source	Timeline	Market Segment(s)	Description
Nigeria Electrification Project ¹²⁴	World Bank/IFC, AfDB, REA	2018-2022	Mini-grids, solar PV, stand-alone solar	<ul style="list-style-type: none"> Nigeria Electrification Project (NEP) is a USD 350m rural electrification program supported by the World Bank to provide a pipeline of potential local investments and financial incentives to catalyze the Nigerian off-grid market, through the provision of detailed market data, grant funding and technical assistance. The NEP is broken up into four main components: (i) Solar Hybrid Mini-Grid, (ii) Stand Alone Solar Systems, (iii) Energizing Education Programme, and (iv) Technical Assistance REA will support the development of mini-grid projects by the private sector, serving at least 300,000 households and 30,000 local enterprises in close to 10,000 communities.¹²⁵ The stand-alone solar systems for homes component of the project significantly increases the market for stand-alone solar systems in Nigeria in order to provide access to electricity to more than one million Nigerian households and MSMEs at lower cost than their current means of service such as small diesel generators. It consists of both market scale-up challenge grants and performance-based grants.¹²⁶
EU Support to Energy Sector in Nigeria- Phase 1	European Union	2016 – present	Rural electrification	<ul style="list-style-type: none"> The EU’s off-grid energy sector financing in Nigeria has gone largely towards increasing electricity access in northern Nigerian states.¹²⁷
Decentralized Renewable Energy Taskforce (DRET) / Scaling Off-grid Energy (SOGE) Grand Challenge for Development	Power Africa, the US Global Development Lab, USAID Nigeria, FHI360, and Power for All	2018	Decentralized energy, energy access	<ul style="list-style-type: none"> The taskforce launched in Nigeria to accelerate modern electricity access initiatives. The partnership was formed under the Scaling Off-grid Energy (SOGE) Grand Challenge for Development, which aims to accelerate growth of Decentralized Renewable Energy (DRE) solutions and provide 20 million households in sub-Saharan Africa with access to modern, clean and affordable electricity.¹²⁸

¹²⁴ “The Nigeria Electrification Project,” REA, (2018): <http://rea.gov.ng/nigeria-electrification-project-nep/>

¹²⁵ “Nigeria Electrification Project,” AfDB, (2018): <https://www.afdb.org/en/projects-and-operations/project-portfolio/p-ng-f00-020/>

¹²⁶ “Solar Mini Grids Put Nigeria on Path to Energy for All by 2030,” World Bank, (2018): <http://blogs.worldbank.org/energy/solar-mini-grids-put-nigeria-path-energy-all-2030>

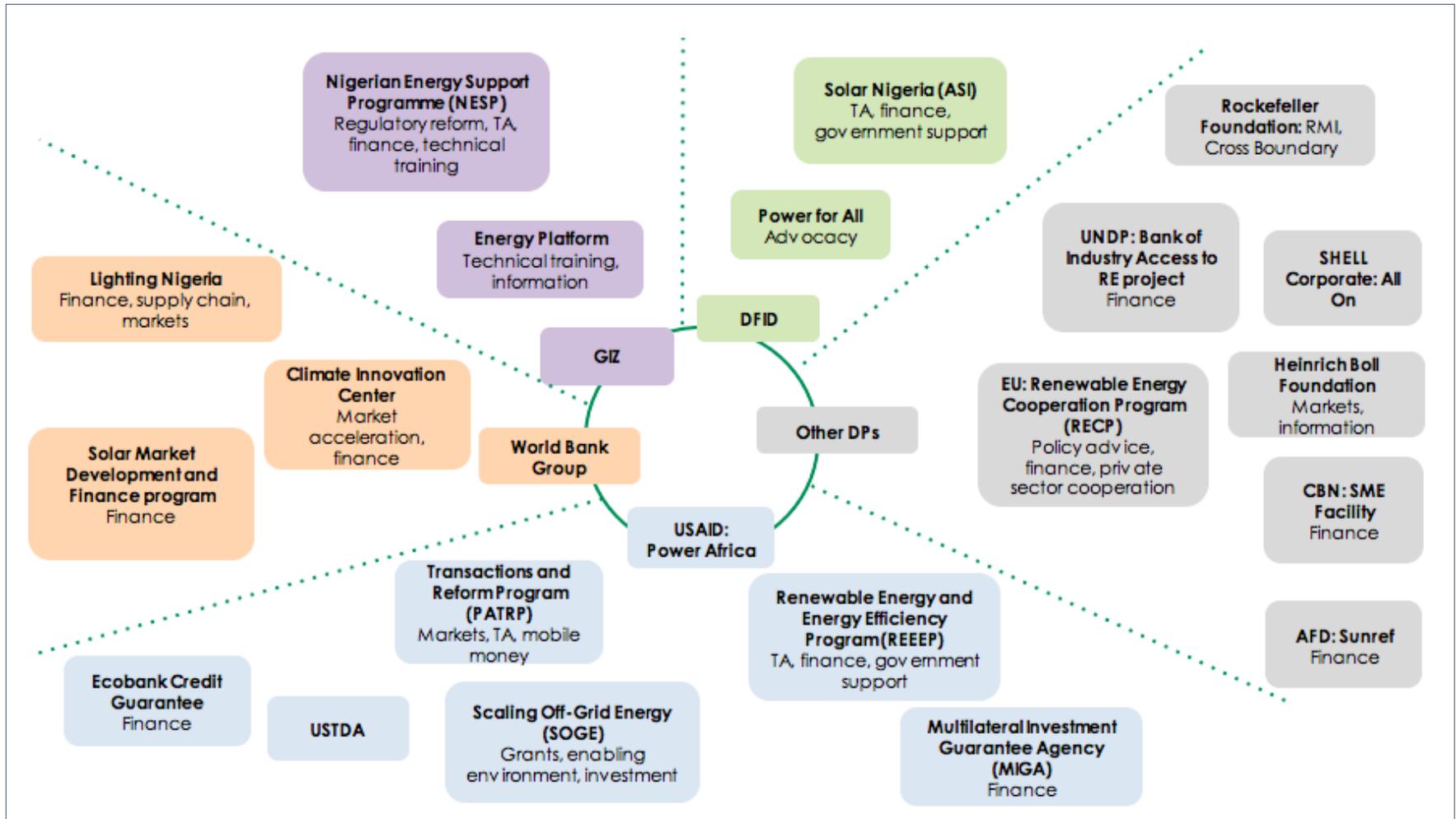
¹²⁷ “Action Document for Energy Sector Support to Nigeria,” European Union, (2016): https://ec.europa.eu/europeaid/sites/devco/files/ad-4-3-aap-nigeria-2016_en.pdf

¹²⁸ “DRE Task Force Kickoff,” Power for All, (2018): <http://www.powerforall.org/blog/2018/2/16/news-release-kickoff-of-dre-task-force>

Project/Program	Funding Source	Timeline	Market Segment(s)	Description
Nigerian Energy Support Programme (NESP)	GIZ	2017-2021	Rural electrification	<ul style="list-style-type: none"> German Corporation for International Cooperation (GIZ) is the agency engaged in supporting implementation of the NESP, including mobilization of investment to promote rural electrification.
Solar Nigeria ¹²⁹	UK DFID	2017 - present	SHS	<ul style="list-style-type: none"> Program to roll-out solar energy systems in rural schools and health clinics in Northern Nigeria
Power Africa	USAID	2013 - ongoing	Off-grid, solar PV	<ul style="list-style-type: none"> Power Africa is supporting off-grid options in Nigeria. With a USD15 million Overseas Private Investment Corporation (OPIC) loan, Lumos, Inc. is deploying rooftop solar panel kits to approximately 70,000 residential and small commercial customers in Nigeria, using a lease-to-own business model. In partnership with General Electric, the U.S. African Development Foundation (USADF) and others, Power Africa has awarded nine USD 100,000 grants to entrepreneurs for innovative, off-grid energy projects in Nigeria.
Energy Africa Campaign	UK	2015 - present	Off-grid development	<ul style="list-style-type: none"> In Nigeria, the Energy Africa Campaign is bringing solar power to millions of homes using the PAYG business model. The Nigeria-UK Energy Africa Compact which was signed in 2015 has promoted the improvement of the policy environment, provided various technical support, as well as financing to catalyze commercial capital within the off-grid sector.
Africa-EU Renewable Energy Cooperation Programme	EU	2015	Off-grid development	<ul style="list-style-type: none"> A market study was conducted by the EUEI-PDF to identify the potential of captive power projects, including off-grid generation and off-grid solar PV solutions
Lighting Africa	World Bank / IFC	2015 - present	Solar PV, SHS, solar lanterns	<ul style="list-style-type: none"> The Lighting Africa Nigeria program was launched in March 2015 to increase access to better, cleaner and safer off-grid lighting and energy products to the rural and peri-urban populations with no access to the grid. The program's key objectives are to help six million people gain access to clean, modern, affordable lighting products, while avoiding 120,000 metric tons of greenhouse gas emissions To achieve these goals, the World Bank/IFC collaborates with manufacturers, distributors, retailers, financial institutions, government agencies, and other stakeholders to support off-grid market development and address the barriers to the adoption of cleaner energy sources among the base-of-the-pyramid (BoP) population Through 2017, the program had impacted some 1.4 million people through the sale of 596,000 quality-verified products

¹²⁹ "Designing Solar Markets in Northern Nigeria," Adam International Smith: <http://www.adamsmithinternational.com/explore-our-work/west-africa/nigeria/designing-solar-markets-in-northern-nigeria/>

Figure 21: Development Initiatives in Nigeria's Off-Grid Sector



Source: Rural Electrification Agency

1.4.3 Other Initiatives

Outside of the Government and DFI/donor initiatives mentioned above, there are also several non-governmental organization (NGO) programs and other related initiatives in Nigeria's off-grid sector. Institutions such as Solar Sister and NGOs like the Women Environmental Programme are working to promote off-grid systems in the country. There are also various energy industry non-profit associations dedicated towards the advancement of renewable energy. Lagos-based non-profit organization, All On, advocates for improved energy access in Nigeria by facilitating partnerships among key stakeholders in the sector. The organization's advocacy work primarily entails supporting impact investors interested in investing in Nigerian off-grid.¹³⁰ The Renewable Energy Association of Nigeria (REAN), launched in 2016, has a core mandate of promoting decentralized renewable energy solutions and improving energy access in rural areas. The Council for Renewable Energy in Nigeria is also working in the country to deploy renewable energy solutions. Launched in 2016, the Sustainable Energy Practitioners Association of Nigeria (SEPAN) is working on providing recommendations towards increasing investor attractiveness to improve access to clean energy services. The Africa Mini-Grid Developers Association, supported by the Shell Foundation, the World Bank and UK Department for International Development (DFID) aims to boost the development of small, renewable localized power grids in the country.

Power for All, US Global Development Lab, Power Africa, United States Agency for International Development (USAID-Nigeria), and FHI360 have set up a multi-stakeholder taskforce to push an initiative to provide access to modern, clean and affordable electricity that will target 20 million Africans including Nigerians. This partnership, created under the Scaling Off-Grid Energy (SOGE) Grand Challenge for Development project, aims at deploying stand-alone systems, mini-grids and mobile solar farms. In Nigeria, this taskforce particularly seeks to accelerate the expansion of off-grid energy in line with the goals and vision of the FGN's commitment towards increasing power access and electrification in rural areas.¹³¹ Additionally, the Senate Committee on Ecology and Climate Change and the Environmental Rights Action/Friends of the Earth Nigeria have launched the "Just Energy Transition" Initiative to promote the transition of a fossil fuel-based economy to renewable energy alternatives. In 2016, Power for All launched a campaign to deliver workshops to distributed RE companies, aid agencies, civil society organizations and government representatives focused on private sector support, communications campaign around decentralized RE, and support to REA to integrate such initiatives in the country.¹³²

There are also several Foundations currently active in Nigeria's off-grid market in Nigeria. For instance, the Heinrich Boell Foundation in Nigeria is focused on increasing access to clean power and has initiated discussion on the different options for off-grid renewable energy for SMEs and agricultural processing. This Foundation has been working on highlighting successful business models for entrepreneurs and innovators in the off-grid renewable energy space and providing platforms and information to encourage a robust foreign and local investment portfolio in the sector. The Yar'Adua Foundation is also committed to improve sustainable energy access in the country and has partnered with Power for All's Initiative on addressing energy poverty and climate change. Under this initiative, Yar'Adua aims at driving rural electricity access through DRE technologies in rural and off-grid communities in the country. Other than these two Foundations, Caritas is also committed to promote access to energy through the deployment of clean stoves in 19 communities of the Oban Corridor of the Cross River National Park and solar lanterns and clean stoves to 5,000 households in the North East.¹³³

¹³⁰ "Our Approach," All On, (2018): <https://www.all-on.com/what-we-do/our-approach.html>

¹³¹ "Nigeria, Power for All, USAID, Others Set Up Taskforce On Clean Energy," allAfrica, (February 2018): <https://allafrica.com/stories/201802210890.html>

¹³² "Power for All in Nigeria," Power for All: <http://www.powerforall.org/nigeria/?rq=nigeria>

¹³³ "Power for All: Nigeria Call to Action," Power for All, (March 2017): <https://static1.squarespace.com/static/532f79fae4b07e365baf1c64/t/58dbd04cbebaf6c9330fa9d/1490800818871/Nigeria+-+Call+to+Action>

II. OFF-GRID SOLAR PV MARKET ASSESSMENT

This section presents the overall market assessment for stand-alone off-grid solar (OGS) energy systems in Nigeria. **Section 2.1** provides an overview of the current household off-grid energy situation and estimates potential household market demand for solar energy systems. **Section 2.2** introduces institutional off-grid energy demand and the potential of solar to supply this market. **Section 2.3** evaluates the demand for off-grid solar to serve productive use applications. **Section 2.4** examines the existing off-grid solar product supply chain in the country. **Table 9** summarizes the overall total cash market potential for OGS systems from each of the analyzed market segments. **Annex 2** provides an overview of the Task 2 methodology.

It should be noted that the Task 2 market sizing assesses the total *potential* demand for off-grid solar, as well as variables that affect demand, such as changes in population density, household income, expansion of national grids and access to finance, among other factors. This data will support policymakers and practitioners as they assess market potential over time. However, the quantitative demand estimate has not been revised to reflect *realistic* market potential. Many other factors and market failures will prevent the full realization of this total market potential, and these will vary by market segment.

For household demand, the off-grid solar market is already tangible. Still, many factors will affect household demand for solar products, such as distribution realities, consumer education, competing economic priorities for households, financial shocks, etc. The institutional market will be affected largely by government and donor budget allocations along with the potential for community-based finance. The productive use market is perhaps the least concrete. Considered a relatively new market segment for the off-grid solar industry, productive use market dynamics are not yet well understood. The ability to realize potential productive use market demand will also be affected by many of the factors that commonly determine enterprise prospects in the country, including infrastructure, rural distribution, marketing, access to finance, insecurity, regulation, etc. The data presented in this report is intended to provide a baseline for future research.

Table 9: Indicative Total Cash Market Potential for Off-Grid Solar PV Products in Nigeria, 2018

Off-Grid Market Segment	Annualized Cash Demand (Units)	Annualized Cash Demand (kW)	Annualized Cash Market Value (USD)	Financed Market Value (USD)
Household				
Pico solar	4,149,702	12,449	\$186,736,609	\$0.00
Plug and play	2,545,151	25,452	\$318,143,852	\$0.00
Small SHS	33,198	1,660	\$8,299,405	\$414,970,241
Medium and Large SHS	16,599	4,150	\$10,374,256	\$985,554,323
Household Subtotal	6,744,650	43,711	\$523,554,122	\$1,400,524,564
Institutional				
Water supply	7,030	29,028	\$72,569,125	-
Healthcare facilities	3,541	1,935	\$4,836,850	-
Primary and secondary schools	1,999	1,696	\$4,617,375	-
Public lighting	1,003	502	\$1,504,500	-
Institutional Subtotal	13,573	33,161	\$83,527,850	-
Productive Use				
SME applications for microenterprises	670,855	167,714	\$419,284,625	-
Value-added applications	329,714	76,611	\$304,839,268	-
Connectivity / ICT (phone charging)	88,370	35,348	\$76,174,985	-
Productive Use Subtotal	1,088,939	279,673	\$800,298,878	-
TOTAL	7,847,162	356,545	\$1,407,380,850	

Source: African Solar Designs analysis

2.1 Demand – Households

This section analyzes the main characteristics of the household (HH) OGS demand in Nigeria. Section 2.1.1 provides an overview of the household market segment, including its geographic components. Section 2.1.2 analyzes current household ability and willingness to pay for electricity services to estimate the total potential household sector demand. From this data, the potential household market for off-grid solar products is then calculated for both cash purchases (Section 2.1.3) and financed (2.1.4) purchases. Section 2.1.5 assesses consumer perceptions, interest, and awareness on OGS.

2.1.1 Overview of Household Market Segment

According to the International Energy Agency (IEA), in 2016 there were 16.2 million households (74.4 million people) in Nigeria without access to electricity.¹³⁴ In that year, an estimated 61% of the population had access to electricity, with the rate of access at 86% in urban areas and 34% in rural areas. This is reflected in **Table 10**, which shows that the majority of the country's household market without access is in the rural low-income demographic, alongside a relatively large low income urban and peri-urban under-grid population.

This section gives an introduction to household consumer market segments, their characteristics and size (**Table 10**). It then discusses household sources of income and geographic distribution of off-grid households, both presently and projected over time. This provides context for the next section, 2.1.2, which sizes household segment potential market demand through a series of detailed analyses.

¹³⁴ See **Annex 2** for more details.

Table 10: Household Consumer Market Segments¹³⁵

Income Quintile	% w/o Access	# HH w/o access	Avg. GDP per HH per year	Energy Tier	2018 Scenario				2023 Scenario				2030 Scenario				Geographic segments	Description
					% w/o Access	# HH w/o access	Avg. GDP per HH per year	Energy Tier	% w/o Access	# HH w/o access	Avg. GDP per HH per year	Energy Tier	% w/o Access	# HH w/o access	Avg. GDP per HH per year	Energy Tier		
Highest 20%	1%	82,994	\$27,188	Tier 3	0.5%	48,585	\$24,358	Tier 3	0.1%	11,630	\$21,520	Tier 3	High income urban and rural	<ul style="list-style-type: none"> • Small portion of rural households and urban under grid households using a petrol generator set • Has a demonstrated ability to pay for solar off-grid systems 				
Fourth 20%	2%	165,988	\$11,985	Tier 3	1%	97,171	\$10,738	Tier 3	0.2%	23,259	\$9,486	Tier 2	Mid to high income urban	<ul style="list-style-type: none"> • Professionals, business owners and salaried people are likely to be connected to the grid. • Small portion without grid access desire replacement to generator power¹³⁶ 				
Third 20%	3%	248,982	\$7,990	Tier 3	1.5%	145,756	\$7,158	Tier 2	0.3%	34,889	\$6,324	Tier 1.5	Low income peri-urban / urban "under-grid"; Low income rural	<ul style="list-style-type: none"> • Low income urban population engaged in SME work or casual labor • Lives near grid but cannot afford or does not have access to connection • Low income rural engaged in farming, or SME • Lives more than 15km from the nearest grid connection. 				
Second 20%	89%	7,386,470	\$5,382	Tier 2	96%	9,354,501	\$4,822	Tier 2	0.4%	46,519	\$4,260	Tier 1.5						
Lowest 20%	100%	8,299,405	\$2,996	Tiers 1, 1.5	100%	9,717,100	\$2,684	Tiers 1, 1.5	23.4%	2,726,961	\$2,372	Tier 1						
Total Households without Access to Electricity		16,183,839			Total	19,363,114			Total	2,843,258								

Source: IEA and World Bank; African Solar Designs analysis

¹³⁵ See **Annex 1** and **Annex 2** for more details.

¹³⁶ This model does not consider connected on-grid households that would purchase OGS systems as a back-up power system due to poor grid quality and reliability. The “households without electricity access” estimates shown here include households without electricity connections, either from a grid connection or from a renewable energy-based off-grid source. This does include “under-grid” households, largely in the lower income quintiles, that live within grid vicinity but are currently not connected. 2023 and 2030 projections assume that under-grid households will become connected in those years.

➤ **Off-grid household characteristics**

In 2018, Nigeria was reported by World Poverty Clock to have the largest number of people living in extreme poverty (at or below USD 1.90 a day), overtaking India with 86.9 million people.¹³⁷ That represents roughly 45% of Nigeria’s total population of 191 million people. The poverty rate in Nigeria has dropped over the last decade, as shown by the most recent World Bank data available (**Table 11**).

Table 11: Poverty Headcount in Nigeria, 2009

Poverty headcount ratio	% of population
Lives at or below \$1.90 a day*	53.3%
Lives at or below \$3.20 a day*	77.6%
Lives at or below \$5.50 a day*	92.1%

*2011 PPP

Source: World Bank

As shown in **Table 10**, the largest household market segments for off-grid solar products in the country are low income households, both in rural areas and urban under-grid.

Feedback from focus group meetings in Nigeria segmented the country’s households as follows:

- **High income:** Less than 5% of the population and concentrated in urban centers
- **Middle income:** Less than 10% of the population. Consisting of mainly employees, civil servants, professionals spread across urban and peri-urban centers
- **Low income:** Over 80% of the population falls in this category. Bulk of which are self-employed, farmers, artisans, etc.

According to feedback from focus group discussion (FGD) participants, low-income households in Nigeria earn below 50,000 naira per year. The bulk of this income (over 80%) is earned from informal businesses and agriculture. Agricultural incomes are seasonal and generated during harvest period. Most members of households are of peasant farmers in the rural communities.

Many development partners have supported the distribution of solar energy in the northern part of Nigeria to help combat climate change and insecurity. This may also be due to the high solar resource in that part of the country. This includes the deployment of 20,000 solar home systems in collaboration with Azuri. Low-income households in the northern part of the nation are not as well off as those in other parts.

➤ **Geographic Components of the Solar Market**

The total number of off-grid households and their geographic distribution will also change significantly over time. To analyze the potential OGS market over time, GIS maps were prepared from demographic information to present potential market areas for OGS. GIS calculations consider drivers of off-grid household market change including grid extension around current urban and peri-urban centers, mini-grid development for more densely populated rural areas, and population growth. Sources of information for the maps presented below (**Figures 22-25**) can be found in **Annex 1**.

GIS maps shown here are for 2018-2023 and 2030. Data shown for 2018-2023 includes information on existing grid lines only. The data of planned “future lines” is not broken down in enough detail to show in

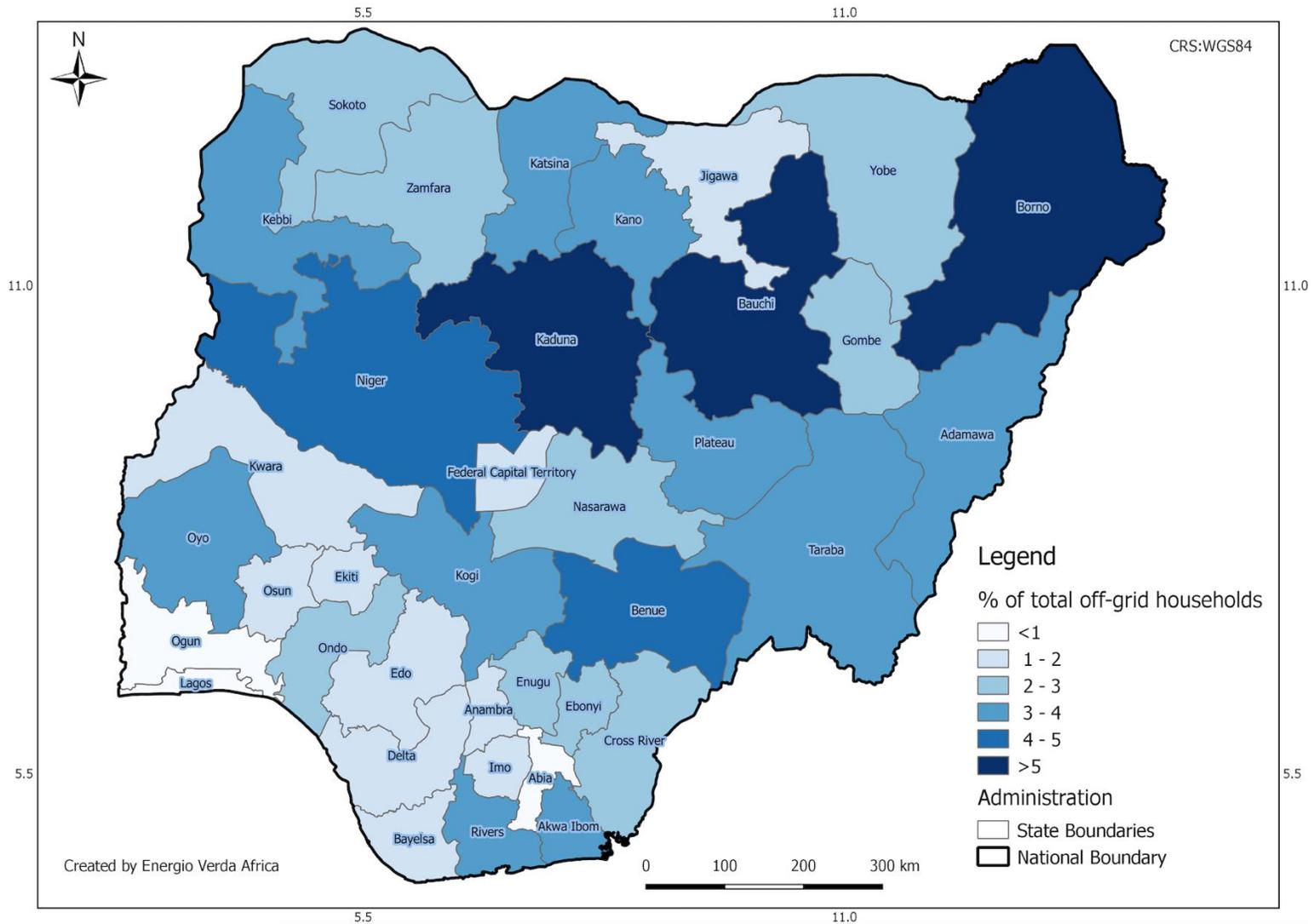
¹³⁷ World Poverty Clock: <https://www.theatlas.com/charts/Hynnu6C-7>

which year future lines will be built, so an assumption was made that all future lines would be built after 2023 but prior to 2030.

As shown in the maps and chart summaries below (**Figures 22-25**), the total size of the OGS market will decrease over time, while also becoming more concentrated in more remote regions. This has implications for solar product market long-term business models, which will need to consider broader distribution areas as the total number of off-grid households declines. Lessons learned in central districts will be valuable in extending market reach to more remote areas, as will new and more innovative business model approaches.

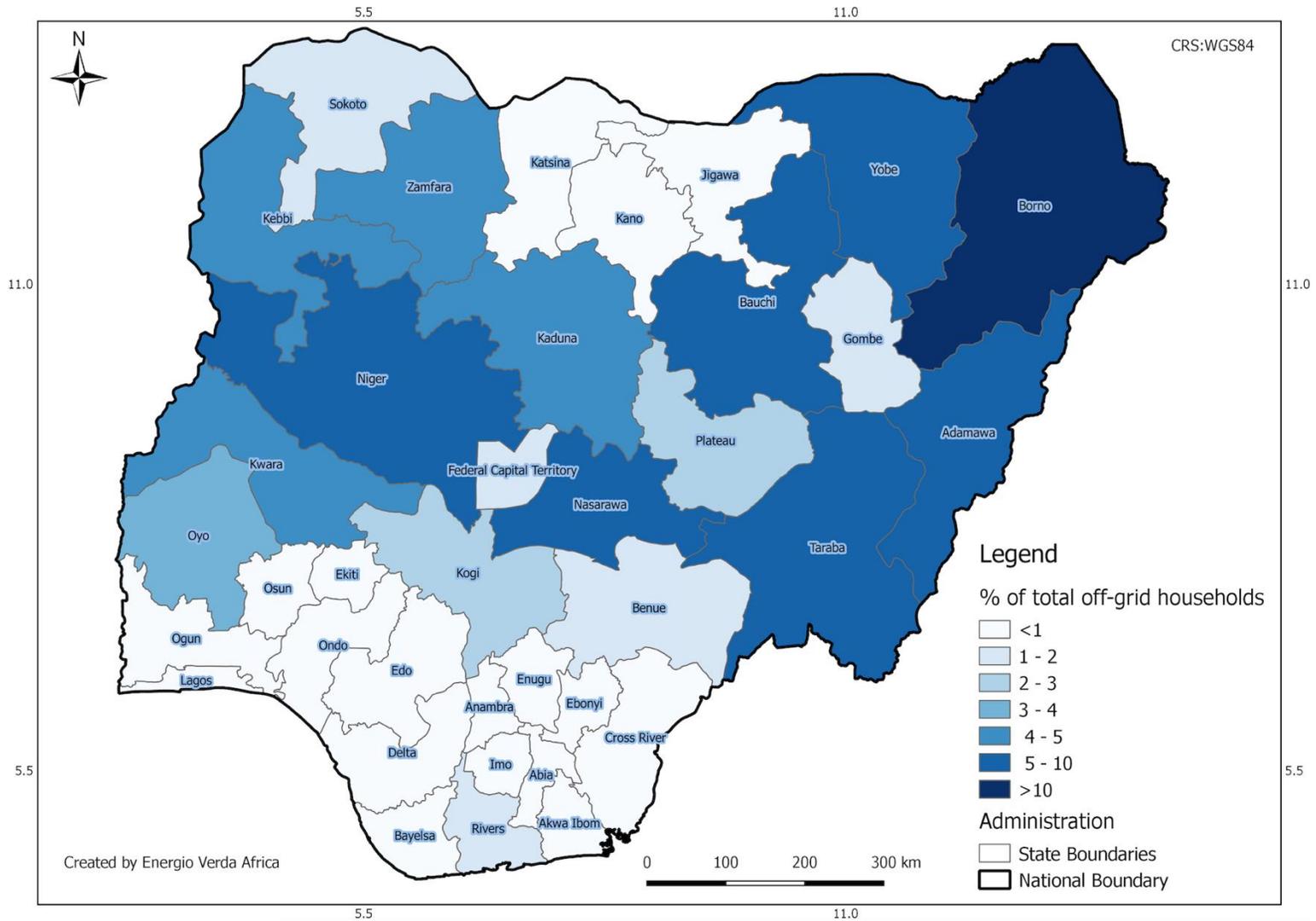
For example, by 2030, the OGS market in the south of the country will shrink significantly while the number of off-grid households will become more concentrated in the northern districts, particularly in Niger, Taraba, Borno and Bauchi.

Figure 22: Distribution of Potential Off-Grid Households by Region, 2023¹³⁸



¹³⁸ See Annex 1 for more details, including data sources.

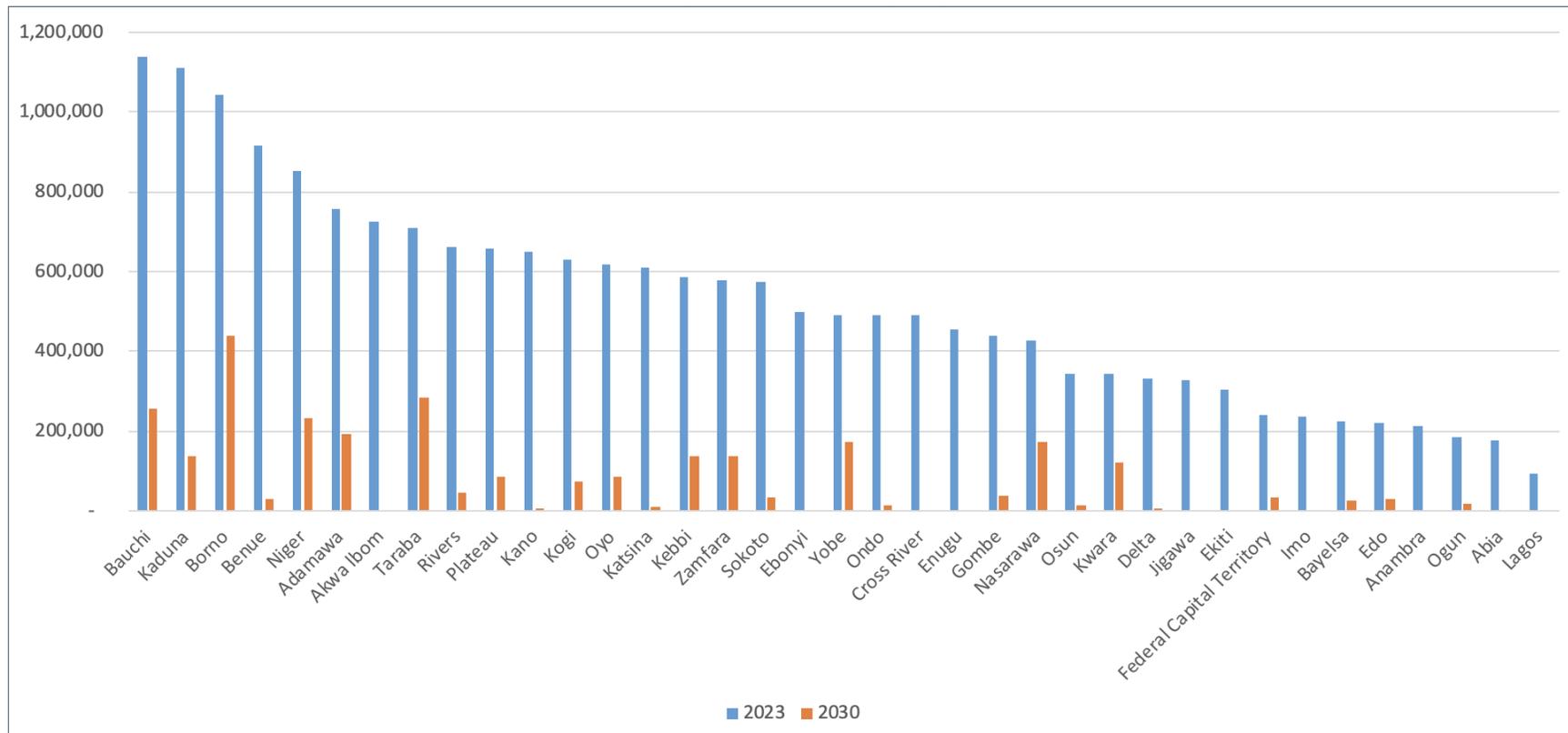
Figure 23: Distribution of Potential Off-Grid Households by Region, 2030¹³⁹



Source: Energo Veda Africa GIS Analysis

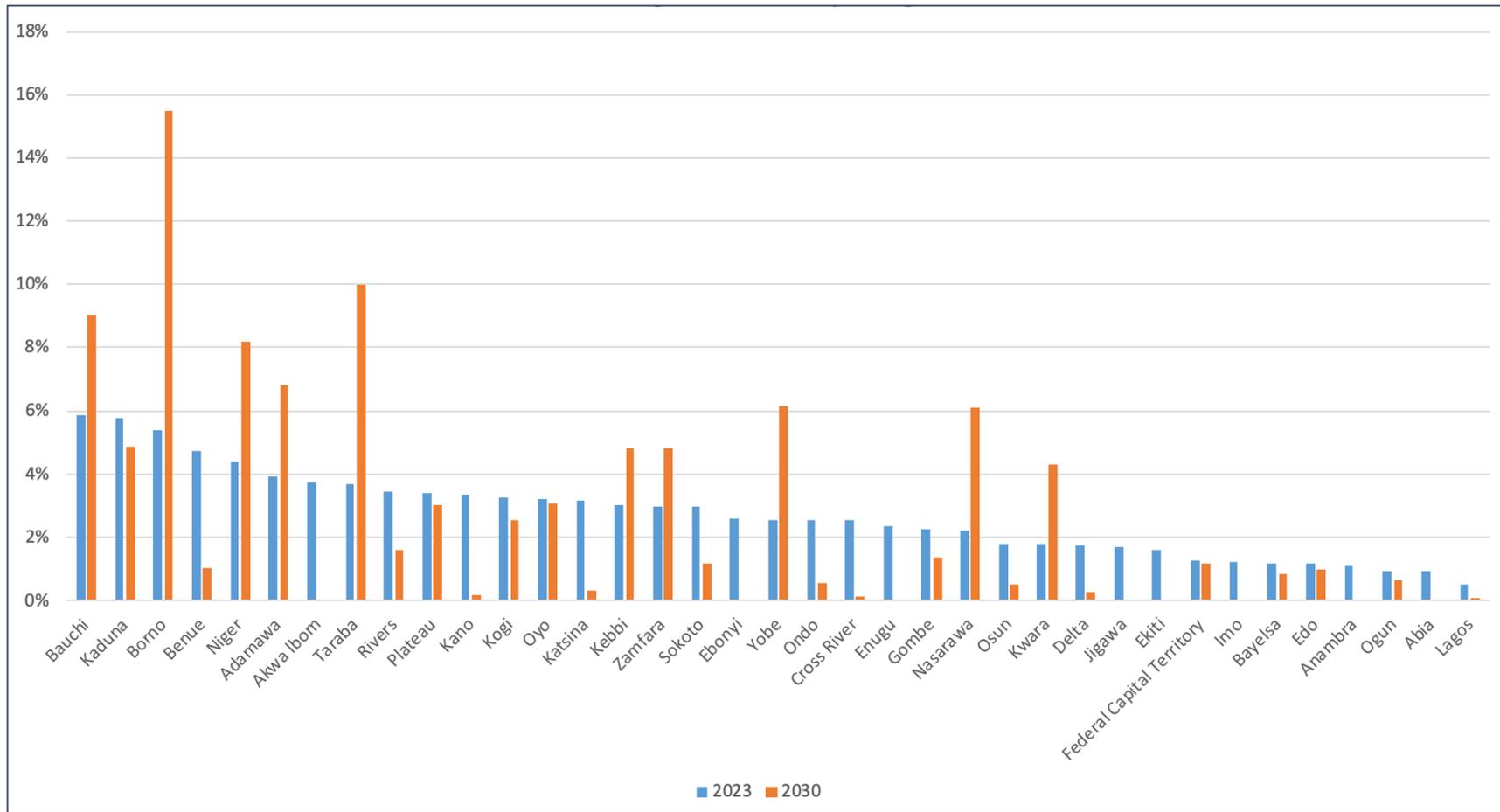
¹³⁹ See Annex 1 for more details, including data sources.

Figure 24: Estimated Number of Off-Grid Households by Region, 2023 and 2030



Source: Energio Verda Africa GIS analysis

Figure 25: Estimated Percentage of Off-Grid Households by Region, 2023 and 2030



Source: Energo Verda Africa GIS analysis

2.1.2 Analysis of Household Market Segment Demand

In order to calculate total potential household demand for off-grid solar products for the national market, this section analyzes several things:

- Household usage and costs of typical rural energy fuels and devices (non-solar)
- How these rural energy technologies align with typical access to “energy tiers”
- Cost of off-grid solar products alternatives, by energy tier
- Household uptake of solar products thus far
- Potential household demand based on household income quintiles

From this data, the potential household market for off-grid solar products is then calculated at the end of this section for both cash purchases and financed purchases.

➤ Consumption and expenditures on typical rural energy fuels and devices (non-solar)

According to feedback from focus group discussion (FGD) participants, off-grid households in Nigeria use candles, batteries and kerosene as current energy sources, as well as diesel generators in both rural and urban areas. Energy is used for lighting and phone charging, as well as for television in peri-urban areas.

Table 12 shows the typical monthly cost of using common rural energy technologies. Household use of different types and amounts of energy technologies is associated with different energy access tiers, as defined in the Multi-Tier Energy Access Framework. For example, a household using one battery powered lantern and one charged cell phone would fall under the Tier 1 level of energy access. A household using two lanterns, one cell phone and a radio would be in Tier 1.5.

These tiers are defined in **Table 13**. Establishing an average monthly household expenditure for each energy tier using common rural technologies shows how household income level aligns with energy tiers. Secondly, it provides a basis to compare these costs to solar products that can offer an equivalent level of service by energy tier. This in turn reveals potential household savings by switching to solar products, as shown in **Figure 26** and **Table 14**.

It should be emphasized that even where households can be categorized into energy tiers by their income, few households actually pay full typical monthly costs because they do not have the available income. In reality, household income is highly variable throughout the year, and they simply do without service for portions of the month and year when cash is not available. This accounts for the difference between “typical monthly costs” (which are real) and “equivalent service costs” (which would be required to maintain the tier-level service). For example, very few households could actually run generators for the number of hours that would enable full tier 3 level services.

Table 12: Rural Energy Technologies and Costs¹⁴⁰

Technology	Description	Average Life (Years)	# of Units/ Month	Unit Operating Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)	Unit Capital Cost (USD)	Typical Monthly Cost (USD)
					2018 Scenario		2023 Scenario		2030 Scenario	
Torch lights/Electric Lanterns	Torch lights/electric lanterns powered by D-type, AA-type or AAA-type batteries	0.5	16	\$0.22	\$2.00	\$3.52	\$2.38	\$4.19	\$3.58	\$6.30
Cell Phone Charging	Done at a charging station	-	8	\$0.21	\$0.00	\$1.70	\$0.00	\$2.03	\$0.00	\$3.05
Smart Phone Charging	Done at a charging station	-	16	\$0.21	\$0.00	\$3.40	\$0.00	\$4.06	\$0.00	\$6.10
Battery-powered DC Radio	Radio powered by dry cells replaced two times per month	-	8	\$0.22	\$0.00	\$1.76	\$0.00	\$2.10	\$0.00	\$3.15
Lead Acid Battery-powered DC TV	DC TV powered by lead acid battery recharged once per week	2	4	\$1.00	\$50.00	\$4.00	\$59.55	\$4.76	\$89.54	\$7.16
Small Petrol Generator	Most popular rural generator for basic use is 0.9kW (for phone charging, lighting, TV, fan, music system)	2	30	\$1.05	\$100.00	\$31.50	\$119.10	\$37.52	\$179.08	\$56.41

Source: African Solar Designs analysis

¹⁴⁰ Data from FGDs, field surveys and various published sources

Table 13: Typical Tier-Based Energy Costs

Device category and indicative energy supplied	Appliances and level of service	Non-solar devices used to power tier requirement	Typical Monthly Cost (USD) 2018	Typical Monthly Cost (USD) 2023	Typical Monthly Cost (USD) 2030
Tier 0 No electricity	<ul style="list-style-type: none"> Characterized by complete lack of electricity services Many cash-poor consumers are in this situation part of each month when they don't have money to buy dry cells or charge phones 	<ul style="list-style-type: none"> Rely solely on kerosene, wood and other fuel sources for cooking and lighting 	<ul style="list-style-type: none"> Subsistence level of energy Absolute energy poverty 	<ul style="list-style-type: none"> Subsistence level of energy Absolute energy poverty 	<ul style="list-style-type: none"> Subsistence level of energy Absolute energy poverty
Tier 1 Range: 1 to 20 Wh/day	<ul style="list-style-type: none"> Access to one torch powered by dry cell batteries One cell phone powered by charging service 	<ul style="list-style-type: none"> One battery-powered light requires dry cell replacement on weekly basis One cell phone charged 8 times per month 	\$3.68	\$5.45	\$13.64
Tier 1.5 Range: 20 to 100 Wh/day	<ul style="list-style-type: none"> Access to one torch and one lantern each powered by dry cells One cell phone powered by charging service Radio powered by dry cells 	<ul style="list-style-type: none"> Two battery-powered light points require dry cell replacement on weekly basis One cell phone charged 8 times per month Radio dry cells replaced two times per month 	\$7.52	\$11.14	\$27.88
Tier 2 Range: 55 to 500 Wh/day	<ul style="list-style-type: none"> One torch and two lanterns powered by dry cells One cell phone and one smart phone powered by charge service Radio DC TV 	<ul style="list-style-type: none"> Three battery light points require dry cell replacement on weekly basis One cell phone charged 8 times per month and one smart phone charged 16 times per month TV/Radio powered by lead acid battery recharged once per week 	\$13.60	\$20.15	\$50.42
Tier 3 Range: 500 to 2500 Wh/day	<ul style="list-style-type: none"> Five lighting points Multiple cell/smart phones AC radio and music system AC TV 	<ul style="list-style-type: none"> Generator powers a set of appliances 	\$42.30	\$62.67	\$156.82

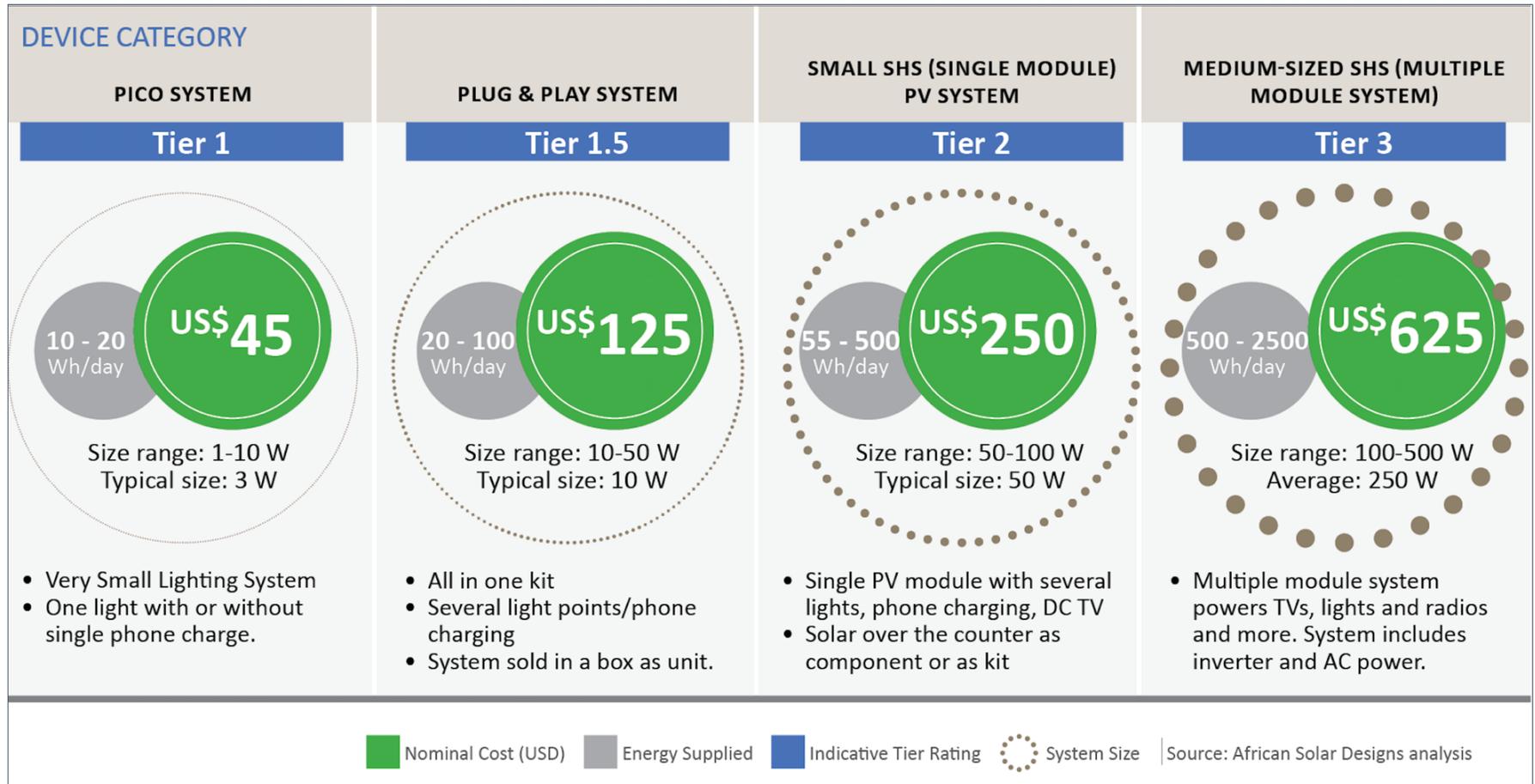
Source: African Solar Designs analysis

Per **Table 13** it can be seen that, given the purchase price of dry cells and the cost of phone charging, the “ideal” electricity availability is extremely difficult to sustain. This is especially true where there is a high incidence of poverty in rural areas and lack of regular incomes. In reality, households often must reduce their energy consumption when cash is not available. This means that even a Tier 2 level family might drop to Tier 1 for a week each month when cash is not available to pay for phone charging or dry cell purchase.

➤ **Household Solar PV System Types**

Solar PV systems can provide lower cost and higher levels of service than existing dry cell, phone charging and generator options. In order to model how solar systems can meet existing energy use categories, levels of service and ability to pay, four types of household solar systems are configured to match the tier-based demands of off-grid communities. The system descriptions, energy outputs, prices, tier ratings and target consumer groups are listed in **Figure 26**.

Figure 26: Household PV System Descriptions and Market Segments



Source: African Solar Designs analysis

➤ **Current usage and procurement process for household solar products**

Focus group participants indicated that 10% of the population is currently using solar systems. The most effective sale areas for solar products are in the Urban Northern and South Western regions. Household solar is defined through some initiatives like the 20,000 solar roll-out in collaboration with Azuri,¹⁴¹ and separately solar home system distribution under the rural electrification fund of Nigeria’s REA.¹⁴² Participants suggested that Nigeria has not taken renewable energy seriously due to the availability of oil. They also observed that the fastest way to electrify the country would be through stand-alone solar systems.

➤ **Potential household demand for off-grid solar products**

Looking beyond current use of off-grid solar products by households, this study analyzes potential for OGS market development by estimating potential household demand based on household income. Household income shown in **Table 14** is sourced from World Bank demographic data based on household surveys, which reports income by population quintiles. From household income, potential for energy spending is estimated as 10% of monthly income (see methodology annex). Future scenarios project higher energy budgets as household incomes rise with economic development over time. In all scenarios, the large majority of off-grid households will fall under the two lowest income quintiles.

Table 14: Energy Expenditure of Different Income Groups

Population Income Quintiles	Per Capita Income (USD per month)	Household Income (USD per month)	Energy as % of Income	Monthly Energy Budget (USD)
2018 Scenario				
Lowest Quintile of Population	\$54.28	\$249.68	10%	\$24.97
2nd Quintile of Population	\$97.50	\$448.51	10%	\$44.85
3rd Quintile of Population	\$144.74	\$665.83	10%	\$66.58
4th Quintile of Population	\$217.12	\$998.74	10%	\$99.87
Highest Quintile of Population	\$492.53	\$2,265.66	10%	\$226.57
2023 Scenario				
Lowest Quintile of Population	\$48.63	\$223.70	10%	\$22.37
2nd Quintile of Population	\$87.35	\$401.83	10%	\$40.18
3rd Quintile of Population	\$129.68	\$596.53	10%	\$59.65
4th Quintile of Population	\$194.52	\$894.80	10%	\$89.48
Highest Quintile of Population	\$441.28	\$2,029.87	10%	\$202.99
2030 Scenario				
Lowest Quintile of Population	\$42.96	\$197.63	10%	\$19.76
2nd Quintile of Population	\$77.18	\$355.01	10%	\$35.50
3rd Quintile of Population	\$114.57	\$527.02	10%	\$52.70
4th Quintile of Population	\$171.85	\$790.53	10%	\$79.05
Highest Quintile of Population	\$389.85	\$1,793.33	10%	\$179.33

Source: African Solar Designs analysis

Figure 27 summarizes the preceding data in this section by comparing household energy spending with typical rural energy costs and their solar equivalents. This analysis presents annualized costs (not including financing cost) of current energy technologies for each energy tier, compared with the annual cost of an equivalent solar product. Both the annual costs of current energy technologies and equivalent solar

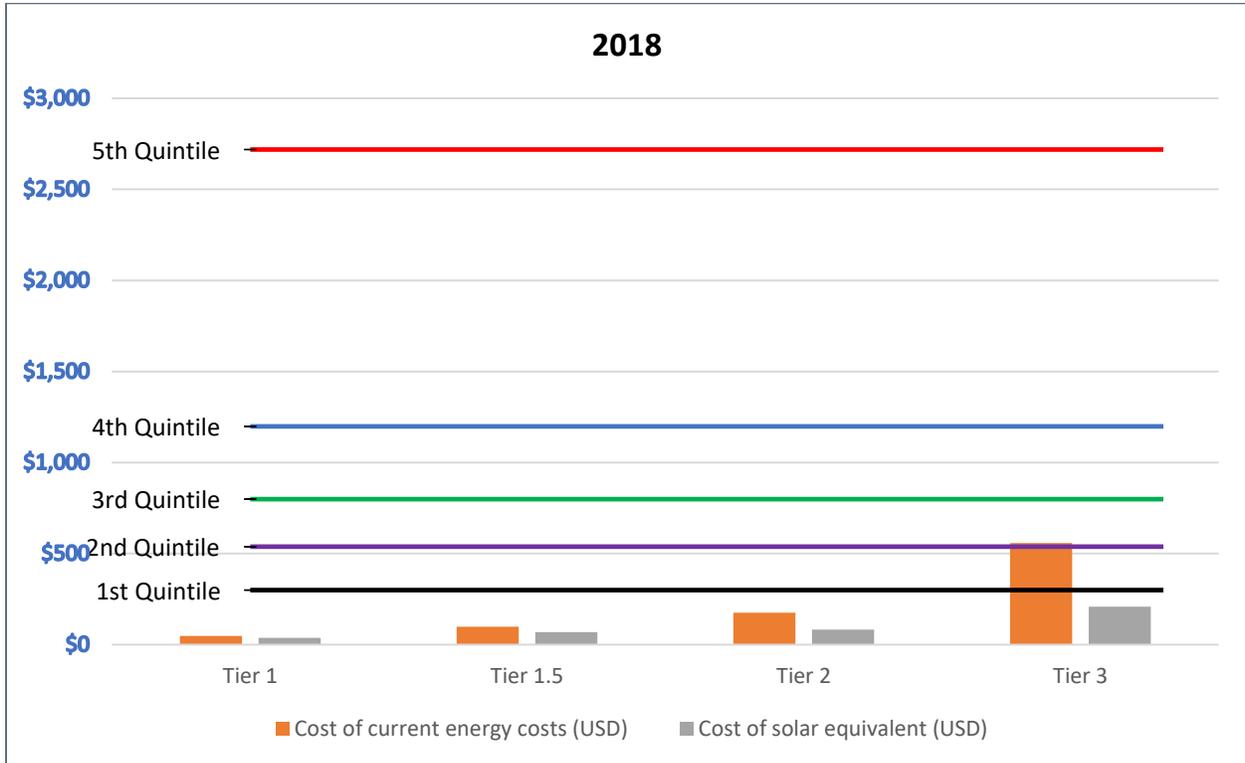
¹⁴¹ See <https://www.azuri-technologies.com/azuri-partners-with-ndphc-to-launch-paygo-solar-in-nigeria/>

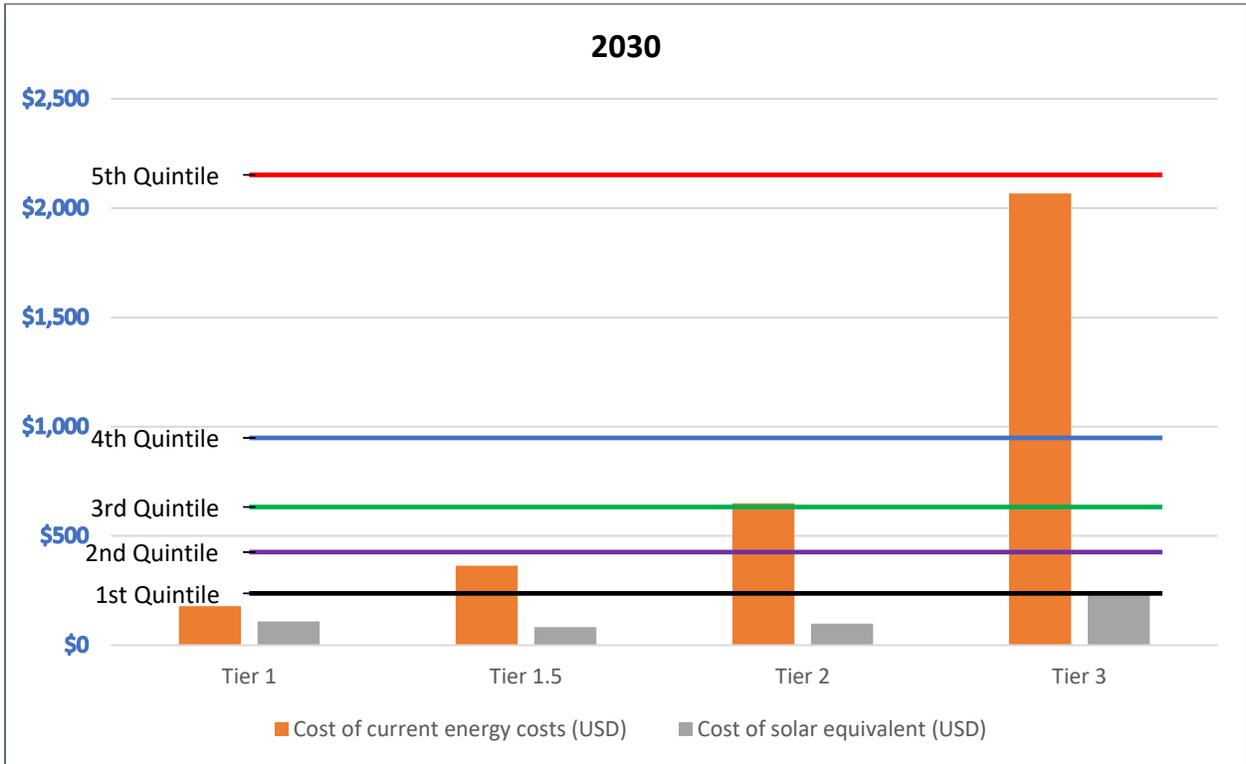
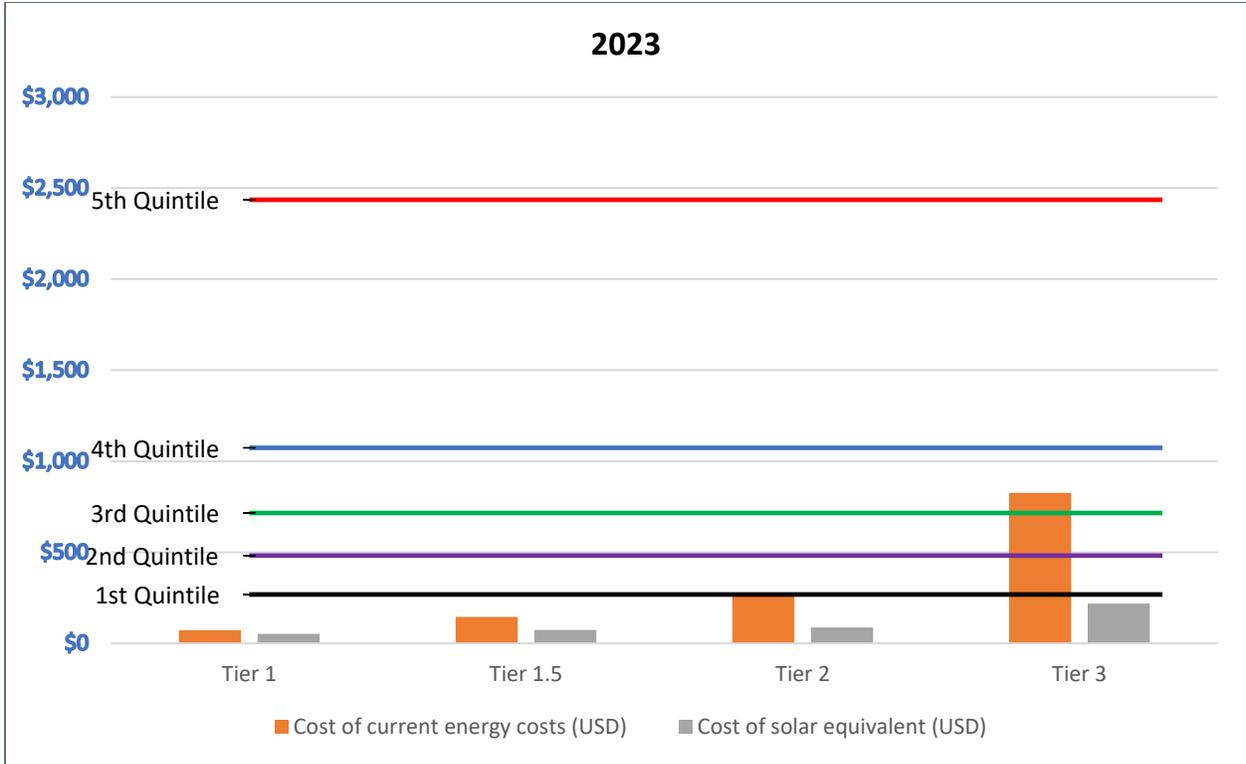
¹⁴² See <http://rea.gov.ng/rural-electrification-fund/>

solutions consider the capital costs of the units, and the operating costs considered over the average unit life times.

The data clearly shows potential savings for households to switch to solar products. Affordability also increases over time, as the cost of solar technology reduces, while the cost of traditional energy sources increases with inflation, and household income increases. Affordability here is shown by comparing annual income and energy costs over the life of a product. This indicates the need for short term financing, as many households still struggle to pay up front unit capital costs to achieve subsequent savings.

Figure 27: Annual Household Energy Budget by Quintile, Annual Energy Costs and Cost of Solar Equivalents





Source: African Solar Designs analysis

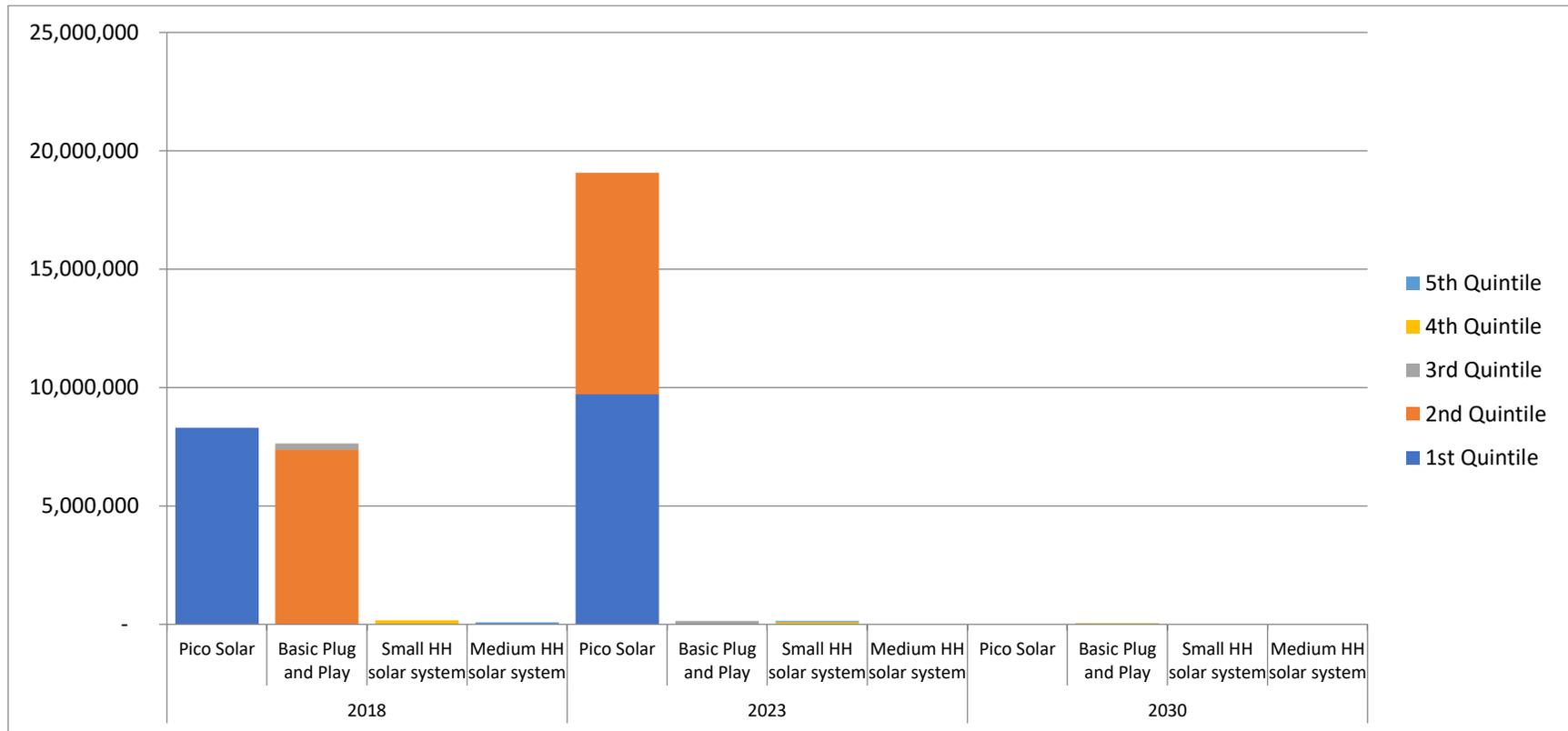
2.1.3 The Market for Household Devices without Consumer Finance

This section analyzes the cash market for various income levels and the corresponding energy services powered by OGS systems they can afford. Modelling of the viable market was based on income quintiles associated with data from the World Bank. The calculations and assumptions made are presented in **Table 14**. It was assumed that for a cash purchase a household is willing to save three months of their current energy expenditure to purchase the OGS system.

Based on the income quintiles and corresponding estimated current energy expenditure, in the 2018 and 2023 scenarios, all of Nigeria's households without electricity access can afford a solar product unfinanced: lowest quintile households can afford pico solar products, while households in higher quintiles can afford basic plug and play systems and SHS. However, in the 2030 scenario, the households in the two lowest income quintiles are unable to afford an OGS system, as inflation outpaces the drop in solar prices and income growth. Therefore, the need for financing solutions especially for the two lower income quintiles, which represent the vast majority of the market without access, is clear.

The model assumes that each household purchases only one system. It also does not consider on-grid households that would purchase OGS systems as a back-up power system due to poor grid quality and reliability. This market has become a key segment of the more mature OGS markets (e.g. in East Africa), but is not the focus of this study, which is based on sizing the current markets in West Africa, alongside a least cost analysis for future access to energy that prioritizes reliable grid connections where possible.

Figure 28: Estimated Number of Households Able to Afford Cash Purchase of OGS Systems by Income Group



Source: African Solar Designs analysis

Table 15 presents the estimated annualized cash market potential for off-grid solar product sales in the country’s household sector.

Table 15: Estimated Cash Market Potential for Household Sector

Solar System	Annualized Demand (Units)	Annualized Demand (kW)	Annualized Market Value (USD)
2018 Scenario			
Pico Solar	4,149,702	12,449	\$186,736,609
Basic Plug and Play	2,545,151	25,452	\$318,143,852
Small HH solar system	33,198	1,660	\$8,299,405
Medium HH solar system	16,599	4,150	\$10,374,256
Total	6,744,650	43,711	\$523,554,122
2023 Scenario			
Pico Solar	9,535,801	28,607	\$591,789,886
Basic Plug and Play	48,585	486	\$6,394,549
Small HH solar system	29,151	1,458	\$7,673,459
Medium HH solar system	0	0	\$0.00
Total	9,613,537	30,551	\$605,857,894
2030 Scenario			
Pico Solar	0	0	\$0.00
Basic Plug and Play	19,383	194	\$2,877,207
Small HH solar system	2,326	116	\$690,530
Medium HH solar system	0	0	\$0.00
Total	21,709	310	\$3,567,737

Source: African Solar Designs analysis

The following considerations should also be taken into account when analyzing this data:

- The most common type of systems which the market can afford on a cash basis are pico and small plug and play systems. Based on available income figures Tier 2 and Tier 3 solutions are less viable for the vast majority of the population in the near term. However, this picture changes significantly with the introduction of financing.
- The model does not adequately address highest quintile and actual sales in the market. Note that the analysis does not predict purchases of Tier 3 equipment and it does not reflect what is happening at the extreme high end of the market. Because the analysis divides the population into relatively wide quintiles, it does not adequately address the very small portion of apex rural (and peri-urban) customers that now use generators.

2.1.4 The Financed Market for Off-Grid Solutions

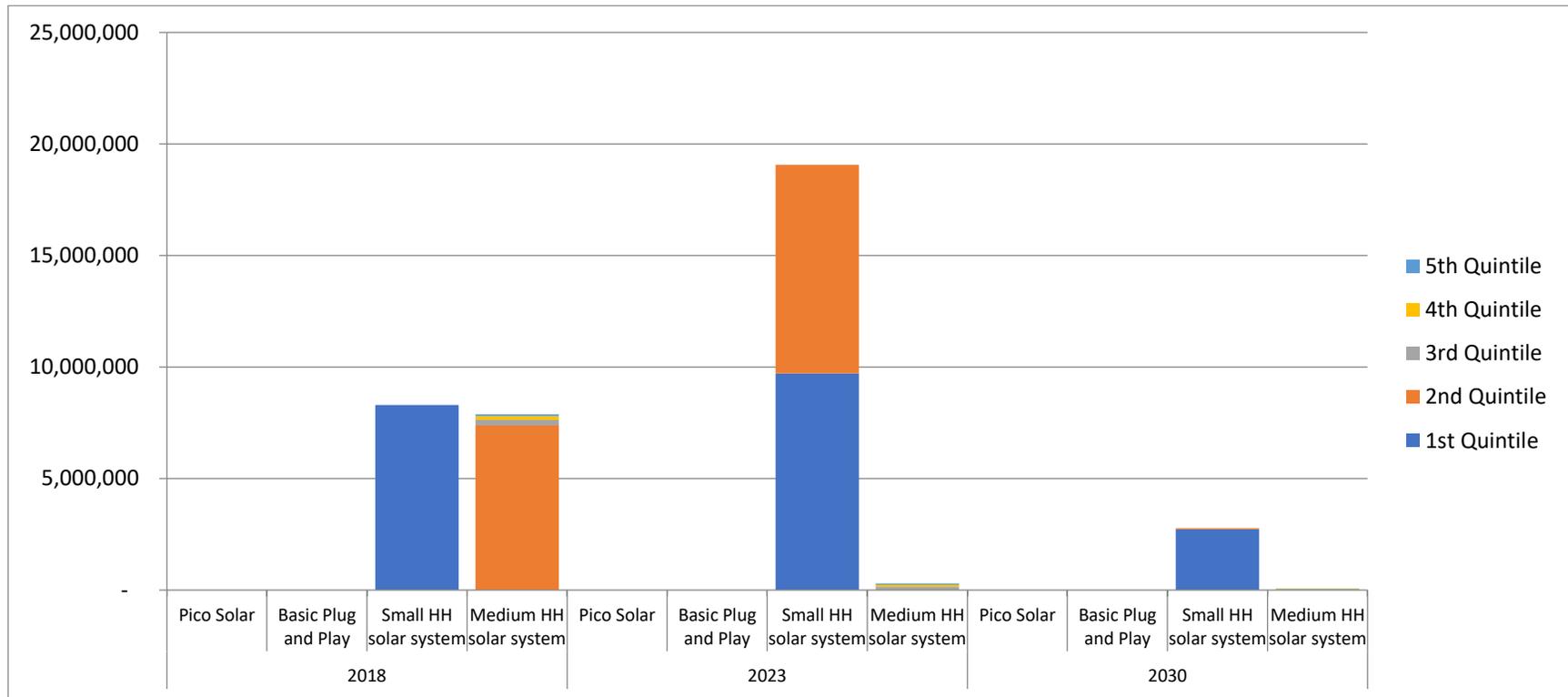
➤ Financial Model

In order to portray the effects of finance, a simple model was prepared that provides OGS system finance with a 60% p.a. interest rate¹⁴³ and a 24-month term. The financial model assumes that the households would be willing to save for three months of their current energy expenditure to cover a small upfront deposit of 10% of the system and their current energy expenditure would be used to pay the monthly installments.

This model assumes that each household will purchase the system that offers the highest energy serve level they can afford. As with the cash market model, it assumes that each household purchases one unit each. However, this finance model greatly over-estimates the potential market for credit as both MFIs and PAYG companies would likely be extremely cautious in approving customers. Without concrete data on the loans given to consumers in each income quintile in the country, it is difficult to estimate what the more realistic figures are. Nevertheless, this model does give a clear indication that long loan tenors combined with a low upfront payment would result in significant market transformation. The results of this analysis are presented below.

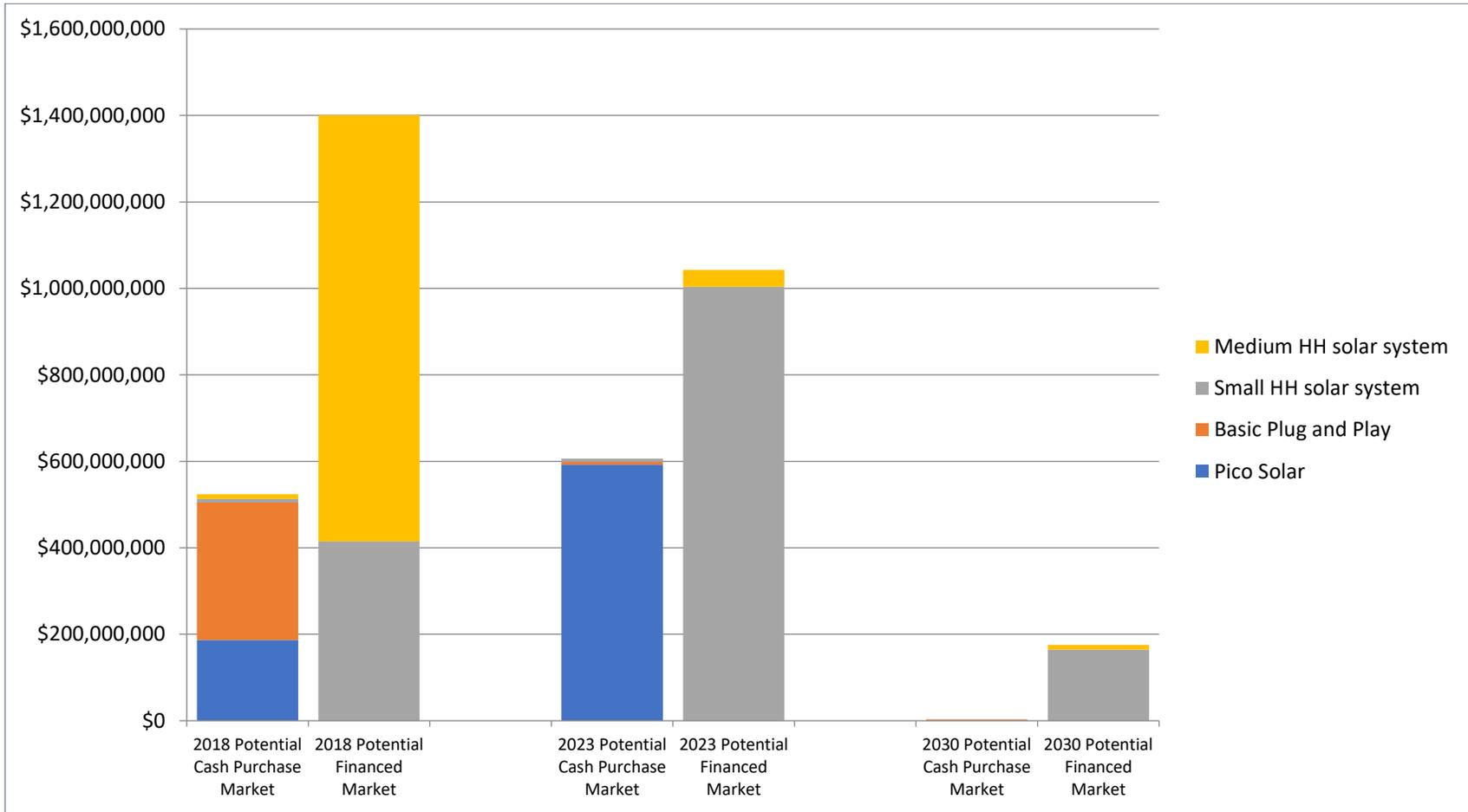
¹⁴³ <https://www.lapo-nigeria.org/blog/products-interest-rates>

Figure 29: Estimated Number of Households Able to Afford Financed OGS Systems by Income Group



Source: African Solar Designs analysis

Figure 30: Estimated Off-Grid Solar Cash and Financed Market Potential for Household Sector by System Type



Source: African Solar Designs analysis

In 2018, without financing, all 16,183,839 households without access in the country could afford an OGS system. However, with financing, they were enabled to acquire the larger systems. Consequently, the annualized potential market size increases from USD 523,554,121 to USD 1,400,524,564 (**Figure 30**).

The least-cost electrification 2023 scenario calculates that 19,363,114 households could be electrified by stand-alone systems, as total population increases by 32.6 million. Under this scenario also, all the households without access have the ability to acquire at least one OGS system, however, financing enables them to acquire the larger systems. The annualized potential market size increases from USD 605,857,894 to USD 1,042,405,867 (**Figure 30**).

The least-cost electrification 2030 scenario calculates that the total number of households that could be electrified by stand-alone systems would drop to 2,843,258. Under this scenario, with inflation outpacing annual income growth and fall in solar prices, only the 69,778 households (2.45% of households without access) in the top three income quintiles are able to acquire at least one OGS system without financing. With financing, however, all the households are enabled to acquire at least one OGS system. The annualized potential market size therefore increases from USD 3,567,736 to USD 175,037,312 (**Figure 30**).

Table 16 presents the estimated annualized financed market potential for off-grid solar product sales in the country’s household sector.

Table 16: Estimated Financed Market Potential for Household Sector

Solar System	Annualized Demand (Units)	Annualized Demand (kW)	Annualized Market Value (USD)
2018 Scenario			
Pico Solar	0	0	\$0.00
Basic Plug and Play	0	0	\$0.00
Small HH solar system	1,659,881	82,994	\$414,970,241
Medium HH solar system	1,576,887	394,222	\$985,554,323
Total	3,236,768	477,216	\$1,400,524,564
2023 Scenario			
Pico Solar	0	0	\$0.00
Basic Plug and Play	0	0	\$0.00
Small HH solar system	3,814,320	190,716	\$1,004,038,572
Medium HH solar system	58,303	14,576	\$38,367,294
Total	3,872,623	205,292	\$1,042,405,866
2030 Scenario			
Pico Solar	0	0	\$0.00
Basic Plug and Play	0	0	\$0.00
Small HH solar system	554,696	27,735	\$164,679,367
Medium HH solar system	13,956	3,489	\$10,357,945
Total	568,652	31,224	\$175,037,312

Source: African Solar Designs analysis

2.1.5 Consumer Perceptions, Interest and Awareness

- **Purchasers of solar are “early adopters” who tend to buy from system integrators as well as hardware traders**
 - **Retail purchasers:** Most purchases are made over-the-counter sales in capital and major cities as cash purchases. As with the consumer migration from kerosene to electric lights, there is a gradual migration from low cost dry-cell electric lamps to solar PV systems. Consumers make purchases in the same shops, and sellers are adapting to changes in demand by offering solar equipment.
 - **High-end consumers:** As elaborated in **Section 2.4**, a small number of early adopting consumers buy from specialized solar integrators who offer quality services and components. A large portion of buyers in this segment opt for systems above 200Wp for residential and small business demand.
 - **PAYG:** As the PAYG market segment is still in its nascent stages, detailed data of PAYG customers is still largely unavailable, although recent experience from East Africa suggests that these customers include both rural and peri-urban inhabitants. The PAYG business model / method is still not widely understood; moreover, there are still questions about how to account for the seasonality of incomes as opposed to regular monthly payment plans.

- **Consumers have a general awareness that solar can economically replace generators and batteries, but they are still largely uninformed about solar electric specifics**
 - While knowledge is gradually improving (particularly for small/pico solar lighting systems) most consumers are not yet educated enough to make informed decisions about solar systems.
 - There are often geographic disparities in awareness levels of OGS products, as households in urban or peri-urban areas tend to have better understanding of solar vis-à-vis rural villages.
 - Consumers are hearing “general messages” (i.e. “solar is good,” “solar can be cheap,” “solar can be more economical”). These messages need to be translated into more specific understanding of the technology (i.e. what are the options, what products are better than others, where to buy solar, what is a best way to pay for solar, what suppliers are more reliable, how to manage O&M, etc.).
 - Consumers often do not get fair information on the product they are buying. Marketing messages are quite mixed and much ‘overpromising’ occurs for systems. Consumers are largely unaware of standards and quality assurance for solar.

- **Perceptions of households vary according to experience they have had with solar**
 - Although many households recognize the benefits of solar, there is a general perception that solar equipment is very expensive and that products are considered largely un-affordable.
 - Many customers are disappointed with solar technology or mistrust it because:
 - They have bought a substandard/not certified product that broke down quickly;
 - There was no adequate maintenance, aftersales service when the system broke down;
 - There was lack of understanding/experience on how to use the system and it broke down due to over usage or incorrect usage.
 - There is no warranty or fault management system (long-term O&M)
 - Households that have a fuel-powered generator, consider them as a ‘sunk cost’ and treat solar only as an addition to that cost.
 - Solar is seen as risky by many. Since there are so many options and little information as to what the best solution is, many people think that it is easy to make a costly mistake in choosing what is best for them. Generators are much better understood.
 - Some consumers have ‘investment fatigue’ from buying multiple solar products of low or unknown quality and are unwilling to make further investments.

➤ **Willingness to Pay is strongly associated with consumer understanding and perceptions of OGS**

Although there is demonstrated ability to pay for households in higher income demographics on cash purchase, and for many households through a financed scenario, willingness to pay is strongly associated with consumer understanding and perceptions of OGS. Component-based Plug-and-Play SHS are much more expensive than battery-powered alternatives and are more than what households expect to pay for access to lighting. Consumers who purchase low-priced inferior lighting products for which they have low expectations are less likely to be willing to purchase a relatively high priced OGS system without fully understanding the difference between the products.

Since most of the retail-shop dry-cell battery-powered lighting products are extremely low cost (and short-lived), conservative rural consumers are wary of expensive new products if they are unable to assess product quality and durability. For this reason, willingness to pay presents a much larger barrier for the development of sales than actual *ability* to pay. East African experience with Global Lighting-certified products has demonstrated that consumer awareness campaigns can grow the demand for quality products.

2.2 Demand – Institutional

2.2.1 Overview of Institutional Market Segment

This section estimates the market potential for off-grid solar products for institutional users in Nigeria. This market includes the following segments: (i) rural water supply, (ii) healthcare facilities, (iii) primary and secondary schools, and (iv) public town center lighting. The following sub-sections provide an overview of the assumptions used for each market segment along with corresponding analysis. The section concludes with an assessment of institutional ability to pay, looking at funding sources and highest potential market segments. **Annex 2** provides an overview of the methodology, including all calculations.

2.2.2 Analysis of Institutional Market Segment Demand

Table 17 shows the estimated annualized cash market potential for institutional users in Nigeria. This estimation is calculated using available GIS data, secondary research, and primary source field data. The analysis is based on available information from planned expansion of the sectors and typical usage patterns and costs of existing systems in the country. There was insufficient GIS data available to properly estimate the market size; as a result, per capita comparisons were made with similar countries to analyze certain sectors as described below.¹⁴⁴

Table 17: Indicative Total Cash Market Potential for Institutional Sector¹⁴⁵

Institutional Sector		Units	kW Equivalent	Cash Value (USD)
Water supply	Low power pumping system	2,870	4,305	\$10,762,875
	Medium power pumping system	2,812	11,247	\$28,117,500
	High power pumping system	1,348	13,476	\$33,688,750
	Subtotal	7,030	29,028	\$72,569,125
Healthcare	Health post (HC1)	2,744	686	\$1,714,750
	Basic healthcare facility (HC2)	778	1,167	\$2,917,875
	Enhanced healthcare facility (HC3)	19	82	\$204,225
	Subtotal	3,541	1,935	\$4,836,850
Education	Primary schools	1,508	754	\$2,261,775
	Secondary schools	491	942	\$2,355,600
	Subtotal	1,999	1,696	\$4,617,375
Public lighting	Public lighting (excluding street lighting)	1,003	502	\$1,504,500
TOTAL		13,573	33,161	\$83,527,850

Source: African Solar Designs analysis

¹⁴⁴ See **Annex 2** for more details.

¹⁴⁵ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

➤ **Water Supply**

Table 18: Key Assumptions for Water Supply Sector Analysis

Sector	System Sizes	Key Assumptions
Water supply	<ul style="list-style-type: none"> • Low Power (1,500 W) • Medium Power (4,000 W) • High Power (10,000 W) 	The type of pump selected is dependent on depth, yield, community need and other factors. System sizes depend on the common pump sizes used for rural applications: <ul style="list-style-type: none"> • Low power pumps are used for low/medium head applications. They replace hand pumps for shallow wells • Medium power pumps have high volume low head and medium volume medium head applications • High power pumps are used for high volume or high head applications such as deep wells and boreholes

The water supply sector analysis considered the electricity needs for water supply for communities’ households in off-grid areas. Energy is only one component of this sector – a variety of factors (water quality, number of users, yields of well, delivery system etc.) need to be considered when planning for off-grid water supply. The supply of solar powered pumping systems for village water supply requires additional planning and study to identify the most viable sites. As available GIS data was not sufficient to conduct the analysis, a per capita comparison made using data from Ghana¹⁴⁶ identified off-grid potable water points such as boreholes and wells that could be electrified by stand-alone systems. Based on these assumptions, the estimated annualized cash market potential for the water supply sector is presented in **Table 19**.

Table 19: Estimated Cash Market Potential for Water Supply ¹⁴⁷

Pump Type	Units	kW Equivalent	Cash Value (USD)
Low power	2,870	4,305	\$10,762,875
Medium power	2,812	11,247	\$28,117,500
High power	1,348	13,476	\$33,688,750
Total	7,030	29,028	\$72,569,125

Source: African Solar Designs analysis

➤ **Healthcare**

Table 20: Key Assumptions for Healthcare Sector Analysis

Sector	System Sizes	Key Assumptions
Healthcare	<ul style="list-style-type: none"> • HC1: Dispensary health post (300 W) • HC2: Basic health facility (1,500 W) • HC3: Enhanced health facility (4,200 W) 	29,669 off-grid healthcare facilities were identified that could be electrified by stand-alone systems

The healthcare sector analysis considered the electricity needs for off-grid health facilities in the country. Off-grid clinics require power for lighting and various Information and Communications Technology (ICT) needs, including phone charging, maternity, medical examinations, vaccine refrigeration, laboratory, sterilization and staff housing. The size of a facility and number of patients served determines the amount of energy it requires.

¹⁴⁶ Ghana was grouped in the same category as Nigeria; See **Annex 2** for more details

¹⁴⁷ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

A combination of available GIS data and local stakeholder interviews identified off-grid health facilities, categorized according to their size (HC1, HC2, and HC3),¹⁴⁸ that could be electrified by stand-alone systems through 2023 and 2030. The analyzed health facilities included:

- Health posts
- Dispensaries
- Public clinic
- Basic/primary health facilities
- Comprehensive health facilities
- District hospitals
- General hospitals
- Specialist hospitals

For purposes of this analysis, these health facilities were categorized as follows:

Health Center	Description
Health Post (HC1)	Health post, dispensary, public clinic
Health Center (HC2)	Basic/primary health clinics
Health Center (HC3)	Comprehensive health facilities, all hospitals

To establish electricity demand, an assessment of equipment found within each category of healthcare facility was undertaken, with the daily demand of each used to calculate the system size required to cater to the electricity load of the facility (**Table 21**). The assumptions of system size below are based on the services offered at each of these facilities.

Table 21: Healthcare Facility Categorization and Electricity Demand¹⁴⁹

Type of Facility	Load Category	Wh/day	Total Load (Wh/day)	System Size (W)
Health post (HC1)	Lighting	240		
	Communication	160		
	ICT	800		
			1,200	250
Basic healthcare facility (HC2)	Lighting	1,600		
	Maternity	800		
	Vaccine refrigeration	800		
	Communication	400		
	Examination room	400		
	ICT	1,600		
	Staff housing	400		
			6,000	1,500
Enhanced healthcare facility (HC3)	Lighting	3,200		
	Communication	1,600		
	Examination room	1,200		
	ICT	2,400		
	Maternity	2,400		
	Laboratory	2,000		
	Sterilization	1,200		
	Vaccine refrigeration	1,200		
	Staff housing	1,600		
			16,800	4,200

Source: GIZ; African Solar Designs analysis

¹⁴⁸ NOTE: This represents a small subset of the overall health infrastructure in the country; See **Annex 2** for more details.

¹⁴⁹ "Photovoltaics for Productive Use Applications: A Catalogue of DC-Appliances," GIZ, (2016): https://www.sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/GIZ__2016__Catalogue_PV_Appliances_for_Micro_Enterprises_low.pdf

Based on these assumptions, the estimated annualized cash market potential for health facilities is presented in **Table 22**. The distribution of potential off-grid health facilities is shown in **Figures 29-30**.

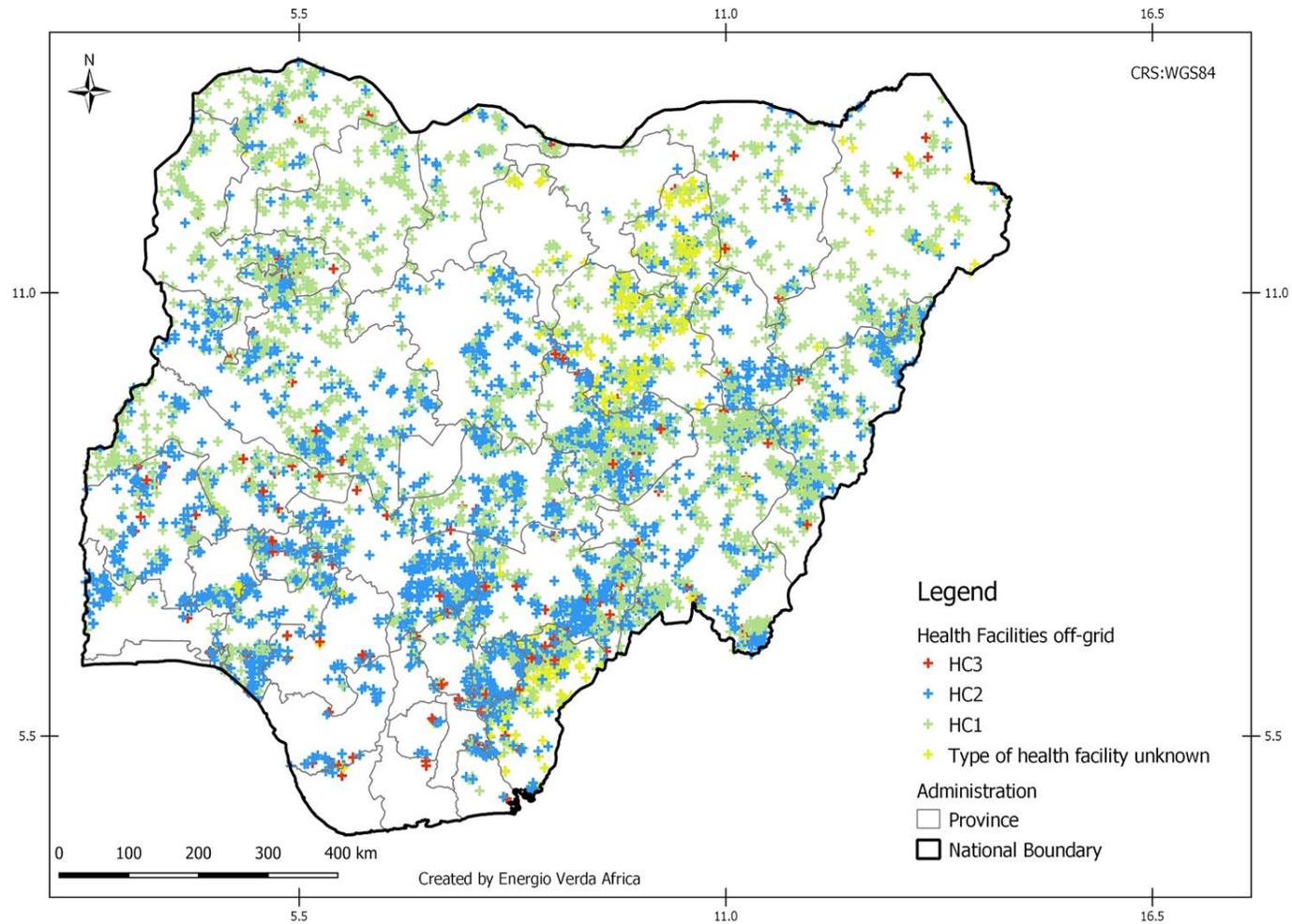
Table 22: Estimated Cash Market Potential for Healthcare Facilities ¹⁵⁰

Type of Facility	Units	kW Equivalent	Cash value (USD)
Health post (HC1)	2,744	686	\$1,714,750
Basic healthcare facility (HC2)	778	1,167	\$2,917,875
Enhanced healthcare facility (HC3)	19	82	\$204,225
Total	3,541	1,935	\$4,836,850

Source: African Solar Designs analysis

¹⁵⁰ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

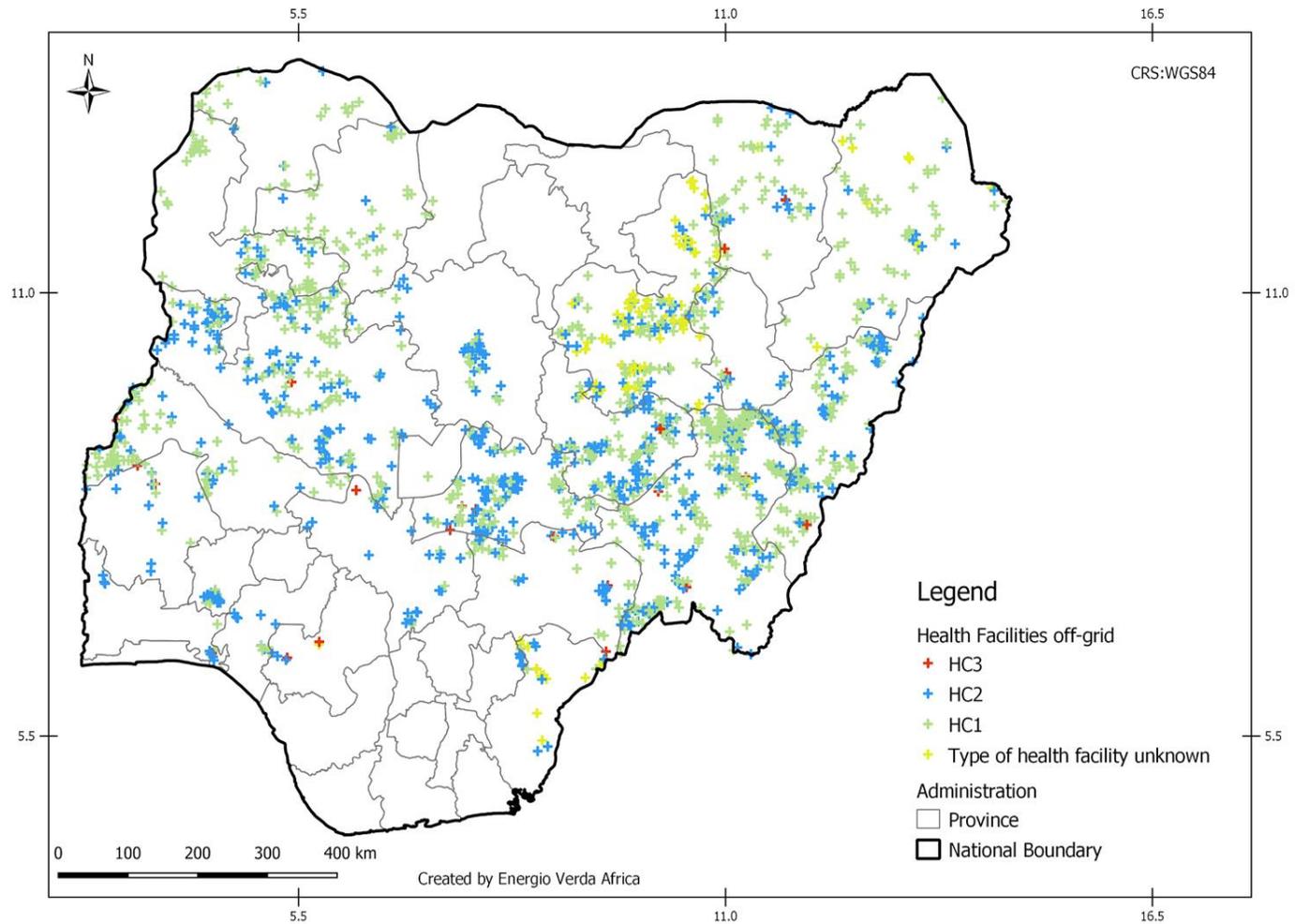
Figure 31: Distribution of Potential Off-Grid Healthcare Facilities, 2023¹⁵¹



Source: Energio Verda Africa GIS analysis

¹⁵¹ Displaying identified facilities with known location (given coordinates) only; see Annex 1 for more details, including data sources.

Figure 32: Distribution of Potential Off-Grid Healthcare Facilities, 2030¹⁵²



Source: Energio Verda Africa GIS analysis

¹⁵² Displaying identified facilities with known location (given coordinates) only; see Annex 1 for more details, including data sources.

➤ **Education**

Table 23: Key Assumptions for Education Sector Analysis¹⁵³

Sector	System Sizes	Key Assumptions
Education	<ul style="list-style-type: none"> Elementary schools (500 W) Secondary schools (1,920 W) 	30,157 off-grid primary schools and 9,815 off-grid secondary schools were identified that could be electrified by stand-alone systems

The education sector analysis considered the electricity needs of off-grid primary and secondary schools.¹⁵⁴ These include lighting, ICT (computers, tablets etc.), communication (phone charging), laboratories and staff housing. The size of a school and number of students determines the amount of energy it requires.

As available GIS data was not sufficient to conduct the analysis, figures provided by the National Bureau of Statistics¹⁵⁵ identified off-grid primary and secondary schools that could be electrified by stand-alone systems. To establish electricity demand, an assessment of equipment found within each type of school was undertaken, with the daily demand of each used to calculate the system size required to cater to the electricity load of the school (**Table 24**).

Table 24: Education Center Categorization and Electricity Demand¹⁵⁶

Type of Facility	Load Category	Wh/day	Total Load (Wh/day)	System Size (W)
Primary School	Communication	160		
	Lighting	640		
	ICT	800		
	Staff house	400		
			2,000	500
Secondary School	Communication	160		
	Lighting	1,920		
	ICT	3,200		
	Laboratory use	800		
	Staff house	1,600		
			7,680	1,920

Source: GIZ; African Solar Designs analysis

Based on these assumptions, the estimated annualized cash market potential for primary and secondary schools is presented in **Table 25**.

Table 25: Estimated Cash Market Potential for Primary and Secondary Schools¹⁵⁷

Type of Facility	Units	kW Equivalent	Cash value (USD)
Primary school	1,508	754	\$2,261,775
Secondary school	491	942	\$2,355,600
Total	1,999	1,696	\$4,617,375

Source: African Solar Designs analysis

¹⁵³ NOTE: While the GIS analysis in **Section 1.2.2.4** covers all education centers (including nursery, pre-primary, primary, secondary, technical-vocational, universities etc.), this analysis only examines primary and secondary schools (see **Annex 1** and **Annex 2**).

¹⁵⁴ Primary schools encompass both primary and nursery schools. Vocational schools and universities were not considered because they tend to be in cities, which are often grid electrified.

¹⁵⁵ Annual Abstract of Statistics, 2016, National Bureau of Statistics: www.nigerianstat.gov.ng

¹⁵⁶ "Photovoltaics for Productive Use Applications: A Catalogue of DC-Appliances," GIZ, (2016): https://www.sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/GIZ_2016_Catalogue_PV_Appliances_for_Micro_Enterprises_low.pdf

¹⁵⁷ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

Focus group participants indicated that the FGN and its development partners have undertaken several projects to electrify primary and secondary schools across the country. As an example, with funding from UNDP, 80 primary schools and 20 secondary schools in Borno State have been electrified using solar power. Another 172 schools in Lagos also received solar electrification, with funding from UK DfID and the Lagos State Government.

➤ **Public Lighting**

Table 26: Key Assumptions for Public Lighting Sector Analysis

Sector	System Sizes	Key Assumptions
Public lighting	Standard system (200 W)	<ul style="list-style-type: none"> District population figures were used to determine the number of market centers per district, assuming 5,000 people per market center Each market center was assumed to have two public lighting points

Analysis of the public lighting sector considered the public lighting needs for off-grid villages and market centers. It did not assess public street lighting, which would generally be included in road infrastructure projects. Based on these assumptions, the estimated annualized cash market potential for the public lighting sector is presented in **Table 27**.

Table 27: Estimated Cash Market Potential for Public Lighting ¹⁵⁸

Public Lighting Network	Units	kW Equivalent	Cash value (USD)
Village lighting (excluding street lighting)	1,003	502	\$1,504,500

Source: African Solar Designs analysis

2.2.3 Ability to Pay and Access to Finance

Financing for institutional off-grid systems in Nigeria typically comes from budget allocations made directly by relevant ministries or, more commonly, by donor-funded projects. In recent years, virtually all institutional solar projects in the country have been financed with tender-based procurements and cash-based contracts. Government allocations are typically made ad-hoc, depending on the needs and priorities of the ministry, and whether funds are available. Operation, maintenance and replacement of parts in energy systems (e.g. solar system batteries and inverters) is typically the responsibility of the institution and community. Schools, clinics and other institutions with generators must buy fuel on a regular basis. With the development of the renewable energy sector, NGO/donor funds increasingly design projects that ensure that maintenance of the system is factored into its implementation. However, when there are no funds to maintain the system any further, usage is typically discontinued, and the system falls into disrepair.

Institutional users that rely on government or donor funds for the purchase and O&M of solar systems may be constrained by limited funds and/or competing budget priorities. Thus, local communities benefiting from solar electrification would also have to bear some long-term costs for the maintenance of systems and replacement of parts. In the event that public or donor funding is made available to cover the initial capital expenditure, funds can be raised by local communities through a minimal tariff to customers of the health facilities, water pumping stations etc. for long-term O&M. A market standard of 5-10% of the capital expenditure is accepted as a rate for annual maintenance of systems.¹⁵⁹

¹⁵⁸ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

¹⁵⁹ Grundfos: <https://www.grundfos.com/service-support/encyclopedia-search/maintenance-and-repaircostscm.html>

Given budgetary constraints, some institutional sectors may be prioritized for solar electrification over others. Advanced health centers for example, could be prioritized by governments and communities given that electricity is essential to run advanced healthcare equipment. It may be easier in this case to extract maintenance fees from community members receiving health services or budget allocations from local government. In contrast, off-grid schools can be run more easily without access to electricity and may therefore present a lower priority institutional market.

2.3 Demand – Productive Use

2.3.1 Overview of Productive Use Market Segment

The section provides an overview of the main characteristics of productive use of energy (PUE) and how off-grid solar applications have the potential to generate economic activity, increase productivity and transform rural livelihoods in Nigeria. Focus group participants noted that productive use applications in the agricultural, food processing and informal sectors already exist in the country, including solar powered lighting, mobile phone charging, refrigeration and chilling, water pumping, irrigation and agricultural processing. The PUE market sizing analyzed demand for SME applications for village microenterprises, value-added applications for solar powered irrigation, milling and refrigeration, and connectivity applications for mobile phone charging enterprises.

The calculation of the estimated off-grid solar market for SMEs focused only on barbering and tailoring appliances, which comprises a small portion of overall SME sector demand. These two microenterprises are indicative of the service-based SME off-grid solar market, as they benefit significantly from extended working hours and the use of modern appliances/machinery. The estimated demand for this market segment is therefore intended to provide a baseline for future research, as a more robust analysis would be necessary to assess realistic demand from all SMEs.

The value-added applications that were analyzed include solar pumping for smallholder agricultural irrigation, solar powered milling and solar refrigeration. Access to energy for agriculture is critical to economic development, particularly given the sector's importance to GDP in the country.

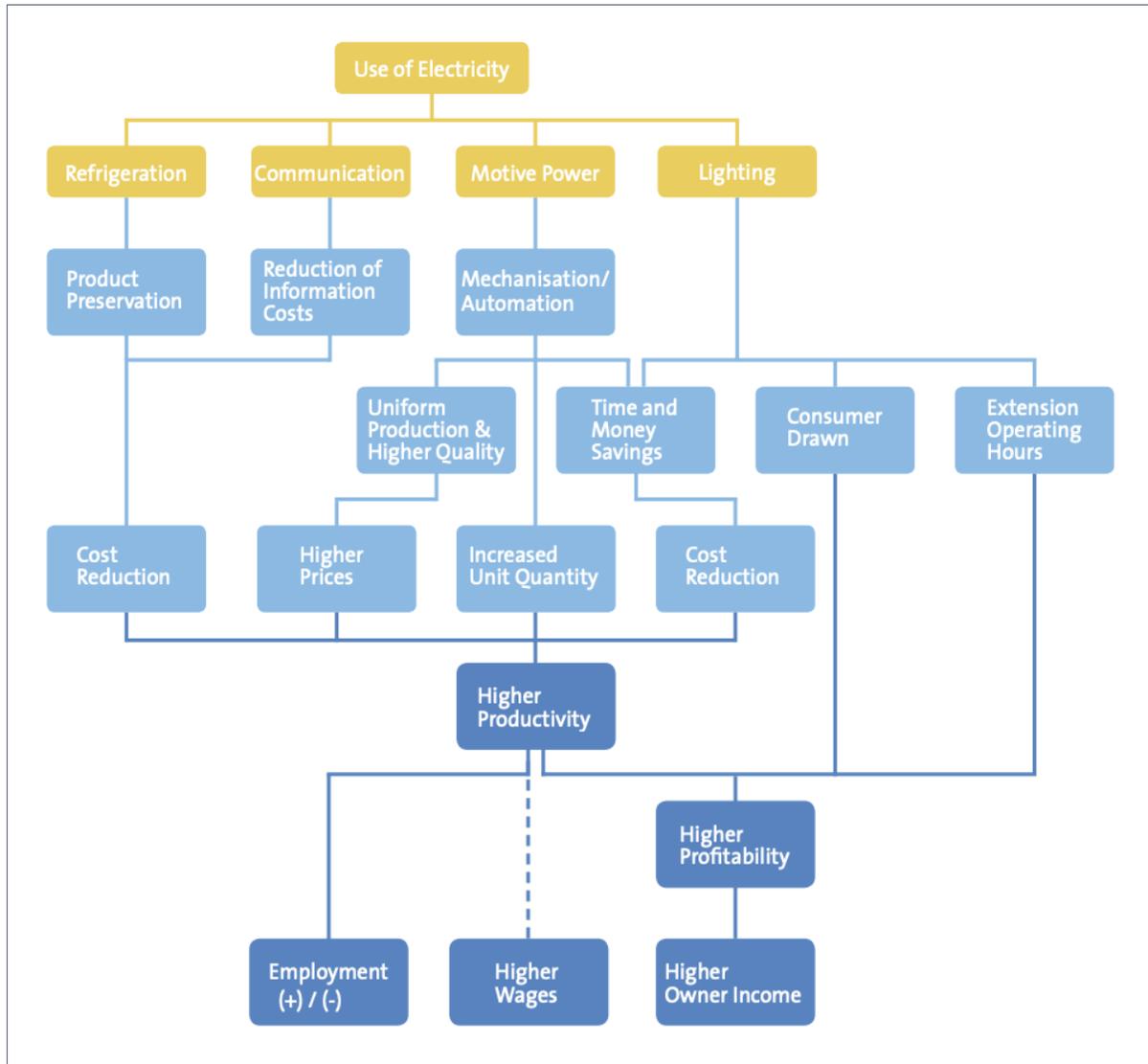
Off-grid solar power supports a wide range of connectivity applications, including mobile phone charging, wi-fi servers, banks, mobile money kiosks, and telecommunications towers. Mobile phone and internet connectivity are also necessary precursors for mobile money and PAYG solutions in the off-grid solar sector. The market sizing examined rates of mobile phone ownership and mobile internet penetration to estimate the market potential for mobile phone charging enterprises (stations/kiosks) in the country.

A number of productive uses have emerged in the country, such as phone charging through solar kiosks as a result of widespread mobile phone usage. The southwestern region of Nigeria appears to have the highest levels of awareness with regard to production use of solar PV. Furthermore, even in areas where there are widespread grid connections, the uncertain and low availability of grid-connected power has required business owners to also deploy off-grid power solutions, usually fossil fuel powered generators (**Figure 6**). There are also a number of productive use sub-sectors where solar power can immediately add value and build income.

In Nigeria, electricity costs amount to up to 40% of operational costs for most SME's, posing significant downward pressure on profits and sustainability. The economic effects of off-grid electrification in the country are highly market and sector specific. The impact of electricity use on SMEs depends on a variety of external and internal factors especially access to finance, the location of the firm, supply of inputs and financial capability.¹⁶⁰ Therefore, the extent to which firms may be able to afford to invest in off-grid solar solutions is determined largely by increases in productivity, profitability, and employment/wages from the investment in the off-grid appliance (**Figure 33**).

¹⁶⁰ Bank of Industry, Solar Energy: <https://www.boi.ng/solar-energy/>

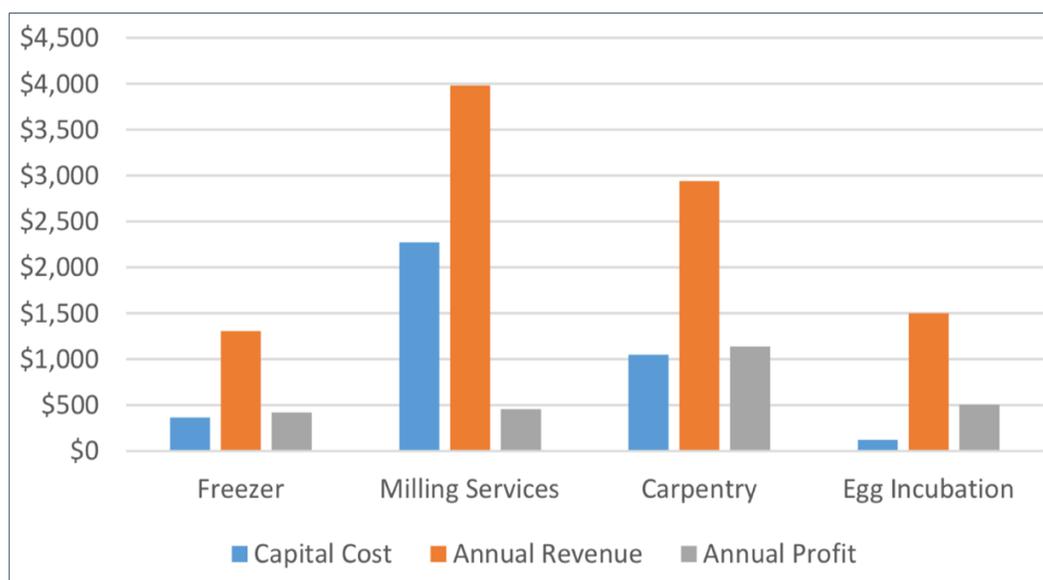
Figure 33: Pathways from Electricity to Income Generation¹⁶¹



Source: EUEI PDF and GIZ: Productive Use of Energy – A Manual for Electrification Practitioners

¹⁶¹ “Productive Use of Energy – A Manual for Electrification Practitioners,” European Union Energy Initiative Partnership Dialogue Facility (EUEI PDF) and GIZ, (2011): <https://www.giz.de/fachexpertise/downloads/giz-eueipdf-en-productive-use-manual.pdf>

Figure 34: Analysis of Cost, Revenue, and Profit for Various Off-Grid Productive Use Applications¹⁶²



NOTE: Annual profit does not include recovery of cost capital

Source: USAID-NREL and Energy 4 Impact: Productive Use of Energy in African Microgrids

In order to organize and simplify this analysis and to deliver meaningful insights on country level market sizing, productive solar applications have been divided into three main groups (Table 28).

Table 28: Overview of Productive Use Applications

Productive Use Application	Description
1) SME applications for village businesses	Barbers and tailors are the two microenterprises that were analyzed. While these businesses employ people and are critical for off-grid towns, they do not create additional income for towns and are not transformative in nature. SME businesses are therefore most at risk during economic downturns because they are at the mercy of the overall economic and political climate.
2) Value-added applications	Solar-powered irrigation, refrigeration/chilling and milling are the three value-added applications that were analyzed. Value-added productive use applications enable businesses to add value to products or services and to build new income streams. This can be done by creating a new product or service or by enhancing the value of an existing product (e.g. milling maize). Water pumping tools that support the agricultural, dairy or fishing value chains are included here (water pumps, refrigerators/chillers, and grain mills).
3) Connectivity / ICT applications	Mobile phone charging is the connectivity application that was analyzed. Connectivity applications enable consumers to communicate and access data from the internet. Following the advent of mobile phones and mobile money in East Africa, solar devices that support connectivity applications became the most important income earning applications in East Africa. Mobile phone charging is extremely important for the telecommunications sector. Other connectivity applications include wi-fi servers, mobile money kiosks, banks, and telecommunications towers.

Source: African Solar Designs

¹⁶² “Productive Use of Energy in African Micro-Grids: Technical and Business Considerations,” USAID-NREL and Energy 4 Impact, (August 2018): https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/productive_use_of_energy_in_african_micro-grids.pdf

➤ **Geographic Locations**

Most of the use of solar powered productive use will take place in the Northern and Southwestern regions of Nigeria, where grid access is limited, and rural agricultural livelihoods are the predominant means of income generation. In response to the severity of its power supply issues, the Government and donors have taken notable action to further the deployment of off-grid power solutions for public facilities. The Nigerian Federal Government developed plans to deploy up to 13GW of off-grid solar power by 2030 and moved to distribute 20,000 solar lighting systems to rural communities in 2017.¹⁶³ Additionally, at the state level, the Lagos State Electricity Board and the UK’s Department for International Development (DFID) instituted the Lagos Solar Project through which they installed nearly 5 MWp of solar off-grid power for 172 schools and 11 clinics. In Kaduna state, under the Solar Nigeria Program, 1.5 MWp has been installed at public health clinics, amongst other off-grid initiatives in partnership with international donors across the country.

2.3.2 Analysis of Productive Use Market Segment Demand

Data from the World Bank, Food and Agriculture Organization of the UN (FAO) and GSMA was used to conduct the PUE market study. In order to conduct the analysis, several key assumptions were made about PUE applications, which are presented in the sections below and in **Annex 2** in greater detail. **Table 29** presents the estimated annualized cash market potential for off-grid solar productive use applications.

Table 29: Indicative Total Cash Market Potential for Productive Use Sector ¹⁶⁴

Productive Use Sector		Units	kW Equivalent	Cash Value (USD)
SME Applications for Village Businesses	Microenterprises	670,855	167,714	\$419,284,625
Value-added Applications	Irrigation	323,750	38,850	\$210,437,500
	Milling	4,961	32,244	\$80,610,518
	Refrigeration	1,003	5,517	\$13,791,250
	Subtotal	329,714	76,611	\$304,839,268
Connectivity Applications	Phone Charging	88,370	35,348	\$76,174,985
TOTAL		1,088,939	279,673	\$800,298,878

Source: Food and Agriculture Organization, GIZ and GSMA; African Solar Designs analysis

➤ **SME Applications for Village Businesses**

Access to solar powered appliances can have a wide-ranging impact on SMEs, many of which would otherwise rely on diesel generators to power their enterprises. An estimated 33% of SMEs in emerging markets use fossil fuel powered generators in order to address energy security.¹⁶⁵ This practice is extremely common in Nigeria, where over 80% of SMEs rely on generators (**Figure 35**).¹⁶⁶

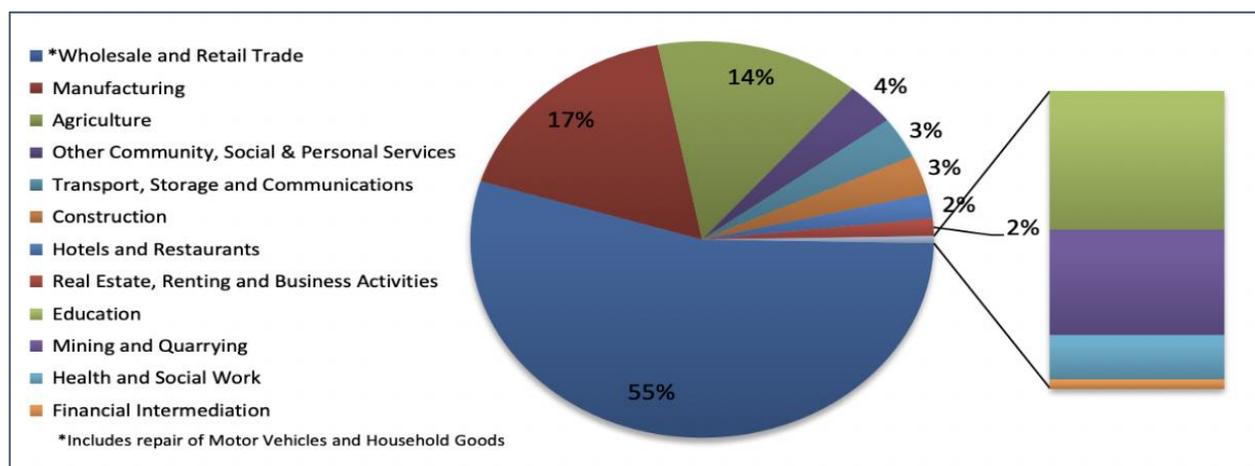
¹⁶³ “Nigeria Energy Sector,” Africa Renewable Energy Cooperation Programme: <https://www.africa-eu-renewables.org/market-information/nigeria/energy-sector/>

¹⁶⁴ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

¹⁶⁵ Foster, V., and Steinbuks, J., “Paying the Price for Unreliable Power Supplies: In-House Generation of Electricity by Firms in Africa,” World Bank Policy Research Working Paper, (2009): <https://openknowledge.worldbank.org/handle/10986/4116>

¹⁶⁶ Ibid.

Figure 35: Distribution of Generators in SMEs by Sector in Nigeria, 2015¹⁶⁷



Source: World Bank

While many rural microenterprises would benefit from access to solar power, it may not be a requirement for a commercial enterprise to have access to electrical appliances. Further, while petit trade is facilitated greatly by the availability of electricity (kiosks and retail shops can be open longer hours and sell more and fresher products), electricity is not essential for SMEs because even without lighting, small shops can still sell their merchandise. Additionally, unlike value-added applications, there is not as strong a correlation between the value of the electric appliance and the economic capability of the SME. For example, a refrigerator used to preserve perishable food and chill beverages, irrespective of the value of food and beverages, may be used by either a large hotel or a street side vendor.

With the exception of replacing diesel gensets, the estimation of the available market for off-grid solar appliances for SMEs is not as closely correlated with economic indicators. Nonetheless, some widely marketed solar powered appliances are more centrally related to the revenue generation of SMEs. Investments in such appliances in off-grid and low-income settings are more likely to be sustainable. This study analyzed barbering and tailoring appliances (i.e. hair clippers and sewing machines designed or marketed for off-grid solar powered settings) with respect to microenterprises that face difficulty in accessing outside capital, as the two appliances would provide an economic opportunity for such entrepreneurs that are demographically most likely to be in off-grid communities. A study undertaken in West Africa that found little correlation between electricity access and a firm’s profitability did, however, find that tailors do consistently benefit from electricity access.¹⁶⁸

Focus group participants also highlighted the potential for solar power to support service-based industries, specifically those participating in retail sales of fish, meat, beverages, entertainment and phone charging. The calculation of the estimated OGS market focused only on barbering and tailoring appliances, which comprises a small portion of overall SME sector demand. These two microenterprises are indicative of the service-based SME off-grid solar market, as they benefit most from extended working hours and the use of modern appliances/machinery. The quantitative demand estimate for this market segment is therefore intended to provide a baseline for future research, as a more robust analysis would be necessary to assess OGS demand from all SMEs.

¹⁶⁷ “Diesel Power Generation: Inventories and Black Carbon Emissions in Nigeria,” World Bank, (2014):

<http://documents.worldbank.org/curated/en/853381501178909924/pdf/117772-WP-PUBLIC-52p-Report-DG-Set-Study-Nigeria.pdf>

¹⁶⁸ Grimm, M., Harwig, R., Lay, J., “How much does Utility Access matter for the Performance of Micro and Small Enterprises?” World Bank (2012): http://siteresources.worldbank.org/INTLM/Resources/390041-1212776476091/5078455-1398787692813/9552655-1398787856039/Grimm-Hartwig-Lay-How_Much_Does_Utility_Access_Matter_for_the_Performance_of_MSE.pdf

According to the analysis, estimated annualized off-grid solar cash market potential for barbers and tailors is USD 19.2 million (**Table 30**).

Table 30: Estimated Cash Market Potential for SMEs – Barbers and Tailors ¹⁶⁹

No. of SMEs with Constrained Access to Finance ¹⁷⁰	Units	kW Equivalent	Cash Value (USD)
3,354,277	670,855	167,714	\$19,284,625

Source: World Bank; African Solar Designs analysis

➤ **Value-Added Applications**

In most West African countries, the national government is typically responsible for carrying out irrigation initiatives, which vary by the scale of the project and often require the construction of civil works such as dams, canals, embankments, and piping. Donor agencies and development partners provide funding for such projects. This analysis focused instead on a small-scale private sector driven approach and estimated the market potential for off-grid solar pumping systems to support smallholder farmers.

The three value-added applications that were analyzed include solar pumping for agricultural irrigation, solar milling and solar powered refrigeration.

Solar Powered Irrigation:

In most West African countries, the national government is typically responsible for carrying out irrigation initiatives, which vary by the scale of the project and often require the construction of civil works such as dams, canals, embankments, and piping. Donor agencies and development partners provide funding for such projects. This analysis focuses instead on a small-scale private sector driven approach and estimates the market potential for off-grid solar pumping systems to support smallholder farmers across the region.

With over 900 dams, Nigeria has huge potential for irrigation; yet, millions of hectares of land are not irrigated, with many dams either abandoned or only partially utilized. Many state governments abandoned dams and irrigation projects due to the high cost of maintaining pumping systems. There is significant potential to reduce these costs by switching from diesel-powered pumps to solar-powered systems.¹⁷¹

It was assumed that for the value-added applications for solar irrigation systems, drip irrigation systems powered by submersible or surface pumps would be used. In Nigeria a variety of irrigation techniques have been deployed (**Table 31**). As such, the market sizing approach for solar powered drip irrigation carried out in this analysis, which focuses on private sector driven approaches for supporting smallholder farmers, does not reflect a feasible or practicable approach for the diverse and large-scale irrigation challenges faced by the country as a whole.

¹⁶⁹ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

¹⁷⁰ “MSME Finance Gap,” SME Finance Forum: <https://www.smefinanceforum.org/data-sites/msme-finance-gap>

¹⁷¹ Oba, J. “Adopting solar-powered irrigation systems to boost agriculture in Nigeria,” Blueprint Newspaper, (18 April 2018): <https://www.sun-connect-news.org/articles/business/details/adopting-solar-powered-irrigation-system-to-boost-agriculture-in-nigeria/>

Table 31: Irrigation Systems in Nigeria

Sources of water		Surface water based			Groundwater based	
Water body	River	Residual moisture	Runoff water harvesting	Shallow aquifer	Deep aquifer	
Acquisition methods	Gravity-fed sprinkler, drip irrigation	Water harvesting	Water harvesting	Tube well Pedal pump, treadle pump	Bore hole	
Seasonality	Seasonal	Systems in which residual moisture along the river is captured after the rainy season • Flood recession	System to capture and store runoff water using circular or semi-circular levees, low ridges of earth	• Seasonal/unlined shallow well		
	Unseasonal	Basin irrigation Border irrigation Furrow irrigation	Wastewater irrigation in which waste water is stored and applied for various crops	• Shallow tube well • Permanent/lined shallow well	Bore-hole (wash bore)	

Source: International Food Policy Research Institute

Solar pumping systems vary in their wattage depending on the area of land irrigated, the depth of water abstracted and the quality of the soil and crops among other factors.¹⁷² GIS analysis demonstrated that access to the water table and surface water is not a major determinant of the costing of applicable solar irrigation systems, as most farming settlements in Nigeria are within close proximity to either surface water or relatively easily extractable sources of water (Figure 36).

It should be noted that many Nigerian farmers, especially those located in peri-urban areas must contend with insecure land tenure rights, and as a result are discouraged from making long-term irrigation investments on their plots.¹⁷³ Generally, land tenure insecurity is more relevant in the southern regions of Nigeria than in the North, where uncultivated land is more abundant. Additionally, the practice of renting out irrigable land during the dry season also serves as a downward pressure on levels of private sector investments in irrigation.

In analyzing the available market for solar-powered irrigation, this market scoping exercise focused exclusively on smallholder farmers and solar water pumping irrigation technologies to address their needs. In doing so, this analysis took into consideration the emerging experience with small-scale productive use pumping in East Africa. Small pumps of 80 Wp-150 Wp (e.g. Futurepump and SunCulture) make up the bulk of sales, while larger-sized pumps (e.g., Grundfos) are also frequently marketed to address differing water access and crop conditions. Table 32 presents the estimated annualized off-grid solar cash market potential for smallholder value-added solar irrigation applications in Nigeria, which has an estimated cash value of USD \$210.4 million (see Annex 2 for more details).

Table 32: Estimated Cash Market Potential for Value-Added Applications – Irrigation¹⁷⁴

Estimated No. of Smallholder Farms Suitable for OGS Pumping for Irrigation	Units	kW Equivalent	Cash Value (USD)
1,942,500	323,750	38,850	\$210,437,500

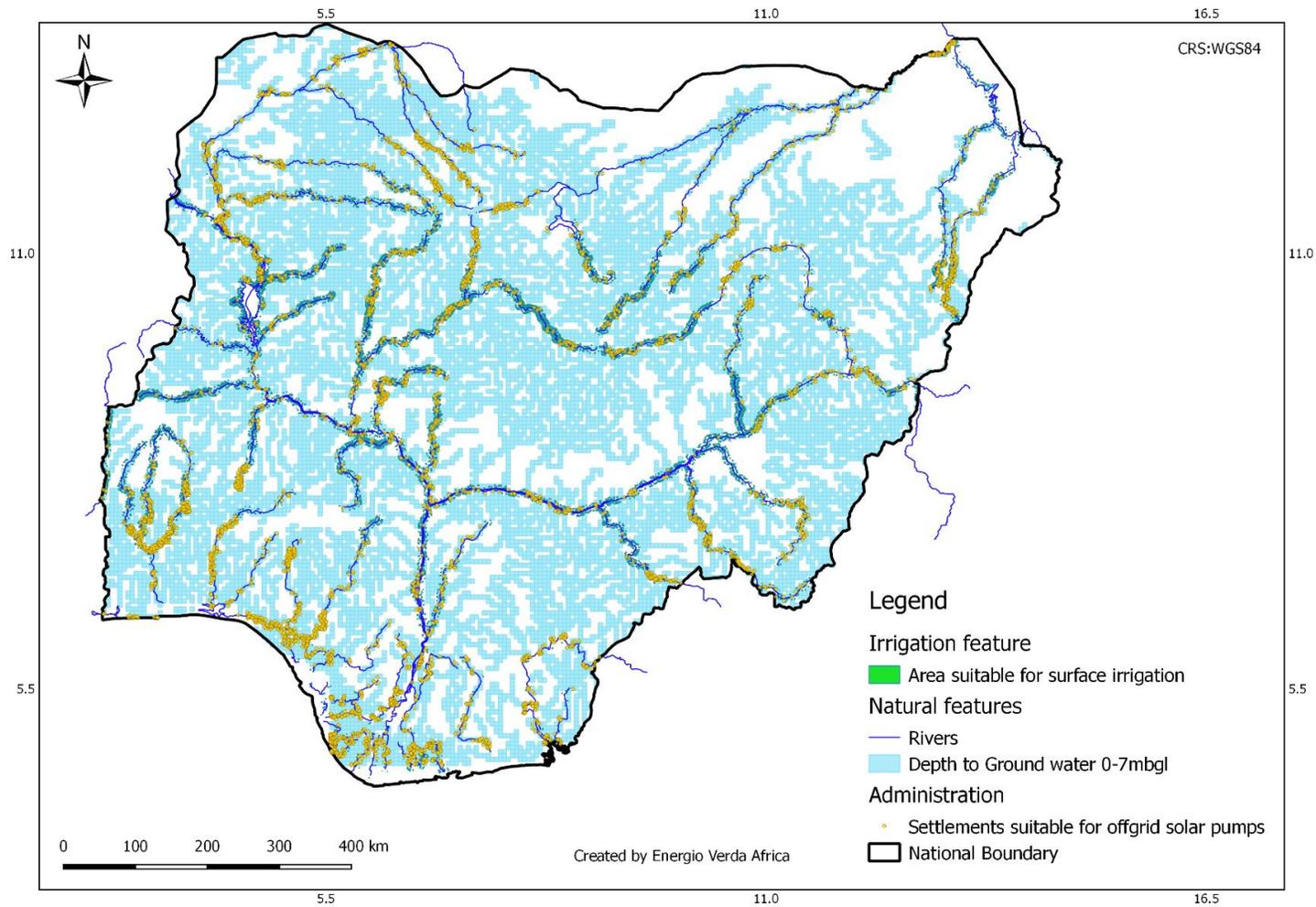
Source: Food and Agriculture Organization; World Bank; African Solar Designs analysis

¹⁷² See GIZ Powering Agriculture Toolbox on Solar Powered Irrigation Systems: https://energypedia.info/wiki/Toolbox_on_SPIS

¹⁷³ Takeshima, H., Salau, S., Adeoti, A., Okoli, S., “Economics of farmers’ demand for private irrigation in Nigeria,” IFPRI (2010): http://nssp.ifpri.info/files/2010/11/final_nssp23.pdf

¹⁷⁴ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see Annex 2 for more details.

Figure 36: Area Suitable for Surface Irrigation and Identified Settlements Suitable for Off-Grid Solar Pumps¹⁷⁵



Source: British Geological Survey, Bureau of Statistics; ESA Climate Change Initiative; National Geospatial Intelligence Agency; Energo Verda Africa GIS Analysis

¹⁷⁵ NOTE: mbgl = meters below ground level;

Sources; Mapping provided by British Geological Survey © NERC 2012. All rights reserved; Irrigation area identified from a Land Cover data set through the ESA Climate Change Initiative, Land Cover project 2017. © Modified Copernicus data (2015/2016): <https://www.esa-landcover-cci.org/?q=node/187>

Solar Powered Milling:

Cereal crops like maize, sorghum, millet, and rice provide an opportunity for value addition through hulling or milling. Off-grid communities use maize or rice milling equipment that is typically powered by diesel generators. Discussions with off-grid community groups revealed that although many are aware of the long-term cost savings associated with solar powered mills, the up-front cost of purchasing equipment was viewed as too high. **Table 33** presents the estimated annualized off-grid solar market potential for smallholder value-added solar grain milling applications in Nigeria, which has an estimated cash value of USD \$80.6 million (see **Annex 2** for more details).

Table 33: Estimated Cash Market Potential for Value-Added Applications – Milling ¹⁷⁶

Estimated No. of Solar Mills	Units	kW Equivalent	Cash Value (USD)
99,213	4,961	32,244	\$80,610,518

Source: Food and Agriculture Organization; African Solar Designs analysis

Solar Powered Refrigeration:

Solar-powered refrigerators and freezers in rural areas serve multiple purposes, including to store milk, fish, meat and vegetables to extend the life of produce and reduce losses. In addition to storing produce, ice-makers can increase the income of rural SMEs by providing ice to businesses that require cold storage (stores, restaurants etc.). **Table 34** presents the estimated annualized off-grid solar market potential for smallholder value-added solar refrigeration applications in Nigeria, which has an estimated cash value of USD 13.8 million (see **Annex 2** for more details).

Table 34: Estimated Cash Market Potential for Value-Added Applications – Refrigeration ¹⁷⁷

Off-Grid Market Centers	Units	kW Equivalent	Cash Value (USD)
20,060	1,003	5,517	\$13,791,250

Source: Solar-Powered Cold Hubs, Nigeria; African Solar Designs analysis

Ultimately, the ability for an agricultural community to benefit from productive use applications has as much to do with access to markets and improved crop inputs, as it has to do with the pricing and availability of financing to purchase the equipment. Hence, the macroeconomic approach used to carry out this market sizing does not account for country-specific cost and supply chain constraints.

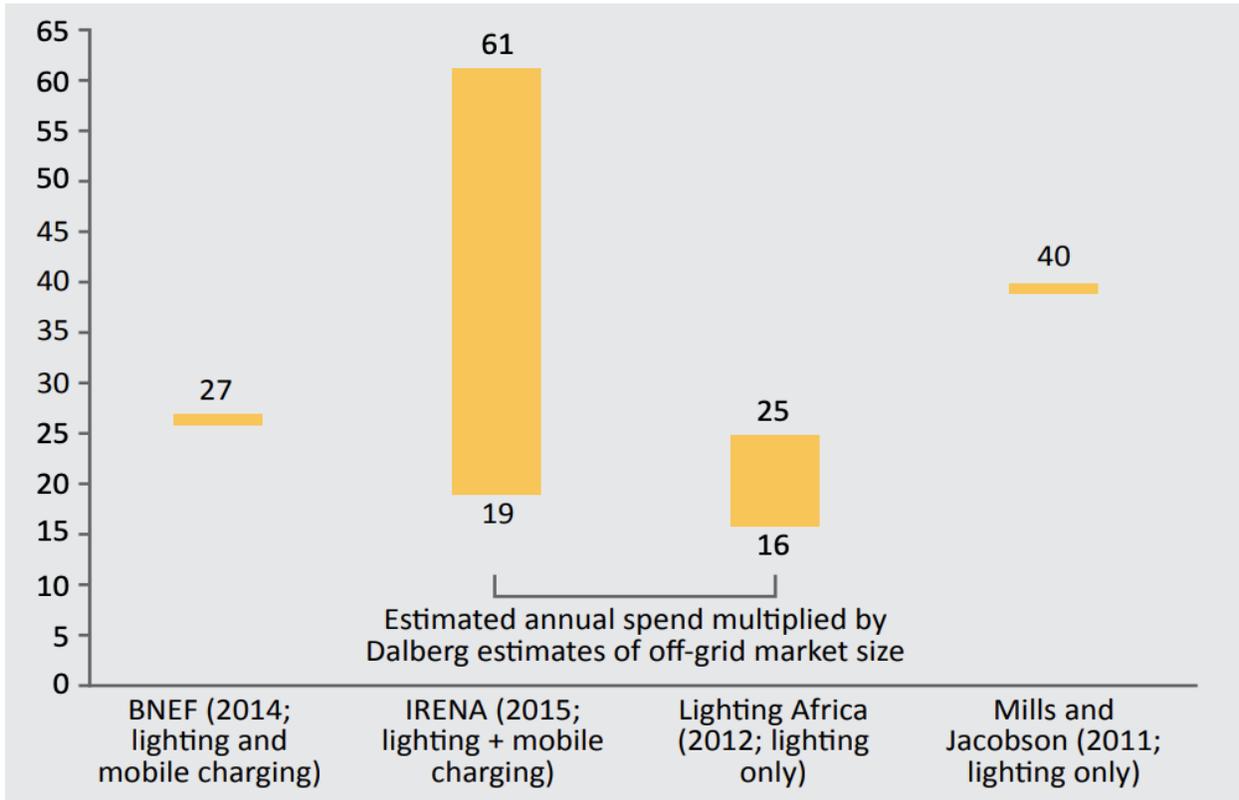
➤ **Connectivity Applications**

Mobile phone charging stations/kiosks make up a critical segment of off-grid solar demand, as the market for solar phone charging is expected to grow significantly in the near-term. Household rates of mobile phone ownership in Nigeria exceed the rates of electricity access by more than a factor of two (**Figure 20**). Moreover, Nigerian households spend a significant share of income on lighting and phone charging (**Figure 37**). Increasingly, off-grid solar devices, such as lighting devices, also include phone-charging capabilities that enable owners to engage in mobile-phone charging businesses.

¹⁷⁶ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

¹⁷⁷ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

Figure 37: Estimated Annual Off-Grid Household Expenditure on Lighting and Mobile Phone Charging¹⁷⁸



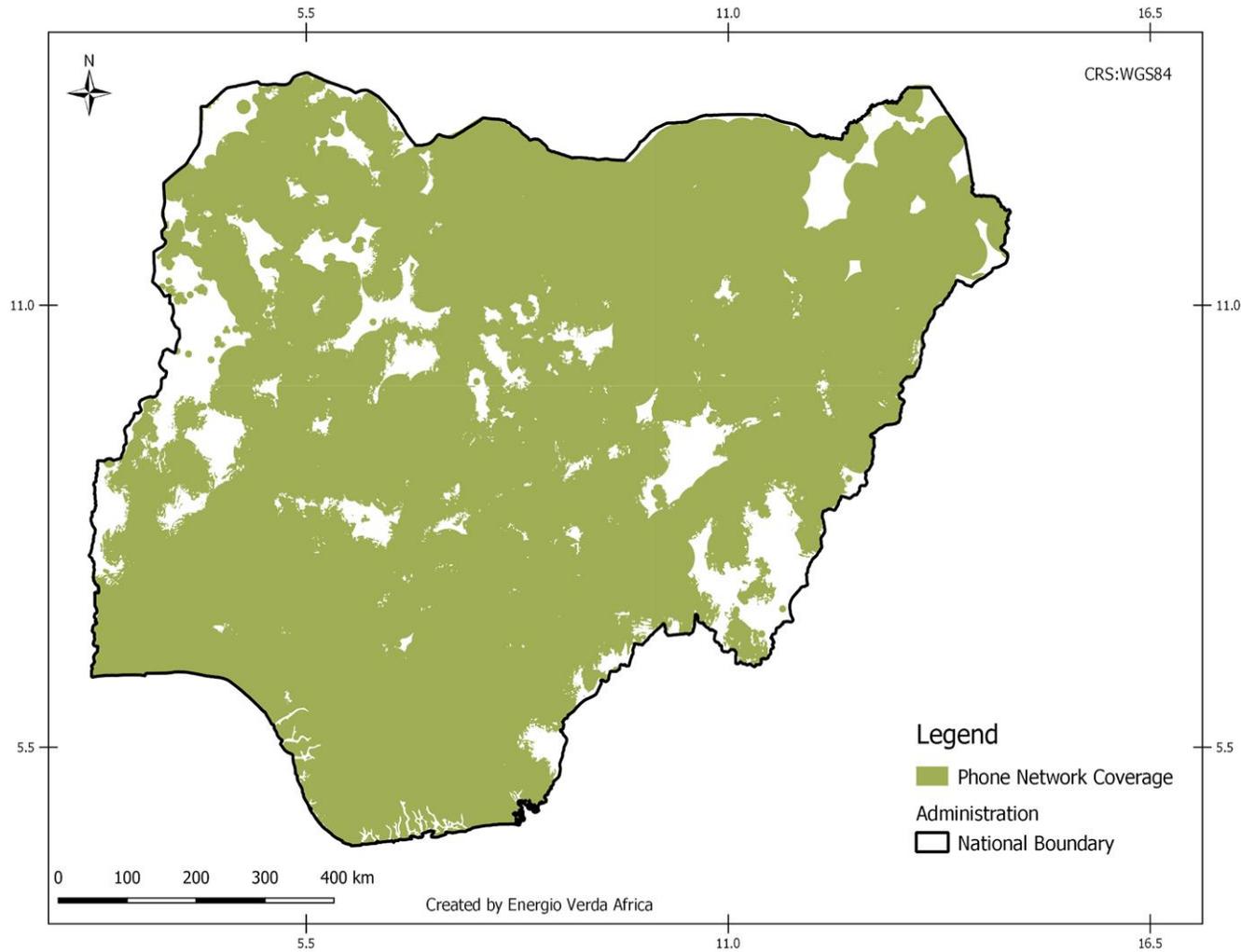
NOTE: Figures in Billion USD

Source: Dahlberg Advisors, Lighting Global, GOGLA and World Bank ESMAP, 2018

Figure 38 shows the relatively broad geographic coverage of cellular signals across the region. Cellular connectivity is essential for solar PV markets. In many African countries, mobile phone charging provides a primary productive use application for off-grid solar. Mobile phone access – and more importantly connectivity – helps drive commerce and employment in rural areas. The penetration of mobile money services is also critical, as it drives greater financial inclusion, expands consumer financing options and further increases demand for phone charging enterprises. Above all, mobile phones and connectivity are a necessary precursor to PAYG solutions in the OGS sector. Countries with expanding mobile phone coverage and especially broadband internet users are more attractive to PAYG solar companies (**Figure 19**).

¹⁷⁸ “Off-Grid Solar Market Trends Report 2018,” Dahlberg Advisors, Lighting Global, GOGLA and World Bank ESMAP, (January 2018): https://www.lightingafrica.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf

Figure 38: Mobile Phone Network Geographic Coverage¹⁷⁹



Source: GSMA

¹⁷⁹ See Annex 2 for more details.

The analysis of the potential solar-powered phone charging market was based on the country’s mobile phone penetration rate, rural population rate, and the average costs of OGS phone charging appliances. **Table 35** presents the estimated annualized cash market potential for off-grid solar mobile phone charging enterprises in Nigeria, which has an estimated cash value of USD 76.1 million (see **Annex 2**).

Table 35: Estimated Cash Market Potential for Mobile Phone Charging Enterprises¹⁸⁰

Mobile Subscribers ¹⁸¹	Rural Population (%) ¹⁸²	Units	kW Equivalent	Cash Value (USD)
86,000,000	52%	88,370	35,348	\$76,174,985

Source: GSMA; World Bank; African Solar Designs analysis

2.3.3 Ability to Pay and Access to Finance

The above analysis illustrates that there is a sizeable off-grid solar cash market for productive use applications in Nigeria. However, more research needs to be done in each segment to better understand affordability of OGS appliances and equipment based on ability and willingness to pay as well as other factors such as access to finance and ultimately whether the expenditure for the equipment is justifiable given increased revenue/productivity in the long-term.

The value-added market for water pumping for irrigation indicates that increased revenues from the use of solar appliances would justify the expenditure for the equipment – although as mentioned, agricultural productivity also depends on other environmental and market factors that are specific to each country. Solar powered irrigation systems may require a financed solution to be profitable investments for farmers, as their cost may exceed benefits depending on how the systems are designed and what components are used. With regard to SMEs, further study would be needed to determine the impact of OGS on this sector, especially as it relates to income and affordability of the sectors analyzed (barbers and tailoring). Providing solar-kits through subsidized micro-credit schemes can lead to productive uses and boost household income. The focus group discussions in countries across the region yielded additional insights into the off-grid solar PUE sector from a consumer point of view:

- Many companies cannot afford the up-front cost of solar products and systems. A potential solution to this problem would be to implement a third-party ownership system and increased access to financing. The International Finance Corporation (IFC) has recently instituted a facility (Small Loan Guaranty Program) whereby it will cover up to 50% of the risk of loans to SMEs that are investing in climate smart equipment including solar appliances.¹⁸³
- The financing tool for solar appliances should not only be provided to end users, but also local and regional suppliers to enable them to effectively market to available end users.
- Despite public and donor lead intervention to lower financial constraints, firms in rural areas still struggle to access financing solutions. This is especially the case for farmers that have invested in milling or solar drying but have not implemented irrigation schemes that would allow them to harvest crops year-round.
- There is also a high degree of skepticism regarding the reliability and quality of solar powered appliances, and as such, more should be done to raise awareness and set appropriate standards for solar products.

¹⁸⁰ Estimated units, kW equivalent and cash value are annualized to reflect typical lifespan of OGS systems; see **Annex 2** for more details.

¹⁸¹ “The Mobile Economy: Sub-Saharan Africa,” GSMA, (2017):

<https://www.gsmaintelligence.com/research/?file=7bf3592e6d750144e58d9dcfac6adfab&download>

¹⁸² World Bank: Rural Population (% of total population) <https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS>

¹⁸³ Press Release: “IFC Invests in Bank of Africa to Expand SME Lending in Eight Countries,” June 4, 2018

<https://ifcextapps.ifc.org/ifcext/pressroom/ifcpressroom.nsf/0/947B76E4C106A246852582A200440E1C?OpenDocument>

2.4 Supply Chain

This section reviews the off-grid solar supply chain in Nigeria, including an overview of key actors, solar products and services, business models, and sales volumes. The section also analyzes the role of informal market players and the impact of uncertified products. The section concludes with an assessment of local capacity and the needs of the supplier market segment. The data presented in this section was obtained through desk research, interviews with local officials and industry stakeholders, focus group discussions and surveys of international and local solar companies (see **Annex 2** for more details). The tier system used to classify solar companies throughout this section is described in **Table 36**.

Table 36: Solar Company Tier Classification

Classification		Description
Tier 1	Startup companies	<ul style="list-style-type: none"> • Less than 3 full time employees • Less than 300 SHS or Less than 1,500 lanterns sold • Less than USD 100,000 annual revenues • Does not have access to outside finance except personal loans and may have a business account
Tier 2	Early stage companies	<ul style="list-style-type: none"> • 3 to 25 full time employees • 300 to 30,000 solar home systems or 1,500 to 50,000 lanterns sold
Tier 3	Growth/Mature	<ul style="list-style-type: none"> • More than 25 full time employees • More than 30,000 solar home systems or 50,000 lanterns sold • More than USD 3 million annual revenues • Has a credit line at a bank and financial statements • Raising equity or other outside financing

Source: ECOWAS Center for Renewable Energy and Energy Efficiency

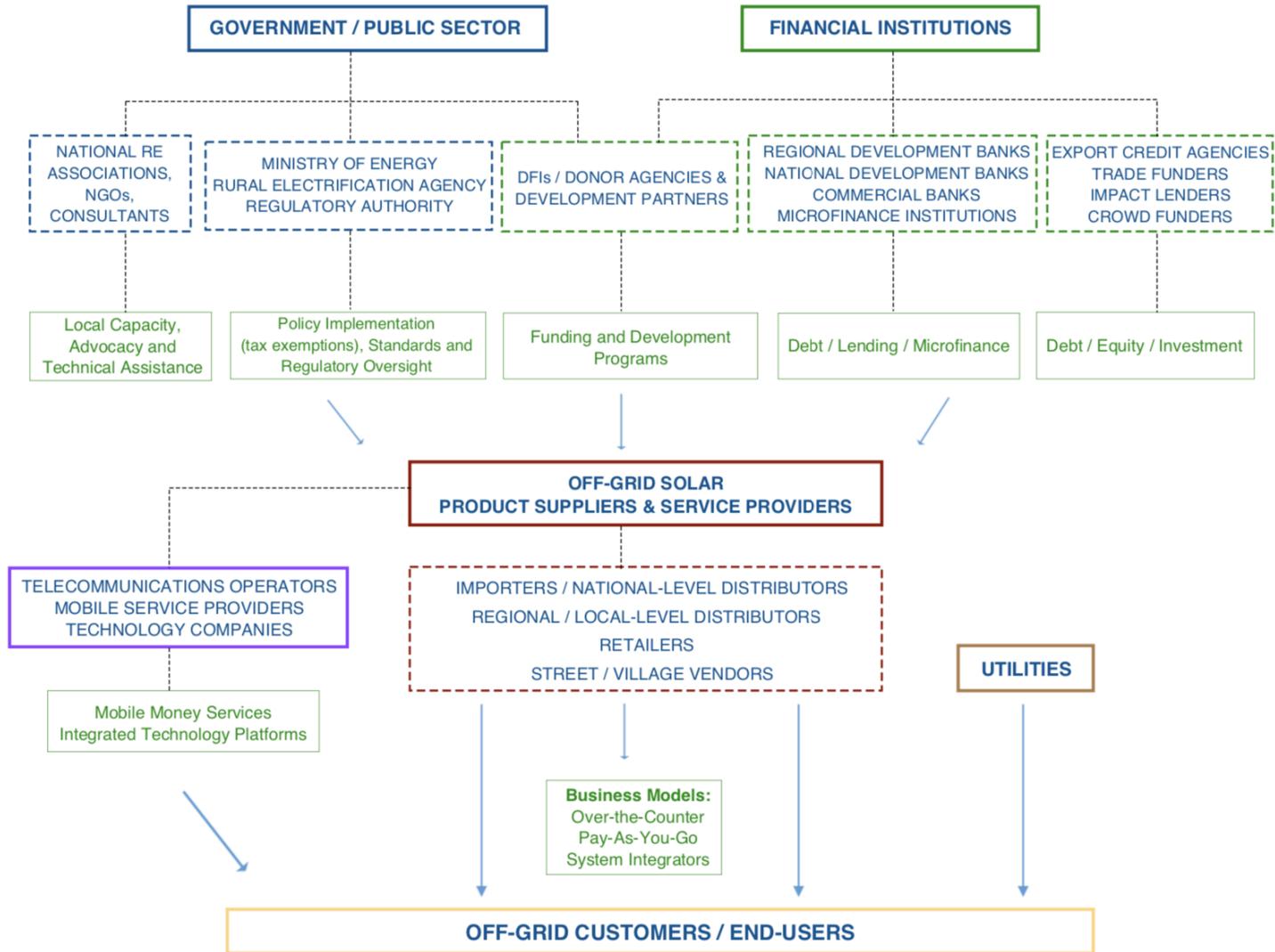
2.4.1 Overview of Commercial Market for Solar PV Equipment

The off-grid solar supply chain in Nigeria is made up of a wide range of stakeholders – importers, distributors, wholesalers, retailers, NGOs, and end-users (**Figure 39**). Nigeria is a rapidly growing solar market, as the country’s overall commercial environment and opportunity for solar companies is improving (**Figure 17**).

A variety of solar products and systems are offered by companies in the market (by both the formal and informal sector) and, as examined in further detail below, there are a number of business models currently being utilized. Rural households make up the main market for off-grid lighting products in the country, as the demand for lighting products and household electrical appliances is growing. Nevertheless, urban households, both electrified and non-electrified, are also a key consumer market, as they may have greater ability to afford OGS products and systems. Moreover, despite the high level of grid connectivity in urban areas, power supply is often not sufficient, continuous, or reliable (**Figure 6** and **Figure 7**), further supporting expanded use of solar PV equipment by this consumer segment.

The main business model deployed by local solar companies is cash/over-the-counter sales, while a few companies have started to utilize PAYG sales. Although large companies selling certified products play a central role in the market, the informal sector remains a key factor. Surveys of local industry stakeholders and focus group discussions noted that a regulatory framework was necessary to address the widespread sale of low-quality, uncertified products, which is hindering development of the country’s OGS market.

Figure 39: Off-Grid Solar Market and Supply Chain Overview



Source: GreenMax Capital Advisors

2.4.2 Overview of OGS Companies in Africa and Level of Interest in the Region

The African off-grid solar market has experienced rapid growth over the last five years. This growth can largely be attributed to the emergence of a progressively diverse, global pool of manufacturers and distributors, decreased system costs and an increase in three major product categories – pico solar, Plug-and-Play SHS, and component-based systems.¹⁸⁴ Leading solar companies such as Greenlight Planet, D.Light, Off-Grid Electric, M-KOPA Solar, Fenix International, and BBOXX represent the largest share of the African off-grid market and are joining other players in West Africa and the Sahel, including Lumos Global, PEG Africa, Barefoot Power, Yandalux, Schneider Electric, Azuri Technologies, Solarama, AD Solar, Enertec, SmarterGrid, GoSolar, Total, Oolu Solar, EnergenWao and SunTech Power to list a few.

Market entry into Africa began in East Africa for a majority of the leading companies, a trend that can be attributed to advancements in mobile money transfer systems such as M-Pesa that have facilitated the PAYG off-grid business model. As the East African market becomes more crowded and mobile money services spread across the Continent, many international off-grid solar companies have recently entered markets in West Africa and the Sahel. The regional market grew from being nearly non-existent in 2013 to accounting for 9% of worldwide sales (20% of SSA) with over 2 million systems sold in 2017.¹⁸⁵

Over 500 solar companies have been identified operating across the region, many of which are small local players. These local distributors either operate independently or act as local affiliates of larger international companies operating in this space. The majority of companies in the region are primarily Tier 1 and Tier 2 companies, with relatively few Tier 3 companies. The highest concentration of Tier 3 companies was identified in Burkina Faso, Cameroon, Côte d’Ivoire, Ghana, Mali, Nigeria and Senegal.¹⁸⁶

A survey of large international solar companies that assessed *inter alia* their level of interest in entering the off-grid markets in West Africa and the Sahel is presented in **Figure 40**. The survey found that among respondents, companies expressed the most interest in Nigeria, Sierra Leone, and Côte d’Ivoire, with at least half of respondents indicating a “very high level of interest” in these markets. There was also a relatively high level of interest in Liberia, Senegal, Burkina Faso, Mali and Togo, with at least half of respondents indicating a “very high” or “moderate” level of interest in these markets.

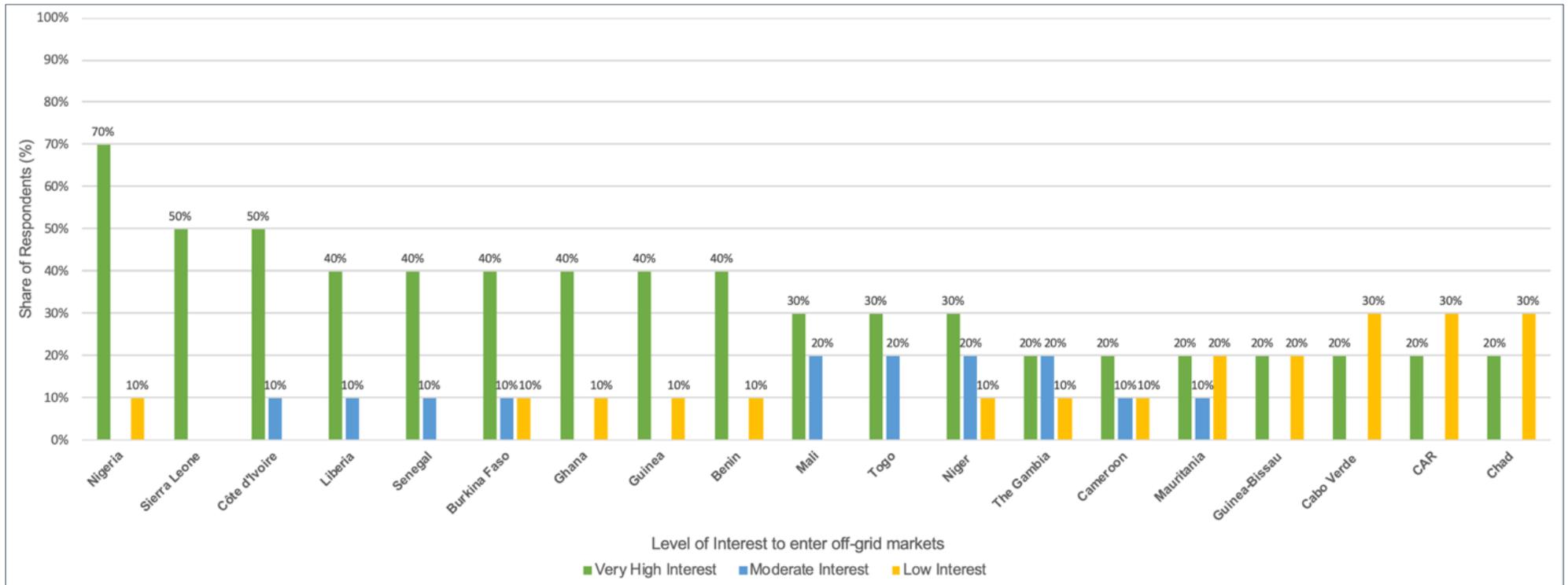
¹⁸⁴ “Off-Grid Solar Market Trends Report, 2018,” Dahlberg Advisors and Lighting Africa, (January 2018):

https://www.lightingafrica.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf

¹⁸⁵ *Ibid.*

¹⁸⁶ “Insights from Interviews with Off-Grid Energy Companies,” ECREEE, (June 2018).

Figure 40: Level of Interest in Off-Grid Markets in West Africa and the Sahel among Major Suppliers¹⁸⁷



Source: Stakeholder interviews; GreenMax Capital Advisors analysis

¹⁸⁷ NOTE: This is not a representative sample of respondents (sample size = 10 respondents). The figure is meant to provide feedback from “major suppliers” of off-grid solar products and services and gauge their level of interest in entering specific ROGEP country off-grid markets. Respondents are all GOGLA members and are either already active in the West Africa and Sahel region or seeking to enter it. The figures presented are the share of respondents (%) who indicated their level of interest in a given country.

2.4.3 Solar Market, Products and Companies in Nigeria

This section characterizes the current formal market (local and international companies) including recent sales trends, the main solar products, brands and prices.

➤ The Formal Market – Local and International Companies

Focus groups and stakeholder interviews identified 75 companies operating in Nigeria’s solar sector, offering a wide range of products and services to consumers throughout the country (see **Annex 2** for a complete list of identified companies). Nigeria has a particularly high concentration of existing and potential Tier 3 companies. These companies notably include Azuri, Lumos Global, D.light, BBOXX, Greenlight Planet, Arnergy, Smarter Grid, Creeds Energy, Go Solar and Schneider Electric among others, while Off-Grid Electric (OGE) and Mobisol are also entering the market. Some of the country’s larger Tier 3 companies (e.g. BBOXX, D.light, Lumos Global etc.) acquired longstanding industry experience in East Africa prior to entering Nigeria and the West African market. Many solar companies are members of the REAN. In addition to local firms, the formal market includes international players that enter the market to install systems for donor-funded projects. As of 2018, most of the solar companies operating in Nigeria were Tier 1 companies, with nine Tier 3 companies identified.

Formal market players are largely Lighting Global and GOGLA affiliated companies and operate across the entire supply chain as distributors, wholesalers and retailers, specializing in the sale of multiple types of products and systems, including very large solar systems, pico and single modular systems, targeting a wide range of sectors. For example, Azuri, a U.K.-based firm, targets rural households in Nigeria with solar lanterns and plug and play systems, utilizing the PAYG business model. Customers make regular payments typically on a monthly basis via mobile money service until the system is fully paid off (usually after about 18 months). The firm has established strong partnerships with local distributors, installers and O&M technicians to provide its services throughout the country.¹⁸⁸ In 2018, Azuri partnered with local private utility, the Niger Delta Power Holding Company, to provide off-grid solar electricity to 20,000 rural households in the region. Other companies such as Arnergy, Blue Camel, Consistent Energy and Protergia Energy, are wholesalers for major international companies such as Canadian Solar and Schneider Electric and offer PAYG financing services to their customers. Arnergy and Jinko Solar among others have also launched a new energy-as-a-service (fee-for-service) business model.

Solar companies in Nigeria form a complex ecosystem of solar component manufacturers (e.g. Canadian Solar, Yingli, Jinko Solar, Schneider Electric, Deka, Gaston, Trojan, SMA and Outback), importers and distributors (e.g. representative of manufacturers – Jubaili Brothers, Gennex Technologies, wholesalers and distributors (e.g. Protergia Energy, Consistent Energy and Creeds Energy), and both formal and informal retailers selling products over-the-counter. While some companies specialize in a specific solar segment, many companies operate across several areas of the supply chain – from pico solar and modular systems to very large solar systems – while some specialize in certain areas such as installation and O&M of systems.

There are a number of business models being utilized in the market. New solar market actors have emerged, including many early-stage PAYG market players and system integrators, acting as agents of large solar companies and distributors. The number of local over-the-counter vendors has increased as well, with a large share of these transactions concentrated in or around the major cities of Abuja and Lagos. While the development of the industry’s large companies and Tier 3 actors plays an important role in Nigeria, the informal sector also remains a key component of the market, as the country is flooded with low quality, low-price, often uncertified lighting products.

¹⁸⁸ “État de lieux du marché des kits solaires en Afrique: acteurs, marchés, investissements, produits et tendances,” Innogence Consulting, (2018): <https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/Etat-Des-Lieux-Du-PayGo-Solaire-en-Afrique.pdf>

➤ **Sales Volumes and Revenue**

Focus group participants indicated that it is challenging to assess the size of the current market due to a lack of standardization in pricing from one company to another and a shortage of sound statistical data. Moreover, during surveys and FGDs, companies were reluctant to share confidential data on sales volumes and market shares. Local industry stakeholders described the market as having significant volume of sales distributed between hundreds of larger installations (>1 kW) and tens of thousands of consumer product sales along with institutional system market activity (with mini-grid projects underway).

Using reports published by GOGLA, some basic market information is presented in **Table 37** and **Table 38**. It is important to note that this data only includes figures from GOGLA-affiliated companies and certified product sales and is therefore not fully representative of off-grid solar market activity in Nigeria.

Table 37: Total Sales Volume and Cash Revenue for Stand-alone Systems in Nigeria, 2016-2017¹⁸⁹

Sales Volume / Revenue	2016	2017	Total
Total Volume of Products Sold (Units)			
Total Volume of Products Sold	278,251	215,575	493,826
Pico Solar	261,556	183,239	444,795
SHS	16,695	32,336	49,031
Total Cash Sales Revenue (USD)			
Total Cash Sales Revenue	\$7,802,775	\$2,928,833	\$10,731,608
Pico Solar	\$6,710,387	\$2,811,680	\$9,522,067
SHS	\$1,092,388	\$117,153	\$1,209,541

Pico solar products categorized as 0-10W

SHS products categorized as >10W

In 2016-2017, about 90% of the overall share of OGS products sold and 92% of total sales revenue in West Africa were pico solar products compared to 10% of products sold and 8% of sales revenue were SHS.

Table 38: Cash and PAYG Sales Volume and Revenue for Pico Solar Products, H1 2018¹⁹⁰

Sales Volume / Revenue	Cash	Share (%)	PAYG	Share (%)	Total
Total Sales Volume Nigeria	102,793	67%	50,319	33%	153,112
Total Sales Volume West Africa	194,521	65%	104,520	35%	299,041
% of Total Sales Volume in West Africa	53%	-	48%	-	51%
Total Sales Revenue Nigeria	\$2,746,851	51%	\$2,605,621	49%	\$5,352,472
Total Sales Revenue West Africa	\$14,972,591	50%	\$15,008,999	50%	\$29,981,590
% of Total Sales Revenue in West Africa	18%	-	17%	-	18%

NOTE: H1 2018 = First half of 2018

Source (Tables 37-38): GOGLA, Lighting Global and World Bank; GreenMax Capital Advisors analysis

¹⁸⁹ Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data,” GOGLA, Lighting Global and World Bank, (July – December 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth2-2017_def20180424_web_opt.pdf; and

“Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data,” GOGLA, Lighting Global and World Bank, (January – June 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth12017_def.pdf; and

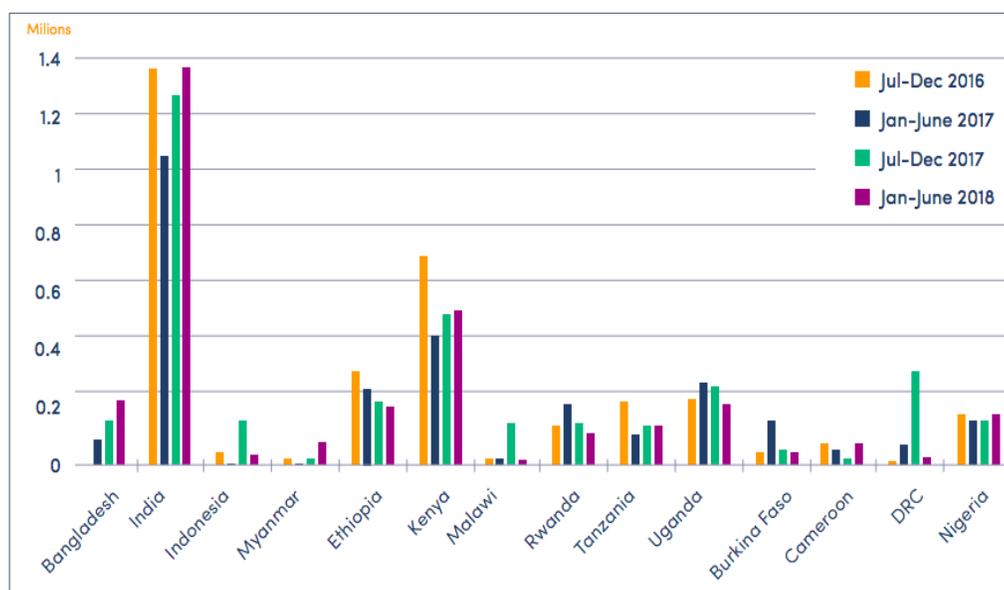
“Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data,” GOGLA, Lighting Global and World Bank, (July – December 2016): https://www.gogla.org/sites/default/files/recource_docs/final_sales-and-impact-report_h22016_full_public.pdf; and

“Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data,” GOGLA, Lighting Global and World Bank, (January – June 2016): https://www.gogla.org/sites/default/files/recource_docs/global_off-grid_solar_market_report_jan-june_2016_public.pdf

¹⁹⁰ “Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data,” GOGLA, Lighting Global and World Bank, (January – June 2018): https://www.gogla.org/sites/default/files/resource_docs/global_off-grid_solar_market_report_h1_2018-opt.pdf

- **Over the period 2016-2017, 493,826 units were sold for a total amount of USD 10,731,608.** The number of products sold has decreased by 29%, from 278,251 units to 215,575 between 2016 and 2017, while cash sales revenue has also dropped by 63%, from USD 7,802,775 to USD 2,928,833 over the same period. Although Nigeria is the most advanced market in the region, it is still a young market, so volatile sales like this are to be expected. The trend can also partially be explained by the country’s overall economic recession during this period.
- **Nigeria is among the top five countries globally in terms of volumes of products sold.** Nigeria ranked fourth globally in sales volumes in H1 2018 behind India, Kenya and Ethiopia. The country’s three-year cumulative sales (2014-2016) amounted to 1.7 million units, with a peak at 820,000 units sold in 2016 followed by a downward trend in 2017 (215,575 units sold in 2017, accounting for 31% of West African sales). In H1 2018, Nigeria sold 153,112 units, increasing by 30% compared to H1 2017 and representing more than 50% of the region’s sales.
- **Pico PV products represent the majority of products sold even though their overall share in units sold is decreasing.** Based on data for the West African region, pico products represented 92% of total volumes sold over the period 2016-2017 (444,795 units) and accounted for 89% of cash sales revenue (USD 9,522,067) over the same period.
- **Nigeria was also a leading market for PAYG sales in H1 2018.** Nigeria was the fourth largest PAYG sales market (volumes and revenue), after Kenya, Uganda and Tanzania. In H1 2018, the country sold 50,319 units representing USD 2,746,851. While PAYG accounted for 35% of total volumes sales, it represented more than 50% of total sales revenue, which suggests higher-end and more expensive products are sold by PAYG. Nigeria represented almost half of total sales volume in West Africa and about 20% of total PAYG sales value in the region.
- **Cash sales transactions still account for the largest volumes sold in Nigeria.** Out of 153,112 total units sold in H1 2018, 102,793 units were sold in cash. Cash is still the dominant model used in Nigeria for transactions even though PAYG accounts for more than 50% of sales.

Figure 41: Total Sales Volume for Stand-alone Solar Systems in Select Countries (USD million)



Source: GOGLA, Lighting Global and World Bank

➤ **Market Prices**

Table 39 presents average prices for off-grid systems and components in Nigeria’s solar market.

Table 39: Estimated Prices of Solar Systems and Components in Nigeria

Off-Grid System / Component	Price range (USD / per unit)
Pico solar and Plug and Play	\$25-\$40
SHS (average, rooftop PV for rural households)	\$1,500
Solar Module (0.265 kW- 0.26 kW)	\$71-\$230
Inverter (0.6 kW-50 kW)	\$154-\$6,000
Lead Acid Battery (100 Ah-220Ah)	\$144-\$500

Source: Stakeholder interviews

➤ **Main Solar Products and Components**

Table 40 lists the brands of common solar products and components in Nigeria. The list does not include non-certified brands that are also common in the country’s grey market.¹⁹¹

Table 40: Off-Grid Solar Products and Components in Nigeria

System category	Companies
Distributors of Solar Lanterns	D.light, Greenlight Planet, Asteven, Lumos Global, Solar Sister, Sosai Renewables, Black Bit Solar, JUA Energy, Total Plc
Single Module distributors	Yingli, SOSAI Renewables (Fosera), JUA Energy, Asteven, Blackbit Solar, Greenlight Planet, Solar Sister, Go Solar
Multi module system distributors	Sosai Renewables, Creeds Energy, Arnergy, Consistent Energy, Blackbit Solar, Blue Camel Energy, Roncho Energy, Ecopower Resources, Enerplaz, Go Solar, Green Village Electricity (GVE) Project, Havenhill Synergy, Solarcentric Tech, Vanpeux Global Synergy, Arthur Energy, M-Rald Global, Pamtronics
Very large system supplier	Protergia, Blue Camel, Asteven, Consistent Energy, Rubitech Solar, Solarmate Engineering, Arnergy, GVE Project, Havenhill Synergy, Pamtronics, M-Rald Global, First Options, Enerplaz, Gelon Nigeria, Solarcentric Tech, Vanpeux Global Synergy
Products	Brands
Pico Solar	Dlight, Greenlight Planet, Asteven, Lumos, Solar Sister, SOSAI Renewables, Black Bit Solar, JUA Energy, Total
Solar Home Systems	Yingli solar, Sunking, Sun power, Asteven Group
Inverters	Scheider, Sinergy, Qanta, Sukam, Techfine, Lumunus, Genus, Mpower, Trojan, Leoch, Victron, Magnu, Xantrex, SMA, Outback
Charge Controllers	Schneider Electric
Battery	Sinergy, Qanta, Deka, Sukam, Lumunus, Genus, Mpower, Trojan, Leoch, Exodece, Hoppecke, Long, Narada, Ritan
Solar PV	Bloomberg, Luxor, Solar World, LG, Suntech, Yingli, AE, Auxano, Roy Solar, Felicity, Canaltin, Juku

Source: Stakeholder interviews

¹⁹¹ In this context, “grey market” refers to products that are not Lighting Global or IEC certified that are typically sold over-the-counter at low prices. Some grey market products are counterfeit or replicas of certified products that undercut the markets of certified products.

➤ **Importation Clearance Processes**

The importation and clearance process for solar equipment in Nigeria is extensive. For the importation of solar products, the main GFN agencies involved are the Nigeria Custom Service, the Standard Organization of Nigeria (SON), the Nigeria Electricity Regulatory Commission (NERC), the Rural Electrification Agency (REA) and the Ministry of Finance. The exemption of custom taxes and duties is not total – a 10% tax is paid on solar panels, a 20% tax on inverters and on batteries. The importation process in Nigeria can take anywhere between two and half months (75 days) and three months (90 days), while the clearance period can take up to an additional two months. A total of 12 agencies can be involved in the import clearance process:

- The Nigerian Export Promotion Council Exporters Registration Certificate
- The Nigerian Assoc. of Chambers of Commerce, Mines & Industry (NACCIMA)
- The Nigerian Agricultural Quarantine Services NAQS
- The Federal Produce Inspection Service, Standards Organization of Nigeria (SON)
- The Nigeria Customs Service (NCS)
- The Federal Ministry of Trade & Investment
- The Department of National Museum & Monument
- The National Agency for Food, Drugs, Administration & Control (NAFDAC)
- The Federal Ministry of Solid Minerals
- The Department of Forestry
- The Federal Inland Revenue Service (FIRS)
- The National Drug Law Enforcement Agency (NDLEA)

The FGN has developed and implemented specific provisions based on GOGLA and Lighting Africa standards in order to ensure the quality of products entering the market. IEC and ISO are also standards used locally to ensure the quality of products imported into the country. Despite these standards in place, the size of the grey market in the country indicates that a significant volume of counterfeit / non-certified products is entering the market illegally.

2.4.4 Overview of Business Models

➤ **Company Approach to Market**

Nigeria’s solar market includes many well-established market players, including many large international companies with extensive industry experience that offer a wide range of products, from solar lanterns and plug and play solar systems, to single and multiple modular systems and very large systems (defined as systems above 1KW that required specialized design and installation including post-sale services). While there is a relatively high number of Tier 3 companies in Nigeria, the majority of companies operating in the country are either Tier 1 or Tier 2 companies.

Households (including large-income clients in urban areas) seem to be the most important clients, although companies also provide services to SMEs and the institutional sector as well (FGN agencies and NGOs). Over-the-counter and cash sales is still the dominant model, not only for the non-standard/informal market but also for wealthy customers who can afford to make one-time cash payments in urban areas. PAYG is widely used to reach the base of the pyramid (BoP) consumer segment of the market in rural and peri-urban areas. Lumos has partnered with mobile operator MTN Nigeria to expand its PAYG business. Two companies – Arnergy, distributor for Jinko Solar and Trojan manufacturer brands, and GVE Project, distributor for Schneider Electric – are expanding their consumer financing options by launching an energy-as-a-service business model.

Many firms are direct importers of solar equipment, who import large volumes and then either distribute products to retailers or sell them to distributors. Importers and distributors act as manufacturer representatives and often have established strong partnerships with foreign manufacturers, representing their brands. They can represent one brand (e.g. Rubi Tech Solar represents Jinko Solar, Africa Energy represents Denka) or several manufacturers (e.g. First Option and Solarmate, representing both SMA and Outback). In exchange, manufacturers avail credit terms to Nigerian suppliers and have helped with regards to technology transfer and capacity building.

➤ **Business Models**

There are four primary business models used in the market, and one business model in its pilot phase (**Table 41**), although in reality solar companies utilize a number of business models to reach a variety of clients:

- **Over-the-counter cash sales** include both informal and formal components. Many traders simply offer solar products over-the-counter. Formal sector solar companies also stock modules, batteries and balance of system and offer them over-the-counter to do-it-yourselfers and agents.
- **System integrators** handle large systems and projects. They design, procure and install systems which range from high-end residential sites, to institutional power to mini-grids. Local integrators represent international solar, inverter and battery brands with whom they partner with on projects.
- **Plug and play and pico suppliers** cooperate with many of the major OGS brands to distribute products in the country. Sellers of plug and play system target customers who can afford more than simple pico lanterns (products are usually sold through PAYG).
- **The PAYG sector** is still in its early stages but is growing rapidly. Suppliers are building up client bases which number in the tens of thousands and are quickly evolving to develop credit mechanisms that fit with local income patterns. The margins are made from subscriptions of thousands of consumers who buy systems through created accounts. The task of installation and after sales services is undertaken by agents. Common products sold include plug and play systems that are fully designed. Nearly all major companies and smaller suppliers utilize this business model in Nigeria.
- **Energy-as-a-service/Fee-for-service** is in its early stages. A few companies have launched pilots of this consumer finance model to reach BoP clients. Under this business model, the solar company retains ownership of the product/system (and the associated risk) and ensures maintenance and repairs, while customers pay a flexible fee through PAYG with no upfront payment required. Nigeria is one of the few markets in West Africa where this model has been launched.

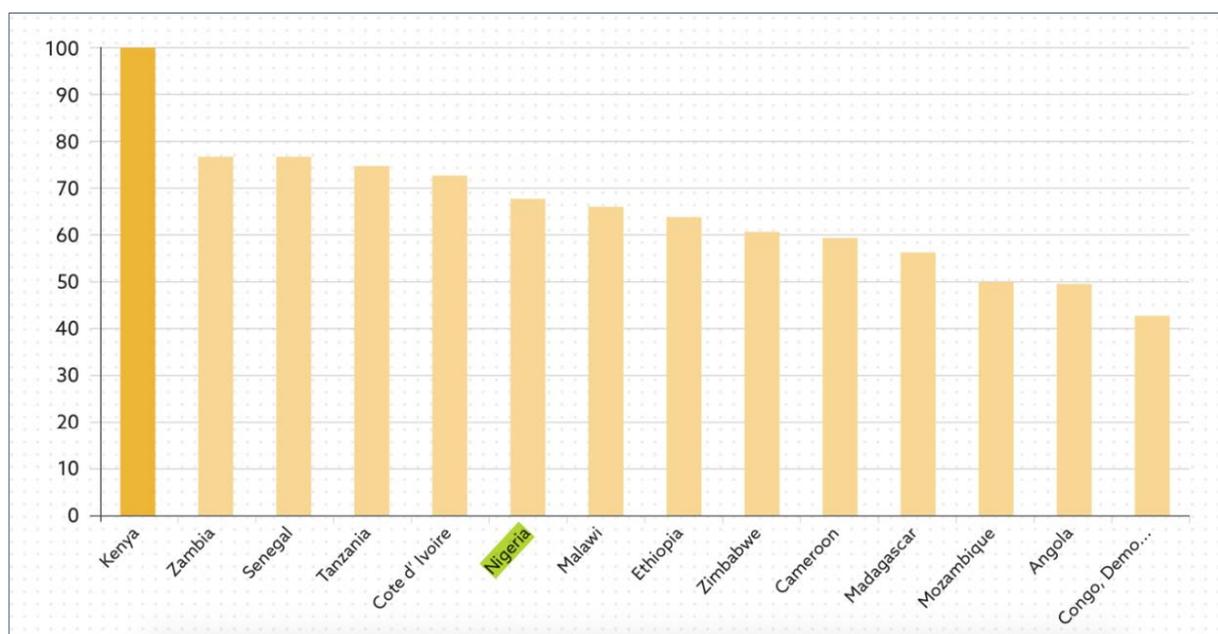
Table 41: Overview of Off-Grid Solar Business Models

Business Model	Strategy and Customer Base	State of Development
Over-the-counter solar market	Formal: Retailers in Nigeria are both large-scale (acting as suppliers and distributors) and medium size and are mainly located in large cities and towns around the country. They already sell lighting/electrical products, including solar, pico systems and also large panels for urban customers.	Mature commercial market
	Informal: Kiosks, street vendors form a key pico-product retailer segment (that has not been fully explored). They sell low-priced products which are often short-lived. They are seen as the entry points for black market low quality solar products to the country.	Early stage commercial development
System integrator	Integrators operate out of central offices with small specialized staff. They do not typically carry stock for sale over-the-counter. Instead, they deal directly with consumers and institutional clients and provide as per orders. Integrators target the NGO/donor market and participate in procurement tenders for supply and installation of larger systems.	Mature commercial market
Plug and Play system supplier	These suppliers distribute equipment to retailers' projects, rural agents, community groups and over-the-counter. Traders of plug and play often sell these devices as part of other businesses.	Early stage commercial development
PAYG Sales	PAYG companies seek to implement the rent-to-own payment-based models used successfully in other countries. The business model is data-driven and relies on mobile money services and a network of agents to meet last-mile customers. Innovative OGS PAYG collaborations between shop-owners, mobile-operators and other larger local businesses are being tested. In Nigeria, the initial deposit represents between 10 to 20% of the total cost of the product) and the remaining amount is paid in installments. If the customer cannot repay anymore, the system is taken away and given to another customer, who will continue to repay the remaining amount (the new customer takes over from the default customer).	Early stage commercial development
Energy-as-a-service	The energy-as-a-service model is relatively new, not only in Nigeria but also in the region and in Sub-Saharan Africa. While this concept offers consumer finance to bottom-of-the-pyramid customers like PAYG, customers pay a monthly fee to access energy service, without up-front costs to purchase the SHS/solar products. The solar provider retains ownership of the systems and is responsible for providing installation, maintenance, solving technical issues, repairs, upgrade of the systems etc.	Early stage commercial development

Source: Focus Group Discussions; Stakeholder interviews; African Solar Designs analysis

A 2018 analysis undertaken by Lighting Global ranked Nigeria highly with regard to the market's attractiveness for the deployment of the PAYG business model, demonstrating that the country possesses sufficient demand (market size, willingness to pay, ability to pay) supply (access to finance, operational infrastructure, low market penetration, human capital) and an enabling environment (e.g. policy / legal framework, commercial environment) to support consumer financing for off-grid solar (**Figure 42**).

Figure 42: PAYG Market Attractiveness Ranking for Select African Countries¹⁹²



Source: Lighting Global

➤ Company Financing

With so many companies utilizing the PAYG model to sell off-grid products and systems on credit (sometimes with lengthy repayment periods), it can become difficult for companies to finance their operations, grow their business and cover transport and inventory costs. In addition to financing customer payment options, suppliers also require significant working capital to purchase equipment, conduct marketing campaigns, and cover field costs. Distributors of international OGS products receive basic trade finance and marketing support options, though typically limited.

While large international companies and established Tier 3 firms operating in the country have access to bank loans, equity and other international funds to finance their growth and development, most local companies in Nigeria are self-financed through cash flow from on-going business transactions and are unable to raise funds to expand their business. Local financiers have yet to develop an appetite for the solar sector. Local banks are extremely conservative with regard to solar enterprises. Commercial financiers – including banks and MFIs – are not set up to service solar distributor financing requirements. Local SME financing is not available to support businesses in their growth phase. If it was available, companies would make use of cash-flow/credit line financing against the signed contracts with major commercial clients, large NGOs or donors.¹⁹³

When importing, companies are exposed to considerable FX risks because they must cover costs of equipment in foreign currency. When projects are delayed, during seasonal low-income periods or when products are delayed in port, dealers must bear FX losses. The lack of consumer financing arrangements

¹⁹² "PAYG Market Attractiveness Index Report," Lighting Global, World Bank Group (2018): <https://www.lightingglobal.org/wp-content/uploads/2018/11/FINAL-PAYG-MAI-2018-Report.pdf>

¹⁹³ Focus group participants underlined the difficulty for companies to obtain financing from commercial banks in Nigeria; they indicated that the most useful type of finance for private companies would be a blend of financing – a combination of debt and equity, along with supportive grant components

impedes the growth of the solar market because distributors must take all finance risks and cannot plan with commercial or MFI financing to grow their business.

➤ **Evolving Business Models**

Nigeria presents a fertile ground for new business model innovations. New models will require partnerships between developers, solar distributors, telco companies, commercial finance and the retail sector. One of the results of the FGD discussions was a list of potential partnerships that can be explored to enhance existing and new business models (**Table 42**).

Table 42: Evolving Off-Grid Solar Business Models

Partnership	Description
Solar Distributors	<ul style="list-style-type: none"> Improve efficiency within the supply/distribution chain, positioning them to be able to manage distribution, seek potential for long-term credit lines and capital infusions Develop better contract terms between large local suppliers in Nigeria with foreign manufacturers Test new sales and distribution strategies that increase sales at minimum cost Prove solar market potential, ultimately attracting a strong group of competing players that scale up solar product access
Commercial financiers	<ul style="list-style-type: none"> Commercial financiers are key to unlocking working capital and consumer finance and enabling the market by providing both the funds and means of transferring these funds Develop financial products for both distributors (financing for working capital needs) and off-grid solar consumers (consumer financing for purchase of systems)
Telecommunications companies and technology providers	<ul style="list-style-type: none"> Bring together telecommunications operators, mobile service providers and technology companies and solar supplier/distributor companies to develop Pay-As-You-Go technology platforms Encourage telecommunications partners to distribute off-grid solar systems through their existing network of agents
Business/Retail Sector	<ul style="list-style-type: none"> Comprises networks of retail stores that cover the entire country and provide all types of domestic and agriculture goods for the rural community Encourage linkages between specialized solar companies and these networks so as to facilitate the increase of the distribution network at a lowest cost possible Provide promotional tools for local retailers to promote solar products to households/SMEs Facilitate microfinancing for the domestic market through these networks
Advocacy Bodies	<ul style="list-style-type: none"> Capitalize on FGN and donor efforts to (i) facilitate interagency dialogue and oversee policy proposals on new business models and (ii) enhance legislative changes to support the sector

Source: Focus Group Discussions; Stakeholder interviews; African Solar Designs analysis

2.4.5 The Role of Non-Standard Players in the Market

Stakeholder interviews and FGDs were unable to estimate the over-the-counter informal market in terms of volumes and cash sales. GOGLA estimates that non-affiliated companies represent 70% of the pico market and 30% of the plug and play and SHS market in Nigeria.¹⁹⁴ FGD participants indicated that despite regulations, the FGN has not been able to prevent influx of sub-standard products into the country. These products come from smuggling, which is a major issue in the country. Illegally imported products in Nigeria are typically re-exported to other countries, which suggests that Nigeria is a hub for the informal market, with products imported from East Asia and exported to other countries in the region.

Informal traders sell modules, inverters, batteries and pico-products. Given that informal sellers are largely unregulated and do not report sales figures, very little data is available on this sector. The sector, however, is very influential as it also dominates the market of lighting products imported mainly from East Asia.

¹⁹⁴ “Off-Grid Solar Market Trends Report 2018,” Dahlberg Advisors, Lighting Global, GOGLA and World Bank ESMAP, (January 2018): https://www.lightingafrica.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf

Informal traders understand growing consumer interest in solar solutions and sell competitively-priced low-quality products. Informal traders do not cooperate with the FGN or work on formal projects.

Informal traders play an important role in the market because they respond to consumer demand rapidly. Many traders do provide IEC-approved components – this means knowledgeable consumers and technicians can assemble quality systems from over-the-counter selections of components that informal traders sell. It is notable that some informal traders are gaining skills and improving product offerings. The presence of a large informal market, however, leads to issues with equipment quality that hamper development of the country’s OGS market.

2.4.6 Equipment Quality and the Impact of Uncertified Equipment

Nigeria’s solar market is largely dominated by informal market players, selling equipment through electronics shops, hardware stores, kiosks and even street vendors. The over-the-counter sales strategies of this group is to provide low-cost, fast moving products. As a sector, informal retailers provide widely-used lighting products mainly from East Asia to rural customers. However, most of their product range does not meet Lighting Global standards. Moreover, given that the most of their lighting products are low-cost and short-lived, they also ignore and avoid regulations and their products lack warranties.

All of the companies surveyed considered the presence of counterfeit, low-quality products in the market as a significant barrier to market growth. These products negatively impact the entire market by creating a misperception about product quality, which in turn undermines consumer confidence in solar equipment. Moreover, grey-market traders significantly undercut the prices of registered businesses who are still subject to taxes and import duties. Low prices of over-the-counter products make compliant products uncompetitive as many customers opt to buy non-compliant goods that are cheaper. However, more established players indicated that their long-standing years of experience have built trusting relationships with customers.

Surveyed companies recommended implementing effective monitoring and control procedures to better check the quality of products entering the country. Despite having GOGLA and Lighting Africa provisions in place to ensure the quality of products in the country, participants indicated that this was not doing enough to control the influx of low-quality products. Companies also highlighted the need for local quality standards, adapted to the country’s specific conditions that industry players would agree upon. Feedback from focus group meetings suggested that there is an important role for the regulator (NERC), the SON, and the REAN to assist in enforcement of standards through mediation efforts between regulatory bodies, market players and consumers.

2.4.7 Local Capacity to Manage Business Development, Installation and Maintenance

Nigeria’s nascent solar market is poised to grow if requisite technical assistance (TA) is provided. The existing market environment is challenging for solar companies. To operate effectively, companies need a significant amount of both local and international technical and financial expertise, and an ability to make practical decisions about their operations. Companies face a number of technical competency requirements – the selection of approaches and solar PV technologies, the design of their associated marketing instruments and the implementation of related initiatives.

The synergy with formal training institutions has yet to be fully explored and most of the players in the industry are not adequately equipped with the skills needed to design and assess policies, understand and

deploy technologies, grasp electricity user needs and ability to pay, and operate and maintain systems. Some of the other areas where TA and capacity building is needed to support growth of the solar market include:¹⁹⁵

- Provision of TA and training to public and private partners on the development of OGS power projects.
- Support in development of vocational training curricula for solar technicians by working with education institutions to adopt the curricula and implement training programs. This support could include development of community training materials to raise community awareness about the importance of solar PV technologies, the various uses ranging from household use, productive uses and institutional uses of energy, and related safety aspects.
- In order to ensure that interaction with local communities is seamless, the collaborating partners could develop a management training manual for villages addressing the different aspects of solar technologies as well. This could include supporting technicians with troubleshooting posters for on-site display that could help identify and tackle operational issues as they arise.
- Solar technicians were noted to be sparse for some areas and lacking in other areas; as a result, solar businesses send out teams from major cities/towns for any installation and maintenance work. Training people based locally in remote areas to support O&M of solar systems (e.g. battery replacement) could help address this issue and expedite market uptake.

2.4.8 Capacity Building Needs of the Supplier Market Segment

An analysis of the supplier market segment revealed a number of interrelated challenges, including financial, capacity, awareness and regulatory challenges. The focus groups and supplier surveys found that:

- Competition with subsidized diesel-powered generators and the duties imposed on solar products was the main policy issue raised during focus group discussions and stakeholder interviews
- While the industry's largest players have access to various sources of financing, local financing is largely not available (or affordable) to support the sector's development; as a result, many companies are self-financed and do not have the working capital they need to grow and expand their operations.
- The reluctance of banks to grant loans to solar companies is another major challenge. For solar companies to successfully utilize the PAYG business model, they need significant working capital.
- Reasons for denied finance by FIs included lack of collateral, lack of expertise in finance, the high cost involved in small transactions, and risk aversion; capacity building of local FIs is critical
- Consumer financing is also needed, mainly for households but also for institutional/social users due to their need for larger and therefore more expensive systems
- Knowledge, technical capacity and expertise is possessed by a few professionals in the industry working for large established solar companies; the majority of vendors lack the expertise or knowledge necessary to adequately service the market
- FGD participants highlighted the gaps between urban and rural customers vis-a-vis customer needs and products demanded, consumer finance and ability to pay. Solutions (much like the fee-for-service business model) need to be delivered to meet these needs and target the wider BoP market
- Increasing awareness through more advocacy and government initiatives. Supply chain stakeholders indicated that overall national awareness on the benefits of solar remains low (at only about 20% of the population), albeit slightly higher for the pico lighting segment (at about 40% due to Lighting Africa's campaign). Marketing and communications campaigns could have a huge impact in Nigeria.

Table 43 presents various areas of support and associated capacity building for the OGS supply chain in Nigeria. Attention should be given to the following:

¹⁹⁵ These TA initiatives could be managed by REA and administered through the Renewable Energy Association of Nigeria (REAN) or the National Power Training Institute of Nigeria (NAPTIN)

- **Importers:** Reducing the cost of financing for importing solar PV products by further reducing VAT and other taxes for the solar product supply chain.
- **Over-the-counter/System Integrators/ PAYG:** Focus on growing the number of solar technicians who are adequately skilled to support the supplier network. Unskilled technicians have connections with solar distributors and retailers who subcontract them (these often involves unlicensed technicians.) Formalizing this through regulation to require only licensed technicians to design and install solar PV systems is critical. This should be complemented by robust TA to build the capacity of all stakeholders.
- **Consumers:** Deal with sociotechnical barriers: Although PV technology has advanced tremendously in the last decades, there are still several sociotechnical barriers to adoption, including the local conditions of the user’s environment, the political and financial arrangements of the market. Like most countries in the region, various counterfeit solar PV products have infiltrated the market. Implementation of the existing regulations on quality/standards could further boost market growth.

Table 43: Capacity Building and Technical Assistance for the OGS Supply Chain in Nigeria¹⁹⁶

Area of Support	Description	Rationale
Awareness raising / consumer education	<ul style="list-style-type: none"> • Supplier and consumer education and benefit awareness campaigns, targeting both segments, distributors and retailers 	<ul style="list-style-type: none"> • Overcome negative perceptions and strengthen trust established over the years • Influence purchase decisions, and ease access to distribution channels
Inventory financing facility	<ul style="list-style-type: none"> • Concessionary credit line so financial institutions can access liquidity for solar market lending; create frameworks that avail loans to solar companies (small household systems, larger PV installations, and mini-grids), pilot with aim of scaling out 	<ul style="list-style-type: none"> • Long inventory financing periods present a key challenge to growth for solar lantern and solar home system distributors • High upfront financing requirements present a key challenge to distributors of larger PV systems (including pumps)
Credit guarantee scheme for inventory financing	<ul style="list-style-type: none"> • Private sector lending portfolio de-risked through guarantees and effect loss sharing agreements to cover irrecoverable inventory loans 	<ul style="list-style-type: none"> • De-risking encourages private sector lending to OGS • Initial security until proof case of economic viability of lending to solar businesses has been established
Market entry and expansion grants	<ul style="list-style-type: none"> • Combination of upfront grants and results-based financing to invest in infrastructure and working capital 	<ul style="list-style-type: none"> • Significant upfront investment to build distribution network and source inventories to serve household market
Supply chain finance	<ul style="list-style-type: none"> • Access to finance across the value chain • Encourage engagement from local banks to provide access to finance 	<ul style="list-style-type: none"> • Support to the entire industry • Scale up new business models (PAYG, Energy-as-a-service)
Technical assistance	<ul style="list-style-type: none"> • Help solar companies set up PAYG technology platforms • Incubation and acceleration of early-stage businesses • Capacity building for solar technicians to enable nationwide installation and maintenance of solar equipment • Capacity building for marketing and sales • Support overall managerial competences 	<ul style="list-style-type: none"> • Make the business environment more conducive and profitable • Strengthen the overall ecosystem surrounding the solar market • Ensure knowledge transfer from abroad for faster, more cost-efficient progress

¹⁹⁶ Capacity building interventions are proposed for all ROGEP countries at national and regional level under ROGEP Component 1B: Entrepreneurship support, which includes technical assistance and financing for companies in the solar product value chain. Through this component, technical assistance to solar companies can build on existing ECREEE training programs as well as through a new regional business plan competition. Technical assistance can leverage national solar ecosystem stakeholders, and operational national service providers identified and mobilized through this component. The market entry and expansion grants suggested here would also align with Component 1B planned financing interventions for matching grants, repayable grants, co-investment grants, and be connected to the technical assistance interventions.

Source: Focus Group Discussions; Stakeholder interviews; African Solar Designs analysis

2.5 Key Market Characteristics

This section reviews the main characteristics of the off-grid solar market in Nigeria, including a summary of key barriers to and drivers of market growth and an overview of gender considerations. The synopsis presented below is largely based on feedback obtained from interviews with local officials and industry stakeholders, as well as focus group discussions and surveys assessing the demand and supply side of the market (see **Annex 2**).

2.5.1 Barriers to Off-Grid Solar Market Growth

Table 44 examines the key barriers to OGS market growth from the perspective of both the demand and supply side of the market. See **Section 1.3.5** for an overview of the gaps in the country’s off-grid policy and regulatory framework.

Table 44: Key Barriers to Off-Grid Solar Market Growth in Nigeria

Market Barrier	Description
Demand¹⁹⁷	
Lack of supportive financial incentives for solar / Fossil fuel subsidy	<ul style="list-style-type: none"> Costs of solar products are inflated by high import duties; costs are passed on to customers, making solar less affordable Fossil fuel subsidies serve as an impediment to development of safe, clean energy access alternatives as diesel generators compete directly with solar technology alternatives Although the FGN removed fossil fuel subsidies from the power sector in 2016, diesel gasoline/petrol continues to be subsidized to support individuals, households and business that require assistance to meet their fuel needs – this subsidy was identified by focus group participants and suppliers as the most important barrier to solar market growth
Consumers are unable to afford solar systems	<ul style="list-style-type: none"> Low-income consumers, particularly in rural areas, lack of access to finance Purchasing solar products of all varieties among end-consumers remains relatively low
Lack of initial funding by HHs, businesses and institutions for the initial capital investment	<ul style="list-style-type: none"> Relatively high costs of OGS systems Consumers rather choose cheaper one-off solutions – like generators and fuel – rather than more expensive up-front solutions that will be cheaper long-term (with incremental payments, e.g. PAYG)
A lack of understanding of and trust in solar solutions among consumers impedes development of the market	<ul style="list-style-type: none"> There is still considerable lack of general awareness about solar solutions There is an inability to distinguish between solar products or product quality Consumers lack information about the most suitable design options, funding options, PAYG benefits and options, points of sales and support, etc. Products are still not widely available in rural areas, so consumers are unfamiliar with them Any poor history / track record with OGS will deter consumers from taking expensive risks
Informal sector competition and market spoilage	<ul style="list-style-type: none"> The non-standard / unlicensed market still accounts for a majority of OGS product sales Consumers need to understand product quality and value issues of quality solar products vis-a-vis inferior over-the-counter lighting products and generators. Educated consumers drive markets.
Lack of experience in maintaining the systems and sourcing qualified technicians	<ul style="list-style-type: none"> A sustainable approach to O&M is critical for long-term success
Supply	
Technical capacity	<ul style="list-style-type: none"> Technical skills lack through the supply chain within the sector, affecting both the upstream, midstream and downstream, thus adversely affecting the ability of the sector to pick up and grow. Majority of the firms decry lack of adequate number of technicians to support the downstream side of the market

¹⁹⁷ The barriers described here apply to some combination of the Household, Institutional, and SME / Productive Use market segments

Transportation costs	<ul style="list-style-type: none"> High transportation costs of inventory deter new entrants; devices and equipment are shipped either from China or from Europe, creating long delivery lead times of up to three months and long inventory holding times once products have arrived in country Typical supplier payment terms are 30% upon placement of the production order and the remaining 70% upon shipment before any cargo has even left its port of origin. Transport by container would reduce the costs dramatically; however, this requires purchases in bulk, which local solar distributors aren't able to make without financing
Poor sales and performance history of the sector	<ul style="list-style-type: none"> A lack of investment into the sector prevents growth; this is due to perceived high risks resulting primarily from lack of track record of sales Solar distributors have limited alternative financing options. Solar suppliers are unwilling to provide trade financing while commercial financiers in Nigeria, including banks and MFIs, are currently not positioned to service the financing requirements of solar distributors
Company finance	<ul style="list-style-type: none"> Entrants into the sector require significant working capital, which is not readily available Equity investments are needed into the local distribution/sales companies. It is quite easy to obtain debt financing and other loans once the solar companies have sufficiently grown and reached the "level of interest" of the larger funds; however, until the number of customers and sales volumes are reached, they need some equity investors to share higher risks with the original founders of the companies
Informal sector competition and market spoilage	<ul style="list-style-type: none"> Several informal entrepreneurs have taken advantage of high import duties by illegally importing low-quality solar products ranging from solar lanterns to larger home installations Black-market traders are able to significantly undercut the prices of registered businesses who are still subject to high taxes and import duties These products are largely low-grade, failure-prone knock-offs with short product lifespans (sometimes of little more than a few weeks) Damaged perceptions of solar systems durability and reliability hinders market uptake
Lack of data	<ul style="list-style-type: none"> No clear figures on the actual needs, actual usage or experience of consumers The data for the private market players on the available opportunities is very limited and not concise due to fragmented data
High 'transaction costs' for solar installations	<ul style="list-style-type: none"> Cash-flow and bureaucratic hurdles for the local suppliers Sales and O&M services in remote areas can be costly, especially for small businesses

Source: Focus Group Discussions; Stakeholder interviews; African Solar Designs analysis

2.5.2 Drivers of Off-Grid Solar Market Growth

Table 45 is a summary of the key drivers of OGS market growth in the country.

Table 45: Key Drivers of Off-Grid Solar Market Growth in Nigeria

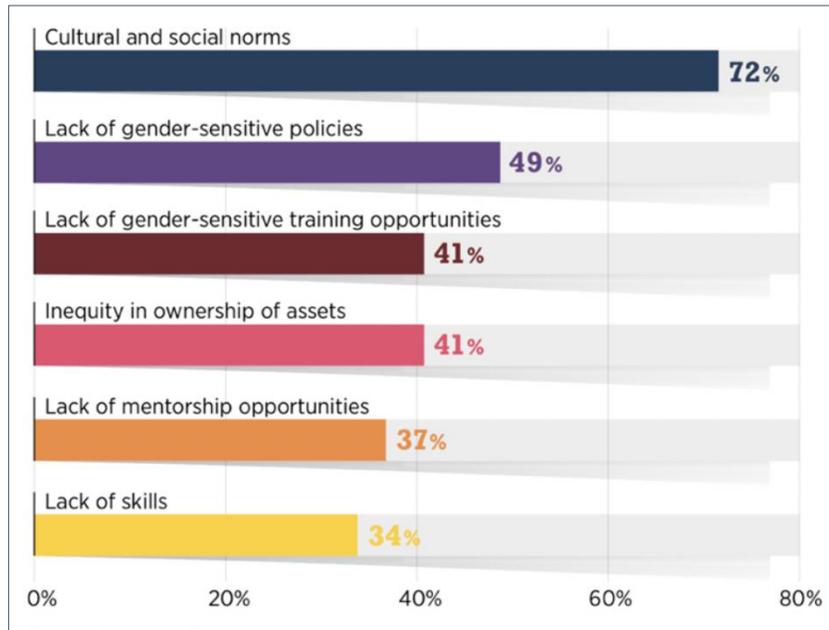
Market Driver	Description
Strong off-grid electricity demand	<ul style="list-style-type: none"> Nigeria is the most populous country in Africa and population growth, economic development and demand for electricity will only continue to increase Consumers from every market segment are aware of the high costs associated with energy access and consumption and are willing to take on quality, cost-effective alternatives
Willing government to support the industry	<ul style="list-style-type: none"> The Government is viewed by sector players as forward-leaning and action-oriented, creating and supporting momentum and positive attention for the solar sector, which helps attract substantial and sustained investment to the market
Increased utilization of PAYG and innovative business models	<ul style="list-style-type: none"> Nigeria's off-grid market is rapidly growing from the increased utilization of PAYG and energy-as-a-service financing solutions which have successfully leveraged increasing rates of mobile phone ownership and mobile internet usage in rural areas
Engaged and open-minded private sector	<ul style="list-style-type: none"> Local OGS suppliers are actively engaged in efforts to improve / reform the sector, accept new business models and strategies and take measures to attract external investment
Strong donor/NGO presence	<ul style="list-style-type: none"> The presence and wide range of donor-funded activities in the country's off-grid sector provides confidence that the market will continue to grow

Source: Focus Group Discussions; Stakeholder interviews; African Solar Designs analysis

2.5.3 Inclusive Participation¹⁹⁸

Given that the off-grid market is only beginning to emerge in Nigeria, women are not yet highly engaged in the sector. The overall lack of inclusive participation in the off-grid space is attributable to a wide range of factors. In a 2018 survey that assessed barriers to women’s participation in expanding energy access, nearly three-quarters of respondents cited cultural and social norms as the most common barrier, which reflects the need for gender mainstreaming (**Figure 43**). More than half of the women surveyed in Africa identified a lack of skills and training as the most critical barrier, compared to just one-third of respondents globally.¹⁹⁹

Figure 43: Key Barriers to Women’s Participation in Expanding Energy Access



Source: International Renewable Energy Agency

As a starting point, electrification (whether grid-connected or off-grid) increases access to information, which can help challenge gender norms and increase the autonomy of women.²⁰⁰ Access to electricity can save women time and/or enable them to complete domestic activities in the evening, thus allowing them to participate in paid work during the day. Many opportunities also exist for women in the productive use of energy, including solar-powered machinery that can support productive applications, particularly in the agricultural sector in the areas of irrigation, water pumping, and milling/food processing.²⁰¹

Women, who are often the primary energy users in households, have a strong influence on the energy value chain. Women can take on different roles, including as engaged end-users, community mobilizers,

¹⁹⁸ See **Annex 4** for more details

¹⁹⁹ “Renewable Energy: A Gender Perspective,” International Renewable Energy Agency, (2019): https://irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_Gender_perspective_2019.pdf

²⁰⁰ “Productive Use of Energy in African Micro-Grids: Technical and Business Considerations,” USAID-NREL and Energy 4 Impact, (August 2018): https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/productive_use_of_energy_in_african_micro-grids.pdf

²⁰¹ “Turning promises into action: Gender equality in the 2030 Agenda for Sustainable Development,” UN Women, (2018): <http://www.unwomen.org/-/media/headquarters/attachments/sections/library/publications/2018/sdg-report-fact-sheet-sub-saharan-africa-en.pdf?la=en&vs=3558>

technicians, and part time and full-time employees and entrepreneurs.²⁰² Women also have unique social networks that typically offer greater access to rural households, which can be important to deploying energy access solutions.

Despite these opportunities, women are typically not part of key decision-making processes at nearly all levels of society. Women tend to have limited access to land and capital, as these are often determined by traditional and religious customs that remain deeply rooted in patriarchal traditions. Women also have more difficulty accessing finance due in part to lack of collateral required to guarantee payment and often resort to obtaining loans from money lenders who charge exorbitant interest rates.²⁰³

The gender analysis undertaken in Nigeria corroborated many of these trends, and revealed several interrelated challenges that women face in the off-grid sector:

- Women lack access to skills, technical capacity, and education/training
- Women broadly lack access to capital, asset ownership, collateral and credit (e.g. to start a business)²⁰⁴
- Extensive household responsibilities reduce their ability to generate income and service credit
- Financial literacy among women remains low and there is a lack of education and information available to women on access to financial resources

A number of initiatives exist that seek to address some of these challenges and help improve the rate of participation among women in Nigeria's off-grid sector. Companies like Solar Sister²⁰⁵ and NGOs such as the Women Environmental Programme²⁰⁶ are working to promote gender equality. For example, Solar Sister has created a deliberately woman-centered direct sales network to bring the breakthrough potential of clean energy technology to even the most remote communities in rural Africa. The Rural Women Energy Security (RUWES) Initiative launched in 2013 to target under-served rural women typically in off-grid, energy poor areas of the country, with the aim of providing small-scale RE and clean cooking technologies to improve the lives of women and their families.

With funding and training from the ECREEE / IRENA program, Promoting a Sustainable Solar PV Market in ECOWAS (ProSPER), Sosai Renewable Energies launched in northern Nigeria in 2018. Sosai provides solar electricity to around 800 women in the region and also supports PUE through solar-powered dyers for agricultural processing.²⁰⁷

As part of efforts to bridge the gap between research, development and marketing in the renewable energy sector in Nigeria, Women in Renewable Energy is a new platform that has called on the FGN, development and funding partners to allocate funding for female researchers and entrepreneurs in the energy industry. The Women in Renewable Energy Conference is part of the Nigeria Alternative Energy Expo in Abuja that focuses on supporting increasing participation of women in the country's renewable energy sector.²⁰⁸ Other programs include the USAID-sponsored wPower Initiative, which seeks to support thousands of female energy entrepreneurs in Nigeria and the wider region. Winrock's Renewable Energy and Energy Efficiency Program (REEEP) includes training for women in public institutions. The program also sponsors

²⁰² "Renewable Energy: A Gender Perspective," International Renewable Energy Agency, (2019): https://irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_Gender_perspective_2019.pdf

²⁰³ See **Section 3.2** for more details.

²⁰⁴ This is a huge challenge for women in the country, particularly in rural areas, where the population depends on seasonal income from the agricultural sector for their livelihood, which makes loans inaccessible or only available at extremely high interest rates. This issue is examined in further detail in **Section 3.2**.

²⁰⁵ <https://solarsister.org>

²⁰⁶ "Women Environmental Program Overview," WEP Nigeria, (2018): <http://wepnigeria.net/index.php/home/>

²⁰⁷ "Empowering Women in Nigeria with Solar Energy," International Renewable Energy Agency, (8 March 2018): <https://irena.org/newsroom/articles/2018/Feb/Empowering-Women-in-Nigeria-with-Solar-Energy>

²⁰⁸ <https://www.nigeriaalternativeenergyexpo.org/women-in-renewable-energy-conference/>

GIZ Solar PV Installers and Supervisors training for women. The Africa Renewable Energy Access Gender Program, managed by the World Bank's Africa Energy Unit and funded by the World Bank ESMAP program, is active in West Africa with plans to expand its operations into Nigeria.²⁰⁹

In 2018, ECREEE partnered with AfDB to launch a regional workshop to advance the participation of women in the renewable energy sector. The program intends to address the lack of inclusion of women in the energy value chain – only 2% of energy sector entrepreneurs in West Africa today are women. The joint initiative ultimately seeks to develop a pipeline of investment-ready, women-owned energy businesses across the region, including in Nigeria.²¹⁰

²⁰⁹ "Mapping of Energy Initiatives and Programs in Africa," Africa-EU Energy Partnership, (May 2016): http://www.euei-pdf.org/sites/default/files/field_publication_file/annex_5_aeep_mapping_of_energy_initiatives_overview_of_initiatives_0.pdf

²¹⁰ "Feasibility study promotes women's participation in energy transition," ESI Africa, (2018): <https://www.esi-africa.com/feasibility-study-promotes-womens-participation-in-energy-transition/>

III. ANALYSIS OF THE ROLE OF FINANCIAL INSTITUTIONS

This section begins with an introduction to financial products for the off-grid sector, including for end-users and stand-alone solar companies (**Section 3.1**). This is followed by a comprehensive overview of the country’s financial market and commercial lending environment (**Section 3.2**), including an assessment of financial inclusion and a summary any off-grid solar lending activity/programs. **Section 3.3** examines other financial institutions (in addition to commercial banks) that are active in the country. **Section 3.4** presents a summary of key findings from the Task 3 analysis. The data presented in this section was obtained through desk research as well as interviews with/surveys of key officials and representatives from local financial institutions. **Annex 3** provides an overview of the Task 3 methodology.

3.1 Introduction to Financial Products for the Off-Grid Sector

A wide range of financial products can be utilized to support development of the stand-alone solar sector in West Africa and the Sahel. These may include instruments such as matching grants, contingent loans, results-based financing (grants reimbursing cost after completion of work), equity investment (seed capital and later stages), concessional debt (subsidized interest or forgiveness of a portion of principal repayment), short-term commercial credits for inventory purchases and working capital, trade finance solutions (from export credit agencies or private trade funders) and medium-term loans secured on assets or receivables from a portfolio of installed projects. This “financial supply chain” consists of capital delivered at different stages of standalone solar enterprise development, by financial sector players that have risk appetites well matched to each specific stage. This section focuses on the roles of commercial financial institutions (FIs) and MFIs in providing debt financing to stand-alone solar consumers and enterprises.

3.1.1 Financial Products for End-Users

In order to determine what kinds of debt instruments are available to support stand-alone solar purchases for end-users, it is important to identify the different end-users.

➤ Households

Households represent the majority of end-users in the West Africa and Sahel region and the level of cash flow this market segment has available for energy access depends heavily upon the formal and/or informal economic activity they are engaged in. In general, the ability for households to pay from their own internal resources declines as their distance from urban centers increases and their opportunity to participate in the formal economy with regular cash income declines. Meanwhile, external funding is typically not available for rural households as they remain largely off of the radar of mainstream FIs (with the exception of households where members have regular sources of income from urban centers). MFIs in fact are generally more appropriate sources of household finance. Most of a given country’s households can access external funding typically only through microfinance or informal financial services such as local money lenders, cooperative societies and rotating savings and credit associations.

➤ Public Institutions

The main public institutional facilities that require funding for off-grid electrification are directly linked to national, provincial or local administrations and budgets, including schools, health facilities, and other public buildings/lighting systems. Sustainable energy finance for community facilities is typically provided through a ministry, department or agency if the facility falls under the purview of the national or provincial budget. The challenge is that budget resources are severely limited and constantly face competing priorities; as a result, many public community facilities are left without access to energy.

In order to implement financial products targeting public institutional projects, a few critical questions need to be answered, such as who would be the borrower and whether there are sufficient financial resources available in the budget to pay for the service over a long period of time. This question is also important if these public community facilities end up being included alongside households as part of a local mini-grid.

➤ **Productive Use**

Financial instruments for SMEs as end-users of sustainable energy represent a very important category of products in that they tend to be commercially viable and are thus important for the long-term sustainability of energy systems. While households and community facilities use energy primarily for consumption, often resulting in other sources of income or budget being allocated to cover the cost of service, SMEs use energy for income-generating activities and can therefore cover electricity costs through the income generated by their business. An enterprise with positive cash flows gives financiers more comfort as well as an opportunity to design financial instruments that are commercial in nature. A loan product with parameters that match the company's ability to service the debt would be a strong and commercially viable option. MFIs often provide short-term loans to microenterprises on this basis while FIs often limit their lending to SMEs with strong balance sheets and available collateral.

➤ **Commercial and Industrial**

C&I facilities such as industrial plants, mining operations, shopping malls, logistics and distribution centers or commercial office buildings generally have considerable power consumption requiring energy supply from much larger solar systems that can range from several hundred kW to several MW in capacity. Where there is particularly high cost advantage for stand-alone solar systems over existing energy supply (i.e. vs. diesel generators), some C&I facility owners may find the payback of these investments so attractive that they will seek to purchase the solar power plant outright, often requiring debt financing to complete the transaction. This entails a corporate loan backed by the full faith and credit of the company, a pledge on the installed assets and usually supplemented by additional collateral and personal guarantees posted by the C&I facility owners. Many commercial FIs will offer credits to their existing C&I customers for this purpose but the C&I facility loan applicants are often unable or unwilling to post the required collateral for this specific purpose as their assets may already be encumbered for other business needs.

3.1.2 Financial Products for Suppliers/Service Providers

The stand-alone solar sector remains nascent in most markets across West Africa and the Sahel. The companies offering standalone solar products and energy services are therefore often at start-up or early development stage. Overall by number of players, small indigenous entrepreneurs are well in the majority; however, a few international companies dominate the overall market share. Most equipment is imported with purchases denominated in hard currency, while sales to consumers – whether on a direct purchase, Lease-to-Own (LTO) or Pay-As-You-Go (PAYG) basis – are almost always in local currency. At start-up or early stages of operation, local entrepreneurs, although in need of funding, are usually not ready to take on debt financing and should rely more on seed capital investment and grants until they are able to generate an initial book of business. Once orders begin to materialize, these enterprises have growing funding needs suitable for debt financing instruments which may include the following:

➤ **Working Capital**

All entrepreneurs need working capital to fuel their business growth and cover basic overheads for operations, marketing and sales. Throughout West Africa and the Sahel, there is a dearth of working capital financing for businesses in all sectors, and the situation is no different for stand-alone solar companies. When available, working capital loans have very short tenors of 3-12 months, must be secured on confirmable cash flows, have difficult-to-meet collateral requirements and carry high interest rates. Since their costs and income are in local currency, local entrepreneurs are best served by working capital loans also denominated in local currency. However, due to high cost of local currency debt, many companies will see advantages in borrowing at much lower interest rates in hard currency as the perceived risk of currency fluctuations across such short tenors is relatively low. Some international companies operating in the West African off-grid solar sector may prefer hard currency financing at the offshore holding company level, depending on how they have structured their local subsidiaries or affiliates in the region.

➤ **Inventory and Trade Finance**

To fulfill orders, solar system providers need inventory on hand. Equipment suppliers to the off-grid sector in West Africa and the Sahel are usually unwilling or unable to offer generous terms, often requiring down payments with balance due in full at cash-on-delivery (COD). Therefore, these businesses are in dire need of short-term loans of 6-12 months duration to finance inventory purchases. Yet, such loans are hard to come by for developing off-grid enterprises. Since equipment purchase arrangements are usually denominated in hard currency, loans also in hard currency over such short tenors are often acceptable. Trade finance from export credit agencies (ECAs) and private trade funders may also provide good solutions, but these lenders are often unwilling to finance orders under a few million USD or EUR in value.

➤ **Asset-Based or Receivables Financing**

Once stand-alone solar system providers achieve a portfolio of operating PAYG or LTO installations, the system assets and revenues from customer payments can be used to leverage debt financing to fund business activities and expansion. Typically, a Special Purpose Vehicle (SPV) is established to house the asset portfolio, which is sold by the solar provider to lenders. This form of financing has been widely deployed in East Africa and is also increasingly available in West Africa through a variety of regionally focused specialized debt funds that are focused on portfolio financings in the range of USD 1-10 million.²¹¹

➤ **Crowd Funding**

Crowd funding platforms have played an important role in offering working capital, inventory financing and smaller increment asset or receivables-backed loans to off-grid entrepreneurs. Loans of two-five years have been provided to both locally-owned and international solar enterprises with a good number of financings in the USD 150-500K range occurring in Nigeria, Ghana and Côte D'Ivoire.²¹²

²¹¹ A total of 11 such specialized debt funds were identified, including those managed by: Sunfunder, responsAbility, Lendable, Sima Funds, Solar Frontier, Neot, Deutsche Bank, Triple Jump, Crossboundary, Lion's Head, Shell and Solar Connect. Only a handful of these have vehicles that are fully funded and deploying capital but as of mid-2018 they reported expectations for financial closings that would make roughly USD 1.5 billion in off-grid focused debt available across Sub Saharan Africa by mid-2019.

²¹² The most active crowd funding platforms in the off-grid space have been Kiva, TRINE, Lendahand and Bettervest with the latter two most focused on West Africa.

3.2 Financial Market Overview

3.2.1 Market Structure

The Nigerian financial system is one of the largest in sub-Saharan Africa, consisting of a fairly diverse array of banking and non-bank financial institutions which are regulated and supervised by the Central Bank of Nigeria (CBN). The structure of the Nigerian financial system has been through remarkable changes, ranging from the ownership structure of the financial institutions, the length and breadth of financial instruments used to the number of institutions established, regulatory and supervisory frameworks as well as the overall macroeconomic environment within which they operate. As of July 2018, the formal Nigerian financial sector consists of nine categories of financial institutions as illustrated in **Table 46** below.

Table 46: Licensed Financial Institutions, 2018²¹³

License Type	Number of FIs
Bureau-de-Change/ Forex Bureaus	2,991
Commercial Banks	21
Development Finance Institutions	6
Discount Houses	5
Finance Companies	64
Merchant Banks	5
Micro-finance Banks	1,023
Non-Interest Banks/Islamic Banks	1
Primary Mortgage Banks	35

Source: Central Bank of Nigeria

Of all the FIs in Nigeria, commercial banks remain the largest and most relevant in terms of total assets, loans and advances, and deposits. According to the CBN, as of June 2017 the total assets and deposit liabilities of the commercial banks stood at NGN 30.78 trillion (USD 100.6 billion) and NGN 18.03 trillion (USD 58.9 billion), respectively. **Table 47** below shows the market share of the largest banks in the country, highlighting the concentrated market structure of the banking sector, with just a few banks controlling more than half of deposits and assets.

Table 47: Market Shares of the Largest Banks²¹⁴

Banks in Nigeria	Total Assets (%)	Deposit Liabilities (%)
6 Largest Banks	60.1%	57.1%
Largest Bank	14.8%	12.9%
2 nd Largest Bank	11.7%	12.9%
Other Banks	0.02% to 9%	0.08% to 9.9%

Source: Central Bank of Nigeria

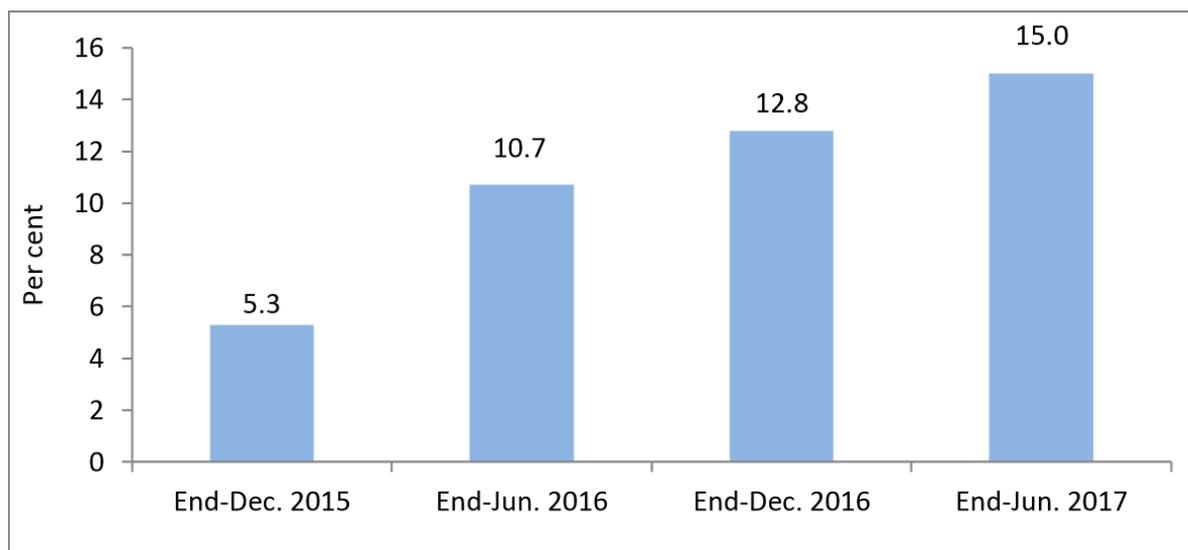
²¹³ Central Bank of Nigeria: <https://www.cbn.gov.ng/supervision/fiinstitutions.asp>

²¹⁴ "Financial Stability Report," Central Bank of Nigeria, (June 2017): <https://www.cbn.gov.ng/Out/2018/FPRD/FSR%20June%202017.pdf>

➤ **Banking Sector Financial Soundness Indicators**

Asset-Based Indicators: The commercial banks are plagued by declining asset quality, with the ratio of non-performing loans (NPLs) to gross loans increasing by 2.2 and 4.3 percentage points to 15% in June 2017 compared with the levels in December 2016 and June 2016, respectively (**Figure 44**). The increase was mainly a result of continued low oil prices and government revenue, as oil and gas loans account for the highest share of total credit to the private sector at about 30%. It is expected that NPL growth will moderate as aggressive debt recovery strategies are employed by banks. Also, to maintain financial system stability, the CBN is developing a framework for the establishment of private asset restructuring companies to acquire non-performing loans from banks and other financial institutions.

Figure 44: Banking Sector Non-Performing Loans to Total Loans (%)



Source: Central Bank of Nigeria

The liquidity ratio for the banking sector increased from 42.6% at end-June 2016 to 45.8% at the end-June 2017. The liquidity position was as a result of the preferred holdings in government securities by banks as against lending to the private sector. However, some banks continued to face intermittent liquidity challenges.²¹⁵ With the exception of three commercial banks, all other banks met the minimum regulatory liquidity ratios of: 30% for commercial banks; 20% for merchant banks; and 10% for non-interest banks at end-June 2017.²¹⁶

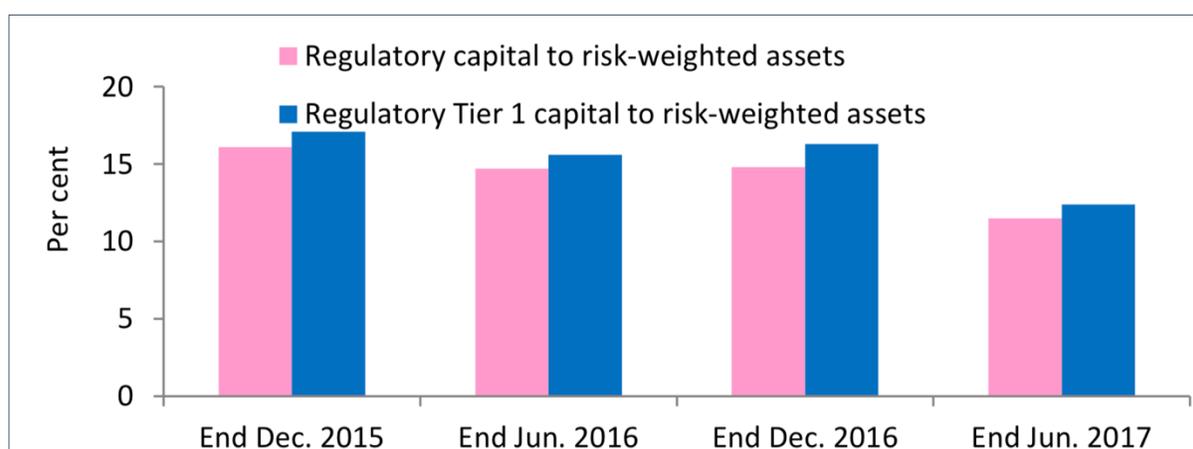
Capital-Based Indicators: As of June 2017, the banking sector average capital adequacy ratio (CAR) was 11.5%, compared with 14.8% and 14.7% in December 2016 and June 2016, respectively (**Figure 45**). The decline in the ratio was due mainly to the reduction in banks’ total qualifying capital arising from the absorption of impairment on non-performing loans and the increase in risk weighted assets following the depreciation of the naira. The industry threshold, however, remained at 15% for banks with international authorization and 10% for banks with either national or regional authorization.²¹⁷

²¹⁵ CBN Financial Stability Report, 2017.

²¹⁶ “CBN Economic Report for the First Half of 2017,” Central Bank of Nigeria, (2017): <https://www.cbn.gov.ng/Out/2018/RSD/half%20year%202017%20innerx.pdf>

²¹⁷ Ibid.

Figure 45: Banking Sector Capital Adequacy Indicators²¹⁸



Source: Central Bank of Nigeria

Table 48 shows key capital-based indicators for the commercial banking sector from 2015-2017.

Table 48: Banking Sector Capital-Based Indicators²¹⁹

Indicator	June 2015	Dec 2015	June 2016	Dec 2016	June 2017
Regulatory capital to risk-weighted assets	17.6%	16.1%	14.7%	14.8%	11.5%
Regulatory Tier 1 capital to risk-weighted assets	17.4%	17.1%	15.6%	16.3%	12.4%
Non-performing loans net of provisions to capital	7.4%	5.9%	23.6%	29%	31.8%

Source: Central Bank of Nigeria

Income and Performance Indicators: Key income and performance indicators for the commercial banking sector from 2015-2017 are presented in **Table 49**.

Table 49: Banking Sector Income and Expense Indicators²²⁰

Indicator	June-2015	Dec-2015	June-2016	Dec-2016	June-2017
Return on assets	2.8%	2.5%	2.3%	1.3%	2.6%
Non-interest expenses to gross income	64.7%	63.1%	54.6%	62.8%	52%
Interest income to gross income	65.0%	62.2%	61.4%	67.6%	57.8%
Staff costs to non-interest expenses	40.1%	35.0%	41.2%	36.1%	34.5%

Source: Central Bank of Nigeria

Table 50 is a summary of financial indicators for the commercial banking sector from December 2015 through June 2017.

²¹⁸ CBN Financial Stability Report, 2017.

²¹⁹ Ibid.

²²⁰ Ibid.

Table 50: Banking Sector Financial Indicators (USD billion)

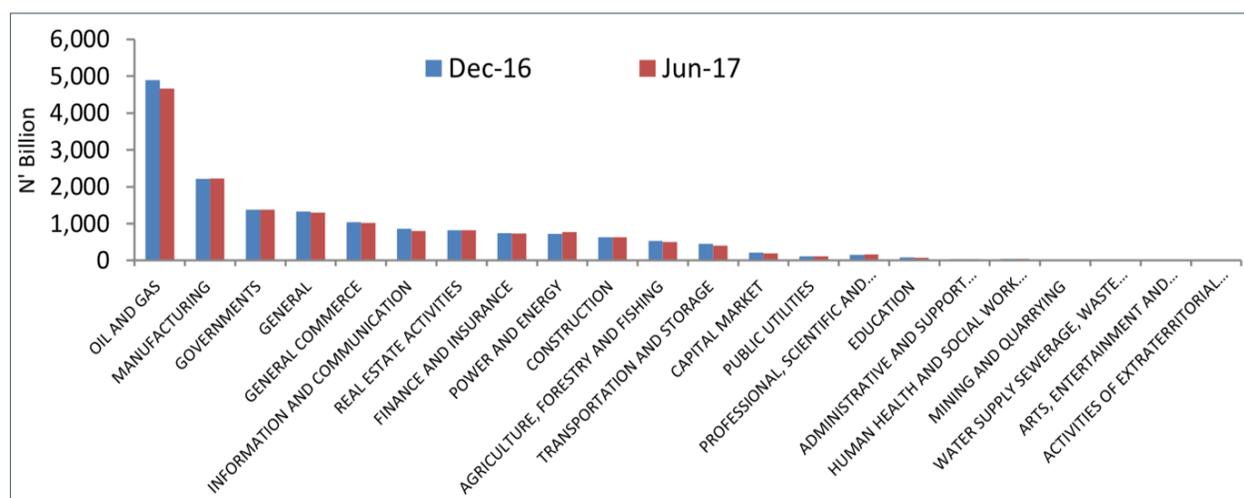
Indicator	Dec-2015 ²²¹	June-2016 ²²²	Dec-2016 ²²³	June-2017 ²²⁴
Total Assets	86.3	98.2	98.8	100.6
Deposit Liabilities	54.7	60.8	60.7	58.9
Loans and Advances	43.6	51.2	53.2	52

Source: Central Bank of Nigeria

➤ **Distribution of Credit by Sector**

As of June 2017, the CBN’s total credit to the private sector fell by 1.47% to NGN 15,907.47 billion (USD 52 billion) from NGN 16,293.48 billion (USD 53.2 billion) at end December 2016. The contribution of manufacturing, construction, and power and energy sub-sectors to total credit increased to 13.97%, 3.98% and 4.83% from 13.59%, 3.89% and 4.46% in the preceding half-year, respectively. The agriculture, forestry and fishery sub-sectors declined to 3.18% from 3.25% over the same period (**Figure 46**).

Figure 46: Distribution of Credit by Sector²²⁵



Source: Central Bank of Nigeria

At NGN 736.19 billion (USD 2.4 billion), consumer credit increased by 1.8% at end-June 2017, compared with the growth of 11.04% at end-June 2016. At that level, consumer loans constituted 3.5% of total credit to the core private sector in the first half of 2017, compared with 3.8% at the end of the corresponding half of 2016 (**Figure 47**). Thus, consumer credit constituted low risk to commercial banks’ exposure to the core private sector.²²⁶

²²¹ “Financial Stability Report,” Central Bank of Nigeria, (December 2015):

<https://www.cbn.gov.ng/Out/2016/FPRD/FSR%20December%202015.pdf>

²²² “Financial Stability Report,” Central Bank of Nigeria, (June 2016): <https://www.cbn.gov.ng/Out/2016/FPRD/FSR%20June%202016.pdf>

²²³ “Financial Stability Report, Central Bank of Nigeria, (December 2016):

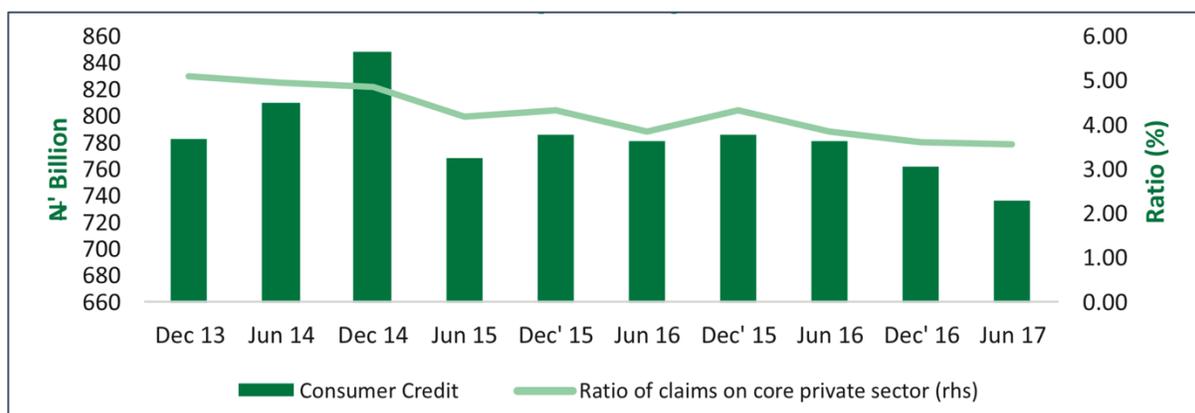
[https://www.cbn.gov.ng/Out/2017/FPRD/FSR%20December%202016%20\(2\).pdf](https://www.cbn.gov.ng/Out/2017/FPRD/FSR%20December%202016%20(2).pdf)

²²⁴ CBN Financial Stability Report, 2017.

²²⁵ Ibid.

²²⁶ CBN Economic Report for the First Half of 2017.

Figure 47: Consumer Credit and Ratio of Claims on Core Private Sector



Source: Central Bank of Nigeria

3.2.2 Financial Inclusion

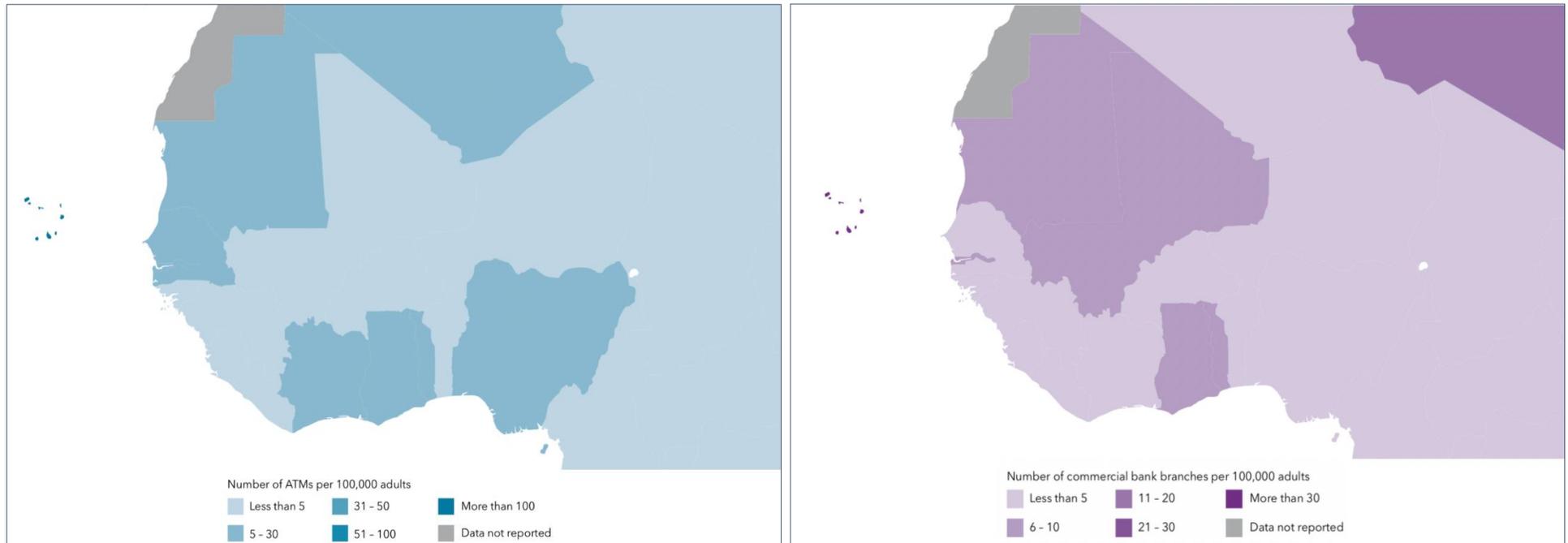
➤ Access to Financial Services

Access to financial services represents an ongoing challenge in West Africa and the Sahel. Overall, about three-quarters of the region’s population remains financially excluded, lacking access to banking and financial services through formal institutions (**Figure 48**).²²⁷ There are, however, notable signs of progress. Between 2011 and 2017, the share of the population covered by formal financial institutions increased by nearly 10%.²²⁸ Many countries across the region, including Nigeria, have also seen an increase in mobile money account ownership (**Figure 49**) and transaction volume (**Figure 50**).

²²⁷ “Le secteur bancaire en Afrique De l’inclusion financière à la stabilité financière,” European Investment Bank, (October 2018): https://www.eib.org/attachments/efs/economic_report_banking_africa_2018_fr.pdf

²²⁸ Demircuc-Kunt, A., Klapper, L., Singer, D., Ansar, S., and Hess, J., “The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution,” World Bank, (2017): <http://documents.worldbank.org/curated/en/332881525873182837/pdf/126033-PUB-PUBLIC-pubdate-4-19-2018.pdf>

Figure 48: ATMs and Branches of Commercial Banks per 100,000 Adults in West Africa and the Sahel, 2017²²⁹

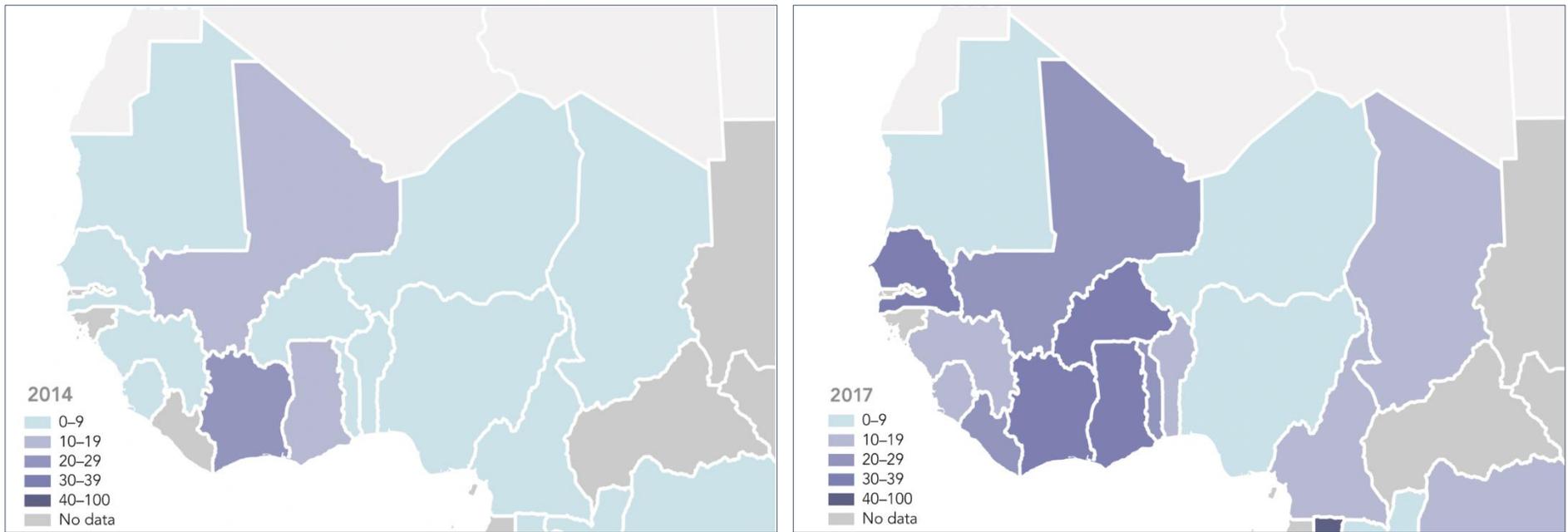


Source: International Monetary Fund

Figure 48 shows the number of ATMs (left) and commercial bank branches (right) per 100,000 adults across West Africa and the Sahel. The shade of the country corresponds to the magnitude of the indicator; the darker the shade, the higher the value. As of 2017, Côte d'Ivoire, Ghana, Mauritania, **Nigeria**, Senegal and Togo had a relatively higher number of ATMs per 100,000 adults compared to the rest of the region, while The Gambia, Ghana, Mali, Mauritania and Togo had a relatively higher number of commercial bank branches per 100,000 adults. Cabo Verde ranked above all countries in the region on both indicators.

²²⁹ International Monetary Fund – Financial Access Survey: <http://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C&slid=1460054136937>

Figure 49: Share of Adults with a Mobile Money Account in West Africa and the Sahel (%), 2014 and 2017²³⁰



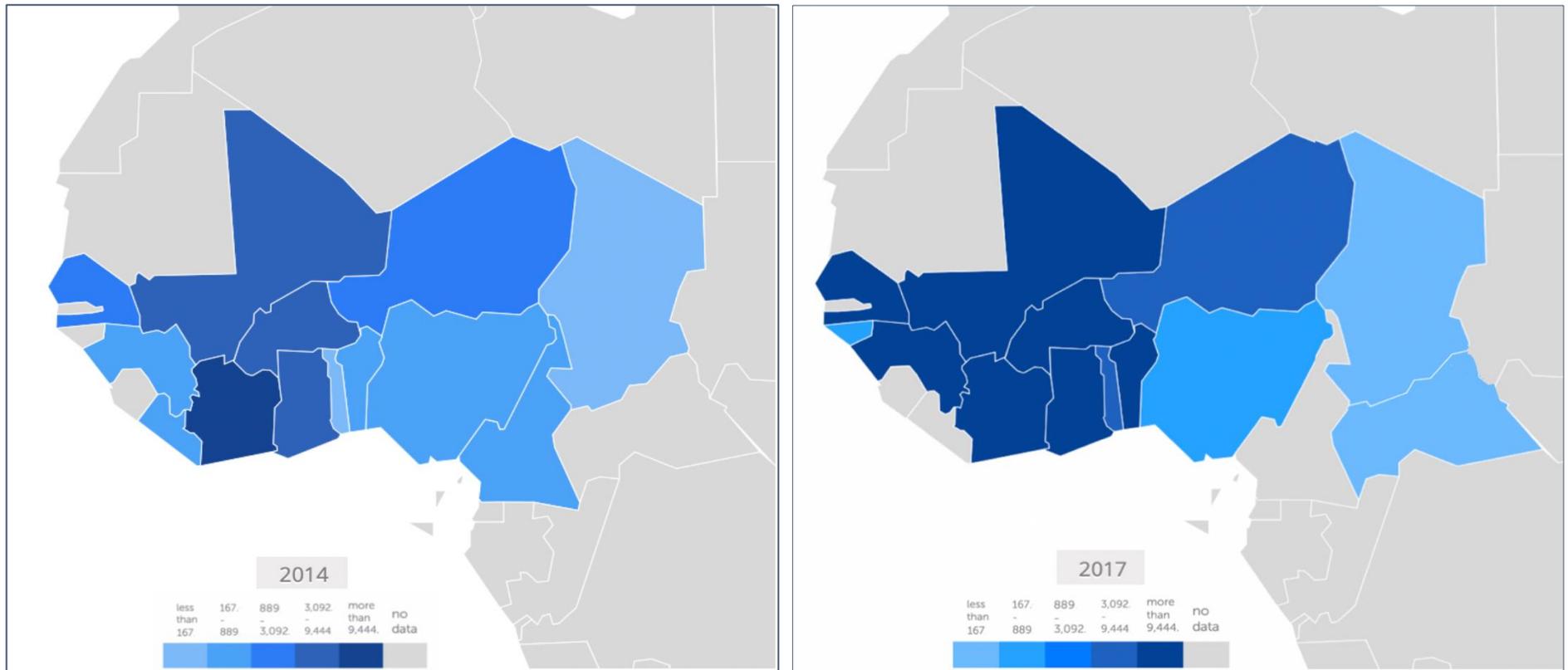
NOTE: Maps exclude Cabo Verde (no data)

Source: World Bank Global Findex Database

Figure 49 shows the increase in the share of adults (%) owning a mobile money account across West Africa and the Sahel between 2014 and 2017. The shade of the country corresponds to the magnitude of the indicator; the darker the shade, the higher the value. As of 2017, the share of adults owning a mobile money account is about 33% in Burkina Faso, Côte d'Ivoire, and Senegal, and 39% in Ghana. Between 2014 and 2017, mobile money account ownership also increased significantly in Benin, Cameroon, Chad, Guinea, Mali, Sierra Leone and Togo, while growth in account ownership was slower in Niger, **Nigeria** and Mauritania. There was either no data or insufficient data available to assess account ownership in Cabo Verde, Central African Republic, The Gambia, Guinea-Bissau, and Liberia.

²³⁰ Demircuc-Kunt et al., 2017.

Figure 50: Mobile Money Transactions per 1,000 Adults in West Africa and the Sahel, 2014 and 2017²³¹



NOTE: Maps exclude Cabo Verde (no data)

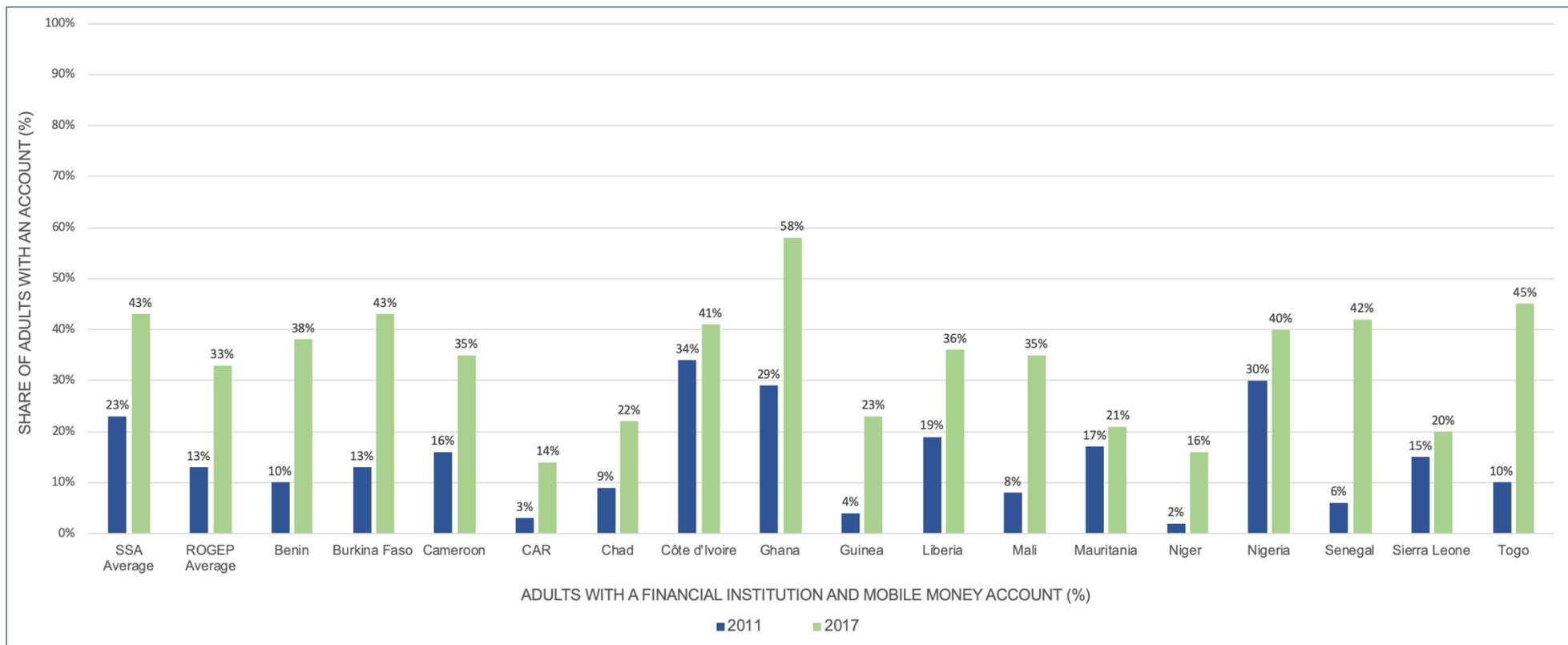
Source: International Monetary Fund

Figure 50 shows the increase in the number of mobile money transactions across West Africa and the Sahel between 2014 and 2017. The shade of the country corresponds to the magnitude of the indicator; the darker the shade, the higher the value. Between 2014 and 2017, mobile money transaction volume increased significantly in Benin, Burkina Faso, Côte d’Ivoire, Ghana, Guinea, Mali, Niger, Senegal and Togo, while growth in transaction volume was slower in **Nigeria** and Chad. There was either no data or insufficient data available to assess transaction volume in Cabo Verde, Cameroon, Central African Republic, The Gambia, Guinea-Bissau, Liberia, Mauritania and Sierra Leone.

²³¹ International Monetary Fund – Financial Access Survey: <http://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C&slid=1460054136937>

In 2017, 40% of Nigeria’s adult population had an account at a financial institution or with a mobile money service provider, up from 30% in 2011. In 2017, the country’s rate of financial inclusion was slightly above the West Africa and Sahel region’s average, but still below the average for Sub-Saharan Africa (**Figure 51**). Despite the improved rate between 2011 and 2017, financial inclusion in Nigeria actually regressed between 2014 and 2017, as shown in **Figure 53**.

Figure 51: Share of Adults with Access to Financial Services in West Africa and the Sahel (%), 2011 and 2017²³²



NOTE: Cabo Verde, Guinea-Bissau and The Gambia excluded (no data); data for Côte d'Ivoire is from 2014 and 2017

Source: World Bank Global Findex Database

²³² Demirguc-Kunt et al., 2017.

In 2010, Nigeria made a commitment to reduce its national financial exclusion rate²³³ from 46.3% to 20% by the year 2020. In order to attain this target, the CBN launched the National Financial Inclusion Strategy (NFIS) in 2012. The major tools adopted by the CBN to drive the NFIS include agent banking, mobile money operation, among other interventions. In line with this, the CBN launched the Agent Banking guidelines in 2012, the Guidelines for Agent Banking and Agent Banking Relationships in 2013, and the Operating Framework for Super Agent in 2015 in an effort to extend bank services to rural and semi-urban areas given that banks in the country are highly concentrated in urban centers.²³⁴ In addition to the agent banking initiative, the CBN has also issued licenses to 25 mobile money operators (MMOs) made up of both non-bank operators and bank operators.²³⁵ However, the regulatory framework for mobile money services released by the CBN prevents mobile network operators (MNOs) from applying for the mobile money licenses that would allow cash transfers without the need for a bank account.²³⁶ Moreover, the roll out of banking agents has been a slow-moving process, and mobile money uptake has been low, with only about 2% of Nigerians (3.84 million customers)²³⁷ in 2017 carrying out transactions via mobile money platforms, despite the country's high mobile phone penetration rate – 84% in 2018.²³⁸

Financial inclusion therefore remains an ongoing challenge. A survey conducted by Enhancing Financial Innovation and Access (EFInA), showed that the national financial exclusion rate had slightly increased from 39.5% in 2014 to 41.6% in 2016 (**Figure 52**), representing one of the highest rates in Sub-Saharan Africa. The exclusion rate drastically increased in the North-Western region of the country from 56% in 2014 to 70% in 2016 and in the North-Central region of the country from 33% to 39% over the same period. These two regions accounted for the highest exclusion rates followed by the South-South and South-East zones, respectively.²³⁹

²³³ According to the CBN's National Financial Inclusion Strategy, financial inclusion is achieved when adult Nigerians have easy access to a broad range of formal financial services that meet their needs at an affordable cost. The services include, but are not limited to, payments, savings, loans, insurance, and pension products.

²³⁴ Central Bank of Nigeria: <https://www.cbn.gov.ng/devfin/fininc.asp>

²³⁵ The banks with mobile money platforms in Nigeria include UBA, Zenith Bank, GTBank, First Bank, Stanbic IBTC and Ecobank.

²³⁶ "Regulatory Framework for Mobile Money Services in Nigeria," Central Bank of Nigeria:

<https://www.cbn.gov.ng/out/2015/bpsd/regulatory%20framework%20for%20mobile%20money%20services%20in%20nigeria.pdf>

²³⁷ "Electronic Payment Fact Sheet," NIBSS Enterprise Intelligence Unit, (2017):

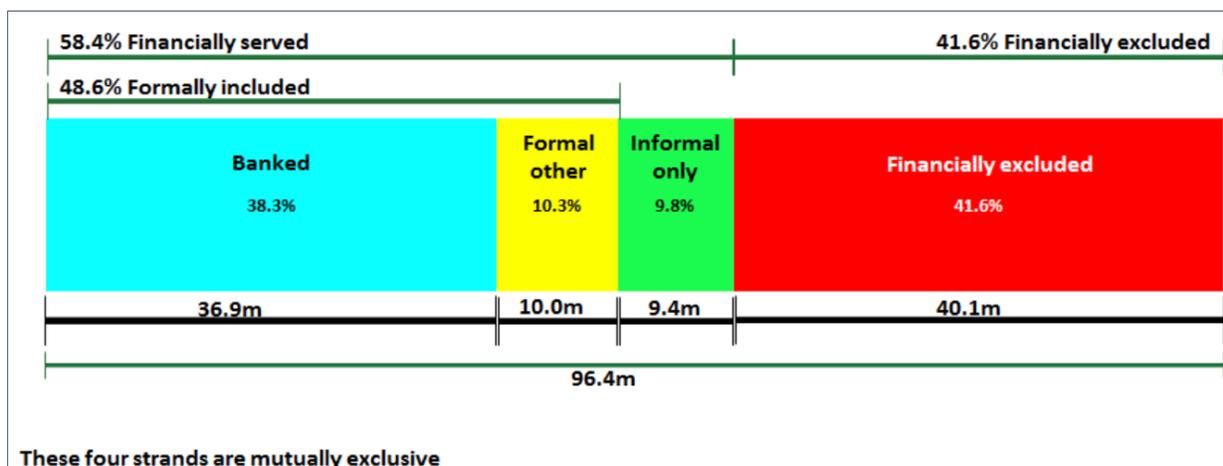
https://nibss-plc.com.ng/wp-content/uploads/2018/01/eFactSheet_-Jan-Dec.-2017-.pdf

²³⁸ Adepetun, A., "Nigeria's mobile phone penetration hits 84 percent," The Guardian, (16 March 2018): <https://guardian.ng/business-services/nigerias-mobile-phone-penetration-hits-84-per-cent/>

²³⁹ "Access to Financial Services in Nigeria Survey," Enhancing Financial Inclusion and Access, (2016):

<http://www.efina.org.ng/assets/A2F/2016/Key-Findings-A2F-2016.pdf>

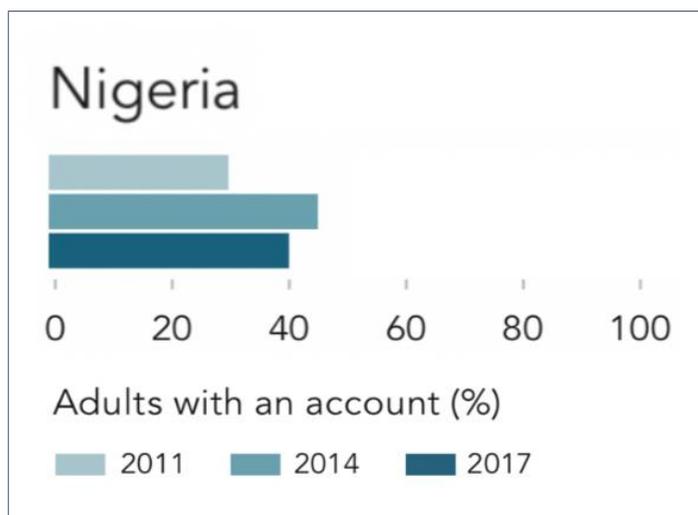
Figure 52: Access to Financial Services²⁴⁰



Source: Central Bank of Nigeria

Nigeria’s regression in financial inclusion is also reflected in the findings of the World Bank’s 2017 Global Findex survey (Figure 53).²⁴¹

Figure 53: Financial Institution Account Ownership



Source: World Bank Global Findex Database

This deficit can be attributed to a wide range of factors, including *inter alia* the country’s elevated levels of poverty, low or irregular sources of income, low rates of financial literacy, and a perceived lack of need. A 2014 survey revealed that nearly half of adults in Nigeria believed that taking loans should be avoided as much as possible, and that adults can easily live their lives without having a bank account.²⁴²

²⁴⁰ CBN Financial Stability Report, 2017.

²⁴¹ Demirguc-Kunt et al., 2017.

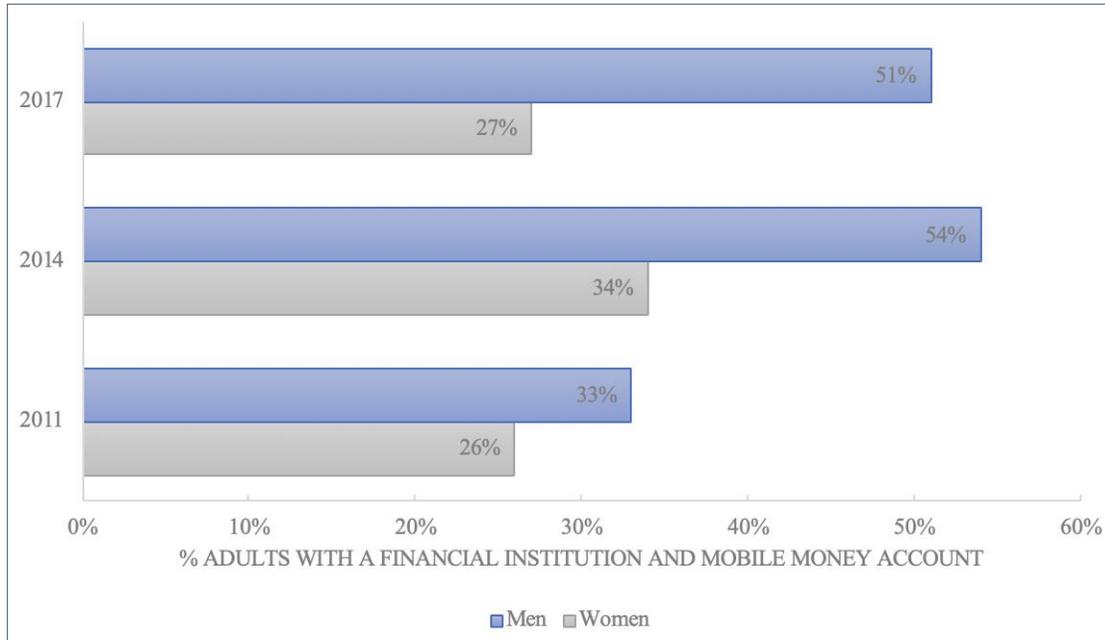
²⁴² “Women in Financial Services,” Oliver Wyman, (2016):

<http://www.mmc.com/content/dam/mmc-web/Files/Women%20In%20Financial%20Services%202016.pdf>

➤ **Gender and Women’s Financial Inclusion**

Nigerian women are disproportionately affected by financial exclusion. Studies have found that increasing financial inclusion can significantly empower women by increasing savings, reducing levels of inequality, and improving decision-making power in the household.²⁴³ In 2017, 27% of women had an account at a financial institution or with a mobile money service provider compared to 51% of men, representing a 24% gap in financial inclusion – one of the largest gender gaps in the world (**Figure 54**). For perspective, the average gender gap for women living in Sub-Saharan Africa in 2017 was 12%.²⁴⁴

Figure 54: Financial Inclusion Gender Gap in Nigeria



Source: World Bank Global Findex Database

In response to these developments, in 2017, the CBN acknowledged that it was not on track to meet its financial inclusion objectives and began a review of the NFIS with the aim of revising its strategy.²⁴⁵ Since completing its review, the CBN adopted a range of initiatives to partner with the banking sector to improve financial inclusion in the country:

- Memorandum of Understanding (MoU) on payment systems: The CBN and the Nigerian Communications Commission (NCC) signed a MoU, to improve the penetration of financial services using mobile phones. In April 2018, the CBN signed a MoU with the NCC with both parties agreeing to jointly implement a payment systems framework to boost mobile money service penetration and financial inclusion in the country.²⁴⁶

²⁴³ “Enhancing Financial Inclusion for Women in Nigeria,” CGAP, (March 2016): <http://www.cgap.org/blog/enhancing-financial-inclusion-women-nigeria>

²⁴⁴ Demirguc-Kunt et al., 2017.

²⁴⁵ “Draft of the National Financial Inclusion Strategy,” Central Bank of Nigeria, (July 6, 2018): https://www.cbn.gov.ng/Out/2018/CCD/Exposure%20Draft%20of%20the%20National%20Financial%20Inclusion%20Strategy%20Refre sh_July%206%202018.pdf

²⁴⁶ Akwaja, C., “NCC, CBN Sign MoU on Mobile Money, Financial Inclusion,” Leadership.NG, (April 11, 2018): <https://leadership.ng/2018/04/11/ncc-cbn-sign-mou-on-mobile-money-financial-inclusion/>

- Regulatory Sandbox for Fintech: The CBN, in collaboration with the Nigeria Inter-Bank Settlement System (NIBSS) created a regulatory sandbox that will allow fintech start-ups to test solutions in a controlled environment.²⁴⁷
- Shared Agent Network Expansion Program (SANEP): In April 2018, the CBN and the Deposit Money Banks (DMBs), in conjunction with the licensed MMOs and super agents launched SANEP to roll-out a 500,000 shared agent network by 2020²⁴⁸ to offer basic financial services such as bank account opening, funds transfer, bill payments and Bank Verification Number (BVN) enrolment services mainly in the Northern geo-political zones, where financial exclusion is most predominant.²⁴⁹

The CBN also launched several interventions and credit enhancement programs to support the non-financial sector of the economy in order to reduce poverty and unemployment by providing long-term funds to banks for on-lending through its development finance programs. These include the Anchor Borrowers' Programme (ABP), the Commercial Agriculture Credit Scheme (CACS) Refinancing and Rediscounting Facilities for SMEs, SME Credit Guarantee Scheme and the NGN 220 billion (USD 719 million) Micro, Small and Medium Enterprise Development Fund (MSMEDF).²⁵⁰

The MSMEDF facility attracts an interest rate of 2% per annum and banks are obligated to on-lend to MSMEs at 9% per annum. The maximum tenor is five years while the tenor for working capital is one year. Under the MSMEDF, a total of NGN 87.3 billion (USD 285 million) had been disbursed from fund's inception in 2012 through 2017. About three-quarters of this total, equivalent to NGN 63.2 billion (USD 207 million), went to state governments, while Micro, Small and Medium Enterprise (MSMEs) collectively accessed the balance, or NGN 24.1 billion (USD 78 million). As of 2017, a total of NGN 23.5 billion (USD 65 million) has been repaid since the program's inception. Some of the funds from the MSMEDF have been used to provide financing for RE projects.²⁵¹

In an effort to increase access to financial services for women, the MSMEDF includes a requirement that participating FIs must disburse 60% of the funding to women entrepreneurs. Accordingly, as of 2017, a total of 113,077 female and 78,411 male microenterprise owners had benefited from the fund. In addition, the CBN has established a Financial Literacy Working Group that develops and implements financial literacy campaigns to drive financial inclusion, with a focus on supporting women. The CBN has also partnered with FIs to implement "know-your-customer" regulations designed to emphasize the collection of gender disaggregated data to better inform decision-making to meet the needs of women.²⁵²

The FGN can also learn from the successes of East Africa and by partnering with telecommunications companies (e.g. Airtel Nigeria, MTN) to expedite growth of the country's mobile money services market. There is some preliminary evidence from other countries in Sub-Saharan Africa that suggests mobile money can help increase access to financial services for women, lower-income segments of the population and other groups traditionally excluded from the formal financial system.

Indeed, widespread mobile phone ownership (**Figure 20**), rapidly growing mobile internet usage (**Figure 19**) and extensive network coverage (**Figure 38**), have led to the proliferation of mobile money services and platforms in the country. These dynamics are collectively increasing usage of mobile banking services,

²⁴⁷ "Draft of the National Financial Inclusion Strategy," Central Bank of Nigeria, (July 6, 2018):

https://www.cbn.gov.ng/Out/2018/CCD/Exposure%20Draft%20of%20the%20National%20Financial%20Inclusion%20Strategy%20Refresh_July%206%202018.pdf

²⁴⁸ The total number of banking agents in Nigeria currently stands at 100,000 according to estimates by EFInA

²⁴⁹ Famofo, B., "Collaborating for Financial Inclusion," This Day, (April 15, 2018):

<https://www.thisdaylive.com/index.php/2018/04/15/collaborating-for-financial-inclusion/>

²⁵⁰ CBN Financial Stability Report, 2017.

²⁵¹ CBN Economic Report for the First Half of 2017.

²⁵² Ibid.

expanding overall access to financial services and driving financial inclusion in Nigeria. Mobile money technology also plays a critical role in the application of off-grid solar solutions, particularly for Pay-As-You-Go systems that rely on the interoperability between digital financial services and stand-alone solar devices.²⁵³

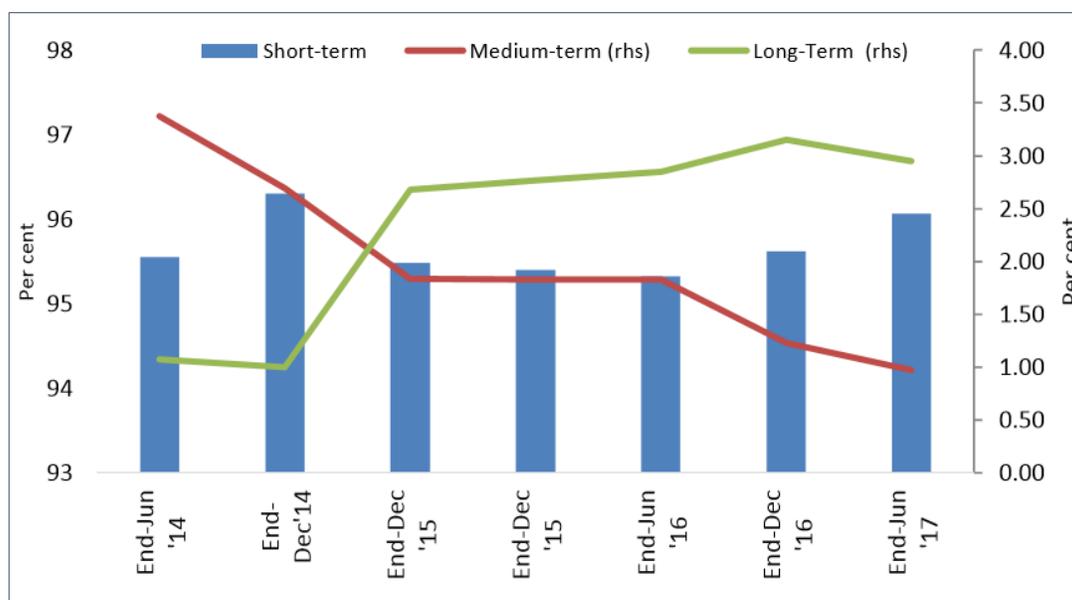
In February 2019, First Bank of Nigeria Limited (FBN), announced a partnership with PAYG technology company, Azuri Technologies, that will help deepen financial inclusion in Nigeria while also supporting development of the country’s off-grid solar sector. Under the arrangement, solar customers will be able to pay for their solar via FBN’s Firstmonie agent network and mobile payment system, which provides basic financial services to customers in rural and peri-urban locations across the country.²⁵⁴

3.2.3 Commercial Lending Environment

➤ Maturity Structure of Bank Deposits and Credit

In the first half of 2017, bank deposit liabilities continued to be dominated by short-term deposits (**Figure 55** and **Table 51**).²⁵⁵ This trend constrains the ability of banks to create long-tenor assets.

Figure 55: Maturity Structure of Bank Deposits



Source: Central Bank of Nigeria

²⁵³ In Nigeria, Lumos has marketed, distributed and sold its off-grid solution via the MTN mobile electricity service and customers can top up their electricity account using their MTN airtime; however, the use of airtime as credit varies by jurisdiction, as airtime is not considered a currency. Therefore, airtime integration and usage for solar payments happen on a case-by-case basis. Smarter Grid International is a solar distributor working with Airtel Nigeria to launch mobile payments for PAYG SHS throughout the country.

²⁵⁴ “Partnership to bring solar power to millions of Nigerians,” ESI Africa, (February 8, 2019); <https://www.esi-africa.com/partnership-to-bring-solar-power-to-millions-of-nigerians/>

²⁵⁵ CBN Financial Stability Report, 2017.

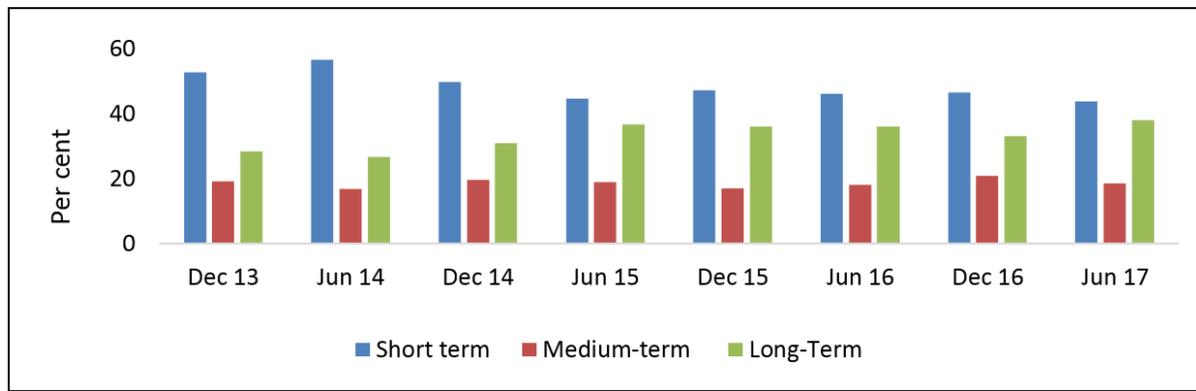
Table 51: Maturity Structure of Bank Deposits

Deposits	Dec-2016	June-2017
Short-term	95.6% ²⁵⁶	96.1%
Medium-term	0.97%	2.9%
Long-term	1.2%	3.2%

Source: Central Bank of Nigeria

Consequently, short-term maturities have dominated the credit market. Commercial and merchant banks’ outstanding credit at the end of the first half of 2017 showed that short-term maturities²⁵⁷ in the credit market, though their share of total credit declined (**Figure 56** and **Table 52**).²⁵⁸

Figure 56: Distribution of Bank Loans and Advances by Maturity



Source: Central Bank of Nigeria

Table 52: Distribution of Bank Loans and Advances by Maturity

Bank Loans	Dec-2016	June-2017
Short-term	46.4%	43.7%
Medium-term ²⁵⁹	20.7%	18.4%
Long-term ²⁶⁰	32.9%	37.9%

Source: Central Bank of Nigeria

➤ **Interest Rates**

Although inflation had decreased for 18 consecutive months to 11.14% in July 2018, it is still well above the CBN’s target range of 6%–9%.²⁶¹ Hence, during its meeting in September 2018, the CBN Monetary Policy Committee maintained a contractionary monetary policy with a monetary policy rate (MPR) of 14.0%. The corridor around the MPR for standing lending and deposit facilities was also retained at +200

²⁵⁶ 74.9% of these had a maturity of less than 30 days.

²⁵⁷ Short-term implies maturities below one year.

²⁵⁸ CBN Financial Stability Report, 2017.

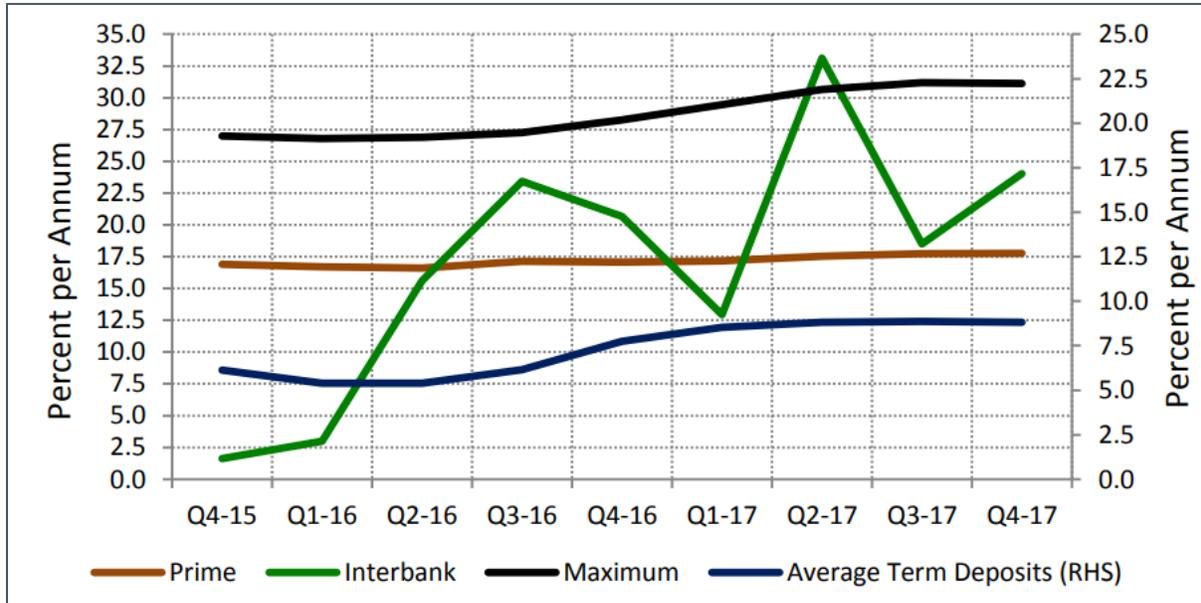
²⁵⁹ Medium-term implies maturities ≥1yr and < 3yrs

²⁶⁰ Long-term implies maturities of 3yrs and above

²⁶¹ “Inflation in Nigeria,” Focus Economics, (December 2018): <https://www.focus-economics.com/country-indicator/nigeria/inflation>

and -500 basis points, respectively. Similarly, the cash reserve ratio (CRR) and liquidity ratio (LR) were also retained at 22.5% and 30.0% for commercial banks, respectively.²⁶²

Figure 57: Select Deposit Money Bank Interest Rates²⁶³



Source: Central Bank of Nigeria

Figure 57 illustrates the movement in bank deposits and lending rates between the fourth quarter of 2015 and the fourth quarter of 2017. On the average, all the rates in 2017 were higher than their levels in 2016. Consequently, the spread between the average term deposit and the average maximum lending rates widened. The increasing spread in rates continued to discourage potential savings due to low returns on deposits. In addition, all deposit rates were negative in real terms, while lending rates were positive in real terms.²⁶⁴ Figure 58 shows the individual commercial bank lending rates as reported to the CBN as of 2018.

²⁶² “CBN Communique No. 120 of the Monetary Policy,” Central Bank of Nigeria, (September 2018):

<https://www.cbn.gov.ng/Out/2018/MPD/CENTRAL%20BANK%20OF%20NIGERIA%20COMMUNIQUE%20NO%20120%20OF%20THE%20MONETARY%20POLICY%20COMMITTEE%20MEETING%20OF%20MONDAY%2024th%20AND%20TUESDAY%2025th%20SEPTEMBER,%202018.pdf>

²⁶³ “CBN Economic Report: Fourth Quarter 2017,” Central Bank of Nigeria (2017):

<https://www.cbn.gov.ng/Out/2018/RSD/CBN%20ECONOMIC%20REPORT%20FOURTH%20QUARTER%20%20%202017%20Published.pdf>

²⁶⁴ Ibid.

Figure 58: Commercial Bank Lending Rates, 2018

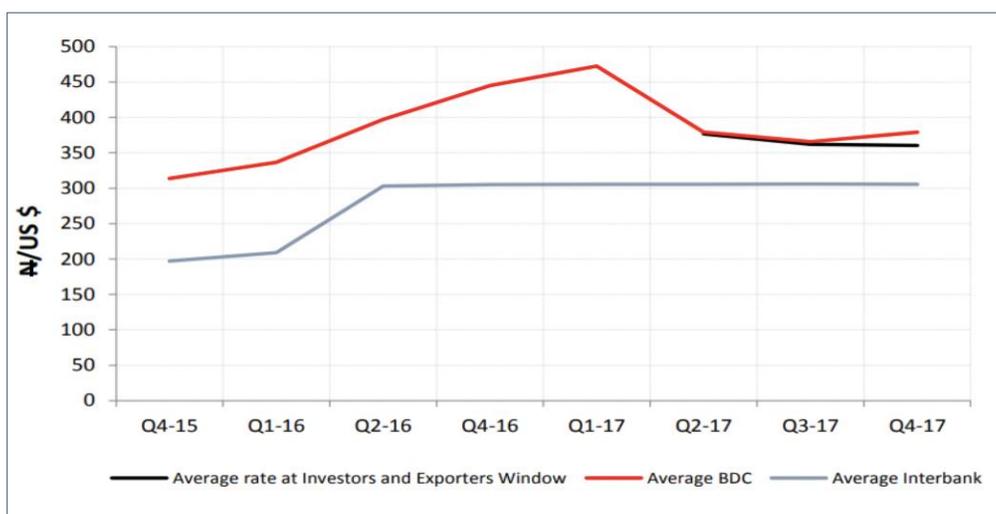
		CBN																									
																											
In furtherance of the transparency and full disclosure stance of the Central bank of Nigeria, the Monetary Policy Committee has decided that henceforth the lending rates obtainable in all Deposit Money Banks (DMBs) be made public to guide business decisions. Consequently, find below the applicable rates for each of the DMBs as at June 29, 2018. The rates will be published every Wednesday in some selected national Newspapers. The rates will also be available on the website of the Central Bank of Nigeria																											
NAME OF BANK	148	ACCESS BANK	CITI BANK	CORONATION BANK	DIAMOND BANK	ECOBANK	FIRST BANK OF NIGERIA	FBN MERCHANT	FCMB	FIDELITY BANK	FSDH	GUARANTY TRUST BANK	HERITAGE BANK	KEYSTONE BANK LTD	NOVA MERCHANT BANK	PROVIDUS BANK	Rand Merchant Bank Nig. Ltd	Standard Chartered Bank	SKYE BANK	STANBIC IBC	STERLING BANK	SUNTRUST	United Bank for Africa	UNION BANK	UNITY BANK	WEMA BANK	ZENITH BANK
DEPOSIT RATES																											
DEMAND DEPOSIT	AVE. INT. RATE	0.05	1.30	-	0.41	0.01	0.00	-	0.41	3.00	-	3.11	0.00	0.42	-	0.00	5.00	0.00	-	0.63	0.00	0.00	0.08	0.50	0.50	1.20	0.42
SAVINGS DEPOSIT	AVE. INT. RATE	4.20	4.20	-	4.20	4.20	4.20	-	4.20	4.20	-	4.20	4.20	4.20	-	4.25	0.00	4.22	4.20	4.20	4.20	2.00	4.20	4.20	4.20	4.20	4.20
TIME DEPOSIT	AVE. INT. RATE	10.10	7.50	12.66	10.54	9.86	7.50	10.03	11.50	11.00	10.50	7.41	13.88	13.93	10.40	9.05	13.23	7.50	10.12	7.91	10.17	12.95	10.99	12.48	16.00	8.69	7.40
LENDING RATES																											
AGRICULTURE, FORESTRY AND FISHING	PRIME	17.00	15.50	18.00	15.00	17.00	9.00	17.50	4.20	6.00	-	7.00	27.00	19.00	-	9.00	-	20.00	9.00	7.00	24.00	21.02	7.00	23.50	24.00	9.00	19.00
	MAX.	30.50	23.50	22.00	30.00	25.00	27.00	18.00	30.00	36.00	-	21.00	30.00	34.00	-	25.00	-	25.00	31.00	36.00	33.00	30.00	25.00	49.50	32.00	25.00	30.50
MINING & QUARRYING	PRIME	-	15.50	-	-	21.00	20.00	-	-	19.00	-	-	-	19.00	-	22.00	-	20.00	28.00	-	21.00	-	24.00	17.50	24.00	-	19.00
	MAX.	-	23.50	-	-	24.00	27.00	-	-	36.00	-	-	-	34.00	-	25.00	-	25.00	34.00	-	30.00	-	29.00	33.00	32.00	-	30.50
MANUFACTURING	PRIME	14.00	15.50	16.50	20.00	14.00	20.00	13.00	5.79	19.00	16.00	12.00	27.00	19.00	-	22.00	17.50	20.00	28.00	7.00	21.00	21.02	19.00	9.50	24.00	29.00	19.00
	MAX.	30.50	23.50	22.00	30.00	24.00	28.00	26.00	30.00	36.00	21.00	24.00	31.00	34.00	-	25.00	20.46	25.00	34.00	36.00	30.00	30.00	29.00	32.00	32.00	29.00	30.50
REAL ESTATE ACTIVITIES	PRIME	15.00	15.50	-	20.00	19.00	20.00	-	5.00	19.00	16.00	18.00	27.00	19.00	-	22.00	24.81	20.00	28.00	16.71	24.00	22.00	24.00	32.00	24.00	29.00	19.00
	MAX.	30.50	23.50	-	28.78	28.00	27.00	-	27.00	36.00	21.00	23.00	30.00	34.00	-	25.00	24.81	25.00	34.00	24.00	30.00	30.00	29.00	36.50	32.00	30.00	30.50
PUBLIC UTILITIES	PRIME	-	-	-	-	14.00	19.00	-	-	19.00	16.00	-	-	19.00	-	22.00	18.88	20.00	-	11.00	21.00	-	24.00	17.50	24.00	-	19.00
	MAX.	-	-	-	-	24.00	28.00	-	-	36.00	21.00	-	-	34.00	-	25.00	20.68	20.00	-	30.00	27.00	-	29.00	24.50	32.00	-	30.50
GENERAL COMMERCE	PRIME	15.00	15.50	16.50	20.00	17.00	20.00	-	5.00	19.00	16.00	17.00	27.00	19.00	-	22.00	18.50	20.00	28.00	10.00	22.00	21.02	24.00	17.50	24.00	29.00	19.00
	MAX.	30.50	23.50	23.00	31.91	28.00	27.00	-	30.00	40.00	21.00	25.00	33.00	34.00	-	28.00	-	27.00	36.00	36.00	33.00	30.00	29.00	49.00	32.00	30.00	30.50
TRANSPORTATION & STORAGE	PRIME	14.00	15.50	19.00	20.00	18.00	20.00	21.50	25.00	19.00	16.00	20.00	27.00	19.00	-	22.00	18.50	20.00	18.00	11.00	21.00	-	19.00	23.00	24.00	29.00	19.00
	MAX.	30.50	23.50	20.50	28.00	24.00	27.00	23.00	26.00	36.00	21.00	20.00	32.00	34.00	-	25.00	25.00	25.00	34.00	30.00	31.00	-	29.00	27.00	32.00	30.00	30.50
FINANCE & INSURANCE	PRIME	18.00	15.50	-	20.00	21.00	20.00	19.00	20.00	19.00	16.00	20.00	27.00	19.00	-	22.00	15.20	21.00	28.00	20.50	21.00	-	19.00	21.00	24.00	29.00	19.00
	MAX.	30.50	23.50	-	27.76	28.00	27.00	23.00	28.00	36.00	21.00	25.00	28.00	34.00	-	25.00	15.20	25.00	34.00	28.00	31.00	-	29.00	23.50	32.00	29.00	30.50
GENERAL	PRIME	18.00	15.50	5.00	20.00	18.00	20.00	-	1.00	19.00	16.00	13.00	27.00	19.00	-	22.00	-	20.00	-	7.00	21.00	21.02	24.00	17.50	24.00	29.00	19.00
	MAX.	30.50	23.50	5.00	29.00	30.00	30.00	-	30.00	40.00	21.00	26.00	33.00	34.00	-	25.00	-	27.00	-	36.00	33.00	30.00	29.00	49.00	32.00	30.00	30.50
GOVERNMENT	PRIME	16.00	-	-	-	17.00	19.00	14.00	1.00	19.00	-	18.00	9.00	19.00	-	19.50	-	20.00	9.00	19.00	21.00	-	24.00	24.00	24.00	29.00	19.00
	MAX.	26.50	-	-	-	21.00	28.00	14.00	9.00	36.00	-	18.00	9.00	34.00	-	25.00	-	20.00	31.00	21.00	29.00	-	29.00	28.00	32.00	28.00	30.50
WATER SUPPLY SEWAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	PRIME	20.00	-	-	-	18.00	20.00	-	1.00	19.00	-	-	27.00	19.00	-	22.00	-	20.00	-	24.00	21.00	-	24.00	17.50	24.00	29.00	19.00
	MAX.	30.50	-	-	-	28.00	27.00	-	30.00	36.00	-	-	30.00	34.00	-	25.00	-	25.00	-	30.00	33.00	-	29.00	33.00	32.00	29.00	30.50
CONSTRUCTION	PRIME	16.00	15.50	23.00	20.00	14.00	19.00	-	21.00	19.00	-	16.00	27.00	19.00	-	22.00	-	20.00	-	18.00	21.00	21.02	24.00	20.00	24.00	29.00	19.00
	MAX.	30.50	23.50	23.00	30.00	24.00	28.00	-	27.00	36.00	-	26.00	31.00	34.00	-	25.00	-	25.00	-	29.00	29.00	30.00	29.00	29.50	32.00	30.00	30.50
INFORMATION AND COMMUNICATION	PRIME	18.00	15.50	-	20.00	14.00	20.00	17.64	6.00	19.00	-	16.00	27.00	19.00	-	22.00	15.97	20.00	-	15.97	21.00	21.02	24.00	22.50	24.00	29.00	19.00
	MAX.	30.50	23.50	-	20.00	28.00	27.00	26.04	24.00	36.00	-	25.00	29.00	34.00	-	25.00	15.97	25.00	-	36.00	33.00	30.00	29.00	30.50	32.00	30.00	30.50
PROFESSIONAL, SCIENTIFIC AND TECHNICAL	PRIME	15.00	15.50	-	20.00	19.00	20.00	-	20.50	19.00	-	16.00	27.00	19.00	-	22.00	-	20.00	-	18.00	21.00	21.02	24.00	26.50	24.00	29.00	19.00
	MAX.	30.50	23.50	-	27.00	28.00	27.00	-	30.00	36.00	-	26.00	31.00	34.00	-	25.00	-	25.00	-	30.00	29.00	30.00	29.00	26.50	32.00	29.00	30.50
ADMINISTRATIVE AND SUPPORT SERVICE	PRIME	19.00	15.50	-	20.00	23.00	20.00	-	10.23	19.00	-	20.00	27.00	19.00	-	22.00	-	20.00	-	11.00	21.00	-	24.00	26.50	24.00	29.00	19.00
	MAX.	30.50	23.50	-	27.76	28.00	30.00	-	27.50	36.00	-	25.00	30.00	34.00	-	25.00	-	25.00	-	33.00	29.00	-	29.00	37.50	32.00	29.00	30.50
EDUCATION	PRIME	19.00	15.50	-	20.00	23.00	19.00	-	18.00	19.00	-	17.00	27.00	19.00	-	22.00	-	20.00	-	18.00	21.00	-	24.00	21.50	24.00	29.00	19.00
	MAX.	30.50	23.50	-	28.87	28.00	27.00	-	30.00	36.00	-	26.00	30.00	34.00	-	25.00	-	25.00	-	33.00	31.00	-	29.00	37.50	32.00	30.00	30.50
HUMAN HEALTH AND SOCIAL WORK ACTIVITIES	PRIME	16.50	15.50	-	20.00	23.00	20.00	-	-	19.00	-	15.00	27.00	19.00	-	22.00	-	20.00	-	22.00	21.00	-	24.00	25.50	24.00	29.00	19.00
	MAX.	30.50	23.50	-	28.72	28.00	28.00	-	-	36.00	-	25.00	30.00	34.00	-	25.00	-	25.00	-	30.00	29.00	-	29.00	33.50	32.00	29.00	30.50
ARTS, ENTERTAINMENT AND RECREATION ACTIVITIES OF EXTRATERRITORIAL ORGANIZATIONS AND BODIES	PRIME	16.00	-	-	20.00	23.00	20.00	-	-	19.00	-	23.00	27.00	19.00	-	22.00	-	20.00	-	18.00	21.00	-	24.00	26.50	24.00	29.00	19.00
	MAX.	30.50	-	-	27.89	28.00	27.00	-	-	36.00	-	23.00	32.00	34.00	-	25.00	-	25.00	-	28.00	29.00	-	29.00	26.50	32.00	29.00	30.50
POWER AND ENERGY	PRIME	-	15.50	-	-	20.00	-	-	-	19.00	-	-	-	19.00	-	22.00	-	20.00	-	11.00	21.00	-	24.00	26.50	24.00	29.00	19.00
	MAX.	-	23.50	-	-	28.00	27.00	-	-	36.00	-	-	-	34.00	-	25.00	-	25.00	-	28.00	27.00	-	29.00	30.50	32.00	29.00	30.50
OIL & GAS	PRIME	15.00	15.50	-	20.00	15.00	20.00	11.80	3.00	19.00	16.00	7.50	27.00	19.00	-	22.00	-	20.00	26.00	11.00	21.00	-	19.00	17.50	24.00	29.00	19.00
	MAX.	30.50	23.50																								

➤ **Foreign Exchange Market**

In 2015, the global decline in oil prices and lower oil production due to the resurgence of unrest in the Niger Delta led to reduced foreign exchange earnings, which resulted in the depreciation of the naira. As a result, the CBN imposed several foreign exchange controls in a bid to curtail the flow of dollars out of the country and maintain the value of the naira. These measures included the suspension of FX (foreign exchange) supplies to the Business Development Companies (BDCs); the exclusion of 41 items from the official foreign exchange window for imports; and the reiteration that all goods and services in Nigeria must be priced in naira in reference to Section 20(5) of the CBN Act. The CBN also restricted access to the official FX window for the purchase of foreign currency bonds, limited the amount Nigerians/customers/consumers could spend on card-based transactions on foreign currency priced websites as well as Point of Sale (POS) and ATM transactions abroad/overseas.

Despite these measures, the demand for foreign exchange remained steady with prices at the parallel market escalating well beyond the then official exchange rate of N197 to the dollar as illustrated in **Figure 59** and **Table 53**. Sustained downward pressure on the naira and the accompanying decrease in Nigeria’s foreign reserves caused the CBN to devalue the naira at the official window to NGN 305 to the US dollar in 2016. Despite the devaluation, the exchange rate at the parallel market, where most Nigerian citizens and businesses access foreign exchange, continued to climb peaking at about NGN 520 to the dollar in the first quarter of 2017.²⁶⁵

Figure 59: Exchange Rates²⁶⁶



Source: Central Bank of Nigeria

Table 53: Official Exchange Rate (NGN-USD)²⁶⁷

Exchange Rate	2013	2014	2015	2016	2017	2018
End of Period	157.26	169.68	197	305	306	307
Period Average	157.31	158.55	192.44	253.49	305.79	306.08

Source: International Monetary Fund

²⁶⁵ “Nigeria Market Challenges,” Export.gov: <https://www.export.gov/article?id=Nigeria-Market-Challenges>

²⁶⁶ CBN Economic Report for the First Half of 2017.

²⁶⁷ International Financial Statistics (IMF): <http://data.imf.org/?sk=4C514D48-B6BA-49ED-8AB9-52B0C1A0179B>

In order to address mounting concerns by the business community, the CBN created another official window for manufacturers and importers of several goods where foreign exchange could be accessed at lower than the market rate but higher than the official rate. In addition, the CBN approved different rates ranging between the official and market rates for use in international money transfers, religious pilgrimages, inter-bank lending and wire transfers for international payments. Confusion over the applicable rates, and lack of access to foreign exchange at the several official windows led to a reduction in operations of numerous import dependent businesses and the withdrawal of several foreign companies over repatriation concerns.²⁶⁸

Since peaking at about NGN 520 on the parallel market in early 2017, the exchange rate began to rebound in line with increased oil prices and higher production. As of end-December 2017, the exchange rate at the BDC market segment was NGN 362.49/USD,²⁶⁹ compared to NGN 490/USD at end-December 2016, while the inter-bank rate was NGN 305.96/USD. The foreign reserve, which had dropped by about 37% from January 2014 to June 2016 due to reduced oil receipts and CBN's actions in holding the exchange rate at an artificial rate, has also started to rebound, rising to USD 39.35 billion at end-December 2017 from USD 26.99 billion at end-December 2016, enough to finance 14.4 months of current level of import of goods and 10.2 months of goods and services.²⁷⁰

The exchange rate of the naira to the US dollar in the first half was stable both at the inter-bank and BDC segments of the foreign exchange market. This is attributed to CBN's sustained intervention in the foreign exchange market to dampen demand pressure by facilitating market-driven transactions. These interventions entailed the opening of several official windows for businesses to access foreign exchange at different rates. In April 2017, the CBN established an investor and exporter (I&E) FX window and another window for small and medium enterprises. In June 2017, the CBN released another circular further liberating the foreign exchange market at the inter-bank level by allowing trading of excess foreign currency by authorized dealers without recourse to the CBN. Other measures adopted included the admittance of more BDCs for foreign exchange sales and increase in the amount of weekly sales to the bureaus. These initiatives boosted liquidity in the foreign exchange market and narrowed the premium between the interbank and BDC rates from 61.6% at end-January 2017 to 19.8% at end-June 2017. The CBN's strategy is to continue to intervene in the market to keep the official rate from depreciating further while ensuring the harmonization of the multiple exchange rates currently obtainable in the market.²⁷¹

➤ Collateral Requirements

Due to exchange rate fluctuations, market uncertainty, and a variety of other causes, Nigerian banks are extremely risk averse in their lending practices and are known to have collateral requirements typically between 120–140% of the loan principal and sometimes as high as over 200%.²⁷² The credit risk policies of the banks are influenced by the CBN's capital allocation requirements and regulations in its role of protecting depositors and promoting stability and efficiency in the financial systems. The banks require collateral mainly in form of real estate and credit guarantee products, which are typically required to be

²⁶⁸ "Nigeria Market Challenges," Export.gov: <https://www.export.gov/article?id=Nigeria-Market-Challenges>

²⁶⁹ This market rate is closer to the exchange rates mandated by the CBN for international transfers and payments as well as on card transactions

²⁷⁰ "CBN Economic Report: Fourth Quarter 2017," Central Bank of Nigeria (2017):

<https://www.cbn.gov.ng/Out/2018/RSD/CBN%20ECONOMIC%20REPORT%20FOURTH%20QUARTER%20%20%202017%20Published.pdf>

²⁷¹ CBN Economic Report for the First Half of 2017.

²⁷² Stakeholder interviews, 2018.

cash-backed. This eliminates commercial credit from the purview of many Nigerian businesses, especially SMEs, due to their inability to provide acceptable collateral.²⁷³

In a bid to improve access to finance particularly for MSMEs, the CBN with support from IFC established the National Collateral Registry (NCR), which became operational in May 2016. The NCR is an online platform that enables low-income individuals and small-scale entrepreneurs to secure loans against movable assets such as machinery, livestock, and inventory. The legal framework for the NCR was completed with the enactment of the Secured Transactions in Movable Assets Act (STMAA) 2017 on May 30, 2017. The STMAA provides for secured transactions, registration and regulation of security interest in movable assets. The NCR allows banks, other financial institutions to determine any prior security interests, as well as to register their security interests over movable assets provided as collateral. Under the STMAA, perfection of security interests in movable assets occurs when a financing statement is registered on the NCR by a registered user, which must be a legal financial institution regulated by the CBN.²⁷⁴ Each financing statement contains a description of the Grantor, name and address of the Creditor or its representatives, a description of the collateral and the period during which the registration shall remain effective. As of August 2017, 136 FIs had registered on the NCR, comprising of 22 commercial banks, 106 MFIs, three merchant banks, three DFIs, one NIB and one non-bank financial institution and a total of 16,236 financing statements had been registered on the NCR platform for 20,684 movable assets valued at NGN 392 billion (USD 1.3 billion) by some these FIs.^{275,276} The NCR is expected to stimulate responsible lending to MSMEs by facilitating access to credit secured with movable assets, however, there is no penalty prescribed for non-participation under the STMAA, hence, the success of the initiative will hinge on the willingness of the local FIs to provide credit to the otherwise excluded MSMEs.²⁷⁷

➤ Banking Supervision

In 2017, CBN deployed a redesigned Credit Risk Management System (CRMS). The new system addressed the challenges associated with lack of unique identifier by adopting the use of Bank Verification Number (BVN) and Taxpayer Identification Number (TIN) as unique identifiers for individual and corporate borrowers, respectively. Also, the redesign was to capture all loans and borrowers of lending institutions irrespective of amount. The CBN issued regulatory guidelines to participating institutions for the operation of the redesigned CRMS.

As of June 2017, the number of registered borrowers in the CRMS database was 824,387, compared with 195,159 and 157,501 in June 2016 and December 2015, respectively (**Figure 60**). The significant increase was due to increased enforcement and the capture of all loans, regardless of amount, as against the previous requirement of reporting only loans of NGN 1 million (USD 2,760) and above. There were 755,076 individuals and 69,311 corporate borrowers at end-June 2017. Similarly, the number of borrowers with outstanding facilities rose significantly to 1,105,671 at end-June 2017, compared with 104,126, 93,168 and 61,580 at end-December 2016, end-June 2016 and December 2015, respectively. Following the issuance of stricter guidelines, improved compliance by banks and the capture of historical data on hitherto unreported

²⁷³ "The USAID Power Africa Renewable Energy and Energy Efficiency Project, 2014-2018: Resources Book," Winrock International, (2018): <https://www.winrock.org/wp-content/uploads/2018/02/REEEP-Resource-Book-20180222-.pdf>

²⁷⁴ Under the STMAA, perfection of the security interest affords the Secured Creditor priority when attempting to enforce or, in the event of winding up, liquidation or bankruptcy of the Obligor. Furthermore, a perfected security interest will have priority and rank ahead of other unregistered security interests, unsecured creditors, and judgment creditors. In cases where there are two registered interests over the same collateral, priority will be determined by the order of registration.

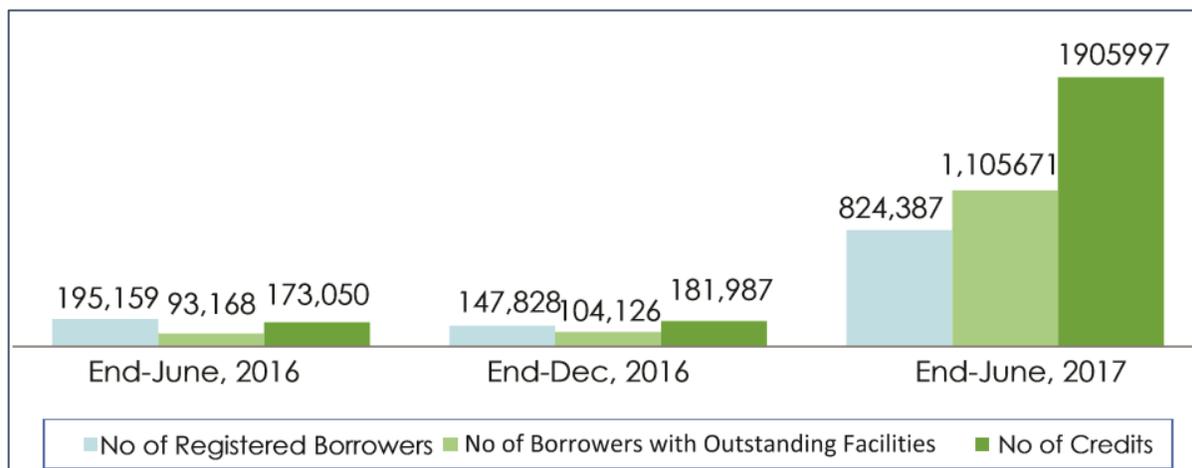
²⁷⁵ "National Collateral Registry (NCR) Newsletter," Central Bank of Nigeria, (August 2017): <https://www.cbn.gov.ng/Out/2017/CCD/NCR%20MAIDEN%20NEWSLETTER.pdf>

²⁷⁶ National Collateral Registry of Nigeria: <https://www.ncr.gov.ng/Home/About>

²⁷⁷ "Review of the Collateral Registry Act and Prospects for Credit Access Expansion in Nigeria," Detail Commercial Solicitors, (August 2017): https://www.detailsolicitors.com/media/archive1/newsletters/August_2017_Newsletter002.pdf

credit, the total number of credit facilities on the database rose to 1,905,997, compared with 181,987 at end-December 2016, 173,050 at end-June 2016 and 120,750 at end-December 2015 respectively. The number comprised of 1,513,452 facilities to individuals and 392,545 facilities to corporate borrowers.²⁷⁸

Figure 60: Credit Risk Management System Statistics²⁷⁹



Source: Central Bank of Nigeria

The three existing private credit bureaus (PCB) licensed in 2008 – CRC Credit Bureau Limited, CR Services Credit Bureau Plc and XDS Credit Bureau Limited – continue to complement the CRMS in credit administration and risk management process in the sector. Following stricter enforcement, increased surveillance, an awareness campaign on credit bureaus and collateral registry as well as adoption of the BVN, there was sustained improvement in the operations of the bureaus during the first half of 2017. As of end-June 2017, the BVN platform had 29,565,684 registered customers with BVNs and 40,676,362 linked bank accounts out of 62,615,344 active customer bank accounts in the country.²⁸⁰

3.2.4 Lending to the Off-Grid Solar Sector

Historically, some Nigerian banks have sought Renewable Energy (RE) lending opportunities in both the on-grid and off-grid market segments, but many lacked a good understanding of the technologies, markets, and business models for clean energy. Typically, across all sectors in Nigeria (not only the RE sector), local banks lend at unfavorable rates, due to high country risk and a lack of long-term funding. Banks offer short tenors and high collateral requirements. However, due to the high upfront cost of off-grid RE projects for small and medium sized households and businesses, these are impossible lending terms for RE companies and their customers. Nevertheless, a few banks, including Bank of Industry, Ecobank, Sterling Bank and Diamond Bank, often in collaboration with donor agencies, have funded or are currently providing funding for the off-grid sector. This financing has primarily targeted companies in need of support to import components and working capital to expand their business with tenors of 2-3 years. Usually, these arrangements have included an equity contribution of 20–30%, collateral valued at 80–140% of the loan amount, and an interest rate of around 25%. Some FIs have been able to reduce their collateral requirements

²⁷⁸ CBN Economic Report for the First Half of 2017; and “CBN Annual Report – 2015,” Central Bank of Nigeria, (2015): <https://www.cbn.gov.ng/out/2016/rsd/central%20bank%20of%20nigeria%20annual%20economic%20report%20-%20draft.pdf>

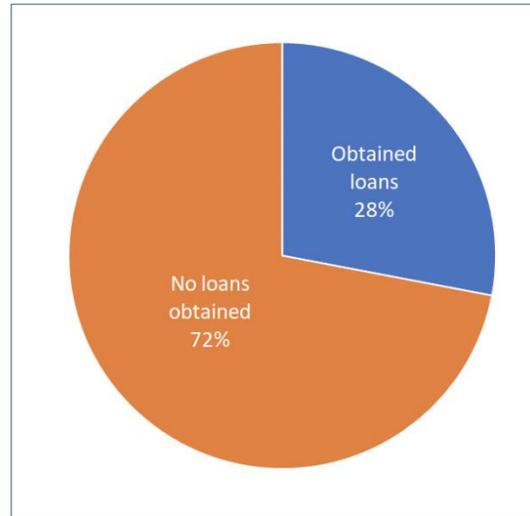
²⁷⁹ CBN Economic Report for the First Half of 2017

²⁸⁰ Ibid.

to as low as 40% of the loan amount due to deployment of partial risk guarantees, such as the MSMEDF and USAID’s Development Credit Authority (DCA).²⁸¹

A countrywide market survey of 57 off-grid solar companies conducted by the International Finance Corporation (IFC) between March and August 2016 found that roughly 72% of the surveyed companies have not received loans from FIs while 28% had received loans (**Figure 61**). Reasons given include discouraging collateral requirements, tedious application processes, high interest rates and upfront fees, etc.

Figure 61: Share of Off-Grid Solar Companies that have Loans from a Financial Institution



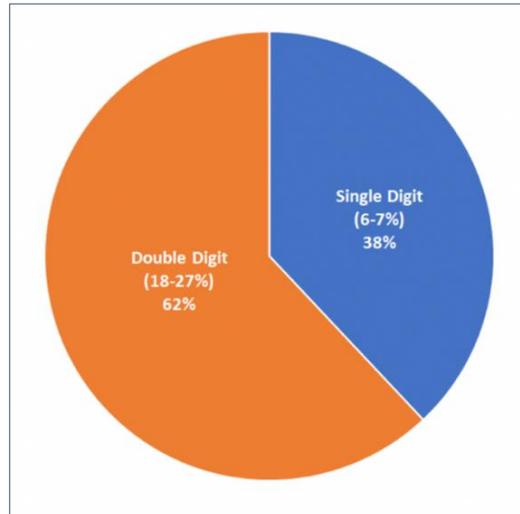
Source: International Finance Corporation

Naira-denominated loans were received in amounts ranging from NGN 460,000 (USD 1,503) to NGN 200 million (USD 653,595) from local FIs, namely: Diamond Bank, Wema Bank, Bank of Industry (BoI), and Zenith Bank. Dollar denominated loans ranged from USD 1 million and above from Zenith Bank and China Exim Bank. Most of the loans received have tenor in the range of three months to three years. Long term loans were obtained from the BoI and China Exim Bank. In addition, most of the loan recipients (62%) reported double digit interest rates from 18 to 27% while only 38% benefited from single digit interest rates between 6-7% (**Figure 62**).²⁸²

²⁸¹ Stakeholder interviews, 2018.

²⁸² “Market Study for Promoting Energy Efficiency and Renewable Energy Investments in Nigeria through Financial Institutions: Summary Report on Solar PV Supply Chain Survey,” International Finance Corporation, (August 2016).

Figure 62: Interest Rates on Loans Secured by Off-Grid Solar Companies



Source: International Finance Corporation

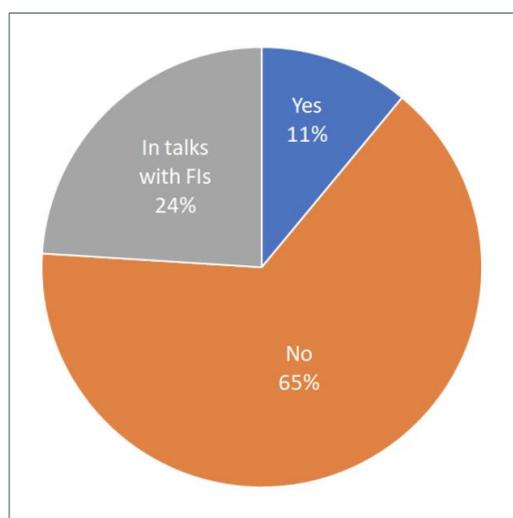
Table 54: Distribution of Bank Loans to Off-Grid Solar Companies

Banks	No. of Off-Grid Solar Companies Financed
Diamond Bank	4
Wema Bank	3
Band of Industry	2
Zenith Bank	2
Access Bank	1
China Development Bank	1
China Exim Bank	1
Ecobank	1
Heritage Bank	1
RenMoney MFB	1
Skye Bank	1
Standard Chartered Bank	1
Touchgold MFB	1

Source: International Finance Corporation

In terms of consumer financing, 65% of the solar companies surveyed indicated that they do not have agreements with banks to provide consumer finance for solar PV products (**Figure 63**).

Figure 63: Off-Grid Solar Companies with Consumer Financing Arrangements with FIs



Source: International Finance Corporation

Of the solar companies interviewed, 24% indicated that they were in talks with FIs such as Ecobank, Zenith Bank, Fidelity Bank, Sterling Bank, insurance companies, and leasing firms such as Cashlink and Opticom Leasing. While Ecobank had a consumer financing interest rate of 24% during the period of the survey, the leasing companies were asking for as much as 30% interest in order to finance consumers of solar products. Only four of the solar companies had existing consumer financing arrangements with FIs. One of the companies had a consumer financing agreement with Sterling Bank while another had an agreement with a leasing firm, Cashlink Leasing Plc.²⁸³

Unfortunately, the foreign exchange crisis that began in 2015 and the resulting economic downturn halted lending in the off-grid solar space for about two years. During 2018, lending in the sector resumed, and Sterling Bank has now emerged as the leading commercial bank in off-grid energy lending, with RE as one of its strategic focus areas. As of July 2018, the bank currently had NGN 120 million (USD 392,157) in loans under its off-grid solar pilot in partnership with four vendors deploying solar solutions to small businesses and households. Sterling Bank provides working capital and inventory financing to its partner vendors as well as consumer financing for end-users on a purely cashflow basis. Similarly, Diamond Bank is partnering with several off-grid solar energy providers, providing consumer financing to its clients to acquire solar systems. Also, with the naira now maintaining stability in the foreign exchange market, Ecobank is looking to resume lending to the space. In the microfinance sub-sector, LAPO Microfinance Bank is the leader in off-grid solar lending providing soft loans with no collateral requirements to individuals/households for pico solar power systems such as solar lanterns. As of September 2018, approximately 140,000 solar lanterns have been financed with NGN 1.1 billion (USD 3 million) by LAPO.

Despite the recent increase in lending by a few FIs, overall, given the size of the Nigerian off-grid market potential, there is still very limited debt financing available. However, it is encouraging that lenders such as Sterling Bank, Diamond Bank, Ecobank, and BoI have made a commitment to this sector, while most others including First City Monument Bank Limited (FCMB), United Bank for Africa (UBA), and Access Bank are also gradually moving towards lending in this space.

²⁸³ "Market Study for Promoting Energy Efficiency and Renewable Energy Investments in Nigeria through Financial Institutions: Summary Report on Solar PV Supply Chain Survey," International Finance Corporation, (August 2016).

3.2.4.1 Current and Planned Off-Grid Solar Programs

➤ Nigerian Energy Support Programme (NESP) – Phase 2

NESP, co-funded by the European Union and the German Government and implemented by GIZ in collaboration with the Federal Ministry of Power, Works and Housing (FMPWH), supports *inter alia* the development of the mini-grid market in Nigeria. During its first phase (2013-2017), NESP supported its local public counterparts with establishment of an enabling environment for private investment in the mini-grid sector on the federal level and in five states (Cross River, Niger, Ogun, Plateau, Sokoto). The program also piloted the development of six off-grid solar mini-grids (50-100 kWp) in collaboration with local private companies using a Public-Private Partnership (PPP) model whereby the private sector covered 50% of the project's capital costs with its own equity and project finance. In collaboration with USAID, NESP also provided TA to the CBN, local financiers (commercial and development banks) as well as international crowdfund financiers such as Bettervest, thereby unlocking access to finance for the six pilot projects.

The second phase of NESP (NESP II) will run from 2018 to 2020 with a budget allocation of EUR 33 million. The main focus of NESP II will be to support mini-grid project implementation. The program will help Federal and State Governments establish support mechanisms to enable the roll-out of privately-led mini-grids to provide sustainable energy access to: (i) previously un-electrified rural dwellers through off-grid solar mini-grids (target: 100,000 people); and (ii) rural (agricultural-processing) businesses that currently use inefficient sources of energy for their activities (target: 400 businesses and 10,000 tons of CO₂ savings p.a.). NESP II will partner with REA and CBN to support the deployment of approximately 15 mini-grids in line with the Rural Electrification Fund Operational Guidelines (REFOG). The projects will be implemented under PPP frameworks by project developers to be selected through an open competitive process. Each project will provide access to electricity to towns of roughly 5,000 households thereby providing access to electricity to approximately 75,000 people. It is foreseen that the 15 mini-grids will represent a total capital investment of EUR 12 million. As part of the NESP II support, up to 40% will be provided through equipment directly procured by NESP II and blended into the project by the REA.²⁸⁴ The remaining 60% of the capital costs will be covered by private investment (including 30% by CBN loans and 30% by the project developers themselves with their own equity).²⁸⁵ In addition, given that the need for access to finance will be much greater than in the first phase, a facility that provides advisory services to financial entities on mini-grid investment decisions will be established under NESP II.

➤ Sustainable Use of Natural Resources and Energy Finance (SUNREF)

In July 2018, the French Development Agency (Agence Française de Développement, AFD) launched the SUNREF Nigeria program with the signing of three separate financing agreements with two Nigerian commercial banks - Access Bank and United Bank for Africa Nigeria, and the Manufacturers Association of Nigeria (MAN), for EUR 74 million co-financed between AFD and the European Union (EU), to finance clean energy investments. The funding includes a EUR 9.5 million investment grant facility and EUR 3.75 million for technical assistance. The program aims to finance over a period of 2 to 3 years a minimum of 10 renewable energy projects in the C&I market segment, with the installed capacity of each project ranging

²⁸⁴ The procurement amount provided by NESP will be calculated based on a fixed amount per connection that will be multiplied by a reasonable forecast of the number of connections as included in the mini-grid project proposal of the selected developer and as certified by the consultants. This amount will then be used by NESP with the support of its consultants to procure the distribution assets of the proposed mini-grid project(s). The ownership of the assets procured by NESP will be transferred to the REA, which will then transfer it to the selected developers under certain conditions (e.g. the quality of generation equipment installed by the developers is as specified in the grant agreement). NESP may decide to additionally procure equipment on the load level (e.g. grid connections or basic in-house installations), maximum procurement amount will however remain at 40% of total capital project costs.

²⁸⁵ Details on the CBN funding/participation were not available at the time of the preparation of this report.

between 1 and 10 MW.²⁸⁶ The pricing of the SUNREF credit lines will be concessional with interest rates expected to be at Government interbank lending rate (which is currently 14%) plus 300 to 400 bps. The maximum loan size shall be USD 15 million with maturity of up to 10 years and a 3-year moratorium. The loans will be offered in EUR to UBA and Access for on-lending to the selected projects. There will be a local currency leg to the credit lines. The eligibility for the loans is not tied in any way to origin of equipment. AFD is partnering with MAN on the selection of potential customers. In addition, AFD plans to expand the SUNREF program by providing additional funding of USD 120 million in 2019 in partnership with other commercial banks.²⁸⁷

Interviews with AFD revealed that the focus of the program on the C&I market segment is based on an initial market assessment conducted specifically for the program by GIZ. The study suggested that it was too early for SUNREF credit lines to finance mini-grids and SHS due to lack of clarity in the delineation of the territoriality and responsibility of the Electricity Distribution Companies (Discos). The Discos believe that their entire franchised region belongs solely to them – not just where their distribution lines currently extend to. A good example of this problem is seen in the legal dispute currently ongoing between the REA and Enugu Electricity Distribution Company (EEDC) regarding REA’s planned 9.5MW embedded power project in Ariaria market in Abia State. Aside from this risk of conflict with the Discos, the GIZ study expressed doubts about the financial viability of projects in the rural off-grid space given that most of the implemented projects in the space have grant components. There were also doubts about certain productive use applications currently being touted, such as solar grain mills, as most of the grain mills in use in the country cannot simply be retrofitted to be powered by solar systems, rather entirely new solar-enabled grain mills have to be delivered. Hence, the study suggested for SUNREF to focus mainly on small scale grid-connected RE and even more so on RE and EE projects in the C&I market segment.²⁸⁸

➤ **Nigeria Electrification Project (NEP)**

The NEP of the World Bank is targeting the off-grid energy sector with an emphasis on privately financed and implemented projects that will qualify for payment of subsidies managed by the REA. The World Bank recently approved an International Development Association (IDA) credit of USD 350 million for the project, which will be implemented by REA.²⁸⁹

Component 1: Solar Hybrid Mini-grids for Rural Economic Development: USD 150 million will be provided by IDA for this component. The target is to provide access to electricity to 300,000 households, and 30,000 MSMEs, through about 850 mini-grids to be built by an estimated 15 mini-grid operators. Early activities are expected in Niger, Sokoto, Ogun, Plateau, and Cross River states based on initial market studies. The component will be implemented under a market-based approach and work with the private sector to construct, operate, and maintain economically viable mini-grids, made possible by subsidies that reduce initial capital outlays. The estimated investment cost of this component is about USD 330 million; hence, it is envisaged that an additional USD 180 million will be provided by private firms, commercial debt providers, other development partners and the Government.²⁹⁰ There are two sub-components that will

²⁸⁶ “AFD supports the Nigerian banking sector with SUNREF,” AFD, (July 4, 2018): <https://www.sunref.org/wp-content/uploads/2018/07/Press-Release-SUNREF-Nigeria.pdf>

²⁸⁷ Stakeholder interviews with UBA Power and Infrastructure, 2018; and

“Nigeria Electrification Project,” World Bank Project Appraisal Document, (May 31, 2018):

<http://documents.worldbank.org/curated/en/367411530329645409/pdf/Nigeria-Electrification-PAD2524-06052018.pdf>

²⁸⁸ Stakeholder interviews, 2018.

²⁸⁹ Itsibor, M., “Nigeria: World Bank Approves Projects to Support Nigeria’s Access to Electricity,” AllAfrica, (29 June 2018):

<https://allafrica.com/stories/201806290038.html>

²⁹⁰ There are indications that the EIB might be interested in contributing to a working capital facility that could be used by private firms participating in this project. For more details, see:

be implemented under this component: (i) Minimum Subsidy Tender for Mini-grids with a budget of USD 70 million, under which the REA will invite private developers to bid for minimum capital cost subsidies according to their business plans to provide electricity to sites pre-selected by REA; (ii) Performance-Based Grants Program with a budget of USD 80 million under which the REA will provide performance-based grants to mini-grid operators on the basis of new customer connections (USD/end-user). The performance-based grants will be made available to developers on a rolling basis until funding is exhausted.

Component 2: Stand-alone Solar Systems for Homes and Enterprises: USD 75 million will be provided by IDA for this component. The goal of this component is to significantly scale up the market for stand-alone solar systems (including solar lanterns, solar kits and SHS) in order to provide access to electricity to more than one million Nigerian households and MSMEs at lower cost than their current service, via stand-alone solar home systems provided by the private sector. Out of the USD 75 million, USD 15 million will be utilized for a Market Scale-up Challenge Grants sub-component under which performance grants will be offered to qualified, large-scale providers to accelerate their sales to households and MSMEs. A rigorous evaluation process and a tranche-based payout will be used to manage any risk of non-performance. The remaining USD 60 million will be utilized for an Output-Based Grants sub-component under which grants up to 20% of the system costs to the grantees, for each eligible system installed and verified by the private sector. The grant amount will be fixed for each system size/level of service category, and continually reduced over the life of the program as the market grows. This component plans to collaborate with the ROGEP and build upon the Lighting Africa Nigeria program. Only products certified by Lighting Global will be eligible under this project. Larger solar systems and their providers will be subject to more technical pre-qualification, which will be assessed by a technical consultant. We believe that in achieving the target set for this component, the ROGEP risk mitigation facility will be crucial in further de-risking this market segment and mobilizing financing for the off-grid energy providers.

3.2.4.2 Programs Supporting Financial Institutions in Off-Grid Solar Lending

➤ IFC Sustainable Energy Finance (SEF) Program

In September 2016, IFC’s Off-Grid and Embedded Solar Market Development and Finance Program, and DFID’s Solar Nigeria Program partnered to launch this program to facilitate the deployment of off-grid and/or captive solar systems in the commercial and industrial sectors of Nigeria. The program has three components: Market Awareness, Quality Assurance and Finance. Under the Finance component, the program is currently providing advisory services to some banks in the country including the DBN, FCMB and BoI – on its NGN 6 billion (USD 19.6 million) solar fund. The program is still considering possibly providing financial instruments to local financial institutions for off-grid energy projects. The SEF program is part of the World Bank Group’s Energy Business Plan for Nigeria where each World Bank Group (WBG) institution (IFC, International Bank for Reconstruction and Development (IBRD), and Multilateral Investment Guarantee Agency (MIGA)) leverage their competencies and products to provide solutions for projects that contribute to the sustainability of the power sector.²⁹¹

➤ IFC Lighting Africa – Nigeria Program

The Lighting Africa Nigeria program was launched in 2015 to increase access to cleaner and safer off-grid lighting and energy products to rural and peri-urban populations without grid access. The program aims to

²⁹¹ “Nigeria Electrification Project,” World Bank Project Appraisal Document, (May 31, 2018):

<http://documents.worldbank.org/curated/en/367411530329645409/pdf/Nigeria-Electrification-PAD2524-06052018.pdf>

²⁹¹ Audu, E. and MacInnis, L., “IFC and DFID Partner to Improve Access to Electricity for More Small and Medium Enterprises,” International Finance Corporation, (September 20, 2016):

<https://ifcextapps.ifc.org/ifcext%5Cpressroom%5Cifcpressroom.nsf%5C0%5CFAFC8787A21A8F5F852580340032A44F>

help six million people gain access to clean, modern, affordable lighting products – solar lanterns and small solar home systems (SHS) – while avoiding 120,000 metric tons of greenhouse gas emissions. To achieve this, the program is collaborating with nine MFIs in the country,²⁹² offering basic knowledge training on pico solar products meeting the Lighting Global Quality Standards to MFI employees,²⁹³ who in turn introduce the products to their customers and provide them with microloans to purchase the products. The MFIs typically offer loans in the NGN 20,000-50,000 (USD 65-163) range with high interest rates ranging between 30-50% per annum and repayment periods of 12–26 weeks. Some of the MFIs provide the loans as add-ons for customers taking regular loans while others offer specific loan products for acquiring the solar systems. These loans have no collateral requirements due to the group lending approach adopted by the MFIs. Under the group lending methodology, a self-selected group of people can access loans individually, but will have group liability. Default rates thus far have been below 5%.²⁹⁴

Interviews with the Lighting Africa team revealed that the MFIs are limited in funding and will need ROGEP credit lines to expand their offerings. However, the team emphasized that a hands-on engagement with the MFIs is critical in ensuring demand for the loans. The Lighting Africa team has been actively engaged in the marketing of the products, with Lighting Africa field agents accompanying the credit officers of the MFIs in engaging customers to generate demand. The Lighting Africa team has also had to carry out consumer education campaigns to drive demand for the solar lanterns and SHS through a combination of road shows, market storms, radio advertising and product presentation forums. As of December 2017, a total of 596,000 pico solar products had been sold under the program, impacting up to 1.4 million people.²⁹⁵

The program plans to cover only 20 of the 36 States in the country due to funding limitations. Also, the Lighting Africa team’s work in the North Eastern region of the country has been limited due to security concerns. To date, the program has focused on more secure/less difficult areas of the country such as the South Western region, particularly Lagos, which accounts for the largest portion of sales.

➤ **Beyond-the-Grid**

Employing an approach similar to the Lighting Africa Nigeria Program, USAID Power Africa’s Beyond the Grid (BTG) team in Nigeria is actively facilitating partnerships between high-potential off-grid energy companies and MFIs. BTG works hand-in-hand with the sales officers of the pico solar companies and the loan officers of the Microfinance Banks (MFBs) to effectively couple off-grid power products with MFI loan products. Through these partnerships, the pico solar sales agents engage the MFI’s customers’ groups, called unions, which comprise of 10 to 50 members, the majority of which are women. Typically, the process involves the pico solar company’s sales agents’ demonstration of their systems to the group, after which the group members indicate their choice of products ranging from 1-watt solar lanterns to 4-watt pico solar products, and the loan officer simultaneously begins the loan approval process. This includes due diligence on the recipient of the loan to ensure proper documentation and credibility of the client. The pico solar company is paid once the loan is issued.

The BTG team provides on-the-ground training to the MFIs’ loan officers to help them market the solar solutions in tandem with their loans to their last-mile customers. The BTG team also monitors and assesses the distribution strategies of the off-grid sales agents working with each MFI to ensure quality delivery. Thus far, the BTG team has established new partnerships with at least three MFIs at the national level, ten

²⁹² The MFIs include LAPO MFB, Grooming Centre, Susu MFB, Olive MFB, and five other State MFIs in Anambra, Ogun and Lagos States
²⁹³ Lighting Global maintains Quality Standards that set a baseline level of quality, durability, and truth in advertising to protect consumers. Meeting the Standards is required for participation in Lighting Global support programs, including Lighting Africa.
²⁹⁴ Stakeholder interviews with IFC, 2018.
²⁹⁵ “Lighting Africa Nigeria: A program designed to impact 6 million people,” International Finance Corporation, (December 2018): <https://www.lightingafrica.org/country/nigeria/>

at the state level, and several others at the local level. The most important partnership to date is with the largest MFI in Nigeria, LAPO microfinance bank, which has over 400 branches across 35 states in Nigeria. BTG's support to the solar companies working with LAPO since November 2016 has resulted in increased sales of solar lanterns and SHS, from an initial point of 500 systems per month to now over 8,000 new solar systems sold per month. In addition to LAPO, the BTG team is also supporting other leading MFIs, including Grooming Centre MFI, Accion MFB, Fortis MFB and Mutual Benefits MFB.²⁹⁶

➤ **USAID Climate Economic Analysis for Development, Investment, and Resilience (CEADIR)**

The CEADIR engagement in West Africa took place from 2016 to 2018. The program's objective was to strengthen the capacity of FIs for clean energy lending in eight West African countries (Côte d'Ivoire, Ghana, Guinea, Liberia, Niger, Nigeria, Senegal and Sierra Leone) addressing their common challenges by developing the capacity of bank staff to provide loans for various clean energy technologies and business models and adapting their support to the specific context each country. CEADIR supported local banks by delivering a national workshop on stand-alone solar and mini-grids, which was complemented with one-on-one technical assistance to help banks develop clean energy lending strategies.²⁹⁷ In Nigeria, CEADIR determined that it was preferable to present a more narrowly focused training activity on addressing opportunities in the commercial and industrial as well as residential real estate sectors. Seven banks participated in the program in some capacity – FCMB, Diamond Bank, Access Bank, Standard Chartered, Stanbic, UBA, and Sterling Bank.²⁹⁸

3.2.4.3 Key Barriers to Off-Grid Solar Lending

➤ **Unfamiliarity with the Off-Grid Solar Sector**

One of the reasons for the low level of lending to the off-grid solar sector in Nigeria is that the local FIs largely have a limited understanding of the sector. Moreover, off-grid solar lending is generally seen as presenting additional risk because most FIs do not know how to conduct credit-risk analysis for off-grid solar projects. Some FIs are also still skeptical that meaningful cash flow can be generated from OGS projects or that the cash flow can be relied upon to repay loans. Given the plethora of unqualified suppliers and the poor quality of many previously installed systems, this is not difficult to understand.²⁹⁹ However, several donor programs such as the recently concluded USAID REEEP and the NESP have done quite a lot in addressing this problem by supporting local lending institutions to better understand the risks associated with the sector and the requirements of its stakeholders, with good level of progress being recorded. Yet, most of the interviewed FIs emphasized a need for further technical support, particularly in conducting due diligence/technical assessments of off-grid solar companies and training of credit officers.

➤ **Maturity Structure of Banks' Funding**

Aside from the high interest rate environment, the dominance of short-term deposits has constrained the ability of Nigerian banks to create long-tenor consumer financing products that is necessary for the acceleration of the off-grid solar market. The USAID REEEP calculated the inflection point where the monthly payback for an off-grid solar system that replaces a traditional generator is lower than the monthly

²⁹⁶ Kponu, E., "Nigerian Micro-Finance Banks Start Selling Solar," Medium, (May 29, 2018): <https://medium.com/power-africa/nigerian-micro-finance-banks-start-selling-solar-203638648b4b>

²⁹⁷ USAID CEADIR: <https://www.climatelinks.org/resources/renewable-energy-lending-west-africa>

²⁹⁸ "Market Assessment Report on Clean Energy: Nigeria," USAID Climate Economic Analysis for Development, Investment and Resilience (CEADIR), (June 2018): <https://www.climatelinks.org/resources/renewable-energy-lending-west-africa>

²⁹⁹ "The USAID Power Africa Renewable Energy and Energy Efficiency Project, 2014-2018: Resources Book," Winrock International, (2018): <https://www.winrock.org/wp-content/uploads/2018/02/REEEP-Resource-Book-20180222-.pdf>

cost of running that generator. It was found that this is achieved with consumer financing at 9% over five years. This was determined to be the tipping point (assuming 100% financing) where replacing a current diesel or petrol generator with an equivalent solar system results in immediate monthly savings on a customer's energy bill.

While Lease-to-Own and Pay-As-You-Go (PAYG) payment models reduce entry barriers for consumers by allowing for small, incremental payments for electricity, rather than demanding a high up-front cost for installation and service, these models push the financial burden from consumers to off-grid energy service providers. This problem is exacerbated in the SHS, C&I and productive use segments, while the pico solar segment is less affected due to the relatively low cost of products and the existence of financing through MFIs, IFC's Lighting Africa Nigeria program and the Power Africa BTG program. However, MFIs would still require additional support in order to expand their offerings to all the regions of the country.

➤ **Lack of Credit History/High Collateral Requirements**

The lack of credit history of off-grid solar service providers is another major bottleneck hampering financing of the sector as banks consider it too risky. Even when loans are made available, potential borrowers often consider collateral requirements too stringent. Given the current high NPL levels in the banking sector, with the banks preferring to invest in treasury bills as against lending to the private sector, all of the interviewed commercial banks emphasized that the availability of adequate credit guarantees is critical in encouraging lending to the space and overcoming this barrier. An example of this is the 80% *parri-passu* USAID DCA USD 5 million credit guarantee facility provided to Ecobank Nigeria for off-grid energy lending. The bank has a collateral requirement of up to 120% of principal amount but it was able to lend to some off-grid solar borrowers with a significantly reduced collateral requirement of between 30-35% of the loan amounts. However, the FX crisis and resulting economic downturn put a halt on lending for about two years, preventing the DCA from reaching its full potential.³⁰⁰

➤ **Foreign Exchange Risk**

Foreign exchange risk remains a major business risk in Nigeria. The foreign exchange crisis that began in 2015 and the resulting economic downturn put a halt on lending in the renewable energy space for about two years. Although, the CBN has since been able to stabilize the Foreign Exchange (FX) market to a large extent, the Nigerian economy still remains vulnerable to FX shocks that may occur due to fluctuations in oil prices. In July 2018, the IMF stated that despite the relief higher oil prices and short-term portfolio inflows have provided to Nigeria's economy, the country remains vulnerable to oil price and production shocks, as the economy remains heavily dependent on oil revenues. Still, activity in the non-oil non-agricultural sector remains weak as lower purchasing power weighs on consumer demand and as credit risk continues to limit bank lending. In addition, the CBN's foreign exchange guidelines discourage lending for imports, including renewable energy products: CBN has a rule that borrowers cannot take hard currency loans if their income is naira-based and if they cannot prove their ability to repay in hard currency.³⁰¹

³⁰⁰ Ibid.

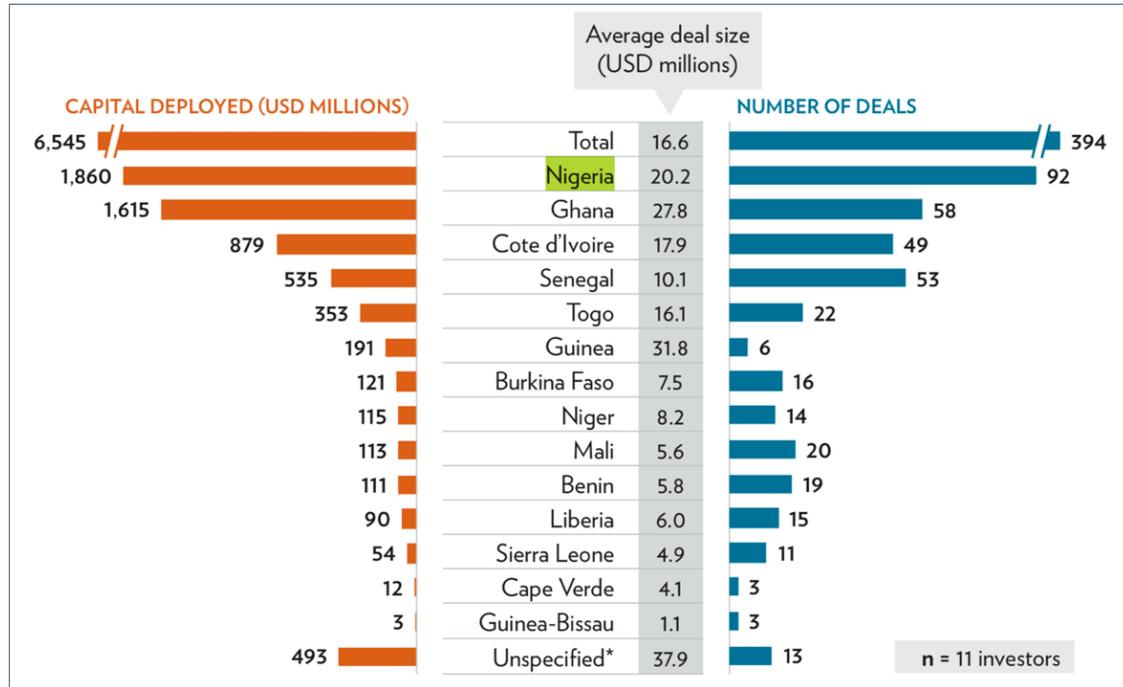
³⁰¹ Chima, O. and Francis, N., "Nigeria Economy Still Vulnerable to Oil Shocks, Says IMF," This Day, (July 14, 2018): <https://www.thisdaylive.com/index.php/2018/07/14/nigerias-economy-still-vulnerable-to-oil-shocks-says-imf/>; and "Market Study for Promoting Energy Efficiency and Renewable Energy Investments in Nigeria through Financial Institutions: Summary Report on Solar PV Supply Chain Survey," International Finance Corporation, (August 2016).

3.3 Financial Institutions³⁰²

3.1.1 Development Finance Institutions

Between 2005 and 2015, USD 1.9 billion of capital was deployed across 92 direct investments in Nigeria, with an average deal size of USD 20.2 million. Nigeria was the largest recipient of capital deployed by DFIs in the region during this period; the amount of funding the country received was equal to 28% of total DFI investment across the region (Figure 64).³⁰³

Figure 64: DFI Investment in West African Countries, 2005-2015



Source: Global Impact Investing Network and Dahlberg

Funding from DFIs focuses mainly on large deals in energy, manufacturing, and information and communications technology (ICT) reflecting the country’s needs in these areas. Large deals of more than USD 50 million account for 60% of total capital deployed, although, in terms of number of deals, most deals are considerably smaller – more than half the number of deals made is below USD 10 million. The DFIs deploy almost all of their investments through debt, with large loans for energy and manufacturing projects making up a significant portion of this.³⁰⁴ In addition to the abovementioned SUNREF II program, the DFIs that have been most active in supporting the off-grid solar sector are described below.

➤ African Development Bank

³⁰² Excluding commercial banks, which are reviewed in detail in Section 3.2.

³⁰³ “The Landscape for Impact Investing in West Africa: Understanding the Current Status, Trends, Opportunities and Challenges,” Global Impact Investing Network and Dahlberg, (2015): https://thegiin.org/assets/upload/West%20Africa/RegionalOverview_westafrica.pdf

³⁰⁴ “The Landscape for Impact Investing in West Africa: Understanding the Current Status, Trends, Opportunities, And Challenges,” Global Impact Investing Network and Dahlberg, (2015): https://thegiin.org/assets/upload/West%20Africa/RegionalOverview_westafrica.pdf

Access to energy has taken a prominent role in the AfDB's agenda since new leadership took over in 2015. In line with this, the bank launched the 'New Deal for Energy in Africa' – a partnership-driven initiative with the aspirational target of connecting 75 million households in Africa through off-grid energy access solutions by 2025. To achieve this goal, AfDB has committed to invest about USD 12 billion between 2016 and 2020 with the expectation of leveraging between USD 45-50 billion in co-financing for energy projects in Africa during the period.³⁰⁵

Facility for Energy Inclusion (FEI): The FEI is a USD 500 million Pan-African debt facility created by the AfDB to support the achievement of its access to energy goals by providing debt capital to SHS companies, small independent power producers and mini-grid developers. The AfDB Board approved a USD 50 million equity investment and USD 50 million convertible debt investment for the facility in December 2016, and the facility is seeking to raise additional USD 400 million from investors. It will offer both senior and subordinated loans to mini-grid developers with a tenor of 10-15 years that fits project economics. FEI will offer both USD and local currency loans, ranging between from USD 2-10 million. In December 2017, the AfDB Board approved a USD 30 million investment in the FEI Off-Grid Energy Access Fund (FEI OGEF), one of the financing windows of the FEI. FEI OGEF is a USD 100 million blended finance debt fund aimed at scaling up access to clean electricity for off-grid households and crowding in local financial institutions as co-lenders. FEI OGEF reached its first close in August 2018 with committed capital of USD 58 million from the AfDB, the Nordic Development Fund (NDF), the Global Environment Facility (GEF), Calvert Impact Capital and All On. In addition, the NDF will provide a EUR 0.5 million grant for technical assistance to support deal structuring and capacity development.³⁰⁶

FEI OGEF, which is being managed by Lion's Head Global Partners, will provide loans predominantly in local currency to off-grid energy companies in form of corporate lending, inventory financing, receivables financing etc. The loans will be provided on commercial terms at interest rates reflective of prevailing market rates in order to avoid crowding out local lenders. A considerable amount of this funding is expected to benefit companies operating or planning to enter Nigeria.

Nigeria Energy Access Fund (NEAF): The NEAF is being jointly developed by AfDB and All On, an independent impact investing fund in Nigeria established by Shell that targets SHS companies, independent power producers and mini-grid developers. NEAF is an equity fund, anchored by USD 10 million in equity from AfDB, USD 5 million from All On, along with additional capital from other local investors and potential support from the Green Climate Fund (GCF) private sector facility. NEAF aims to mobilize USD 100 million and expects to provide loans in both USD and local currency, depending on the financing needs of the borrower. The fund was expected to achieve a USD 40 million first close by Q2 2018. An interview with the All On team revealed that recent changes at the GCF resulted in some delay in the initial plan to achieve a USD 40 million first close by Q2 2018, however, discussions are now back on track and the process for the recruitment of a Fund Manager is expected to commence in October 2018.³⁰⁷

³⁰⁵ "The New Deal on Energy for Africa: A transformative partnership to light up and power Africa by 2025," African Development Bank Group, (2018): https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Brochure_New_Deal_2-En.pdf

³⁰⁶ "African Development Bank, Nordic Development Fund, Global Environment Facility and Calvert Impact Capital partner in \$55 million investment into Off-Grid Energy Access Fund," African Development Bank Group, (January 4, 2018): <https://www.afdb.org/en/news-and-events/african-development-bank-nordic-development-fund-global-environment-facility-and-calvert-impact-capital-partner-in-us-55-million-investment-into-off-grid-energy-access-fund-17743/>; Nigeria Electrification Project," World Bank Project Appraisal Document, (May 31, 2018): <http://documents.worldbank.org/curated/en/367411530329645409/pdf/Nigeria-Electrification-PAD2524-06052018.pdf>; and "African Development Bank, Nordic Development Fund and Partners launch Off-Grid Energy Access Fund with US\$ 58 million," African Development Bank Group, (August 27, 2018): <https://www.afdb.org/en/news-and-events/african-development-bank-nordic-development-fund-and-partners-launch-off-grid-energy-access-fund-with-us-58-million-18432/>

³⁰⁷ Stakeholder interviews, 2018; and

Nigeria Electrification Project," World Bank Project Appraisal Document, (May 31, 2018):

<http://documents.worldbank.org/curated/en/367411530329645409/pdf/Nigeria-Electrification-PAD2524-06052018.pdf>

➤ **International Finance Corporation**

IFC has been active in facilitating solutions to help increase energy access in Nigeria. In 2014, IFC provided a USD 20 million facility to FCMB for on-lending to energy efficiency and renewable energy projects in the country. In 2015, in collaboration with the World Bank, IFC launched the Lighting Africa Nigeria program and in 2016 it partnered with the UK DFID to launch the Sustainable Energy Finance program. IFC is also supporting a proposed 120 MW solar PV grid-connected project in Kogi State being developed by Alten Renewable Energy Developments Africa, Green Continent Partners Holding B.V. and Nemoante Limited.³⁰⁸

3.1.2 Economic Development Finance Institutions

There are six existing State-owned Economic Development Finance Institutions in Nigeria, namely: Bank of Industry (BoI), Federal Mortgage Bank of Nigeria (FMBN), Nigerian Export-Import Bank (NEXIM), Bank of Agriculture (BOA), The Infrastructure Bank (TIB) and the newly established Development Bank of Nigeria (DBN).³⁰⁹ **Table 55** and **Table 56** show key performance indicators and market shares of these institutions (excluding DBN) as of end-June 2017.

Table 55: Nigerian Economic DFIs Financial Indicators (USD million)

Indicator	Dec-2016	June-2017	% Change
Total Assets	3,151	3,217	2.1%
Net loans and advances	1,869	2,211	18.3%
Paid-up capital	754	760	0.7%
Shareholders' funds	671	649	-3.3% ³¹⁰

Source: Central Bank of Nigeria

³⁰⁸ Progress in the execution of this project and the other 13 grid-connected solar PV project with Nigerian Bulk Electricity Trader (NBET)-signed PPAs has been stalled due to various issues. These include inconsistencies in agreements on tariffs between project developers, NBET and the Federal Ministry of Finance, who would be backstopping the put-call option agreements (PCOA), and on indemnities issued by the FGN. The degree of insolvency in the sector has affected the willingness of the World Bank to provide Partial Risk Guarantees (PRGs) (though a number of projects had been nominated), which are required by both equity and debt providers. This has also delayed the flow of concessionary financing required by these projects, given the high costs and patient capital required. See: <https://thelawreviews.co.uk/edition/the-renewable-energy-law-review-edition-1/1173972/nigeria>; and Audu, E. and MacInnis, L., "Alten and IFC Boost Renewable Energy Supply and Energy Security in Nigeria," International Finance Corporation, (December 8, 2015): <https://ifcextapps.ifc.org/ifcext/pressroom/ifcpressroom.nsf/0/6D8062E42B4B966085257F1600240411>

³⁰⁹ CBN Financial Stability Report, 2017.

³¹⁰ The decline in shareholder funds is attributed mainly to increased loan provisioning arising from loan defaults.

Table 56: Market Share of Nigerian Economic DFIs

Financial Institution	Share of Total Assets (%)	Share of Net Loans and Advances (%)
Bank of Industry	67.7%	74.5%
Federal Mortgage Bank of Nigeria	21.3%	19.2%
Nigeria Export-Import Bank	6.9%	6.1%
Bank of Agriculture	3.4%	0.1%
The Infrastructure Bank	0.7%	0.5%

Source: Central Bank of Nigeria

The Nigerian Economic Development Finance Institutions that have been active in the off-grid solar/SME sector to date are described below.

➤ **Bank of Industry**

BoI is Nigeria’s oldest and largest Economic Development Finance Institution. It was reconstructed in 2001 out of the Nigerian Industrial Development Bank (NIDB) Limited, which was incorporated in 1964. It is owned by the Ministry of Finance (94.80%), Central Bank of Nigeria (5.19%) and other Nigerian citizens (0.0008%). The bank is primarily engaged in providing financial services for the establishment and expansion of large, medium small scale and micro economic enterprises. In the first half of 2017, BoI disbursed a total of N54.2 billion to Microenterprise, Small and Medium Enterprises and Large Enterprise with each sub-sector receiving 10.3%, 11.8% and 77.9% respectively.³¹¹ In July 2018, the bank secured a USD 750 million (NGN 250 billion) syndicated loan facility from 16 lenders including the African Export-Import Bank, the ECOWAS Bank for Investment and Development (EBID) and British Arab Commercial Bank Plc, which will be disbursed at single digit interest rate. This is in line with the bank’s target to raise NGN 1 trillion (USD 3.3 billion) loan facility, locally and abroad, to partially-finance the industrial component of the FGN’s Economic Recovery and Growth Plan. Through the facility, BoI plans to provide single digit interest loans with longer terms of between seven to eight years to MSMEs in the country.³¹²

BoI has been active in off-grid energy financing; in 2015, the bank kickstarted a pilot scheme through which off-grid solar electrification projects were deployed in six rural communities in Gombe, Niger, Osun, Anambra, Edo and Kaduna States, in partnership with two off-grid energy companies – GVE Projects Limited and Arnergy Solar Limited. Under the pilot scheme, BoI provided NGN 240 million (USD 784,000) in long-term financing (15-year tenor) at 7% interest rate for the installation of micro-grid and stand-alone solar solutions. The loans were secured by All Assets Debentures. Based on the success of the pilot, BoI, in September 2016, signed a USD 2 million agreement with the UNDP to fund the second phase of the project to provide solar energy solutions to 11 additional off-grid communities in Gombe, Niger, Anambra and Kaduna States. Under the partnership, the bank would provide USD 1.4 million as debt financing, while the UNDP would provide a grant contribution of USD 600,000.³¹³ The implementation of these second phase projects is still ongoing, with seven projects already completed as of late 2018. Three of the four remaining installations will be completed by 2019. The loans for these projects also secured by All Assets Debentures and the work is being implemented under the same loan terms as the initial pilot and by the same two solar energy providers. In addition to these projects, BoI also provides debt facilities to

³¹¹ CBN Economic Report for the First Half of 2017.

³¹² Kareem, T., “Bank of Industry: Nigeria’s Game Changer in Boosting Small Business,” Leadership.NG, (July 24, 2018): <https://leadership.ng/2018/07/24/boi-nigerias-game-changer-in-boosting-small-business/>

³¹³ Agunbiade, Y., “UNDO, BoI Sign \$2M Agreement on Solar Power to Nigerian Communities,” Information Nigeria, (September 29, 2016): <http://www.informationng.com/2016/09/undp-boi-sign-2m-agreement-solar-power-nigerian-communities.html>

local commercial banks for on-lending to SMEs in specified sectors, some of which may indirectly include off-grid solar.³¹⁴

In January 2017, BoI announced the launch of an NGN 1 billion (USD 3.3 million) Solar Energy Fund to provide funding for solar projects powering MSMEs (mainly in urban areas) across Nigeria in line with its mandate, shifting its focus from rural electrification. Interviews with the BoI RE team revealed that the size of the fund has recently been increased to NGN 6 billion (USD 19.6 million). Through the fund, MSMEs involved in activities which include but are not limited to: (i) Value addition along all key supply chains in sectors such as agriculture, solid minerals, etc.; (ii) Cottage Industries; (iii) Artisans; (iv) and other services industries (e.g. barbers, tailors, welders, etc.) will be able to access 3-5 year loan tenors at 9% interest rate, with a moratorium of six months to 1 year for solar energy projects. Loan sizes will range between NGN 10-350 million (USD 32,680 – 1.1 million). Projects with funding requirements beyond the NGN 350 million (USD 1.1 million) single obligor limit of the fund can apply to the bank’s traditional fund which offers an interest rate of 10% with five-year tenor. The funds may be accessed directly by well-structured SMEs or via a solar project developer serving as the obligor with the responsibility for deploying the solar solutions as well as collection of revenue from the end users. Initially, eight solar energy providers including GVE Projects, Arnergy Solar, Go Solar, and Nayo Tropical were approved as technical partners for mobilizing the fund.³¹⁵ However, this approach has been jettisoned as access to the fund is no longer restricted to the pre-approved solar energy providers. Any solar energy company or direct end-user that meets BoI’s Risk Acceptance Criteria (RAC) can access the fund at 9% interest rate. Regarding security arrangements and collateral for accessing funding, the facilities financed will operate under credit insurance guarantee (or bank guarantee or legal mortgage), personal guarantee of the business’ managing director/notarized statement of net worth, and an all assets debenture on the equipment to be financed.³¹⁶

In addition, for end users who do not meet the bank’s RAC, the funds may also be accessed through local commercial banks and MFIs. BoI intends to on-lend to local FIs at 12% interest rate for the FIs to lend to MSMEs at up to 18% interest rate.³¹⁷ However, stakeholder interviews revealed that several FIs declined to partner with the facility, citing BoI’s Bank Guarantee requirement. As of 2018, no disbursements had been made from the fund – with the fund’s stringent collateral requirements identified as a key deterrent.

➤ **Development Bank of Nigeria (DBN)**

The DBN was granted license to operate as a wholesale National Economic Development Finance Institution in the first half of 2017. The bank’s mandate is to provide funding to Participating Financial Institutions (PFIs) for on-lending to the MSME sub-sector. The DBN was created by the Federal Government of Nigeria to address financing challenges hindering private sector investment in the country – statistics show that less than 5% of over 37 million MSMEs in the country have access to credit. The DBN is expected to provide funding and risk sharing facilities to MSMEs as well as small corporates. The bank’s funding partners include the World Bank, AfDB, AFD, and KfW. DBN currently has about USD 1.3 billion in funding and recently received a USD 70 million equity injection from the European Investment Bank (EIB) and AfDB.³¹⁸

³¹⁴ Bank of Industry: <https://www.boi.ng/on-lending-to-commercial-banks/>

³¹⁵ “BoI announces N1 billion solar energy fund for small businesses,” Financial Nigeria, (January 23, 2017): <http://www.financialnigeria.com/boi-announces-n1-billion-solar-energy-fund-for-small-businesses-sustainable-photovideo-details-683.html>

³¹⁶ “Accessing BoI’s 1 Billion Naira Solar Fund for MSMEs,” Nigeria Energy Future,” (8 May 2017): <http://www.nigeriaenergyfuture.org/finance/11-energy-finance/54-accessing-boi-s-1-billion-Naira-solar-fund-for-msmes>

³¹⁷ Bank of Industry Solar Energy Fund: <https://www.boi.ng/solar-energy/>

³¹⁸ Ujah, E., “DBN to deploy \$1.3 billion as loans to MSMSs,” Vanguard, (May 14, 2018): <https://www.vanguardngr.com/2018/05/dbn-deploy-1-3b-loans-msmes/>

In May 2018, DBN announced the selection of five commercial banks (Sterling Bank, Wema Bank, Ecobank, Diamond Bank, and Fidelity Bank) and four microfinance banks (MicroCred, Infinity, Busack, and Fortis) to manage its intervention fund to MSMEs. The bank has stated it aims to provide up to NGN 5 billion (USD 13.8 million) in long-term funding to about 20,000 MSMEs in its first year of full operation. The loans will have tenors of up to 10 years with a moratorium of up to 18 months. In terms of pricing, the loans will be benchmarked against the prevailing money market rates. In addition, DBN plans to set up a subsidiary that will provide 50% guarantees for all credit disbursed through the DBN. The subsidiary, which would become operational in 2019, would have USD 35 million of start-up funding.³¹⁹ The DBN would make its funds available to MSMEs across all sectors of the economy – including the solar sector.³²⁰

➤ **Bank of Agriculture (BOA)**

Initially established in 1972 and restructured in 2000, the BOA, is a state-owned bank that is jointly owned by the CBN (40%) and the Federal Ministry of Finance Incorporated (60%). The bank is focused on agricultural and rural development and provides credit facilities to both small- and large-scale rural farmers and small businesses. However, BOA is currently struggling to provide sustainable support to the agricultural sector due to its high NPL ratio. In August 2018, BOA signed a cooperation agreement with Daystar Power for the installation of off-grid solar systems at the bank’s 158 locations and to provide solar power solutions to rural areas in the country in order to improve agricultural productivity. Further details on the agreement are currently unavailable.³²¹

3.1.3 Microfinance Institutions

As defined in the Guidelines for MFBs, a microfinance bank is any company licensed to carry on the business of providing microfinance services, such as savings, loans, domestic funds transfer, and other financial services that are needed by the economically active poor, micro, small and medium enterprises to conduct or expand their businesses. There are three categories of licenses issued to MFIs by the CBN (**Table 57**):³²²

Table 57: Categories of Microfinance Bank Licenses

Type	Area of Coverage	Paid-up Capital (NGN)
Unit License	Permits the MFI to own and operate a single office at a single location.	NGN 20 Million
State License	Permits the MFI to own several branches but operate only within a single State.	NGN 100 Million
National License	Permits the MFI to operate several branches in as many States within the country.	NGN 2 Billion

Source: Central Bank of Nigeria

³¹⁹ “Sterling Bank, others to supervise DBN loan disbursement,” National Daily, (May 14, 2018): <https://nationaldailyng.com/sterling-bank-others-to-supervise-dbn-loan-disbursement/>

³²⁰ The possibility of providing a ROGEP credit line and/or a risk sharing facility dedicated to off-grid solar projects through DBN Partner FIs is a possible area of collaboration between DBN and ROGEP.

³²¹ “Daystar Power and Nigerian Bank of Agriculture partner to electrify rural Nigeria,” Private Equity Wire, (21 August 2018): <https://www.privateequitywire.co.uk/2018/08/21/267606/daystar-power-and-nigerian-bank-agriculture-partner-electrify-rural-nigeria/>; and

“Nigerian farmers refuse to repay NGN 60 billion loan – Bank of Agriculture,” Premium Times Nigeria, (March 28, 2018): <https://www.premiumtimesng.com/news/headlines/263324-nigerian-farmers-refuse-to-repay-n60-billion-loan-bank-of-agriculture.html>

³²² Bank of Industry: <https://www.boi.ng/solar-energy/>

Following the expiration of the December 31, 2007 deadline for all existing community banks to re-capitalize to a minimum of NGN 20 million (USD 55,000) shareholders’ fund, unimpaired by losses, and in turn convert to MFIs, the existence of community banks ceased. A total of 600 community banks successfully converted to MFBs and since then the CBN has issued additional licenses bringing the total number of MFIs in the country to 1,023.³²³ However, despite the large number of MFIs, the microfinance sub-sector in the country is highly concentrated with the top 10 out of the existing 991 MFIs as of March 2017, accounting for 40%, 37% and 39% of the sector’s total loans, deposits and assets, respectively.³²⁴ **Table 58** shows key performance indicators for the MFI sector as of June 2017, while **Table 59** presents a summary of the FY 2016 results of four major MFIs in Nigeria.

Table 58: Microfinance Sector Financial Indicators (USD million)³²⁵

Indicator	Dec-2016	June-2017	% Change
Total Assets	1,157	1,226	5.9%
Net loans and advances	622	631	1.5%
Deposit Liabilities	564	605	7.3%
Paid-up capital	206	208	0.9%
Shareholders’ funds	261	298	14.4% ³²⁶
Reserves	55	91	64.1%

Source: Central Bank of Nigeria

Table 59: Summary of FY 2016 Results for Four Major MFIs³²⁷

Indicator	LAPO	Accion	NPF	MicroCred
Capital Adequacy Ratio (%)	38.6%	49.0%	40.6%	58.7%
Return on Assets (%)	11.7%	9.8%	6.5%	0.4%
Return on Equity (%)	56.3%	22.0%	18.4%	0.7%
Cost to Income (%)	71.0%	76.3%	69.8%	107.9%
Non-Performing Loan (NPL) ratio (%)	5.8%	18.6%	3.2%	3.6%
NPL coverage (%)	82.0%	67.5%	40.1%	35.0%
Total Asset (NGN billion)	62.7	7.5	12.4	-
Net Asset (NGN billion)	13.6	3.4	4.5	-
Customer Deposit (NGN billion)	27.7	2.0	6.8	-
Gross loans and advances (NGN billion)	52.3	6.5	9.2	-
Gross Earnings (NGN billion)	26.9	4.0	2.9	-
Profit Before Tax (NGN billion)	6.7	0.7	0.8	-
Profit After Tax (NGN billion)	4.6	0.5	0.6	-
Operating Expense (NGN billion)	16.4	2.3	1.9	-
Operating Income (NGN billion)	24.1	3.4	2.7	-
Loan Loss Expense (NGN billion)	1.0	0.5	0.04	-
Liquidity Ratio (%)	35.2%	NA	28.0%	-
Cost of Funds (%)	7.1%	NA	NA	-

Source: 2016 Annual Reports

³²³ Central Bank of Nigeria: <https://www.cbn.gov.ng/supervision/AllFinInstitutions.asp>

³²⁴ Emmanuel, P., “10 Microfinance banks account for 40% of industry loans – CBN,” Vanguard, (July 23, 2017): <https://www.vanguardngr.com/2017/07/10-microfinance-banks-account-40-industry-loan-cbn/>

³²⁵ “Financial Stability Report,” Central Bank of Nigeria, (June 2017): <https://www.cbn.gov.ng/Out/2018/FPRD/FSR%20June%202017.pdf>

³²⁶ The increases in paid-up capital and shareholders’ funds are largely attributed to additional capital injection and increase in retained earnings, respectively.

³²⁷ Data obtained from 2016 Annual Reports.

3.1.4 Informal Financial Institutions

Much like in other African states, there is a large informal financial sector in Nigeria (**Figure 65**). This sector often serves as a major source of savings and credit services for women, the low-income population and others who lack access to formal institutions. The sector is not only confined to rural areas in the country, but also serves urban and peri-urban areas. According to EFINA, in 2016, about 9.4 million Nigerians were served only by the informal financial sector.³²⁸

The main informal financial institutions in the country include local money lenders, hire-purchase operators, professional/trade credit unions, cooperative societies, rotatory savings and credit associations (ROSCAs) among other groups. The local money lenders are individuals/group of individuals that are wealthy enough to lend part of their financial resources to others at a price. Known locals approach the money lenders to raise short term funds for petty trading, farming, social functions, etc. The interest rates on the loans are usually high and largely without no collateral requirements. Both principal and interest are paid back by the borrower at agreed installments or at once. The hire-purchase operators typically enter into arrangements whereby equipment (e.g. motorcycles) is provided to borrowers (e.g. commercial riders) while principal and interest are paid back to the lenders from their daily proceed.³²⁹

The credit unions/ROSCAs are called different names by the different tribes in the country: “Esusu” or “Ajo” (Yoruba), “Isusu” or “Utu” (Igbo), “Osusu” (Edo), “Etibe” (Ibibio), “Adashi” (Hausa), “Dashi” (Nupe), “Oku” (Kalabari). While these institutions have no formal organizational structure, they typically have arrangements in place to mobilize savings and issue credits as well as implementation of compliance among members, which may be based on an association constitution, whether written or unwritten. They mostly either allocate the total savings contributed to a member on a rotational basis, or provide loans to members that request and thereafter, share accrued savings at the end of the financial year. They commonly require that prospective members belong to a profession, community or trade association. They are typically owned and operated by their members while the leadership rotates among key active members.

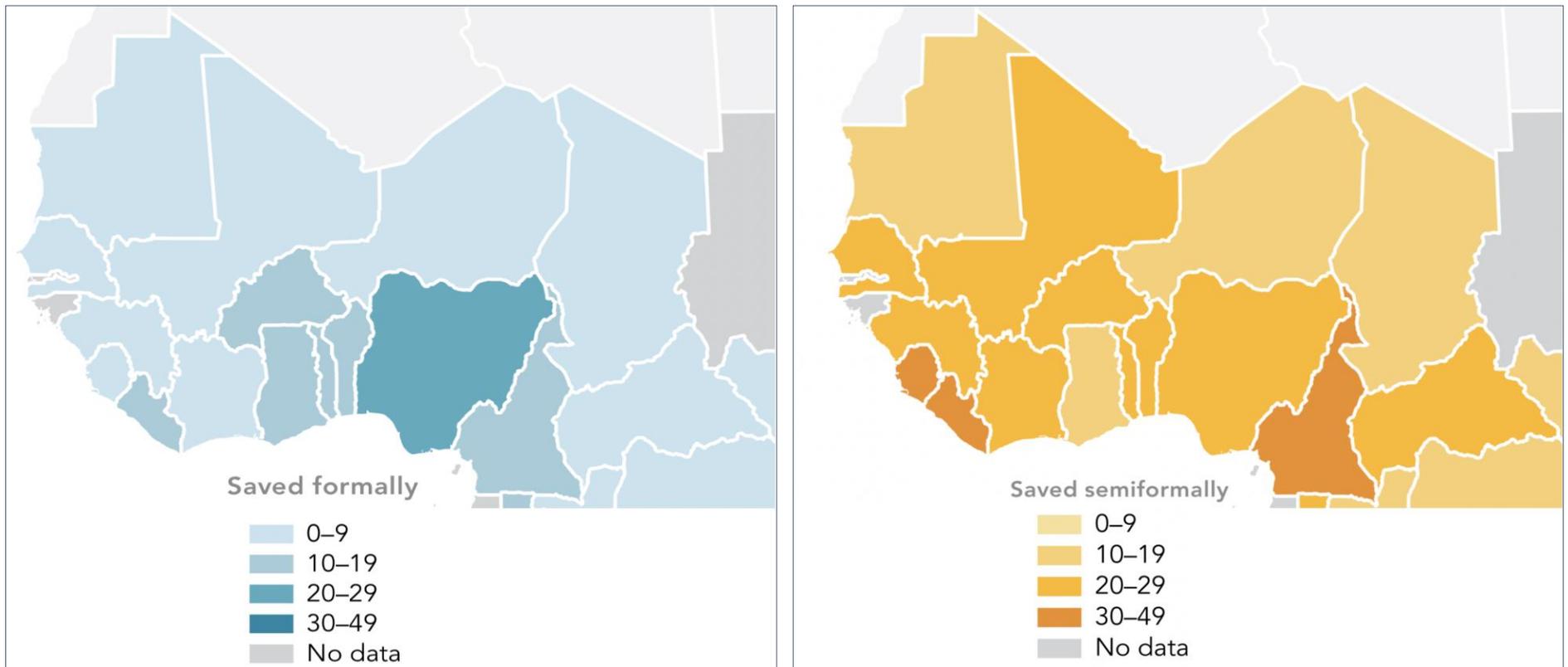
Unlike conventional banks, credit unions/ROSCAs do not normally require collateral before giving out loans. This is because borrowers are part of the pool of funds where loans are disbursed. Each member also has adequate information about the borrower and sometimes about the purpose of the loan. Collateral requirements, if at all, is very simple and within the reach of average members. It may consist of a satisfactory guarantor, who must be an active member of the association. The borrowers who default and are unable to pay as and when due, create problems for their guarantors. Hence, there is mutual monitoring of borrowers, to ensure that loans are repaid on time which is a key reason why informal financial institutions have high loan recovery rates. These institutions also charge relatively low interest rates on loans allocated, as compared to conventional banks or the market rates. The rate charged is usually predicated on the prevailing rates in other comparable associations as well as the need to make surplus for members. The loan repayment is usually done on a daily, weekly, fortnightly or monthly basis over a one-year period.³³⁰

³²⁸ “Access to Financial Services in Nigeria Survey,” Enhancing Financial Inclusion and Access, (2016): <http://www.efina.org.ng/assets/A2F/2016/Key-Findings-A2F-2016.pdf>

³²⁹ “The Nigerian Financial System at a Glance,” Central Bank of Nigeria, Monetary Policy Department, <https://www.cbn.gov.ng/Out/2017/CCD/THE%20NIGERIAN%20FINANCIAL%20SYSTEM.pdf>

³³⁰ Adeleke, A., “The Informal Financial Markets in Nigeria,” Central Bank of Nigeria, (2014): <https://www.cbn.gov.ng/out/2016/mpd/understanding%20monetary%20policy%20series%20no%2043.pdf>

Figure 65: Share of Adults Saving in the Past Year (%), 2017³³¹



NOTE: Maps exclude Cabo Verde (no data)

Source: World Bank Global Findex Database

Figure 65 shows how the savings behavior of adults varies in West Africa and the Sahel. The shade of the country corresponds to the magnitude of the indicator; the darker the shade, the higher the value. Saving semi-formally is much more common than saving formally across the region, including in Nigeria.

³³¹ Demircuc-Kunt et al., 2017.

3.1.5 Export Credit Agencies and Trade Funders

Several export credit agencies (ECAs) have been active in Nigeria for a number of years. Some of these include African Export-Import Bank, Export-Import Bank of China, US EXIM Bank, UK Export Finance, and the Export-Import Bank of India among others.

➤ **African Export-Import Bank**

Founded in 1993 in Abuja, Afrexim Bank is one of the major Pan-African multilateral financial institutions devoted to promoting intra- and extra-African trade. In 2017, Afrexim Bank stated it had disbursed over USD 35 billion in trade and project financing to Nigerian public and private entities since its inception. The bank's credit exposure to Nigeria at the time stood at USD 3.5 billion. Some of Afrexim Bank's disbursements to Nigeria include: (i) financing provided to Nigerian banks to improve trade finance and foreign exchange liquidity; (ii) facilities arranged for entities involved in export processing, manufacturing, aviation and hospitality; and (iii) loans granted to local oil companies to acquire and operate oil mining leases divested by major international oil companies. Afrexim Bank is also creating capacity in Nigeria for SMEs to access working capital finance through its factoring program.³³²

➤ **Export-Import Bank of China**

China is the biggest exporter to Nigeria, accounting for more than a third of all non-oil goods imported. China's growing interest and strengthening economic ties with Africa have been well-documented. China's Export-Import Bank has provided financing for several large-scale infrastructure public-private partnership projects in Nigeria. It has also been reported that the China Exim Bank has plans to commit USD 1 billion to special economic zones across the country.³³³

➤ **United States Export-Import Bank**

The Export-Import Bank of the United States (U.S. EXIM Bank) helps finance the sale of U.S. exports, primarily to emerging markets throughout the world. The bank works with commercial lenders to help U.S. companies increase export sales and American jobs and minimize risk by accessing Ex-Im Bank financing and export credit insurance. Between 2009 and 2016, U.S. EXIM Bank had provided over USD 6 billion in financing for transactions across Sub-Saharan Africa. In 2016, U.S. EXIM Bank and UBA signed a memorandum of understanding (MOU) with the goal of expanding trade between the U.S. and Africa through EXIM financing of up to USD 100 million across the region. EXIM Bank and UBA will work together to share information and develop export-financing opportunities in key sectors including commodities, agriculture, infrastructure, energy and large and small equipment purchases. Under the MOU, the two banks will explore options for offering a range of financing solutions for American exporters and African buyers, including short and medium-term financing programs that allow for flexible repayment terms and competitive insurance policies guaranteed by EXIM.³³⁴

³³² "Afrexim bank's trade and project financing in Nigeria reaches \$35 billion," Financial Nigeria, (19 May 2017): <http://www.financialnigeria.com/afreximbank-s-trade-and-project-financing-in-nigeria-reaches-35-billion-sustainable-photovideo-details-830.html>

³³³ "China Exim Bank to spend \$1bn on Nigeria's economic zones," (November 17, 2016): <https://punchng.com/china-exim-bank-spend-1bn-nigerias-economic-zones/>

³³⁴ "UBA, U.S. Exim Bank sign agreement to facilitate trade," Financial Nigeria, (12 May 2016): <http://www.financialnigeria.com/uba-u-s-exim-bank-sign-agreement-to-facilitate-trade-news-592.html>

➤ **UK Export Finance**

The UK Export Finance (UKEF), which is the export credit agency of the UK, helps UK companies provide buyers overseas with competitive long-term financing for projects that support bilateral trade. UKEF guarantees a buyer credit loan to an overseas borrower in local currency, financing the purchase of capital goods and/or services from a UK exporter. UKEF provides a range of innovative and flexible products, providing up to 85% funding for projects containing a minimum of 20% UK content. In 2018, UKEF announced it supported North Sea Ventilation, a specialist manufacturer in the energy sector, to secure a GBP 500,000 order to supply cooling equipment to Nigeria LNG under its new bank partnership program. The program allows exporters to instantly access government-backed trade finance products directly from their bank. It gives five high street banks authority to issue UKEF guarantees for their SME customers.³³⁵

In 2018, in a bid to further support trade and investment between the UK and Nigeria, UKEF listed the naira as one of the currencies eligible for local currency financing, making the naira one of only three African currencies pre-approved for financing the purchase of capital goods and services.³³⁶ Previously, in 2014, UKEF named Ecobank Nigeria, and 19 other global lenders as its partnering financial institutions to help deliver GBP 3 billion Direct Lending Facility support to UK exporters.³³⁷

➤ **Export-Import Bank of India**

In 2017, India’s Export-Import Bank announced it will provide USD 100 million in concessionary loans to fund power projects in Nigeria. These include a solar-power plant to supply the northern city of Kaduna and two gas-fired facilities to be built in the south-eastern states of Enugu and Cross River. India has identified renewable energy as a new area of cooperation with Nigeria as more companies from the Asian nation focus on providing solar-energy supplies to Africa’s most populous country.³³⁸

➤ **Nigerian Export-Import Bank**

NEXIM was established in 1991 as an ECA with a share capital of NGN 50 billion (USD 138.5 million) held equally by the Federal Ministry of Finance and the CBN. The bank presently provides short- and medium-term loans to Nigerian exporters. It also provides short term guarantees for loans granted by Nigerian Banks to exporters as well as credit insurance against political and commercial risks in the event of non-payment by foreign buyers. The bank does not finance imports of finished goods for resale. However, through its Foreign Input Facility, the bank finances the imports of machinery, raw materials and other components which shall be used to process goods for export purposes.³³⁹

In addition to these, the African Development Bank (AfDB) also provides trade funding. For instance, in 2016, AfDB approved USD 300 million and USD 50 million trade finance loans to First Bank of Nigeria (FBN) and FSDH Merchant Bank Nigeria to support local enterprises involved in import-export activity.

³³⁵ Wass, S., “UKEF reveals first success story under bank partnership scheme,” Global Trade Review, (27 February 2018): <https://www.gtreview.com/news/europe/uken-reveals-first-success-story-under-new-bank-partnership-scheme/>

³³⁶ “British government moves to increase UK-Nigeria trade,” The Guardian, (12 February 2018): <https://guardian.ng/news/british-government-moves-to-increase-uk-nigeria-trade/>

³³⁷ Laah, Y., “UK Export Finance Names Ecobank Nigeria, JP Morgan, others to Deliver £3 Support to Exporters,” Invest Advocate, (October 11, 2014): <https://investadvocate.com.ng/2014/10/11/uk-export-finance-names-ecobank-nigeria-jpmorgan-others-to-deliver-3b-support-to-exporters/>

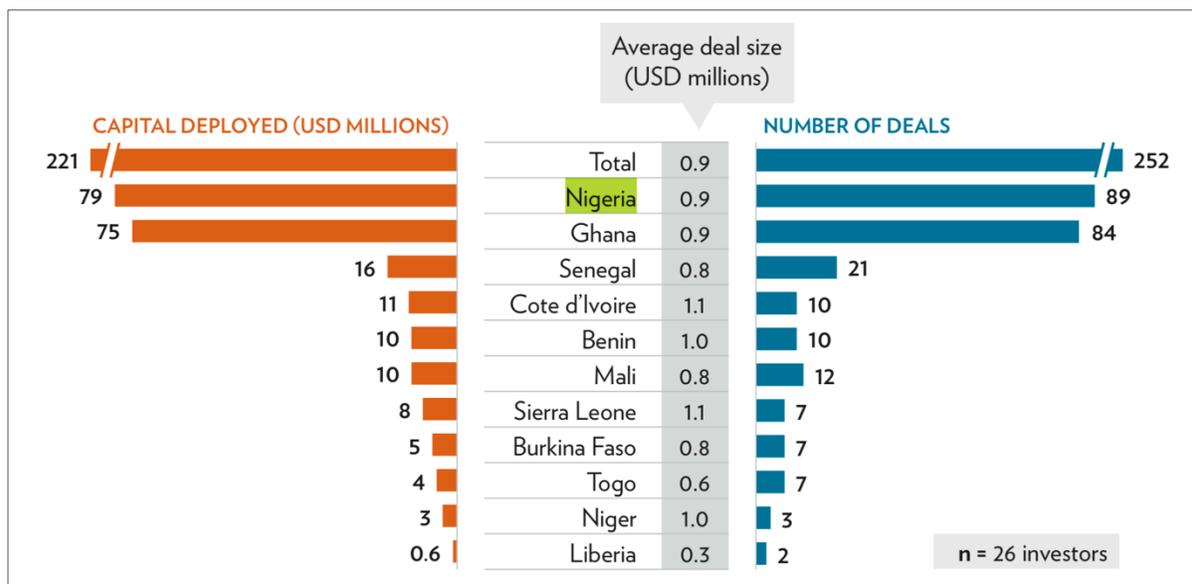
³³⁸ “India Exim Bank’s \$100 Million Funds Nigeria Power Projects,” Capital Markets Africa, (November 9, 2017): <https://www.capitalmarketsinafrica.com/india-exim-banks-100-million-funds-nigeria-power-projects/>

³³⁹ Nigeria Export-Import Bank: <http://www.neximbank.com.ng/about-nexim/>

3.1.6 Impact Investors

An assessment carried out by the Global Impact Investing Network (GIIN) found that while impact investing steadily increased across Africa between 2005-2015, most of the investment in West Africa has been highly concentrated. Nigeria was the largest recipient of impact capital deployed in the region over this period, with a total of USD 79 million deployed across 89 deals (Figure 66).³⁴⁰

Figure 66: Non-DFI Investment in West African Countries, 2005-2015



Source: Global Impact Investing Network and Dahlberg

As of 2015, a total of 20 impact investors were identified to be active in the country, including Shell Foundation, Tony Elumelu Foundation, Alitheia, Aspire Nigeria, Dorteo Partners, Sahel Capital Fund, among others. Between 2005-2015, USD 79 million was deployed by 12 impact investors across 89 direct investments, and USD 2 million deployed to one indirect investment in the country over the same period. In terms of sectoral focus, the impact investors strongly favor financial services—microfinance, in particular—through small deals with average size of USD 0.9 million. Over half of all capital deployed and deals made were in the USD 1-5 million range and majority of the number of deals were less than USD 1 million. The impact investors mainly favor quasi-equity and equity instruments, which reflect a hands-on approach to growing early- and growth-stage SMEs. They typically invest between four and 10 years and expect returns of between 13% and 17% Internal Rate of Return.³⁴¹

Furthermore, most of the impact investors are headquartered outside the country, with only five having a local presence as of 2015, due in large part to the high cost of living and operating businesses in the country. The impact investors rely almost exclusively on a combination of DFIs, family foundations, and high-net-worth individuals from outside the country for funding. The Tony Elumelu Foundation was the only identified impact investor that relied significantly on local sources of capital. While the impact investing

³⁴⁰ “The Landscape for Impact Investing in West Africa: Understanding the Current Status, Trends, Opportunities, And Challenges,” Global Impact Investing Network and Dahlberg, (2015):

https://thegiin.org/assets/upload/West%20Africa/RegionalOverview_westafrica.pdf

³⁴¹ “The Landscape for Impact Investing in West Africa: Nigeria,” Global Impact Investing Network and Dalberg, (December 2015):

<https://thegiin.org/assets/upload/West%20Africa/02%20Nigeria%20Chapter.pdf>

sector in Nigeria outpaces other countries in West African, the community of investors is small relative to the size of the market.³⁴² A review of three impact investors that are active in Nigeria's OGS sector is presented below.

➤ **All On Partnerships for Energy Access**

In 2016, an independent impact investing fund, All On Partnerships for Energy Access ('All On'), was established by Shell to work with partners to increase access to commercial energy products and services for the under-served and un-served off-grid markets in Nigeria, with a special focus on the Niger Delta. All On aims to collaborate with a wide range of organizations to act as a catalyst in the growth of Nigeria's market for sustainable energy and off-grid solutions. To fulfill its mission, All On is taking a three-pronged approach that combines investment, technical support and ideas on market development. The fund provides capital to enterprises with proven off-grid energy technology solutions.

Within the first two years of its existence, All On has become a key player in the off-grid renewable energy sector in Nigeria. To date, the fund has invested in three renewable energy firms to expand access to affordable and viable energy sources in the Niger Delta. The financial support includes (i) equity and debt funding to Green Village Electricity (GVE) Projects Limited; (ii) quasi-equity investment in Lumos Global BV to facilitate a quick rollout of its Solar Home Systems in the Niger Delta; and (iii) a convertible debt facility to ColdHubs to support expansion of its solar-powered marketplace cold storage business.³⁴³

All On provides six investment archetypes, as appropriate for potential investee's business model and stage of development. These include short-term debt with 1-3 year tenors (working capital, inventory/receivables financing), long-term debt with 3-7 year tenor, seed equity, growth equity, results-based financing and to a lesser extent, grants. Based on its investment policy, the fund does not take majority stake in any company it invests in and typically takes a preferred equity position in order to have sufficient level of control. Typical deal size ranges between USD 25,000 to USD 3 million, although it can invest as high as USD 5-7 million. As of July 2018, the highest total investment made by All On in a single entity was USD 3.2 million. All On prefers to make initial investments of not more than USD 1 million in promising businesses, and then it makes follow-on investments based on the outcome of its initial investments. All On offers both NGN and USD loans at interest rates not more than 15%. All On is funded on a year-by-year basis, with a current 2018 budget of about USD 18 million. The fund is designed to be sustainable and the first three years of its operation is planned to serve as a proof of concept, after which its funding may be increased up to USD 200 million.

All On works alongside other global and local investors and partners to improve access to energy. In December 2017, All On entered into a three-year partnership with the US African Development Foundation (USADF). Under the partnership, over the next three years, both parties will provide a USD 3million fund to up to 30 Nigerian-owned off-grid energy companies to expand access to energy for unserved and underserved markets in Nigeria. The USADF will provide grant funding to the selected companies while All On will provide an equal amount of impact capital in the form of convertible loans and/or equity. All On has also entered into a grant agreement with Solar Nigeria, a UK Aid-funded program, for the receipt of grant funding to further de-risk investments made by All On in the off-grid solar sector.³⁴⁴ In addition to

³⁴² Ibid.

³⁴³ Okafor, C., "All On, Others Sign a Power Act," This Day, (February 17, 2018):

<https://www.thisdaylive.com/index.php/2018/02/17/all-on-others-sign-power-pact/>; and

"Shell's 'All-On' makes first investments in Nigeria's off-grid power market," Off-Grid Nigeria, (November 6, 2017):

<http://www.offgridnigeria.com/shells-all-on-makes-first-investments-nigerias-off-grid-power-market/>

³⁴⁴ "USADF, All On partner to invest in off-grid energy in Nigeria," The Guardian, (7 December 2017): <https://guardian.ng/news/usadf-all-on-partner-to-invest-in-off-grid-energy-in-nigeria/>; and

"Shell's 'All-On' makes first investments in Nigeria's off-grid power market," Off-Grid Nigeria, (November 6, 2017):

providing capital, All On provides technical support to existing and early-stage entrepreneurs in the energy access sector and works with strategic partners such as REA on broader market development activities, including advocacy and policy issues to support a RE enabling environment.³⁴⁵

➤ **Shell Foundation**

In 2016, the Shell Foundation, Power Africa, USAID, and the UK DFID launched the Scaling Off-Grid Energy (SOGE) Grand Challenge for Development. Under SOGE, Greenlight Planet, distributors of the Sun King™ series of solar lanterns, obtained a USD 1.25 million grant to expand across its distribution channels in Nigeria and Uganda. Greenlight aims to sell over 20,000 units in these two markets by the end of 2018.³⁴⁶ Shell Foundation is also supporting the Nigeria Off-grid Market Acceleration Programme (NoMAP) in collaboration with USAID and is seeking to co-invest in a number of local OGS companies.³⁴⁷

➤ **FRAGG Investment Management**

FRAGG Investment Management is an impact investor and SME-focused fund that mobilizes investment and raises capital for high-growth companies in West Africa. FRAGG finances and invests in growing and inclusive SMEs that create social and environmental impact but are not able to attract capital for their business at affordable conditions. The fund provides businesses with long-term risk capital that allows them to operate at their full potential; these come by way of long-term debt facility and equity investments.³⁴⁸ Outside of Nigeria, the fund is also engaged in Benin, Togo, Ghana and Côte d’Ivoire.

3.1.7 Crowd Funders

Crowdfunding is increasingly proving to be a viable source of financing for solar energy projects particularly energy access related projects. The crowdfunding platforms that have provided funding to off-grid solar projects in Nigeria to date are described below.

➤ **Bettervest**

In early 2017, a number of solar mini-grid developers in Nigeria secured debt financing from a Germany-based crowd-funding platform – Bettervest – through the support of NESP and REEEP. Bettervest is an online crowdfunding debt platform for energy efficiency, renewable energy and CO₂ emissions reduction projects. The platform mediates subordinated loan contracts between private or institutional investors based in Germany (lenders) and international corporate entities (borrowers). The projected project cash-flows are prepared in detail and disclosed to investors on the platform as a basis upon which to form their investment decisions. To date, the following Nigerian off-grid energy companies have successfully raised funding via the Bettervest platform:

Havenhill Synergy Limited: Raised EUR 113,700 in 65 days in 2017 from 233 investors for a 41.6kWp solar mini-grid project in Kwaku community in Central Nigeria. The investors are to be repaid over a seven-year period at an annual interest rate of 8.25%.

<http://www.offgridnigeria.com/shells-all-on-makes-first-investments-nigerias-off-grid-power-market/>

³⁴⁵ Stakeholder interviews, 2018.

³⁴⁶ Scaling Off-Grid Energy: <http://www.scalingoffgrid.org/greenlight-planet/>; and <http://www.scalingoffgrid.org/year-review>

³⁴⁷ Lois, A., “Nigeria’s Off-Grid Energy Market Acceleration Programme Comes Alive,” Independent, (September 27, 2018):

<https://www.independent.ng/nigerias-off-grid-energy-market-acceleration-programme-comes-alive/>

³⁴⁸ FRAGG Investment Management: <http://www.fragginvest.com/about-us/>

GVE Projects Limited: Raised EUR 250,000 in 69 days in 2017 from 401 investors for two solar mini-grid projects with a combined capacity of 90kWp for Angwan Rina and Demshin villages in Platuae State. Investors are to be paid back over a seven-year period at an annual interest rate of 9.25%.

Nayo Tropical Technology Ltd.: Raised EUR 235,300 from 409 investors in 154 days in 2017 for a 100.7 kWp solar mini-grid project in Tunga Jika village in Niger State. Investors are to be repaid over a seven-year period, at an annual interest rate of 10%.

Rubitec Nigeria Ltd.: Raised EUR 224,100 from 394 investors in 106 days in 2017 for an 85 kWp solar Mini-grid project in Gbamu-Gbamu village, Ogun State. Investors are to be repaid over a 7-year period, at an annual interest rate of 10%.

Sosai Renewable Energies Company: In 2017, Sosai has successfully closed three funding campaigns on Bettervest’s platform: (i) raised EUR 112,100 from 239 investors in 38 days with an expected return of 8.5% over a period of four years to deploy 250 50W SHS for off-grid power supply in Northern Nigeria; (ii) raised EUR 112,100 from 178 investors in four days with an expected return of 7.5% over a period of four years to deploy another 250 50W SHS for off-grid power supply in Northern Nigeria; and (iii) raised EUR 224,200 from 390 investors in 89 days with an expected return of 7.5% over a period of four years to deploy 500 50W SHS for off-grid power supply in Northern Nigeria.³⁴⁹

Solarmate: As of late 2018, Solarmate has an ongoing campaign to raise EUR 299,200 with an expected return of 10% over a period of four years, to deploy 435 units of 50-200W SHS in South-Western Nigeria on a PAYG basis.³⁵⁰

➤ **Kiva**

Sosai, a local solar off-grid energy provider, has successfully raised two loans from the social lending platform, Kiva. In December 2012, Sosai secured a USD 22,975 no-interest loan with 16 months tenor from 710 lenders on the platform for the sales of Barefoot solar lighting products in rural Northern Nigeria. After successfully repaying the loan, Sosai went on to secure a second no-interest loan of USD 35,000 from 1,150 lenders with 14 months tenor in October 2016 for the distribution of solar products (solar refrigerators, solar lamps & solar dryers) through a lease-to-own model also in rural Northern Nigeria.³⁵¹

➤ **Trine**

In July 2018, Rensource, a local off-grid solar provider, successfully secured a EUR 500,000 loan from 824 investors on the Trine platform to provide access to clean energy to at least 4,000 shops in the country. The loan is to be repaid over 36 months with an expected return of 6.25%. Rensource is the first Nigerian company to raise funding through Trine. The loan will be partially guaranteed (at least 60%) by Swedish International Development Cooperation Agency (SIDA) in collaboration with Trine.³⁵²

³⁴⁹ Bettervest – Funded Projects: <https://www.bettervest.com/en/funded-projects/>

³⁵⁰ Bettervest – Solarmate: <https://www.bettervest.com/en/projekt/SHS-Solarmate-Nigeria>

³⁵¹ Kiva Sosai Renewable Energy: <https://www.kiva.org/lend/1133430>

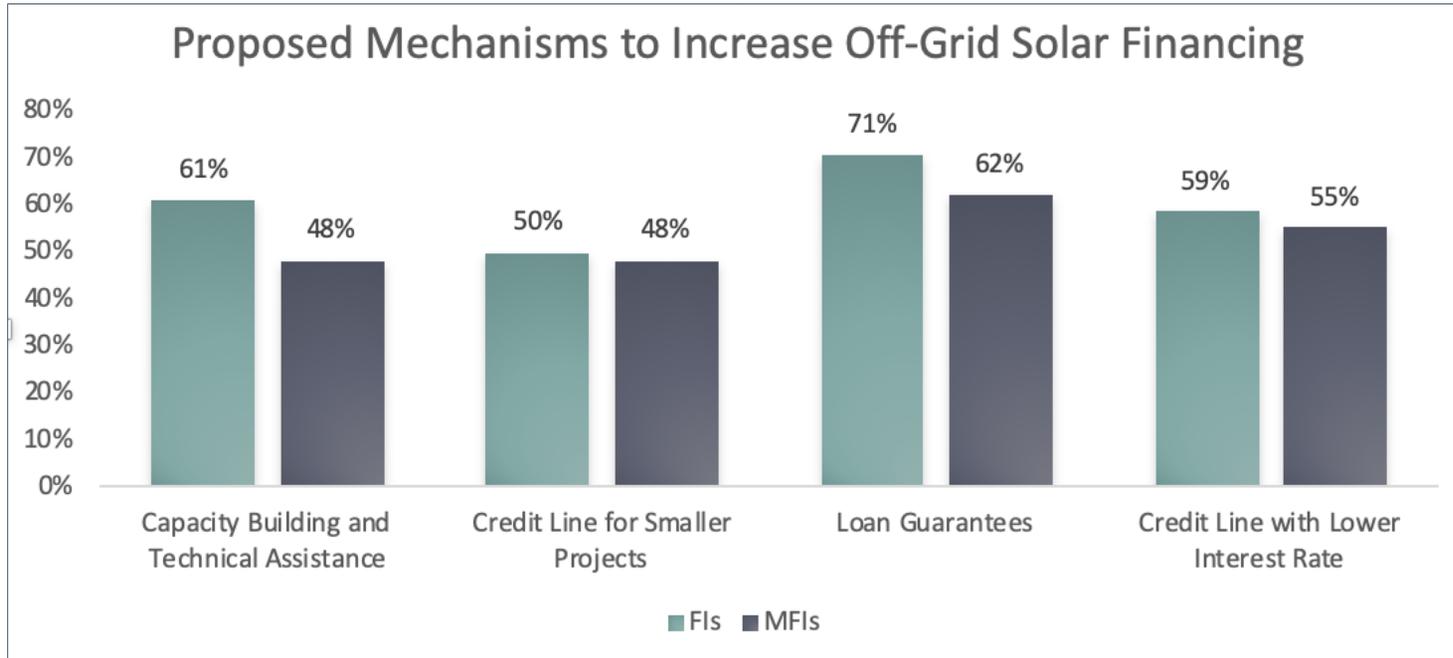
³⁵² Trine: <https://www.jointrine.com>

3.4 Summary of Findings

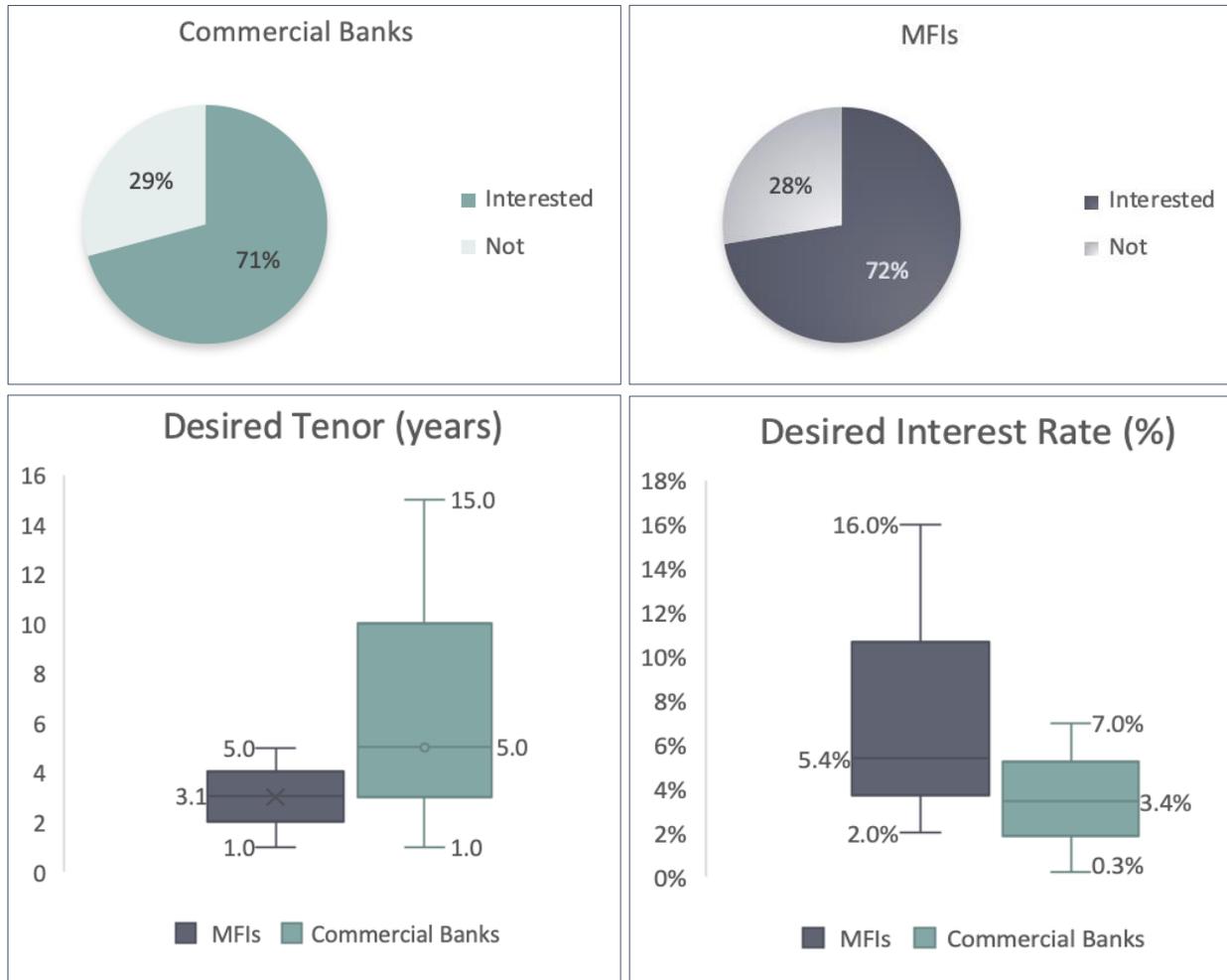
- **Opportunity for ROGEP Credit Lines:** While there are some national development credit lines available for lending either directly to off-grid enterprises or on-lending to FIs (e.g. the BoI Solar Fund, DBN Funding), many of the interviewed FIs stressed the need to access alternative funding options with low interest rates and longer tenors for on-lending to providers and end users/SMEs, in order to make OGS projects attractive. Stakeholder interviews suggested that there is a potential for ROGEP to place as much as USD 120 million in credit lines if priced reasonably.
- **Local Currency and Pricing:** Most loans to off-grid enterprises and all loans for consumer purchases of stand-alone solar devices must be denominated in local currency. Local currency cost of capital remains so high for FIs that pricing for these loans remain in the range of 24-32%. This severely constrains off-grid market growth. Yet, taking up hard currency denominated credit lines presents severe challenges for local lenders who would have to bear the FX risk. When pricing in a hedge to cover this risk, many hard currency denominated credit lines become unattractive, as the cost of capital to the FI becomes too high to provide a competitive offer to borrowers. Many of the interviewed FIs indicated that hard currency denominated lines of credit from ROGEP would likely need to be offered at deeply concessional pricing in the range of 3-5% in order to be widely accepted by the market.
- **Collateral Requirements:** The collateral requirements of commercial banks are generally greater than 120%. The two lenders already in the space are deeply constrained from originating loans where the borrower cannot meet these requirements. Without alternative forms of collateral, Sterling Bank and EcoBank have difficulty to expand their off-grid lending as rapidly as they would like. Use of third-party *pari-passu* guarantees replaces borrower collateral. 50% coverage is helpful, 70-80% coverage would likely be transformative. However, pricing from most available third-party guarantors can be in the range of 3%+ per annum, which most lenders view as too high to remain competitive; lenders believe that 1-1.5% is the maximum they could pay for such guarantee coverage. This creates an opportunity for ROGEP to either provide low-cost guarantees directly or to subsidize the premiums offered by existing third-party guarantors such as GuarantCo, Afrexim and Africa Guarantee Fund.
- **Risk Perception of New Lenders:** Although some commercial banks in Nigeria (e.g. Sterling Bank and EcoBank) have launched solar loan products and a few others are increasingly showing interest in the sector, the predominant view among Nigerian FIs is that the OGS space remains too risky for near-term focus. In order to attract lenders to this market segment, there is a need for reasonably priced credit enhancement mechanisms. To cover these “market entry” risks for lenders that are unwilling to enter the market, guarantee instruments that cover first loss are needed. However, first-loss coverage does not address the key issue of collateral and is therefore likely insufficient on its own to stimulate growth in FI engagement unless it is coupled with third-party guarantee coverage.
- **Technical Assistance:** A well designed TA intervention is just as important as reasonably priced credit lines and credit enhancements in accelerating OGS lending in Nigeria. The recommended key areas of focus including training of bank credit department and account representative personnel to originate deals and appropriately assess the credit risk of standalone solar firms and projects; extensive due diligence support to qualify products and approve vendors; and targeted support for new lenders to the sector with product structuring and development as well as building deal-flow. The TA intervention should build upon previous programs such as USAID/Power Africa Beyond the Grid, Lighting Africa and USAID REEEP among others. Special attention should also be paid to offering advisory services on the side of the standalone solar enterprises. Lenders opine that these entrepreneurs often do not have proper financial management and accounting systems in place, are unable to present quality financial models and lack the expertise required to structure their companies to take on debt obligations.

- **Digital Financial Services:** The advent of digital financial services and mobile money is one of the most important developments in off-grid solar market development to date, as it has allowed new and innovative business models to emerge that are now driving unprecedented growth in the sector. Mobile communication technology facilitates payments for solar products and systems (lease-to-own, pay-as-you-go) and/or for electricity usage (energy-as-a-service) and enables monitoring for operations and maintenance of equipment. Expanding access to mobile money services also creates new opportunities to better serve women, the lower-income population, and other groups that are traditionally excluded from the formal financial system. The Government should take steps to support capacity building of and foster linkages between off-grid solar companies operating in the market and key stakeholders from various sectors, including energy access policymakers and regulators, financial and telecommunications companies, mobile network operators, financial service providers (commercial banks and microfinance institutions), mobile money service providers, international organizations, NGOs and civil society groups involved in financial inclusion etc.

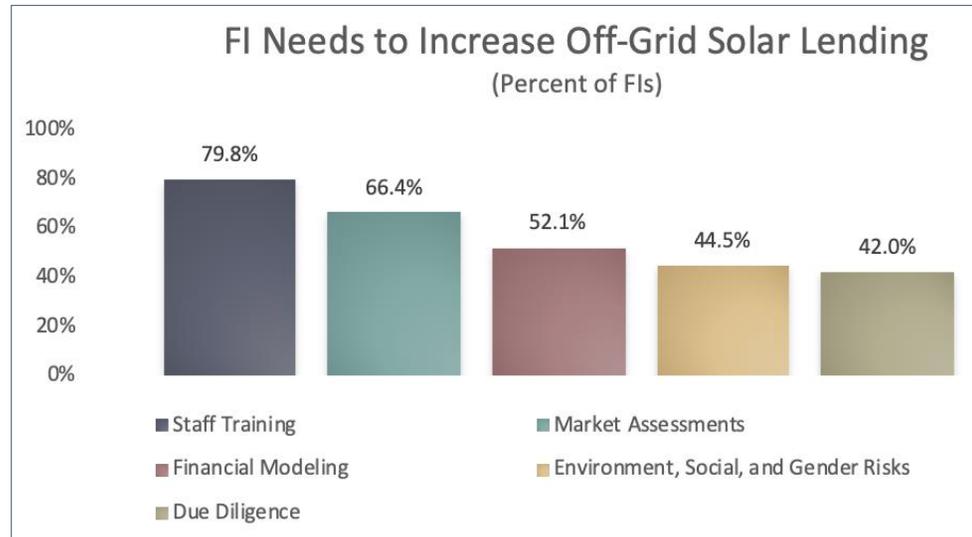
Key findings from the Task 3 FI survey activity are presented below. The results are based on feedback from a total of 121 FIs (including commercial banks, microfinance institutions and other non-bank FIs) that were interviewed across the 19 ROGEP countries. This summary only focuses on responses from commercial banks and MFIs, which together account for 92% of all respondents. See Annex 3 for more details.



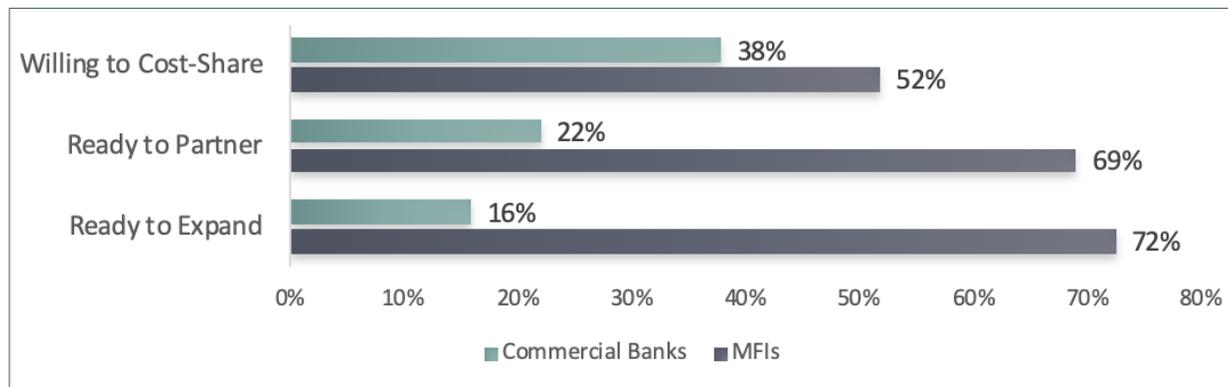
According to the survey, there is strong financial-sector interest across ROGEP countries to finance renewable energy projects, especially in off-grid solar. Commercial banks and MFIs identified loan guarantees as the most important measure that could improve their capacity to lend to the renewable energy sector. Most of the surveyed institutions also identified clear interest in credit lines.



More than 70% of surveyed commercial banks and MFIs are interested in a credit line to finance off-grid solar projects. Commercial banks want tenors of 1-15 years and interest rates from 0.25-7%. MFIs are seeking tenors of 1-5 years with interest rates from 2-16%. On average, commercial banks want a credit line with a 5-year tenor and 3.4 % interest rate, and MFIs want a 3.1-year tenor with 5.4% interest rate.



In addition to their clear interest in credit lines and loan guarantees to finance off-grid projects, surveyed financial institutions (commercial banks and MFIs) in ROGEP countries also identified several areas of internal capacity that require improvement in order to lend (or increase lending) to the off-grid solar sector.



Compared to commercial banks, MFIs reported a greater willingness to cost-share capacity building activities and a higher level of readiness to partner with solar companies and expand operations to serve rural and off-grid areas.

ANNEX 1: TASK 1 METHODOLOGY

STATE OF ENERGY ACCESS AND ENABLING MARKET ENVIRONMENT

Data presented in this section was collated from a range of public documents and reports as well as primary source documents either provided by ECREEE or obtained through supplemental market research (desk research and interviews with local public officials and industry stakeholders). These findings were subsequently corroborated by attendees of national validation workshops held in each country at the conclusion of the market assessment. Information obtained from the Task 2 focus group discussions and surveys of industry stakeholders (see **Annex 2**) was also used to support the Task 1 analysis.

GIS DATA ANALYSIS APPROACH / METHODOLOGY

1. Categorizations, key definitions and datasets for geospatial least-cost analysis

The main steps of the GIS analysis are as follows:

- (i) Categorization/definition of settlements: scenario 2023;
- (ii) Categorization/definition of settlements: scenario 2030;
- (iii) Definition of un-electrified settlements within grid areas; and
- (iv) Determination of population per settlement

1.1. Categorization/definition of settlements: Scenario 2023

1.1.1. *Electrification by grid extension* – settlements which are located within 5 km of the current electrical grid network³⁵³ (according to WAPP densification plans).

1.1.2. *Electrification by mini-grid* – settlements that:

- Are located within 15 km of areas that have a high night-lights value (above 50/225 on grayscale raster)³⁵⁴ and outside the buffer area established for the electrification by grid extension
- Are located within areas that have a population density of more than 350 people per km² (as defined by Eurostat for rural areas)³⁵⁵, plus an additional 50 people per km² for greater feasibility of mini-grids³⁵⁶ and are within 1 km³⁵⁷ of a social facility (education center or health facility) and existing mini-grids of 2018.

1.1.3. *Electrification by off-grid stand-alone systems* – settlements that do not fall into the above categories

1.2. Categorization/definition of settlements: Scenario 2030

1.2.1. *Electrification by grid extension* – settlements which are located within 15 km of the current electrical grid network (average distance mentioned by energy utilities in West Africa) or within 5 km of planned future line extensions³⁵⁸

³⁵³ NOTE: Low-voltage distribution lines were not considered in this analysis (data was unavailable)

³⁵⁴ The 50/225 classification represents the areas emitting light of the country with reduction of scattering light. The classification was first introduced in the USAID report ZAMBIA ELECTRIFICATION GEOSPATIAL MODEL and evaluated in cross-checks throughout the country. USAID: https://pdf.usaid.gov/pdf_docs/PA00T2JC.pdf

³⁵⁵ <http://ec.europa.eu/eurostat/web/rural-development/methodology>

³⁵⁶ Identified in discussions with different international mini-grid developer.

³⁵⁷ Preferred maximum distance for mini-grids from discussions with different international developer.

³⁵⁸ NOTE: Low- and medium-voltage distribution lines were not considered in this analysis (data was unavailable)

1.2.2. *Electrification by mini-grid* – settlements that:

- Were defined as mini-grid settlements in the 2023 scenario
- Are located within 1 km of the above mini-grid settlements, which is the preferred distance of mini-grid developers for their grid according to discussions with several international developers.
- Are located within 15 km of economic growth centers – airports, mines and urban areas; average worker distance in Africa is 10 km, a distance of 5 km is added to include the growth of businesses in the periphery of the growth centers.³⁵⁹

1.2.3. *Electrification by off-grid stand-alone systems* – settlements that do not fall into the above categories

1.3. Definition of un-electrified settlements within grid areas

To identify settlements that are located close to the national electrical grid but are not served by it, the following criteria were used:

- Within the main grid line zones (see buffer zones for *electrification by grid extension* above)
- Outside 15 km night-lights of buffered areas to capture the densification within 5 years
- Within areas of low population density (less than 350 people per km²)

1.4. Determination of population per settlement

A key component of the least-cost analysis was the number of people living in each settlement (city, town, village, hamlet) of a given country. While there are different publicly available sources of information on total population (e.g. World Bank demographic data), a more granular view of the population distribution was necessary to perform the geospatial analysis.

Another difficulty was the identification of locations of settlements. The exact location of each settlement (with given coordinates) was not available / accessible in many of the countries. As a result, the least-cost analysis had to revert to other studies of population distribution – such as the population distribution developed by WorldPop. WorldPop utilizes a range of geospatial datasets to develop accurate population data:

“New data sources and recent methodological advances made by the WorldPop program now provide high resolution, open and contemporary data on human population distributions, allowing accurate measurement of local population distributions, compositions, characteristics, growth and dynamics, across national and regional scales. Statistical assessments suggest that the resultant maps are consistently more accurate than existing population map products, as well as the simple gridding of census data.”³⁶⁰

A Voronoi polygon analysis³⁶¹ was used to create boundaries for each identified settlement. These boundaries were then used in combination with the population density layer to estimate the total settlement population of the given year. The current annual national population growth rate of 2.6%³⁶² was applied to the geospatial analysis to project populations for the Scenario 2023 and 2030 analyses.

³⁵⁹ Lall, S., Henderson, J., and Venables, A., “Africa’s Cities: Opening Doors to the World,” (2017): <https://openknowledge.worldbank.org/handle/10986/25896>

³⁶⁰ <https://www.worldpop.org>

³⁶¹ To learn more about Voronoi polygons, see wikidot: <http://djjr-courses.wikidot.com/soc128:qgis-voronoi-polygons>

³⁶² “Population Growth (annual %),” the World Bank, (2017): <https://data.worldbank.org/indicator/SP.POP.GROW?locations=NG>

2. Summary of Key Datasets

The table below summarizes the key datasets used for scenarios 2023 and 2030 as well as the criteria applied and sources used.

Overview of Key Datasets of the Least-Cost Electrification Analysis								
Dataset	Description	Criteria used by technology						Source and Year
		Scenario 2023			Scenario 2030			
		On-grid	Mini-grid	Off-grid	On-grid	Mini-grid	Off-grid	
Electricity grid network (current)	Current national grid network (HV & MV lines)	≤ 5km distance	≥ 5km distance	≥ 5km distance	≤ 15km distance	≥ 15km distance	≥ 15km distance	ECOWREX, 2018; Reiner Lemoine Institut, 2017; Facebook, 2019 ³⁶³
Electricity grid network (planned)	Future network planned to be built (HV lines)	Not considered	Not considered	Not considered	≤ 5km distance	≥ 5km distance	≥ 5km distance	ECOWREX, 2018
Mini-grids	Existing mini-grids in 2018	Not considered	≤ 1km distance	≥ 1km distance	Not considered	≤ 1km distance from all identified mini-grids in Scenario 2023	≥ 1km distance from all identified mini-grids in Scenario 2023	ECOWREX, 2018
Night-lights	Night-time light emissions used to identify electrified areas	Not considered	≤ 15km distance	≥ 15km distance	Not considered	Not considered	Not considered	NASA Earth Observatory, 2016
Population density	Population distribution in people per km ² .	≥ 350 people per km ² ³⁶⁴	≥ 350 people per km ²	≤ 350 people per km ²	Not considered	Not considered	Not considered	Hrsl layer Ciesin/ Facebook lab, 2015 ³⁶⁵

³⁶³ Source: Reiner Lemoine Institut, Rural electrification modelling in the framework of the Nigerian Energy Support Programme (NESP), 2017; digitized by Energio Verda Africa; url: <http://rrep-nigeria.integration.org/>

Source: Facebook, A new predictive model for more accurate electrical grid mapping, 2019; digitized by Energio Verda Africa: <https://code.fb.com/connectivity/electrical-grid-mapping/>
<https://energydata.info/dataset/medium-voltage-distribution-predictive>

³⁶⁴ Based on Eurostat definition plus an additional 50 people per km² for greater feasibility of mini-grids as identified in discussions with different international mini-grid developer. Source: <http://ec.europa.eu/eurostat/web/rural-development/methodology>

³⁶⁵ Facebook Connectivity Lab and Center for International Earth Science Information Network - CIESIN - Columbia University, 2016, High Resolution Settlement Layer (HRSL). Source imagery for HRSL © 2016 DigitalGlobe.

ECREEE: OFF-GRID SOLAR MARKET ASSESSMENT AND PRIVATE SECTOR SUPPORT FACILITY DESIGN

Settlements	Towns and villages	Used	Used	Used	Used	Used	Used	National Geospatial-Intelligence Agency (NGA), 2015 ³⁶⁶
Social facility: education centers	Small list from OpenStreetMap (OSM); Indicator of active local economy	Not considered	≤ 1km distance ³⁶⁷	≥ 1km distance	Not considered	Not considered	Not considered	Humanitarian Data Exchange (HDX), 2014 ³⁶⁸
Social facility: health centers	Hospitals, health centers, clinics, dispensaries, and teaching facilities collected for the Nigeria MDG Information System (NMIS) between 2009 and 2014 combined with data from OpenStreetMap; Indicator of active local economy	Not considered	≤ 1km distance ³⁶⁹	≥ 1km distance	Not considered	Not considered	Not considered	HDX, 2014 ³⁷⁰
Growth center: airport, mines, urban areas	Economic growth centers for the analysis up to 2030; Urban areas as defined by Electricity Demand	Not used	Not used	Not used	Not considered	≤ 15km distance	≥ 15km distance	airports: HDX, 2017 mines: HDX, 2015 urban areas: ECOWREX website, 2015 ³⁷¹

³⁶⁶ Extracted from Humanitarian Data Exchange (HDX)

³⁶⁷ Preferred maximum distance for mini-grids from discussions with different international developer.

³⁶⁸ Original source: Nigeria NMIS facility database (2014), the Office of the Senior Special Assistant to the President on the Millennium Development Goals (OSSAP-MDGs) & Columbia University

³⁶⁹ Preferred maximum distance for mini-grids from discussions with different international developer.

³⁷⁰ Ibid.

³⁷¹ <http://www.ecowrex.org/mapView/index.php?lang=eng>

ANNEX 2: TASK 2 METHODOLOGY

OFF-GRID SOLAR PV MARKET ASSESSMENT METHODOLOGY

FGDs were held in Abuja, Lagos, Kaduna and Port Harcourt in July 2018 with key stakeholders from each of the four off-grid market segments analyzed under Task 2: (i) household, (ii) institutional, (iii) productive use, and (iv) supplier. Focus group participants included representatives from government, the donor community, NGOs, solar companies, business and industry associations, academia, community groups, and women's groups. Each market segment had its own dedicated meeting, although some stakeholders attended more than one discussion. Each FGD lasted approximately 90 minutes and covered a range of topics related to demand for off-grid solar vis-à-vis each market segment.

In addition to the FGDs, three additional survey activities were undertaken to support the Task 2 analysis: (i) a survey of large-scale international solar companies to gauge their level of interest in the country and wider region; (ii) a survey of local small-scale retail suppliers of solar equipment; and (iii) an assessment of an off-grid village to better understand how solar was being utilized for productive uses. The FGDs and surveys largely yielded qualitative inputs to supplement the quantitative analysis that was undertaken.

The methodology and assumptions utilized to assess each market segment under Task 2 is presented below.

1. HOUSEHOLD DEMAND

1.1 Household market segments

- 1.1.1 Total population without access to electricity was calculated using World Bank total population figures,³⁷² multiplied by electricity access rates from the International Energy Agency (IEA),³⁷³ and translated to households using World Bank open data average household size. This method is used to align population data throughout the report, with IEA seen as an overarching source for energy access data and the World Bank providing important population and household income data. See **Annex 1** for more details.
- 1.1.2 Based on the country demographic and income data, the household solar market was broken down into segments by income quintile, as shown in **Section 2.1.1**. For the purpose of this analysis, income quintiles were aligned with energy tiers, as indicated by the Multi-Tier Energy Access Framework, which is roughly determined by household ability to pay for tier levels of energy. Quintiles were also aligned roughly with geographic segments.
- 1.1.3 World Bank demographic data used does not provide household income data broken down by rural, urban, on-grid or off-grid. For example, the data shows the total population falling under a certain poverty line, shows the total population that does not have access to electricity, and shows the total population that is rural, but does not cross reference any of these indicators to e.g. show the total rural population without access to electricity living under the poverty line. For this reason, assumptions were made regarding the number of households per income quintile that are off-grid (detailed in section 1.3.1 of these assumptions). It was assumed that the majority of off-grid households are rural. The data gap prevents the presentation of an overlapping map of the traditional poverty line income pyramid with electricity access.

³⁷² World Bank Open Data, 2017: <https://data.worldbank.org/>

³⁷³ IEA Energy Access Outlook, 2017:

https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf

1.2 Household energy expenditure and potential savings

- 1.2.1 Current household expenditure on energy-related items (believed to be candidates for replacement with solar products) was estimated using information from the FGDs.
- 1.2.2 From the existing household expenditures, “typical” monthly costs were estimated that households would incur in order to receive a standard level of electricity service according to the Multi-Tier Energy Access Framework.
- 1.2.3 The unit monthly costs were used for each of the energy-related items identified above.
- 1.2.4 The cumulative monthly expenditure was then determined for each tier.
- 1.2.5 Monthly expenditure by tier was compared with monthly cost associated with OGS products by tier to estimate potential household cost savings. Monthly cost for OGS products was based on representative data from the West African region.

1.2.6 In the process of this analysis, the following assumptions were made:

1.2.6.1 Solar system sizes and costs:

- Cost per watt on solar systems vary greatly and have changed rapidly in the past five years. Smaller pico and plug and play systems have a much higher per cost per watt. The USD/Watt prices are based on sample cost ranges from Lighting Global equipment available on the open market.
- Average system size by watts: values are chosen as representative values for solar systems from each of the Tier values. They are intended to represent system sizes that typical members of each group would purchase.
- Average system life values represent typical operating life of Lighting Global products.

1.2.6.2 Current household energy usage:

Current Household Energy Usage (# Units/HH)				
Technology	Tier 1	Tier 1.5	Tier 2	Tier 3
Torch lights/Lanterns	1	2	3	
Mobile Phone Charging	1	1	2	
DC Radio	-	1	-	-
DC Music Player/Radio	-	-	1	-
Small Generator	-	-	-	1

- Numbers of units of torch lights/lanterns, cell phones, dc radio, and small generator represent the numbers of appliances that are demonstrated to be in use in typical households of each tier based on FGDs and multiple survey documents.

1.2.6.3 Current household energy costs

- Typical purchase and operation costs of HH off-grid appliances were based on FGDs, field energy surveys and reports.

1.3 Total Cash and Financed Market for Off-Grid Solar

1.3.1 Beginning with World Bank demographic and population data for Nigeria, the number of off-grid households by income quintile was derived. For this, a percentage of off-grid households by quintile was assumed, as follows:

Quintile	% Off-Grid
Highest 20%	1%
Fourth 20%	2%
Third 20%	3%
Second 20%	97.5%
Lowest 20%	100%

It was assumed that there is a general correlation between income and access to electricity. The highest quintile has the highest percentage of population that are both urban and connected to the grid. Evidence indicates that the vast majority of households connected to the grid are from the top two quintiles. Similarly, it was assumed that virtually all people in the bottom two quintiles are off-grid.

1.3.2 From this, average household energy expenditure was determined based on income, with the assumption that all households spend an average of 10% of their income on energy.

Average rural household expenditure on energy varies considerably. A study from Sierra Leone found that the “cost of lighting, on average, occupied between 10-15% of household incomes. Households using generators were found to spend a greater proportion of their income (upward of 20%) on lighting.”³⁷⁴ Other research has shown household energy spending between 6-12% for low income segments in sub-Saharan Africa.³⁷⁵ For the purpose of this research, we have assumed that households can allocate 10% of their income on average to energy.

1.3.3 The monthly energy budget for each household per quintile was calculated by multiplying monthly Household income by the assumed 10% of Household income spent on energy. Monthly Household income per month was calculated by multiplying per capita income per month by the avg. # of persons/household. Per capita income per month for each quintile is calculated by dividing the Share of the country GDP for each quintile by the population of each quintile, which is one-fifth of the country population. The share of the country GDP for each quintile is based on World Bank, World Development Indicators demographic data.

1.3.4 A simple model was used to evaluate the market using the World Bank income quintile data and average energy expenditures as input data.

1.3.5 In determining the monthly energy expenditure related to each tier, the following assumptions were made with guidance from the FGDs output:

- **Tier 0:** Assumed to be an absolute energy poor household, relying solely on kerosene and charcoal both for cooking and lighting.
- **Tier 1:** The household was assumed to have access to 1 torch light/lantern powered by dry cells, charging services for a phone charged on average 8 times a month.

³⁷⁴ Lai, K., Munro, P., Keabay, M., and Thoronko, A., “Promoting Renewable Energy Services for Social Development in Sierra Leone: Baseline Data and Energy Sector Research, Final Report,” European Union, (July 2015).

³⁷⁵ 10% is an acceptable figure for lighting and cell phone charging costs for low income groups. See:

<https://www.brookings.edu/blog/africa-in-focus/2017/03/17/figures-of-the-week-benefits-of-off-grid-electricity-solutions/>

- **Tier 1.5:** The household was assumed to have access to 1 torch light and 1 lantern each powered by dry cells, one regular cell phone charged on average 8 times a month, and a radio powered by dry cells (assume access to 2 low quality cells) replaced 4 times a month.
- **Tier 2:** The household was assumed to have access to 1 torch light and 2 lanterns each powered by dry cells, one regular cell phone charged on average 8 times a month, and one smart phone charged on average 16 times a month, a radio/music player powered by dry cells (assume access to 4 low quality cells), replaced 4 times a month.
- **Tier 3:** The household was assumed to have access to a generator powering a number of appliances but available only for 2-3 hours a day.
- **Annualized energy costs** for each of the systems = $([\text{Capital system cost}/\text{average system life in years}] + [\text{Monthly operating cost} * 12])$

1.3.6 The **potential market size** for each solar tier was then calculated by multiplying the number of off-grid households per quintile that will be willing to pay for each solar tier by the cost of each system (system cost is based on representative data from Nigeria, as shown in 2.2.5).

1.3.7 In determining the number of off-grid households per quintile that will be willing to pay for each solar tier, the key assumption of the model is that each off-grid household purchases only one system and that they will opt for the highest solar system tier they can afford.

- For cash purchases, the assumption was that they will be willing to save (set aside) up to 3 months (number of months can be adjusted on the 'HH Assumptions' tab) of their monthly energy budget to purchase the system.
- For PAYG/financed, the assumption was that they will be willing if their monthly energy budget is less than or equal to the monthly PAYG payment AND if the PAYG upfront payment is less than or equal to 3 months of their monthly energy budget.

1.3.8 The interest rate for consumer finance was estimated to be 60% p.a., based on information from the leading Microfinance Institution in Nigeria.³⁷⁶

2023 and 2030 Household Demand Scenario: Assumptions

1. The GIS analysis³⁷⁷ estimated that by 2023, 54.8% of the population will be grid connected, 5.4% will be connected by mini-grids while 39.9% of the population will be connected by off-grid stand-alone solutions. By 2030, the GIS analysis estimated that 88.1% of the population will be grid connected, 7.0% will be connected by mini-grids while only 4.9% of the population will be connected by off-grid stand-alone solutions. Based on these dynamics in the demographic patterns, coupled with the existing government plans, the following assumptions regarding the off-grid population based on the quintiles were made:

- In the 2023 scenario, it was assumed that as the grid gets extended and mini-grids are deployed (based on GIS data), the households in the quintiles with the highest income will be given priority due to their relatively higher power demand and ability to pay for power consumption. Hence, the highest quintile was assumed to have only 0.5% off-grid households, while the second highest quintile was assumed to have 1% off-grid households with the third quintile having 1.5% off-grid households. It was assumed that virtually all people in the bottom two quintiles remain off-grid. These assumptions have been made such that the total number of off-grid households assumed is equal to the GIS data 2023 estimate.
- Similarly, in the 2030 scenario, it was assumed that the higher income quintiles will be

³⁷⁶ <https://www.lapo-nigeria.org/blog/products-interest-rates>

³⁷⁷ See **Annex 1** for GIS methodology.

prioritized for electrification, based on economic considerations, above the lower quintiles. Hence, the highest four quintiles were assumed to have only 0.1%, 0.2%, 0.3%, and 0.4% off-grid households respectively, while the lowest quintile was assumed to have 23.4% off-grid households. These assumptions have been made such that the total number of off-grid households assumed is equal to the GIS data 2030 estimate.

Quintile	% Off-Grid (2023)	% Off-Grid (2030)
Highest 20%	0.5%	0.1%
Fourth 20%	1.0%	0.2%
Third 20%	1.5%	0.3%
Second 20%	96.3%	0.4%
Lowest 20%	100%	23.4%

- Inflation rates for Nigeria: According to the IMF World Economic Outlook data, inflation in Nigeria is estimated to be at 14% in 2023. It was assumed that the rate will remain the same through 2030. Based on this assumption, the expected prices of the current household energy technologies and the solar alternatives were estimated using an annual price escalation factor of 1.14.
- Based on a 2.6% population growth rate from the World Bank³⁷⁸ and the population density dataset used in the study, the estimated total population will be 223,493,298 in 2023 and 267,482,904 in 2030.
- The least-cost electrification analysis found that the share of the population with access to electricity via the national grid and mini-grids will be 60.1% in 2023 and 95.1% in 2030.
- To estimate GDP, it was assumed that the current annual GDP growth rate of 0.8% will be maintained through 2023 and 2030:

Parameter	2023	2030
Population	223,493,298 (GIS estimate)	267,482,904 (GIS estimate)
GDP (constant 2010 USD)	\$483,046,675,687	\$510,755,230,037

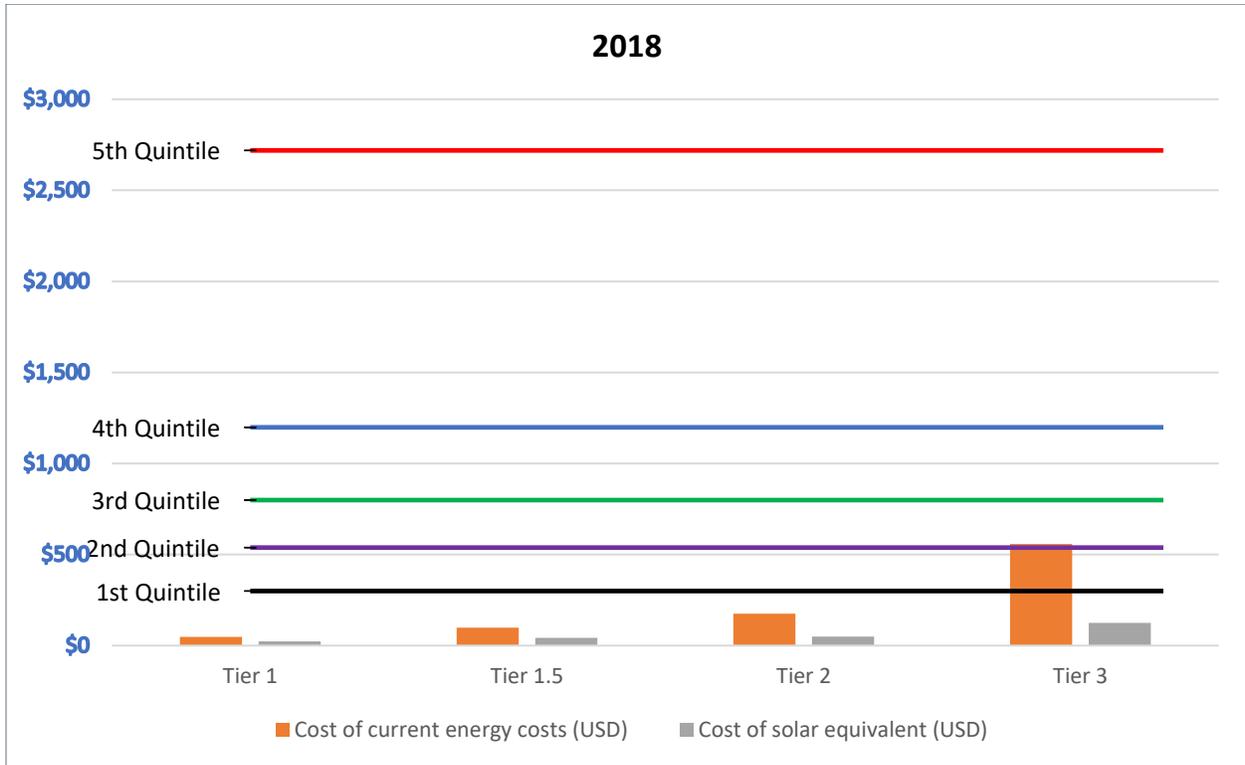
- According to the Lighting Global Off-Grid Solar Market Trends Report 2018,³⁷⁹ the price of pico solar products is expected to fall to USD 10.60 in 2020 and USD 10.10 in 2022 down from USD 10.90 in 2016. Based on these 2020 and 2022 figures, the average annual decrease in prices from 2020 was estimated at 2.36%. It was assumed that the annual price decrease will be maintained at this rate through 2030 (annual cost reduction factor of 0.98).
- According to the same report, the price of small SHS components is expected to fall to USD 60.40 in 2020 and USD 47.40 in 2022, down from USD 77.80 in 2016. Based on these 2020 and 2022 figures, the average annual decrease in prices from 2020 was estimated at 10.76%. It was assumed that the annual price decrease will be maintained at this level through 2030 (annual cost reduction factor of 0.89).
- It was assumed the interest rates in Nigeria will stagnate at the current rate of 60% or possibly decline.

³⁷⁸ <https://data.worldbank.org/indicator/SP.POP.GROW?locations=BJ>

³⁷⁹ "Off-Grid Solar Market Trends Report 2018," Dahlberg Advisors, Lighting Global, GOGLA and World Bank ESMAP, (January 2018): https://www.lightingafrica.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf

Household Cost Savings and Affordability Calculation

Annual Household Energy Budget by Quintile, Annual Energy Costs and Annual Costs of Solar Equivalents



- This analysis presents annualized costs (not including financing cost) of current energy technologies for each energy tier, compared with the annual cost of an equivalent solar product. The analysis was also completed for the 2023 and 2030 scenarios.
- Both the annual costs of current energy technologies and equivalent solar solutions consider the capital costs of the units, and the operating costs considered over the average unit life times.
- These costs were compared against a 10% monthly energy budget for households of different income quintiles. This analysis did not assess affordability for cash vs. financed purchase over time.

2. INSTITUTIONAL DEMAND

2.1 Country Categorization

To assess institutional sector demand, the ROGEP countries were grouped into four categories based on income and population density, which are two key factors that influence the number of public service institutions in a given country. The countries were categorized as follows:

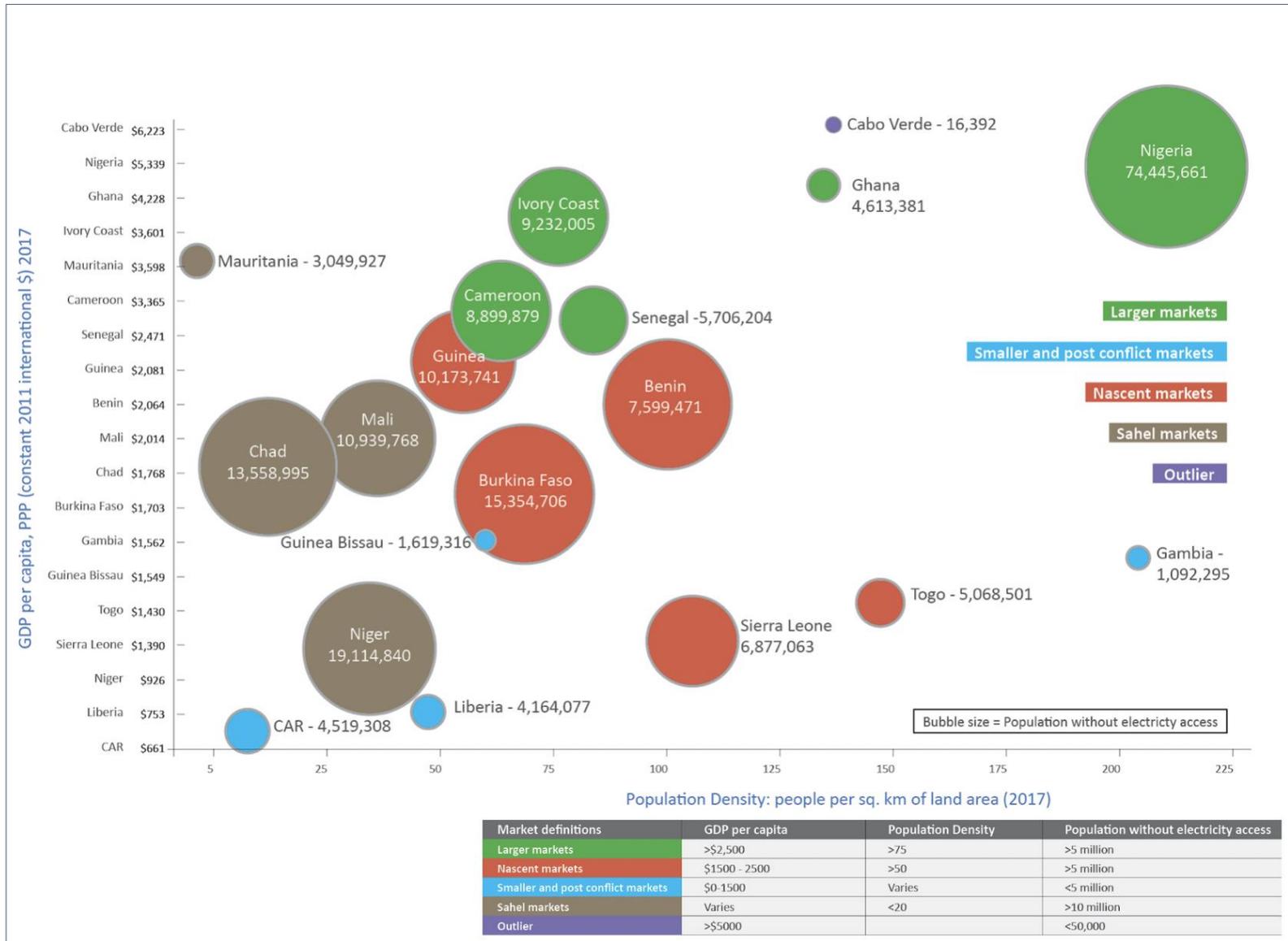
Country Categorization by Income and Population Density			
Category 1: Low-income / low population density	Category 2: Low-income / high population density	Category 3: High-income/ low population density	Category 4: High-income / high population density
Niger Burkina Faso Chad Mali Guinea Guinea-Bissau Central African Republic Liberia	Benin Sierra Leone Togo Gambia	Cameroon Côte d'Ivoire Mauritania Senegal	Nigeria Ghana Cabo Verde

These categories were used to address data gaps, as obtaining accurate and comprehensive data on the number of off-grid public institutions in many of the countries was challenging. Where data was not available, per capita assumptions based on data from similar countries in the same category were used. The following countries were used as reference countries for each category:

Category 1	Guinea, Liberia, Niger
Category 2	Benin, Sierra Leone
Category 3	Côte d'Ivoire
Category 4	Ghana

Categories are defined as follows (and illustrated in the figure below):

- Low population density: <95 people per square km of land area
- High population density: >95 people per square km of land area
- Low income: <\$2,200 GDP per capita
- High income: >\$2,200 GDP per capita



Source: African Solar Designs analysis

2.2 Energy Needs by Institutional Market Segment

Institutional Sector	Description	Rating (W)	Time of use (hrs)	Total Wh/day	Total Load	Recommended system (W)
Water Pumping						
Low power		1,500	6	9,000		1,500
Medium power		4,000	6	24,000		4,000
High power		10,000	6	60,000		10,000
Healthcare						
HC1 Health post	Lighting	30	8	240		
	Communication	20	8	160		
	ICT	100	8	800	1,200	250
HC2 Basic healthcare facility	Lighting	200	8	1,600		
	Maternity	200	4	800		
	Vaccine refrigeration	100	8	800		
	Communication	100	4	400		
	Medical exams	200	2	400		
	ICT	200	8	1,600		
	Staff housing	50	8	400	6,000	1,500
HC3 Enhanced healthcare facility	Lighting	400	8	3,200		
	Communication	200	8	1,600		
	Medical exams	600	2	1,200		
	ICT	300	8	2,400		
	Maternity	600	4	2,400		
	Laboratory	1,000	2	2,000		
	Sterilization	1,200	1	1,200		
	Vaccine refrigeration	150	8	1,200		
	Staff housing	200	8	1,600	16,800	4,200
	Education					
Primary school	Communication	20	8	160		
	Lighting	80	8	640		
	ICT	100	8	800		
	Staff house	50	8	400	2,000	500
Secondary school	Communication	20	8	160		
	Lighting	240	8	1,920		
	ICT	400	8	3,200		
	Laboratory use	100	8	800		
	Staff house	200	8	1,600	7,680	1,920
Public Lighting						
Street lighting	Lights	200	8	1,600	1,600	500

Source: The estimates in the table above are based on data obtained from local experts, interviews with solar industry stakeholders and corroborated by secondary desk research.

CALCULATIONS: Rating of systems is based on data for sizes of the appliances from a 2016 GIZ solar PV catalogue.³⁸⁰ The solar PV sizing factor is based on the peak sun hours available across most of Africa.

³⁸⁰ "Photovoltaics for Productive Use Applications: A Catalogue of DC-Appliances," GIZ, (2016): https://www.sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/GIZ_2016_Catalogue_PV_Appliances_for_Micro_Enterprises_low.pdf

Energy Needs Assumptions:

Water Supply: Power requirements (low, medium, high) are based on the type of water point:

- Borehole: 40% low power pumps; 40% medium power; 20% high power
- Protected dug well: 80% no pump; 10% low power pumps; 10% medium power; no high-power
- Unprotected dug well: No pump
- Protected spring: No pump
- Unprotected spring: No pump
- Public tap/standpipe (stand-alone or water kiosk): No pump
- Sand/Sub-surface dam (with well or standpipe): No pump
- Piped water into dwelling/plot/yard: No pump
- Rainwater harvesting: No pump

Healthcare: The size of the healthcare facility (HC1, HC2, HC3) determines the amount of energy each facility requires.

Education: The size of the school and number of students determines the amount of energy each school requires.

Public lighting: It was assumed that two [2] public lighting points would be required to meet the energy needs of a town/market center.

2.3 Institutional Market Sizing Calculations

Household systems, cost and price per watt:

System Type	Tier Rating	USD/Watt ³⁸¹	Average Size (Watts)	Total Cost (USD)
Pico solar system	Tier 1	\$15.00	3	\$45.00
Basic Plug and Play system	Tier 1.5	\$12.50	10	\$125.00
Small HH solar system	Tier 2	\$5.00	50	\$250.00
Medium HH solar system	Tier 3	\$2.50	250	\$625.00

Size of systems used in institutional sector market sizing calculation:

Sector	Description	Size (corrected for time of use)	HH systems
Water Supply	Low Power	1,500	N/A
	Medium Power	4,000	N/A
	High power	10,000	N/A
Healthcare	HC1	250	Tier 3
	HC2	1,500	N/A
	HC3	4,200	N/A
Education	Primary	500	N/A
	Secondary	1,920	N/A
Public lighting		500	N/A

³⁸¹ Cost per watt derived from African Solar Designs analysis and from IRENA:
<https://www.irena.org/publications/2016/Sep/Solar-PV-in-Africa-Costs-and-Markets>

Institutional Sector Market Sizing Calculations:

NOTE: Prices cover only solar components (except for the HC1 tier 3 system, which comes with lighting)

Water Supply						
# of water pumps	X	Size of solar system (watts) (low, medium, high power)	X	Cost per watt for pumping (\$2.50) divided by system lifetime of 20 years	=	Estimated Annualized Off-Grid Solar Market Potential for Water Supply Sector

Healthcare						
# of healthcare facilities	X		X		=	Estimated Annualized Off-Grid Solar Market Potential for Healthcare Sector
HC 1		Cost per tier 3 system (\$625)		Divided by system lifetime of 5 years		
HC 2		Size of solar system in Watts (1500W)		Cost per watt (\$2.50) divided by system lifetime of 20 years		
HC 3		Size of solar system in Watts (4200W)		Cost per watt (\$2.50) divided by system lifetime of 20 years		

Education						
# of schools	X		X		=	Estimated Annualized Off-Grid Solar Market Potential for Education Sector
Primary		Size of solar system in Watts (500W)		Cost per watt (\$3) divided by system lifetime of 20 years		
Secondary		Size of solar system in Watts (1920W)		Cost per watt (\$2.50) divided by system lifetime of 20 years		

Public Lighting						
# of off-grid market centers	X	Size of solar system in Watts (500W)	X	Cost per watt (\$3) divided by system lifetime of 20 years	=	Estimated Annualized Off-Grid Solar Market Potential for Public Lighting Sector

2.4 Data Collection Approach by Institutional Market Segment

NIGERIA			
Water Supply	Healthcare	Education	Public Lighting
Per capita assumption	Per capita assumption	National Bureau of Statistics ³⁸²	Per capita assumption

Data was collected on the total number of off-grid institutions by institutional market segment for Nigeria from a combination of available GIS data, input from local experts, stakeholder interviews and desk research. Where there were gaps in available data, per capita assumptions were made, as explained in **Section 2.2**.

Assumptions:

Water Supply: Of the identified potable water points, it was assumed that 50% would be equipped with a solar-powered water pump. Of the equipped water sources, the division of pumps between low, medium

³⁸² Annual Abstract of Statistics, 2016, National Bureau of Statistics: www.nigerianstat.gov.ng

and high-powered pumps was: 50%, 35% and 15%, respectively. The lower cost of the low power pumps is the driving factor for this assumption. Where this information was not available, a per capita comparison was made with a country in the same category.

Healthcare: Wherever possible, specific data on the number of off-grid healthcare facilities by size was used (i.e. HC1, HC2, HC3). Where this information was not available, a per capita comparison was made with a country in the same category.

Education: Wherever possible, specific data on the number of off-grid primary and secondary schools was used. Primary schools encompass both primary and nursery schools. Vocational schools and universities were not considered because they tend to be in cities, which are often grid-electrified. Where this information was not available, a per capita comparison was made with a country in the same category. The following per-capita assumptions were made.³⁸³

- **Primary school:** Per capita calculation using the off-grid population that is 0-14 years
- **Secondary school:** Per capita calculation using the off-grid population that is 15-19 years

Public lighting: Using population figures by region, and assuming that the population per market center was 5,000 people, the number of market centers was calculated. An assumption of two [2] public lighting points per market center was used in the calculation. No data on street lighting was included, as it was assumed that street lighting projects are linked to road infrastructure rather than institutions.

2.5 Ability to Pay Analysis (Strongest Potential Market Segment)

Data was not available to estimate the monthly energy expenditures of institutional users. Secondary data was available through government and donor program annual budgets for public services but was not comprehensive. A rudimentary analysis was undertaken based on these funding sources and compared to the total solar product market estimate for each institutional market segment in order to discuss the realistic potential market outlook based on the ability to pay. Due to a lack of data, the analysis was not able to take into account other potential sources of funding, such as funds pooled at the national or local level, fees for services etc.

³⁸³ Population without access to electricity:

https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf

Population ages 0-14: <https://data.worldbank.org/indicator/SP.POP.0014.TO>

Population ages 15-19: <https://data.worldbank.org/indicator/SP.POP.1519.MA.5Y>;

<https://data.worldbank.org/indicator/SP.POP.1519.FE.5Y>

3. PRODUCTIVE USE DEMAND

3.1.1 PUE Applications for Off-Grid Microenterprises (barbers and tailors)

The market sizing calculation for the barbers and tailors sector assumed that hair cutting and sewing appliances will be retrofitted to be powered by a Tier 3 DC solar system (5-year system life). By using a single price for all of the ROGEP countries, this methodology does not take into account country-specific cost and supply chain constraints.

Microenterprises					
# of financially constrained SMEs ³⁸⁴	X	Cost per tier 3 system (\$625)	Divided by system lifetime of 5 years	=	Estimated Annualized Off-Grid Solar Market Potential for SMEs

3.1.2 Value-Added PUE Applications

Available data from various sources such as the World Bank, the UN’s Food and Agriculture Organization and GSMA was used to estimate the potential OGS market for productive use applications in each of the analyzed market segments – solar pumping for agricultural **irrigation**, solar powered **milling** and solar powered **refrigeration**.

3.1.3 Irrigation

The market sizing calculation for solar-powered irrigation was based on smallholder irrigation potential (i.e. the amount of irrigable land suitable for smallholder farmers) that could benefit from a solar pumping system (\$650, 6-year system life, 120 W system). This methodology does not take into account affordability (ability to pay) nor does it account for country-specific cost and supply chain constraints.

Value-Added PUE Applications – Solar Irrigation											
Irrigation Potential (hectare) ³⁸⁵	X	=	Smallholder Irrigation Potential (hectare) ³⁸⁶	Divided by 0.3 ³⁸⁷	=	Estimated No. of Smallholder Farms Suitable for Solar Irrigation	X	\$650 (cost of solar pumping kit) ³⁸⁸	Divided by 6 year (life of system)	=	Estimated Annualized Off-Grid Solar Market Potential for irrigation

Methodology for identifying areas suitable for irrigation activities on farms:

The areas for potential irrigation activities were calculated using the visible cropland³⁸⁹ adjacent to permanent surface water sources. As identified by experts in a study in Zambia³⁹⁰ and based on other expert consultations, beyond a 5 km distance from surface water, the returns are not economically feasible. **Figure 36** is a map of the cropland within a 5 km distance from permanent surface water.

³⁸⁴ “MSME Finance Gap,” SME Finance Forum: <https://www.smefinanceforum.org/data-sites/msme-finance-gap>

³⁸⁵ AQUASTAT – Food and Agriculture Organization: <http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en>

³⁸⁶ Assumption that 25% of irrigable land irrigated by smallholder farmers;

See: “Lessons Learned in the Development of Smallholder Private Irrigation for High Value Crops in West Africa,” World Bank, (2011): http://siteresources.worldbank.org/INTARD/Resources/West_Africa_web_fc.pdf

³⁸⁷ Assumption that smallholder private irrigation consists of small farms (0.3 hectare);

See: “Off-grid Solar Market Assessment in Niger and Design of Market-based Solutions,” World Bank, (December 2017): <https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/>

³⁸⁸ 120W solar pumping kit: <https://futurepump.com/futures-bright-farmers-kenya/>

³⁸⁹ “Prototype Land Cover Map over Africa at 20m Released,” Esa, (February 2018): <https://www.esa-landcover-cci.org/?q=node/187>

³⁹⁰ “Zambia Electrification Geospatial Model,” USAID and Power Africa, (April 2018): https://pdf.usaid.gov/pdf_docs/PA00T2JC.pdf

3.1.4 Milling

The market sizing calculation for solar-powered milling utilized a series of inputs from the UN Food and Agriculture Organization to estimate the smallholder milling potential that could benefit from a 6.5 kW solar powered milling system (20-year system life). Cereals (e.g. rice, maize, millet and sorghum) as well as roots and tuber crops (e.g. cassava, yams and potatoes) were analyzed, as they provide an opportunity for value addition through hulling or milling.

Value-Added PUE Applications – Solar Milling													
Cereals, roots tuber crops (tons) ³⁹¹	X	70% ³⁹²	X	50% ³⁹³	=	Smallholder Milling Potential (tons)	Divided by 2 tons per day X 70% capacity factor ³⁹⁴	=	Estimated No. of Solar Mills	X	6,500 W x \$2.50 per watt Divided by system lifetime of 20 years	=	Estimated Annualized Off-Grid Solar Market Potential for Milling

Ultimately, the ability for an agricultural community to benefit from productive use applications has as much to do with access to markets and improved crop inputs, as it has to do with the pricing and availability of financing to purchase the equipment. Hence, the macroeconomic approach used to carry out this market sizing does not account for country-specific cost and supply chain constraints.

3.1.5 Refrigeration

The market sizing calculation for solar-powered refrigeration utilized the estimated number of off-grid market centers in each country to estimate the number that could benefit from a 5.5 kW solar refrigeration system (20-year system life).

Value-Added PUE Applications – Solar Refrigeration							
# Off-Grid Market Centers by country ³⁹⁵	X	5,500 W ³⁹⁶	X	\$2.50 per watt	Divided by system lifetime of 20 years	=	Estimated Annualized Off-Grid Solar Market Potential for Refrigeration

3.2 PUE Applications for Connectivity/Mobile Phone Charging Enterprises

The market sizing calculation for solar-powered phone charging enterprises was based on each country’s mobile phone penetration rate (number of unique subscribers), rural population rate, and the average costs of OGS phone charging appliances (\$862, 5-year system life, 400 W system).

Mobile Phone Charging Enterprises							
# of Mobile Phone Subscribers in 2017 ³⁹⁷	X	% rural population	Cost of solar phone charging appliances* divided by lifetime of 5 years	X	0.01 (assuming 1 phone charger per 100 mobile phone users)	=	Estimated Annualized Off-Grid Solar Market Potential for Phone Charging Enterprises

³⁹¹ Food and Agriculture Organization: <http://www.fao.org/faostat/en/#data/RF>

³⁹² Assumption that 70% of crops are milled

³⁹³ Assumption that 50% of milled crops are processed at smallholder farmer level

³⁹⁴ Solar mill (6.5 kW system) can mill 2 tons of produce per day; assume capacity factor of 70% (for maintenance/seasonality)

See: “Off-grid Solar Market Assessment in Niger and Design of Market-based Solutions,” World Bank, (December 2017):

<https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/>

³⁹⁵ <https://www.citypopulation.de>

³⁹⁶ 5.5kW solar powered refrigeration system – See: <https://www.deutschland.de/en/solar-powered-coldhubs-nigeria>

³⁹⁷ “The Mobile Economy, Sub-Saharan Africa,” GSMA Intelligence, (2017):

<https://www.gsmaintelligence.com/research/?file=7bf3592e6d750144e58d9dcfac6adfab&download>

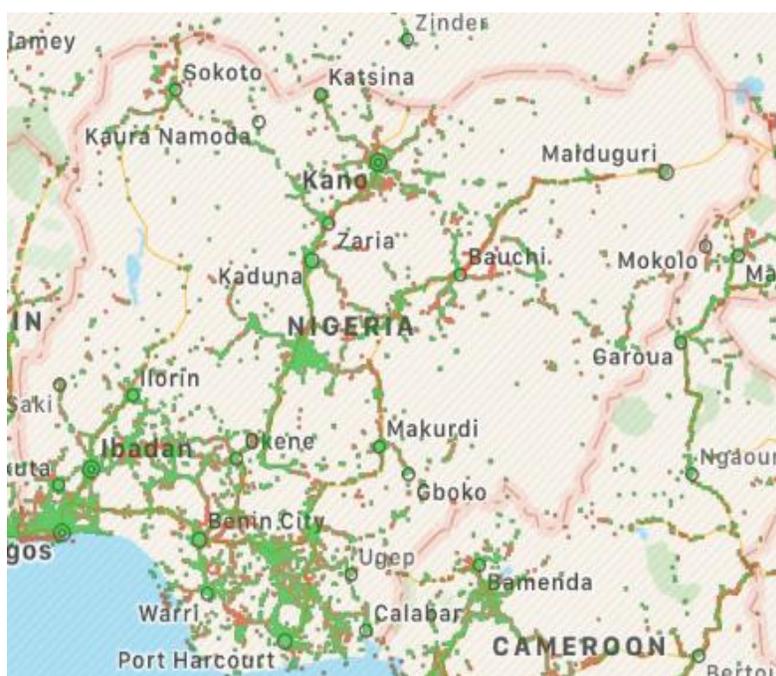
* Indicative Costs for Phone Charging Appliances³⁹⁸

Charging Stations	Cost (USD)	Manufacturer
Charging ECOBOXX Qube (sizes - 50) 5Wp panel	\$83	EcoBoxx/ Sungrid Group (PTY) LTD South Africa
Charging ECOBOXX Qube (sizes - 90) 10Wp panel	\$205	EcoBoxx/ Sungrid Group (PTY) LTD South Africa
Charging ECOBOXX Qube (sizes - 160) 2*10Wp panel	\$209	EcoBoxx/ Sungrid Group (PTY) LTD South Africa
Portable charging station ECOBOXX 300	\$681	EcoBoxx/ Sungrid Group (PTY) LTD South Africa
Portable charging station ECOBOXX 600	\$965	EcoBoxx/ Sungrid Group (PTY) LTD South Africa
Portable Charging Station ECOBOXX 1500	\$1,532	EcoBoxx/ Sungrid Group (PTY) LTD South Africa
Portable charging station BOSS Kit Portable	\$3,025	Phaesun GmbH
Charging Sundaya Charging Station	\$193	Sundaya
Average Cost	\$862	

Source: GIZ and African Solar Designs analysis

Identifying areas of phone network coverage

The mobile phone network geographic coverage was mapped across each country (**Figure 38**). The source for this data is GSMA, which gives a radius ranging between 2-30 km. The radius is affected by a number of variables including tower height, power output, frequencies in use, and antenna type. Since this does not indicate the quality of network, the data was compared with data from OpenSignal, which tracks the signal from users registered on the platform.



Green: Strong Signal (>-85dBm)
 Red: Weak Signal (<-99dBm)
 Source: Open Data Signal

³⁹⁸ "Photovoltaics for Productive Use Applications: A Catalogue of DC-Appliances," GIZ, (2016): https://www.sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/GIZ_2016_Catalogue_PV_Appliances_for_Micro_Enterprises_low.pdf

4. SUPPLY CHAIN ANALYSIS

The Task 2 supply chain analysis was based on the following key sources of data:

- Supplier focus group discussions held in Abuja, Lagos, Kaduna and Port Harcourt in July 2018
- Survey of 10 locally-based solar companies/suppliers in the country
- Survey of 10 larger international solar product suppliers
- ECREEE supplier database
- GOGLA semi-annual sales reports³⁹⁹
- Additional supplemental desk research and solar industry stakeholder interviews

These findings were subsequently corroborated by attendees of national validation workshops held in each country at the conclusion of the market assessment.

A list of identified solar companies that are active in Nigeria is included below:

1	Africa Energy
2	Afriipower
3	Afrowatt Nigeria
4	Ahix-Solar
5	Arnergy
6	Ashdam
7	Asolar Nigeria
8	Asteven International
9	Awps Renewable Energy Ltd
10	Azuri
11	Blue Camel
12	Boyl Designs Ltd
13	Canadian Solar
14	Consisten Airwawes Tech
15	Consistent Energy
16	Creeds Energy
17	Deka
18	D.Light
19	Double-Link Corporate Ventures
20	Eauxwell Engineering
21	East Wall Solutions
22	Ecophilia Energy Limited
23	First Point

³⁹⁹ "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (January – June 2018): https://www.gogla.org/sites/default/files/resource_docs/global_off-grid_solar_market_report_h1_2018-opt.pdf
 "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (July – December 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth2-2017_def20180424_web_opt.pdf
 "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (January – June 2017): https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth12017_def.pdf
 "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (July – December 2016): https://www.gogla.org/sites/default/files/recource_docs/final_sales-and-impact-report_h22016_full_public.pdf
 "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data," GOGLA, Lighting Global and World Bank, (January – June 2016): https://www.gogla.org/sites/default/files/recource_docs/global_off-grid_solar_market_report_jan-june_2016_public.pdf

24	Fukconsults Federal University, Kashere Consultancy Services Limited
25	Gas On Wheels Limited
26	Gastec Group, Nigeria
27	Gaston
28	Gennex Technologies
29	Gelon Nigeria Limited
30	Genus
31	Greenlight Planet
32	GVE Projects Ltd
33	HavenHill Synergy
34	Icimi
35	Jinko Solar
36	Jubaili Brothers
37	Keg Consultancy, Inc.
38	Knight Solar Contractors
39	Koda Matigho Nigeria Limited
40	Luminous
41	Lumos Global
42	Martechlink System Ventures
43	Moriah Blessed Ventures
44	MPower
45	Nayo Tropical Tech
46	Oginni Ever Increasing Ent. Nig. Ltd
47	Opa Divine Ventures
48	Oretronics Technology
49	Outback
50	Protergia Energy
51	Re Mekatronix Engineering Company Limited
52	Roncho Energy
53	Rubi Tech Solar
54	Rubycom Technologies Limited
55	Samaritan Touch Multimedia Ltd
56	Schimaticblue Energy Limited
57	Schneider Electric
58	Shiraan Limited
59	Simba Solar
60	SMA
61	Solarcentric Technologies Limited
62	Solarmate Engineering Limited
63	Sosai Renewable Energies Company
64	Solar Sister
65	Spider Solutions Nigeria
66	3Cubetech
67	Topstep Nigeria Limited
68	Trojan

69	Wallis Décor
70	Wedotebary Nigeria Limited
71	Besi Energy & Waste Recycling Limited
72	Solar Direct
73	Rubitec Power
74	Tonbofa
75	Yingli Solar Nigeria

Source: ECREEE, Focus Group Discussions; Stakeholder interviews

ANNEX 3: TASK 3 METHODOLOGY

FINANCIAL INSTITUTION ASSESSMENT

Data collection under Task 3 included a combination of desk research, collaboration with local experts, and extensive stakeholder engagement with key officials and representatives from local and regional commercial banks, microfinance institutions and other development banks and agencies in Nigeria. Interviews were also conducted with regional development banks (namely BOAD and EBID) and other financiers active in the African off-grid solar sector, including export credit agencies, trade funders, crowd funders and impact investors.

The stakeholder engagement activity, which included both phone interviews as well as in-person meetings with key representatives from each FI, was undertaken across the 19 countries with extensive support from ECREEE. As a follow up to each interview/meeting, a questionnaire was administered in order to gather critical data on each institution, including *inter alia* their level of experience and capabilities with off-grid sector lending, SME and consumer lending, relationships with local and international partners etc. Feedback from the interviews and questionnaire, as well as quantitative data from each bank's published annual reports, was compiled and analyzed in order to assess which FIs could be most suitable local partners / implementing agents for the proposed ROGEP facility.⁴⁰⁰

The questionnaire that was administered to FIs in the country and across the ROGEP region is included below.⁴⁰¹ The results of the survey are summarized in **Section 3.4**.

- Has the bank provided any loans to any segment of the off-grid sector? If so, please describe.
- Has the bank received any inquiries from any segment of the off-grid sector? How many inquiries?
- Did the bank engage in serious discussions or dismiss the inquiry(ies) as not within the bank's area of lending or not interesting as a new business line? If dismissed, please provide the bank's reasons.
- If the bank engaged in serious review/discussions and rejected the opportunity, please describe the bank's due diligence approach and reasons for rejection.
- Is the bank interested to pursue lending to any segment of the off-grid sector? Which segment and which of the bank's departments and existing products apply?
- Describe the bank's current loan products and lending activity for the SME, Corporate, Consumer and Agri markets. Please provide rough figures on volumes in number of loans and value in each category. For each category please provide average margins, pricing, loan tenors to borrowers, collateral requirements.
- Does the bank have a structured finance department? Has the bank provided financing to any IPPs? If so, please provide details on the transactions (location, technology, size, maturity, portion of bank engagement in the total financing)
- Does the bank have a trade finance department? What are standard terms and conditions? What are the volumes in number of loans and values?
- Does the bank operate nationwide or only in certain regions? Does the bank have a presence in rural areas and is rural consumer and SME and Agri lending a key business focus?
- Does the bank have experience with managing DFI credit lines? In which sectors/departments? Which DFIs? What volumes? Were the lines fully committed and disbursed? What was the bank's overall experience with these credit lines?
- Has the bank had dealings with the ECOWAS Bank for Investment and Development (EBID)? What type of relationship? Credit lines? Co-lending? Credit enhancement? Have the experiences been positive?
- What is the bank's view on accepting hard currency credit lines and on-lending in hard currency? Would the bank hedge hard currency credit lines and on-lend in local currency?

⁴⁰⁰ The results of this assessment and corresponding recommendations were prepared for ECREEE in a separate, confidential report.

⁴⁰¹ The survey was adapted based on the type of FI that was being interviewed (commercial banks, MFIs, Regional Development Banks)

- Is the bank interested to explore a credit line with ROGEP? What size of credit line would the bank be comfortable launching with initially?
- Does the bank feel that it would need a third-party guarantee in order to reduce risk enough to make loans to off-grid enterprises? If so, would it be enough if a guarantor were to cover 50% of losses on par with the bank? Or will the bank need the guarantor to take the first 10-20% of losses in an off-grid loan portfolio?
- What pricing does the bank consider to be fair and affordable for third party pari-passu guarantees? For first loss coverage?
- Has the bank had experience with any of the following as guarantors on the bank's loans: Africa Guarantee Fund, Africa Trade Insurers, Afrexim Bank, GuarantCo, IFC, USAID DCA? Has their pricing been fair and affordable? Does the bank have any preference in working with one over the others?
- To engage in lending to the off-grid market segments, would Technical Assistance be helpful? What types of TA would be most useful? Outside consultants to help design specific loan products and underwriting guidelines for the off-grid sector? Outside consultants to develop deal flow and conduct due diligence? Training of bank credit department and account representative personnel? Direct funding to the bank to develop marketing and promotional materials and hire staff?
- Does the bank adhere to and is in compliance with all aspects of the Basel II and III accords?
- Does the bank adhere to and have implemented controls for the Equator Principals and the World Bank/IFC Environmental and Social Standards?

ANNEX 4: GENDER ASSESSMENT

1. Context and Purpose of the Gender Analysis

Within the context of this assignment, a gender-focused analysis was undertaken to assess the level of participation of women in each country's off-grid energy sector. This analysis is critical to the overall market assessment given the clear linkages between energy and gender, namely different rates of access and use as well as the impacts of energy sources and appliances in the home, community and wider society. Energy sector studies often fail to obtain gender-disaggregated data, which is necessary to inform policymakers and better understand the needs and priorities of women in the context of sustainable development.

Women in energy-poor households are at substantially higher risk of illness attributable to indoor air pollution and solid fuel (biomass) use.⁴⁰² Moreover, the significant time burdens that women and girls face in collecting fuel and water, cooking and processing food often keep girls from attending school; there is evidence that electrified milling equipment and water pumps can significantly reduce this burden. Lack of access to electricity also means that women do not have access to information and communication technologies that could improve their lives.⁴⁰³

As a region, West Africa and the Sahel has remained traditionally gender-stratified whereby males on average have greater access to resources, are more empowered by society and have more opportunities than women.⁴⁰⁴ To address these challenges, governments across the region have adopted a range of policies to improve gender equality and promote gender mainstreaming. Member states of ECOWAS have adopted a Policy for Gender Mainstreaming in Energy Access, an initiative committed to promoting favorable policies and frameworks and mobilizing resources to more fully engage women in all areas of energy access, including as energy suppliers, planners, financiers, educators and customers.⁴⁰⁵ ECREEE, the agency that is administering this policy throughout the region, is supporting implementation of regulatory and institutional measures that aim to improve inclusive energy access in each country by 2030. ECREEE has also partnered with AfDB to launch a separate regional initiative to advance the participation of women entrepreneurs in the renewable energy sector.⁴⁰⁶

Outside of ECOWAS, Cameroon, Chad and Central African Republic are pursuing gender mainstreaming at a regional level through the Economic Community of Central African States (ECCAS) Regional Policy for universal access to modern energy services and economic and social development (2014-2030).⁴⁰⁷ Mauritania is also implementing a national policy to address this issue – the National Strategy of Institutionalization of Gender (la Stratégie Nationale d'institutionnalisation du genre).

⁴⁰² "The Energy Access Situation in Developing Countries: A Review Focusing on the Least Developed Countries and Sub-Saharan Africa," UNDP and World Health Organization, (2009): <http://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Sustainable%20Energy/energy-access-situation-in-developing-countries.pdf>

⁴⁰³ Rewald, R., "Energy and Women and Girls: Analyzing the needs, uses, and impacts of energy on women and girls in the developing world," Oxfam, (2017): <https://www.oxfamamerica.org/static/media/files/energy-women-girls.pdf>

⁴⁰⁴ "Situation Analysis of Energy and Gender Issues in ECOWAS Member States," ECREEE, National Energy Laboratory, (2015): <https://www.seforall.org/sites/default/files/Situation-Analysis-of-Energy-and-Gender-Issues.pdf>

⁴⁰⁵ Ibid.

⁴⁰⁶ "Feasibility study promotes women's participation in energy transition," ESI Africa, (May 7, 2018): <https://www.esi-africa.com/feasibility-study-promotes-womens-participation-in-energy-transition/>

⁴⁰⁷ "Central Africa Regional Integration Strategy Paper," African Development Bank, (2011-2015): <https://www.afdb.org/fileadmin/uploads/afdb/Documents/Policy-Documents/RISP%20CENTRAL%20AFRICA-ECCAS%20English%20FINAL.pdf>

➤ **Description of Approach / Methodology**

While the data collection for this assignment was not sex dis-aggregated (which was beyond the scope of work), a gender-focused perspective was applied to the overall analysis. The methodology adopted to carry out this exercise included a combination of desk research, literature review, FGDs and face-to-face interviews with key gender “focal points” identified by ECREEE in each country. Representatives from women’s groups, female-led businesses and energy sector organizations attended the focus group meetings that were held in Abuja, Lagos, Kaduna and Port Harcourt in July 2018 to share their insights and inform the overall market study. A gender questionnaire was also distributed to key stakeholders in Nigeria to assess the main barriers/constraints for inclusive participation in the country. The survey examined a number of key gender issues, including *inter alia* access to credit, access to education and information, entrepreneurial and income-generating activities for women (including productive use of energy), representation of women in leadership positions in business and government.

➤ **Gender Questionnaire**

The following questionnaire was administered to key stakeholders in each country. Respondents were asked to reply Yes/No to each question and elaborate as needed.

HOUSEHOLD

Are women generally involved in influencing decisions on household energy use/services?

Are off-grid solar solutions (E.g. solar lanterns, solar home systems) largely accessible/made available to the household sector, particularly women-headed households?

Are there any related programs and initiatives (donor, government, private sector, NGO etc.) that are specifically targeting energy access for women in the household sector?

Are off-grid solar products and services generally affordable for households headed by women? If not, are Microfinance Institutions or other organizations in the country providing credit/financing (grants/loans) to the household sector, particularly women-headed households to increase energy access?

Are women aware of the health impact of unclean energy (e.g. fuel-wood for cookstoves) and the solutions (i.e. solar) to address it?

COMMUNITY/INSTITUTIONAL

Are women represented in any high-level energy sector positions? Please provide names/examples, if available, of women in senior management positions in government, committees, boards etc.

Is the mobility and safety of women constrained due to poor energy services (e.g., unavailability of streetlights due to unreliable electricity supply)?

PRODUCTIVE USE

What kind of productive use activities do women engage in and what women-led productive use activities can be supported by off-grid solar solutions?

- Agriculture (irrigation, water pumping etc.)
- Shops (retail, artisanal/handicrafts, grocery, salons etc.)
- Restaurants (bar, cafe etc.)
- Kiosks (e.g. mobile money etc.)
- Tourism
- Other

SUPPLIER

Please describe the level of engagement that women have in in the off-grid energy services sector. Are women highly employed in this area (e.g. is there data collected on the number of women-owned businesses/SMEs)?

Are there any related programs and initiatives (donor, government, private sector, NGO etc.) that provide training for women to manage or be employed by energy-related enterprises?

ADDITIONAL

What are the main barriers women face to access information?

What are the main barriers/constraints for women entrepreneurs to have access to credit?

Do women have equal access to capacity building and training services (e.g. vocational training/technical education) or do they experience discrimination in access to these services?

What policy, regulatory and institutional framework(s) exist, if any, to address gender mainstreaming⁴⁰⁸ (e.g. national gender action plans/related policies etc.)?

Are gender-related issues taken into consideration in energy policy provisions and/or are energy-related issues reflected in gender policies (e.g. existence of ‘gender units’ within public sector agencies and/or ‘gender audits’ in energy sector)?

2. Gender Profile

2.1 The State of Gender Equality in Nigeria

Structural inequalities and gender discrimination against women and girls persist in Nigeria, as inclusive participation remains an ongoing challenge. Nigeria is a multi-ethnic and culturally diverse society; women’s social role differs according to religious and customary factors. However, Nigeria is a highly patriarchal society, as women tend to have a less prominent role at the community and household levels. The gender assessment found that while there have been improvements in recent years to certain social indicators such as access to primary education as well as healthcare, gender disparities still exist across the economy, particularly in access to resources, higher education, land ownership, inheritance systems, political power and decision-making.

2.2 Gender and Poverty

With about 190 million inhabitants, Nigeria accounts for nearly half of West Africa’s population and has one of the largest populations of youth in the world. Inequality in terms of income and opportunities has been growing rapidly and has adversely affected the Government’s efforts to reduce poverty, as many Nigerians still lack access to basic services. In fact, Nigeria has the largest number of people living in extreme poverty in the world (86.9 million people).⁴⁰⁹ As Nigeria faces a major population boom – it will become the world’s third largest country by 2050 – this problem will likely worsen.⁴¹⁰ A lack of job opportunities is at the core of the country’s high poverty levels, of regional inequality, and of social and political unrest.⁴¹¹ An estimated 71.7 % of the labor force is considered working poor at PPP \$3.10/day.⁴¹²

2.3 Gender, Human Capital and Economic Empowerment

2.3.1 Education, Skills Development and Training

⁴⁰⁸ **Gender mainstreaming:** The process of ensuring that women and men have equal access to and control over resources, development benefits and decision-making, at all stages of development process, projects, programs or policy.

⁴⁰⁹ Kazeem, Y., “Nigeria has become the poverty capital of the world,” Quartz Africa, (June 25, 2018): <https://qz.com/africa/1313380/nigerias-has-the-highest-rate-of-extreme-poverty-globally/>

⁴¹⁰ Ibid.

⁴¹¹ “Nigeria Overview,” World Bank: <https://www.worldbank.org/en/country/nigeria/overview>

⁴¹² “UN Human Development Indicators: Nigeria,” UN Development Programme, (2018): <http://hdr.undp.org/en/countries/profiles/NGA>

Nigeria remains among the lowest ranked countries in the world in a wide range of UN Human Development Indicators.⁴¹³ Nigeria's education system faces enormous pressures, as the country accounts for nearly 20% of the total out-of-school children population in the world. In northern Nigeria, almost two-thirds of students are functionally illiterate. The states of Jigawa, Kaduna, Katsina, Kano, and Sokoto have shown commitment to improving their education systems, but still face severe challenges including high poverty levels, low enrollment, gender disparities, poor quality, infrastructure and learning conditions.⁴¹⁴ Only about half of adults are literate,⁴¹⁵ while female access to higher levels of education in the country remains lower compared to men (**Figure 12** and **Figure 13**). These issues are worse in rural areas, particularly in northern Nigeria.

At the level of junior and senior secondary schools, efforts are underway by the Federal and State Governments to improve the quality of technical education beginning with increased admission of student teachers at the tertiary level to study technical subjects. The FGN established a total of 46 Federal Universities apart from 40 state and 61 private universities in the country – 15 of the state universities are specifically designated for Science and Technology. There are also vocational and technical schools, called Polytechnics and Mono-technics, but the number of these schools, both public and private is not sufficient.

2.3.2 Fertility Rates and Reproductive Health

Nigeria has one of the highest fertility rates in the world. As of 2017, the fertility rate in Nigeria remained extremely high, at 5.8 children per woman. Healthcare and general living conditions in Nigeria are poor, especially for women and children. Women's reproductive roles continue to expose them to more health risks compared to men as the medical services available for women before and after birth are insufficient. Nigeria's maternal and infant mortality rates are among the highest in the world, as female access to quality health care is limited, particularly in rural areas. As of 2018, 27.6% of women had an unmet need for family planning.⁴¹⁶

2.3.3 Participation and Decision-Making

Socio-cultural perspectives in Nigeria remain male-dominated, as conventional gender roles continue to hold women back. This is reflected in household decision-making, which often plays a role in restricting the rights and empowerment of women, as well as in rates of female representation in the leadership positions in business and government. In 2017, female participation in the labor market was 50.4% compared to 59.8% for men.⁴¹⁷ As of 2018, women hold only 5.8 % of the country's seats in parliament.⁴¹⁸

2.4 Gender Policy, Institutional and Legal Framework in Nigeria

2.4.1 Gender Mainstreaming initiatives by the Government

Gender equality has become a priority in many of Nigeria's development plans in recent years. The FGN has adopted gender mainstreaming as a policy measure to improve gender equality and address poverty reduction, economic growth, and sustainable development.

⁴¹³ "Human Development Indices and Indicators: 2018 Statistical Update," UN Development Programme, (2018): http://hdr.undp.org/sites/default/files/2018_human_development_statistical_update.pdf

⁴¹⁴ "Education in Nigeria," Global Partnership for Education: <https://www.globalpartnership.org/country/nigeria>

⁴¹⁵ Human Development Indices and Indicators: 2018 Statistical Update," UN Development Programme, (2018): http://hdr.undp.org/sites/default/files/2018_human_development_statistical_update.pdf

⁴¹⁶ Ibid.

⁴¹⁷ Ibid.

⁴¹⁸ "UN Human Development Indicators: Nigeria," UN Development Programme, (2018): <http://hdr.undp.org/en/countries/profiles/NGA>

The Government’s policy framework to promote gender equality and women’s empowerment is guided mainly by its 2006 National Gender Policy, which focuses on the empowerment of women through reforms to education policy at the federal and provincial level. The FGN, through the Department of Women’s Affairs of Federal Ministry of Women Affairs and Social Development (FMWA), coordinates the implementation of the National Gender Policy through a National Gender Resource Centre, which aims to implement a Women Development Center (WDC) in each state.

The ECOWAS Policy for Gender Mainstreaming in Energy Access is another initiative adopted by the GoN that is committed to promoting favorable policies and frameworks and mobilizing resources to more fully engage women in all areas of energy access.⁴¹⁹ The regional policy aims to achieve this by securing the local support of a gender focal point in government to integrate gender into energy policies and by conducting gender audits of the sector.

2.4.2 Gaps in the Gender Policy/Legal Framework

Despite the Government’s policy initiatives and legislative reforms, gender inequality remains an ongoing challenge across the country’s political, economic and socio-cultural landscape, as women still face many barriers to inclusive participation. Access to education and information remains the most significant barrier for women across the country. Overall, Nigeria performs poorly in the UNDP Gender Inequality Index.⁴²⁰

While the country’s 1999 constitution guarantees gender equality and freedom of discrimination on the basis of social or economic status, customary and religious laws continue to restrict women’s rights and curtail their decision-making. Nigeria has a tripartite legal system consisting of statutory, customary, as well as, in the northern states, sharia laws. The three bodies of law create contradictions and inconsistencies and discriminatory provisions are widespread within each source of law particularly in the areas of family and property law.

2.5 Summary of Recommendations

Given the increased attention that gender inclusion has received in development planning, there are a number of tools that are now available to policymakers that can be utilized to support gender mainstreaming and encourage women’s participation in the energy sector. Despite encouraging progress in the discourse on gender and energy access, substantial efforts are still needed, especially in enabling women’s participation in the sector in different roles, including as energy entrepreneurs and in leadership positions.⁴²¹

In seeking solutions to improve women’s engagement in energy access, a 2018 IRENA survey found that access to necessary technical, business or leadership skills development programs was the single most important measure that could be taken. Over half of survey respondents also highlighted the need to integrate gender perspectives in energy access programs as well as enhanced access to finance.⁴²²

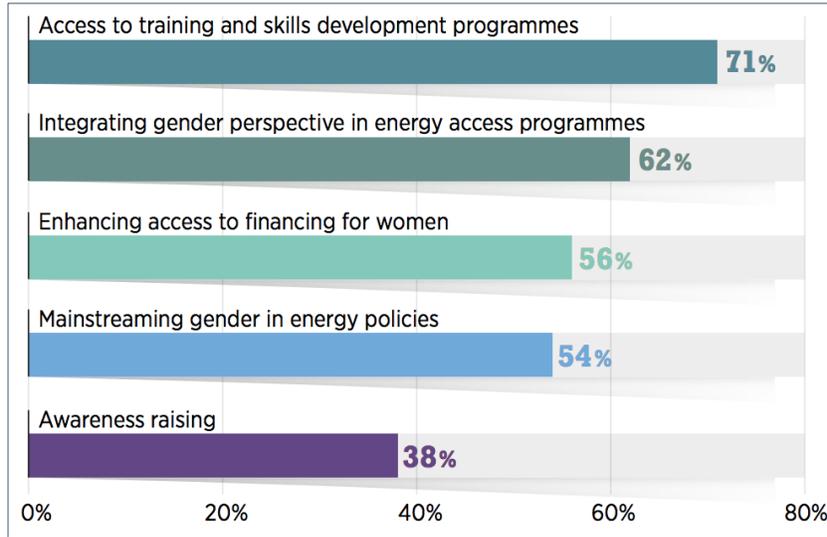
⁴¹⁹ “Situation Analysis of Energy and Gender Issues in ECOWAS Member States,” ECREEE, National Energy Laboratory, (2015): <https://www.seforall.org/sites/default/files/Situation-Analysis-of-Energy-and-Gender-Issues.pdf>

⁴²⁰ “Gender Inequality Index,” UNDP, (2015): <http://hdr.undp.org/en/composite/GII>

⁴²¹ “Renewable Energy: A Gender Perspective,” International Renewable Energy Agency, (2019): https://irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_Gender_perspective_2019.pdf

⁴²² Ibid.

Measures to Improve Women’s Engagement in Energy Access



Source: International Renewable Energy Agency

In addition to the measures highlighted in the figure above, below is a list of additional policy recommendations that could further improve gender equality in Nigeria’s energy sector:⁴²³

- Take measures to close the gender gap in access to education, particularly in higher levels of education
- Implement a quota system to increase the number of women employed in government’s energy ministry and ensure that women are part of decision-making processes in the energy sector
- Implement policy and budgetary measures to support programs that aim to raise awareness and promote opportunities for women as energy customers, suppliers, financiers, and educators
- Commission studies to collect, synthesize and publish gender-specific/sex-disaggregated data on women’s energy access and usage to inform (i) public policy development to improve rates of access for women; and (ii) private sector on potential customer needs (e.g. clean cooking technologies, productive use of energy applications etc.)
- Undertake a “gender audit” of the energy sector and develop a gender action plan to inform long-term policy objectives targeting gaps in the existing framework and promoting inclusive participation (e.g. by adding gender categories to policies and projects and accounting for gender impacts in strategic planning).
- Establish a Gender Focal Point or Unit within key national (i.e. REA) and local institutions in order to administer targeted gender policies and programs
- Raise awareness / provide training and technical support to private sector businesses / SMEs on (i) the benefits of gender inclusion and in viewing business decisions through a gender lens; (ii) the value of gender-disaggregated data; and (iii) how to develop and implement gender strategies to encourage inclusive participation.⁴²⁴

⁴²³ **NOTE:** This is not an exhaustive list of recommendations as it is only intended to address inclusive participation in the energy sector; there are many gender-related challenges that warrant further study and attention within the context of the country’s complex economic and social structures that are beyond the scope of this analysis

⁴²⁴ “ECOWAS-CTCN Project on Mainstreaming Gender for a Climate Resilient Energy System in ECOWAS Countries: Final Report,” ECREEE and CTCN, (May 2018): https://www.ctc-n.org/system/files/dossier/3b/180627_final_report-uk.pdf



GreenMax Senior Consultant, Segun Adaju (above, fourth from left) with ROGEP focus group participants in Abuja (above) and Lagos (below) in July 2018.





GreenMax Senior Consultant, Segun Adaju (first row, fourth from left) with ROGEP focus group participants in Port Harcourt in July 2018.

REFERENCES

- Acumen, 2018, "Accelerating Energy Access: The Role of Patient Capital," <https://acumen.org/wp-content/uploads/Accelerating-Access-Role-of-Patient-Capital-Report.pdf>
- Adam Smith International, "Designing Solar Markets in Northern Nigeria," <http://www.adamsmithinternational.com/explore-our-work/west-africa/nigeria/designing-solar-markets-in-northern-nigeria/>
- Adeleke, A., Central Bank of Nigeria, 2014, "The Informal Financial Markets in Nigeria," <https://www.cbn.gov.ng/out/2016/mpd/understanding%20monetary%20policy%20series%20no%2043.pdf>
- Adepetun, A., The Guardian, 2018, "Nigeria's mobile phone penetration hits 84 percent," <https://guardian.ng/business-services/nigerias-mobile-phone-penetration-hits-84-per-cent/>
- AFD, 2018, "AFD supports the Nigerian banking sector with SUNREF," <https://www.sunref.org/wp-content/uploads/2018/07/Press-Release-SUNREF-Nigeria.pdf>
- Africa Renewable Energy Cooperation Programme, "Nigeria Energy Sector," <https://www.africa-eu-renewables.org/market-information/nigeria/energy-sector/>
- Africa-EU Energy Partnership, 2016, "Mapping of Energy Initiatives and Programs in Africa," http://www.euei-pdf.org/sites/default/files/field_publication_file/annex_5_aEEP_mapping_of_energy_initiatives_overview_of_initiatives_0.pdf
- African Development Bank Group, 2011-2015, "Central Africa Regional Integration Strategy Paper," <https://www.afdb.org/fileadmin/uploads/afdb/Documents/Policy-Documents/RISP%20CENTRAL%20AFRICA-ECCAS%20English%20FINAL.pdf>
- African Development Bank Group, 2018, "African Development Bank, Nordic Development Fund, Global Environment Facility and Calvert Impact Capital partner in \$55 million investment into Off-Grid Energy Access Fund," <https://www.afdb.org/en/news-and-events/african-development-bank-nordic-development-fund-global-environment-facility-and-calvert-impact-capital-partner-in-us-55-million-investment-into-off-grid-energy-access-fund-17743/>;
- African Development Bank Group, 2018, "Nigeria Electrification Project," <https://www.afdb.org/en/projects-and-operations/project-portfolio/p-ng-f00-020/>
- African Development Bank Group, 2018, "The New Deal on Energy for Africa: A transformative partnership to light up and power Africa by 2025," https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Brochure_New_Deal_2-En.pdf
- African Development Bank Group, Energy Policy, Regulation and Statistics Division, 2018, "Electricity Tariffs in ECOWAS Region," http://www.ecowrex.org/sites/default/files/pesr1_-_energy_statistics_bulletin_september_2018.pdf
- African Economic Outlook, African Development Bank, 2018, "Nigeria Economic Outlook," <https://www.afdb.org/en/countries/west-africa/nigeria/nigeria-economic-outlook/>
- Agunbiade, Y., Information Nigeria, 2016, "UNDO, Bol Sign \$2M Agreement on Solar Power to Nigerian Communities," <http://www.informationng.com/2016/09/undp-boi-sign-2m-agreement-solar-power-nigerian-communities.html>

Akin-Fadeyi, T., 2016, "Enhancing Financial Inclusion for Women in Nigeria," Consultative Group to Assist the Poor (CGAP), <http://www.cgap.org/blog/enhancing-financial-inclusion-women-nigeria>

Akwaja, C., Leadership.NG, 2018, "NCC, CBN Sign MoU on Mobile Money, Financial Inclusion," <https://leadership.ng/2018/04/11/ncc-cbn-sign-mou-on-mobile-money-financial-inclusion/>

allAfrica, 2018, "Nigeria, Power for All, USAID, Others Set Up Taskforce On Clean Energy," <https://allafrica.com/stories/201802210890.html>

Adu, E. and MacInnis, L., International Finance Corporation, 2016, "IFC and DFID Partner to Improve Access to Electricity for More Small and Medium Enterprises," <https://ifcextapps.ifc.org/ifcext%5Cpressroom%5Cifcpressroom.nsf%5C0%5CFAFC8787A21A8F5F852580340032A44F>

Bavier, J., 2018, "Off-grid power pioneers pour into West Africa," Reuters, <https://www.reuters.com/article/us-africa-power-insight/off-grid-power-pioneers-pour-into-west-africa-idUSKCN1G41PE>

Blimpo, M., and Cosgrove-Davies, M., 2019, "Electricity Access in Sub-Saharan Africa: Uptake Reliability and Complementary Factors for Economic Impact," AFD and World Bank, <https://openknowledge.worldbank.org/bitstream/handle/10986/31333/9781464813610.pdf?sequence=6&isAllowed=y>

Bloomberg New Energy Finance, 2016, "How can Pay-As-You-Go Solar Be Financed?" https://www.bbhub.io/bnef/sites/4/2016/10/BNEF_WP_2016_10_07-Pay-as-you-go-solar.pdf

Capital Markets Africa, 2017, "India Exim Bank's \$100 Million Funds Nigeria Power Projects," <https://www.capitalmarketsinafrica.com/india-exim-banks-100-million-funds-nigeria-power-projects/>

Central Bank of Nigeria, Monetary Policy Department, "The Nigerian Financial System at a Glance," <https://www.cbn.gov.ng/Out/2017/CCD/THE%20NIGERIAN%20FINANCIAL%20SYSTEM.pdf>

Central Bank of Nigeria, "Regulatory Framework for Mobile Money Services in Nigeria," <https://www.cbn.gov.ng/out/2015/bpsd/regulatory%20framework%20for%20mobile%20money%20services%20in%20nigeria.pdf>

Central Bank of Nigeria, 2015, "CBN Annual Report – 2015," <https://www.cbn.gov.ng/out/2016/rsd/central%20bank%20of%20nigeria%20annual%20economic%20report%20-%20draft.pdf>

Central Bank of Nigeria, 2017, "CBN Economic Report for the First Half of 2017," <https://www.cbn.gov.ng/Out/2018/RSD/half%20year%202017%20innerx.pdf>

Central Bank of Nigeria 2017, "CBN Economic Report: Fourth Quarter 2017," <https://www.cbn.gov.ng/Out/2018/RSD/CBN%20ECONOMIC%20REPORT%20FOURTH%20QUARTER%20%20%20%202017%20Published.pdf>

Central Bank of Nigeria, 2017, "Financial Stability Report," <https://www.cbn.gov.ng/Out/2018/FPRD/FSR%20June%202017.pdf>

Chima, O. and Francis, N., This Day, 2018, "Nigeria Economy Still Vulnerable to Oil Shocks, Says IMF," <https://www.thisdaylive.com/index.php/2018/07/14/nigerias-economy-still-vulnerable-to-oil-shocks-says-imf/>

Climatescope, 2017, "Nigeria mini-grid regulation," Bloomberg New Energy Finance, <http://global-climatescope.org/en/policies/#/policy/5319>

Commercial Solicitors, 2017, "Review of the Collateral Registry Act and Prospects for Credit Access Expansion in Nigeria," Detail https://www.detailsolicitors.com/media/archive1/newsletters/August_2017_Newsletter002.pdf

Dahlberg Advisors, Lighting Global, GOGLA and World Bank ESMAP, 2018, "Off-Grid Solar Market Trends Report 2018," https://www.lightingafrica.org/wp-content/uploads/2018/02/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf

Dahlberg Advisors, 2017, "Improving Access to Electricity Through Decentralized Renewable Energy," <https://www.dalberg.com/system/files/2017-08/off-grid%20policy.pdf>

Demircuc-Kunt, A., Klapper, L., Singer, D., Ansar, S., and Hess, J., 2018, "The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution," World Bank, Washington, DC. <http://documents.worldbank.org/curated/en/332881525873182837/pdf/126033-PUB-PUBLIC-pubdate-4-19-2018.pdf>

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), 2015, "The Nigerian Energy Sector," <https://www.giz.de/en/downloads/giz2015-en-nigerian-energy-sector.pdf>

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), 2016, "Photovoltaics for Productive Use Applications: A Catalogue of DC-Appliances," https://www.sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/GIZ__2016__Catalogue_PV_Appliances_for_Micro_Enterprises_low.pdf

ECOWAS Center for Renewable Energy and Energy Efficiency and National Renewable Energy Laboratory, 2015, "Situation Analysis of Energy and Gender Issues in ECOWAS Member States," <https://www.seforall.org/sites/default/files/Situation-Analysis-of-Energy-and-Gender-Issues.pdf>

Energy 4 Impact and USAID-NREL, 2018, "Productive Use of Energy in African Micro-Grids: Technical and Business Considerations," <https://www.nrel.gov/docs/fy18osti/71663.pdf>

Energy Sector Management Assistance Program, 2017, "Upscaling mini-grids for low-cost & timely access to electricity," <http://documents.worldbank.org/curated/en/851271512391124096/pdf/121831-ESM-Nigeriabriefingbookv-PUBLIC.pdf>

Enhancing Financial Inclusion and Access, 2016, "Access to Financial Services in Nigeria Survey,"

ESI Africa, 2018, "Feasibility study promotes women's participation in energy transition," <https://www.esi-africa.com/feasibility-study-promotes-womens-participation-in-energy-transition/>

ESI-Africa, 2018, "Nigeria: Electricity Tariffs Correlate with Metering of Consumers"

ESI-Africa, 2018, "Nigeria to begin electricity trading with neighboring countries," <https://www.esi-africa.com/nigeria-to-begin-electricity-trading-to-other-neighbouring-countries/>

ESI Africa, 2019, "Partnership to bring solar power to millions of Nigerians," <https://www.esi-africa.com/partnership-to-bring-solar-power-to-millions-of-nigerians/>

European Investment Bank, 2018, “Le secteur bancaire en Afrique De l’inclusion financière à la stabilité financière,” https://www.eib.org/attachments/efs/economic_report_banking_africa_2018_fr.pdf

European Union Energy Initiative Partnership Dialogue Facility (EUEI PDF) and GIZ, 2011, “Productive Use of Energy – A Manual for Electrification Practitioners,” <https://www.giz.de/fachexpertise/downloads/giz-eueipdf-en-productive-use-manual.pdf>

European Union, 2016, “Action Document for Energy Sector Support to Nigeria,” https://ec.europa.eu/europeaid/sites/devco/files/ad-4-3-aap-nigeria-2016_en.pdf

Export.gov, “Nigeria Market Challenges,” <https://www.export.gov/article?id=Nigeria-Market-Challenges>

Famoofo, B., 2018, “Collaborating for Financial Inclusion,” This Day, <https://www.thisdaylive.com/index.php/2018/04/15/collaborating-for-financial-inclusion/>

Food and Agriculture Organization of the United Nations, “Family Farming Knowledge Platform, Smallholders DataPortrait,” <http://www.fao.org/family-farming/data-sources/dataportrait/farm-size/en/>

Federal Government of Nigeria, (2009), “Vision 20: 2020”, <http://www.nationalplanning.gov.ng/images/docs/NationalPlans/nigeria-vision-20-20-20.pdf>

Federal Ministry of Power, Works and Housing, Government of Nigeria, 2016, “Rural Electrification Strategy and Implementation Plan (RESIP),” <http://rea.gov.ng/inc/uploads/2017/09/RESIP.pdf>

Financial Nigeria, 2016, “UBA, U.S. Exim Bank sign agreement to facilitate trade,” <http://www.financialnigeria.com/uba-u-s-exim-bank-sign-agreement-to-facilitate-trade-news-592.html>

Financial Nigeria, 2017, “Afrexim bank’s trade and project financing in Nigeria reaches \$35 billion,” <http://www.financialnigeria.com/afreximbank-s-trade-and-project-financing-in-nigeria-reaches-35-billion-sustainable-photovideo-details-830.html>

Financial Nigeria, 2017, “Bol announces N1 billion solar energy fund for small businesses,” <http://www.nigeriaenergyfuture.org/finance/11-energy-finance/54-accessing-boi-s-1-billion-Naira-solar-fund-for-msmes>

Focus Economics, 2018, “Inflation in Nigeria,” <https://www.focus-economics.com/country-indicator/nigeria/inflation>

Foster, V., and Steinbuks, J., 2009, “Paying the Price for Unreliable Power Supplies: In-House Generation of Electricity by Firms in Africa,” World Bank Policy Research Working Paper, <https://openknowledge.worldbank.org/handle/10986/4116>

Global Impact Investing Network and Dahlberg, 2015, “The Landscape for Impact Investing in West Africa: Understanding the Current Status, Trends, Opportunities and Challenges,” https://thegiin.org/assets/upload/West%20Africa/RegionalOverview_westafrika.pdf

Global Off-Grid Lighting Association, Lighting Global and World Bank, 2016, "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data (January-June 2016),"

https://www.gogla.org/sites/default/files/recource_docs/global_off-grid_solar_market_report_jan-june_2016_public.pdf

Global Off-Grid Lighting Association, Lighting Global and World Bank, 2016, "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data (July-December 2016),"

https://www.gogla.org/sites/default/files/recource_docs/final_sales-and-impact-report_h22016_full_public.pdf

Global Off-Grid Lighting Association, Lighting Global and World Bank, 2017, "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data (January-June 2017),"

https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth12017_def.pdf

Global Off-Grid Lighting Association, Lighting Global and World Bank, 2017, "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data (July-December 2017),"

https://www.gogla.org/sites/default/files/resource_docs/gogla_sales-and-impact-reporth2-2017_def20180424_web_opt.pdf

Global Off-Grid Lighting Association, Lighting Global and World Bank, 2018, "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data (January-June 2018),"

https://www.gogla.org/sites/default/files/resource_docs/global_off-grid_solar_market_report_h1_2018-opt.pdf

Grimm, M., Harwig, R., Lay, J., 2012, "How much does Utility Access matter for the Performance of Micro and Small Enterprises?" World Bank http://siteresources.worldbank.org/INTLM/Resources/390041-1212776476091/5078455-1398787692813/9552655-1398787856039/Grimm-Hartwig-Lay-How_Much_Does_Utility_Access_Matter_for_the_Performance_of_MSE.pdf

http://siteresources.worldbank.org/INTLM/Resources/390041-1212776476091/5078455-1398787692813/9552655-1398787856039/Grimm-Hartwig-Lay-How_Much_Does_Utility_Access_Matter_for_the_Performance_of_MSE.pdf

GSMA Intelligence, 2018, "The Mobile Economy: West Africa 2018,"

<https://www.gsmaintelligence.com/research/?file=e568fe9e710ec776d82c04e9f6760adb&download>

IndexMundi, "Power outages in firms in a typical month (number) – Africa,"

<https://www.indexmundi.com/facts/indicators/ic.elc.outg/map/africa>

Innogen Consulting, 2018, "État de lieux du marché des kits solaires en Afrique: acteurs, marchés, investissements, produits et tendances," <https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/Etat-Des-Lieux-Du-PayGo-Solaire-en-Afrique.pdf>

International Energy Agency, 2017, "Energy Access Outlook, 2017: From Poverty to Prosperity,"

https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf

International Finance Corporation, 2016, "Market Study for Promoting Energy Efficiency and Renewable Energy Investments in Nigeria through Financial Institutions: Summary Report on Solar PV Supply Chain Survey,"

International Finance Corporation, 2017, "MSME Finance Gap," <https://finances.worldbank.org/Other/MSME-Finance-Gap/ijmu-5v4p/data>

International Finance Corporation, 2018, "Lighting Africa Nigeria: A program designed to impact 6 million people,"

<https://www.lightingafrica.org/country/nigeria/>

International Finance Corporation, 2018, "Unlocking Private Investment: A Roadmap to achieve Côte d'Ivoire's 42 percent renewable energy target by 2030," https://www.ifc.org/wps/wcm/connect/25885390-8a37-464f-bfc3-9e34aad01b4/IFC-Côte_dIvoire-report-v11-FINAL.PDF?MOD=AJPERES

International Renewable Energy Agency, 2018, "Empowering Women in Nigeria with Solar Energy," <https://irena.org/newsroom/articles/2018/Feb/Empowering-Women-in-Nigeria-with-Solar-Energy>

International Renewable Energy Agency, 2019, "Renewable Energy: A Gender Perspective," https://irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_Gender_perspective_2019.pdf

Itsibor, M., AllAfrica, 2018, "Nigeria: World Bank Approves Projects to Support Nigeria's Access to Electricity," Japan International Cooperation Agency, "Country Gender Profile Nigeria Final Report," www.jica.go.jp/.../gender/background/pdf/e10nig.pdf

Kareem, T., Leadership.NG, 2018, "Bank of Industry: Nigeria's Game Changer in Boosting Small Business," <https://leadership.ng/2018/07/24/boi-nigerias-game-changer-in-boosting-small-business/>

Kazeem, Y., 2018, "Nigeria has become the poverty capital of the world," Quartz Africa, <https://qz.com/africa/1313380/nigerias-has-the-highest-rate-of-extreme-poverty-globally/>

Kponu, E., Medium, 2018, "Nigerian Micro-Finance Banks Start Selling Solar," <https://medium.com/power-africa/nigerian-micro-finance-banks-start-selling-solar-203638648b4b>

Lall, S., Henderson, J., and Venables, A., 2017, "Africa's Cities: Opening Doors to the World" Lighting Global, World Bank Group, 2018, "PAYG Market Attractiveness Index Report," <https://www.lightingglobal.org/wp-content/uploads/2018/11/FINAL-PAYG-MAI-2018-Report.pdf>

Lois, A., 2018, "Nigeria's Off-Grid Energy Market Acceleration Programme Comes Alive," Independent, <https://www.independent.ng/nigerias-off-grid-energy-market-acceleration-programme-comes-alive/>

National Daily, 2018, "Sterling Bank, others to supervise DBN loan disbursement," <https://nationaldailyng.com/sterling-bank-others-to-supervise-dbn-loan-disbursement/>

Nigeria Energy Regulatory Commission, 2018, "Electricity Tariff in Nigerian Electricity Supply Industry," <http://www.nercng.org/index.php/home/myto>

Nigerian Electricity Regulatory Commission, 2015, "Multi-Year Tariff Order for 2015-2018," <https://www.nigeriaelectricityhub.com/download/myto-2-1-multi-year-tariff-order-for-2015-2018/>

Oba, J., 2018, "Adopting solar-powered irrigation systems to boost agriculture in Nigeria," Blueprint Newspaper, <https://www.sun-connect-news.org/articles/business/details/adopting-solar-powered-irrigation-system-to-boost-agriculture-in-nigeria/>

Off-Grid Nigeria, 2017, "Shell's 'All-On' makes first investments in Nigeria's off-grid power market," <http://www.offgridnigeria.com/shells-all-on-makes-first-investments-nigerias-off-grid-power-market/>

Okafor, C., 2018, "All On, Others Sign a Power Act," This Day, <https://www.thisdaylive.com/index.php/2018/02/17/all-on-others-sign-power-pact/>

Power for All, 2017, "Power for All: Nigeria Call to Action," <https://static1.squarespace.com/static/532f79fae4b07e365baf1c64/t/58dbd04cbeba6b6c9330fa9d/1490800818871/Nigeria+-+Call+to+Action>

Premium Times Nigeria, 2018, "Nigerian farmers refuse to repay NGN 60 billion loan – Bank of Agriculture," <https://www.premiumtimesng.com/news/headlines/263324-nigerian-farmers-refuse-to-repay-n60-billion-loan-bank-of-agriculture.html>

Private Equity Wire, 2018, "Daystar Power and Nigerian Bank of Agriculture partner to electrify rural Nigeria," <https://www.privateequitywire.co.uk/2018/08/21/267606/daystar-power-and-nigerian-bank-agriculture-partner-electrify-rural-nigeria/>

Pulse New Agency, 2018, "Construction of transmission lines to connect Nigeria, other West African nations to commence," <https://www.pulse.ng/news/local/wapp-start-constructing-transmission-lines-to-connect-nigeria-id8207745.html>

Rewald, R., 2017, "Energy and Women and Girls: Analyzing the needs, uses, and impacts of energy on women and girls in the developing world," Oxfam, <https://www.oxfamamerica.org/static/media/files/energy-women-girls.pdf>
Rural Electrification Agency, 2017, "The Off-grid Opportunity in Nigeria," http://rea.gov.ng/inc/uploads/2017/12/REA-Presentation-Off-Grid-Opportunity_africa2017.pdf

Rural Electrification Agency, 2018, "Environmental and Social Management Framework," <http://rea.gov.ng/inc/uploads/2018/03/Draft-NEP-Environmental-and-Social-Management-Framework-ESMF-for-Consultation-March-2018-2.pdf>

Rural Electrification Agency, 2018, "The Nigeria Electrification Project," <http://rea.gov.ng/nigeria-electrification-project-nep/>

Rural Electrification Agency, 2018, "World Bank Approves \$350M for REA Off-Grid Projects," <http://rea.gov.ng/wbank-approves-350m-for-reas-solar-power-projects-in-schools-others/>

Scaling Off-Grid Energy: A Grand Challenge for Development, 2018, "Scaling Access to Energy in Africa: 20 Million Off-Grid Connections by 2030," US Agency for International Development, UK Department for International Development and Shell Foundation, https://static.globalinnovationexchange.org/s3fs-public/asset/document/SOGE%20YIR_FINAL.pdf?uwUDTyB3ghxOrV2gqvsO_r0L5OhWPZZb

Sustainable Energy for All, 2016, "Nigeria Sustainable Energy for All Country Action Agenda," https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/NIGERIA_SE4ALL_ACTION_AGENDA_FINAL.pdf

Takeshima, H., Salau, S., Adeoti, A., Okoli, S., 2010, "Economics of farmers' demand for private irrigation in Nigeria," IFPRI, http://nssp.ifpri.info/files/2010/11/final_nssppn23.pdf

The Guardian, 2017, "USADF, All On partner to invest in off-grid energy in Nigeria," <https://guardian.ng/news/usadf-all-on-partner-to-invest-in-off-grid-energy-in-nigeria/>

The Guardian, 2018, "British government moves to increase UK-Nigeria trade," <https://guardian.ng/news/british-government-moves-to-increase-uk-nigeria-trade/>

Ujah, E., Vanguard, 2018 "DBN to deploy \$1.3 billion as loans to MSMSs," <https://www.vanguardngr.com/2018/05/dbn-deploy-1-3b-loans-msmes/>

United Nations Development Programme, 2018, "Human Development Indices and Indicators: 2018 Statistical Update," http://hdr.undp.org/sites/default/files/2018_human_development_statistical_update.pdf

United Nations Development Programme, 2018, "UN Human Development Indicators: Cameroon," <http://hdr.undp.org/en/countries/profiles/SLE>

United Nations Development Programme, 2018, "UN Human Development Indicators: Nigeria," <http://hdr.undp.org/en/countries/profiles/NGA>

United Nations Development Programme and ETH Zurich, 2018, "Derisking Renewable Energy Investment: Off-Grid Electrification," [https://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Strategies/DREI%20Off-Grid%20Electrification%20-%20Full%20Report%20\(20181210\).pdf](https://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Climate%20Strategies/DREI%20Off-Grid%20Electrification%20-%20Full%20Report%20(20181210).pdf)

United Nations Development Programme and World Health Organization, 2009, "The Energy Access Situation in Developing Countries: A Review Focusing on the Least Developed Countries and Sub-Saharan Africa," <http://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Sustainable%20Energy/energy-access-situation-in-developing-countries.pdf>

United Nations Educational, Scientific and Cultural Organization Institute for Statistics, 2018, "Nigeria Participation in Education," <http://uis.unesco.org/en/country/bf?theme=education-and-literacy>

United Nations, 2017, "Household Size and Composition Around the World," http://www.un.org/en/development/desa/population/publications/pdf/ageing/household_size_and_composition_around_the_world_2017_data_booklet.pdf

UN Women, 2018, "Turning promises into action: Gender equality in the 2030 Agenda for Sustainable Development," <http://www.unwomen.org/-/media/headquarters/attachments/sections/library/publications/2018/sdg-report-fact-sheet-sub-saharan-africa-en.pdf?la=en&vs=3558>

United States Agency for International Development – Climate Economic Analysis for Development, Investment and Resilience, 2018, "Market Assessment Report on Clean Energy: Nigeria," <https://www.climatelinks.org/resources/renewable-energy-lending-west-africa>

United States Agency for International Development, 2018, "Nigeria Power Africa Fact Sheet," <https://www.usaid.gov/powerafrica/nigeria>

United States Agency for International Development – National Renewable Energy Laboratory and Energy 4 Impact, 2018, "Productive Use of Energy in African Micro-Grids: Technical and Business Considerations," https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/productive_use_of_energy_in_african_micro-grids.pdf

USAID-NREL and Energy 4 Impact, 2018, "Productive Use of Energy in African Micro-Grids: Technical and Business Considerations," https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/productive_use_of_energy_in_african_micro-grids.pdf

USAID, 2018, "Nigeria Power Africa Fact Sheet," <https://www.usaid.gov/powerafrica/nigeria>

Wass, S., Global Trade Review, 2018, "UKEF reveals first success story under bank partnership scheme," <https://www.gtreview.com/news/europe/ukef-reveals-first-success-story-under-new-bank-partnership-scheme/>

Winrock International, 2018, "The USAID Power Africa Renewable Energy and Energy Efficiency Project, 2014-2018: Resources Book," <https://www.winrock.org/wp-content/uploads/2018/02/REEEP-Resource-Book-20180222-.pdf>

World Bank, 2011, "Lessons Learned in the Development of Smallholder Private Irrigation for High Value Crops in West Africa,"

World Bank, 2014, "Diesel Power Generation: Inventories and Black Carbon Emissions in Nigeria,"
<http://documents.worldbank.org/curated/en/853381501178909924/pdf/117772-WP-PUBLIC-52p-Report-DG-Set-Study-Nigeria.pdf>

World Bank, 2016, "World Development Indicators, Population,"
<https://data.worldbank.org/indicator/SP.POP.TOTL>: <https://data.worldbank.org/indicator/SP.POP.TOTL>

World Bank, 2017, "Mini Grids in Nigeria,"
<https://openknowledge.worldbank.org/bitstream/handle/10986/29016/121827-ESM-dNigeriaMiniGridsCaseStudyConfEd-PUBLIC.pdf?sequence=1&isAllowed=y>

World Bank, 2017, "Nigeria - Power Sector Recovery Program,"
<http://documents.worldbank.org/curated/en/115731517496257028/Nigeria-Power-Sector-Recovery-Program>

World Bank, 2017, "Program for Results Information Document No.PIDC0122348: Power Sector Recovery Performance-Based Loan," <http://documents.worldbank.org/curated/en/266341497992825758/pdf/Nigeria-Power-Sector-Recovery-P4R-Concept-Stage-PID-8-3-2017.pdf>

World Bank, 2017, "Sahel Irrigation Initiative Support Project," Project Appraisal Document,
<http://documents.worldbank.org/curated/en/515131512702151121/pdf/WESTERN-AFRICA-PADnew-11142017.pdf>

World Bank, 2018, "Nigeria Electrification Project: Project Appraisal Document,"
<http://documents.worldbank.org/curated/en/367411530329645409/pdf/Nigeria-Electrification-PAD2524-06052018.pdf>

World Bank, 2018, "Policy Matters: Regulatory Indicators for Sustainable Energy,"
<http://documents.worldbank.org/curated/en/553071544206394642/pdf/132782-replacement-PUBLIC-RiseReport-HighRes.pdf>

World Bank, 2018, "Solar Mini Grids Put Nigeria on Path to Energy for All by 2030,"
<http://blogs.worldbank.org/energy/solar-mini-grids-put-nigeria-path-energy-all-2030>

World Bank Energy Sector Management Assistance Program, 2017, "Upscaling mini grids for low-cost & timely access to electricity,"
<http://documents.worldbank.org/curated/en/851271512391124096/pdf/121831-ESM-Nigeriabriefingbookv-PUBLIC.pdf>